NORTEL NETWORKS

Passport 7400, 15000, 20000

Packet Voice Gateway Technology Fundamentals

241-5701-780

Passport 7400, 15000, 20000

Packet Voice Gateway Technology Fundamentals

Publication: 241-5701-780
Document status: Standard
Document version: 5.2S3
Document date: March 2004

Printed in Canada

Publication history

March 2004

5.2S3 Standard
General availability. Contains information on Passport 7400, Passport 15000, and Passport 20000 for the PCR5.2 release.

Contents

List of figures

List of tables

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 packet voice gateway (PVG) on Passport.

How this guide is organized

The 241-5701-780 *Passport 7400, 15000, 20000 Packet Voice Gateway Technology Fundamentals* is organized as follows:

- "Introduction to Passport Packet Voice Gateway" (page 27) provides an overview of Passport PVG for non-switched PVG using ATM, switched PVG using ATM, and switched PVG using IP.
- "Non-switched PVG using ATM functionality" (page 37) provides an overview of the non-switched PVG feature.
- "Switched PVG using ATM functionality" (page 51) provides an overview of the switched PVG using ATM feature.
- "Switched PVG using IP functionality" (page 63) provides an overview of the switched PVG using IP feature.
- "Switched PVG using ATM or IP functionality" (page 79) provides an overview of functionality that is common to both switched PVG using ATM and switched PVG using IP.

- “ATM connections for PVG” (page 105) describes how PVG can use the various types of ATM connections.
- “Installing and setting up PVG” (page 127) provides prerequisites to set up the ATM and time division multiplexing (TDM) interfaces and link them to create a voice gateway.
- “Traffic management for PVG” (page 135) contains guidelines for configuring ATM traffic management parameters for PVG.
- “Fault management for PVG” (page 149) contains information about troubleshooting NSTA (the software component of PVG), including how to fix specific problems.

What’s new in this document

The following features were added to this document:

- “H.248 Carrier Grade” (page 18)
- “PVG: VrAp Carrier Grade” (page 18)
- “Voice Services Processor 3 with Optical TDM Interface (2pOc3ChSmIrVsp3)” (page 19)

H.248 Carrier Grade

The following sections were updated for this feature:

- “PVG carrier grade” (page 98)

PVG: VrAp Carrier Grade

The following sections were updated for this feature:

- “Media gateway controller connections for switched PVG using ATM” (page 59)
- “AAL5 VCC configuration for call control connections” (page 59)
- “VoIP using ATM transport and VR” (page 66)
- “VoIP using Ethernet transport and VR” (page 67)
- “VoIP using Ethernet transport and VR on Passport 7400 and Passport 15000-VSS” (page 67)

- “VoIP using Ethernet transport and VR on Passport 15000-VSS” (page 69)
- “RTP, UDP, IP and ICMP support” (page 74)
- “PVG carrier grade” (page 98)
- “Hot CPSO” (page 99)
- “Hitless equipment protection (HEP)” (page 100)
- “VSP2 and VSP3 HEP for switched PVG with VR interworking” (page 100)
- “Hitless software migration (HSM)” (page 101)
- “VSP2 and VSP3 HSM for switched PVG with VR interworking” (page 102)
- “Voice-band connection admission control” (page 145)

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

The following sections were updated for this feature:

- “Introduction to Passport Packet Voice Gateway” (page 27)
- “PVG requirements” (page 28)
- “Echo cancellation” (page 30)
- “Fax and modem calls” (page 33)
- “Considerations for G.729 Annex A and B voice encoding” (page 34)
- “Data calls” (page 35)
- “G.729 Annex A and B voice call compression” (page 55)
- “Supported packet features using VSP2/VSP3/VSP3-o and ATM functionality” (page 56)
- “Switched ATM-to-TDM gateway” (page 56)
- “Signaling between the narrowband network and PVG for switched PVG using ATM” (page 57)
- “Local traffic switching for switched PVG using ATM” (page 57)

- “Definition of supported tones for the United States” (page 248)

What you need to know

In order to understand and configure PVG on Passport, you need a basic understanding of the following areas:

- Passport hardware, including installation and maintenance procedures
- Passport operations and maintenance procedures, including how to configure a node
- Passport 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
  Passport 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 241-5701-060 *Passport 7400, 15000, 20000 Components*. 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 24) or “Provisioning mode” (page 24).

- 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 25).

Operational mode

Procedures contained within this document can either be performed in operational mode or provisioning mode. When you initially log into a Passport node, you are in operational mode. Passport 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. Passport 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 25).

For information on operational and provisionable attributes, see 241-5701-060 *Passport 7400, 15000, 20000 Components*.

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 Passport node to fail. See 241-5701-050 *Passport 7400, 15000, 20000 Commands*, 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.

- 241-7401-240 *Passport 7400 Hardware Installation, Maintenance and Upgrade*
- 241-5701-615 *Passport 7400, 15000, 20000 FP Configuration Reference*
- 241-5701-600 *Passport 7400, 15000, 20000 Configuration Guide*
- 241-1501-210 *Passport 15000, 20000 Hardware Installation Guide*
- 241-5701-700 *Passport 7400, 15000, 20000 ATM Overview*
- *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 Passport Packet Voice Gateway

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

For more information about Passport PVG functionality, see the following sections:

- “Non-switched PVG using ATM functionality” (page 37)
- “Switched PVG using ATM functionality” (page 51)
- “Switched PVG using IP functionality” (page 63)
- “Switched PVG using ATM or IP functionality” (page 79)

For more information about Passport PVG requirements, see the section “PVG requirements” (page 28).

PVG supports the following types of calls:

- “Voice calls” (page 28)
- “Fax and modem calls” (page 33)
- “Data calls” (page 35)

PVG requirements

To support Passport PVG, you must install a Passport switch that includes 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
- Passport base software
- Passport networking software
- ATM networking (ATM core) software
- PVG software

Note: Passport PVG supports the automatic interoperation with T1 or E1 trunks on the TDM side. PVG automatically selects the companding standard as mu-law for T1 trunks or A-law for E1 trunks.

For more information about Passport hardware, see 241-5701-615 *Passport 7400, 15000, 20000 FP Configuration Reference*. For more information about Passport software, see 241-5701-270 *Passport 7400, 15000, 20000 Software Installation Guide* and 241-5701-272 *Passport 7400, 15000, 20000 Software Upgrade*.

Voice calls

PVG provides various services for voice calls, including:

- “Silence suppression” (page 29)
- “Echo cancellation” (page 30)
- “Packet delay variation and the de-jitter buffer” (page 32)
- “Non-switched PVG using ATM services for voice calls” (page 40)
- “Switched PVG using ATM services for voice calls” (page 54)
- “VoIP services for voice calls” (page 74)

- “Switched PVG using ATM or IP services for voice calls” (page 79)

Silence suppression

Speech in telephone conversations contains many periods of silence. To save bandwidth, PVG 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.

PVG 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.

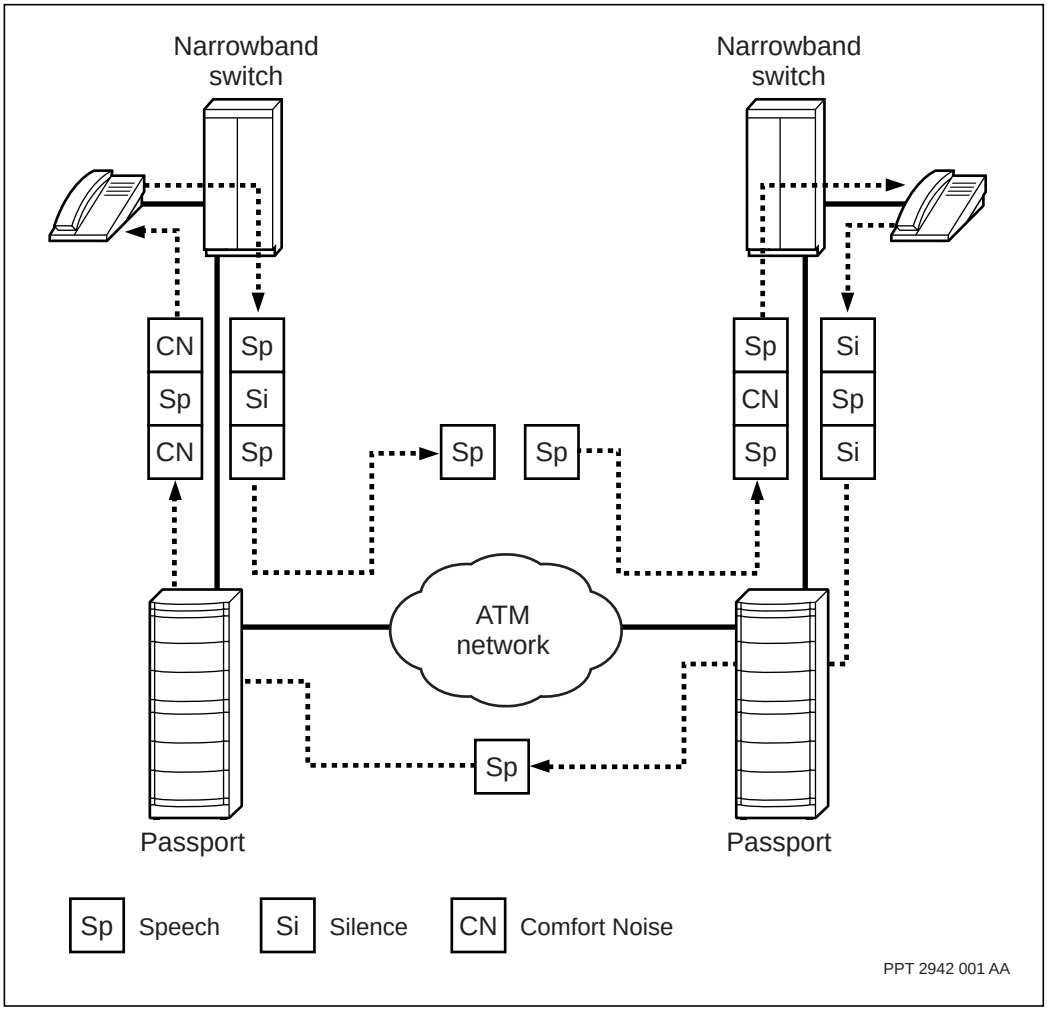
The speech activity detection (SAD) mechanism dynamically tracks the background noise and sets the speech detection threshold relative to this noise. The purpose of this mechanism is to minimize the audibility of silence suppression. The level of comfort noise matches the background noise level to within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

The figure “Silence suppression and comfort noise generation” (page 30) shows the process of replacing silence with comfort noise.

PVG uses the following methods to prevent speech clipping:

- PVG 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.
- PVG 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, PVG 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 PVG” (page 32) shows the typical sources of echo.

Passport cancels 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.

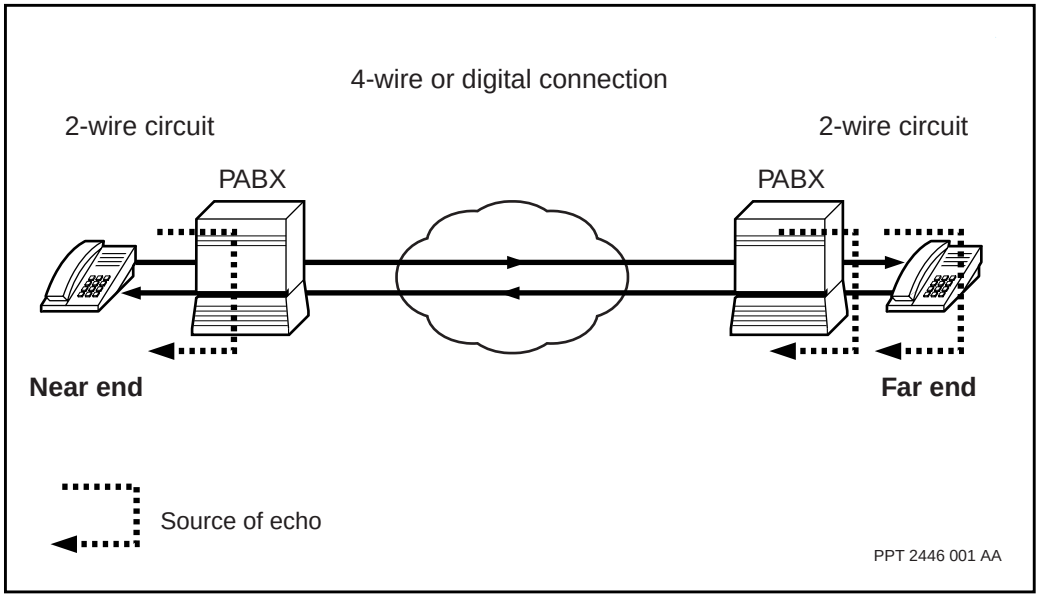
To successfully cancel echo in a system requires a network loss plan. A network loss plan specifies the signal levels throughout a network to which a network conforms. PVG provides default settings for echo cancellation (egress and ingress gain control) to satisfy standard North American networks. However,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

PVG can support four lengths of tail delay for echo cancellation. A 32-milliseconds tail delay is available on the VSP1 and VSP2 for switched PVG using ATM or IP. A 128-millisecond tail delay is available on switched VoAAL2 VSP3 and VoIP VSP3. Semantic checks will prevent the 128 ms option from being selected on VSP2 and VSP1 cards.

PVG also enables you to disable echo cancellation for fax and modem calls. For more information, see “Fax and modem calls” (page 33).

Note: Echo cancellation for switched PVG is controlled by the MGC. In tandem environments, echo cancellation for switched PVG 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 PVG 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 PVG



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, PVG 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 PVG to transmit comfort noise. However, if the condition persists for more than the configured length of time, PVG activates

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

Fax and modem calls

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

- PVG 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 PVG 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 PVG, you can enable fax idle suppression (FIS). FIS can reduce the use of bandwidth by up to 45%. FIS applies to non-switched PVG only.

To avoid data corruption, you can configure PVG 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 PVG and switched PVG 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 34)
- "G.729a fax and modem call compression" (page 34)

G.726 fax and modem call compression

You can configure PVG 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 PVG 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 PVG only supports upspeeding on detection of 2100 Hz and DTMF tones.

Considerations for G.729 Annex A and B voice encoding

When PVG 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 Passport 7400:

- 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 Passport 7400:

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

Using the voice services processor 2 (VSP2) FP in Passport 15000 or 20000:

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

Using the voice services processor 3 (VSP3) FP for switched PVG using IP in Passport 15000 or 20000:

- 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

Data calls

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

If you configure PVG to monitor signaling information, the system can identify the type of traffic on each channel. Note that non-switched PVG does not support monitoring of E1 signaling information. To avoid data corruption, PVG treats video and data from the TDM network as a contiguous data stream. PVG 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.

