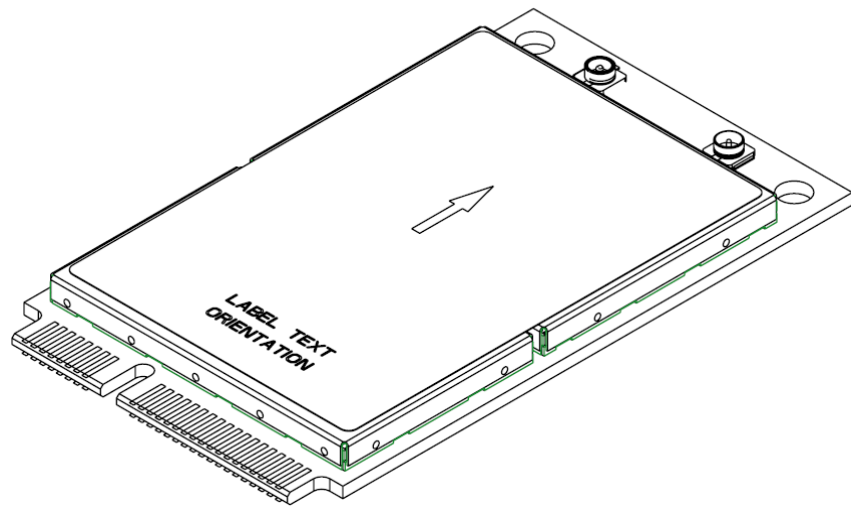


# MC5728V Mini Card

## Software Integration Guide

Proprietary and Confidential



# Preface

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[www.sierrawireless.com](http://www.sierrawireless.com)

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# About This Guide

## Introduction

This guide is for original equipment manufacturers (OEMs) and other integrators who are using the Sierra Wireless MC5728V Mini Card modem but are not using the Watcher™ enabling software provided for it by Sierra Wireless.

If you are using the Mini Card with an operating system other than Microsoft® Windows®, or if you choose not to use the Sierra Wireless enabling software, you may develop your own enabling software with the assistance of these Development Kit documents:

- 2130759—*Software Integration Guide* (this document)
- 2130620—*AT Command Reference*
- 2130754—*CnS Reference*
- 2130652—*Activation Guide*
- 2130634—*USB Driver Developer's Guide*

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*Note: This guide is not for end users, and is proprietary to Sierra Wireless. Integrators are not authorized to duplicate any part of this document in end-user documentation.*

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You are responsible for using the information in this guide to create appropriate end-user software and documentation applicable to your specific products.

This guide includes information on how to command and control the Mini Card using software of your own design. It provides the methods to access features using the available interfaces:

- [AT](#) commands
- [CnS](#) messages

The functionality covered includes:

- [Configuration](#) (page 28)
- [Device Management](#) (OMA-DM) (page 33)
- [1X/IS-95 data connections](#) (page 36)
- [1xEV-DO data connections](#) (page 42)
- [Voice connections](#) (page 45)
- [SMS message](#) receive and send (page 56)
- [Location-Based Services](#) (page 68)
- [Fax connections](#) (page 73)

*Note: More information about CDMA networks is available on the CDMA Development Group web site, [www.cdg.org](http://www.cdg.org).*

Using the Mini Card with your enabling software requires an active CDMA wireless account. See the *Activation Guide* (document 2130652).

### Customized editions

Various CDMA service providers may have differing requirements of the supporting software. This means that the Mini Card firmware may vary in behavior based on different editions for differing service providers.

As you establish your business relationship with a provider, ensure you are current with any behaviors, capabilities, or performance requirements of the software. Keep in mind that special requirements may exist and you may need to provide appropriate software.

Sierra Wireless may make available application notes for firmware editions that have significantly different behavior from that described in this document.

## Document structure

This guide is divided into the following chapters.

[About This Guide](#)—The current chapter introduces the purpose of this guide, as well as providing information about the currency of the guide, additional resources, and terminology.

[Interface Overview](#) (page 18)—Describes the USB port, modem states, and three methods of software control. Any or all of the methods can be used in your application.

[General Features](#) (page 28)—Discusses how to set up many of the options of Mini Card, and access connection status information. Some options are specific to a connection feature and are covered in the chapter for the feature, but some configuration options impact multiple connection types or overall modem operation; those options are covered here.

[Device Management](#) (page 33)—Describes operations related to OMA Device Management.

[1X/IS-95 Data Connections](#) (page 36)—Describes how to set up 1X/IS-95 data connections, and manage dormancy. Covers both circuit switched and Quick Net Connect (QNC) connections.

[1xEV-DO Data Connections](#) (page 42) – Describes how to set up 1xEV-DO data connections and manage dormancy.

[Voice Connections](#) (page 45)—Covers the operation of the modem with respect to voice calls, including dialing, answering, call options (such as Call Waiting and three-way calls), and emergency (E911) calls.

[SMS Messages](#) (page 56)—Details the mechanisms to receive and send Short Message Service (SMS) messages.

[Location-Based Services](#) (page 68)—Provides information on using the GPS feature supported by some carriers/networks.

[Fax Connections](#) (page 73)—Provides information on configuring the modem to receive or originate fax connections.

[Troubleshooting](#) (page 77)—Provides both an overview of developer support available from Sierra Wireless, and a description of how to troubleshoot connection problems.

[Appendix A: Acronyms and definitions](#) (page 79)

[Appendix B: ASCII Table](#) (page 85)

[Appendix C: Data Connection Application Note](#) (page 86)—Describes the configuration for a data connection, initiating and ending a data session, active/dormant transitions.

[Appendix D: Voice Connection Application Note](#) (page 93)—Describes the configuration for a voice connection, originating and terminating a voice call, Call Waiting and three-way calling.

[Appendix E: SMS Application Note](#) (page 98)—Describes the configuration for and receiving and sending SMS.

[Appendix F: Configurations](#) (page 106)—Shows PRI and ERI download, using CnS.

[Appendix G: CDMA System Architecture](#) (page 108)—Provides system level description for data, voice, SMS and **OTASP** services support for **IS-95** and **1X** network.

[Appendix H: LBS Application Note](#) (page 127)—Shows the CnS objects used in a mobile originated single position fix session and mobile originated position tracking session.

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*Note: You are assumed to have a solid understanding of the CDMA infrastructure. The details of network elements such as PRL, PRI, and account parameters are beyond the scope of this document.*

---

An understanding of packet data and Windows Dial-up Networking / RAS is also useful.

## References

For some background on the CDMA data network, we suggest you consult web sites including (but not limited to):

- CDMA Developers Group ([www.cdg.org/](http://www.cdg.org/))
- Qualcomm ([www.qualcomm.com/cdma](http://www.qualcomm.com/cdma))
- Palowireless Resource Centre ([www.palowireless.com/3g/cdma.asp](http://www.palowireless.com/3g/cdma.asp))
- Carrier infrastructure manufacturers:
- Ericsson ([www.ericsson.com](http://www.ericsson.com))
- Lucent ([www.lucent.com/](http://www.lucent.com/))
- Motorola ([www.mot.com/home](http://www.mot.com/home))

- Nortel Networks ([www.nortelnetworks.com](http://www.nortelnetworks.com))
- Spread Spectrum Scene magazine ([www.sss-mag.com](http://www.sss-mag.com))

Information can also be found in [Appendix G: CDMA System Architecture](#) on page 108.

## Terminology and acronyms

This document makes frequent use of acronyms. For a glossary of acronyms and terms used in Sierra Wireless documentation, please consult the document downloads at our web site: [www.sierrawireless.com](http://www.sierrawireless.com).

See also [Table 9](#) on page 79.

## Currency

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*Note: Documents with a letter in the revision are drafts and subject to change before final release.*

---

This document may be revised from time to time as new firmware features become available. For revisions, please check our web site. This document edition is:

**Rev 2, 23 August 2012**

## Firmware

This document is current with the modem firmware revisions shown in the following table:

Product	Firmware version
MC5728V	SWI6800V2_FP.01.04

The revision can be determined using the [AT](#) command **+GMR** or by using the Watcher menu option **Help > About**.

## Upgrading

If your modem firmware is an earlier version, you can acquire updated firmware from our web site or by contacting your account manager. Upgrade instructions are provided with the upgrade package.

## Revision history

Version	Summary of changes
<b>1.0 May 07</b>	Initial release
<b>1.1 Apr 08</b>	Added support for MC5727 Mini Card.
<b>1.2 Mar 09</b>	Added support for MC5727V and MC5728V Mini Cards. Added “ <a href="#">Retrieving satellite information</a> ” section (page 70) and “ <a href="#">Device Management</a> ” chapter (page 33). Added the last row to <a href="#">Table 1</a> (page 18).
<b>2 Aug 12</b>	New template. Changes to the patents section. Removed products that have reached end-of-life (MC 5725, 5725V, 5727, 5727V).

# Interface Overview

## Introduction

There are two possible protocol interfaces to use between your enabling software and the Mini Card modem. The modem itself uses two: **AT** commands/**PPP** (page 26) and **CnS** messages (page 26). A third interface is available for diagnostics (**DM**) access.

In addition to the software interfaces, there may be some hardware control signals that are also used to control modem behavior: serial port control signals, power mode, reset, and status outputs. For more information, see the Reference Guide for your modem.

## Physical interface to software interface mapping

The Mini Card supports only a USB physical interface, which provides limited options for software interface mapping. In addition, Sierra Wireless provides a muxing protocol (**HIP**) that allows **CnS** and **DM** to exist on the same physical interface. The following table outlines the possible selections. The port mapping setting is controlled via PRI table settings and is typically programmed via **CCT**. Port mapping **NV** item is 408.

Table 1: Mini Card port mapping

Port Mapping	NV Value	AT/PPP	CnS	DM
Mode 4 (USB with optional <b>DM</b> over UART)	57	USB	USB ( <b>HIP</b> )	UART1
Mode 5 (USB with optional <b>DM</b> over <b>HIP</b> )	74	USB	USB ( <b>HIP</b> )	USB ( <b>HIP</b> )
Mode 6 (USB without <b>CnS</b> and with <b>DM</b> )	66	USB	None	USB
UART with <b>CnS</b> and <b>DM</b> over USB	45	UART1	USB ( <b>HIP</b> )	USB ( <b>HIP</b> )

## USB

The USB port of the Mini Card is used for both [AT/PPP](#) and control and status transactions. By implementing over the USB port, you gain full access to all features via the [CnS](#) interface. For additional USB integration details, see the *USB Driver Developer's Guide* (document 2130634).

### Capability

- Standard modem support
- Monitoring and status during active data session - allows interrogation of the modem's operating state, connection state, signal strength, roaming, data transfer statistics, and more.
- Complete support for all notifications via the [CnS](#) interface
- Full voice support
- Full SMS support

### Limitations

- Requires a USB driver on the host.

### Handshaking

Handshaking is intended for devices that are portable and need to conserve power. If the device does not care about power, then handshaking can be disabled. The handshaking method for USB port integration must use SUSPEND, RESUME, and REMOTE WAKEUP.

### Connection dormancy

A 1X data connection can become dormant. Without [notifications](#) on the control port, the host has no way to detect this.

Many applications are not affected by a session becoming dormant, although others may have problems if the underlying [PPP](#) connection must be rebuilt upon leaving dormancy, possibly resulting in a change to the IP address of the device.

## Modem states

Before getting into the details of the interfaces available, it is important to understand the operating states of the modem and how the modem transitions from one state to another, as these affect the behavior of the software interfaces.

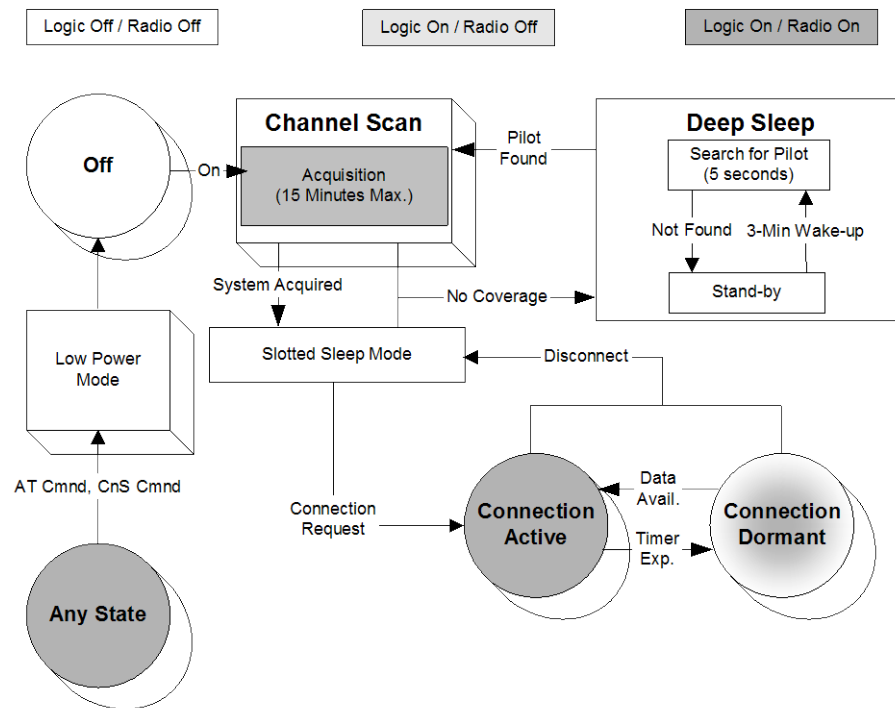
The states offer varying power consumption, operational capability, and functional limitations. For example: with an active [1X](#) data session open, you cannot make or receive voice calls, but when the 1X connection goes into dormant state, voice calls are possible but [IS-95](#) data and fax are not.

When the modem is in particular states, the traffic over the **AT** and **CnS** interfaces may be halted. In addition, some transitions require the use of the DTR control signal.

**Figure 1** on page 20 shows an overview of the modem states and broad reasons for transitions. The subsequent pages provide more detailed descriptions and diagrams.

Shading is used to provide a very rough idea of the power demands of a given state. For details on power consumption, see the Reference Guide for your modem.

Figure 1: Mini Card state diagram



## Acquisition

From power-up, reset, or return from low power mode, the modem attempts to find CDMA service. This process can take several minutes as the radio tunes channels defined by the service provider's PRL (Preferred Roaming List).

During the acquisition state, the modem is fully powered and all interfaces are functional. A connection cannot be made until the modem successfully locates a CDMA service channel.

If the modem fails to find a channel, then it drops into Deep Sleep state; otherwise it switches to Slotted Mode Sleep where it waits for a connection attempt.

## Deep Sleep

When the modem cannot acquire a CDMA radio channel, it drops into a power-saving state called Deep Sleep. In this state the modem cycles between being **Inactive** and **Searching for Pilot**.

**Inactive** While out of coverage, the modem waits in the inactive state for three minutes. At the end of this time, the modem searches for a pilot signal.

While inactive, the modem switches off the radio (**Stand-by**) and can also switch off additional circuitry to further reduce power.

**Search for Pilot** At three-minute intervals the modem turns on logic and radio circuitry to look for a pilot signal. If none is found, the modem returns to Inactive.

When a pilot is detected, the modem returns to the Channel State and tries to acquire CDMA service.

## Slotted mode sleep

When not active in a call, the modem is permitted to shut down the radio for brief periods to conserve power. The modem wakes at a specified time slot, to check the paging channel for traffic.

Figure 2 (below) illustrates the slotted mode state.

In this state, the modem cycles between being **Inactive** and **Checking Paging Channel**, much like the Deep Sleep state.

**Check Paging Channel** At intervals defined by the SCI (Slot Cycle Index), which is generally set by the CDMA network, the modem performs a check of the paging channel to determine if the network has a connection request for the modem. This check requires 120–150 ms, during which the modem's logic and radio receiver are on.

If there is no traffic from the network, the modem returns to Inactive.

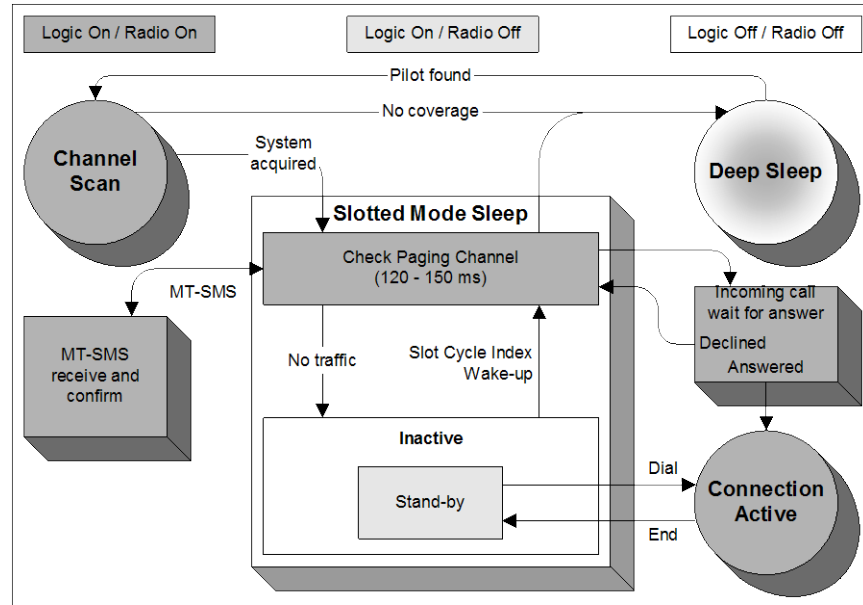
When a connection request is received, the modem processes the request and then returns to slotted mode sleep.

---

*Note: CDMA service providers give priority attention to voice traffic. To avoid extended latency in detecting and responding to incoming calls, they prefer to use fairly short slot cycles, typically values of two (2) or less.*

---

Figure 2: Mini Card slotted mode sleep state diagram



**Inactive** While waiting the interval defined by the SCI, the modem is in the inactive state.

While inactive, the modem switches off the radio (Stand-by) and can also switch off additional circuitry to further reduce power if the host suspends the USB bus.

This disables serial communication over the port, and the host or modem is not allowed to send data while in the "Slumber" state.

During Slumber state, the modem issues only [notifications](#) during the awake period between slots. Notifications can also be enabled/disabled with a [CnS](#) message.

Prior to sending data over the CnS port, handshaking must be performed to transition the modem from Slumber state to standby mode: either the host resumes the USB bus, or the modem issues a remote wakeup on the USB bus.

**Connection requests** The modem manages the process of handling incoming traffic through configurable signals to the host for: MT-SMS (incoming) messages, incoming calls (voice, fax, or data); and for host-initiated calls.

**MT-SMS** The modem manages receiving and acknowledging MT (Mobile Terminated) SMS messages and return to slotted mode operation. On these events, the modem can be configured to:

- Send [CnS notifications](#) to the host
- Trigger the [RI](#) signal to wake a sleeping host

**Incoming calls** On detection of an incoming call (voice, fax, or data), the modem can be configured to:

- Send CnS notifications to the host
- Trigger the RI signal to wake a sleeping host
- Automatically answer (after a specified period)

If the call is declined by the host, the modem returns to slotted mode sleep.

If the call is answered, the modem shifts to the Connection Active state.

**Host-initiated connections** If the host initiates a connection for MO-SMS, voice, fax, IS-95 data, or 1X data, the modem shifts to an active connection state.

### Connection active

While a connection is active, the modem keeps all logic and the radio powered.

The transmitter is switched on as needed, so current consumption varies based on the amount of time the transmitter is needed.

A 1X data connection that is not actively used to move data can go into dormant state based on a timer set by the network. (For details, see [Figure 10](#) on page 92.)

IS-95 data, fax, and all voice calls do not go dormant; they require the connection to remain active until the call is ended.

While the modem has an active connection, it cannot initiate another connection, with the exception of SMS handling.

When a connection is closed (regardless of whether it was host initiated or received from the network), the modem returns to slotted mode sleep.

**SMS while connection active** CMDA allows short SMS messages to be transacted outside of the usual traffic channel. This means that you may be able to send and receive SMS messages while there is another active connection.

A voice connection does not tie up the primary serial port, but other connection types do. This means that the exchange of SMS messages while in a connection other than a voice call requires use of the CnS interface on the secondary port. Without the secondary port, the host has to wait until the current connection is closed to gain access to the AT interface to retrieve any pending SMS messages.

## Connection dormant

When the modem has an active 1X connection, you cannot make voice calls.

Service providers do not want mobiles to miss voice calls if they can avoid it.

High-speed data connections offer a special case to the Connection Active state: **dormant state**. Many networks switch a connection into dormant state after fairly brief periods of inactivity (this period is set by the network service provider, but is always less than one minute). For details, see [Figure 10](#) on page 92.

While the data connection is dormant, the modem can make or receive voice calls.

You are not be able to transmit or receive data during the voice call, but the connection is not lost.

When you end the voice call, you can resume data transmission without the need of reestablishing the connection.

---

*Note: Some service providers continue to bill for accumulated time while the modem is dormant. For details, check with your provider.*

---

While dormant, the modem releases the radio resource (the physical layer) but keeps the upper layers of the connection active, including the PPP session on the primary port.

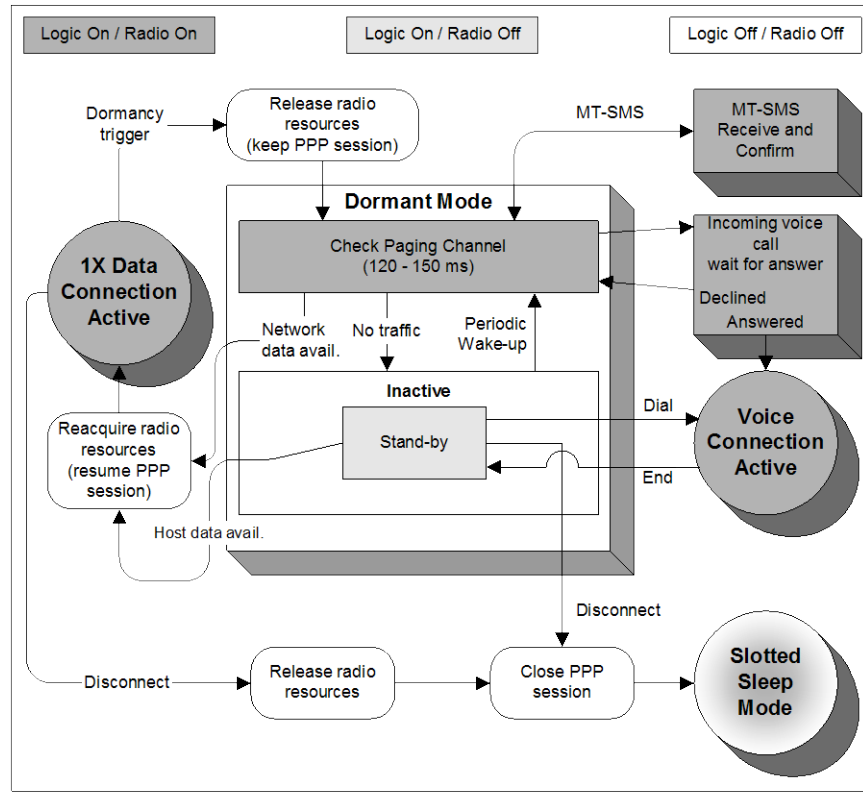
Just how long a dormant connection is held active (the PPP layer preserved) varies by service provider. After a set period, the network also tears down the PPP session. If this happens, and the host then tries to resume traffic, the host must detect the lost PPP session and build a new one. This can add significant latency to time-critical applications and can lead to dynamic IP changes in what should appear to be a single session.

Some applications require that the connection never go dormant. This may be due to the higher latency in restoring the connection, or to preserve the IP address of the PPP connection for VPNs. If your application cannot permit dormancy, then you may need a keep-alive protocol that permits periodic “dummy” traffic to maintain the connection.

Dormant state (illustrated in [Figure 3](#) on page 25) behaves very much like slotted mode sleep, except that the host appears to have a PPP session open.

Additionally, the modem can make use of the radio resource for voice calls when the 1X connection is dormant. Should this happen, the 1X connection cannot be restored until the voice connection is closed.

Figure 3: Mini Card dormant mode state diagram



**Restoring a dormant connection** When either the host or the network has traffic, the modem must reacquire the radio resources to rebuild the physical layer (and, in some cases, the PPP session). The connection then resumes as active.

Note that the transition from dormant to active for traffic originating from the network may place the modem in an active connection while the host has turned off DTR.

The restoration of the connection is treated by the modem as a new connection. This means the modem can generate (if so configured):

- **CnS notifications** of the connection
- **RI** to wake the host for an incoming call

## Low power mode

Reasons to carefully control the modem's power mode include:

- Being well-behaved on the network
- Reducing the power consumption

Entering low power mode state can be triggered by:

- **AT** command (**!PCSTATE**)
- **CnS** command (**0x0007 RADIO POWER**)

For more information on power control, see the Reference Guide for your modem.

## AT command interface

The Mini Card primary port supports the **AT** command interface. This looks like a standard modem on a serial connection.

The *AT Command Reference* (document 2130620) provides information about the connection characteristics in addition to a full reference on each command.

This guide covers the AT commands used to make use of modem features.

## Query and response

The **AT** command interface is built on a query response model. The host issues AT commands, the modem responds.

When working with a wireless modem, there is often an interest in radio status, such as received signal strength or quality. In normal operation, this information is provided as periodic **notifications** by the modem using the **CnS** interface (page 26). The AT command interface cannot support notifications.

Although the status information is available through the AT command interface, the onus is on the host application to solicit this information when needed.

## CnS message interface

The secondary port of the Mini Card supports the Control and Status (**CnS**) message interface. This is intended to be the principal control mechanism of the modem.

The *CnS Reference* (document 2130754) provides a detailed description of this proprietary protocol. The Mini Card encapsulates CnS messages within a transport packet called **HiP** (Host Interface Protocol). To use this interface, your software has to assemble and disassemble HiP and CnS packets.

## Query, response, and notification

The **CnS** interface is the principal interface because it can support asynchronous **notifications** in addition to the traditional query and response interaction.

Notifications allow the modem to keep the host application informed of radio signal quality, connection status, and other aspects of the radio modem operation, without the need for the host application to issue repeated queries.

## Limitations

Although all modem feature commands and status information can be exchanged across this interface, the **AT** command interface is still used to create data connections.

Dialing, answering, and ending both data and fax connections require use of AT commands. The CnS interface is used to originate and answer voice calls.

For additional details on the limitations of the CnS message interface, consult the *CnS Reference* (document 2130754).

## Test and upgrade access (passthrough)

Connecting test software (such as CAIT) is essential for **CDG** testing. If your device cannot support CAIT directly, a serial passthrough connection between the Mini Card in your device and an external serial port is needed.

This passthrough may also be needed to perform firmware and carrier provisioning upgrades. Without it, you may not be able to upgrade your modem without removing it from the host device and reinstalling afterward.

# General Features

## Introduction

This chapter covers the programming of features and status reporting that are not specific to any particular connection type:

- [Basic configuration](#)—confirming the modem’s setup, compatibility, and state
- [Modem status](#)—information about the current coverage status and any active connections (page 29)
- [User security](#)—controlling the user “PIN” modem locking feature (page 31)

## Basic configuration

When receiving a voice call or SMS message, you may want to produce a sound or other alert to the user of the event. You will need to configure the modem to notify the application of these events.

### Incoming call

Detection of incoming calls requires the application to receive a [notification](#), either via the hardware Ring Indicator or software messages.

**CnS** Notification **0x3004 Incoming Call** reports the type of call arriving. Note that this is one of many notifications enabled with the **Call Notification Status** object **0x3000**.

Following receipt of the incoming call notification, information on caller ID may become available.

This notification applies to both incoming voice and data/fax calls.

**AT** Incoming data and voice calls trigger the RING result code from the modem, unless the modem is set to quiet operation (Q=1). If the modem has register S0 set, the modem automatically negotiates answering the call, issuing the CONNECT message when the call is connected. Negotiation of [PPP](#) is expected to come from the host.

Incoming voice calls only generate the [RI](#) hardware signal.

## Call Alert

Depending on the billing plan, you may have a feature called Call Alert. When a voice call is active, this feature notifies you when you have another incoming call. You can then ignore the new incoming call or put your current caller on hold and answer the new call. (If you require more information about Call Alert, contact your service provider.)