PVG 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 PVG, 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 PVG 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 PVG 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 PVG shelf

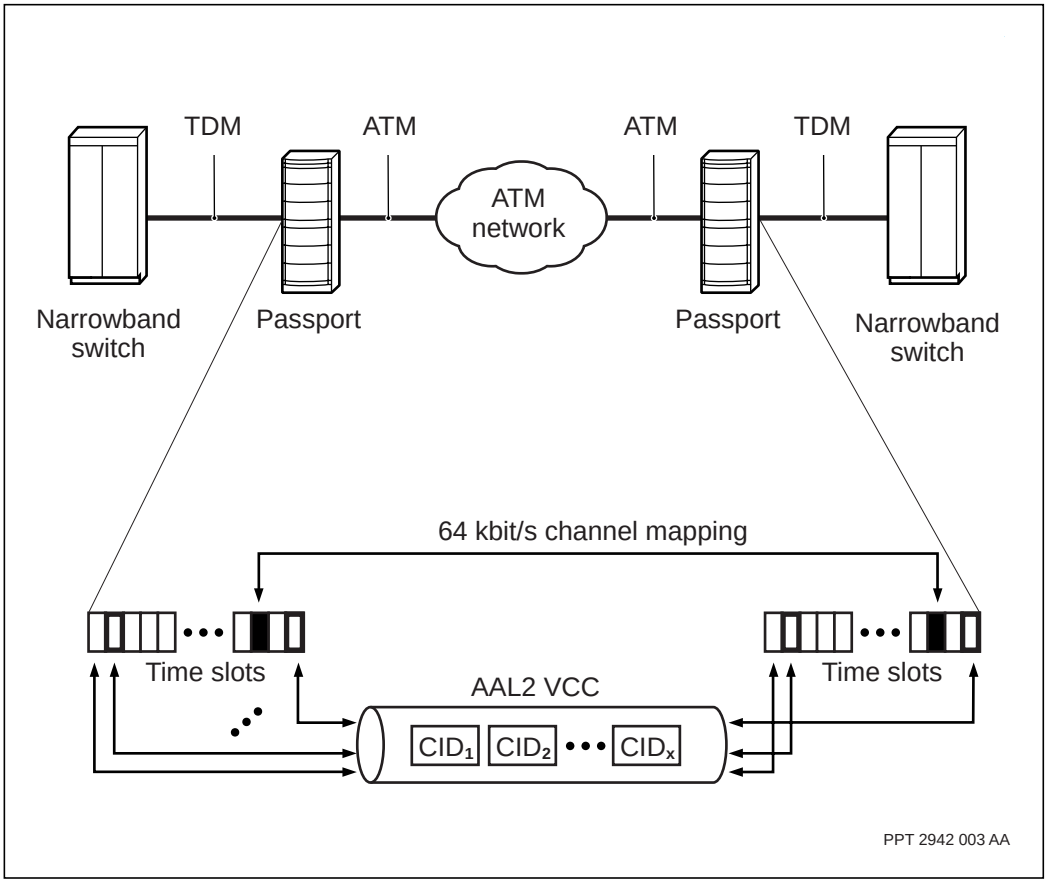
Switched PVG using IP CCD calls provide test trunk capability and hairpinning of CCD calls out on the same VSP2 or VSP3 FP. CCD calls in switched PVG using IP have the following requirements:

- supported on VSP2 and VSP3 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 PVG using ATM functionality

In non-switched PVG, a narrowband call arriving at the Passport switch 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 Passport switch. At the remote end, it is mapped back to TDM time slots and passed to another narrowband switch in the service provider's network. In this application, narrowband calls do not terminate at the Passport switch, but rather travel transparently over the ATM network. This configuration is shown in the figure "Non-switched PVG application" (page 38).

Figure 3
Non-switched PVG application



Non-switched PVG 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 PVG” (page 105) for a description of how PVG 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 PVG is transporting the narrowband call through an ATM PVC.

For narrowband services, such as voice and voice band data (fax and modem calls), Passport PVG 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 PVG 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 PVG” (page 105) for a description of how PVG can use each type of ATM connection.

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

- supported for voice services processor 2 (VSP2) and not VSP
- supported for PVG-to-PVG 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 PVGs, see 241-5701-781 *Passport 7400, 15000, 20000 Configuring Non-Switched Packet Voice Gateway*. For more information about non-switched PVG using ATM, see the following sections:

- "Introduction to Passport Packet Voice Gateway" (page 27)
- "Non-switched PVG using ATM services for voice calls" (page 40)
- "Non-switched PVG interworking function" (page 41)
- "Non-switched trunking using AAL2" (page 43)
- "Congestion management for non-switched PVG using ATM" (page 45)
- "CCS and CAS signaling transport" (page 47)
- "Standards compliance for non-switched PVG" (page 49)

Non-switched PVG using ATM services for voice calls

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

- "Voice compression algorithms supported by non-switched PVG using ATM" (page 40)
- "Voice calls" (page 28)

Voice compression algorithms supported by non-switched PVG using ATM

Non-switched PVG 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 40)
- "G.729a voice call compression" (page 41)

G.726 voice call compression

Non-switched PVG supports G.711 pulse code modulation (PCM) voice and G.726 ADPCM voice at 32, 24, and 16 kbit/s. Non-switched PVG 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 PVG 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 PVG 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 PVG can compress voice calls to a rate between the maximum and minimum voice rates.

G.729a voice call compression

Non-switched PVG supports G.711 PCM voice at 64 kbit/s and CS-ACELP voice at 8 kbit/s. Non-switched PVG 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, PVG 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 PVG only supports upspeeding on detection of 2100 Hz and DTMF tones.

Non-switched PVG interworking function

A non-switched gateway uses PVG 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 42).

Passport 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 switches these cells to the voice services FP for encoding. PVG identifies the cell streams as voice, fax/modem, or data calls. The PVG can be provisioned for CAS, CCS or no signaling types. See figure “Non-switched ATM-to-TDM gateway bearer traffic path” (page 42).

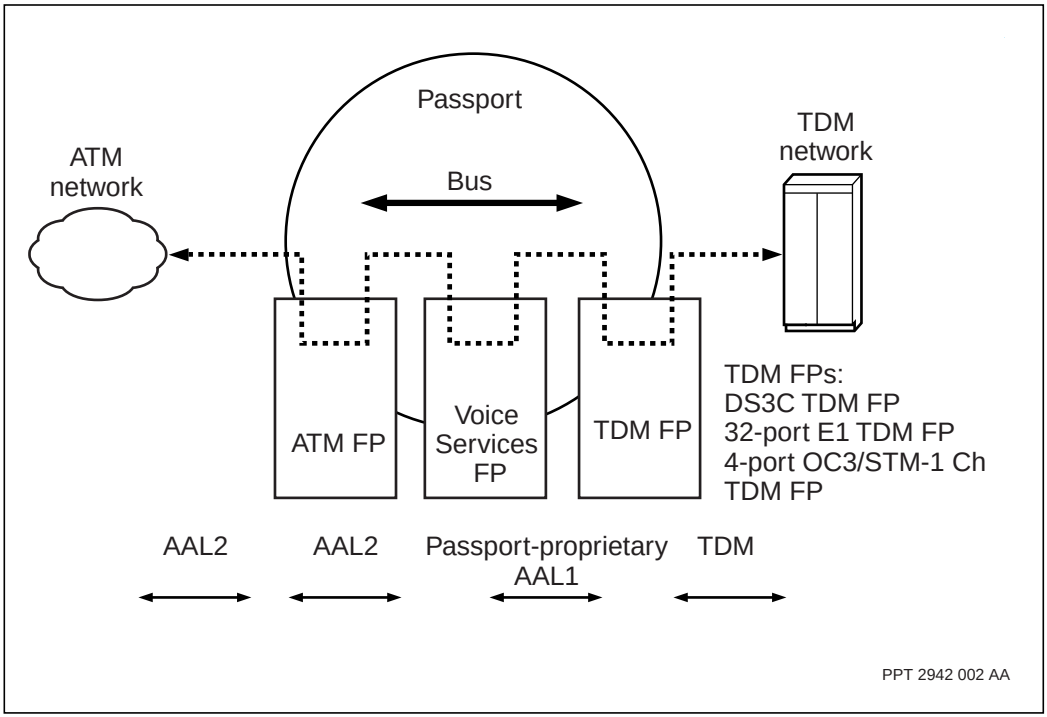
For information on which TDM FPs support non-switched PVG, refer to 241-5701-615 *Passport 7400, 15000, 20000 FP Configuration Reference*.

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, Passport 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 switches 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.

PVG 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 PVG application" (page 38).

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. PVG supports both non-switched trunking and proprietary switched trunking.

This section describes non-switched trunking. Switched trunking is described in “Switched PVG using ATM functionality” (page 51).

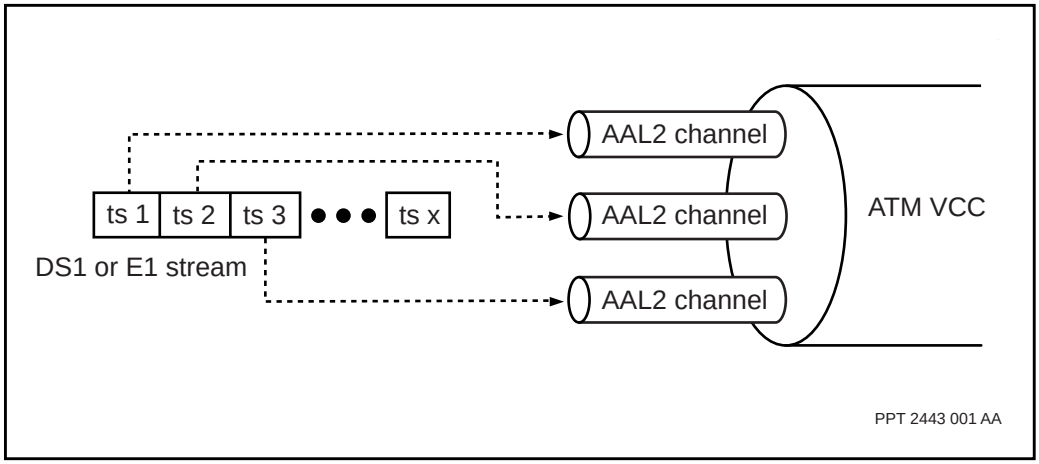
Non-switched trunking does not terminate signaling, but instead transports it transparently. PVG supports non-switched trunking using AAL2.

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 44). 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 PVG using ATM

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

The speed at which Passport sends 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 PVG" (page 135) for details on calculating the values for PCR, SCR, and MBS.

Non-switched PVG 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 45)
- "Congestion management with G.729a" (page 46)
- "Connection admission control" (page 144)

Congestion management with G.726

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

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

To gauge congestion levels, non-switched PVG 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 PVG compresses voice calls to the rate that you configure for the system. If you have configured PVG to apply silence suppression whenever the system

experiences congestion, non-switched PVG 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 PVG starts to upspeed active voice channels.

During periods of congestion, Passport admits 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 PVG

- 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 PVG 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 PVG transmits calls at the configured rate, either 8 kbit/s or 64 kbit/s. Non-switched PVG 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 PVG checks the number of cells the system transmits toward the ATM network at configured intervals. Non-switched PVG 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 PVG continuously rechecks the level of congestion. If the link is still congested, non-switched PVG 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 PVG provides transparent transport for CCS and CAS. It also supports unsignaled trunks. If you use CCS, non-switched PVG can monitor signaling information to determine the type of call and the call state.

Non-switched PVG 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 PVG, 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 PVG 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 48)
- “Channel associated signaling” (page 48)

- "Unsignaled trunks for non-switched PVG using ATM" (page 49)

Common channel signaling

If you use CCS, non-switched PVG maps each D channel to an AAL5 ATM VCC. Non-switched PVG maps each B channel to a channel on an AAL2 ATM VCC. Non-switched PVG 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 PVG 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 PVG, is the use of D-channel signaling for the bearer B-channels of a primary rate interface (PRI) circuit.

Non-switched PVG 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 PVG 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 PVG does not transmit idle channels.
- transmits signaling bits only when a call state changes

Unsignaled trunks for non-switched PVG using ATM

Non-switched PVG 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 PVG using ATM on Passport 15000 or 20000

There is a capacity issue with CAS-monitored voice trunks when used on a Passport 15000 or 20000 PVG in the non-switched voice mode. Nortel Networks recommends to 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 PVG

Non-switched PVG 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 PVG.

For standards compliance information for Passport hardware, see 241-7401-200 *Passport 7400 Hardware Description* or 241-1501-200 *Passport 15000, 20000 Hardware Description*. For standards compliance for the ATM Core service, see 241-5701-700 *Passport 7400, 15000, 20000 ATM Overview*.

Chapter 3
Switched PVG using ATM functionality

In switched PVG using ATM, an interworking function (IWF) terminates narrowband signaling. This method allows Passport PVG 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 PVG using ATM, the IWF consists of the following three parts:

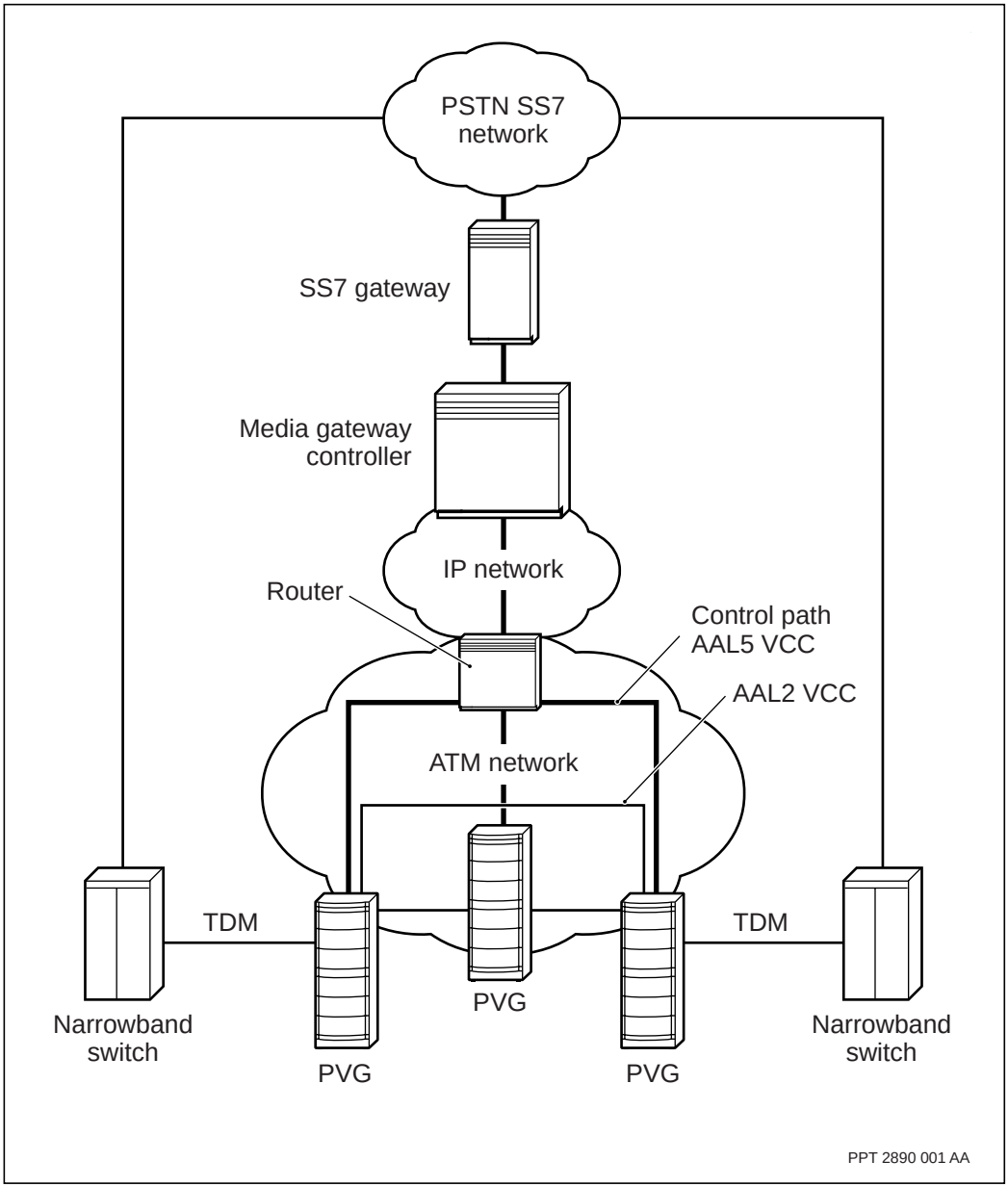
- a voice gateway service (provided by Passport PVG)
- a MGC (provided by third-party equipment)
- an SS7 gateway (also provided by third-party equipment)

The relationship between each element in the interworking function is shown in the figure "Switched PVG using ATM" (page 53). Passport PVG 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 Passport PVG. The SS7 gateway provides the controller with links into the SS7 network. Control traffic between each element is carried over an IP network, with Passport PVG connecting with the IP network on a single AAL5 VCC.

Switched PVG 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 PVG” (page 105) for a description of how PVG can use each type of ATM connection.