**CnS** Notification **0x3004 Incoming Call** reports a “Call Waiting” type for call alert [notification](#).

**AT** The [AT](#) command interface does not support Call Alert.

## New SMS message

**CnS** **0x2000 SMS Receive Status** can be queried or used as a notification to report new SMS messages.

**AT** The [AT](#) interface does not notify the application of incoming SMS messages. The host must query the modem using **!CNTSMS** to check for new messages.

## Modem status

This section deals with the modem’s status with the network:

- Determine the current signal strength ([RSSI](#)), roaming status, CDMA and [1xEV-DO](#) network availability, and other network connection parameters
- View call statistics
- Configure the modem to answer data or fax calls

Many elements about connectivity are not known until an attempt is actually made to connect to the network. Although coverage may be present, authentication and permission to connect are determined at the time the connection is initiated.

## Signal strength

CDMA and [1xEV-DO](#) do not strictly use a Received Signal Strength Indicator (RSSI). A dBm value is provided by the modem using an algorithm that factors signal and noise levels.

**CnS** Both query and [notifications](#) are available. Use object **0x1065 RSSI and Ec/Io for CDMA and HDR**. Notification on this object is issued only when new value crosses predefined threshold.

Alternatively, use **0x1001 RSSI** to obtain CDMA RSSI value only, and **0x1067 HDR RSSI** to obtain [HDR](#) RSSI value only. These values are checked every second; notifications are issued only when the new and old values are different.

**AT** The CDMA RSSI can be reported only using the command **!RSSI**. A command for **HDR** RSSI is not provided.

### Service availability

With the introduction of **1xEV-DO**, the process of determining what service indication to display to the user has become more complex. A number of **CnS** objects must be used to determine the proper value as indicated in [Table 2: Service Indication](#) (below).

**CnS** Object **0x1006 Service Indication** is used (either query or notification) to detect whether or not a CDMA network is detected. If this indicates there is a service, then use **0x101C Protocol Revision Number** to determine if **1X** is supported.

Object **0x1069 HDR Service State** is used (either query or notification) to detect whether or not there is 1xEV-DO network detected.

Object **0x106A HDR Hybrid Preference** needs to be queried to properly determine service available based on the information in [Table 2: Service Indication](#) (below).

**AT** The command **+CAD?** queries for the presence of service. There is no direct way in the **AT** interface to detect the type of service.

Table 2: Service Indication

HDR hybrid preference	Service Indication	HDR Service State	Protocol Revision Number	Service Indicator
On	No service	No service	Don't care	No service
On	Digital	Digital (1xEV-DO Rev. 0 or Rev. A)	Not yet received	1xEV-DO & wait for CnS_PREV for CDMA
On	Digital	No service	P_Rev 1 or 3	IS-95A only
On	Digital	No service	P_Rev 4	IS-95B only
On	Digital	No service	P_Rev 6	1X only
On	Digital	No service	Not yet received	Invalid—wait for CnS_PREV
On	Digital	Digital (1xEV-DO Rev. 0 or Rev. A)	P_Rev 1 or 3	1xEV-DO & IS-95A
On	Digital	Digital (1xEV-DO Rev. 0 or Rev. A)	P_Rev 4	1xEV-DO & IS-95B
On	Digital	Digital (1xEV-DO Rev. 0 or Rev. A)	P_Rev 6	1xEV-DO & 1X

HDR hybrid preference	Service Indication	HDR Service State	Protocol Revision Number	Service Indicator
On	No service	Digital (1xEV-DO Rev. 0 or Rev. A)	Don't care	1xEV-DO only
Off	No service	No service	Don't care	No service
Off	Digital	No service	Not yet received	Invalid—wait for CnS_PREV
Off	Digital	No service	P_Rev 1 or 3	IS-95A only
Off	Digital	No service	P_Rev 4	IS-95B only
Off	Digital	No service	P_Rev 6	1X only
Off	No service	Digital (1xEV-DO Rev. 0 or Rev. A)	Don't care	1xEV-DO only

### Roaming status

**CnS** Object **0x1007 Roaming Status** (either query or [notification](#)) reports whether the detected [SID](#) of CDMA network matches the home SID of the modem. As a notification, it reports whenever the detected network SID changes.

Object **0x1068 HDR Roaming Status** (either query or notification) reports whether the detected [SID](#) of the [1xEV-DO](#) network matches the home SID of the modem. As a notification, it reports whenever the detected network SID changes.

**AT** CDMA and [1xEV-DO](#) roaming status are items reported by the **!STATUS** command.

### User security

*Note: Locking the Mini Card modem does not prevent you from dialing E911 services.*

The Mini Card supports a personal locking mechanism using a four-digit lock code.

*Note: Although the modem can be locked and unlocked using [CnS](#), the [AT](#) command interface does not support user security lock control. Neither does the [AT](#) interface support E911 calls on a locked modem. Single port integrations do not support locking, so access to E911 services should never be impaired.*

When locked, the modem restricts many operations:

- The [AT](#) interface is disabled except the unlock command.
- Data calls are not permitted.
- Originating SMS is not permitted, although reception still works.

- Outgoing dialing (voice, fax, data) is limited to E911 numbers and **OTASP** (\*2) numbers
- Incoming voice calls do not provide caller ID

By default the lock code is the last four digits of the modem phone number. If the lock code has not been changed from its default setting, then, upon successful completion of the activation process, the lock code is reset to the last four digits of the phone number that was entered during the activation process.

### Lock status

**CnS** The object **0x1018 Modem Lock Status** reports whether or not the modem is currently locked. There is no [notification](#); this is a query only.

### Lock / unlock modem

**CnS** The object **0x1019 Lock/Unlock Modem** is used for both operations.

### Change lock code

**CnS** Object **0x101A Set Locking PIN** is used to set the value of the lock code. Both the current and new values must be provided.

### Lock modem automatically

The modem can be set to lock on power up or reset. This makes the modem and account unusable to anyone who might take the wireless device.

When enabled, the modem remains unlocked until the next power cycle or reset. The modem must be unlocked as described earlier to be able to disable the feature.

**CnS** **0x1043 Enable/Disable Power-up Auto-Lock** is used to both read and set the automatic locking feature. No PIN number is needed to enable or disable the automatic lock. The modem must be unlocked to use this object.

# Device Management

OMA Device Management is a device management (DM) protocol specified by the Open Mobile Alliance (OMA) Device Management Working Group and the Data Synchronization (DS) Working Group.

## Current OMA-DM configuration of the modem

**CnS** Object **0x0E00 DM Configuration** is used to get/set the current [OMA-DM](#) configuration of the modem.

**AT** The command **!DMDC** is used to set or query the Device Configuration Session setting. The command **!DMFUMO** is used to set or query the [FUMO](#) Session setting. The command **!DMPRL** is used to set or query the [PRL](#) Update session setting.

## Start a User-Client Initiated (U-CI) OMA-DM session

**CnS** Object **0x0E01 Start DM session** is used to start a User-Client Initiated (U-CI) OMA-DM session.

**AT** The command **!DMDC** is used to start a User-Client Initiated (U-CI) OMA-DM session. The command **!DMFUMO** is used to start a User-Client Initiated (U-CI) [FUMO](#) OMA-DM session. The command **!DMPRL** is used to start a [CIPRL](#) session.

## Cancel a DM Session

**CnS** Object **0x0E02 Cancel DM session** is used to cancel any active or retry-pending (for example, an [HFA](#) retry pending) OMA-DM session.

**AT** The command **!DMCANCEL** cancels any active or retry-pending (for example, an [HFA](#) retry pending) OMA-DM session.

## State of the DM session

**CnS** Object **0x0E03 DM Session State** is issued to indicate a change in the [DM](#) session state.

**AT** The command **!DMLOG** displays the contents of an OMA-DM [EFS](#) session log.

## Deny/allow a Network-Initiated Alert queued in the modem

**CnS** Object **0x0E04 Network-Initiated Alert** is used to deny/allow a Network-Initiated Alert queued in the modem. The notification is sent when a new Network Initiated Alert (NIA) is received, or an event (in the modem) triggered the modem to report a previously received NIA that was queued in the modem.

**AT** This interface does not support denying/allowing a Network-Initiated Alert queued in the modem

## Status of the DM Download

**CnS** Object **0x0E10 DM DL Progress** is used to get the status of the **DM** download. During a download session, a notification is sent out multiple times to report the progress of the operation.

**AT** This interface does not support querying the status of the **DM** download.

## User response (download and/or install the package) during a FOTA/FUMO operation

**CnS** Object **0x0E11 DM Download Alert** is used to indicate the user response (whether or not to download and/or install the package) during a **FOTA/FUMO** operation.

**AT** The command **!DMDLRSP** is used to indicate the user response (whether or not to download and/or install the package) during a **FOTA/FUMO** operation.

## Description of a FOTA/FUMO download package

**CnS** Object **0x0E12 DM Download Description** is used to get a description of a **FOTA/FUMO** download package.

**AT** This interface does not support querying the description of a **FOTA/FUMO** download package.

## Status of the most recent installation attempt of a DM download

**CnS** Object **0x0E13 DM Download** — **Installation Status** indicates the status of the most recent installation attempt of a **DM** download.

**AT** This interface does not support displaying the contents of an OMA-DM **EFS** session log.

# 1X/IS-95 Data Connections

## Introduction

This chapter describes how to open and close [1X/IS-95](#) data connections. It covers both high-speed packet-switched data connections and circuit-switched data connections.

For call flow diagrams on topics discussed in this chapter, see [Appendix C: Data Connection Application Note](#) on page 86.

## High-Speed Packet-Switched Data (HSPD)

*Note: Depending on the billing plan, there may be a surcharge for packet data calls. Billing may be for data transmitted instead of time online.*

Maximum throughput for a packet-switched data connection is 153.6 kbps—roughly ten times the circuit-switched maximum—but it is only available in areas where the service provider has implemented a [1X](#) infrastructure.

With a packet data session, the modem is “active” if data transmission is occurring. If data transmission stops for a period of time (set by the network), the modem becomes “dormant”. You can place voice calls while the modem has a dormant connection, but not while the modem is active. Packet-switched data calls may only be originated from the modem; incoming packet-switched data calls are not supported.

## Circuit-Switched Data (CSD)

*Note: Some service providers do not allow making voice calls while a packet data call is dormant. Check with your carrier.*

Maximum throughput for a circuit-switched data connection is 14.4 kbps, regardless of whether the connection is Dial-up or Quick Net Connect. Both connections may occur on either a 1X or IS-95 network.

- Dial-up – The Mini Card functions like a standard landline modem, but using the CDMA network data transmission. It can connect to any other modem.
- Quick Net Connect (QNC) – QNC is a CDMA-specific rapid-dialup connection. The time required to initiate the connection is shorter than a dial-up connection.

*Note: Not all service providers support QNC calls. Check with your carrier.*

Circuit-switched data calls may be originated from the modem. Provided that the modem is configured to answer incoming calls as data calls, incoming circuit-switched data calls are also supported.

## Detecting 1X coverage

To detect the presence of [1X](#) coverage:

**CnS** Object **0x1006 Service Indication** is used (either query or [notification](#)) to detect whether or not a CDMA network is detected. If this

indicates there is a service, then use **0x101C Protocol Revision Number** to determine if 1X is supported.

**AT** The command **+CAD?** queries for the presence of CDMA service. To detect the type of service (**1X** or **IS-95**) use **!PREV?**. A response of 6 indicates 1X service; 3, 4, or 5 indicates IS-95.

For details, see [Table 2: Service Indication](#) (page 30).

## Opening a packet-switched data connection

To make an **HSPD** connection you must use an **AT** command to dial a special number. The data call itself, including the **PPP** handshaking and login, is handled on the primary port. The **CnS** interface does not initiate connections, but reports the connection status, as noted later.

To originate:

1. Issue **ATDT#777**. This attempts a high-speed connection if the modem detects **1X** service. If there is no 1X service, the modem attempts a QNC connection using **IS-95**.
2. Assuming the connection is initiated, the host receives the **CONNECT** message. At that point, the host must manage the username, password, and PPP negotiations like any other modem.

The progress of the connection can be monitored via the secondary port, using **CnS**, through use of [notifications](#).

**CnS** First, enable **0x3000 Call Notification Status**. This enables a family of notifications related to connection monitoring.

As the connection is being initiated, **0x3011 Call Connecting** is received, identifying the origin as being non-CnS; that is, the AT command was used to dial the connection. When the connection is established, you will receive **0x300A Call Connected**.

## Dormant data connections

For a description of dormant connection, see “[Connection dormant](#)” on page 24.

The host can detect when a connection becomes dormant via [notifications](#) on the secondary port. The [AT](#) interface remains dedicated to the PPP session, so it does not indicate dormancy.

**CnS** When a data connection enters dormant state, **0x3012 Dormant Packet Call** is issued. When returning to active state, the [notifications](#) will depend on the initiator of the state change, as shown in the following table.

Table 3: Notifications issued when returning to active state

Initiator of the state change	Notifications
Host	<b>0x3011 Call Connecting</b> and <b>0x300A Call Connected</b>
Network	<b>0x3004 Incoming Call</b> and <b>0x300A Call Connected</b>

## Closing a 1X connection

The connection is closed by the application disconnecting the [PPP](#) session. When the session is closed, the modem automatically ends the data connection. No command action is needed by the host.

**CnS** The modem issues **0x300C Call Disconnected** and reports that the base station released the call.

**AT** The modem issues NO CARRIER.

## Opening a circuit-switched data connection

Circuit-switched data calls also require the use of an **AT** command to dial. The data call itself, including the **PPP** handshaking and login, is handled on the primary port. The **CnS** interface does not initiate data connections, but reports the connection status, as noted later.

### QNC connection

To originate a QNC (Quick Net Connect) connection:

1. Issue **ATDT#762**. This forces the modem to attempt a QNC connection regardless of the presence of **1X** data services.

As an alternative, you can have the modem to attempt a **1X** connection where **1X** coverage is available. To permit the faster **1X** connection where available, use **ATDT#777**.

2. Assuming the connection is initiated, the host receives the **CONNECT** message. At that point, the host must manage the username, password, and **PPP** negotiations like any other modem.

### Dial-up connection

To originate a dial-up connection to any modem:

1. Issue **ATDT#<num>** where **<num>** is the phone number to dial. The modem attempts a standard circuit-switched data (CSD) call to the destination number. The call is in fact routed to an interworking function at the CDMA service provider, which in turn makes the call on the **PSTN**.

Because of the modem relays involved in this type of connection, it may take more time than expected to make the connection. To allow a longer than normal wait for carrier, changes may be needed to status registers.

2. Assuming the connection is initiated, the host receives the **CONNECT** message. At that point, the host must manage any login procedures just like a landline modem.

### Monitoring data connection progress

The progress of the connection can be monitored via the secondary port, using **CnS**, through the use of **notifications**.

**CnS** First, enable **0x3000 Call Notification Status**. This enables a family of notifications related to connection monitoring.

As the connection is being initiated, **0x3011 Call Connecting** is received, identifying the origin as being non-CnS—that is, the **AT** command was

used to dial the connection. When the connection is established, you will receive **0x300A Call Connected**.

## Closing data connections

### QNC connections

The connection is closed by the application disconnecting the **PPP** session. When the session is closed, the modem automatically ends the data connection. No command action is needed by the host.

**CnS** The modem issues **0x300C Call Disconnected** and reports that the base station released the call.

**AT** The modem issues **NO CARRIER**.

### Dial-up connections

A dial-up connection is treated more like a standard phone call. The call is disconnected by escaping the data state of the modem (**+++**) and using the **AT** command **ATH** to hang up.

The usual secondary port **notifications** for call status (as described above) are supported.

## Answering data connections

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*Note: The CDMA architecture requires that the type of call be known prior to the call initiation (first ring).*

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By default the MC5728V Mini Card is set to answer all calls as voice calls. To receive a dial-up data call, you must set the MC5728V Mini Card to answer appropriately.

Once configured, the call can be answered automatically or manually.

### Configuration to answer data

**CnS** Object **0x1014 Set Answer Mode** is used to control the method of answering a call.

**AT** Set the modem to answer data calls using either:

- **\$QCVAD=3** Answers next call (within 10 minutes) as data
- **\$QCVAD=4** Answers all calls as data

Optionally set **S0=1** to autoanswer the call.

### Detecting an incoming data call

When a data call arrives with the modem properly configured to answer it, it generates the RING message on the **AT** interface (primary port) and triggers the **RI** hardware control.

The secondary port reports the incoming call via **notifications**:

**CnS** Object **0x3004 Incoming Call** is issued to indicate the connection request. Caller ID may also be available via **0x3006** or **0x3009** (Caller ID and Extended Caller ID respectively).

### Answering a data call

If the modem was set to answer the call automatically, it goes off hook and negotiates the connection. When complete, the CONNECT message is sent on the **AT** interface, and communication can begin.

If auto answer is not set, the call must be answered via **AT** command: **ATA**. The **CnS** interface does not support commands to answer data calls.

The usual data connection monitoring **notifications** are issued (if enabled) on the secondary port.

# 1xEV-DO Data Connections

## Introduction

This chapter describes how to open and close [1xEV-DO](#) data connections.

Connections over a 1xEV-DO network provide asymmetric data rates. For 1xEV-DO Rev. A, maximum throughput for the uplink direction is 1.8 Mbps; maximum throughput for the downlink is 3.1 Mbps.

For 1xEV-DO Rev. 0, maximum throughput for the uplink direction is 153.6 kbps; maximum throughput for the downlink is 2.4 Mbps.

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*Note: Some service providers do not allow making voice calls while a packet data call is dormant. Check with your carrier.*

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1xEV-DO systems support only packet-switched data calls. No voice calls are supported over 1xEV-DO. If a service provider wants to provide both voice and packet data services, it must deploy both a 1xEV-DO system and a [1X/IS-95](#) system (on separate frequencies).

Assuming that the service provider offers 1X and 1xEV-DO services, the modem is capable of monitoring for incoming voice calls and SMS messages while in an active or dormant 1xEV-DO data connection. If a voice call or SMS message is received, the modem may suspend the data transmission and reply to the incoming event. Once the voice call or SMS message is complete, data transmission may be resumed.

For call flow diagrams on topics discussed in this chapter, see [Appendix C: Data Connection Application Note](#) (page 86).

## Detecting 1xEV-DO coverage

To detect the presence of 1xEV-DO coverage:

**CnS** Object **0x1069 HDR Service State** is used (either query or indication) to determine whether or not a 1xEV-DO network is detected. If needed, you may also use **0x1006 Service Indication** to detect whether a [1X](#) network is also detected.

**AT** The **!STATUS** command is used to determine whether 1xEV-DO service is available.

## Opening a packet-switched data connection

If the modem has 1xEV-DO service, then a 1xEV-DO connection may be made by using an **AT** command to dial. The data call itself, including the **PPP** handshaking and login, is handled on the primary port. The **CnS** interface does not initiate data connections, but reports the connection status, as noted later.

To originate:

1. Issue **ATDT#777**. This attempts a high-speed connection if the modem detects 1xEV-DO service. (If 1xEV-DO service is not available, but **1X** is, then the connection attempt is made over 1X.)
2. Assuming the connection is initiated, the host receives the **CONNECT** message. At that point, the host must manage the username, password, and **PPP** negotiations like any other modem.

The progress of the connection can be monitored via the secondary port, using **CnS** through the use of **notifications**.

**CnS** First, enable **0x3000 Call Notification Status**. This enables a family of notifications related to connection monitoring.

As the connection is being initiated, **0x3011 Call Connecting** is received, identifying the origin as being non-CnS—that is, an **AT** command was used to dial the connection. When the connection is established, you will receive **0x300A Call Connected**.

## Dormant data connections

The host can detect when a connection becomes dormant via **notifications** on the secondary port. The **AT** interface remains dedicated to the **PPP** session, so it does not indicate dormancy.

**CnS** When a data connection enters dormant state, **0x3012 Dormant Packet Call** is issued. When returning to active state, the notifications will depend on the initiator of the state change, as shown in the following table.

Table 4: Notifications issued when returning to active state

Initiator of the state change	Notifications
Host	<b>0x3011 Call Connecting</b> and <b>0x300A Call Connected</b>
Network	<b>0x3004 Incoming Call</b> and <b>0x300A Call Connected</b>

## Closing a packet-switched data connection

The connection is closed by the application disconnecting the [PPP](#) session. When the session is closed, the modem automatically ends the data connection. No command action is needed by the host.

**CnS** The modem issues **0x300C Call Disconnected** and reports the base station released the call.

**AT** The modem issues NO CARRIER.

## Monitoring 1X while in an active 1xEV-DO connection

If the modem is configured to run in hybrid mode, then even while it is on a [1xEV-DO](#) network, the modem monitors for incoming calls on the [1X](#) network. To do so, the modem periodically tunes away from the 1xEV-DO network and checks the 1X network.

**CnS** While tuned to the 1X network, if an incoming voice call is detected, the modem issues **0x3004 Incoming Call**. The host may issue a **0x3005 Answer Incoming Call** to direct the modem to initiate dormancy for any current data call and to respond to the incoming call. The host first receives a **0x3012 Dormant Packet Call** and then a **0x300A Call Connected** message for the incoming voice call. (If it was an MT SMS message that was found on the 1X network, then the appropriate [CnS](#) SMS messaging is sent back to the host, along with the dormancy [notification](#).)

Once the voice call (or SMS transmission) has ended, the data call comes out of dormancy as a result of data being sent from either the near end or far end. Whether the data call is resumed on the 1X or 1xEV-DO network depends on the timing of the data arrival. (For example, if data is being sent to the modem before it has tuned back to 1xEV-DO, the call may be resumed on the 1X network.)

# Voice Connections

## Introduction

This chapter describes how to open and close voice connections. Both call origination and call answering are covered. SMS message origination and reception are covered in the chapter “[SMS Messages](#)” starting on page 56.

Voice services involve a variety of resources, both in the modem and the host device. Configuration of those resources is covered first. That is followed by answering voice calls. Originating voice calls is covered third, and lastly, the use of voice call features that may be available from the service provider (such as call alert and three-way calling).

For call flow diagrams on topics discussed in this chapter, see [Appendix D: Voice Connection Application Note](#) on page 93.

## Configuring voice options

To use the voice interface there are a variety of options that can be configured and controlled both by the modem and the host device. This section discusses:

- Audio (headset) signal levels
  - [Key tones \(DTMF\) playback](#) (page 46)
  - [Speaker volume](#) and [muting](#) (page 46)
  - [Microphone muting](#) (page 47)
  - [Sidetone](#) (page 47)
  - [Echo cancellation](#) (page 48)
  - [Use of TTY equipment](#) (page 48)
- Call connection management
  - [Answer mode](#) (page 49)
  - [Software notifications](#) (page 49)
  - [RI \(Ring Indicator\)](#) (page 51)
- Dialing controls
  - [DTMF tone duration](#) (page 54)
  - [Single key tones](#) and [bursts](#) (page 54)

## Audio configuration

The audio circuitry of the modem provides a variety of level controls and mutes. This section describes the control of these features. During system calibration, the overall range of speaker output and the sensitivity of microphone input are set.

### Alert and tone volume

The volume of the key tones ([DTMF](#)) played back on the speaker (“comfort tones”) is distinct from the level of normal voice playback. This tone level is also used to control the volume of alert tones played on the speaker output.

Settings are in the range from 0 (silent) to 6 (loudest). Note that a setting of 0 here is not the same as muting. Muting permits preservation of a preset volume level.

**CnS** The speaker tone volume level is read and set using object **0x102A Get/Set Tone Level**.

**AT** This interface does not support setting the tone level.

### Speaker tone muting

It is possible to mute the playback of [DTMF](#) tones and alerts independently of muting the speaker as whole.

Muting the tones is distinct from setting the tone level to zero. Tone mute switches off the playback of tones, while preserving the preset level. When tone mute is turned off, the tone volume resumes at the original setting.

**CnS** The object **0x102D Mute/Unmute Tone** is used to set or clear the mute state of tone playback.

**AT** Use **!AVSETPROFILE** with **<generator>** set to **1** (DTMF), and **<earmute>** set to **1** (mute the tones) or **0** (unmute).

### Speaker volume

Settings are in the range from 0 (silent) to 6 (loudest). The default level is 3. Note that a setting of 0 here is not the same as muting. Muting permits preservation of a preset volume level.

**CnS** The speaker volume level is read and set using object **0x1026 Get/Set Speaker Volume**.

**AT** Use **!AVSETPROFILE** with **<generator>** set to **0** (voice), and **<volume>** set to the desired level.

Note that the calibration command **~SPKLVL** is **not** to be used by applications.

## Speaker muting

*Note: This is rarely used. Do not confuse this with microphone muting.*

Muting the speaker mutes both tone playback and the normal voice signal. It is distinct from setting the volume level to zero. Using mute switches the speaker off, while preserving the preset level. When mute is turned off, the speaker volume resumes at the original setting.

**CnS** The object **0x1027 Mute/Unmute Speaker** is used to set or clear the mute state.

**AT** Use **!AVSETPROFILE** with **<generator>** set to **0** (voice), and **<earmute>** set to **1** (mute the speaker) or **0** (unmute).

## Microphone muting

The level of the microphone input is preset using a calibration process. It is not user/application adjustable. However, the microphone can be switched on and off, allowing the user to mute the transmission side of a voice call while continuing to listen.

**CnS** The microphone is turned on and off (muted) using object **0x1029 Mute/Unmute Mic**.

**AT** Use **!AVSETPROFILE** with **<generator>** set to **0** (voice), and **<micmute>** set to **1** (mute the microphone) or **0** (enable the microphone).

## Sidetone

Sidetone is the amount of sound from the microphone input that is played back to the speaker output. This allows the person who is speaking to better hear himself or herself.

The sidetone gain level can be controlled using the range from 0 (off) to 6 (loudest). The default setting is 2.

This level feeds into the speaker like regular signals and is in turn adjusted by the overall speaker volume and mute settings.

**CnS** Use object **0x5009 Sidetone Gain Level** to read and set the volume of side tone.

**AT** Use **!AVCODECSTG** to control the side tone gain.

## Echo cancellation

The MC5728V Mini Card comes with several preset profiles for managing echo cancellation. These are optimized for particular environments (shown in the following table).

Table 5: Echo cancellation profiles

Environment	Setting
Factory default (same as headset)	0
No echo cancellation	1
Handset	2
Headset	3
Acoustic (AEC)	4
Speakerphone	5

**CnS** The echo cancellation environment is set and read using object **0x1035 Get/Set Echo Cancellation Level**.

**AT** The command **!AVEC** is used to set the echo cancellation profile.

## TTY mode

A TTY (TeleTYpewriter) is a device for people with hearing and speech impairments. The device allows people to communicate over phone systems using a typewriter-like keyboard.

*Note: This feature has not been tested in the current release.*

When TTY Mode is enabled, you can attach a TTY device to the headset connector and use a TTY device with the modem. The modem supports switching between:

- **Off**—TTY disabled; normal voice operation
- **On (Full)**—both speaker and microphone are in TTY mode

**CnS** Object **0x1046 TTY Option** controls the mode for headset operation. A setting of zero (0) is the default; normal audio operation. Setting it to 1 enables the TTY interface.

**AT** To switch to TTY mode, use **!AVSETPROFILE** with **<profile>** set to 5 (TTY).

## Answer mode

The MC5728V Mini Card is set by default to answer calls as voice calls unless the mode is set differently. The modem can be set to answer all calls in any of the three modes (voice, fax, or data) and to answer only the next call as fax or data, then revert to voice mode. If this latter option is chosen, the setting holds until either a call arrives and is answered, or until ten minutes passes without receiving an incoming call.

Table 6: Call answer modes

Mode	CnS/AT Setting
All calls as voice	0
Fax—next call only	1
Fax—all calls	2
Data—next call only	3
Data—all calls	4

**CnS** To change the answer mode, use object **0x1014 Get/Set Answer Mode**. The **CnS** interface offers an additional mode value for Call Answer: 5. The value of 5 may be set, when auto-answer is to be disabled completely.