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

Figure 6
Switched PVG using ATM



To provision switched PVG using ATM, see “Installing and setting up PVG” (page 127) and 241-5701-782 *Passport 7400, 15000, 20000 Configuring Switched Packet Voice Gateway*. For more information about switched PVG using ATM functionality, see the following sections:

- “Introduction to Passport Packet Voice Gateway” (page 27)
- “Switched PVG using ATM services for voice calls” (page 54)
- “Switched ATM-to-TDM gateway” (page 56)
- “Unsignaled trunks for switched PVG using ATM” (page 57)
- “Local traffic switching for switched PVG using ATM” (page 57)
- “Call control for switched PVG using ATM” (page 59)
- “Switched PVG using ATM or IP functionality” (page 79)

Switched PVG using ATM services for voice calls

Switched PVG supports the following voice services:

- “Voice compression for switched PVG using ATM” (page 54)
- “Supported packet features using VSP2/VSP3/VSP3-o and ATM functionality” (page 56)
- “Voice calls” (page 28)
- “Switched PVG using ATM or IP services for voice calls” (page 79)

Voice compression for switched PVG using ATM

Switched PVG 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 PVG using ATM. See the following sections for more information:

- “G.711 voice call compression” (page 54)
- “G.726 voice call compression” (page 55)
- “G.729 Annex A and B voice call compression” (page 55)

G.711 voice call compression

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

G.726 voice call compression

Switched PVG 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 PVG 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 Passport 7400 (720-DS0 channel capacity) and on Passport 15000 or 20000 (800-DS0 channel capacity)
- supported for voice services processor 3 (VSP3) on Passport 15000 or 20000 (1512-DS0 channel capacity)
- supported for voice services processor 3 with optical TDM interface (VSP3-o) on Passport 15000 or 20000 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.

Note:

When DTMF tones are detected, PVG 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 PVG 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 PVG 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.

  Note: The VSP3-o FP card only supports VoATM and does not support VoIP.

- 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 PVG interworking function” (page 41). 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 PVG for switched PVG using ATM” (page 57).

See also “Switched PVG using ATM” (page 53).

Signaling between the narrowband network and PVG for switched PVG using ATM

Signaling between the narrowband network and PVG is handled by an SS7 gateway and a media gateway controller. When using ASPEN to make a bearer traffic connection in the PVG, the MGC sends a CREATE CONNECTION (CRCX) message with the appropriate parameters to the PVG. When using H.248 to make a bearer traffic connection in the PVG, the MGC sends an ADD command with the appropriate parameters to the PVG. In the Passport PVG, 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 Passport PVG and the media gateway controller, see “Call control for switched PVG using ATM” (page 59).

Unsignaled trunks for switched PVG using ATM

Switched PVG 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 PVG using ATM

Passport PVG 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 PVG supports local traffic switching through AAL2 using virtual channel connections (VCC) to either of the following:

- internal switching across the backplane of a Passport 7400 or across the fabric cards of a Passport 15000 and 20000
  - — 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 PVG” (page 105) for a description of how PVG can use each type of ATM connection.
  - — Internal switching method must have each end of the VCCs provisioned on the Passport PVG 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 PVG” (page 105) for a description of how PVG can use each type of ATM connection.

  Note: The recommended method is to use internal switching across the backplane of a Passport 7400 or across the fabric cards of a Passport 15000 and 20000, and not use external switching through the external ATM network.

Call control for switched PVG 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 PVG through a single control link to the VSP2/VSP3/VSP3-o FP. The control protocol for sending commands between the media gateway controller and Passport PVG 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 PVG using ATM” (page 59)
- “Communication between media gateway controllers for switched PVG using ATM” (page 61)
- “PRI backhaul for switched PVG” (page 88)
- “EN 300 V5.2 backhaul for switched PVG” (page 91)
- “Voice profiles” (page 61)

Media gateway controller connections for switched PVG using ATM

Call control connections can be configured as follows:

- “AAL5 VCC configuration for call control connections” (page 59)

AAL5 VCC configuration for call control connections

Control traffic travels over an IP network. Each Passport PVG 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 PVG. The PVG 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 PVG (where conversion from TDM takes place) to a terminating PVG (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 PVGs to connect their respective TDM end points to the same CID in the same VCC for the same call, communication between the two PVGs is required. Each PVG 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 PVG and the media gateway controller (MGC) is set up to support STARTUP messages and HEARTBEAT messages. The controller sends a STARTUP message to the PVG 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 PVG to detect its presence and the status of the network path over which the messages are sent. After receiving a HEARTBEAT message, the PVG 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 PVG connection is controlled by ServiceChange commands. PVG 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 PVG.

If PVG 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 PVG does not reply after a provisioned number of attempts and has not received any other messages from the MGC, the PVG 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 PVG using ATM

Communication between two PVGs is achieved through the exchange of session descriptors. When a call is to be setup, the originating PVG produces a session descriptor with its ATM NSAP address specified and the VCCI and CID fields left blank. The PVG 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 PVG. The terminating PVG 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 PVG 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.

PVG 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 PVG using IP functionality

For information on VoIP using ATM transport applications see:

- “VoIP using ATM transport and external routing” (page 64)
- “VoIP using ATM transport and VR” (page 66)

For information on VoIP using Ethernet transport applications see:

- “VoIP using two gigabit Ethernet ports of VSP3 and external routing” (page 66)
- “VoIP using Ethernet transport and VR” (page 67)
- “VoIP using Ethernet transport and VR on Passport 7400 and Passport 15000-VSS” (page 67)

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

- “Introduction to Passport Packet Voice Gateway” (page 27)
- “Voice compression for VoIP” (page 70)
- “Switched IP-to-TDM gateway” (page 71)
- “DTMF relay” (page 72)
- “Fax relay” (page 73)
- “VBD terminal support” (page 74)
- “VoIP services for voice calls” (page 74)
- “Call control for VoIP” (page 76)

- "Switched PVG using ATM or IP functionality" (page 79)

To provision VoIP, see "Installing and setting up PVG" (page 127) and 241-5701-782 *Passport 7400, 15000, 20000 Configuring Switched Packet Voice Gateway*.

VoIP using ATM transport and external routing

PVG connects with the IP network using ATM. PVG 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 PVG using ATM. This method allows Passport PVG 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.

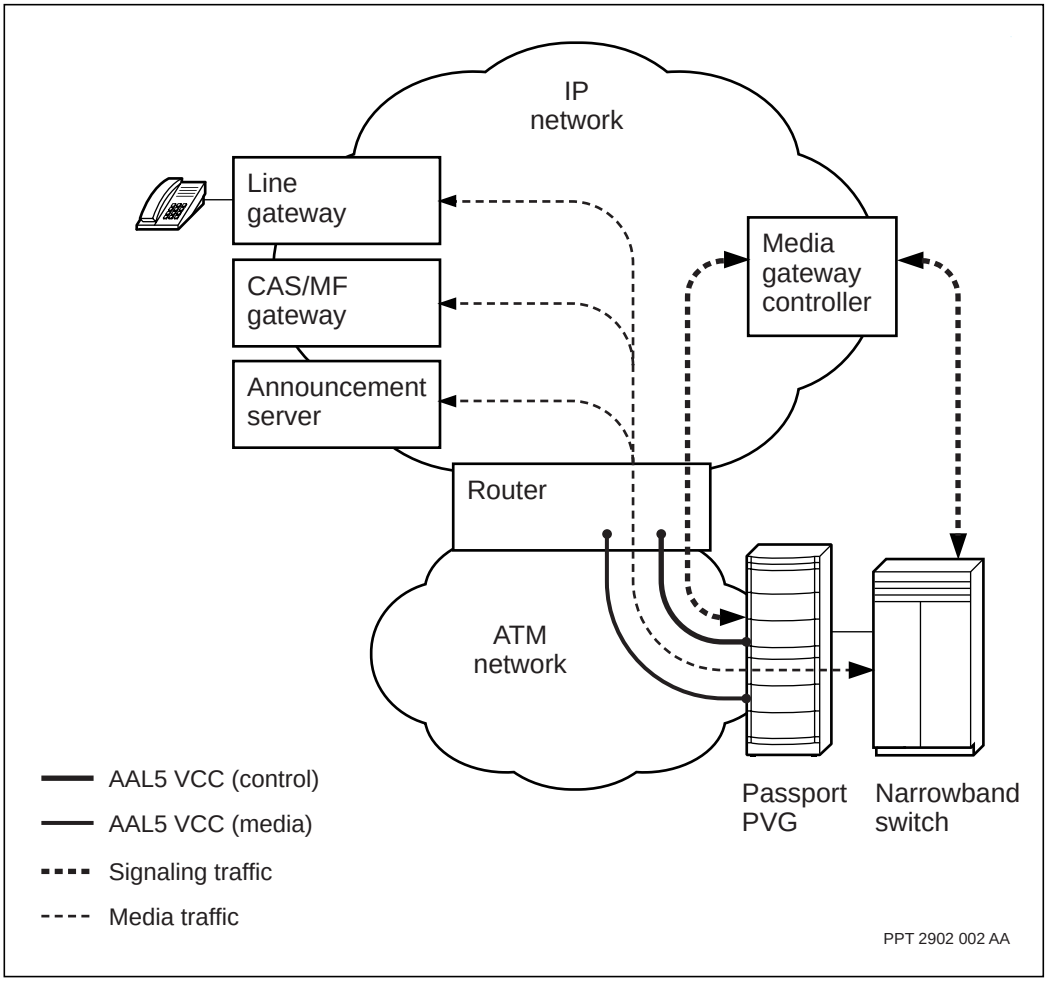
For VoIP, the interworking function consists of the following two parts:

- a voice gateway service (provided by Passport PVG)
- 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 65).

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 PVG" (page 105) for a description of how PVG 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 PVG, the MGC sends a CREATE CONNECTION (CRCX) message with the appropriate parameters to the PVG. When using H.248 to make a bearer traffic connection in the PVG, the MGC sends an ADD command with the appropriate parameters to the PVG. In the PVG, 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

VoIP using ATM transport and VR

PVG connects with the IP network using virtual router access point (VR AP) functionality. PVG 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 HEP and 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

PVG connects with the IP network using the 2 gigabit Ethernet ports of the VSP3 FP. PVG 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 Passport 15000 or 20000 switch 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

PVG connects with the IP network using virtual router access point (VR AP) functionality. PVG sends TDM traffic to the IP network as IP through VR AP functionality and a 4-port gigabit Ethernet FP card.

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.

VoIP using Ethernet transport and VR on Passport 7400 and Passport 15000-VSS

PVG connects with the IP network using Ethernet transport and VR functionality. PVG sends TDM traffic to the IP network as IP through VR functionality. This implementation is only available on Passport 7400 or Passport 15000-VSS.

Note: The VR functionality used by this configuration is different than VR AP functionality used in section “VoIP using Ethernet transport and VR” (page 67).

To configure VoIP using Ethernet transport and VR on Passport 7400, you must install a Passport 7400 switch 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

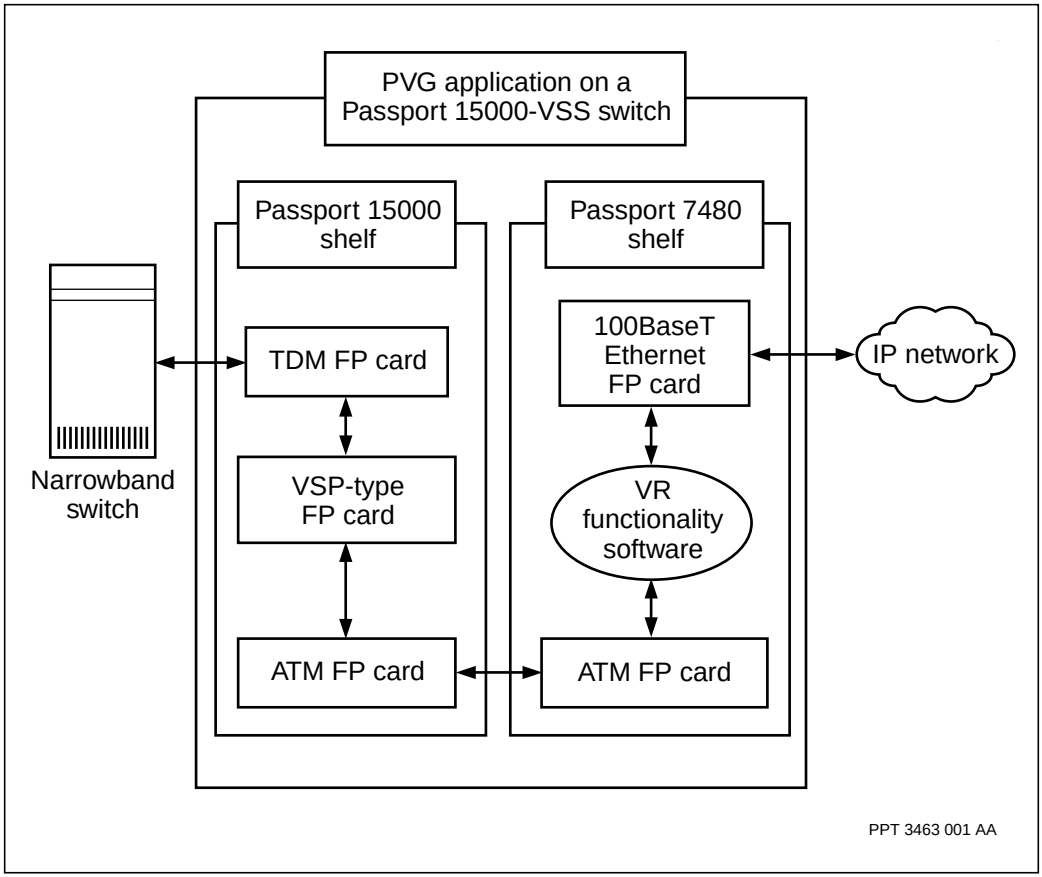
To configure VoIP using Ethernet on Passport 15000-VSS, you must install a Passport 15000-VSS that contains the following:

- On the Passport 7400

  - — 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 Passport 15000
  - — 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 Passport 15000-VSS for VoIP using Ethernet is shown in “VoIP using Ethernet transport and VR on Passport 15000-VSS” (page 69).

Figure 8
VoIP using Ethernet transport and VR on Passport 15000-VSS



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

- the base application and its atmCore feature
- the PVG 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 70)
- "G.729a voice call compression" (page 70)

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 Passport 7400 (1008-DS0 channel capacity) and on Passport 15000 or 20000 (1120-DS0 channel capacity)
- supported for VSP3 on Passport 15000 or 20000 (2016-DS0 channel capacity)
- 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 Passport 7400 (720-DS0 channel capacity) and on Passport 15000 or 20000 (800-DS0 channel capacity)
- supported for VSP3 on Passport 15000 or 20000 (1512-DS0 channel capacity)
- 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, PVG 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, PVG 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 PVG 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 74). Switched PVG dynamically maps time slots from a TDM network onto real-time transport protocol (RTP) flows.

From the TDM side, Passport receives 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 switches these cells to the voice services FP (VSP2 or VSP3) for encoding. PVG identifies the cell streams as voice, fax/modem, or data calls.

For the Passport 7400 VSP2, the maximum number of VPMs per VSP2 is eighteen. For the Passport 15000 or 20000 VSP2, the maximum number of VPMs per VSP2 is twenty. Each VPM can support up to fifty-six time slots. For the Passport 15000 or 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 Passport PVG.

Signaling between the narrowband network and PVG for VoIP

Signaling between the narrowband network and PVG is handled by a MGC. When using ASPEN to make a bearer traffic connection in the PVG, the MGC sends a CREATE CONNECTION (CRCX) message with the appropriate parameters to the PVG. When using H.248 to make a bearer traffic connection in the PVG, the MGC sends an ADD command with the appropriate parameters to the PVG. In the Passport PVG, 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 Passport PVG and the MGC, see “Call control for VoIP” (page 76).

DTMF relay

VoIP functionality supports DTMF relay on the Passport 15000 or 20000 using the VSP3 FP. 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 Passport 15000 or 20000 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

VBD terminal support

VoIP functionality supports VBD terminals (per ITU V-series recommendations) as VBD on the Passport 15000 or 20000 using the VSP3 FP. 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 74)

Support for text telephony terminals

Text telephony terminals are supported in "VBD terminal support" (page 74) 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 PVG supports various services for voice calls, including

- "RTP, UDP, IP and ICMP support" (page 74)
- "Supported packet features using VSP2 and IP functionality" (page 75)
- "Supported packet features using VSP3 and IP functionality" (page 75)
- "Voice calls" (page 28)
- "Switched PVG using ATM or IP services for voice calls" (page 79)

RTP, UDP, IP and ICMP support

Passport PVG uses RTP to encapsulate voice packets so they can be transported with the user datagram protocol (UDP) over IP. Passport PVG accepts RTP packets with payload types of G.711 voice, comfort noise and NSE. Passport PVG processes the RTP payload according to the sequence number, time stamp, and payload type. PVG can support RTCP on VSP3 FPs.