**AT** Use **\$QCVAD=<n>** to set the mode for answering calls.

## Software notifications

The **AT** interface can only use the **RI** control signal and result codes such as RING, CONNECT, and NO CARRIER. These are discussed in the next sub-section.

To manage the detection of incoming calls, the connection process of both incoming and outgoing calls, and the disconnection of calls, a host application usually relies on **notifications** from the modem delivered over the **CnS** interface.

The connection management notifications include the following events:

- [Incoming call](#)
- [Call connecting](#)
- [Call connected](#)
- [Call disconnected](#)
- [Packet call entering dormant state](#)
- [Connection error](#)
- [OTASP state](#)

All of these [notifications](#) are controlled with a single notification call.

**CnS Object 0x3000 Call Notification Status** is used to enable the family of notifications for connection management.

### Incoming call

#### **CnS 0x3004 Incoming Call**

This is issued when a connection request arrives from the network. The type of call must have been preset (“[Answer mode](#)” on page 49) if it is not expected to be a voice call. This [notification](#) is also issued for “[Call Waiting](#)” (page 52).

### Call connecting

#### **CnS 0x3011 Call Connecting**

Issued when a connection request is being sent by the modem (originating a call), this advises the application of all call originations, including data and fax calls initiated over the [AT](#) command interface.

### Call connected

#### **CnS 0x300A Call Connected**

This indicates a successful call connection. The call state indicates all active connections (for example a voice call during a dormant [1X](#) data session).

### Call disconnected

#### **CnS 0x300C Call Disconnected**

A call has disconnected and the reason is reported. The connection state is also reported so that any other active connections can be monitored (for example, when a voice is ended during a dormant 1X data session).

### Packet call entering dormant state

#### **CnS 0x3012 Dormant Packet Call**

Indicates when a data call enters dormancy. Leaving dormancy is indicated with either the “call connecting” (the modem initiated reconnection) or “incoming call” (the network initiated reconnection).

### Connection error

#### **CnS 0x300E Connection Error**

Error codes are reported along with the command that generated the call error.

## OTASP state

### CnS 0x3014 OTASP State

This indicates the progress of an **OTASP** call and the success or failure of the step.

### RI (Ring Indicator)

**AT** The modem sends a RING indication, indicating an incoming call.

## Answer voice calls

You cannot receive a voice call while there is an active **1X** or **1xEV-DO** data connection. Callers either receive a busy signal or are forwarded to voice mail, based on the CDMA account.

You can receive voice calls during dormant data connections. See “[Connection dormant](#)” (page 24).

When there is an incoming call, the modem can alert the host using [notifications](#) on the secondary port (**CnS**) or through the hardware **RI** signal and messages on the **AT** interface. See “[Software notifications](#)” on page 49.

*Note: Incoming data and fax calls must be answered on the AT interface only.*

To answer a call, use one of the following actions.

**CnS** The object **0x3005 Answer Incoming Call** is used to answer a voice call. The call is disconnected using **0x300D Disconnect All Calls**.

**AT** Voice calls are answered using the **\$QCCAV** command. Do not use the data/fax call answer (**A**) command. The modem remains in command state after answering so that other commands can be used for over dialing (generating **DTMF** to voice mail systems and so on), controlling speaker level, and other related operations.

To end the voice call, use **+CHV**.

The process of monitoring the connection process using the secondary port (**CnS** interface) relies on the call management notifications described in “[Software notifications](#)” on page 49.

## Originate voice calls

You cannot make a voice call when there is an active data connection. You can make voice calls during dormant **1X** and **1xEV-DO** connections. See “[Connection dormant](#)” (page 24).

To initiate a call, users must connect a headset or TTY, unless your device provides a microphone and speaker.

The process of managing **DTMF** comfort tones is described in “[Alert and tone volume](#)” (page 46).

The process of monitoring the connection process using the secondary port (**CnS** interface) relies on the call management [notifications](#) described in “[Software notifications](#)” on page 49.

**CnS** The object **0x3007 Originate Call** is used to make a voice call. It only supports the voice call type (including E911 and \*2 **OTASP** calls). The call is disconnected using **0x300D Disconnect All Calls**.

**AT** Voice calls are initiated with the **+CDV<num>** command. The number can include the usual modem dialing string options. The modem remains in command state after dialing so that other commands can be used for over dialing (generating **DTMF** to voice mail systems and so on), controlling speaker level, and other related operations.

To end the voice call, use **+CHV**.

## Voice feature options

Service providers may include services such as caller ID, Call Waiting, and three-way or conference calls. The MC5728V Mini Card supports the controls covered in this sub-section. Also covered here are alerts that the modem can generate as tones in the headset.

### Caller ID

Two ID options can be used: normal and extended. The content of these IDs is determined by the network.

**CnS** Caller ID can be queried directly or provided by notification using:

- **0x3006 Caller ID**, and
- **0x3009 Extended Caller ID**

**AT** This interface does not support Caller ID

### Call Waiting

If the CDMA account supports Call Waiting, the host is notified of the second incoming call via the usual Incoming Call [notifications](#). Answering the waiting call is handled via the Flash operation (see the following section), or by ending the first call and using a standard answer.

**CnS** Use **0x300F Send Flash** with option 1 to hold party 1 and connect to the waiting call. The same call then switches between the two calls if desired.

**AT** This interface does not support Call Waiting.

## Flash

Using the hook-flash is a common mechanism to access additional call management services, such as placing a call on hold while answering a waiting call. The MC5728V Mini Card supports a flash command to access:

- 0—Manual flash (minimal error checking) to access network determined actions.
- 1—Call Waiting; to hold a current call and switch to a second waiting call
- 2—Three-way calling dial
- 3—Three-way calling setup, connection, and disconnection.

**CnS 0x300F Send Flash** is used to pass the appropriate type of action. See [“Three-way connections”](#) on page 53.

**AT** This interface does not support a flash command.

## Three-way connections

The MC5728V Mini Card supports three-way calls, provided the CDMA service provider account supports them.

**CnS** To set up a three-way call:

1. Use **0x3007 Originate Call** to place a call to the first party.
2. Use **0x300F Send Flash** with option **3** to hold party 1 and obtain “dial tone” for the second call.
3. Use **0x300F Send Flash** with option **2** to dial party 2.
4. Use **0x300F Send Flash** with option **3** to join party 1 with party 2 on the three-way call.
5. Use **0x300F Send Flash** with option **3** to disconnect party 2, keeping party 1 active, or  
Use **0x300D Disconnect All Calls** to disconnect both parties.

**AT** This interface does not support three-way calls.

## Overdial and comfort tone controls

These operations relate to generating **DTMF** tones over the air for controlling voice mail and other such systems.

The modem can generate DTMF key tones for the keys 0–9, \*, and #. These can be generated as over-the-air tones (overdial when already in a call, such as tone controlled voice mail or credit card number entry), which are both sent and played as comfort tones on the headset, or as comfort tones only (during dialing) that are not sent over the air.

Typically dialing a call uses the comfort tones as the user enters the keys and the dial string is captured in the application. Nothing is sent over the air at this time. When the user selects to send, then the application actually sends the connection request over the air as a CDMA command, which does not play tones.

Comfort tones can be muted as described in “[Speaker tone muting](#)” (page 46).

The tone duration for overdial tones is determined by the setting in the previous sub-section. The tone is generated over the air via a CDMA command. Although the modem requests the durations as set, the timing over the air is ultimately controlled by the network.

The timing of the comfort tone in the headset does follow the duration setting when overdialing, but not for the commands that generate comfort tone only. Those are continuous, until released by a separate command.

### DTMF tone duration

The timing used for [DTMF](#) tones (on time and off between tones in a burst) can be set. The setting is used for playing comfort tones in the headset. It is also passed to the network with the CDMA command to generate tone, but the duration over the air is ultimately determined by the network.

The default settings are:

- 300 ms for single key tones in a range from 100–3000 ms.
- 200 ms on (in a range of 95–350) and 100 ms off (in a range of 60–200) for burst tones

**CnS** Object **0x102F DTMF Duration** is used to set the timing for both single tone and burst tone generation.

### Single key tones

**CnS** Use **0x102E DTMF Key** to generate single tones for overdial. For comfort tones only (not over the air), use **0x1030 Key Pressed** and **0x1031 Key Released**.

**AT** Use **!AVTONEPLAY** to generate a single key tone (comfort tone); the tone is played only locally—not over the air.

### Bursts of key tones

It is possible to send a string of key tones using timing as set in “[DTMF tone duration](#)” (page 54). The comfort tone in this case is a single chirp of about 200 ms, unless suppressed by the [DTMF mute](#) (“[Speaker tone muting](#)”, page 46).

**CnS** Object **0x1034 DTMF Burst** takes up to 32 keys (no spaces, brackets, dashes, or commas are allowed).

### Minute alert

When enabled, minute alert issues a beep at one minute intervals while on voice calls. This allows the user to keep track of the duration of the call.

**CnS** This feature is not supported on the [CnS](#) interface.

**AT** This feature is not supported on the [AT](#) interface.

### Service alert

When enabled, the modem emits a tone whenever it goes from being out of service to being in service, and whenever it goes from being in service to being out of service.

**CnS** This feature is not supported on the [CnS](#) interface.

**AT** This feature is not supported on the [AT](#) interface.

# SMS Messages

## Introduction

This chapter describes how to handle both receiving (MT-SMS) and sending (MO-SMS) SMS messages.

The management of saving messages within your application is up to you. Generally, MT (Mobile Terminated) messages are stored in an “inbox” until the user has read them and chosen to either delete them or have them expire on a timer. MO (Mobile Originated) messages may be stored by the application in an “outbox” or “sent items” folder until no longer needed. These decisions are up to you.

Normal handling of SMS messages is via the [CnS](#) interface, although it is possible to process SMS across the [AT](#) command interface. The limitations of the AT command interface are:

- SMS messages can be sent or received only when there is no active data connection
- Receiving SMS messages requires a host-initiated poll
- Verifying status of sent SMS messages requires polling

The CnS interface adds the capability to:

- Receive and send SMS messages while the primary port is active with a data connection
- Receive [notifications](#) of newly arrived SMS messages in a timely fashion without polling
- Receive notifications of the status of sent messages without polling

For call flow diagrams on topics discussed in this chapter, see [Appendix E: SMS Application Note](#) (page 98).

## Mobile terminated SMS

The modem can receive SMS messages whenever it has acquired CDMA service from a provider that supports your account.

Messages can be received even while other connections (voice or data) are active, providing you are using the CnS interface.

### Process overview

SMS messages arrive from the network and are stored on the modem. The modem's storage is limited, and it is up to the application to clear the message queues in a timely fashion. The exact limit is based on message length more than the number of messages, so it cannot be readily quantified.

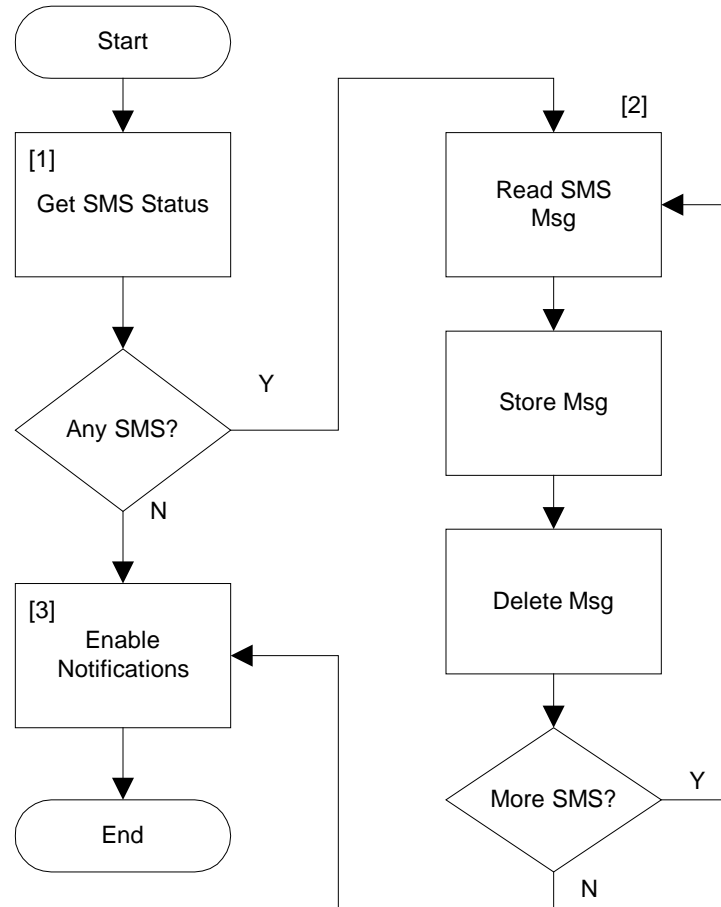
The handling of overflow depends on the service provider's network—some networks hold the message for a while; some discard it as undeliverable.

The modem can be configured to notify the host device when a message arrives using [CnS notifications](#). Alternatively, the application can poll the modem, although this mechanism is discouraged in favor of the notification. Single-port integrations cannot receive CnS notifications but can use the [RI](#) to signal arriving messages.

The recommended process is to use a poll to query for messages when the host application starts and then rely on notifications from that point on. This reports any messages that may have arrived while the modem was running with the host either offline or powered down.

The recommended procedure for managing incoming SMS messages is shown in [Figure 4](#) on page 58.

Figure 4: SMS receive flow chart



1. On application startup, poll the modem for SMS status (“[Polling for MT-SMS messages](#)”, page 60). If there are none, then skip to step 3.
2. Retrieve all pending messages (“[Retrieving MT-SMS messages](#)”, page 60). As messages are retrieved and stored by the host, delete them from the modem (“[Deleting MT-SMS messages](#)”, page 62). Call the retrieve/delete services repeatedly until they report there are no more messages.
3. Enable [notifications](#) for additional incoming messages (“[Notifications of MT-SMS messages](#)”, page 63).

When the modem reports that there are messages in the modem, the application should read through all messages as done in step 2.

## MT-SMS queues

Upon receipt of an SMS message, the modem stores it in one of three queues:

- Urgent
- Normal
- Voice

**Urgent** These messages have their header indicate a priority other than normal (interactive, urgent, and emergency). This queue is the first to be read when SMS messages are retrieved from the modem.

**Normal** Most standard SMS messages go here. The header indicates a normal priority, and the message contains text or data. This queue is read only when there are no pending urgent messages.

**Voice** This is not strictly a queue. It can only indicate a single message, which contains a count of the number of voice mail messages being held by the network. It is retrieved only when there are no other unread messages.

## Voice queue SMS message

The voice queue has a unique behavior. From the factory the queue has no message and reports a value of 0. When the network sends an SMS message advising the mobile of a voice mail message, the queue contains that message and reports 1 message in the queue.

As subsequent voice mail messages arrive, the single message is updated with the actual number of voice mail messages being held by the network. The queue does not add messages, only changes the content of the one voice message it holds. The modem still issues [notification](#) of the new “message” arrival.

---

*Note: The [CnS](#) interface offers a special message to delete the voice mail SMS message from the modem to help synchronize with the network, should there be a mismatch.*

---

When this voice mail SMS message is retrieved and deleted, the modem resets the voice mail message count within the message to zero, but **does not delete the message** itself. This means that the modem always reports 1 SMS message in the voice queue. To know if there are actual pending voice mail messages at the network, the application must retrieve the voice SMS message and read the counter it contains.

This is another reason why notifications are the preferred mechanism to detect new messages. If your application uses a polling mechanism, it will detect this voice queue SMS message every time, and must retrieve it to read the counter every time. If notifications are used, the host does not need to read the voice queue message unless there has been a notification of a new SMS message.

## Polling for MT-SMS messages

Polling for the status of the SMS message queues is needed on application startup to ensure that any messages received while the host was not able to receive [notifications](#) will be read.

**CnS** To poll the modem for message status, use the object **0x2000 SMS Receive Status**. This object reports the number of messages in each of the three message queues.

**AT** The command **!CNTSMS** reports the number of messages in the three queues. (There is an additional list intended for read messages not yet deleted, but it has not been implemented.) The response lists the counters in the order shown:

---

*Note: Ignore the Old Messages (Index 3) list. It has not been implemented.*

---

```
AT!CNTSMS
New Urgent Msg {Index = 1}: 0
New Regular Msg {Index = 2}: 0
Old Messages {Index = 3}: 0
Voice Messages {Index = 4}: 0
```

## Retrieving MT-SMS messages

Only the [AT](#) interface allows random access to messages on the modem. The [CnS](#) interface reads the messages using the algorithm illustrated in [Figure 5](#) on page 61.

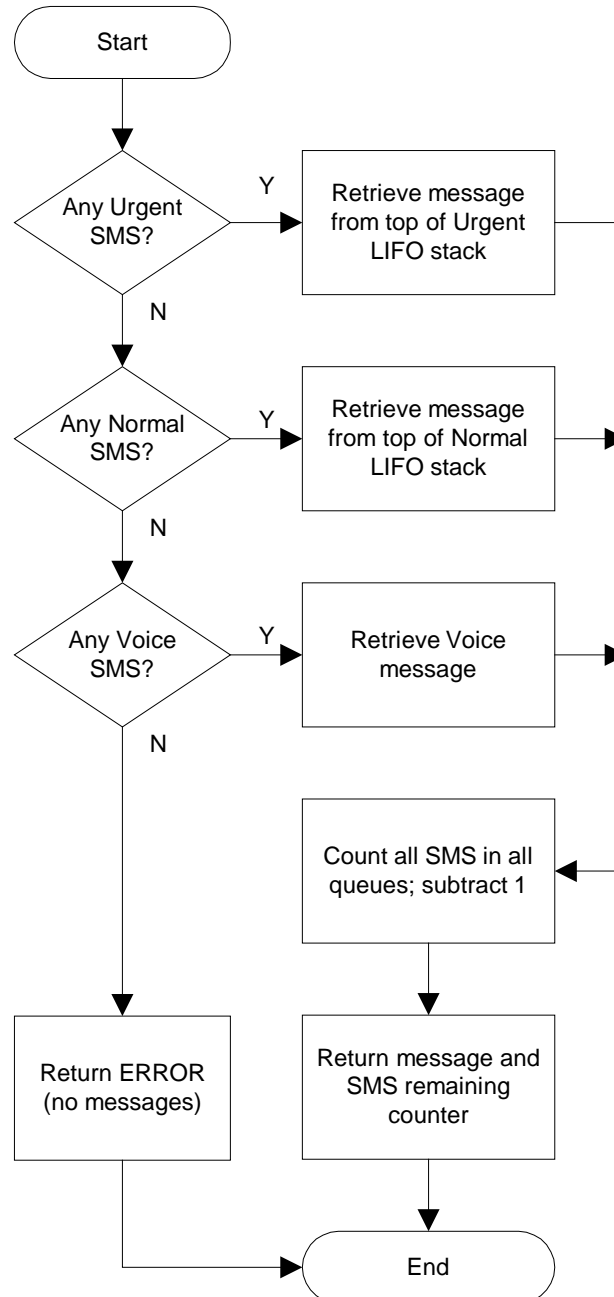
---

*Note: Retrieving a message does not remove it from the queue (stack).*

---

Messages are retrieved from the queues in priority order, and within the queues starting with the most recently arrived message. The queues behave like LIFO stacks.

Figure 5: SMS single message retrieve flow chart



Newly arriving messages go to the top of the appropriate queue. This means that part way through reading a set of pending messages, a newly arriving message (of the same priority) “jumps to the head of the line”. If retrievals are fetching from the normal queue and a new urgent message arrives, the urgent message is returned on the next call to retrieve a message, while older, less urgent, messages wait. On the other hand, if a new normal message arrives while there are older urgent messages, the urgent messages are still retrieved ahead of it.

Using this algorithm, it is important that messages are deleted after being read, before proceeding to retrieve the next message. If you fail to delete a read message, the modem returns the same (highest queue priority, top of stack) message over and over.

The modem returns (within the protocol used) a count of the number of remaining SMS messages (the count of all messages less one for the message currently being retrieved).

**CnS** Retrieve SMS messages using the object **0x2001 SMS Read**. The process involves multiple calls, using differing parameters to manage message segmentation due to protocol constraints. For full details of the process, please consult the *CnS Reference* (document 2130754).

Following each successful message retrieval, the application must store the message and then delete it from the modem (see the next section, “[Deleting MT-SMS messages](#)”) before retrieving the next message. If the message is not deleted, it is detected by the algorithm as the next message to retrieve, repeating until the message is deleted or a new message of the same or higher priority arrives.

The **count** field of the SMS packet header indicates if there are more messages to be read. Repeat the retrieval and delete process until the count field reports zero. An appendix in the *CnS Reference* discusses this process in detail.

**AT** Unlike the other interfaces, this one allows you to read messages from the modem in any sequence. The command **!GSMS** is used, specifying both the index list (which of the four queues) and the message number in the list (base 1).

If the modem reports via **!CNTSMS** that index list 2 (regular) has 3 messages, then you can retrieve them using **!GSMS=2,1** (the oldest message) through **!GSMS=2,3**.

### Deleting MT-SMS messages

As messages are read, they should be deleted from the modem. This is required for users of the CnS interface.

**CnS** This interface deletes messages using the message ID number that is passed in the **CnS** protocol’s SMS packet header—this is distinct from the SMS message header. Use object **0x2002 SMS Delete** to delete individual messages.

**AT** This interface offers two deletion options: selectively delete an individual message, or delete all messages.

The command **!DSMS** is used to delete a single message, specified by index (queue) and number, as used for retrieval. As messages are deleted, the index closes around it, much like removing a card from a deck.

To delete all messages from all queues—including unread messages—you can use **!DASMS**. This command is rarely used unless you are sure there are no unread messages in the modem.

### Notifications of MT-SMS messages

When a message arrives, the modem can notify the host in two ways:

- **CnS notification**—notify the host application via software (requires the secondary port)
- **RI (Ring Indicator) trigger**—notify the host device via hardware

You can implement both hardware and software notifications simultaneously. However, if you are allowing the host device to sleep, it may not be awake in time to receive the software notification. The secondary port does not impose RTS/CTS flow control, so the notification is sent whether the host is ready to receive it or not.

**CnS** To enable or disable the **CnS** notification use the object **0x2000 SMS Receive Status**. This object reports the number of messages in each of the three message queues. The notification is issued whenever a new message arrives.

**AT / Hardware** To enable the **RI** trigger, use the **AT** command **+WWKUP**, setting a value with bit 2 set. (The default value is 5, enabling RI for both incoming calls and SMS messages.) This setting uses a bitmask to control which events trigger the RI signal. Bit 2 is used to trigger on received SMS messages.

When the RI is triggered, the application may need to query the modem to determine what type of event caused the trigger. The AT command **+WGETWK** reports the reason for the RI trigger using the same bitmask as that used to enable the trigger. Thus, if the response has bit 2 set, there is a new SMS message.

Each incoming SMS message causes the RI trigger to assert /RI1 in a duty cycle of 200 ms on and 200 ms off for three cycles.

## Mobile originated SMS

The Mini Card can send SMS messages whenever it has acquired CDMA service from a provider that supports your account.

If you are using the [CnS](#) interface, messages can be sent even while other connections (voice or data) are active.

### Process overview

The process of sending a MO-SMS involves several steps:

1. Compose a message in the host application and create the SMS header.
2. Store the message on the modem, similar to placing it in an outbox. Retain a copy in the application in case a retry is needed.

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*Note:* The [AT](#) interface uses a single command to store and send messages.

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The Mini Card can store up to ten SMS messages in the outbox.

3. Send the outbox message(s) to the network.
4. Optionally wait for the network to acknowledge the message(s).

When sent, the message is removed from the modem's outbox.

Only after confirmation by the network should your application allow deletion of its retained copy of the sent message. If there is a failure reported in sending the message, the host application must repeat the process of storing and sending.

### The modem SMS outbox

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*Note:* The modem outbox is not available on the [AT](#) interface.

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Although it is possible to store and send single messages at a time—as is the most common use—the modem offers a time-saving mechanism for handling batches of messages.

The multi-message outbox is implemented to save call setup and tear-down time when several messages will be sent at once. This is particularly useful for sending one message to a group of recipients. The host application can store up to ten copies of the message, with different recipients, then send them all as a single batch.

Your application's use of the outbox is a design decision for you to make as best suits your requirements.

Once a message is stored in the modem's outbox, it can only be sent; it cannot be recalled, edited, or deleted.

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*Note:* The message is stored in volatile memory and will be lost if the modem is reset or power cycled before the message is sent.

---

When the command is given to send the contents of the outbox to the network, the message is deleted from the outbox, regardless of the success or failure of the transmission. This means that the host should

monitor the modem for a [notification](#) indicating the success or failure, so that the application can repeat the store and send process if needed.

It is possible to store messages to the modem while the send process is active. This will keep the send process running as long as there is a message in the outbox to be sent.

If the host application attempts to store a message when there is no space in the modem, an error is returned. The host must wait for the send process to free slots in the outbox before it can store additional outgoing messages.

## Composing MO-SMS messages

Message composition within the host involves both the SMS message header and body.

The header contents are defined by the CDMA specifications. The format of the data fields required by the modem is defined by data structures for the [CnS](#) interface. The [AT](#) interface uses a simpler format, in which the application need only pass the following:

- Priority
- Destination phone number
- Callback phone number (if not the modem's current account number)

For details of the portions of the SMS header the application is responsible for, consult the respective reference documents.

For the [CnS](#) interface, the application must assign a unique message number to each SMS message sent. This number is used to track and report the success or failure of sending the message. The application is responsible for ensuring the uniqueness of the message numbers.

Should you attempt to store two messages to the outbox that share a common message number, they are treated as separate messages, and the application is unable to associate confirming [notifications](#) with a unique message.

The [AT](#) interface does not use the outbox, so transmission status is associated with the last message sent.

## Storing MO-SMS messages

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*Note: Users of the [AT](#) interface can skip this section and proceed to "[Sending MO-SMS messages](#)" on page 66.*

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For users of the [CnS](#) interface, the first step in sending an SMS message (following composition) is to store the message in the modem's outbox.

The outbox can hold up to ten messages at once. An attempt to store an eleventh message results in an error being returned. The application will have to retry the message later.

**CnS** Storing a message using the CnS interface requires the application to segment the header and body into two or more protocol messages. Object **0x2003 SMS Write** is used to store a message.

The protocol uses its own SMS packet header to manage the segmentation of each SMS message. For details on handling segmentation, consult the *CnS Reference* (document 2130754).

**AT** The **AT** command interface does not use the outbox. Skip directly to sending the message as discussed in the following section.

### **Sending MO-SMS messages**

To send the message(s) stored in the modem's outbox (or directly send a message using the **AT** interface), issue the send command.

Upon receipt of the send command, the modem sets up the necessary network connection (either on the traffic channel or the access channel), and sends the first message.

The send process continues to send messages from the outbox until it is empty. The modem maintains a counter of unsent messages, incrementing it as messages are stored, and decrementing as they are sent. The send process continues as long as the counter indicates there is a message to send.

When the outbox is empty, the modem releases the radio resource used to send SMS messages.

**CnS** Object **0x2004 SMS Send** initiates the send process.

**AT** This interface handles the store-and-send as a single process, handling only one message at a time. The command **!SSMS** is used to pass the header data and body text. The body of the message can include any binary data except the delimiting quotation mark (0x22). The OK result to sending a message means only that the message has been stored and the send process begun. Success or failure of the transmission must be queried via the confirmation process (described next).

### **Confirming MO-SMS messages**

Following transmission of a MO-SMS message, the network will acknowledge it. There are several types of acknowledgement:

- Received by the network (sent)
- Failed by the network (requires a retry by the host)
- Delivered to the destination
- Read by the recipient

Only the first two—success or failure of the transmission—are reported to the application using a [notification](#). If a message fails for any reason, the application must repeat the store and send process for that message. The modem does **not** internally retry transmission of SMS messages.

Only after confirmation by the network should the host application delete its retained copy of the sent message.

The other (optional) acknowledgements are managed by an exchange of SMS messages. Delivery and read acknowledgments appear at the modem as new SMS messages, with a header field indicating that the message type is an acknowledgement.

In cases where the option to report a message delivered or read has been set, there may be a significant delay (minutes, hours, or even days) before those acknowledgements arrive.

Your host application is responsible for handling delivery receipts, distinguishing them from normal SMS messages, and for matching them to the original MO-SMS messages.

**CnS** The [notification](#) object **0x2005 SMS Send Status** is used to report the status of each message sent. The notification includes the message number (as assigned by the application) along with an error class (0 if no error) and cause code (0 if no error).

**AT** Notifications are not supported in the [AT](#) interface, so the message confirmation is available by query only. Using **!SSMS?** the application can get a report of the message status for the most recently sent message. For details of the possible responses, consult the *AT Command Reference* (document 2130620).

# Location-Based Services

## Introduction

Location-Based Services (**LBS**; also known as Position Determination Session Management [PDSM]) is a **GPS** feature supported by some carriers/networks. The **CDMA** network is used to assist the modem to acquire a GPS location fix.

gpsOne™ is a QUALCOMM technology that uses data from both GPS satellites and CDMA networks to provide the greatest availability as well as the highest accuracy across a wide variety of environments. Originally deployed for E-911 use, gpsOne technology allows emergency dispatchers to identify the location of a 911 call made from a wireless handset to within 5–50 meters in most environments, with industry precision indoors.

The gpsOne architecture includes both device and network components. GPS receivers detect signals from a constellation of more than twenty-four GPS satellites operated by the United States Air Force. These signals are decoded in the mobile device, and the network (PDE) or the modem calculates the latitude and longitude of the device (accuracy is roughly 8–60 meters).

A Position Determination Entity (PDE) is deployed on the carrier network. The PDE assists the GPS receiver inside the mobile device in two ways:

- The PDE, upon request, sends assistance data (almanac/ephemeris) to the device, allowing the device to search only for GPS satellites that should be visible to it. This reduces the time required for the GPS receiver to perform the first location fix (subsequent location fixes occur much faster, since the receiver is now “tuned” to the visible satellites).
- The PDE may also assist in the calculation of latitude and longitude. The PDE has access to the Carrier Base Station Almanac (BSA), allowing the PDE to calculate the location of a device by triangulating its location among the base stations that are visible to the device. This technique is known as Advanced Forward Link Trilateration (AFLT). The PDE may calculate the latitude and longitude of a device exclusively through AFLT, or it may perform a hybrid calculation based on AFLT in conjunction with processing raw GPS data sent from the device.

Because the PDE assists the mobile device, this method of location determination is also known as “assisted GPS” (A-GPS). This section of the documentation describes how to configure and command the modem to perform location based services.

## Types of LBS clients

**Registered clients** are clients that are interested in receiving notification about [LBS](#) events.

A **requesting** (or **active**) client is a client that has initiated the current LBS session or event. A requesting client is typically also a [registered](#) client.

## Enabling notifications (CnS)

Since an application that requires one location fix notification or one download data notification will typically need all of the notifications of that type, it is recommended that you enable **0x0F07 Location notification status** and **0x0F08 Download notification status**.

If your application is interested in the value of, or change in, one or more [LBS](#) parameters, enable **0x0F09 Parameter notification status**.

## Current status of Location-Based Services

**CnS** Object **0x0F03 PDSM Status** is used to retrieve the current status of the Location-Based Services.

**AT** The command **!GPSSTATUS** queries the status of the Location-Based Services.

## Getting the location of the terminal

### Last known location

**CnS** Object **0x0F0A Position Fix Data** is used to request the last known location.

**AT** The command **!GPSLOC** returns the last known location.

### Single location fix

**CnS** See the following description, and also [Figure 39](#) on page 127.

Object **0x0F02 PD Get Position** is used to initiate a location fix.

Object **0x0F0D Position Fix Session Begin** notifies the [registered](#) host clients that a position determination fix session has begun.

Object **0x0F0A Position Fix Data** is used to return the results of the location fix.

Object **0x0F0C Position Fix Session End** notifies the host clients if the position determination fix session has ended in error.

Object **0x0F0B Position Fix Session Done** notifies the registered host clients that a position determination fix session has completed.

**AT** The command **!GPSFIX** initiates a location fix. **!GPSSTATUS** returns the status of the position location session. If the session has completed successfully, **!GPSLOC** returns the location information.

## Retrieving satellite information

**CnS** Object **0x0F1F Satellite Information** is used to retrieve information about satellites visible during the latest position fix session and satellites used in the latest position fix.

**AT** The command **!GPSSATINFO** queries the modem for information for all satellites in view and those used in the last known, successful location fix.

## Downloading ephemeris and almanac data

**CnS** Object **0x0F01 PD download** requests the modem to perform a download of the ephemeris and almanac data. The host uses Download Option to indicate whether the data download should occur just once or periodically, in an effort to keep the data “warm”.

Object **0x0F0F Download Data Session Begin** notifies the [registered](#) host clients that a download session of ephemeris and almanac data has begun.

Object **0x0F10 Download Data** notifies the registered host clients that ephemeris and almanac data has been downloaded.

Object **0x0F12 Download Data Session End** notifies the registered host clients if a position determination download data session has ended in error.

Object **0x0F11 Download Data Session Done** notifies the registered host clients that a position determination download session has completed.

**AT** The command **!GPSDLOAD** initiates a download of ephemeris and almanac data. **!GPSSTATUS** returns the status of the download session.

## Tracking the location of the terminal

**CnS** See the following description, and also [Figure 40](#) on page 128.

Object **0x0F04 PD Track** is used to start a tracking session. This object should be used when an application requires multiple location fixes over a small period of time (for example, a fix between every 1 to 240 seconds)

If necessary, downloads ephemeris and almanac data:

- Object **0x0F0F Download Data Session Begin** notifies the [registered](#) host clients that a download session of ephemeris and almanac data has begun.
- Object **0x0F10 Download Data** notifies the host clients that ephemeris and almanac data has been downloaded.
- Object **0x0F12 Download Data Session End** notifies the registered host clients if a position determination download data session has ended in error.
- Object **0x0F11 Download Data Session Done** notifies the registered host clients that a position determination download session has completed.

Object **0x0F0D Position Fix Session Begin** notifies the registered host clients that a position determination fix session has begun.

Object **0x0F0A Position Fix Data** is used to return the results of the location fixes.

Object **0x0F0C Position Fix Session End** notifies the host clients if the position determination fix session has ended in error.

Object **0x0F0B Position Fix Session Done** notifies the [registered](#) host clients that a position determination fix session has completed.

**AT** The command **!GPSTRACK** initiates a location tracking session. **!GPSSTATUS** returns the status of the session. If the session has completed successfully, **!GPSLOC** returns the last computed location fix.

## Terminating a position determination session

### Terminating a location fix session

**CnS** Object **0x0F05 PD End Session** is used to request the termination of a tracking session (location fix session or download data session).

Object **0x0F0C Position Fix Session End** notifies the host clients if the position determination fix session has ended in error.

Object **0x0F0B Position Fix Session Done** notifies the [registered](#) host clients that a position determination fix session has completed.

**AT** The command **!GPSEND** ends an active position session.

### Terminating a download session

**CnS** Object **0x0F05 PD End Session** is used to request the termination of a tracking session (location fix session or download data session).

Object **0x0F12 Download Data Session End** notifies the registered host clients if a position determination download data session has ended in error.

Object **0x0F11 Download Data Session Done** notifies the registered host clients that a position determination download session has completed.

**AT** The command **!GPSEND** ends an active position session.

## Accessing the default position determination parameters

**CnS** Object **0x0F06 PA Parameter Settings** is used to retrieve the default parameter settings used during **LBS** sessions. The entire set of position determination parameters is returned (IP Address, Port ID, GPS Lock, Transport Mechanism, Privacy, Network Access).

The parameters can also be accessed individually (objects **0x0F13 TCP/IP Address**, **0x0F14 GPS Lock**, **0x0F15 Transport Mechanism**, **0x0F16 Port ID**, **0x0F17 Privacy Level**, **0x0F18 Network Access Permissions**).

**AT** The command **!GPSLOCK** queries/sets the GPS lock for location processing. **!GPSIPADDR** queries/sets the TCP/IP Address. **!GPSPORTID** queries/sets the Port ID. **!GPSPTLM** queries/sets the Transport Mechanism. **!GPSPRIV** queries/sets the Privacy Level. **!GPSNETACC** queries/sets the Network Access Permissions.

# Fax Connections

## Introduction

This chapter describes how to configure the modem to originate and answer fax calls. A third-party fax application is required to manage fax operations.

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*Note:* If an incoming call arrives during a fax connection, the caller gets a busy signal or is put through to voice mail.

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## Configuring for fax

The Mini Card's primary port appears as a standard modem to the operating system. Most fax applications are able to originate and receive fax transmissions by using the port normally; however, some configuration elements must be properly set.

### Serial data speed

The modem's primary port is set to 115.2 kbps by default. Fax applications usually move data at much slower rates (14.4 kbps typically).

To ensure your fax transmissions run smoothly, you should configure the port to a slower speed—19200 is recommended—when using fax. Setting the serial port data speed can be done using **AT+IPR=19200**

Both the modem and the application must be set to the correct speed.

### Fax class

The Mini Card supports only fax class 2.0. Note that this is distinct from the earlier fax class 2 standard. Neither fax class 1, nor the early version of class 2 is supported.

The initialization string of the application must use **AT+FCLASS=2.0**

### Flow control

The Mini Card supports only hardware flow control. This means that the application must be configured to use only hardware flow control, and the initialization must include **AT+FLO=2**

## Answer as fax

The CDMA network requires that the modem be configured to answer a call as a fax **in advance of receiving the ring**. If the modem has not been so configured, the call negotiation fails when the call is answered.

The modem can be configured to answer “all calls as fax” or answer “next call as fax”. If the latter option is selected, the modem answers the next incoming call (within 10 minutes) as a fax, then reverts to voice mode for subsequent calls. If no call arrives within the 10-minute interval, the modem reverts to voice mode.

To configure the modem to answer fax calls, use one of the options in the following table.

Table 7: Settings to answer calls as fax

Interface	All as Fax	Next as Fax
AT command	AT\$QCVAD=2	AT\$QCVAD=1
CnS	Object <b>0x1014</b> , with parameter <b>0x0002</b>	Object <b>0x1014</b> , with parameter <b>0x0001</b>

## Use with Symantec® Winfax® Pro 10.0

To configure the Mini Card for use with WinFax Pro 10.0:

1. Make sure the Mini Card is installed as a modem in Control Panel.
2. Launch Windows Terminal and make sure the Mini Card is connected to the data port. Change the modem’s baud rate to 19200 using **AT+IPR=19200**. After confirmation, close Windows Terminal.
3. Launch Symantec WinFax PRO Message Manager.
4. Go to **Tools > Program Setup**.
5. Double-click **Modems and Communications Devices**.
6. Select the **Active** box for the “Sierra Wireless MC5728V Modem Device”; clear any other Active check boxes for all other devices.
7. A message may pop up similar to “The MC5728V has not been configured to work with WinFax PRO. Do you want to run the WinFax PRO modem configuration wizard now?” Choose **Yes**, then the defaults: **Next, Next, Next, Finish**.
8. When prompted for **Locations**, choose “Cellular (PCS/GSM-Digital)” only. At this point, you may need to select the Active box for the MC5728V Mini Card again.
9. Highlight the entry for your modem (“Sierra Wireless MC5728V Modem Device”) and choose **Properties**.

10. On the **General** tab under “Communications port”, ensure that:
    - a) The **COM port** is set correctly
    - b) **Initialize at 19200 bps** is selected
    - c) **Class 2.0** is selected under the **Modem Type** category.
  11. On the **Fax** tab, ensure that the **Regular or Cellular (PCS-GSM-Digital)** has been selected from the modem connection drop-down list.
  12. Under the **Initialization string sequence** section, the fields should be populated as follows:

**AT&F&C1&D2S7=55** (This may or may not be populated by default).

**AT\$QCVAD=2**
  13. Beside the **Flow Control** option, enter **AT+FCLASS=2.0;+FLO=2**, and ensure that the **Use hardware flow** control box is selected.
  14. Click **OK** in the Properties window.
  15. Click **Dialing Setup**, then select the **Location** tab. Ensure that the phone number for the modem is entered into the appropriate fields.
  16. Click **OK**. Then choose **OK, Close**.
- The modem is now configured for sending faxes. To set the modem to answer a fax:
17. Set the modem to answer calls as fax using a command option from [Table 7](#) on page 74.
  18. In WinFax Pro, click the **Receive Setup** button.
  19. Select the box beside **Automatically answer incoming calls**, and set the application to answer after **2 rings**.
  20. Click **OK**.

## Sending a fax

You cannot send a fax while the modem is active with another call, either data or voice. A dormant **1X** data call still requires the primary port to keep the **PPP** session open, making it unavailable for fax.

To originate a fax:

1. Configure the fax application to use the COM port assigned to the Mini Card's primary port.
2. Set the data rate of the modem and application, and use hardware flow control.
3. Send the fax as you would using a normal landline modem.

## Receiving a fax

By default the MC5728V Mini Card is set to answer all calls as voice calls. To receive a fax or data call, you must:

1. Configure the fax application to use the COM port assigned to the Mini Card's primary port.
2. Set the data rate of the modem and application, and use hardware flow control.
3. Set the Mini Card to answer appropriately as described in [Table 7](#) on page 74.
4. Set the fax application to automatically answer incoming calls after 2 rings.

Now wait for the incoming call.

# Troubleshooting

## Overview

This chapter provides information to aid your development and technical support staff in resolving problems with the Watcher enabling software.

## Integration support

During your integration development, support is available from Sierra Wireless. The purchase of the Mini Card Development Kit includes an initial allotment of tier-3 support. You should have been advised by your account manager how to access this support.

The specifics of your integration govern how successfully Watcher can communicate with the Mini Card. If Watcher reports modem communication problems, review your installation of Watcher, the allocation of the communication ports, and your hardware integration of those ports.

## Troubleshooting

Most problems you may encounter relate to one of these three subjects:

- Communication port allocation and configuration
- Dial-up Networking connectoids
- Network coverage

This section describes how to diagnose and solve these and other problems. If, after reading this section, you are unable to resolve a problem, contact your service provider. If problems persist, contact Sierra Wireless integration support.

Table 8: Problem causes and suggestions

Problem	Possible Causes	Suggestions
Watcher displays “ <b>Searching for ... modem...</b> ”	There is a resource allocation problem with the secondary COM port.	<ul style="list-style-type: none"> <li>• Use the port tool to ensure correct port allocation.</li> <li>• Ensure no other application is using the port</li> </ul>
The Watcher screen is frozen.	If you are unable to resolve this problem by restarting your device, you may have a resource conflict.	See above.

Problem	Possible Causes	Suggestions
<p>Watcher displays the message <b>“Not in service”</b>, and the antenna icon is crossed out.</p>	<p>Inadequate signal strength may occur for any of these reasons:</p> <ul style="list-style-type: none"> <li>• You are outside the network coverage area, or in an area where the signal is blocked.</li> <li>• Your antenna is not attached or is pointed in the wrong direction.</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure your antenna is properly attached and aligned.</li> <li>• Verify that you are within the coverage area of your service provider.</li> <li>• Try changing your location or re-orienting your antenna</li> </ul>
<p>When attempting a dial-up data connection, Watcher displays the message <b>“There is no answer”</b>.</p>	<ol style="list-style-type: none"> <li>a. You have an account problem or the network is overloaded with calls.</li> <li>b. The phone number is incorrectly set up in the Dial-Up Manager</li> </ol>	<ol style="list-style-type: none"> <li>a. Make a call to a local number. If you are able to complete this call, the problem is likely in the way that the connection is set up; otherwise, contact your service provider.</li> <li>b. Verify that the number you want to dial is set up properly in the Dial-Up Manager.</li> </ol>
<p>When attempting to add a connection to the Dial-Up Manager, Watcher displays the message <b>“You already have a connection with the name .... Please choose a different name.”</b></p>	<p>The connection already exists in Windows Dial-Up Networking.</p>	<p>Choose a different name for your connection.</p>

# Appendix A: Acronyms and definitions

## Acronyms and definitions

Table 9: Acronyms and definitions

Acronym or term	Description
1X	A high-speed standard for cellular packet data communications. Supports Internet connections with data rates up to 153.6 kbps (downlink from the network) and 76.8 kbps (uplink to the network). Actual speed depends on the network conditions.
1xEV-DO	A high-speed standard for cellular packet data communications. Rev. A supports Internet connections with data rates up to 3.1 Mbps (downlink from the network) and 1.8 Mbps (uplink to the network). Rev. 0 supports Internet connections with data rates up to 2.4 Mbps (downlink from the network) and 153 Kbps (uplink to the network). Average data rates are roughly: for Rev. A: 600-1300 Kbps (downlink from the network) and 300-400 Kbps (uplink to the network); for Rev. 0: 400-700 Kbps (downlink from the network) and 40-80 Kbps (uplink to the network). Actual speed depends on the network conditions. Compare to <a href="#">1X</a> .
AAA	Authentication, Authorization, Accounting
AT (command)	A set of modem commands, preceded by "AT," originally developed by Hayes, Inc. for their modems. The structure but not the specific commands, which vary greatly from manufacturer to manufacturer, is a de facto modem industry standard.
ATCoP	<a href="#">AT</a> Command Processor
BS	Base station
CCT	CDMA Configuration Tool—a program used to configure Sierra Wireless modems.
CDG	CDMA Development Group—a consortium of companies that develop and promote the products and services for CDMA wireless systems.

Acronym or term	Description
CDMA	Code Division Multiple Access—A wideband spread spectrum technique used in digital cellular, personal communications services, and other wireless networks. Wide channels (1.25 MHz) are obtained through spread spectrum transmissions, thus allowing many active users to share the same channel. Each user is assigned a unique digital code, which differentiates the individual conversations on the same channel.
CHAP	Challenge Handshake Authentication Protocol
CIPRL	Client-Initiated <a href="#">PRL</a> Update
CnS	Control and Status (language)—a proprietary protocol for managing the control and status of the Mini Card. CnS is described in detail in the Sierra Wireless document “ <i>CnS Reference</i> ” (document 2130754)
co-located	The <a href="#">1X</a> and <a href="#">1xEV-DO</a> systems are associated with each other in the PRL (Preferred Roaming List).
datagram	A packet that may or may not contain other packets and is transmitted via the Internet Protocol.
DM	<ul style="list-style-type: none"> <li>• Device Management</li> <li>• Diagnostics Monitor</li> </ul>
DTMF	Dual Tone MultiFrequency—the tone generation system used by standard telephone networks. Each key is allocated a row and column tone; both are played at once to create the DTMF signal.
EFS	Encrypted File System
FA	Foreign Agent
FOTA	Firmware Update Over The Air—a feature included in OMA Device Management ( <a href="#">OMA-DM</a> ).
FUMO	Firmware Update Management Object
GPS	Global Positioning System—a system that uses a series of 24 geosynchronous satellites to provide navigational data.
HA	Home Agent
HDR	High Data Rate—a Qualcomm wireless technology that provides high-speed, high-capacity IP packet data services.

Acronym or term	Description
HFA	Hands Free Activation
HIP	Host Interface Protocol—a proprietary protocol for managing the control and status of the Mini Card. Intended to carry a variety of other protocol packets across a single link layer. <b>CnS</b> is one of the types of packets that can be carried inside HiP.
HLR	Home Location Register
HSPD	High-Speed Packet Data
ICMP	Internet Control Message Protocol—a protocol that reports errors and provides other information related to IP packet processing.
IKE	Internet Key Exchange
IMSI	International Mobile Station Identity
IP	Internet Protocol
IPSec	IP Security
IPCP	IP Control Protocol
IS-95	2G radio standards targeted for voice (cdmaONE)
ISP	Internet Service Provider
IWF	Interworking Function—A function that converts information for one or more network entities. A data service IWF enables a mobile station to communicate with data terminal equipment connected to the network.
LAC	Link Access Control
LBS	Location-Based Services—a <b>GPS</b> feature supported by some carriers/networks. The <b>CDMA</b> network is used to assist the modem to acquire a GPS location fix.  Also known as Position Determination Session Management (PDSM).
LCP	Link Control Protocol

Acronym or term	Description
MAC	Medium Access Control
MIP	Mobile IP
mobile	Sierra Wireless' mobile includes a host device (PC/PDA) and a CDMA wireless modem.
MS	Mobile Station
MSC	Mobile Switching Center
NAI	Network Access Identifier
notification	A mechanism to send unsolicited data from either side (host; modem) of the interface; used when no reply or return data is required from the receiver (or conversations do not require stop-and-wait flow control)
NV	Non-Volatile (memory)
OMA-DM	Open Mobile Alliance - Device Management. A device management (DM) protocol specified by the Open Mobile Alliance (OMA) Device Management Working Group and the Data Synchronization (DS) Working Group.
OTAPA	Over-the-Air Parameter Administration. For more information, see <a href="#">"OTASP services"</a> on page 125.
OTASP	Over-the-Air Service Provisioning. For more information, see <a href="#">"OTASP services"</a> on page 125.
PAP	Password Authentication Protocol
PCF	Packet Control Function
PDSN	Packet Data Serving Node
PL	Physical Layer
PPP	Point-to-Point Protocol

Acronym or term	Description
PRL	Preferred Roaming List—an account configuration item set by the user's service provider. It controls the radio channels/network carrier used by the modem.
PSTN	Public-Switched Telephone Network
QoS	Quality of Service
RADIUS	Remote Authentication Dial In User Service
R-P	<a href="#">RN-PDSN</a>
RI	Ring Indicator
registered (LBS client)	A client that is interested in receiving notification about <a href="#">LBS</a> events.
requesting (LBS client)	A client that has initiated the current <a href="#">LBS</a> session or event. A requesting client is typically also a <a href="#">registered</a> client.
RLP	Radio Link Protocol
RN	Radio Network
RRC	Radio Resource Control
RRQ	Registration Request (Mobile IP)
RSSI	Received Signal Strength Indication—the signal power level at the antenna of the modem, usually measured in dBm.
SID	System Identifier—identifies your home network area and is used in conjunction with your phone number to determine if you are “home” or “roaming”.
SIP	Simple IP
SLIP	Serial Line Internet Protocol—The original communications protocol used between computers, or between computers and routers on the Internet. This protocol allows applications, such as Watcher, to communicate with the modem by exchanging <a href="#">datagrams</a> across the serial port connection. See also <a href="#">PPP</a> .

Acronym or term	Description
SPI	Security Parameter Index
SS7	Signaling System 7
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
VLR	Visitor Location Register

# Appendix B: ASCII Table

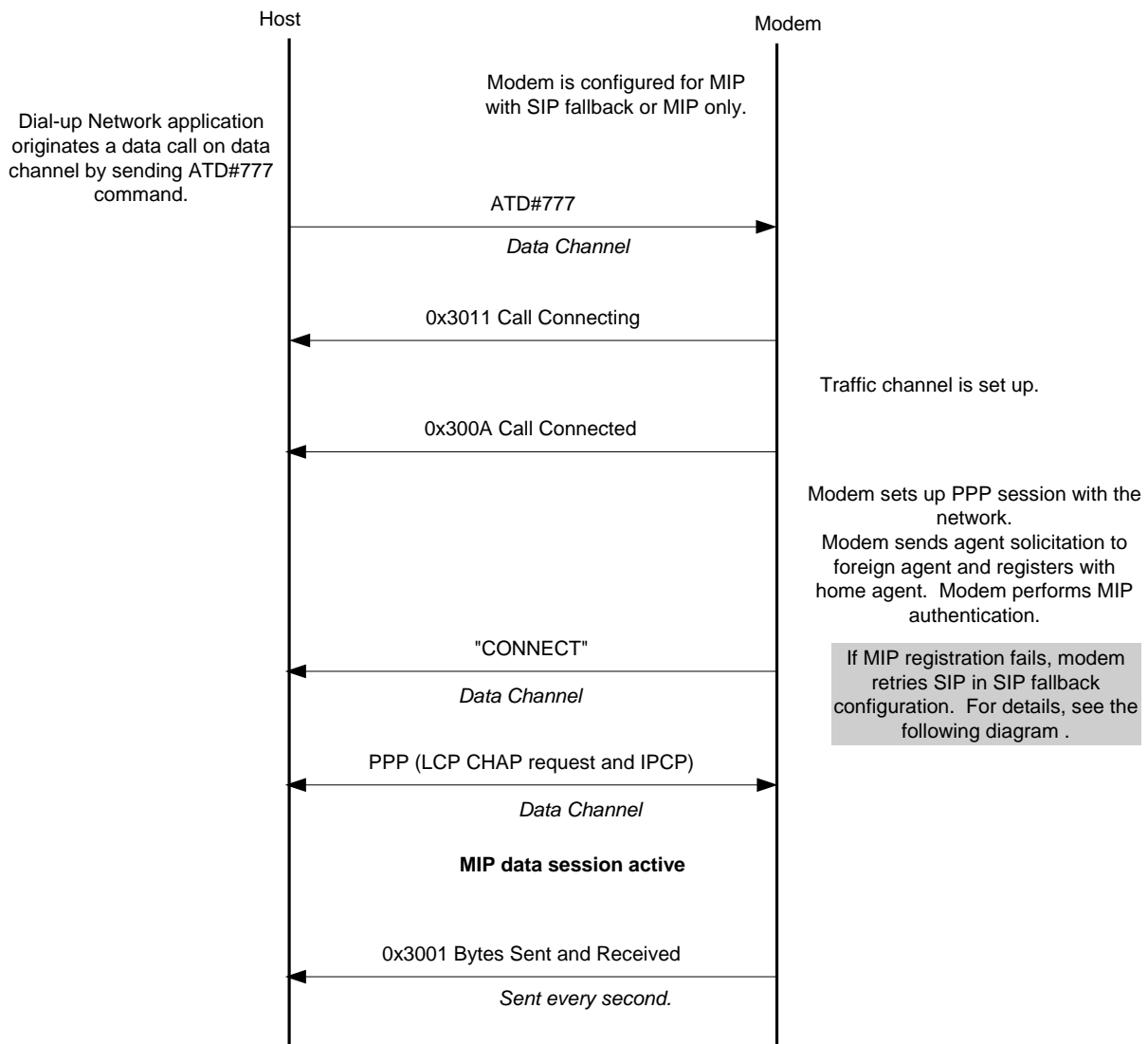
Char	Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char	Dec	Hex
NUL	0	00	SP	32	20	@	64	40	'	96	60
SOH	1	01	!	33	21	A	65	41	a	97	61
STX	2	02	"	34	22	B	66	42	b	98	62
ETX	3	03	#	35	23	C	67	43	c	99	63
EOT	4	04	\$	36	24	D	68	44	d	100	64
ENQ	5	05	%	37	25	E	69	45	e	101	65
ACK	6	06	&	38	26	F	70	46	f	102	66
BEL	7	07	'	39	27	G	71	47	g	103	67
BS	8	08	(	40	28	H	72	48	h	104	68
HT	9	09	)	41	29	I	73	49	i	105	69
LF	10	0A	*	42	2A	J	74	4A	j	106	6A
VT	11	0B	+	43	2B	K	75	4B	k	107	6B
FF	12	0C	,	44	2C	L	76	4C	l	108	6C
CR	13	0D	-	45	2D	M	77	4D	m	109	6D
SO	14	0E	.	46	2E	N	78	4E	n	110	6E
SI	15	0F	/	47	2F	O	79	4F	o	111	6F
DLE	16	10	0	48	30	P	80	50	p	112	70
XON	17	11	1	49	31	Q	81	51	q	113	71
DC2	18	12	2	50	32	R	82	52	r	114	72
XOFF	19	13	3	51	33	S	83	53	s	115	73
DC4	20	14	4	52	34	T	84	54	t	116	74
NAK	21	15	5	53	35	U	85	55	u	117	75
SYN	22	16	6	54	36	V	86	56	v	118	76
ETB	23	17	7	55	37	W	87	57	w	119	77
CAN	24	18	8	56	38	X	88	58	x	120	78
EM	25	19	9	57	39	Y	89	59	y	121	79
SUB	26	1A	:	58	3A	Z	90	5A	z	122	7A
ESC	27	1B	;	59	3B	[	91	5B	{	123	7B
FS	28	1C	<	60	3C	\	92	5C		124	7C
GS	29	1D	=	61	3D	]	93	5D	}	125	7D
RS	30	1E	>	62	3E	^	94	5E	~	126	7E
US	31	1F	?	63	3F	_	95	5F	DEL	127	7F