Passport PVG uses IP version 4 and supports provisionable differentiated services code point. Only voice packets arriving from the configured remote IP address are processed by PVG. Until the remote IP address is configured via media control signaling, packets from all source addresses are accepted. Passport PVG 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. Passport PVG 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. PVG 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 PVG can determine if the 2100-Hz tone is from the packet side or from the TDM side. The packet side can have PVG 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. PVG 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 75). Both VSP2 and VSP3 FPs 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 a Passport PVG. Each voice services FP in a Passport PVG acts as an independent gateway.

When the MGC receives signaling information, it sends the appropriate commands for call establishment, release, and maintenance to the PVG through its control VCC. By following these commands, the PVG creates a dynamic media channel between itself and another media gateway. The control protocol for sending commands between the MGC and Passport PVG 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).

Passport PVG 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 76)
- "PRI backhaul for switched PVG" (page 88)
- "EN 300 V5.2 backhaul for switched PVG" (page 91)

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 PVG using ATM or IP functionality

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

- “Switched PVG using ATM or IP services for voice calls” (page 79)
- “PRI backhaul for switched PVG” (page 88)
- “EN 300 V5.2 backhaul for switched PVG” (page 91)
- “Anchor Packet Gateway” (page 95)
- “Custom Local Area Signaling Services (CLASS)” (page 97)
- “PVG carrier grade” (page 98)

For more information about switched Passport PVG functionality, see the following sections:

- “Introduction to Passport Packet Voice Gateway” (page 27)
- “Switched PVG using ATM functionality” (page 51)
- “Switched PVG using IP functionality” (page 63)

Switched PVG using ATM or IP services for voice calls

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

- “Voice calls” (page 28)
- “Switched PVG using ATM services for voice calls” (page 54)

Audible tones for switched PVG

Passport PVG plays audible tones towards the TDM ports when the MGC instructs it to do so.

The tones are inserted into the speech path, not mixed with it.

Passport PVG 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 PVG using either the VGCP based on ASPEN 2.1, or the H.248 control protocol. The PVG does not support SGCP.

Supported tone packages for tones controlled by the MGC

The MGC instructs the PVG 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 Passport 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 tone
(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 tone
	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, PVG supports tones towards TDM only. • The bcg and cg package names are aliased. • PVG supports aliases of bcg/bpt and bcg/bprt (same tone as cg/prt) • PVG 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 can play up to three simultaneous monotones, whereas the voice services processor 3 (VSP3) and voice services processor 3 with optical TDM interface (VSP3-o) 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 voice services processor is used.

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

The VSP3 can play traffic in tones. Therefore, for tones that require this, the definition of “silence” is “traffic” instead.

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 PVG supports, see “Definitions of audible tones by country” (page 165).

Behavior of tones controlled by the MGC

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

Passport PVG 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 PVG 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 PVG 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 PVG continues to play out those tones from the Portuguese toneset.
- For new SIGNAL REQUEST messages, the PVG plays out tones from the Spanish toneset.

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

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

The MGC instructs the PVG 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 PVG

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

Note: To use PVG 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 PVG.

For more information about digit collection, see

- "Types of digit collection" (page 85)
- "Digit collection timers" (page 86)
- "Digit collection statistics" (page 86)
- "Digit collection buffer" (page 87)

Types of digit collection

Passport PVG 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 PVG 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.

Passport PVG 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 PVG 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 *longDigitTimerDuration* attribute. For more information about digit timers, see "Digit collection timers" (page 86).

Digit collection timers

Passport PVG 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 PVG. 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. Passport PVG 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 241-5701-782 *Passport 7400, 15000, 20000 Configuring Switched Packet Voice Gateway*.

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 PVG

Passport PVG 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 PVG 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 PVG assumes that the MGC contains the continuity timer. The PVG 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.

Passport PVG 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 PVG

Passport PVG can serve as a signaling gateway (SG) for primary rate interface (PRI) backhaul. In PRI backhaul, the PVG 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 PVG, 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 PVG has two links to transport PRI D-channel signaling as follows.

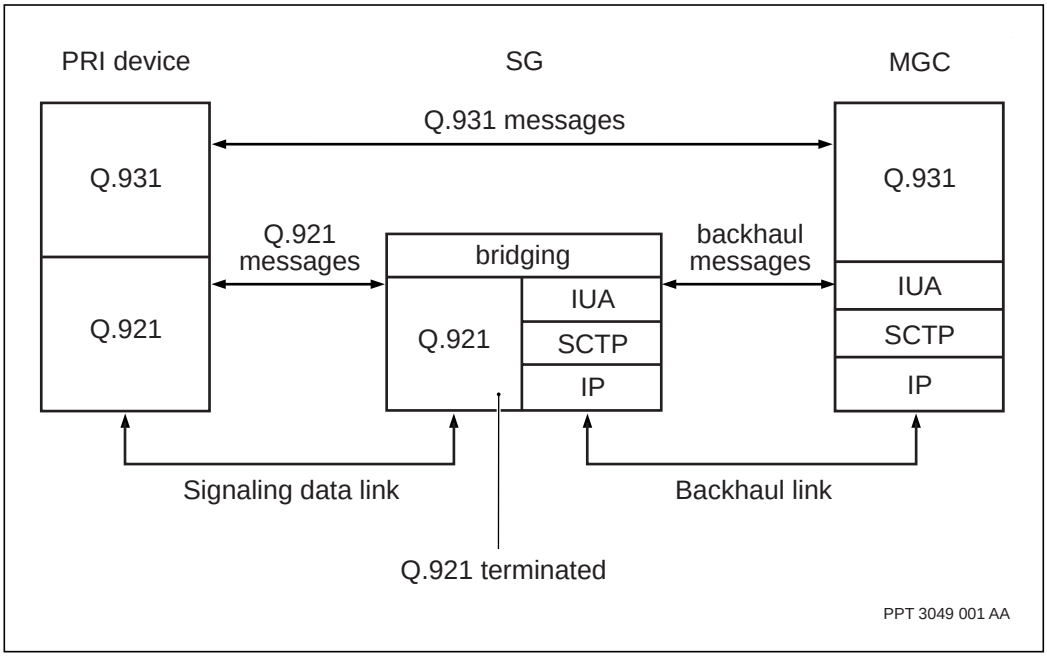
- a signaling datalink between the PVG and PRI-controlled device
- a backhaul link between the PVG and the MGC

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 PVG and the PRI-controlled trunks using protocol of Q.931 encapsulated in Q.921 over the signaling datalinks. The PVG terminates Q.921 messages from the PRI-controlled trunks. The IUA/SCTP protocol is used to transport Q.931 signaling messages between the PVG and the MGC over the backhaul links.

PVG can be configured to be the network end or the user end of the PRI trunk. The default configuration is for the PVG 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 89).

Figure 9
Protocol layers for control messages of PRI backhaul



PRI backhaul enables the PVG 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:

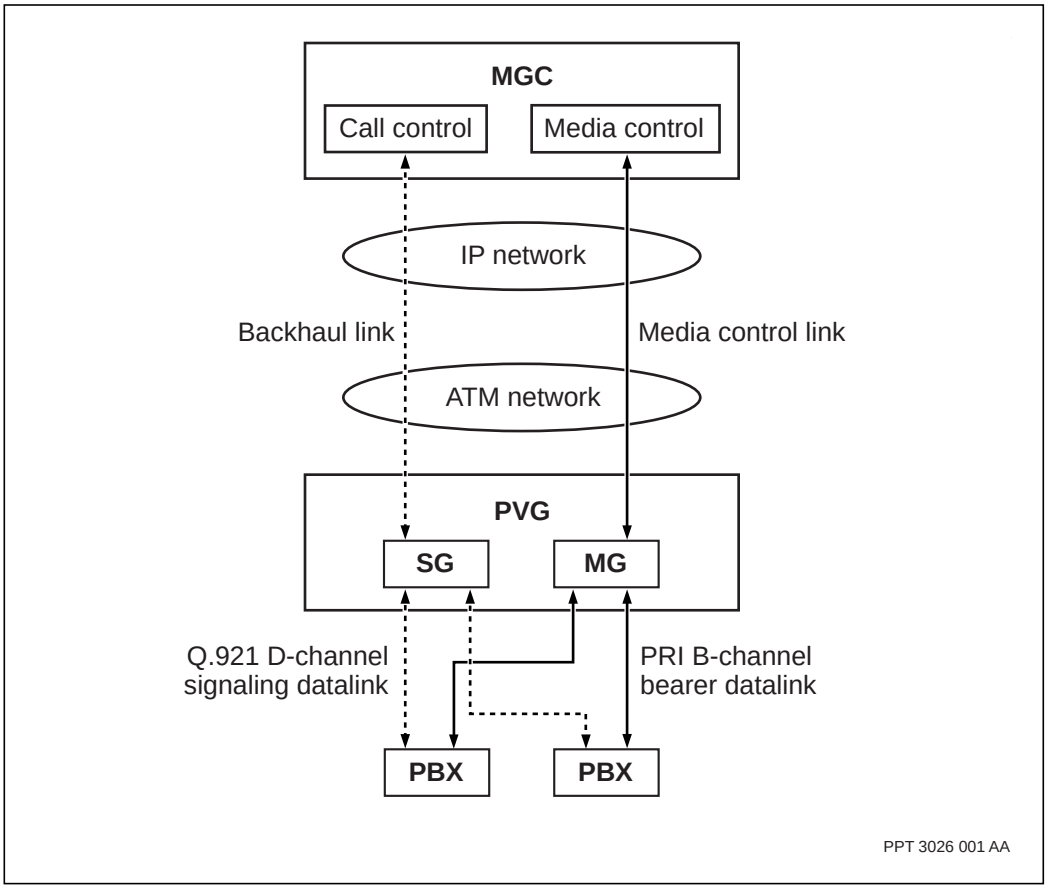
- the signaling gateway (SG) part
- the media gateway (MG) part

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 PVG (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 PVG" (page 90). For more information on the MG, refer to "Media gateway controller connections for switched PVG using ATM" (page 59).

Figure 10
Architecture diagram of PRI backhaul for PVG



PRI backhaul for PVG requires the following.

- VSP2 or VSP3 FP
- SG sparing by VSP2 or VSP3 sparing using cold standby for unrecoverable failures
- one D-channel maximum per T1/E1 carrier facility
- each SG entity of Passport PVG can be controlled by only one MGC at a time (each VSP2 or VSP3 FP card can contain one SG entity)

EN 300 V5.2 backhaul for switched PVG

Passport PVG 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 PVG does not.

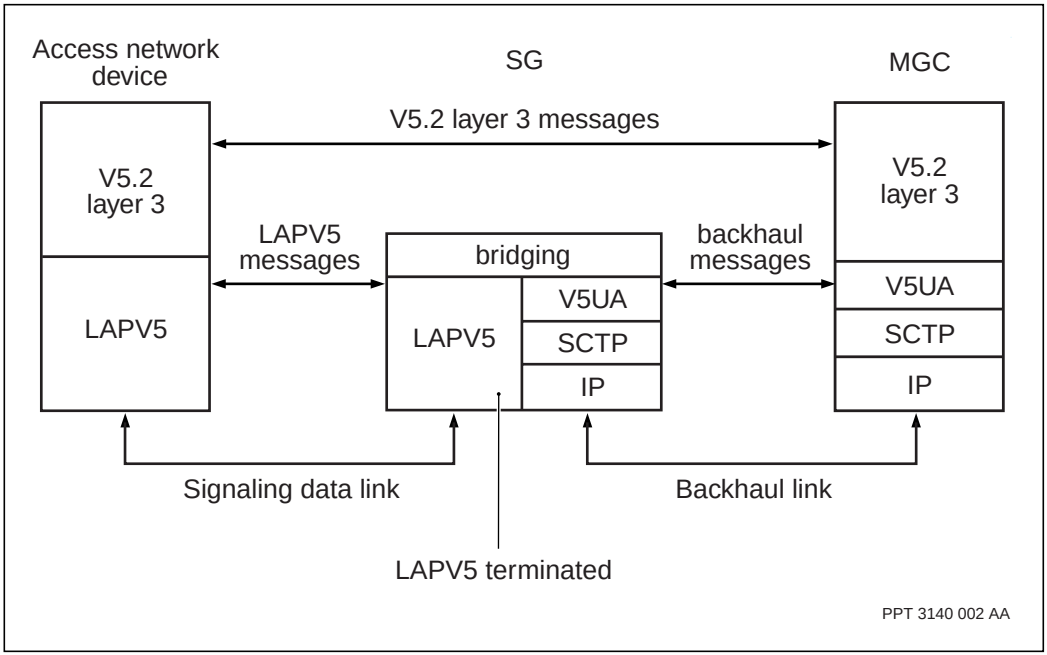
In V5.2 backhaul, the PVG serves as a SG to transport V5.2 signaling between an access network device and a MGC. V5.2 backhaul is defined as the termination at the SG of the lower layers of the signaling stack for a switched circuit network and the transport (or backhaul) to the MGC of the higher layers 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 92).

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

- a signaling datalink between the PVG and access network device
- a backhaul link between the PVG 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 PVG 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 PVG 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 PVG and the MGC over the backhaul links.

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



V5.2 backhaul enables the PVG 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

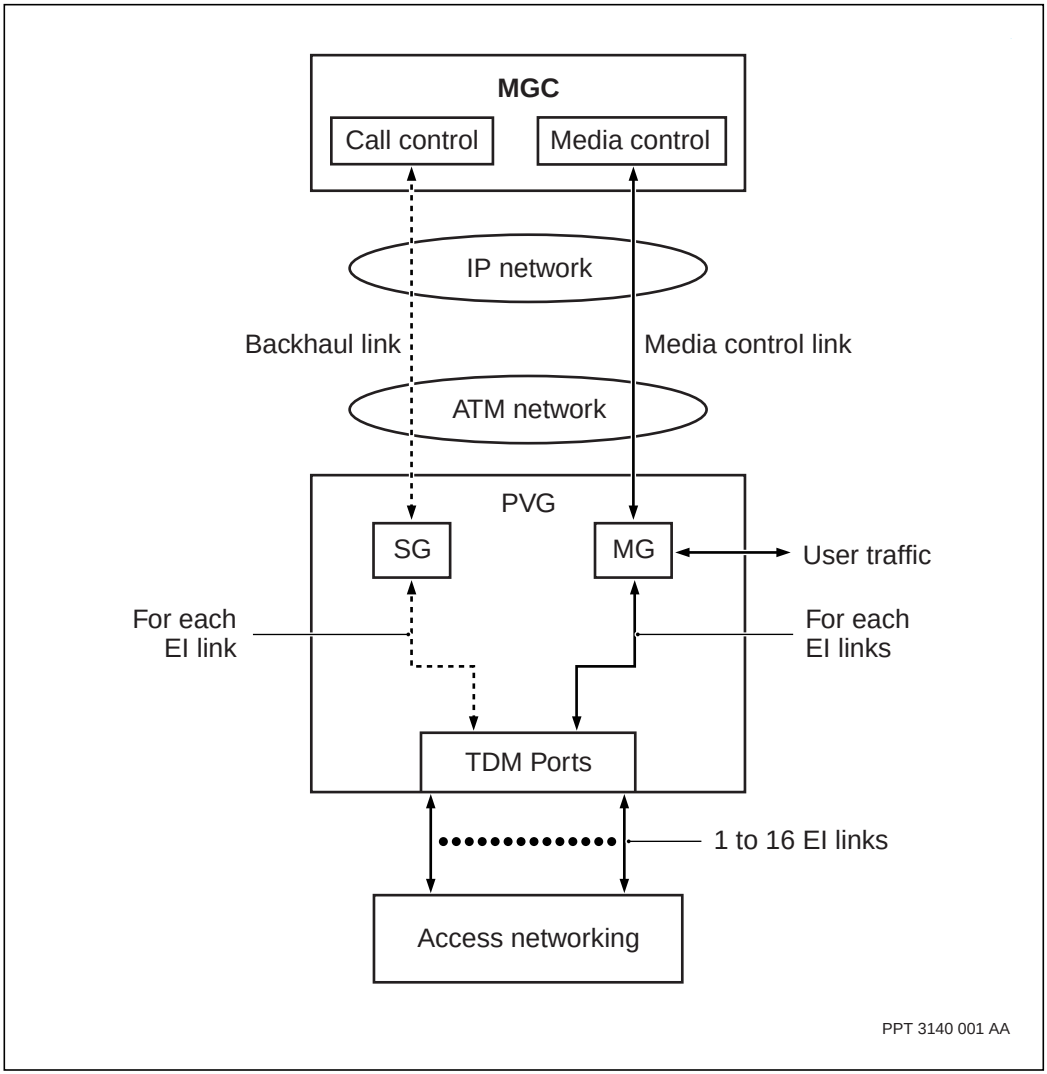
The SG part uses V5UA/SCTP/IP to backhaul the following types of messages between the access network device and the MGC:

- 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 PVG (ASPEN is also known as VGCP).