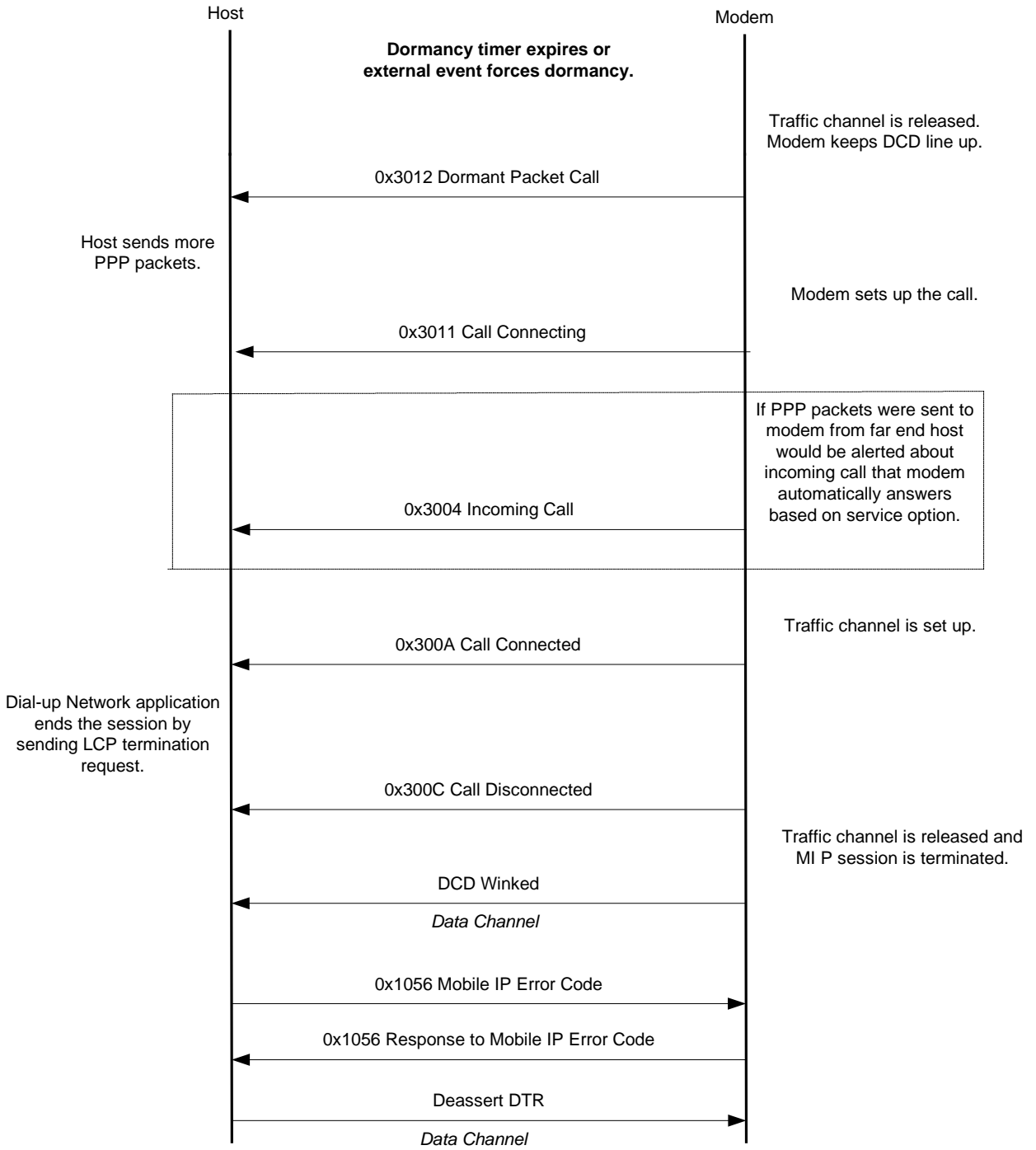
# Appendix C: Data Connection Application Note

## Packet data call

### Initiate and end a data session via Mobile IP

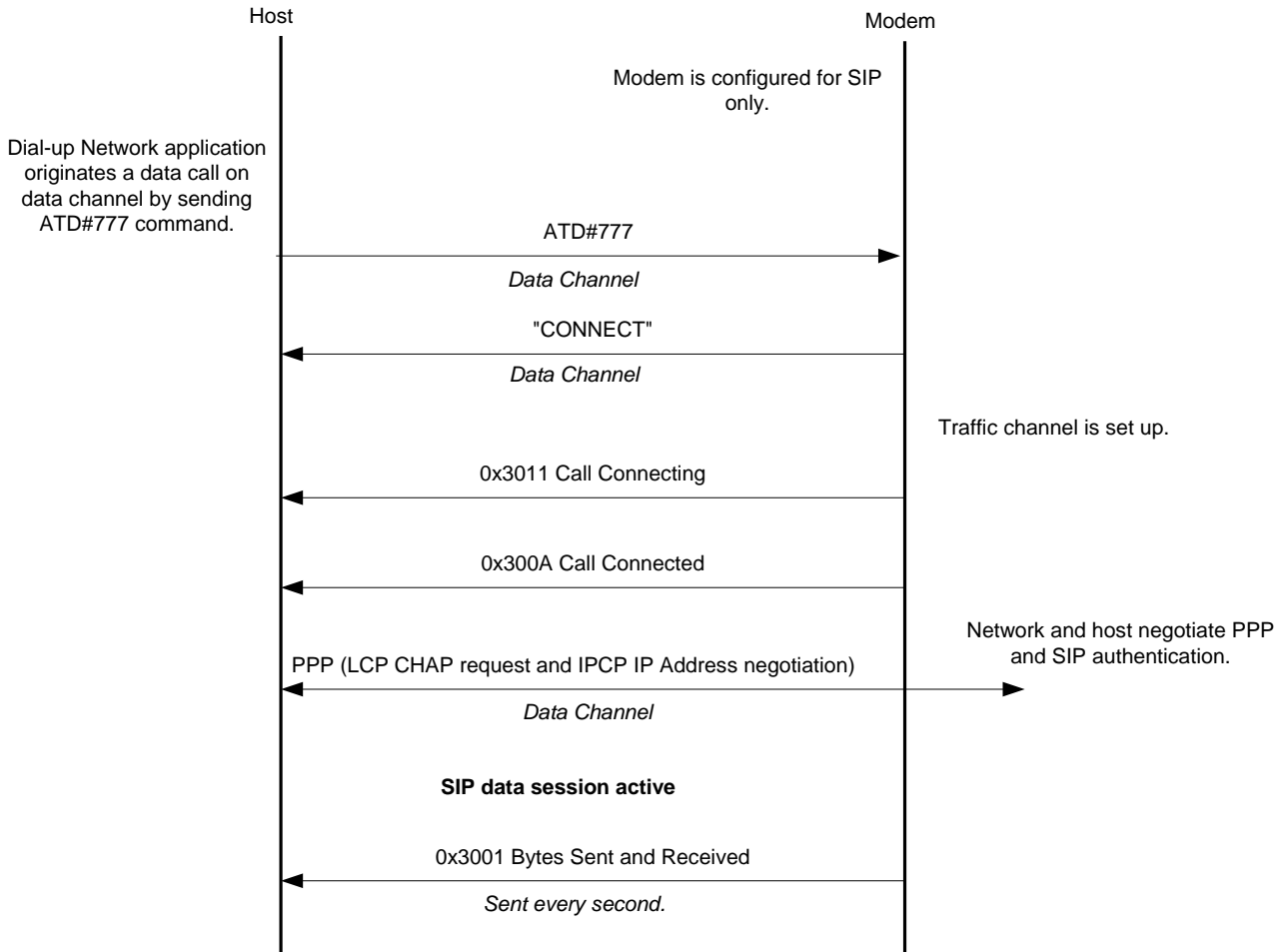
Figure 6: Initiating and ending a Mobile IP data session





## Initiate and end a data session via Simple IP

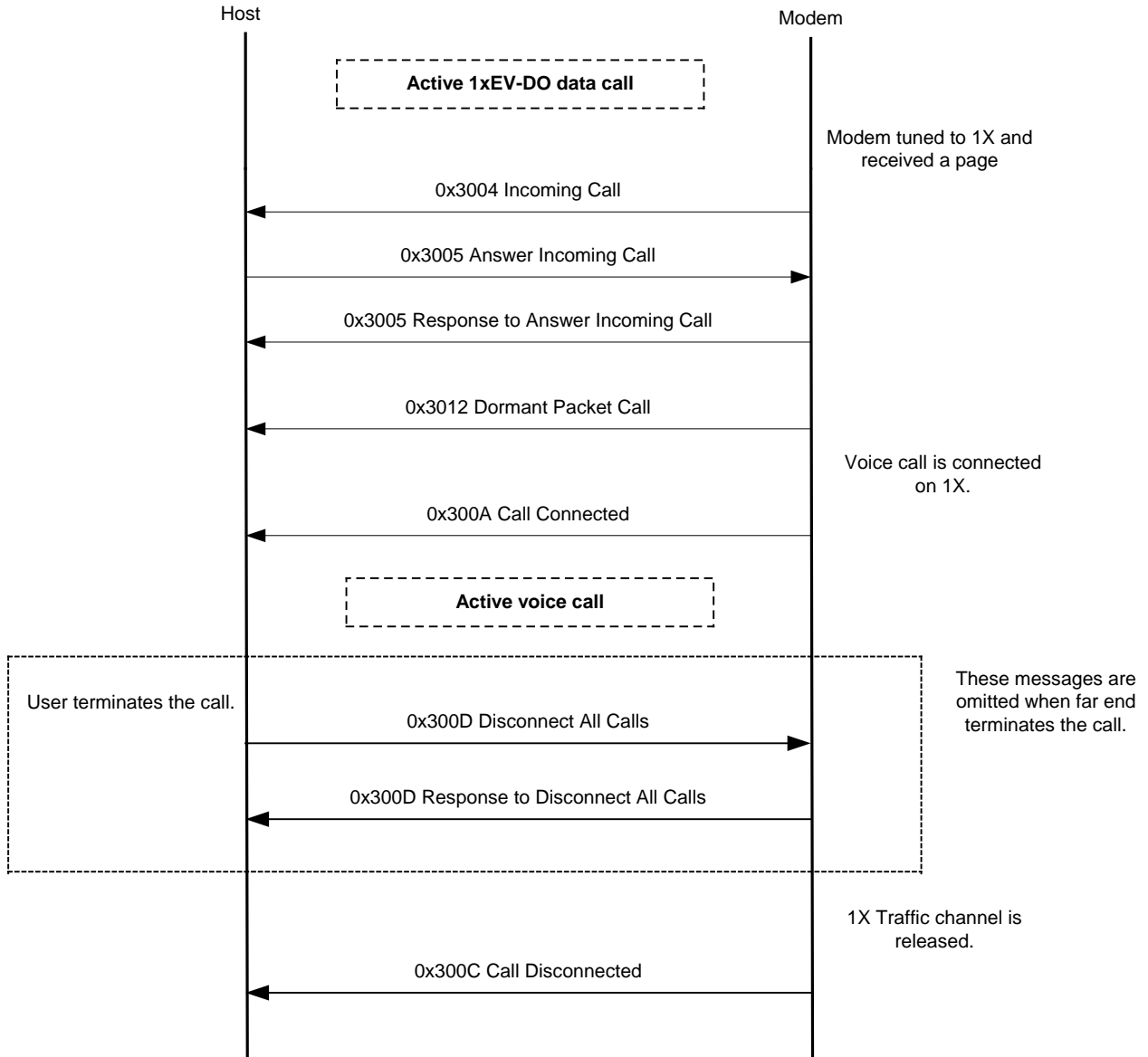
Figure 7: Initiating and ending a Simple IP data session

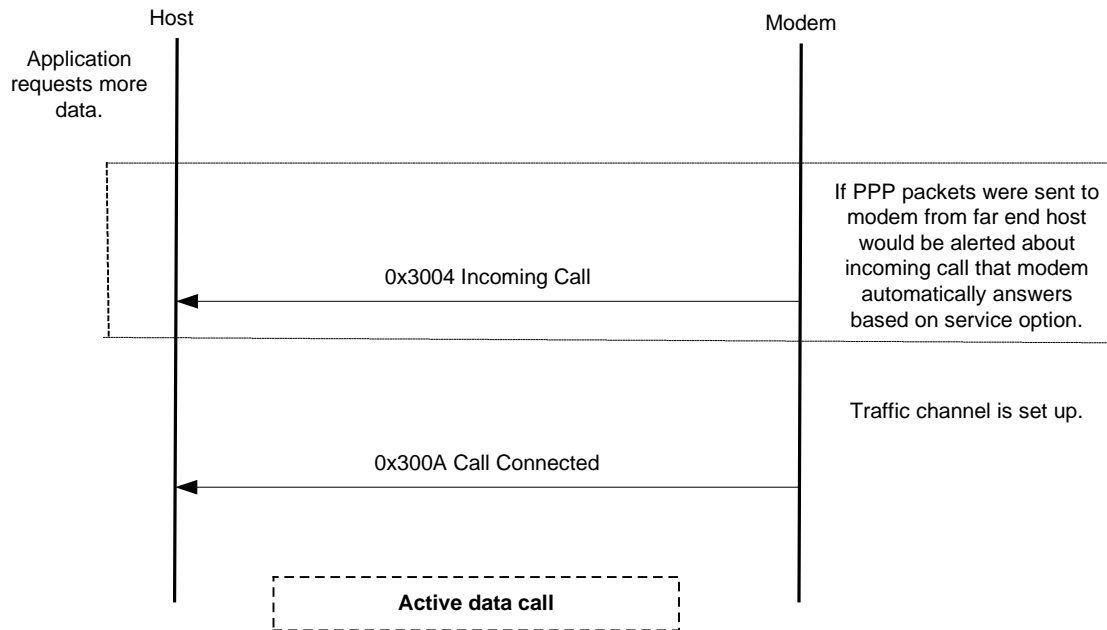


Transitioning to dormant state and back to active, and tearing down the session is identical to MIP data connection. For details on messaging, see the MIP data connection diagram.

### Answer an incoming voice call while in an active 1xEV-DO data connection

Figure 8: Answering an incoming voice call while in an active 1xEV-DO data connection

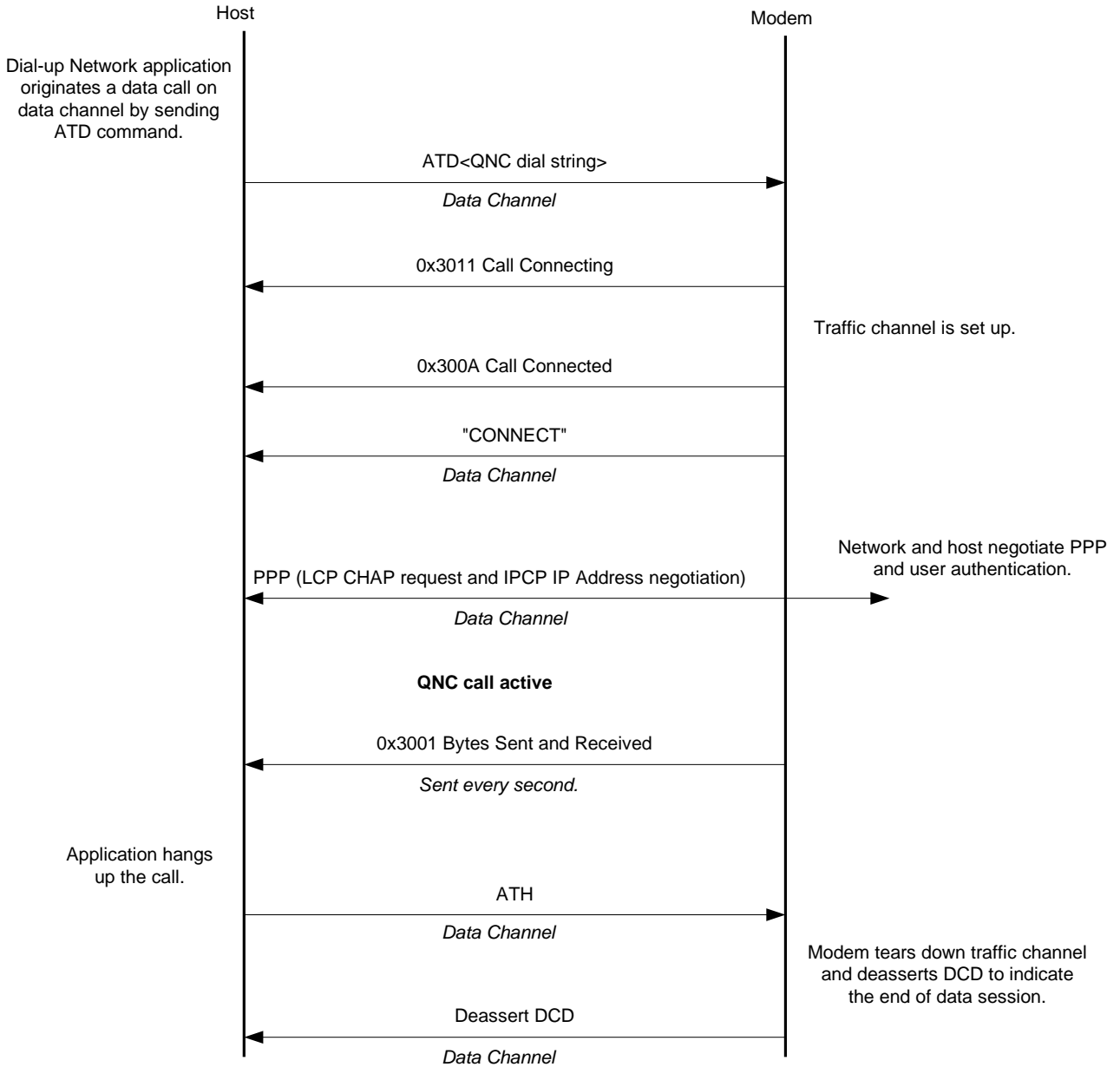




## Circuit-switched and QNC data call

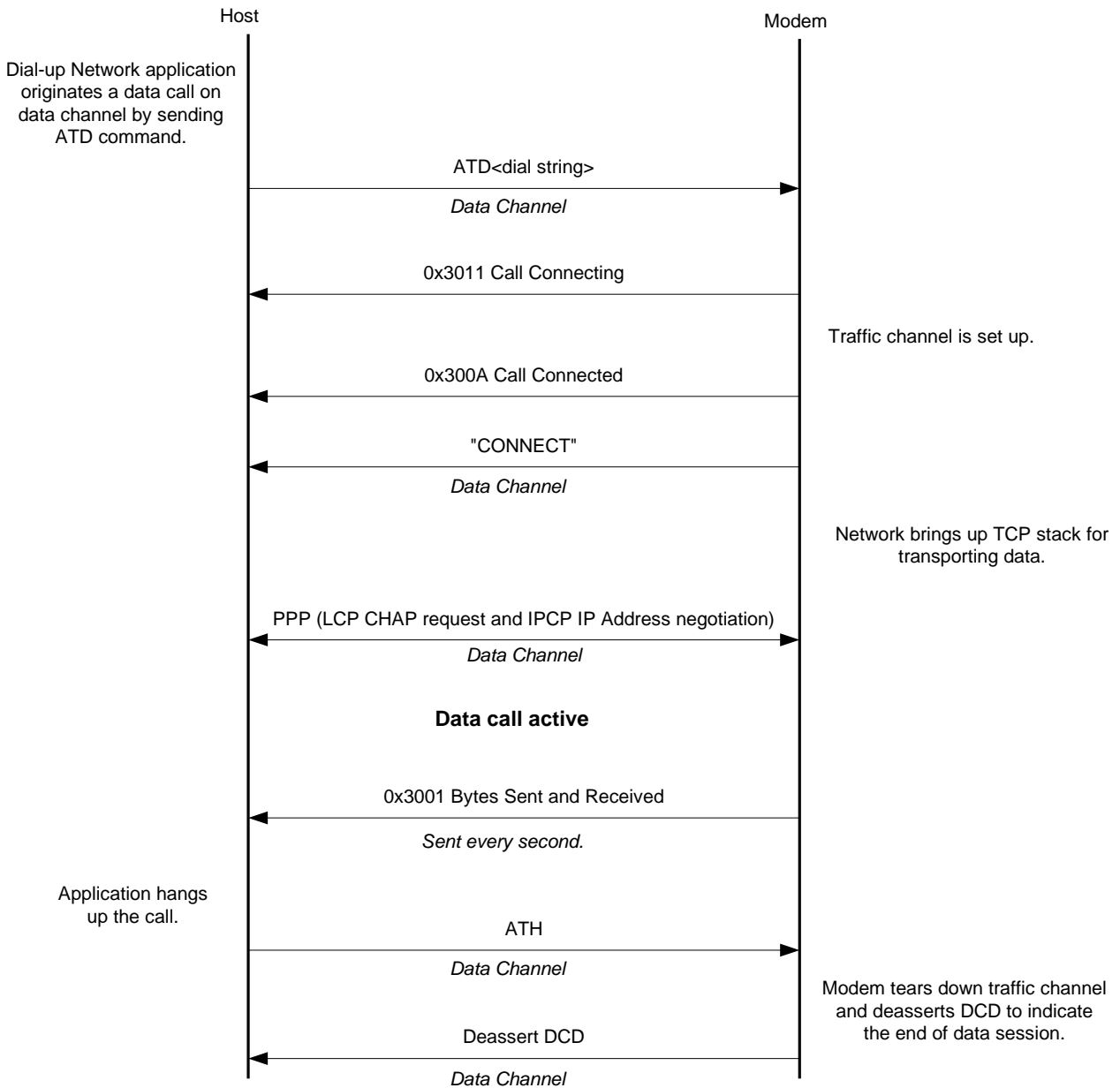
### Initiate and end a QNC data connection

Figure 9: Initiating and ending a single-stack QNC data connection



### Initiate and end a circuit-switched data connection

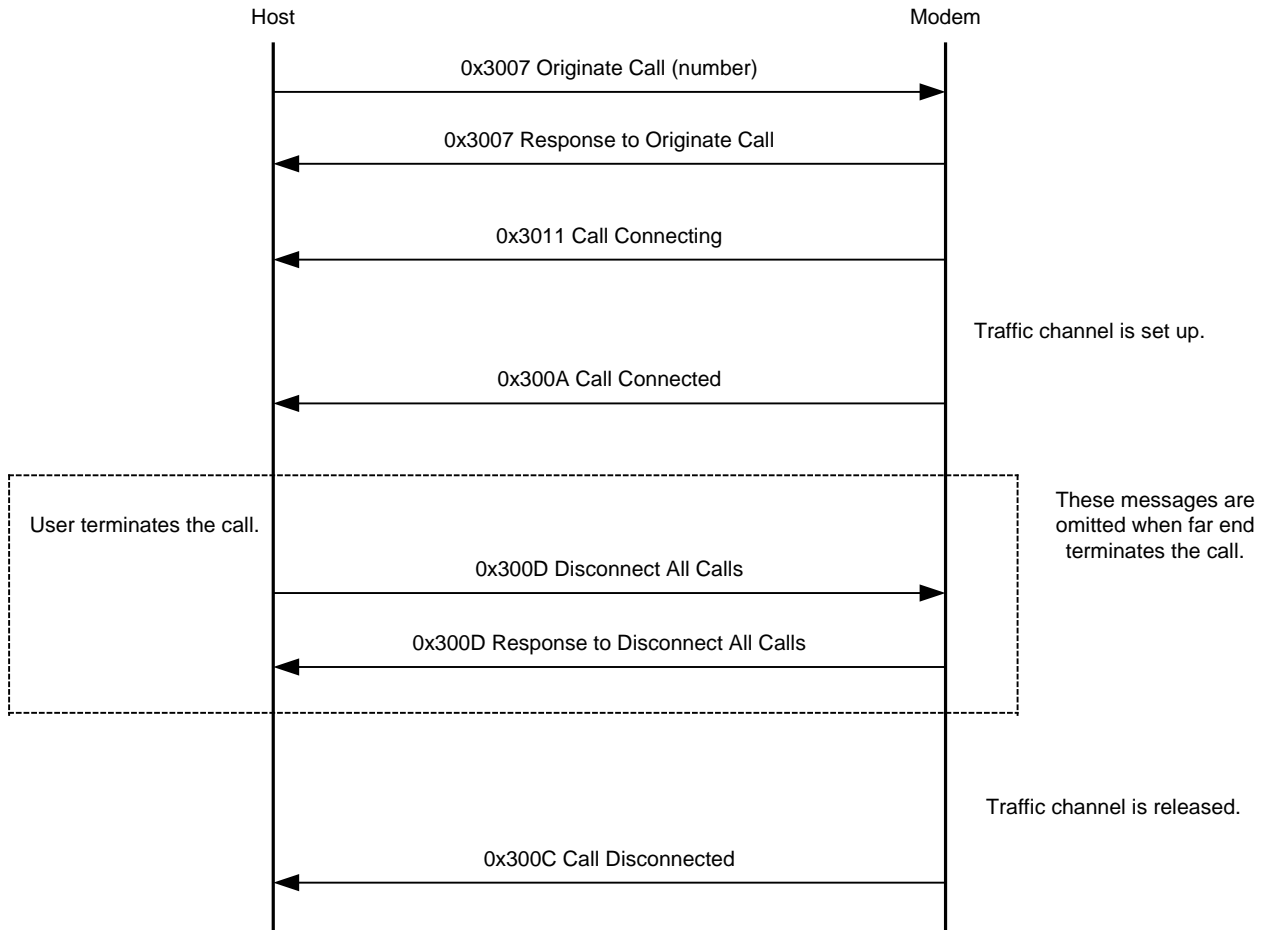
Figure 10: Initiating and ending a circuit-switched data connection