The SG and MG logical parts of the PVG are shown in “Architecture diagram of V5.2 backhaul for switched PVG” (page 94). For more information of the MG, refer to “Media gateway controller connections for switched PVG using ATM” (page 59).

Figure 12
Architecture diagram of V5.2 backhaul for switched PVG



V5.2 backhaul for switched PVG requires the following.

- VSP2 or VSP3

- SG sparing by VSP2 or VSP3 sparing using cold standby for unrecoverable failures
- each SG entity of Passport PVG 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 95).

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 PVG 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 PVGs provides protection against single point failures.

Anchor Packet Gateway

The Anchor Packet Gateway (APG) is a PVG 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 PVG 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 PVGs: PVG1 and PVG2. PVG1 is controlled by MGC1 and PVG2 is controlled by MGC2. MGC2 also controls a third PVG that acts as an APG.
- The call goes from PVG1 through the packet network to the APG.
- The APG accepts the call from PVG1 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 PVG2.
- PVG2 accepts and completes the call.

The APG function requires each PVG 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 PVG 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 PVG 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
- 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 digit duration of 70ms and inderdigit duration of 70ms
- 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.

PVG carrier grade

PVG has robustness functionality in support of carrier grade standards of reliability on the Passport 15000. The following carrier grade features are supported by PVG on Passport 15000:

- “Hitless equipment protection (HEP)” (page 100)
- “Hitless software migration (HSM)” (page 101)

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

- 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

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

- supported for switched PVG using either ATM or IP
- supported for the ASPEN version 2.1 protocol for connection control between the PVG 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 PVG 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 PVG shelf (a warning is generated when BGP is provisioned as part of another VR on the PVG shelf and a 4-port gigabit Ethernet FP card is on the PVG shelf)

- integrates support of multiple virtual routers (MVR) on 4-port gigabit Ethernet FP card
- supports hot control processor switchover (CPSO) for switched PVG using ATM or IP with virtual router (VR) interworking by provisioning component *VirtualRouterAccessPoint (VrAp)* (see "Hot CPSO" (page 99))

HEP or HSM switchovers on PVG 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 *Passport 7400, 15000, 20000 Configuration Guide*. PVG 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
- PVG recovery is limited to one second

- no support of hot CPSO in a configuration of switched PVG using IP (VoIP) with Ethernet transport and VR

Hitless equipment protection (HEP)

PVG 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 switch 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. PVG support of HEP requires a standby configuration of each of the FP cards in a PVG. 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 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 thePassport 15000 shelf
- supports the provision of an unprotected active VSP2/VSP3 FP with hot-standby 1:1 sparing configuration of VSP2/VSP3 FPs
- supports all the PVG services that are supported by HSM
- VSP2 and VSP3 HEP is supported by virtual router (VR) interworking by provisioning component *VirtualRouterAccessPoint (VrAp)* for switched PVG (VoATM and VoIP) - see “VSP2 and VSP3 HEP for switched PVG with VR interworking” (page 100)

VSP2 and VSP3 HEP for switched PVG with VR interworking

VSP2 and VSP3 HEP is supported for switched PVG 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. VR interworking with the VSP2 and VSP3 FP cards, provides IP routing on the PVG without the need for an external router (an external router is not required for traffic forwarding between VSP2/VSP3 FP cards connected to the same VR).

Considerations for support of VSP2 and VSP3 HEP for switched PVG 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 PVG 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)

Hitless software migration (HSM)

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

- supported on PVG 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)
- supports V-CAC
- 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 only supported for VSP2 and VSP3 HSM in the configuration of switched PVG with VR interworking - see "VSP2 and VSP3 HSM for switched PVG with VR interworking" (page 102)

A description of HSM for the Passport 15000 switch is found in the 241-5701-270 *Passport 7400, 15000, 20000 Software Installation Guide*.

VSP2 and VSP3 HSM for switched PVG with VR interworking

VSP2 and VSP3 HSM is supported for switched PVG 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 VSP2 and VSP3 HSM for switched PVG 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 (does not support dynamic routing through OSPF routes)
- supports a maximum outage time of one second for VSP2 and VSP3 HSM
- no support when the 4-port gigabit Ethernet FP is part of the PVG shelf

VSP2 and VSP3 HSM is supported for the following types of cards in a PVG 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)

Chapter 6
ATM connections for PVG

This section describes ATM connections and how Passport PVG 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 PVG, each ATM node in the ATM network, and the terminating PVG. 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 PVG can use ATM PVCs, including non-switched PVG, and switched PVG using ATM.

For details on how PVG can use ATM PVCs, see

- "Network scenarios for using PVG and ATM PVCs" (page 106)
- "Application access points" (page 107)

Additional details about ATM PVCs can be found in 241-5701-702 *Passport 7400, 15000, 20000 ATM Routing and Signaling Fundamentals*.

Network scenarios for using PVG and ATM PVCs

For non-switched PVG, 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 PVG application" (page 38).

For switched PVG 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 PVG using ATM" (page 53).

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 65).

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 PVG, 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, PVG 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 PVG can use a type of ATM SPVC called an ATM provisioned SPVC.

For details on how PVG uses ATM PSVCs, see

- “Network scenarios for using PVG and ATM provisioned SPVCs” (page 108)
- “Application access points” (page 109)
- “ATM signaling” (page 110)
- “ATM call processing” (page 111)

Additional details about ATM SPVCs can be found in 241-5701-702 *Passport 7400, 15000, 20000 ATM Routing and Signaling Fundamentals*.

Network scenarios for using PVG and ATM provisioned SPVCs

For non-switched PVG 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 PVG. This network scenario is shown in "Non-switched PVG application" (page 38).

For switched PVG 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 at the switch at the edge of the ATM network. The router is then linked to the ATM edge switch using PVCs. This network scenario is shown in "Switched PVG using ATM" (page 53).

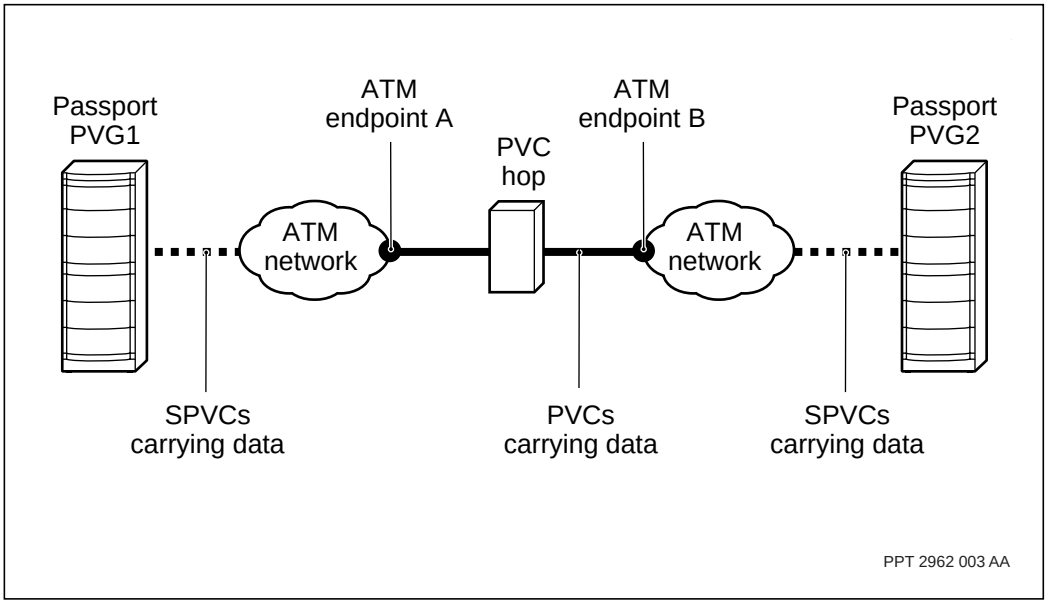
> ***Note:*** The voice services processor 3 with optical TDM interface (VSP3-o) FP card does not support PVC connections.

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 65).

As well, ATM SPVCs can be used where two ATM networks are between two PVGs and the two ATM networks are connected together by a hop that supports only ATM PVCs. See "ATM SPVCs for trunks between two PVGs" (page 109).

In this case, SPVCs are used to create dynamic trunks. The ATM trunk between PVG1 and PVG2 consists of two SPVCs and one PVC that connects the SPVCs together. One SPVC runs from PVG1 and terminates at ATM endpoint A. The other SPVC runs from PVG2 and terminates at ATM endpoint B. The PVC connects points A and B. Both PVGs establish SPVCs with the same remote VPI/VCI combination that is used by the PVC.

Figure 13
ATM SPVCs for trunks between two PVGs



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 PVG, 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.

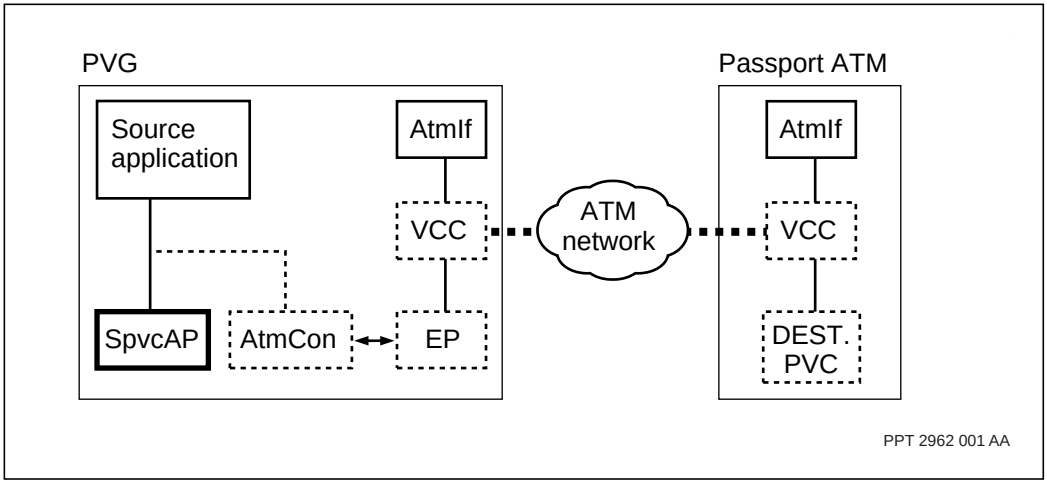
> ***Note:*** The *Nsta Vgs AtmTConn SpvcAp* component is not identical to the *Nsta Vgs Ctrl SpvcAp* component. For example, you can set three addresses in a list for the *addressToCall* attribute of the *Nsta Vgs Ctrl SpvcAp* component while you can only set one address for the equivalent attribute 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 Passport switch, 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 110) 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

Passport PVG 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 241-5701-702 *Passport 7400, 15000, 20000 ATM Routing and Signaling Fundamentals*.

ATM call processing

Passport PVG applications can originate SPVC calls, but cannot terminate them.

For non-switched PVG using ATM, the PVG application is:

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

For switched PVG using ATM, the PVG 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 PVG using IP, the PVG 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 PVG 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 PVG using ATM can use SVCs.

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

See 241-5701-702 *Passport 7400, 15000, 20000 ATM Routing and Signaling Fundamentals* for a more complete description of ATM SVCs.

Network scenarios for using PVG and ATM SVCs

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

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

PVG 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 PVGs 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 PVG 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 the Passport 15000 and 20000 VSP2/VSP3/VSP3-o FP cards and Passport 7400 VSP2 FP cards. All Passport 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.

Passport PVG 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 PVG applications can use PSVCs.

For details on how PVG uses ATM PSVCs, see:

- “Network scenarios for using PVG and ATM PSVCs” (page 115)
- “Application access points” (page 115)
- “ATM signaling” (page 117)
- “ATM call processing for non-switched and switched PVG using ATM” (page 117)
- “ATM call processing for switched PVG using IP” (page 118)
- “Additional call processing details” (page 120)
- “Additional call processing details” (page 120)

See 241-5701-702 *Passport 7400, 15000, 20000 ATM Routing and Signaling Fundamentals* for a more complete description of ATM SVCs.

Network scenarios for using PVG and ATM PSVCs

For non-switched PVG 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 PVG. This network scenario is shown in "Non-switched PVG application" (page 38).

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 PVG 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 PVG using ATM" (page 53).

For switched PVG 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 65).

> ***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 PVG using ATM, the *Nsta Vgs AtmTConn* component and the *Nsta Vgs Ctrl* component are examples of applications that use access points. For non-switched PVG using ATM, the *Nsta Conn* component, is an example of applications that use access points.

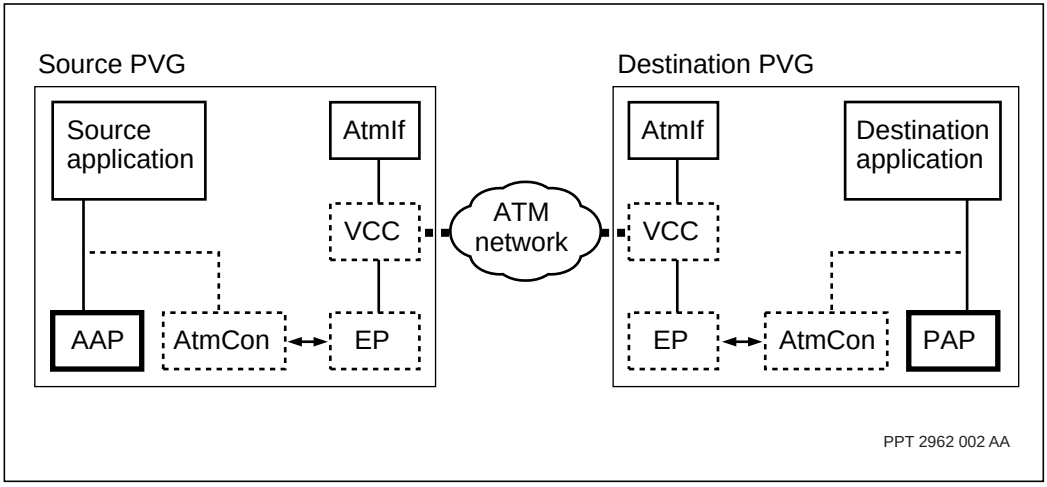
To use PSVCs, applications use a switched access point that can be either an active access point (AAP) or a passive access point (PAP).

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 116) 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

Passport PVG 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 241-5701-702 *Passport 7400, 15000, 20000 ATM Routing and Signaling Fundamentals*.

ATM call processing for non-switched and switched PVG using ATM

To originate and terminate PSVC calls, the PVG applications at both ends of a connection must have ATM addresses. See “ATM network addressing” (page 121) for more details.

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

For switched PVG using ATM, the PVG 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 PVG application’s unique ATM address. The *addressToCall* attribute specifies the remote end’s ATM address. For switched PVG 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 120).

For AAL2 VCCs, the PVG 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 PVG using IP

To originate and terminate PSVC calls, the PVG applications at both ends of a connection must have ATM addresses. See "ATM network addressing" (page 121) for more details.

For switched PVG using IP, the PVG 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 PVG application's unique ATM address. The *addressToCall* attribute specifies the remote end's ATM address. For switched PVG 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 120).

Additional call processing details

A PVG 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, PVG 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

Passport PVG 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). ATM network addressing for Passport is explained in detail in 241-5701-702 *Passport 7400, 15000, 20000 ATM Routing and Signaling Fundamentals*.

For PVG, the address prefix is determined by the *nodePrefix* attribute from the Passport shelf. Passport PVG applications are assigned addresses with the same prefix but with different ESI. For PVG, 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 121)
- "Network addresses for the Ctrl component" (page 121)
- "Network addresses for the IpMConn component" (page 122)
- "Network addresses for the AtmTConn component" (page 122)
- "Network addresses for the Conn component" (page 122)

Network addresses for the *Vgs* component

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

See 241-5701-060 *Passport 7400, 15000, 20000 Components* for a description of the network address.

Network addresses for the *Ctrl* component

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

See 241-5701-060 *Passport 7400, 15000, 20000 Components* for a description of the network address.

Network addresses for the *IpMConn* component

Switched PVG 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 241-5701-060 *Passport 7400, 15000, 20000 Components* 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 PVG 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 241-5701-060 *Passport 7400, 15000, 20000 Components* for a description of the network address.

Monitoring alarm signals and indications

Passport PVG 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 PVG application.

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

- and only one remote address is provisioned, the PVG 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 PVG 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 123). During this time, the PVG 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 PVG application waits 2.5 seconds to determine if AIS or RDI conditions exist.

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

If AIS or RDI conditions do exist:

- and the indication comes from a PAP, the PVG application is not enabled.
- and the indication comes from an AAP or SPVC access point with many provisioned remote addresses, the PVG 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 PVG 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 PVG 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 PVG 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 241-5701-050 *Passport 7400, 15000, 20000 Commands* 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 124)
- “Retry interval for Ctrl or IpMConn components” (page 125)

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 PVG applications of the event. Attempts to originate new ATM calls are suspended until the PVG 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 PVG applications can be created on the same VSP/VSP2/VSP3 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 PVG using ATM.

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

For AAL2 VCCs carrying bearer traffic for switched PVG 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 PVG

Before you configure PVG, you must be familiar with Passport operations and maintenance and with provisioning commands. See the following documents before you configure PVG:

- 241-5701-600 *Passport 7400, 15000, 20000 Configuration Guide* provides background and descriptive information and procedural about operating and maintaining Passport nodes.
- 241-5701-050 *Passport 7400, 15000, 20000 Commands* provides information about provisioning commands.

The system requirements for PVG are listed in “System requirements for PVG” (page 128).

The prerequisites for configuring PVGs on a Passport switch are

- “Installing Passport hardware” (page 129)
- “Commissioning the node for PVG” (page 129)
- “Installing PVG software” (page 129)
- “Configuring logical processor types for PVG” (page 131)
- “Configuring logical processors for PVG” (page 131)
- “Configuring function processors for PVG” (page 132)

System requirements for PVG

To configure PVG, you must install a Passport switch that contains the following:

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

  Note: On the Passport 15000 and 20000, 1:1 and 1:N sparing of the VSP2 and VSP3 FP cards can be done where the maximum value of N is 13. On the Passport 15000 and 20000, 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 (not required for VSP3-o FP card)
- at least one ATM FP (except when using the gigabit Ethernet interface of the VSP3 FP card)
- one or two control processors
- at least one ATM line to connect the Passport switch to an ATM device or network
- at least one TDM line to connect a TDM FP to a narrowband switch or TDM network

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

- Passport PVG software
- networking software (switched mode only)
- atmNetworking software (switched mode only)

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

Installing Passport hardware

Before you configure PVG, you must physically install your Passport switch, 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 241-7401-240 *Passport 7400 Hardware Installation, Maintenance and Upgrade* or 241-1501-210 *Passport 15000, 20000 Hardware Installation Guide*.

Commissioning the node for PVG

Passport enables a network operator to configure and maintain a Passport 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 241-5701-271 *Passport 7400, 15000, 20000 Network Management Connectivity* for further instructions.

You can use Preside Multiservice Data Manager to manage your Passport nodes. Run StartUp to connect to Preside Multiservice Data Manager. Then see 241-6001-023 *Preside MDM Configuration Management for Passport User Guide*.

> ***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 PVG software

Use the procedures in 241-5701-270 *Passport 7400, 15000, 20000 Software Installation Guide* to install PVG software. Before you can configure Passport PVG, you must install the appropriate software, for each type of PVG, on your CP.

Table 2
Application and features for installing PVG software

Application or feature	Non-switched PVG	Switched PVG using ATM	Switched PVG 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

Echo canceller options for Passport 7400 with VSP

PVG with the VSP FP on the Passport 7400, 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 PVG on the Passport 7400 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 PVG

After you install the appropriate software on the node, you must configure the LPTs for PVG. Follow the procedures in 241-5701-600 *Passport 7400, 15000, 20000 Configuration Guide* or 241-5701-615 *Passport 7400, 15000, 20000 FP Configuration Reference*.

Configure the following logical processor types (LPTs):

- Create an ATM LPT and set its *featurelist* attribute to *atmCore*.
- Create an NSTA LPT and set its *featurelist* attribute to *nsta*.
- Create a VGS LPT. For switched PVG using ATM, set its *featurelist* attribute to *vgsAtm*. For switched PVG 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 PVG

After you install the LPTs on the node, you must configure the LPs for PVG. Follow the procedures in 241-5701-600 *Passport 7400, 15000, 20000 Configuration Guide* or 241-5701-615 *Passport 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 in the shelf.
  - 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:
  - 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 PVG" (page 131)

Configuring function processors for PVG

After you configure the LPs on the node, you must configure the FPs. Follow the procedures in 241-5701-600 *Passport 7400, 15000, 20000 Configuration Guide* or 241-5701-615 *Passport 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 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 PVG 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 PVG

Different types of traffic have unique traffic characteristics (in terms of rate and density variation) and performance needs (in terms of delay and loss). PVG 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 PVG, 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 V-CAC is not used, see the following sections for more information:

If V-CAC is used, see section "Voice-band connection admission control" (page 145) 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 136)
- "txTrafficDescType attribute" (page 137)
- "txTrafficDescParm attribute" (page 137)

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. Passport also enables you to establish bandwidth pools to manage traffic. You can establish up to three pools for each ATM port. For more information, see 241-5701-700 *Passport 7400, 15000, 20000 ATM Overview*.

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 PVG, 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 PVG

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 PVG" (page 137)
- "Calculating SCR for non-switched PVG" (page 138)
- "Calculating MBS for non-switched PVG" (page 139)

Calculating PCR for non-switched PVG

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 138).

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 PVG connection has a PCR value of 300.

Calculating SCR for non-switched PVG

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 138)
- “Calculation of SCR with silence suppression enabled” (page 139)

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 PVG

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 PVG connection has an MBS value of 50.

Determining congestion thresholds

Passport PVG manages congestion by using a series of thresholds. As traffic levels rise and fall around these thresholds, PVG 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%.

Passport PVG 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 141)
- "Hold-over time and PDVT" (page 142)

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 PVG 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, Passport warns you when it checks the provisioning.

Considerations for switched ATM connections

When provisioning PVG 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 143)
- "Connection admission control" (page 144)
- "Other parameters" (page 144)

ATM service category

For switched PVG 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 PVG 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 PVGs 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 PVG.

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

Voice-band connection admission control (V-CAC) is a PVG feature for congestion avoidance of voice-band traffic over the ATM. The V-CAC feature ensures voice-band traffic conforms to the negotiated traffic level for the ATM network's QoS performance. The V-CAC feature checks that PVG does not exceed internal resources. Passport PVG uses the V-CAC feature to decide on the following requests.

- a request for a voice-band connection
- a request for additional bandwidth on an existing voice-band connection

The V-CAC feature decides if a request for a voice-band connection can run over an existing VCC based on the resources of the ATM and the PVG. Use of the V-CAC feature avoids congestion through the PVG and ATM. The QoS of existing voice-band connections is sustained in an ATM network where congestion may occur. The V-CAC feature assumes the usage parameter control (UPC) is enabled. A comparison is made by the V-CAC feature of an estimate of the total resources required for a candidate voice-band connection and for all the other existing connections on the same VCC, and the ATM parameters of the same VCC. Based on this comparison, the V-CAC feature decides if a requested voice-band connection can be made over an established VCC while still maintaining the QoS of all connections within the provisioned parameters.

V-CAC is not supported for VoIP on PVG using virtual router (VR) access point (AP). Also, V-CAC is not supported when a VR configuration is used.

The V-CAC feature also decides on requests for additional bandwidth on an existing voice-band connection. Requests for additional bandwidth can be made by a modify connection command or by transition to the VBD mode. A decision is made by the V-CAC feature to allow the bandwidth request if there is sufficient bandwidth resources on all paths affected by the voice-band connection. No account is taken by the V-CAC feature for bandwidth changes due to in-band signaling packets or transitory upspeeding due to DTMF tones.

Provisioning of the V-CAC feature is optional. The V-CAC feature is provisioned on component *Nsta Vgs VoiceCallAdmissionControl* (for provisioning information see and 241-5701-782 *Passport 7400, 15000, 20000 Configuring Switched Packet Voice Gateway*. If this

VoiceCallAdmissionControl component is not provisioned, the V-CAC feature continues to operate for switched PVG using ATM, based on the provisionable attribute *maxNumberAal2Trunks* of the component *Nsta Vgs AtmTrunkConnection*.

The provisioning of bandwidth on a PVG is based on the following:

- The maximum number of channels required is estimated using the Erlang B formula (using an estimate of the busy hour traffic between any two of the voice services processor cards VSP2/VSP3/VSP3-o FPs and an acceptable blocking factor). (Note: VSP3-o FP is the voice services processor 3 with optical TDM interface FP card)
- If the VoiceCallAdmissionControl component is provisioned, the value of provisionable attribute maxNumberAal2Trunks of the Nsta Vgs AtmTConn component, should be greater than the maximum number of channels.
- If the VoiceCallAdmissionControl component is not provisioned, the value of provisionable attribute maxNumberAal2Trunks of the Nsta Vgs AtmTConn component, should equal the maximum number of channels.

The V-CAC feature uses the following provisionable attributes associated with the component Nsta Vgs AtmTConn.

- maxNumberAal2Trunks
- holdOverTime

The V-CAC feature uses the following provisionable attributes associated with the component Nsta Vgs VoiceCallAdmissionControl.

- packetLossProbabilityIndex
- averageActiveDuration
- sourceActiveTime
- deleteCallsOnVbd
- allocatedShelfBandwidth

The V-CAC feature uses the actual values of an established VCC for the following:

- ATM traffic parameters: PCR, SCR, and MBS
- ATM service category: CBR and VBR-rt

The V-CAC feature is supported on VSP2 and VSP3 FP hardware and is not supported on VSP and VSP3-o FP hardware.

Chapter 9
Fault management for PVG

Passport generates alarms and state change notifications whenever it detects a problem. For general guidelines on troubleshooting PVG, 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)

Passport 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 241-5701-500 *Passport 6400, 7400, 15000, 20000 Alarms*. For information about PVG OSI states, see either 241-5701-781 *Passport 7400, 15000, 20000 Configuring Non-Switched Packet Voice Gateway* or 241-5701-782 *Passport 7400, 15000, 20000 Configuring Switched Packet Voice Gateway*.

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 Passport 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 a Passport PVG

Passport PVG faults can be categorized into TDM interface, ATM interface, and buffer underflow faults. And, depending on your configuration, you can change how PVG communicates ATM failures to the narrowband switch to which it connects. See the following sections for more information:

- "TDM interface faults" (page 151)
- "ATM interface faults" (page 153)
- "Buffer underflow faults" (page 155)
- "Configuring the response to failures" (page 156)

TDM interface faults

Passport generates 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 PVG faults" (page 152)
- "Switched PVG faults" (page 152)

Non-switched PVG faults

Passport reports all alarm conditions to the fault management system. No further action occurs for DS and FAI alarms. With all other alarms, Passport informs the remote interworking function using fault indication packets (FIP).

When RAI, LOS, LOF, or AIS alarms occur, Passport creates a FIP that shows all local conditions. Passport 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, Passport sends an updated FIP.

When a FIP with one or more fields showing an alarm condition arrives on an AAL2 channel, Passport reacts differently depending on the type of fault. For RAI faults, Passport transmits RAI fault indications to the TDM network. For all other faults, Passport 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 PVG faults

Detection of TDM fault conditions and port management type reactions to TDM failures are identical to those of non-switched PVG. Passport PVG 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, Passport PVG does not propagate the fault indication to the far end TDM interface. Instead, PVG deletes any narrowband calls using that trunk and notifies the media gateway controller of the state change of the TDM interface.

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

For switched PVG 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, PVG responds to control commands (such as Create Connection) for any endpoint on the affected trunk with a negative acknowledgement. When the fault clears, PVG sends another notification or RSIP to the controller and begins to accept control commands again.

ATM interface faults

Passport generates 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

Passport follows OAM fault management procedures defined in ITU-T I.610. Passport supports both end-to-end and segment F5 fault management flows.

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

- “Behavior of non-switched PVG” (page 154)
- “Behavior of switched PVG” (page 154)

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

- “Bearer VCC failure” (page 154)
- “Control VCC failure” (page 155)

Behavior of non-switched PVG

Passport interprets all ATM alarms as ATM VCC loss of connectivity. Therefore, Passport conditions 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 PVG

Passport PVG continues to interpret all ATM alarms (except CPS) as ATM VCC loss of connectivity; however, in switched mode, PVG reacts differently. When any media ATM trunk receives loss of continuity (LOC) alarms, PVG does not propagate the fault condition to the near end TDM interface. Instead, PVG 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. Passport PVG 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 PVG ATM trunks can re-route themselves by using PSVCs or SPVCs.

For switched PVG 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 123). 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 PVG'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 PVG using IP.

Control VCC failure

When a VCC transporting control information loses ATM connectivity, the PVG 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 PVGs.

Existing narrowband calls are maintained on the PVG 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, Passport monitors the time it takes to refill the buffer. If the time exceeds the value configured for the *lossIntegrationPeriod* attribute, the Passport sets a buffer underflow fault. The system then applies trunk conditioning to the affected time slot and sends out a fault indication packet (FIP). Passport 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, PVG 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 PVG problems

Passport notifies you of problems with PVG 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 241-5701-520 *Passport 7400, 15000, 20000 Troubleshooting and Testing* or 241-5701-615 *Passport 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 241-5701-781 *Passport 7400, 15000, 20000 Configuring Non-Switched Packet Voice Gateway* or 241-5701-782 *Passport 7400, 15000, 20000 Configuring Switched Packet Voice Gateway*.

See “Troubleshooting general PVG problems” (page 157) to help diagnose and correct problems. For additional troubleshooting information, see 241-5701-520 *Passport 7400, 15000, 20000 Troubleshooting and Testing* and 241-5701-700 *Passport 7400, 15000, 20000 ATM Overview*.

Table 6
Troubleshooting general PVG 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 Passport switch.	Verify the cabling.
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 Passport switch.	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.

(Sheet 1 of 6)

Table 6 (continued)
Troubleshooting general PVG problems

Symptom	Probable causes	Corrective measures
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.
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 Passport switch.	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 Passport switch.	Check the far end device for problems.
(Sheet 2 of 6)		

Table 6 (continued)
Troubleshooting general PVG problems

Symptom	Probable causes	Corrective measures
The PVG 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.
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.

(Sheet 3 of 6)

Table 6 (continued)
Troubleshooting general PVG problems

Symptom	Probable causes	Corrective measures
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 switch 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 241-5701-700 *Passport 7400, 15000, 20000 ATM Overview*.
	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.
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, Passport also generates a common part sublayer alarm.	Verify that the setting for cell scrambling matches the device to which it connects.