# Appendix D: Voice Connection Application Note

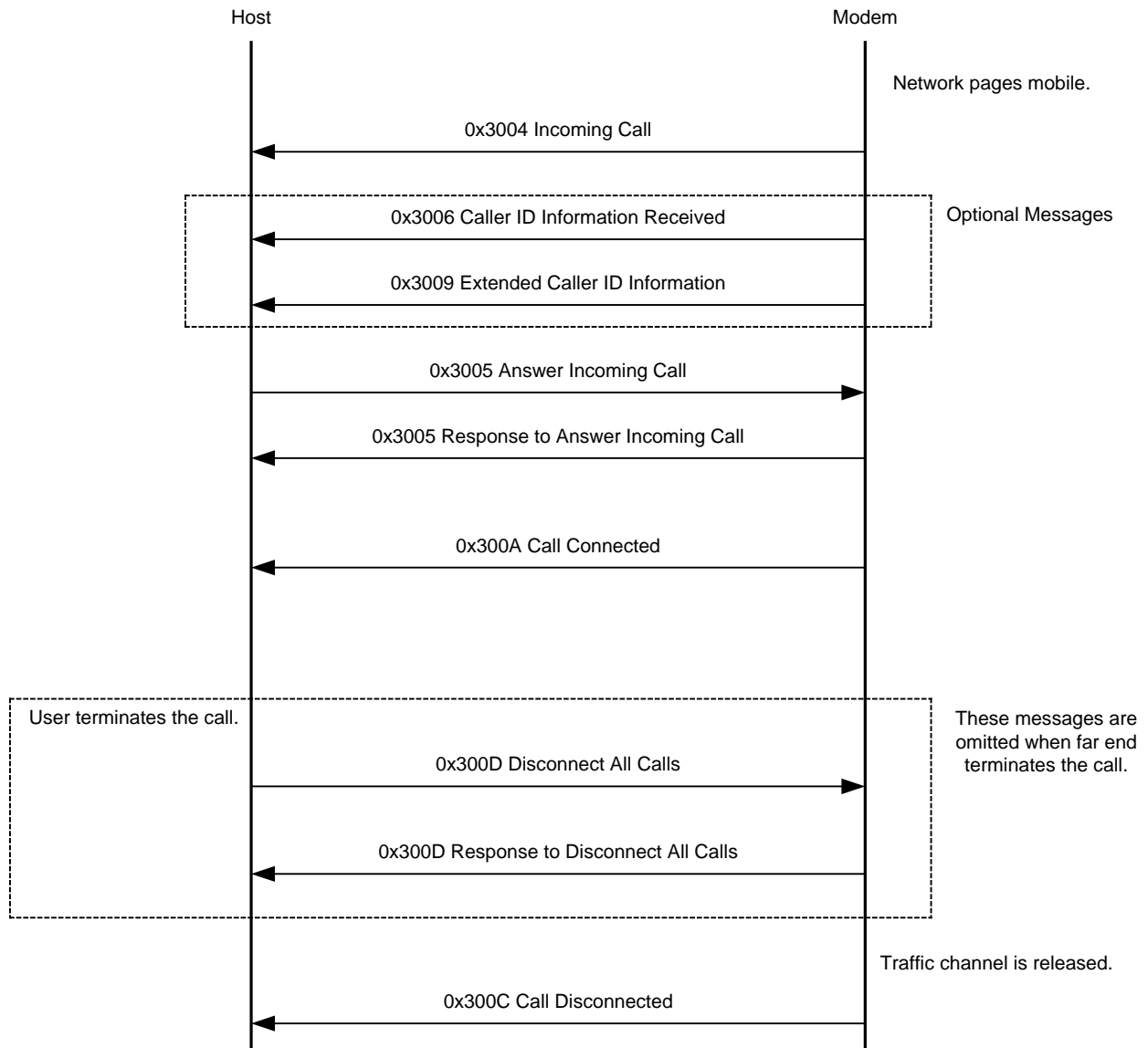
## Originate a voice call

Figure 11: Originating a voice call



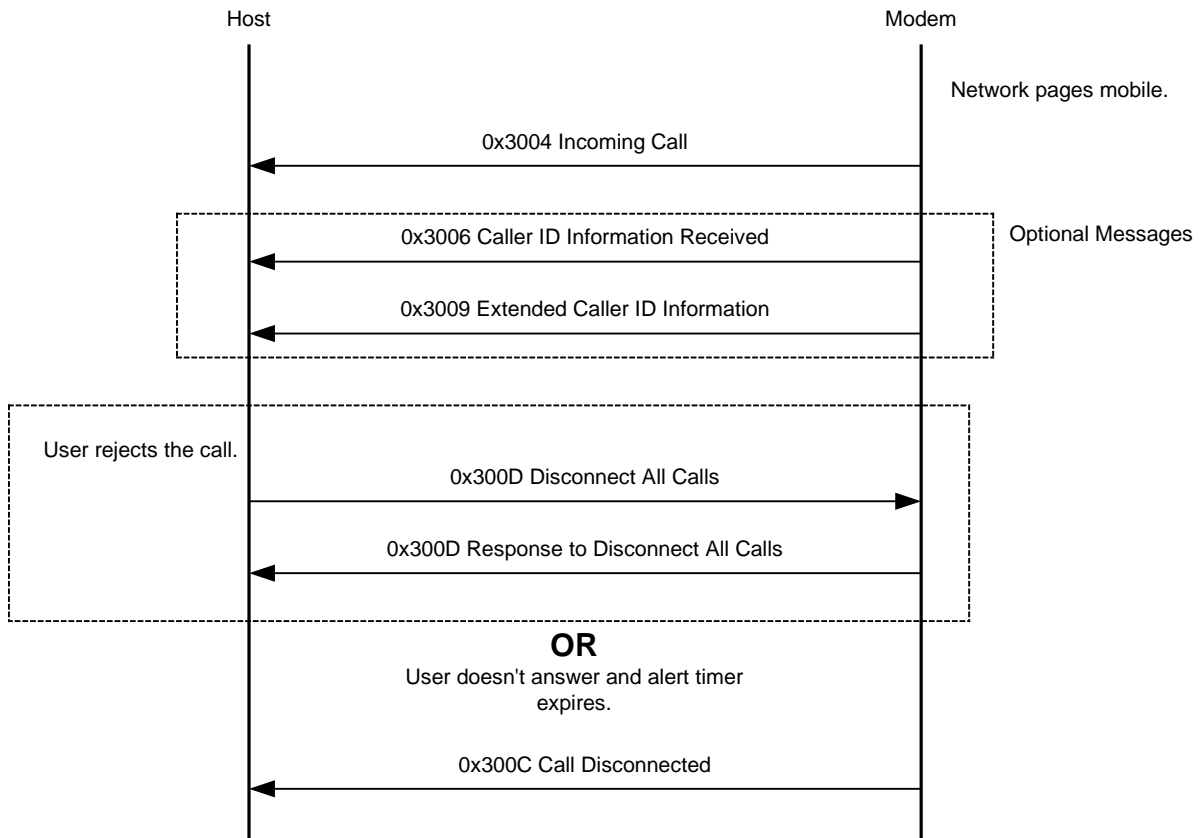
## Answer an incoming voice call

Figure 12: Answering an incoming voice call



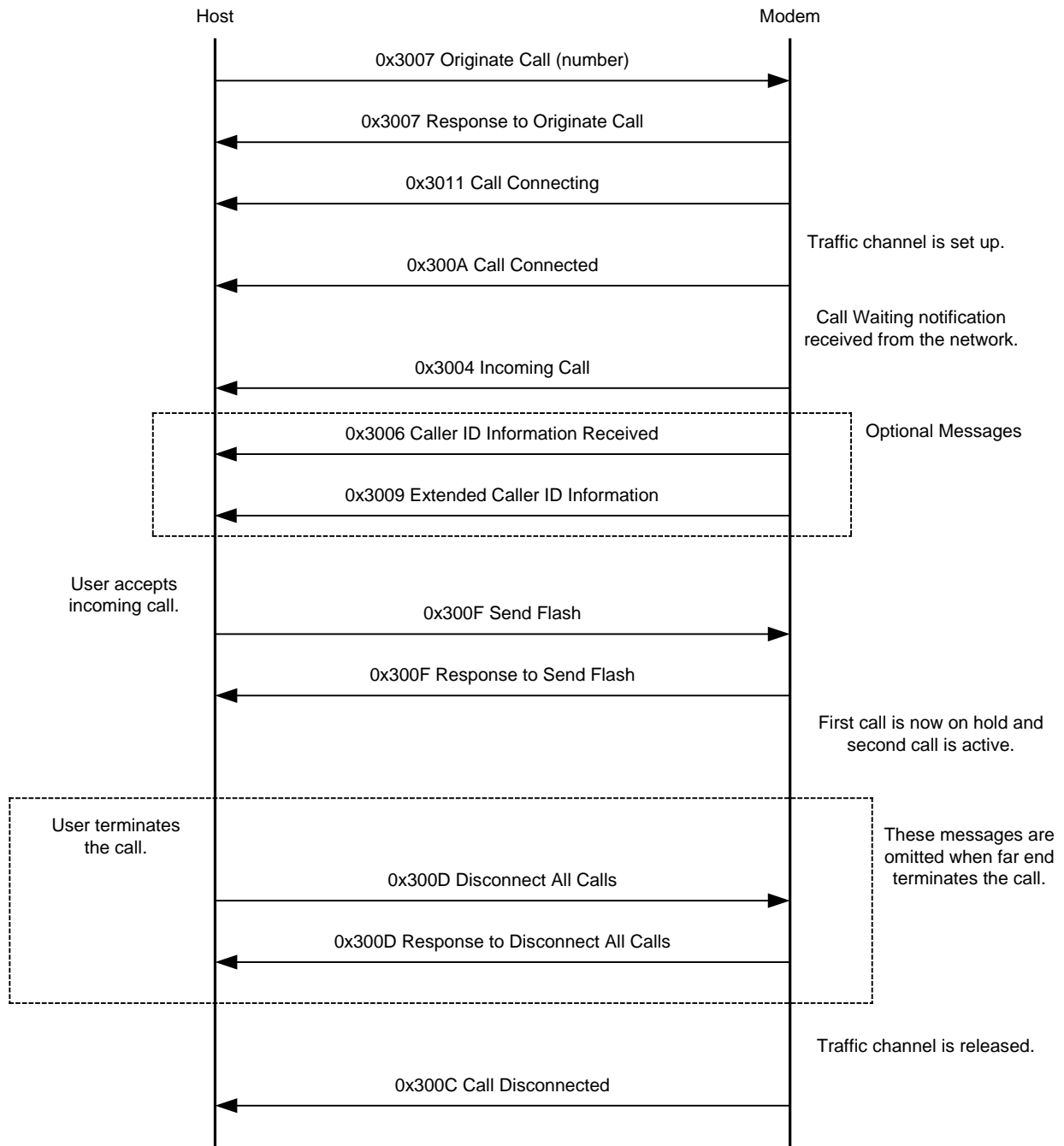
## Reject an incoming voice call

Figure 13: Rejecting an incoming voice call



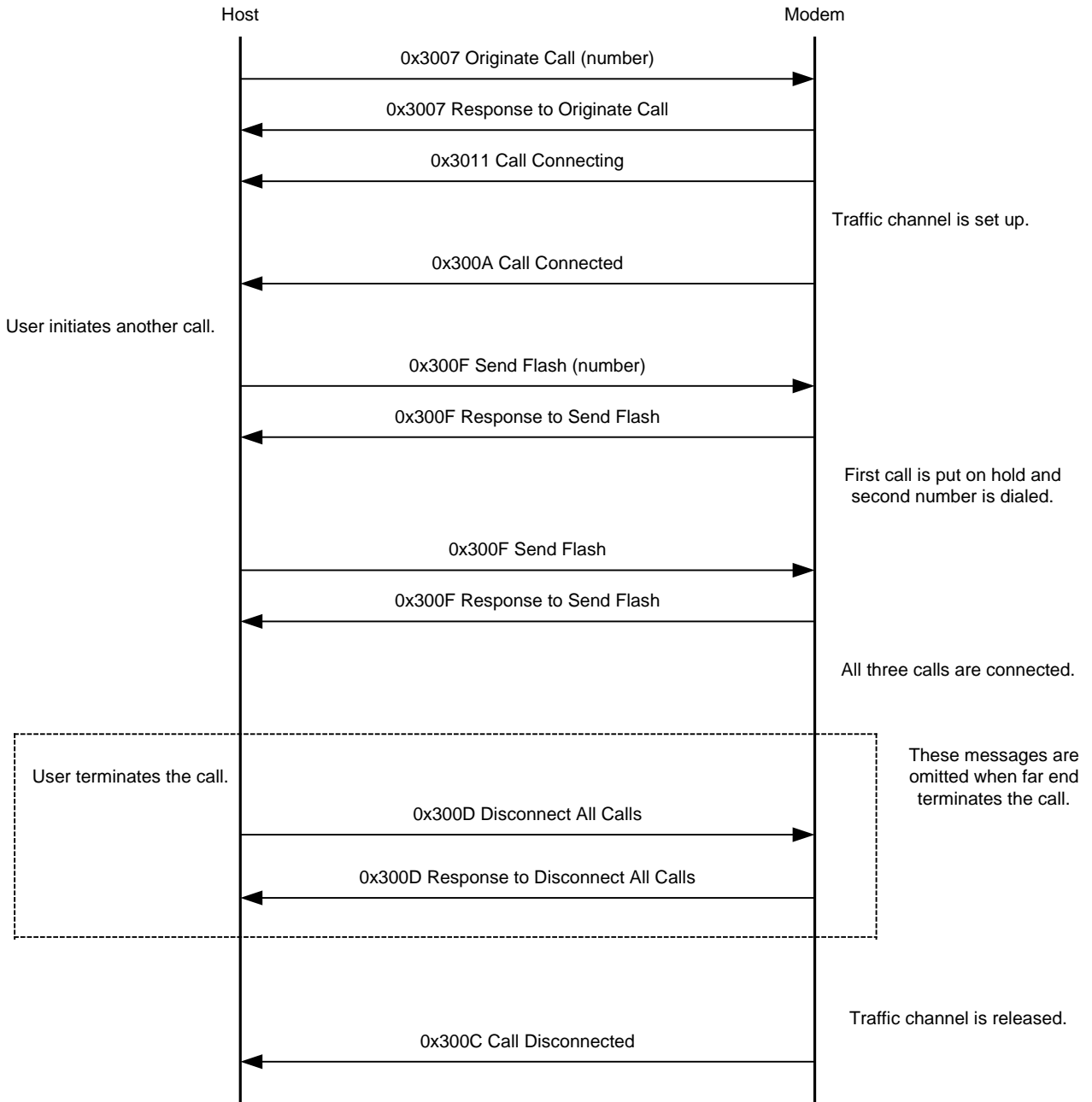
# Call Waiting

Figure 14: Call Waiting



# Three-way call

Figure 15: Three-way calling



# Appendix E: SMS Application Note

## Mobile terminated SMS (MT SMS)

### Short MT SMS

Figure 16: Receiving a short SMS without network Page

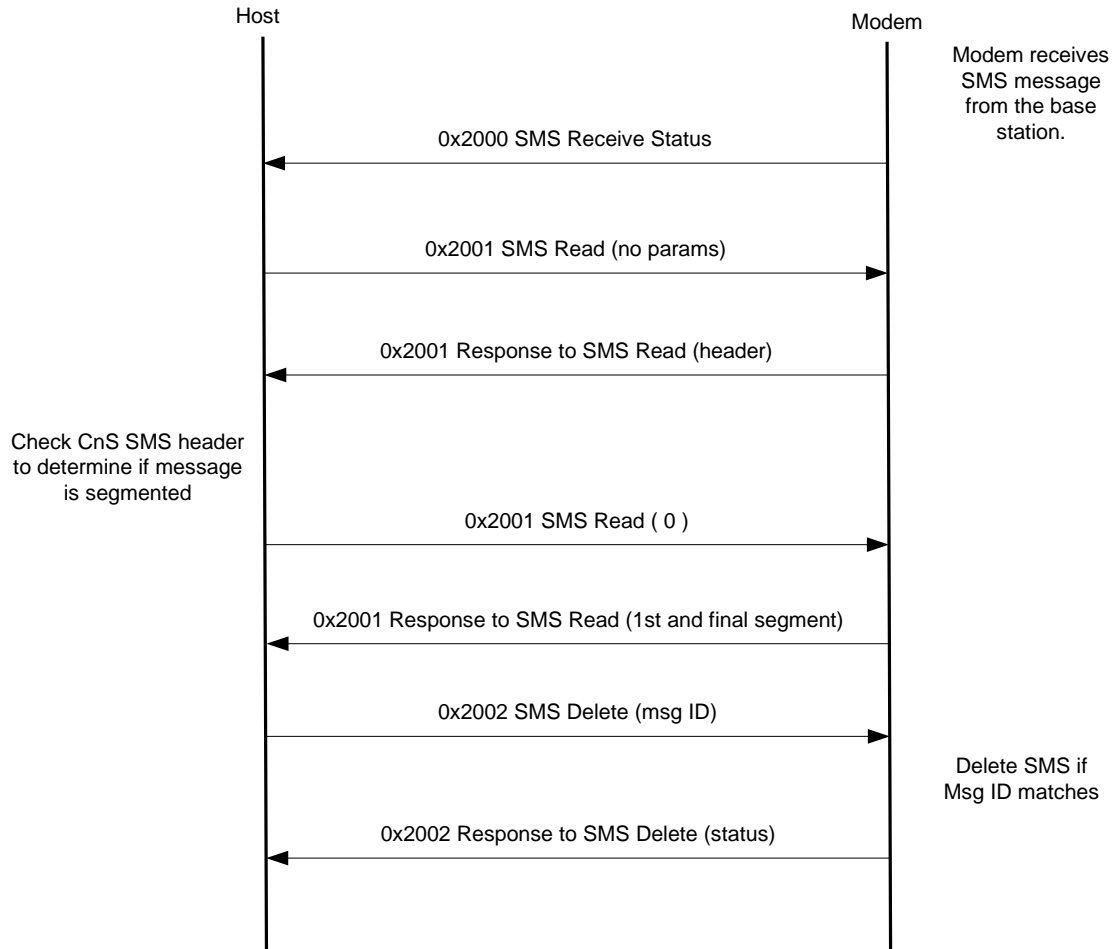


Figure 17: Receiving a short SMS with network Page

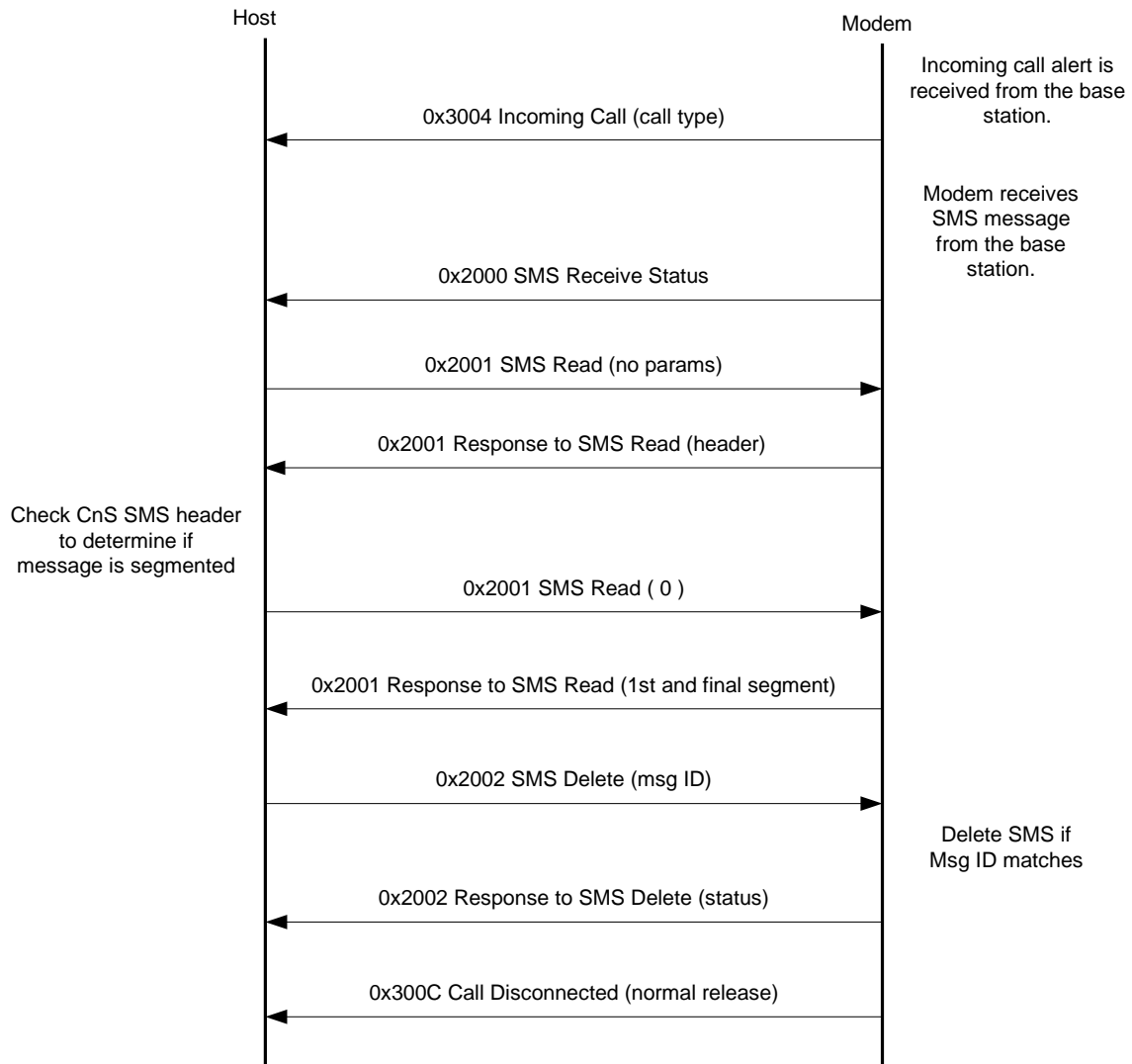
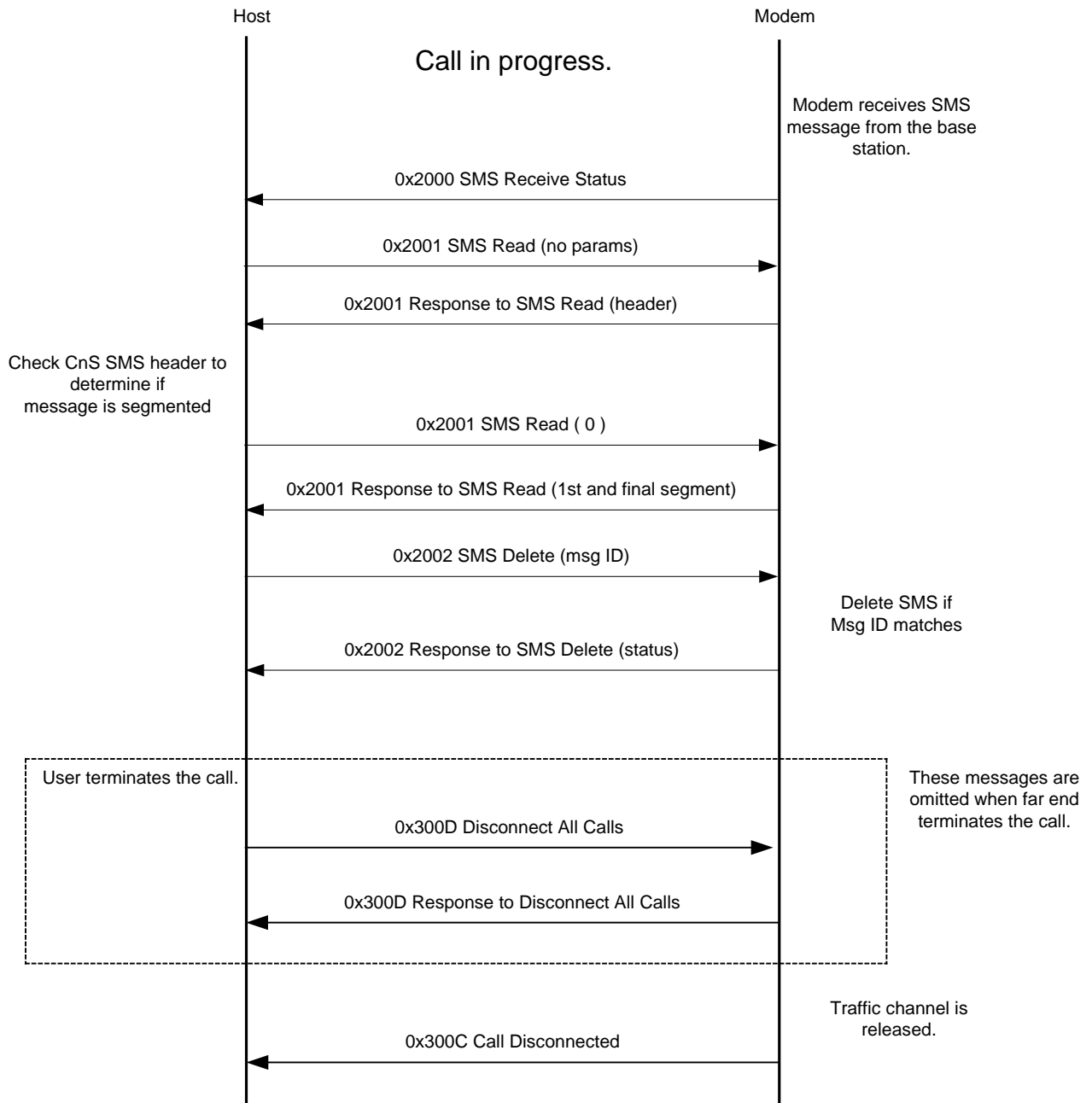


Figure 18: Receiving a short SMS in Conversation state



### Long MT SMS

Figure 19: Receiving a long SMS in Idle state

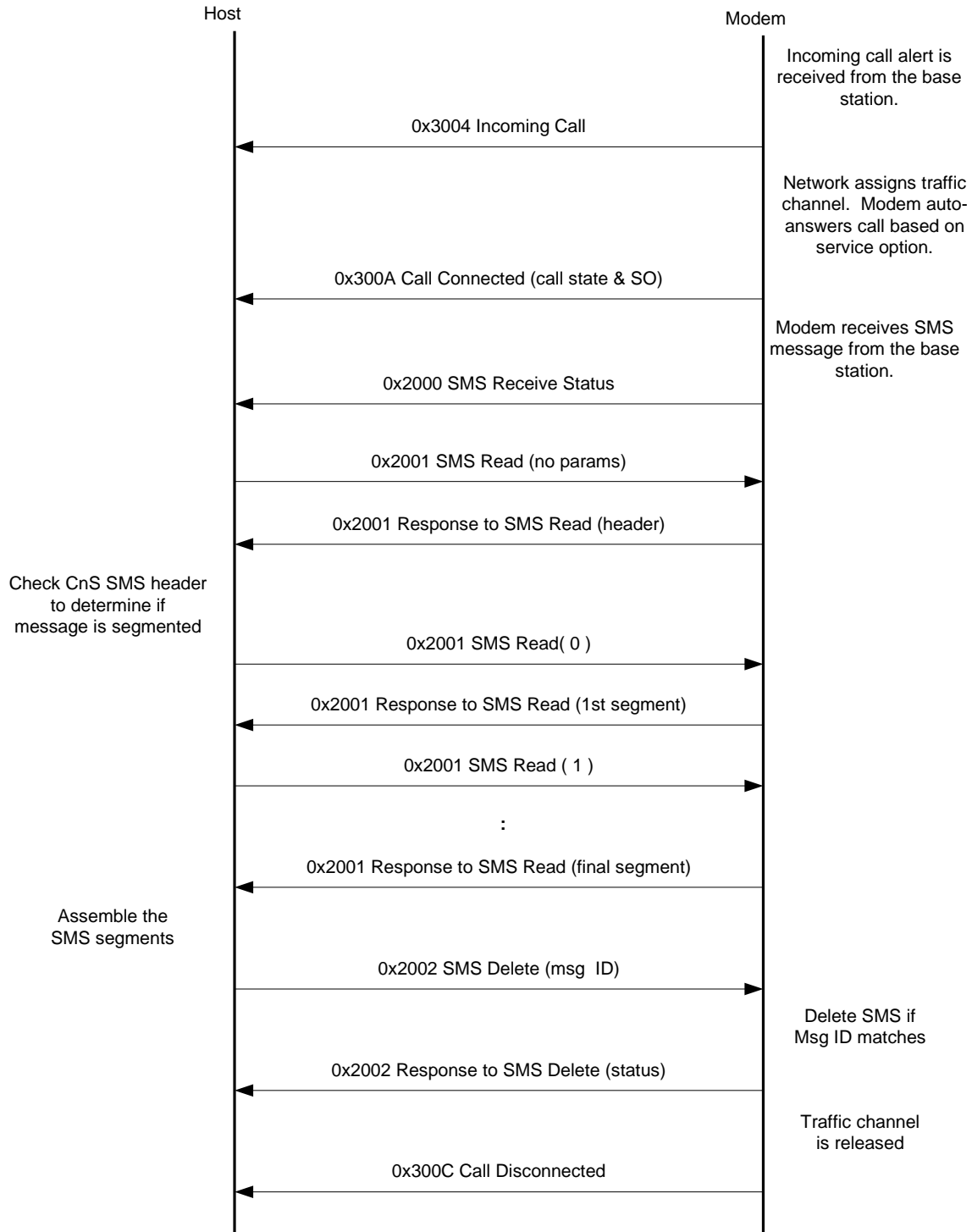
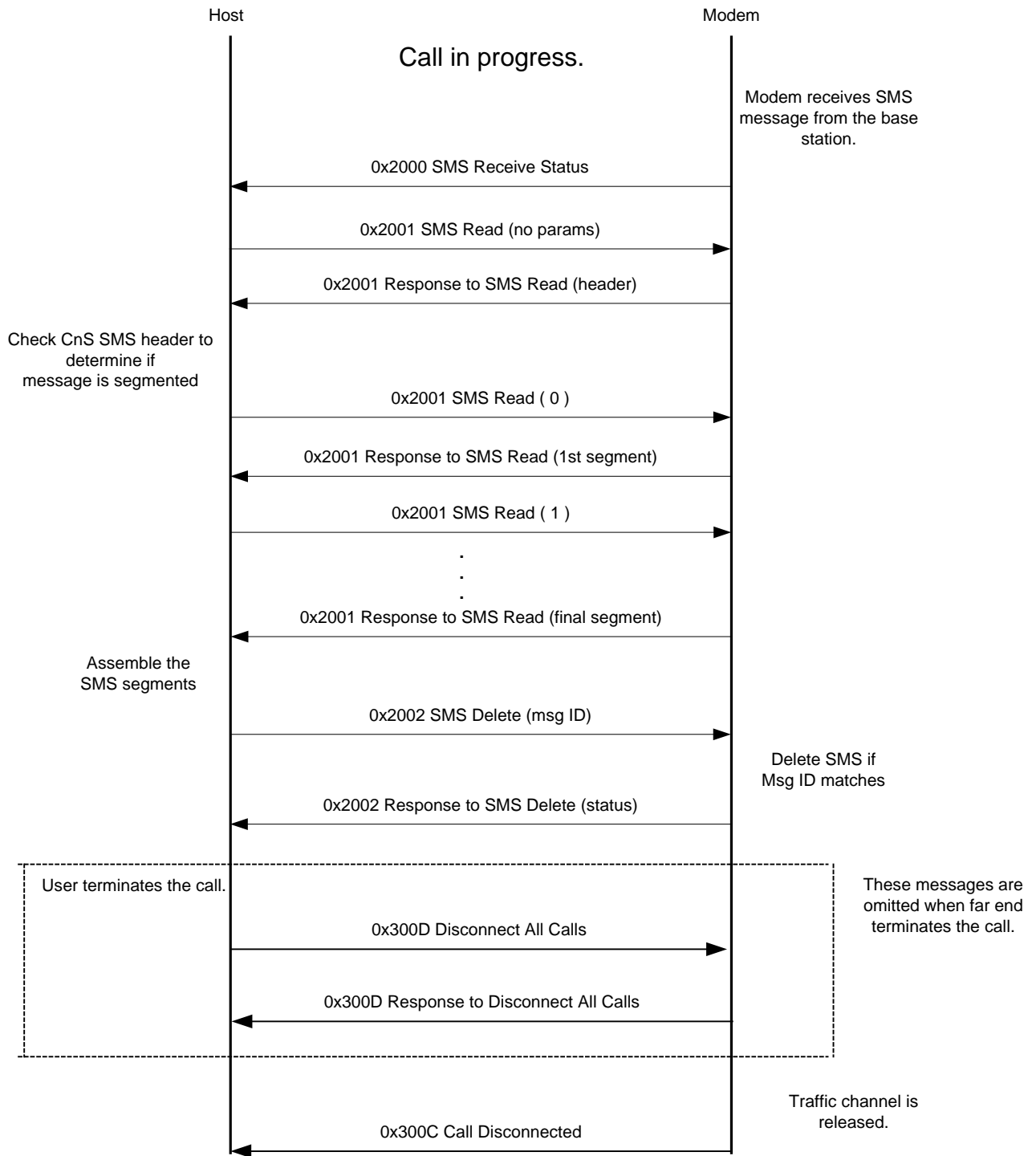