(Sheet 4 of 6)

Table 6 (continued)
Troubleshooting general PVG problems

Symptom	Probable causes	Corrective measures
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 PVG problems

Symptom	Probable causes	Corrective measures
Modem/Fax calls not working.	Clock-timing source of PVG is different from other nodes in the connected network.	Check the clock-timing sources of the PVG and other network nodes in the connected network. For information, see 241-1501-205 *Passport 15000, 20000 Site Requirements and Preparation Guide*.
	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 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 163) provides additional guidelines to help you solve problems that may be associated with G.729 Annex A and B functionality.

Table 7
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 PVG 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 PVG 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 164) provides additional guidelines to help you solve problems that may be associated with PRI backhaul.

Table 8
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 Passport PVG can generate for the following countries:

Argentina

Table 9
Definition of supported tones for Argentina

VGCP tone name	VGCP signal 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/pt	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)
comfort	xcg/cmft	silence (no frequency) signal complete immediately			

(Sheet 1 of 2)

Table 9 (continued)
Definition of supported tones for Argentina

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
off-hook warning	xcg/roh	1400 + 2060 + 2450 (VSP3 /VSP3-o only) + 2600 (+/- 2%)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o) (+/-1.5 dB)
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 10
Definition of supported tones for Australia

VGCP tone name	VGCP signal 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/pt	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

(Sheet 1 of 2)

Table 10 (continued)
Definition of supported tones for Australia

VGCP tone name	VGCP signal 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	same as cg/rt and cg/bt
comfort	xcg/cmft	undefined. play nothing. signal complete immediately			
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	undefined. play nothing. signal complete immediately			
message waiting	srvtn/mwt	400 + 425 + 450	0.1 on, 0.04 off	10	-18 + -18 + -18

(Sheet 2 of 2)

Austria

Table 11
Definition of supported tones for Austria

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz) (+/- 5%)	Cadence (s) (+/- 20%)	Duration (s) (+/-10%)	Level (dBm) (+/- 3.5 dB)
dial	cg/dt	420	continuous	20	-13.5
(audible) ringing	cg/rt	420	1 on, 5 off	infinite	-13.5
busy	cg/bt	420	0.4 on, 0.4 off	infinite	-13.5
congestion	cg/ct	420	0.2 on, 0.2 off	60	-13.5
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	-13.5/ -13.5/ -13.5
warning	cg/wt	1400 (+/- 1.5%)	0.5 on, (+/- 10%)	1 cycle	-34 (+/-1 dB)
pay phone recognition	cg/pt	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	-6.5
caller waiting	cg/cr		cg/rt for 30 (+/- 10%), followed by cg/bt for remainder	infinite	
comfort	xcg/cmft	undefined. nothing played. signal complete immediately			

(Sheet 1 of 2)

Table 11 (continued)
Definition of supported tones for Austria

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz) (+/- 5%)	**Cadence (s) (+/- 20%)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/- 3.5 dB)**
off-hook warning	xcg/roh	1400 + 2060 + 2452 (VSP3/ VSP3-o only) + 2604 (+/- 15)	continuous	infinite	-5 + -5 + -5 VSP2 -6 + -6 + -6 + -6 VSP3/ VSP3-o (+/-1 dB)
negative acknowledge	xcg/nack	380 + 420	0.4 on, 0.4 off	60	-16.5 + -16.5
vacant number	xcg/vac	mapped to cg/ct			
special conditions dial tone	xcg/spec	380 + 420	continuous	20	-16.5 + -16.5
recall dial tone	srvtn/rdt	mapped to cg/dt			
confirmation	srvtn/conf	380 + 420	1.0 on, 5.0 off	1 cycle	-16.5 + -16.5
held	srvtn/ht	450 (+/- 15)	3.25 off, 0.25 on, 0.25 off, 0.25 on	infinite	-8 (+/-1 dB)
message waiting	srvtn/mwt	420	(0.1 on, 0.1 off) x 10 then continuous	20	-13.5

(Sheet 2 of 2)

Belgium

Table 12
Definition of supported tones for Belgium

VGCP tone name	VGCP signal 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/pt	1633 (f1) 1336 (f2) (+/- 8%)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on	1 cycle	-20/ -20 (+/- 2 dB)

(Sheet 1 of 3)

Table 12 (continued)
Definition of supported tones for Belgium

VGCP tone name	VGCP signal 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	
comfort	xcg/cmft	440 (+/- 2%)	0.05 on, 0.05 off (+/- 10%)	infinite	-11 (+/- 2 dB)
off-hook warning	xcg/roh	1404 + 2060 + 2452 (VSP3/ VSP3-o only) + 2604 (+/- 15)	continuous	infinite	-5 + -5 + -5 -6 + -6 + -6 + -6 (+/- 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	425 (+/- 5)	1.0 on. 0.25 off (+/- 0.05)	20	-4.5
recall dial tone	srvtn/rdt	mapped to cg/dt			

(Sheet 2 of 3)

Table 12 (continued)
Definition of supported tones for Belgium

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/- 0.5 dB)**
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

(Sheet 3 of 3)

Brazil

Table 13
Definition of supported tones for Brazil

VGCP tone name	VGCP signal 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/pt	1633 (f1) 1336 (f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on, 2.0 off,	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

(Sheet 1 of 2)

Table 13 (continued)
Definition of supported tones for Brazil

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz) (+/- 25 Hz)	Cadence (s) (+/- 10%)	Duration (s) (+/- 10%)	Level (dBm) (+/- 0.5 dB)
comfort	xcg/cmft	300	continuous	infinite	-15
off-hook warning	xcg/roh	1400 + 2066 + 2467 (VSP3/ VSP3-o only) + 2600 (+/- 1%)	0.1 on, 0.1 off	infinite	-6 + -6 + -6 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o)
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
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

(Sheet 2 of 2)

Canada

Table 14
Definition of supported tones for Canada

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz) (+/- 0.5%)	**Cadence (s) (+/- 10%)**	**Duration (s)**	**Level (dBm) (+/- 1.5 dB)**
dial	cg/dt	350 + 440	continuous	20 (+/- 10%)	-13 + -13
(audible) ringing	cg/rt	440 + 480	2.0 on, 4.0 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) (+/- 50 Hz)	0.33 (f1), 0.33 (f2), 0.33 (f3), 1.0 off	1 cycle	-24/ -24/ -24
warning	cg/wt	1400 (+/- 1.5%)	0.5 on	1 cycle	-7
pay phone recognition	cg/pt	1100 (f1) 750 (f2)	(0.2 (f1) on 0.2 (f1) off, 0.2 (f2) on 0.2 traffic) x 5	13	-6/ -7
call waiting	cg/cw	440	0.3 on	1 cycle	-13
caller waiting	cg/cr	440 + 480 (f1) 440 (f2)	2.0 (f1) 0.3 (f2) 3.7 off	infinite	-19 + -19/ -13
comfort	xcg/cmft	undefined. nothing played. signal complete immediately			

(Sheet 1 of 2)

Table 14 (continued)
Definition of supported tones for Canada

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz) (+/- 0.5%)	**Cadence (s) (+/- 10%)**	**Duration (s)**	**Level (dBm) (+/- 1.5 dB)**
off-hook warning	xcg/roh	1400 + 2060 + 2450 (VSP3/ VSP3-o only) + 2600 (+/- 2%)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o)
negative acknowledge	xcg/nack	480 + 620	0.25 on, 0.25 off	infinite	-24 + -24
vacant number	xcg/vac	Mapped to cg/ct		infinite	
special conditions dial tone	xcg/spec	Mapped to cg/dt			
recall dial tone	srvtn/rdt	350 + 440	(0.1 on, 0.1 off) x 3, then continuous	20 (+/-10%)	-13 + -13
confirmation	srvtn/conf	350 + 440	0.1 on, 0.1 off	3 cycles	-13 + -13
held	srvtn/ht	620	0.25 on, 0.25 off, 0.25 on, 3.25 off	infinite	-24
message waiting	srvtn/mwt	350 + 440	(0.1 on, 0.1 off) x 10, then continuous	20 (+/- 10%)	-13 + -13

(Sheet 2 of 2)

Chile

Table 15
Definition of supported tones for Chile

VGCP tone name	VGCP signal 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/pt	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)
comfort	xcg/cmft	silence (no frequency) signal complete immediately			
off-hook warning	xcg/roh	1400 + 2060 + 2450 (VSP3/ VSP3-o only) + 2600 (+/- 2%)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 + -5 (VSP3/ VSP3-o) -3.5 + -3.5 + -3.5 (VSP2) (+/-1.5 dB)

(Sheet 1 of 2)

Table 15 (continued)
Definition of supported tones for Chile

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
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 tone	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)

(Sheet 2 of 2)

China

Table 16
Definition of supported tones for China

VGCP tone name	VGCP signal 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/pt	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
comfort	xcg/cmft	silence (no frequency), signal complete immediately			

(Sheet 1 of 2)

Table 16 (continued)
Definition of supported tones for China

VGCP tone name	VGCP signal 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 tone	xcg/spec	450 (+/- 25)	0.4 on, 0.04 off	60	-10
recall dial tone	srvt/rdt	450 (+/- 25)	continuous	10	-10
confirmation	srvt/conf	950 (+/- 50)	continuous	2	-20
held	srvtn/ht	silence (no frequency), signal complete immediately			
message waiting	srvtn/mwt	450 (+/- 25)	0.4 on, 0.04 off	60	-10

(Sheet 2 of 2)

Czech Republic

Table 17
Definition of supported tones for Czech Republic

VGCP tone name	VGCP signal 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/pt	1633 (f1) 1336 (f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on, 2.0 off	1 cycle	-5/ -5
call waiting	cg/cw	425 (+/- 10%)	0.33 on	1 cycle	-5 (+/- 1)

(Sheet 1 of 3)

Table 17 (continued)
Definition of supported tones for Czech Republic

VGCP tone name	VGCP signal 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)
comfort	xcg/cmft	silence (no frequency), signal complete immediately			
off-hook warning	xcg/roh	1400 + 2060 + 2450 (VSP3/ VSP3-o only) + 2600 (+/- 2%)	1.0 on, 1.0 off	infinite	-5 + -5 + -5 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o) (+/- 1.5 dB)
negative acknowledge	xcg/nack	425 (+/- 10%)	0.165 on, 0.165 off all +/- 10%	60	-5 (+/- 1)
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)

(Sheet 2 of 3)

Table 17 (continued)
Definition of supported tones for Czech Republic

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
special conditions dial tone	xcg/spec	425 (+/- 10%)	(0.165 on, 0.165 off) x 3, 0.66 on, 0.66 off, (+/- 16)	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%)	1.0 on, 1.0 off, 3.0 on, 1.0 off	1 cycle	-10 + -10 (+/- 2 dB)
held	srvtn/ht	silence (no frequency) signal complete immediately			
message waiting	srvtn/mwt	400 + 425 (+/- 7 Hz)	continuous	20	-6 + -6

(Sheet 3 of 3)

France

Table 18
Definition of supported tones for France

VGCP tone name	VGCP signal 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/pt	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	
comfort	xcg/cmft	440 (+/- 2)	0.05 on, 0.05 off	infinite	-11 (+/- 2 dB)

(Sheet 1 of 2)

Table 18 (continued)
Definition of supported tones for France

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s) (+/-10%)	Duration (s) (+/-10%)	Level (dBm)
off-hook warning	xcg/roh	1404 + 2060 + 2452 (VSP3/ VSP3-o only) + 2604 (+/- 15)	continuous	infinite	-5 + -5 + -5 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o) (+/-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)
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 2 of 2)

Germany

Table 19
Definition of supported tones for Germany

VGCP tone name	VGCP signal 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/pt	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

(Sheet 1 of 3)

Table 19 (continued)
Definition of supported tones for Germany

VGCP tone name	VGCP signal 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	
comfort	xcg/cmft	undefined. nothing played signal complete immediately			
off-hook warning	xcg/roh	1400 + 2066 + 2450 (VSP3/ VSP3-o only) + 2600 (+/- 2%)	0.1 on, 0.1 off	infinite	-5+ -5 + -5 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o) (+/ -2 dB)
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			
confirmation	srvtn/conf	425 (+/- 7)	0.16 off, 0.16 on, 0.16 off, 0.32 on, 0.48 off	1 cycle	-3

(Sheet 2 of 3)

Table 19 (continued)
Definition of supported tones for Germany

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/-1 dB)**
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
(Sheet 3 of 3)					

Greece

Table 20
Definition of supported tones for Greece

VGCP tone name	VGCP signal 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/pt	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
comfort	xcg/cmft	silence (no frequency) signal complete immediately			
off-hook warning	xcg/roh	1400 + 2060 + 2450 (VSP3/ VSP3-o only) + 2600 (+/- 2%)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 + -5 (VSP3/ VSP3-o) -3.5 + -3.5 + -3.5 (VSP2) (+/- 1.5 dB)

(Sheet 1 of 2)

Table 20 (continued)
Definition of supported tones for Greece

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
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)

(Sheet 2 of 2)

Hong Kong

Table 21
Definition of supported tones for Hong Kong

VGCP tone name	VGCP signal 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/pt	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	
comfort	xcg/cmft	Undefined. Nothing played. Signal complete immediately			

(Sheet 1 of 3)

Table 21 (continued)
Definition of supported tones for Hong Kong

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
off-hook warning	xcg/roh	1400 + 2060 + 2450 (VSP3/ VSP3-o only) + 2600 (+/- 2%)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 + -5 (VSP3/ VSP3-o) -3.5 + -3.5 + -3.5 (VSP2) (+/- 1.5 dB)
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)

(Sheet 2 of 3)

Table 21 (continued)
Definition of supported tones for Hong Kong

VGCP tone name	VGCP signal 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)

(Sheet 3 of 3)

India

Table 22
Definition of supported tones for India

VGCP tone name	VGCP signal 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	infinite	-10 (+/- 5)
busy	cg/bt	400	0.75 on, 0.75 off	infinite	-10 (+/- 5)
congestion	cg/ct	400	0.25 on, 0.25 off	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/pt	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)
caller waiting	cg/cr	400 modulated by 25 at 100% depth	0.4 on, 0.2 off, 0.4 on, 2.0 off	infinite	-10 (+/- 5)
comfort	xcg/cmft	silence. (no frequency). signal complete immediately.			
off-hook warning	xcg/roh	400	continuous	infinite	-10

(Sheet 1 of 2)

Table 22 (continued)
Definition of supported tones for India

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
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	infinite	-10 (+/- 5)
message waiting	srvtn/mwt	400 + 300	continuous	20	-13 + -13 (+/- 5)

(Sheet 2 of 2)

Ireland

Table 23
Definition of supported tones for Ireland

VGCP tone name	VGCP signal 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/pt	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

(Sheet 1 of 2)

Table 23 (continued)
Definition of supported tones for Ireland

VGCP tone name	VGCP signal 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	
comfort	xcg/cmft	425 (+/- 5)	0.06 on, 0.06 off	infinite	-13
off-hook warning	xcg/roh	1400 + 2067 + 2467 (VSP3/ VSP3-o only) + 2600	1.0 on, 0.1 off	infinite	-5 + -5 + -5 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o)
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	undefined. nothing played. signal complete immediately			
message waiting	srvtn/mwt	400 (f1) 440 (f2)	0.32 (f1), 0.04 (f2)	20	-13/ -13

(Sheet 2 of 2)

Israel

Table 24
Definition of supported tones for Israel

VGCP tone name	VGCP signal 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/pt	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
comfort	xcg/cmft	silence (no frequency), signal complete immediately			

(Sheet 1 of 3)

Table 24 (continued)
Definition of supported tones for Israel

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
off-hook warning	xcg/roh	1400 + 2060 + 2450 (VSP3/ VSP3-o only) + 2600	0.12 on, 0.08 off	infinite	-6 + -6 + -6 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o)
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

(Sheet 2 of 3)

Table 24 (continued)
Definition of supported tones for Israel

VGCP tone name	VGCP signal 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

(Sheet 3 of 3)

Italy

Table 25
Definition of supported tones for Italy

VGCP tone name	VGCP signal 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/pt	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	
comfort	xcg/cmft	300	continuous	infinite	-15

(Sheet 1 of 2)

Table 25 (continued)
Definition of supported tones for Italy

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15 Hz)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 1 dB)**
off-hook warning	xcg/roh	1404 + 2060 + 2452 (VSP3/ VSP3-o only) + 2604 (+/- 15)	continuous	infinite	-5 + -5 + -5 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o)
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
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

(Sheet 2 of 2)

Japan

Table 26
Definition of supported tones for Japan

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
dial	cg/dt	400	continuous	30	-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	950 (f1) 1400(f2) 1800 (f3)	0.33 (f1) 0.33 (f2) 0.33 (f3) 1.0 off	1 cycle	-10/ -10/ -10 (+/- 2 dB)
warning	cg/wt	1400	0.35 to 0.5 on	1 cycle	-34 (+/- 1.5 dB)
pay phone recognition	cg/pt	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

(Sheet 1 of 2)

Table 26 (continued)
Definition of supported tones for Japan

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
caller waiting	cg/cr	400 modulated by 16 at 85% depth	1.0 on 2.0 off	infinite	-5
comfort	xcg/cmft	silence (no frequency), signal complete immediately			
off-hook warning	xcg/roh	400	-36 dB for 3 -25 dB for 3 -11 dB for 3 0 dB for 13	infinite	see values at Cadence
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	20	-16
recall dial tone	srvtn/rdt	400	continuous	30	-16
confirmation	srvtn/conf	400	0.125 on, 0.125 off, 0.125 on, 0.625 off	repeated	-16
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	20	-16

(Sheet 2 of 2)

Korea

Table 27
Definition of supported tones for Korea

VGCP tone name	VGCP signal 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/pt	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
comfort	xcg/cmft	silence (no frequency), signal complete immediately			

(Sheet 1 of 2)

Table 27 (continued)
Definition of supported tones for Korea

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
off-hook warning	xcg/roh	1400 + 2060 + 2450 (VSP3/ VSP3-o only) + 2600 (+/- 2%)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o) (+/- 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
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

(Sheet 2 of 2)

Malaysia

Table 28
Definition of supported tones for Malaysia

VGCP tone name	VGCP signal 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/pt	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

(Sheet 1 of 2)

Table 28 (continued)
Definition of supported tones for Malaysia

VGCP tone name	VGCP signal 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
comfort	xcg/cmft	silence. no frequency. signal complete immediately.			
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 immediately.			
message waiting	srvtn/mwt	425	0.16 on, 0.16 off	20	-8 (+/- 2)

(Sheet 2 of 2)

Mexico

Table 29
Definition of supported tones for Mexico

VGCP tone name	VGCP signal 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/pt	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
comfort	xcg/cmft	silence (no frequency), signal complete immediately			

(Sheet 1 of 2)

Table 29 (continued)
Definition of supported tones for Mexico

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
off-hook warning	xcg/roh	1400 + 2067 + 2467 (VSP3/ VSP3-o only) + 2600	0.1 on, 0.1 off	infinite	-6 + -5 + -6 (VSP2) -6 + -5 + -6 + -6 (VSP3/ VSP3-o)
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 tone	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 off	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

(Sheet 2 of 2)

Netherlands

Table 30
Definition of supported tones for the Netherlands

VGCP tone name	VGCP signal 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/pt	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)

(Sheet 1 of 3)

Table 30 (continued)
Definition of supported tones for the Netherlands

VGCP tone name	VGCP signal 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	
comfort	xcg/cmft	440 (+/- 2%)	0.05 on, 0.05 off (+/-10%)	infinite	-11 (+/- 2 dB)
off-hook warning	xcg/roh	1404 + 2060 + 2452 (VSP3/ VSP3-o only) + 2604 (+/- 15)	continuous	infinite	-5 + -5 + -5 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o) (+/- 1 dB)
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)
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)

(Sheet 2 of 3)

Table 30 (continued)
Definition of supported tones for the Netherlands

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s) (+/- 10%)**	**Level (dBm)**
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)

(Sheet 3 of 3)

New Zealand

Table 31
Definition of supported tones for New Zealand

VGCP tone name	VGCP signal 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/pt	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)
comfort	xcg/cmft	not defined. Signal complete immediately			

(Sheet 1 of 3)

Table 31 (continued)
Definition of supported tones for New Zealand

VGCP tone name	VGCP signal 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 31 (continued)
Definition of supported tones for New Zealand

VGCP tone name	VGCP signal 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 32
Definition of supported tones for Panama

VGCP tone name	VGCP signal 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/pt	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)
comfort	xcg/cmft	silence (no frequency), signal complete immediately			
off-hook warning	xcg/roh	1400 + 2060 + 2450 (VSP3/ VSP3-o only) + 2600 (+/- 2%)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o) (+/- 1.5 dB)
negative acknowledge	xcg/nack	425	0.25 on, 0.25 off	60	-10 (+/- 5)

(Sheet 1 of 2)

Table 32 (continued)
Definition of supported tones for Panama

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
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 immediately			
message waiting	srvtn/mwt	425	continuous	20	-10 (+/- 5)

(Sheet 2 of 2)

Philippines

Table 33
Definition of supported tones for the Philippines

VGCP tone name	VGCP signal 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/pt	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	30, followed by busy tone	-10 (+/- 5)
comfort	xcg/cmft	silence (no frequency). Signal complete immediately			

(Sheet 1 of 2)

Table 33 (continued)
Definition of supported tones for the Philippines

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
off-hook warning	xcg/roh	1400 + 2067 + 2467 (VSP3/ VSP3-o only) + 2600	0.1 on 0.1 off	infinite	-10 (+/- 1)
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

(Sheet 2 of 2)

Poland

Table 34
Definition of supported tones for Poland

VGCP tone name	VGCP signal 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 (f2) 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/pt	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

(Sheet 1 of 3)

Table 34 (continued)
Definition of supported tones for Poland

VGCP tone name	VGCP signal 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	
comfort	xcg/cmft	Undefined. Nothing played. Signal complete immediately			
off-hook warning	xcg/roh	1400 + 2066 + 2450 (VSP3/ VSP3-o only) + 2600 (+/- 2%)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 + -5 (VSP3/ VSP3-o) -3.5 + -3.5 + -3.5 (VSP2) (+/- 2 dB)
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			
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)

(Sheet 2 of 3)

Table 34 (continued)
Definition of supported tones for Poland

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
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 35
Definition of supported tones for Portugal

VGCP tone name	VGCP signal 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/pt	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	
comfort	xcg/cmft	300	continuous	infinite	-13

(Sheet 1 of 2)

Table 35 (continued)
Definition of supported tones for Portugal

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 1 dB)**
off-hook warning	xcg/roh	950 + 1400 + 1800 (VSP3/ VSP3-o only) + 2600	0.1 on, 0.1 off	infinite	-18 + -18 + -18 (VSP2) -19 + -19 + -19 + -19 (VSP3/ VSP3-o)
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 tone	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	infinite	-13

(Sheet 2 of 2)

Romania

Table 36
Definition of supported tones for Romania

VGCP tone name	VGCP signal 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/pt	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
comfort	xcg/cmft	silence (no frequency), signal complete immediately			
off-hook warning	xcg/roh	3000	continuous	infinite	3
negative acknowledge	xcg/nack	450	0.5 on, 0.5 off	60	-8

(Sheet 1 of 2)

Table 36 (continued)
Definition of supported tones for Romania

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm))**
vacant number	xcg/vac	450	0.362 on, 0.11 off, (0.02 on, 0.11 off) x 6	infinite	-4.5
special conditions dial tone	xcg/spec	450 modulated by 25 at 100% depth	0.4 on, 0.04 off	20	-4.5
recall dial tone	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 immediately			
message waiting	srvtn/mwt	450 modulated b 25 at 100% depth	0.4 on, 0.4 off	20	-4.5

(Sheet 2 of 2)

Singapore

Table 37
Definition of supported tones for Singapore

VGCP tone name	VGCP signal 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	1 cycle	-20
pay phone recognition	cg/pt	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
comfort	xcg/cmft	silence. no frequency. signal complete immediately			
off-hook warning	xcg/roh	3200	continuous	infinite	-8 (+/- 2 dB)

(Sheet 1 of 2)

Table 37 (continued)
Definition of supported tones for Singapore

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
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 immediately.			
message waiting	srvtn/mwt	425	0.25 on, 0.25 off, 0.25 on, 0.25 off	20	-12

(Sheet 2 of 2)

Spain

Table 38
Definition of supported tones for Spain

VGCP tone name	VGCP signal 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/pt	1600	0.05 on	1 cycle	-20
call waiting	cg/cw	425	0.175 on, 0.175 traffic, 0.175 on	1 cycle	-6

(Sheet 1 of 3)

Table 38 (continued)
Definition of supported tones for Spain

VGCP tone name	VGCP signal 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	
comfort	xcg/cmft	300	continuous	infinite	-6
off-hook warning	xcg/roh	1404 + 2060 + 2452 (VSP3/ VSP3-o) + 2604	continuous	infinite	-5 + -5 + -5 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o)
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
confirmation	srvtn/conf	450	0.16 off, 0.16 on, 0.16 off, 0.32 on, 0.48 off	1 cycle	-8

(Sheet 2 of 3)

Table 38 (continued)
Definition of supported tones for Spain

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15)	**Cadence (s) (+/- 5%)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/-1 dB)**
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

(Sheet 3 of 3)

Sweden

Table 39
Definition of supported tones for Sweden

VGCP tone name	VGCP signal 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/pt	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	
comfort	xcg/cmft	300	continuous	infinite	-9

(Sheet 1 of 2)

Table 39 (continued)
Definition of supported tones for Sweden

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15)	**Cadence (s) (+/-10%)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/-1 dB)**
off-hook warning	xcg/roh	1404 + 2060 + 2452 (VSP3/ VSP3-o) + 2604	continuous	infinite	-5 + -5 + -5 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o)
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	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
held	srvtn/ht	undefined. play nothing. signal complete immediately			
message waiting	srvtn/mwt	425	(0.1 on, 0.1 off) x 10 then continuous	20	-9

(Sheet 2 of 2)

Switzerland

Table 40
Definition of supported tones for Switzerland

VGCP tone name	VGCP signal 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/pt	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	

(Sheet 1 of 2)

Table 40 (continued)
Definition of supported tones for Switzerland

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 1.5 dB)**
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

(Sheet 2 of 2)

Taiwan

Table 41
Definition of supported tones for Taiwan

VGCP tone name	VGCP signal 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/pt	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
comfort	xcg/cmft	300	continuous	infinite	-13
off-hook warning	xcg/roh	480	continuous	infinite	-3
negative acknowledge	xcg/nack	480 + 620	0.25 on, 0.25 off	60	-24 + -24

(Sheet 1 of 2)

Table 41 (continued)
Definition of supported tones for Taiwan

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
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 immediately			
message waiting	srvtn/mwt	350 + 440	(0.1 on, 0.1 off) x 3 then continuous	20	-13 + -13

(Sheet 2 of 2)

Thailand

Table 42
Definition of supported tones for Thailand

VGCP tone name	VGCP signal 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/pt	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
comfort	xcg/cmft	Silence. Signal complete immediately			
off-hook warning	xcg/roh	400	0.3 on, 0.3 off	infinite	-10

(Sheet 1 of 2)

Table 42 (continued)
Definition of supported tones for Thailand

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
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)

(Sheet 2 of 2)

Turkey

Table 43
Definition of supported tones for Turkey

VGCP tone name	VGCP signal 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/pt	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
comfort	xcg/cmft	silence (no frequency), signal complete immediately			

(Sheet 1 of 2)

Table 43 (continued)
Definition of supported tones for Turkey

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz) (+/- 5%)	**Cadence (s)**	**Duration (s)**	**Level (dBm) (+/- 0.4)**
off-hook warning	xcg/roh	1400 + 2060 + 2452 (VSP3/ VSP3-o only) + 2600	0.1 on, 0.1 off	infinite	0 + 0 + 0 (VSP2) -1 + -1 + -1 + -1 (VSP3/ VSP3-o)
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
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 off, 0.2 on, 0.6 off	20	-11.8

(Sheet 2 of 2)

United Kingdom

Table 44
Definition of supported tones for the United Kingdom

VGCP tone name	VGCP signal 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/pt	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	
comfort	xcg/cmft	undefined. play nothing. signal complete immediately			

(Sheet 1 of 2)

Table 44 (continued)
Definition of supported tones for the United Kingdom

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz) (+/- 2%)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 2 dB)**
off-hook warning	xcg/roh	1400 + 2066 + 2450 (VSP3/ VSP3-o only) + 2600	0.1 on, 0.1 off	infinite	-5 + -5 + -5 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o)
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	
confirmation	srvtn/conf	351 + 439	0.1 on, 0.1 off, 0.3 on, 0.1 off	1 cycle	-10 + -10
held	srvtn/ht	undefined. play nothing. signal complete immediately			
message waiting	srvtn/mwt	350 + 440	(0.1 on, 0.1 off) x 10 then continuous	infinite	-10 + -10

(Sheet 2 of 2)

United States

Table 45
Definition of supported tones for the United States

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz) (+/- 0.5%)	**Cadence (s) (+/- 10%)**	**Duration (s)**	**Level (dBm) (+/-1.5 dB)**
dial	cg/dt	350 + 440	continuous	20 (+/- 10%)	-13 + -13
(audible) ringing	cg/rt	440 + 480	2.0 on, 4.0 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) (+/- 50 Hz)	0.33 (f1) on 0.33 (f2) on 0.33 (f3) on 1.0 off	1 cycle	-24/ -24/ -24
warning	cg/wt	1400 (+/- 1.5%)	0.5 on	1 cycle	-7
pay phone recognition	cg/pt	1100 (f1) 750 (f2)	(0.2 (f1) on 0.2 (f1) off, 0.2 (f2) on 0.2 traffic) x 5	13	-6/ -7
call waiting	cg/cw	440	0.3 on	1 cycle	-13
caller waiting	cg/cr	440 + 480 (f1) 440 (f2)	2.0 (f1) 0.3 (f2) 3.7 off	infinite	-19 + -19/ -13
comfort	xcg/cmft	undefined. play nothing. signal complete immediately			

(Sheet 1 of 2)

Table 45 (continued)
Definition of supported tones for the United States

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz) (+/- 0.5%)	**Cadence (s) (+/- 10%)**	**Duration (s)**	**Level (dBm) (+/-1.5 dB)**
off-hook warning	xcg/roh	1400 + 2060 + 2450 (VSP3/ VSP3-o only) + 2600 (+/- 2%)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 (VSP2) -6 + -6 + -6 + -6 (VSP3/ VSP3-o)
negative acknowledge	xcg/nack	480 + 620	0.25 on, 0.25 off	infinite	-24 + -24
vacant number	xcg/vac	mapped to cg/ct			
special conditions dial tone	xcg/spec	map to cg/dt		infinite	
recall dial tone	srvtn/rdt	350 + 440	(0.1 on, 0.1 off) x 3, then continuous	20 (+/- 10%)	-13 + -13
confirmation	srvtn/conf	350 + 440	0.1 on, 0.1 off	3 cycles	-13 + -13
held	srvtn/ht	620	0.25 on, 0.25 off, 0.25 on, 3.25 off	infinite	-24
message waiting	srvtn/mwt	350 + 440	(0.1 on, 0.1 off) x 10, then continuous	20 (+/-10%)	-13 + -13

(Sheet 2 of 2)

Venezuela

Table 46
Definition of supported tones for Venezuela

VGCP tone name	VGCP signal 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)	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/pt	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
comfort	xcg/cmft	silence (no frequency), signal complete immediately			
off-hook warning	xcg/roh	1440	0.5 on, 0.5 off	infinite	+3
negative acknowledge	xcg/nack	425 (+/- 10)	0.25 on, 0.25 off	60	-10

(Sheet 1 of 2)

Table 46 (continued)
Definition of supported tones for Venezuela

VGCP tone name	VGCP signal package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
vacant number	xcg/vac	425 (+/- 10)	0.25 on, 0.25 off	infinite	-10
special conditions dial tone	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 immediately			
message waiting	srvtn/mwt	425	0.1 on, 0.1 off	20	-10

(Sheet 2 of 2)

Passport 7400, 15000, 20000

Packet Voice Gateway Technology Fundamentals

Release Release 5.2

Publication: 241-5701-780
Document status: Standard
Document version: 5.2S3
Document date: March 2004
Printed in Canada

NORTEL NETWORKS