Figure 20: Receiving a long SMS in Conversation state



## Mobile originated SMS (MO SMS)

Figure 21: Sending an SMS in Idle state, no Traffic Channel required

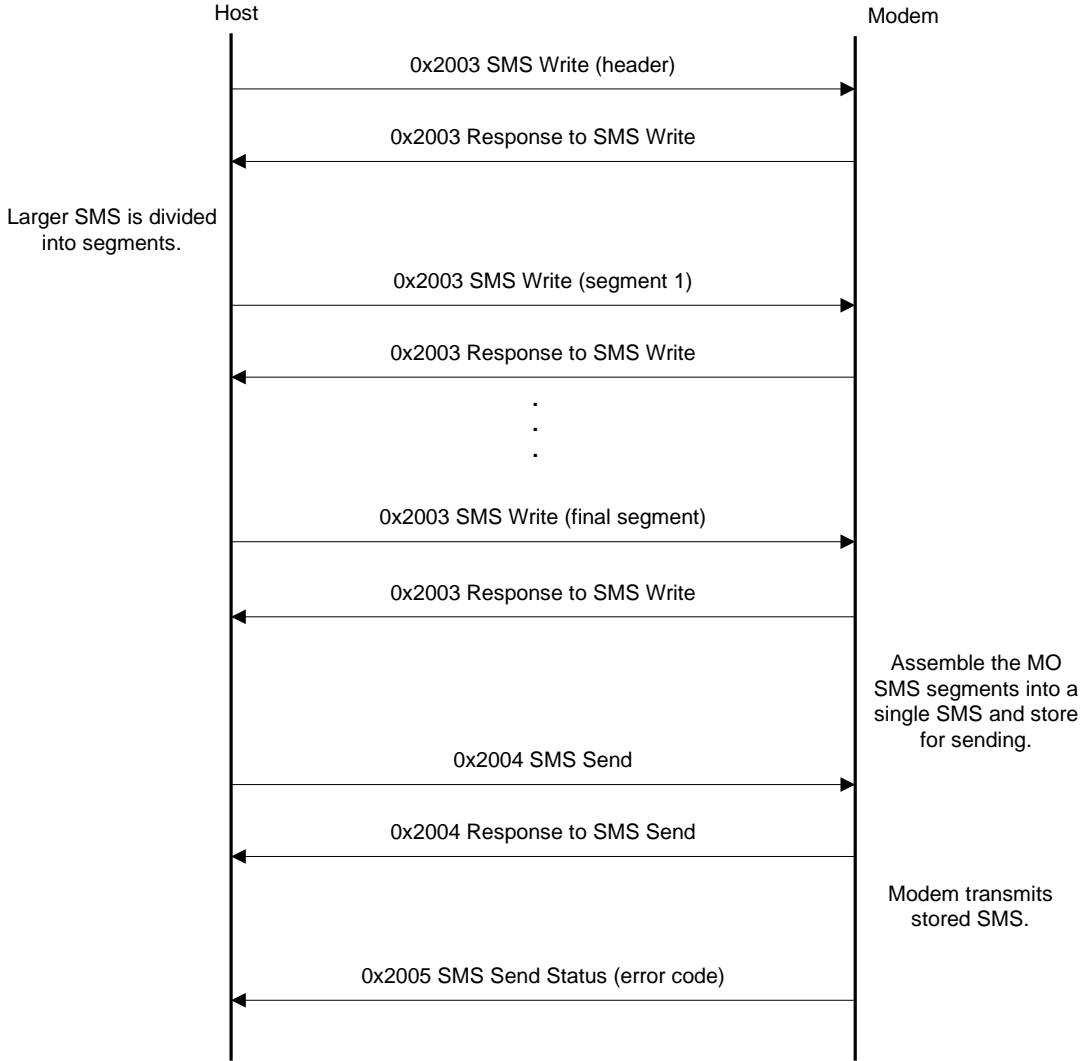


Figure 22: Sending an SMS in Idle state, Traffic channel required

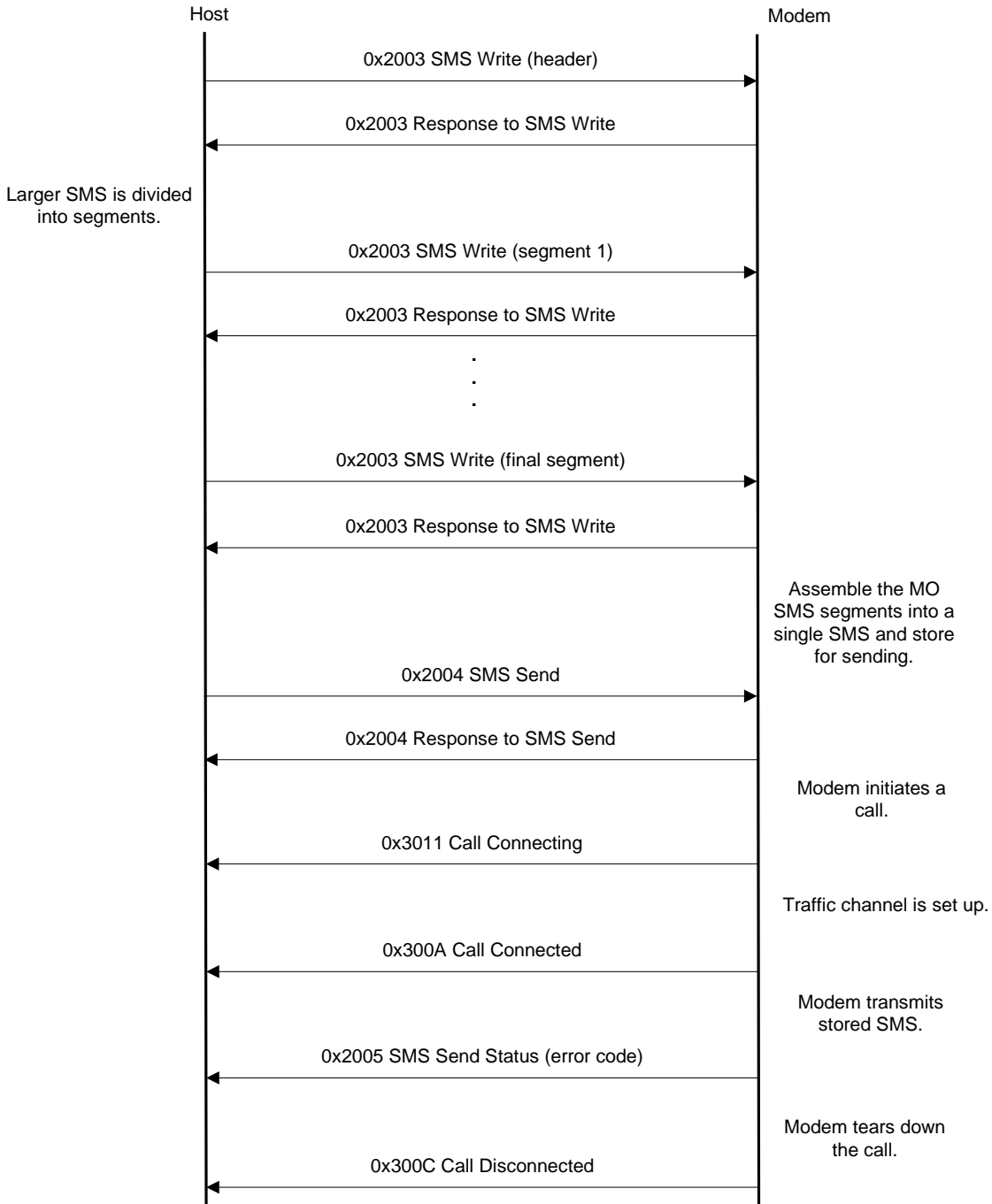
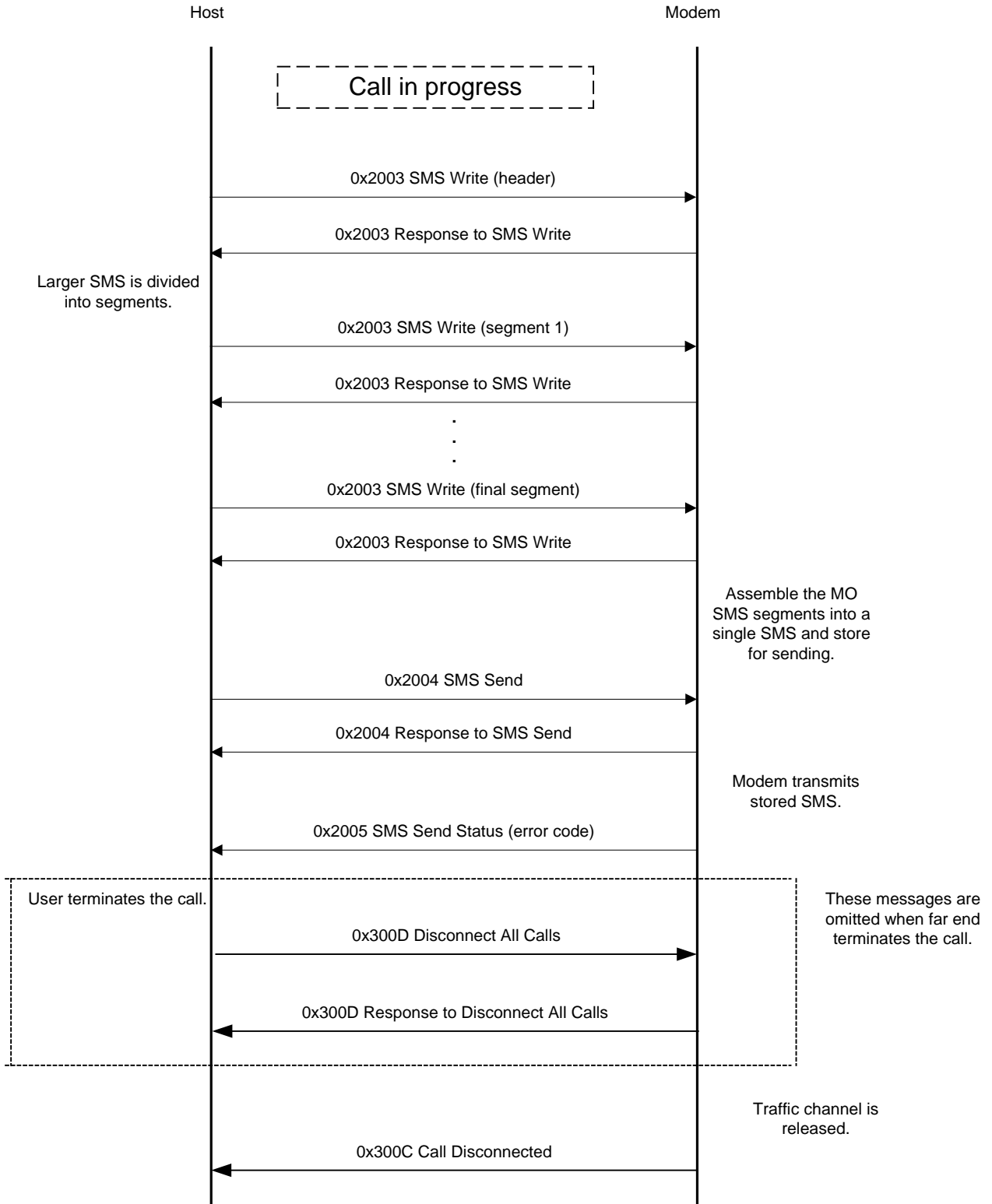


Figure 23: Sending an SMS in Conversation state



# Appendix F: Configurations

Figure 24: PRL download using CnS

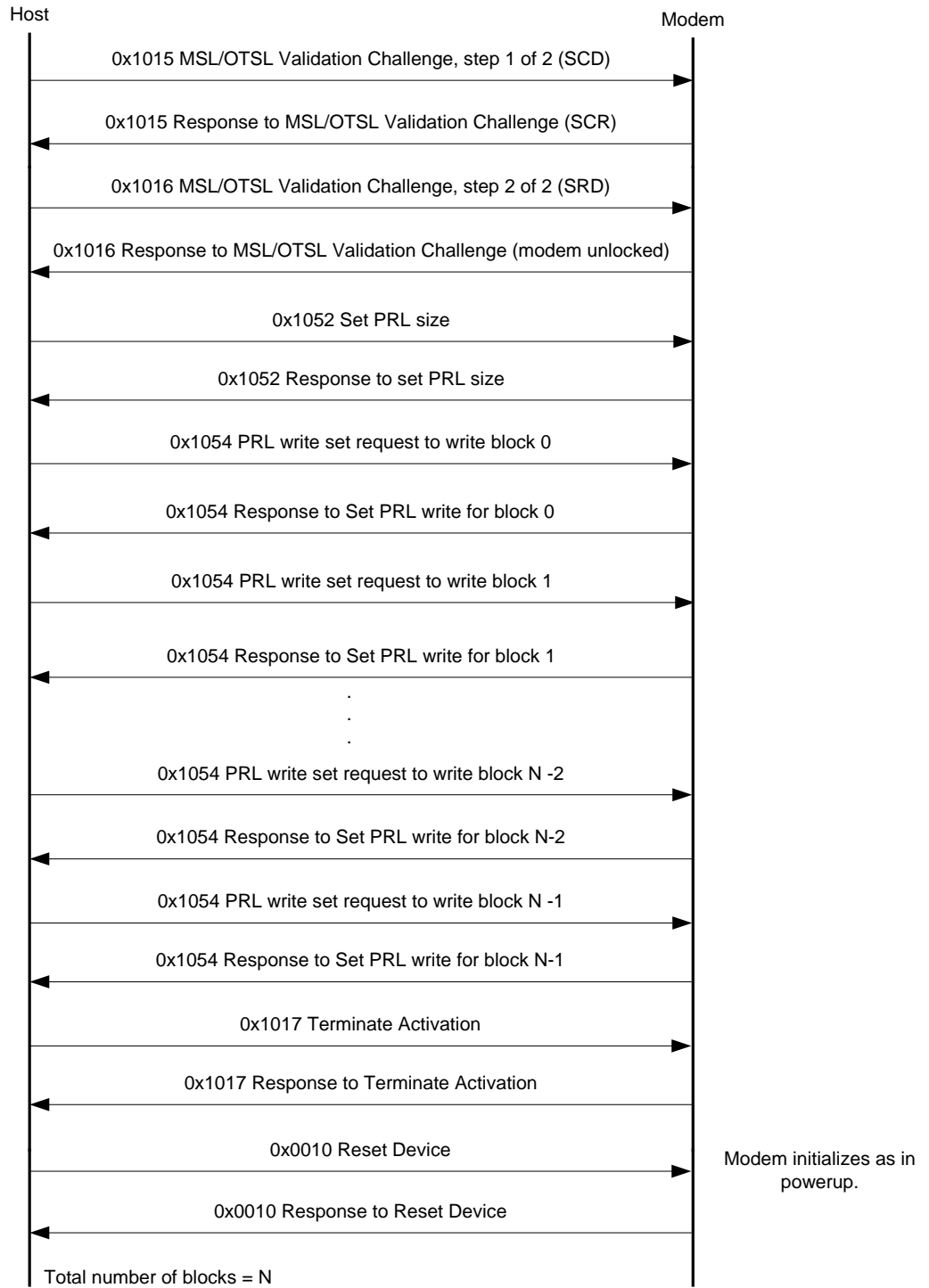
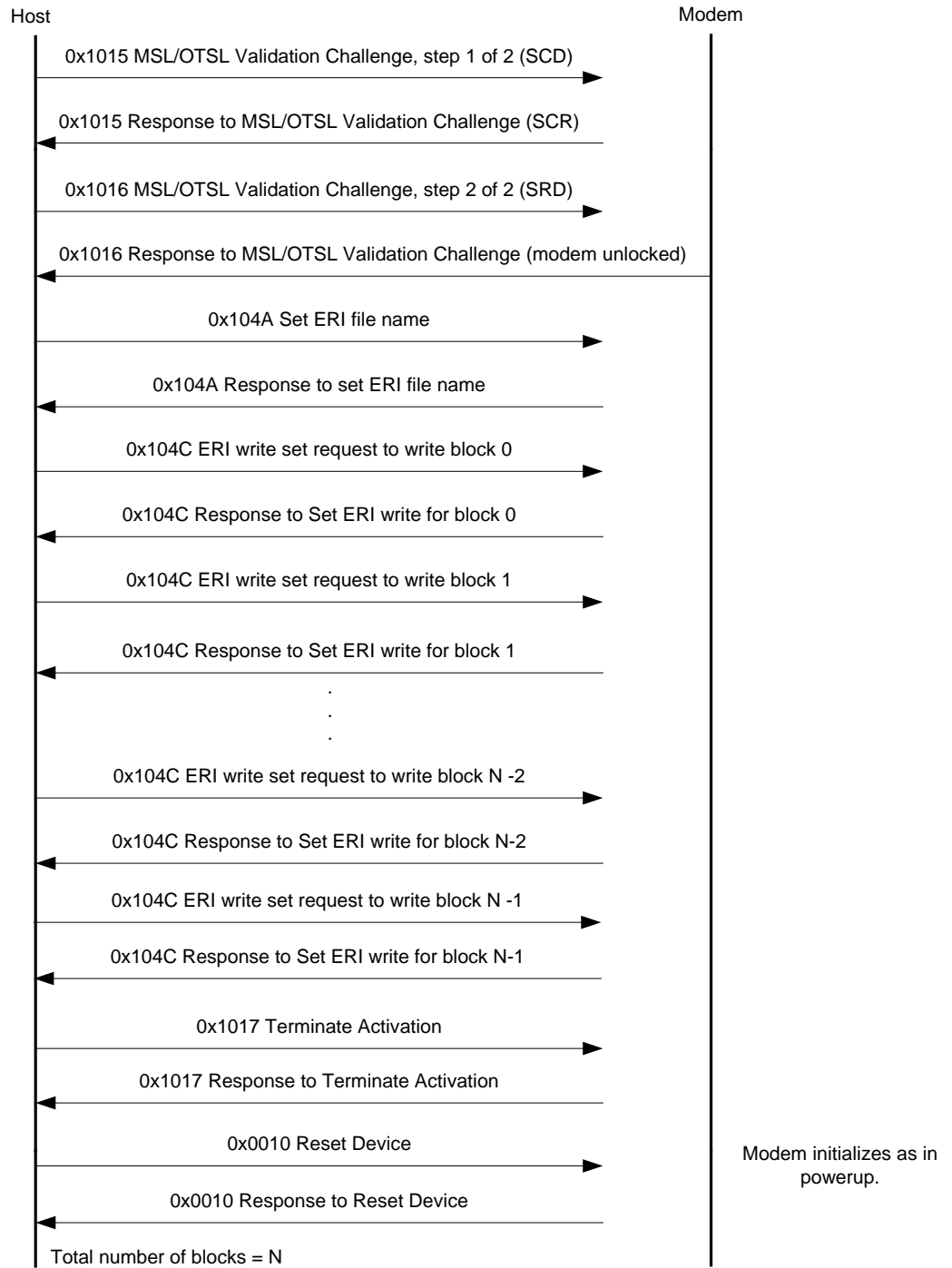


Figure 25: ERI download using CnS



# Appendix G: CDMA System Architecture

This appendix provides a system-level description for data, voice, SMS and **OTASP** services support for **IS-95** and **1X** networks. The Mini Card supports these data services:

- [Asynchronous data/fax](#) (page 116)
- [Double Stack QNC](#) (page 117)
- [Single stack QNC/ packet relay model](#) (page 118)
- [Packet network model data services](#) (page 121)

## References

### Standards

- TIA/EIA IS-707, “*Data Service Options for Wideband Spread Spectrum Systems*”, April 1999
- TIA/EIA/IS-835, “*Wireless IP Network Standard*”, June 2000
- TIA/EIA-637, “*Short Message Service for Spread Spectrum Systems*”, September 1999.
- TIA/EIA/IS-683-A, “*Over-the-Air Service Provisioning of Mobile Stations in Spread Spectrum Systems*”, June 1998.

### General references

- “*Mobile IP, The Internet Unplugged*”, James D. Solomon, 1998
- “*Mobile IP in the Sprint PCS Network V1.0*”, July 2001

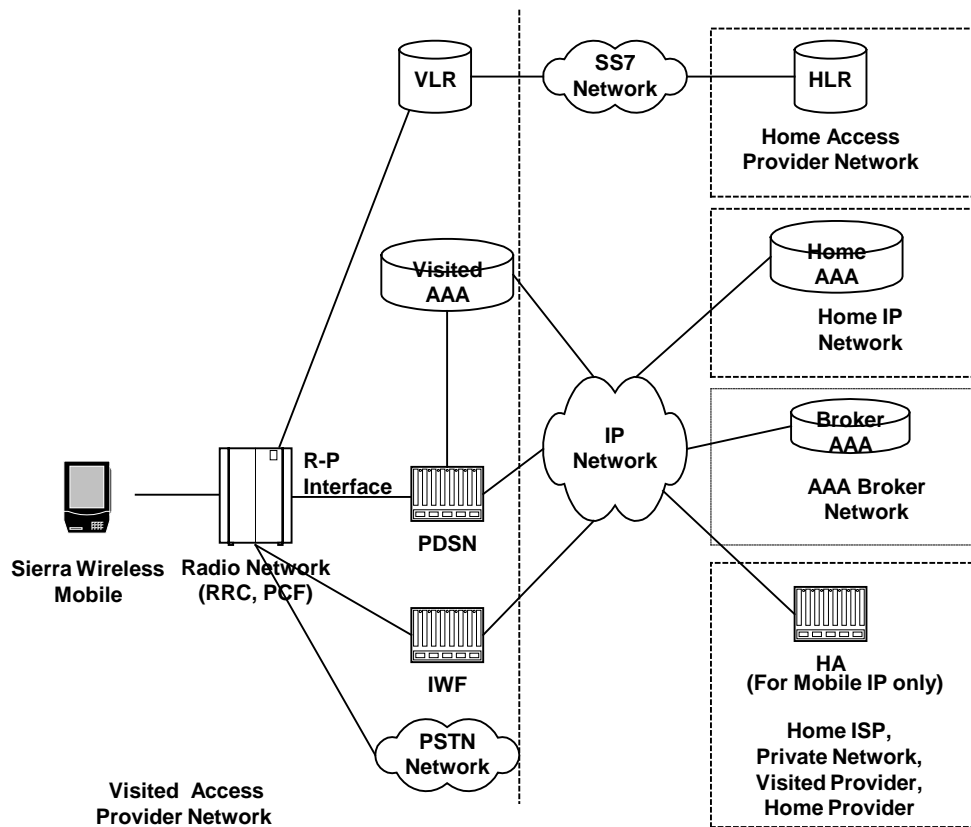
## Network architecture

This section gives a system overview of wireless network and shows the relationship between the Sierra Wireless **mobile** and the network components. It also provides the functional description of two network access methods: Mobile IP and Simple IP.

[Figure 26](#) (page 109) shows the system overview of the CDMA network. The Sierra Wireless **mobile** gains access to a service provider network using the IS2000 CDMA air interface to connect to the Radio Network (RN). For data service options, the base station communicates with the **IWF** during a circuit switched data call and with the **PDSN** during a packet switched data call. For voice service options, the base station communicates with **PSTN** and the **mobile**.

A mobile station may access only one service provider network at a time. The service provider network may be the user's home access provider or, in roaming cases, the visited access provider. Access mobility management is achieved using existing air interface procedures that include interactions with Visited Location Registers (VLR) and Home Location Registers (HLR). Information about access service parameters is maintained in the access service profile stored in the HLR and cached in the VLR while the mobile station is registered in the service provider access network. An open interface known as the R-P interface is defined between the Radio Network and the PDSN. The PDSN interacts with the local or visited AAA server and with other servers using IP protocols within the IP Network.

Figure 26: Network architecture



### Network components

- **Sierra Wireless Mobile:** Sierra Wireless' mobile includes a host device (PC/PDA) and a CDMA wireless modem.
- **Radio Network:** The Radio Network includes Radio Resource Control and Packet Control Function. The RRC establish, maintain, and terminate radio resources for the exchange of packets between the mobile station and the PCF. The PCF is connected to the PDSN using the R-P interface as specified in IOS-4.0. PPP connections between

the Wireless Mobile and PDSN are tunneled through the R-P interface.

- VLR: when the subscriber is located in the area covered by a VLR (Visiting Location Register), the VLR dynamically stores subscriber information (ESN, MDN, user profile) obtained from the user's HLR.
- AAA: The authentication, authorization, and accounting server is essentially a database that is accessed by the FA using the RADIUS protocol. The AAA authenticates a user ANI and password combination, and contains the user profile for that NAI which indicates the services that ANI is authorized to use. The AAA also receives usage information from the PDSN and passes it to the billing systems.
- PDSN: Packet Data Service Node establishes the PPP session with the mobile and thus determines if the mobile is attempting to use SIP or MIP. The PSDN contains the Mobile IP Foreign Agent functionality.
- IWF: The Interworking Function connects the wireless network to the internet.
- PSTN: Public Switching Telephone Network is the wireline-based telephone network.
- HLR: Home Location Register maintains all subscriber information (ESN, MDN, authentication data, allowed services, location, billing info) for the mobile.
- Home Agent: The HA intercepts packets that are destined to the mobile node. The HA forwards these packets inside a tunnel to the care-of address of the mobile, which is typically the Foreign Agent.
- Foreign Agent: The FA advertises itself to mobiles in its area. Once the MIP session is initiated, the FA acts as a router for the mobile. The FA provides the mobile with a care-of address to use when registering with its Home Agent. (In the network architecture shown in Figure 26 (page 109), PDSN is the FA).

### Network access via Simple IP and Mobile IP

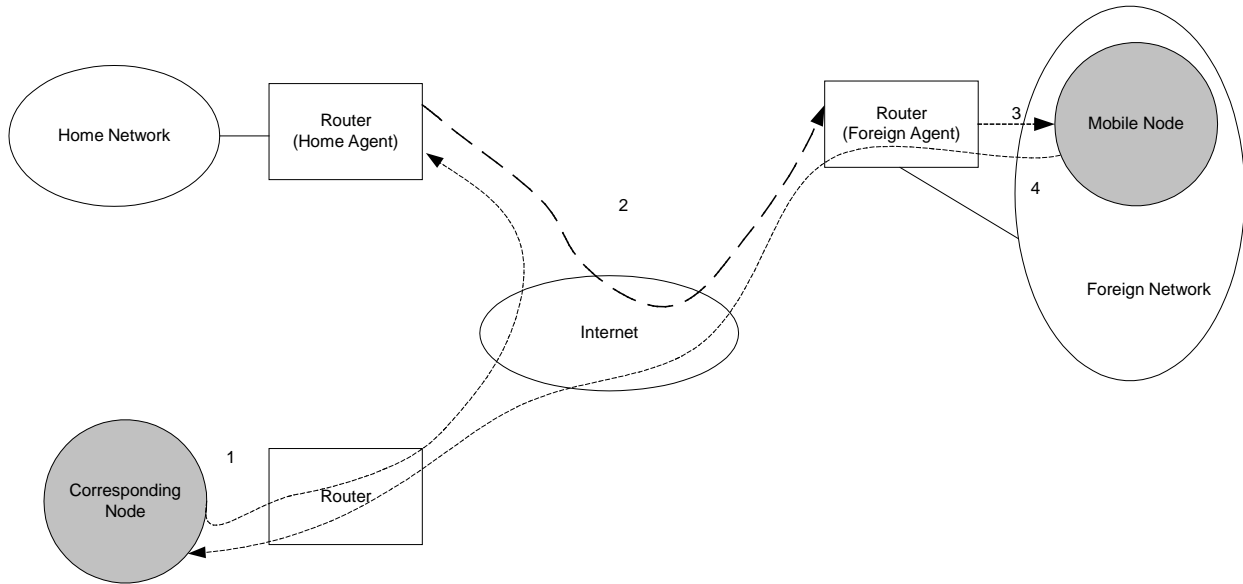
Mobile can access local, public and private networks via two network access methods: Simple IP or Mobile IP.

Simple IP refers to a service in which the user is assigned a dynamic IP address from the local PDSN and is provided IP routing service by a service provider network. The user retains its IP address as long as it is served by a radio network that has connectivity to the PDSN that assigned address to the user.

Mobile IP refers to a service in which the user is provided IP routing service to a public IP network and/or secure IP routing service to predefined private IP networks. The MS is able to use either a non-zero static IP address or a dynamically assigned IP address belonging to its home IP network Home Agent. The user is able to maintain a persistent

IP address even when handing off between radio networks connected to separate PDSNs. The packet delivery mechanism to and from the mobile node for Mobile IP is shown in Figure 27.

Figure 27: Packet delivery to and from the Mobile Node for Mobile IP



The network can simultaneously support Simple IP and Mobile IP service. Table 10 compares the operation of Mobile IP and Simple IP.

Table 10: Mobile IP and Simple IP comparison

	Simple IP	Mobile IP
IP Address Assignment	<ul style="list-style-type: none"> <li>Dynamic IP address assigned from its local PDSN during the IPCP phase of PPP.</li> <li>Only one IP address is supported on the PPP link.</li> </ul>	<ul style="list-style-type: none"> <li>Dynamic or static IP address assigned by its home IP network home agent.</li> <li>Multiple IP addresses can be supported on the PPP link.</li> <li>Reject LCP Configuration request for CHAP authentication</li> </ul>
PDSN to PDSN Handoff	<p>Simple IP does not maintain its IP address across PDSNs. When handing off to a new PDSN:</p> <ul style="list-style-type: none"> <li>Mobile station establishes a new PPP session with the new PDSN</li> <li>The new PDSN</li> </ul>	<p>Mobile IP maintains persistent IP addresses across PDSNs.</p> <p>When handing off to a new PDSN, mobile station:</p> <ul style="list-style-type: none"> <li>Establishes a new PPP session with the new PDSN,</li> </ul>

	Simple IP	Mobile IP
	dynamically assigns a new IP Address.	<ul style="list-style-type: none"> <li>• Detects a new Foreign Agent via the Agent Advertisement Message</li> <li>• Registers with its Home Agent.</li> </ul>
PCF to PCF Handoff	<ul style="list-style-type: none"> <li>• PCF to PCF handoff may occur while a mobile station is active or dormant.</li> <li>• If the new PCF and the old PCF belong to the same PDSN, the same PPP session can be maintained.</li> <li>• Otherwise, see the above row ("PDSN to PDSN Handoff") in this table</li> </ul>	<ul style="list-style-type: none"> <li>• PCF to PCF handoff may occur while a mobile station is active or dormant.</li> <li>• If the new PCF and the old PCF belong to the same PDSN, the same PPP session can be maintained.</li> <li>• Otherwise, see the above row ("PDSN to PDSN Handoff") in this table</li> </ul>
Compression	<ul style="list-style-type: none"> <li>• VJ (TCP/IP) Header Compression</li> <li>• PPP compression: Stac-LZS; Deflate; Microsoft Point-to-Point Compression</li> </ul>	<ul style="list-style-type: none"> <li>• VJ (TCP/IP) Header Compression</li> <li>• PPP compression: Stac-LZS; Deflate; Microsoft Point-to-Point Compression</li> </ul>
Radio Access Security	<ul style="list-style-type: none"> <li>• Authentication</li> <li>• Air interface encryption</li> </ul>	<ul style="list-style-type: none"> <li>• Authentication</li> <li>• Air interface encryption</li> </ul>
IP Network Security	<ul style="list-style-type: none"> <li>• Service provider network may use CHAP or PAP to authenticate and authorize the mobile station.</li> <li>• MN-AAA Challenge Extension procedures are performed between service provider network and home IP network.</li> </ul>	<ul style="list-style-type: none"> <li>• Neither CHAP nor PAP should be performed.</li> <li>• MN-AAA Challenge Extension procedures are performed between service provider network and home IP network.</li> <li>• Service provider network uses the Foreign Agent Challenge to authenticate and authorize the mobile station.</li> <li>• Mobile IP Foreign-Home authentication extension</li> <li>• Additional security between PDSN and HA: IKE and public</li> </ul>

	Simple IP	Mobile IP
		certificates; Dynamic pre-shared IKE secret distributed by the home RADIUS server; Statically configured IKE pre-shared secret
Relay Model Support	Simple IP can be supported using the relay model	To support Mobile IP using the relay model, the host stack must be modified.
Network Model Support	Simple IP can be supported using the network model	Mobile IP can be supported using the network model
Service Option	33	33
Mobile IP Registration	N/A	<p>Mobile Station sends Agent Solicitations right after PPP is established. The source IP Address can either be the home address if one already exists, or be all zeros if an IP address has not been assigned.</p> <p>Mobile Station processes Agent Advertisements, and sends a Mobile IP RRQ. Mobile Station configures the Mobile IP RRQ differently, depending on whether:</p> <ul style="list-style-type: none"> <li>• Dynamic or static IP address is used</li> <li>• Reverse tunneling is supported</li> <li>• VJ header compression is used.</li> </ul>

## Data services

The CDMA wireless network provides various data services, including:

- [Asynchronous](#) (page 114)
- [Packet Data Service](#) (page 114)
- [Quick Net Connect](#) (page 115).

### Asynchronous data/fax

In this mode, the mobile appears to an external host device as a serial port modem. It supports the [AT](#) command set as described in IS-707.3, and can be used for general-purpose asynchronous data or fax transmissions.

IS-2000 supports new high rate circuit services and provides [QoS](#) services as well as flexible [RLP](#) (Transparent & Non-transparent Modes) for circuit data services.

### Packet Data Service

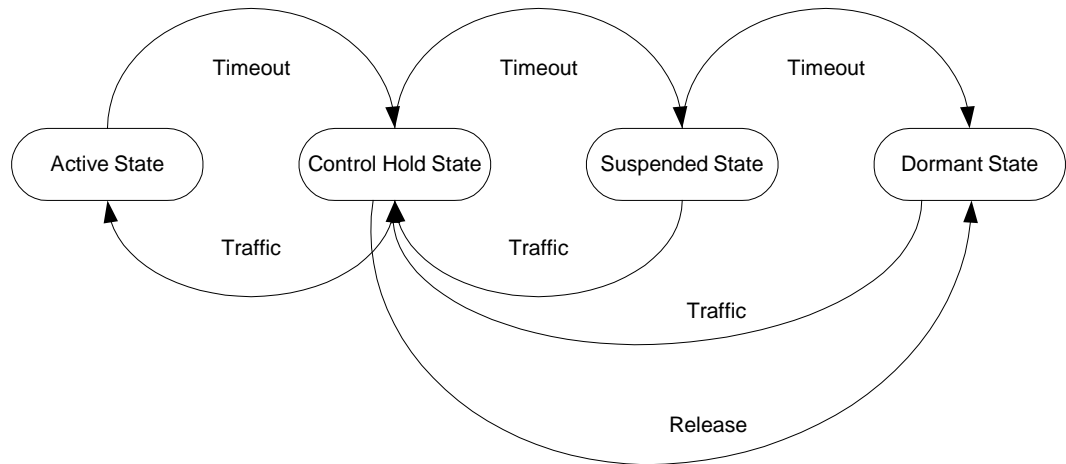
In this mode, the modem appears to the host as an IP router, and can support IP services to a fixed IP address. Packet data service can be supported with Relay Model or Network Model as explained in IS-707A.5 TIA/EIA IS-707, “*Data Service Options for Wideband Spread Spectrum Systems*”, April 1999.

In Relay Model ([Figure 31](#) on page 118), the host is responsible for all aspects of packet mobility and network address management. A [PPP](#) connection is established between the host and the network ([IWF](#)).

In Network Model, the modem is responsible for all aspects of packet mobility management and network address management. A [PPP](#) connection is established between the modem and the host to exchange IP packets. A second [PPP](#) connection (running over [RLP](#)) carries the packets between the modem and [IWF](#). For a detailed stack diagram for network model packet data, see TIA/EIA IS-707, “*Data Service Options for Wideband Spread Spectrum Systems*”, April 1999.

IS-2000 defined two new states, the control hold and the suspended state, which are intermediate between the active and the dormant states. In these two states, service configuration and [RLP](#) state are maintained. Thus, once there is more data to be transmitted between the devices and network, which requires transitioning back to the active state from these intermediate states, physical connection can quickly be re-established. [Figure 28](#) shows the different packet data [MAC](#) operational states.

Figure 28: Packet data operation states



### Quick Net Connect

QNC was designed as an expeditious way of deploying packet data services in carrier networks before infrastructures for packet data services are in place. A circuit-switched data service typically takes around 20 seconds to connect; a packet data service and QNC takes about 2 seconds.

QNC provides a data service that is functionally equivalent to the packet data service described in TIA/EIA IS-707, "*Data Service Options for Wideband Spread Spectrum Systems*", April 1999 with the following exceptions: in QNC, there are no:

- Dormancy support
- Mobile terminated calls

A QNC call is originated with service option 4 or 12, which are circuit-switched data service options.

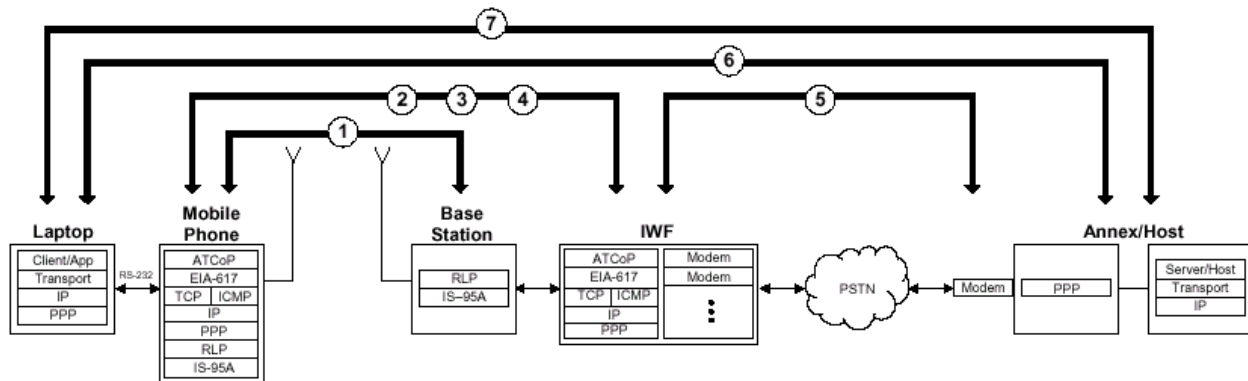
## Asynchronous data & fax services

### Functional description

In this mode, the mobile appears to an external host device as a serial port modem. It supports the [AT](#) command set as described in IS-707.3, and can be used for general-purpose asynchronous data or fax transmissions.

Figure 29 shows the synchronization sequence of an asynchronous data/fax call.

Figure 29: Asynchronous protocol sync stages



- 1 **RLP Sync:** Occurs once Traffic Channel Conversation substate is reached. Takes approximately 6-8 frames (120-160 msecs).
- 2 **Async PPP Neg:** Negotiates IP and Link parameters. Takes 3 or 4 round trips (approximately 500 msecs or less).
- 3 **Async TCP Establish:** Establishes TCP connection from mobile to IWF (approximately 1 sec.).
- 4 **AT Initialization Command Exchange:** Mobile forwards AT parameter commands to IWF (approximately 500 msec).
- 5 **PSTN Modem Training:** Negotiates landline versus protocols, including bandwidth. Takes 10 or more sec.
- 6 **Serial End-to-End PPP Neg:** Negotiates IP and Link parameters, including TE2 IP address (approximately 500 msecs or less).
- 7 **End-to-End TCP Sync:** Establishes end-to-end connection (approximately 2 sec.).

### Implementation details

An asynchronous call is originated with service option 4 and 12.

A Fax call is originated with service option 5 and 13.

Pre-arrangement is used to instruct the mobile to receive either a fax or data call. When pre-arrangement is set to data, the mobile sends page response with data to indicate that mobile is only accepting data calls. User can set the pre-arrangement via UI or use **AT\$QCVAD**.

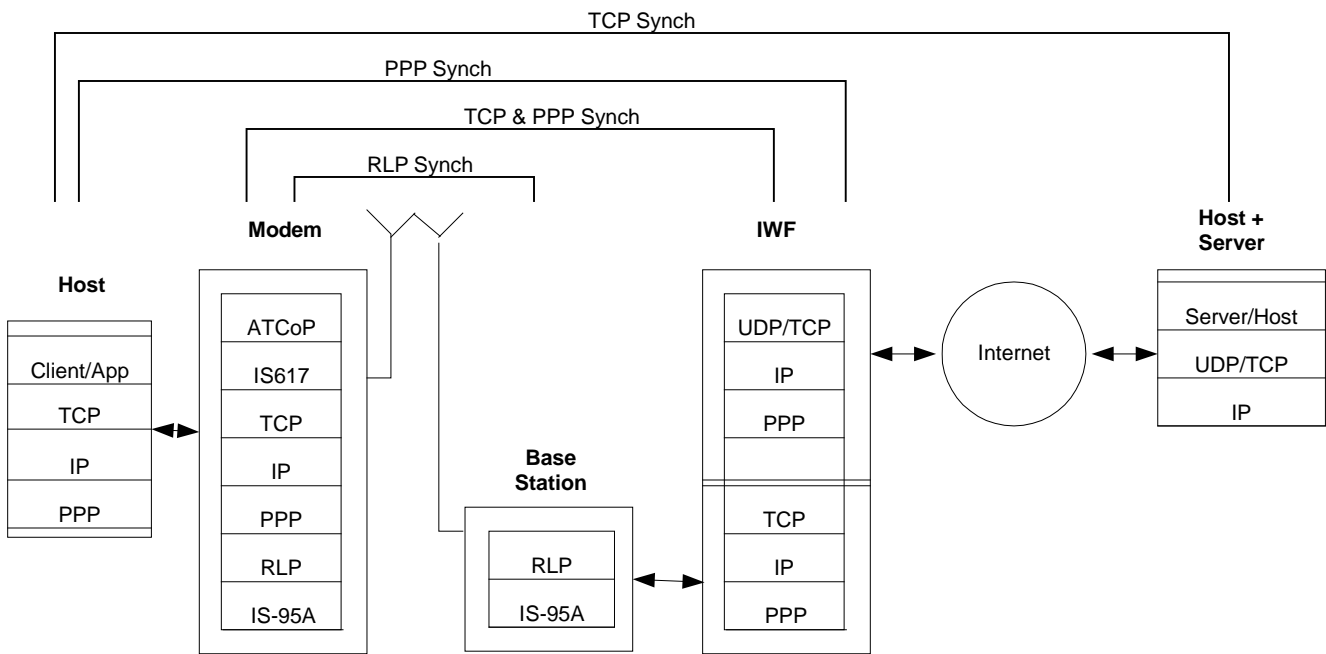
DMSS software does not support service negotiation on the Traffic Channel.

## Double Stack QNC

### Functional description

In a double stack QNC call, the call is detected by the dialed digits in the ATD command, and not by the IP packet address. Carriers will provide **AT** commands to set up a double stack QNC call. Double stack QNC is a mechanism for running the application's protocol stack over async data, but using only the airlink portion of the async data. Since async data, especially the **PSTN** link and modems, had unacceptable connection delays, by removing the PSTN link and modems from async data, the **IWF** could take the **PPP** frames arriving over the async air link, un-frame the IP packets from them, and then forward them to the Internet.

Figure 30: Double Stack QNC



### Implementation details

A double stack QNC call is originated with service option 4 or 12.

The dialed digits (#2932 for Sprint PCS) are sent in the origination message for a double stack QNC. In the double stack QNC call, the dialed digits are sent to **IWF**, which indicates that the call is a double stack QNC call.

## Packet Relay Model data service

The Relay Layer Rm interface protocol option supports host applications in which the host is responsible for all aspects of packet data service mobility management and network address management (e.g., [IPCP](#), and the CDPD registration and authentication protocols).

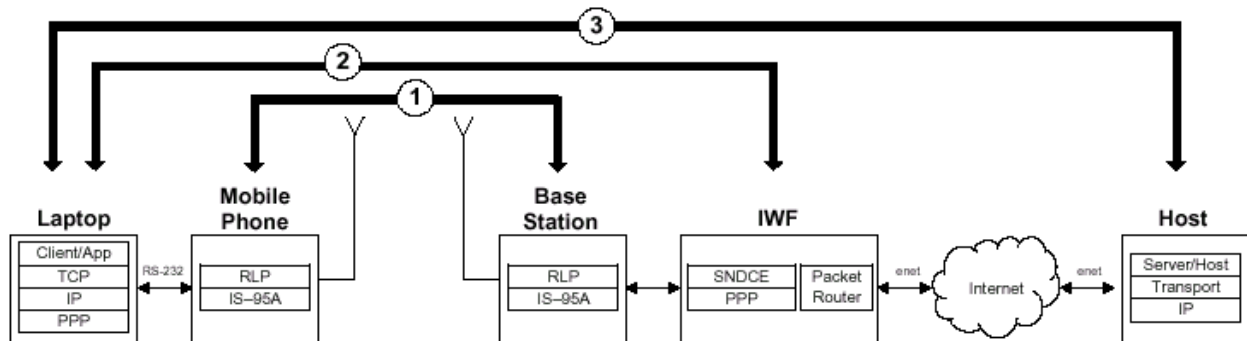
### IS-95 Packet Relay Model (Single Stack QNC)

#### Functional description

As mentioned at the beginning of “[Data services](#)” (page 114), QNC was designed to provide pseudo-packet data support before carrier deployment of packet data networks. Single Stack QNC uses the relay model where only the [TCP/IP](#) stack on the host is used and [PPP](#) connection is established between the host and the [IWF](#). The [AT](#) command to setup a single stack QNC call is: **ATDT#777**.

Figure 31 shows the synchronization sequence of [IS-95](#) Packet Relay Model (Single Stack QNC) call.

Figure 31: IS-95 Packet Relay Model (Single Stack QNC) sync stages



- 1 RLP Sync:** Occurs once Traffic Channel Conversation substate is reached. Takes approximately 6-8 frames (120-160 msec).
- 2 Serial end-to-end PPP Neg:** Negotiates IP and Link parameters, including TE2 IP address (approximately 500 msec or less).
- 3 End-to-end TCP Sync:** Establishes end-to-end connection (approximately 2 seconds).

#### Implementation detail

Sprint PCS does not route packets from Single Stack QNC calls to the Internet. It can only be used for WAP browser access to the UP.Link gateway. All other Internet access must use double stack.

QCOM recommends using single stack QNC (relay model) due to processor loading concerns. However, due to the Sprint PCS's limitation, the [mobile](#) must use double stack QNC (#2932) to get access to the entire Internet. If a WAP browser is integrated with host, then the WAP browser can use single stack (#777) to access the UP.Link gateway.

The PPP negotiation parameters for QNC should be set up identically to those for packet data. The mobile station will request a temporary IP address to be assigned by the IWF.

A Single Stack QNC call is originated with service option 4 or 12.

The dialed digits that are sent in the origination message for a double stack QNC call are not necessary.

The destination address in the first IP packet sent across the PPP link is used by the IWF to determine whether the call is a real circuit-switched call or single stack QNC call.

Mobile must send an IP packet immediately after the PPP link with the IWF is established. Otherwise, this call is considered a circuit-switched call.

For browsers that use only one server, mobile should set the destination IP address in the first IP packet to the server address.

For browsers that use multiple servers via a name lookup server such as DNS, mobile should set the destination IP address in the first IP packet to the DNS server address.

**IS2000 Packet Relay Model**

*Functional description*

In 1X network, packet data services are deployed. Figure 26 (page 109) provides a system overview of the 1X network. As mentioned earlier in “Network access via Simple IP and Mobile IP” (page 110), there are two network access methods: Simple IP, and Mobile IP. Packet Relay Models with Simple IP and Mobile IP are shown in Figure 32 and Figure 33.

Figure 32: IS2000 Packet Relay Model with Simple IP

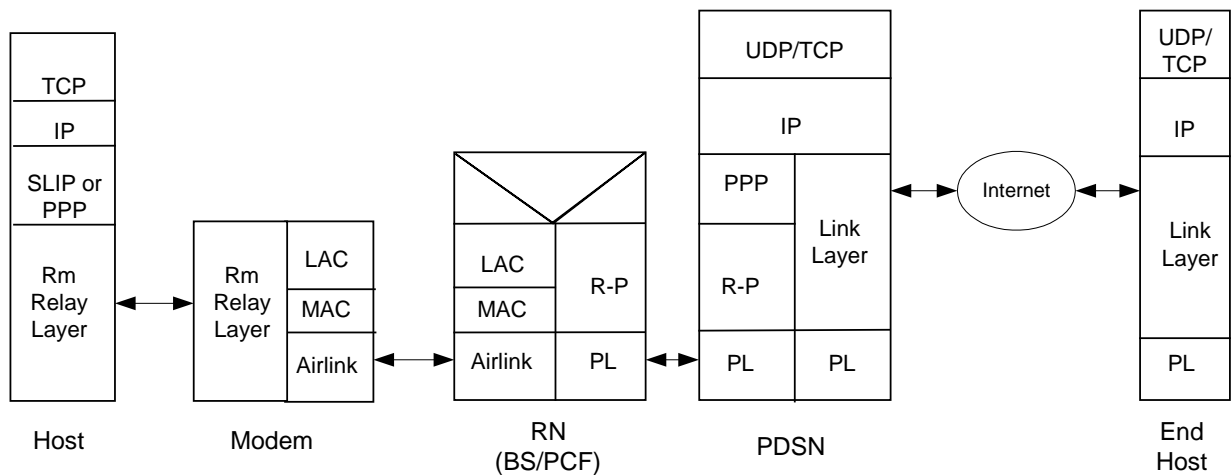
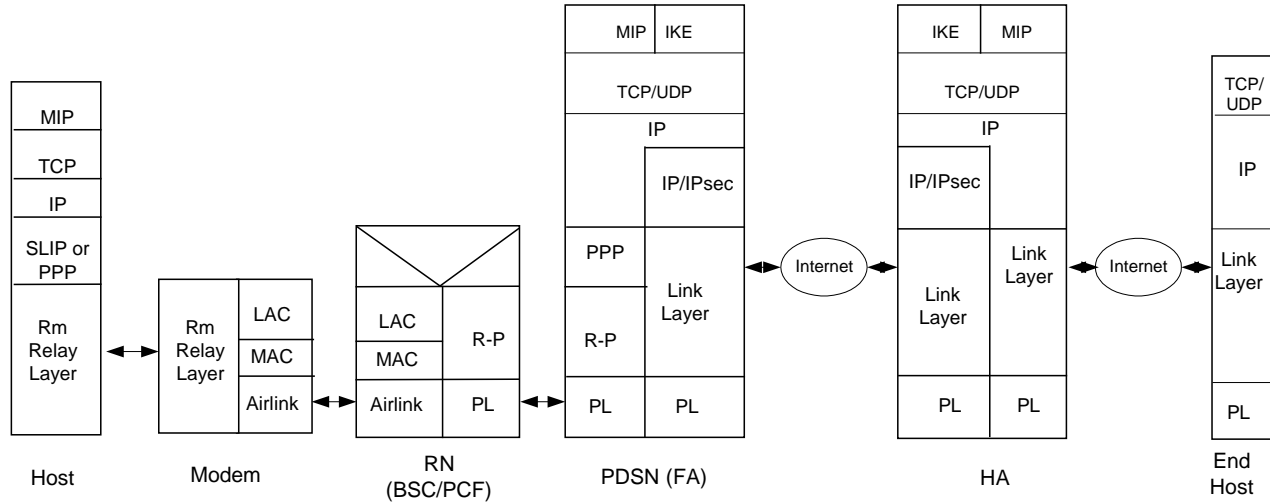


Figure 33: IS2000 Packet Relay Model with Mobile IP

**Implementation detail**

Host stack needs to be modified to support mobility management and address management for Mobile IP. The following changes should be done to the host stack:

- Reject LCP Configuration request for CHAP authentication
- Use the IP address if one is already assigned by its home IP network; or set IP address to all zeroes to obtain a IP address from its home IP network and use it from then on.
- The same IP address is maintained across PDSNs.
- When handing off to a new PDSN, host should detect a new foreign agent via the agent advertisement message, and registers with its home agent. The Mobile IP Registration request message is configured differently depending on whether reverse tunneling is supported, dynamic or stack IP address is used, or whether VJ header compression is used.
- Perform foreign-home authentication procedures with service provider network.
- Sends Agent Solicitations right after PPP is established.
- The TCP/IP stack running on laptops or PDAs today doesn't support Mobile IP.

### Packet Network Model data service

#### Functional description

The Packet Network Model is required to support transparent mobility and Mobile IP. Transparent mobility support requires that any changes over the Um link not affect the Rm link. The Network Model creates separate PPP links over the Rm and Um links—this enables the Rm link to be isolated from the Um link. Packet Network Model can also be used to support Simple IP.

The protocol diagram for Packet Network Model with Simple IP is shown in Figure 34.

Figure 34: IS2000 Packet Network Model with Simple IP

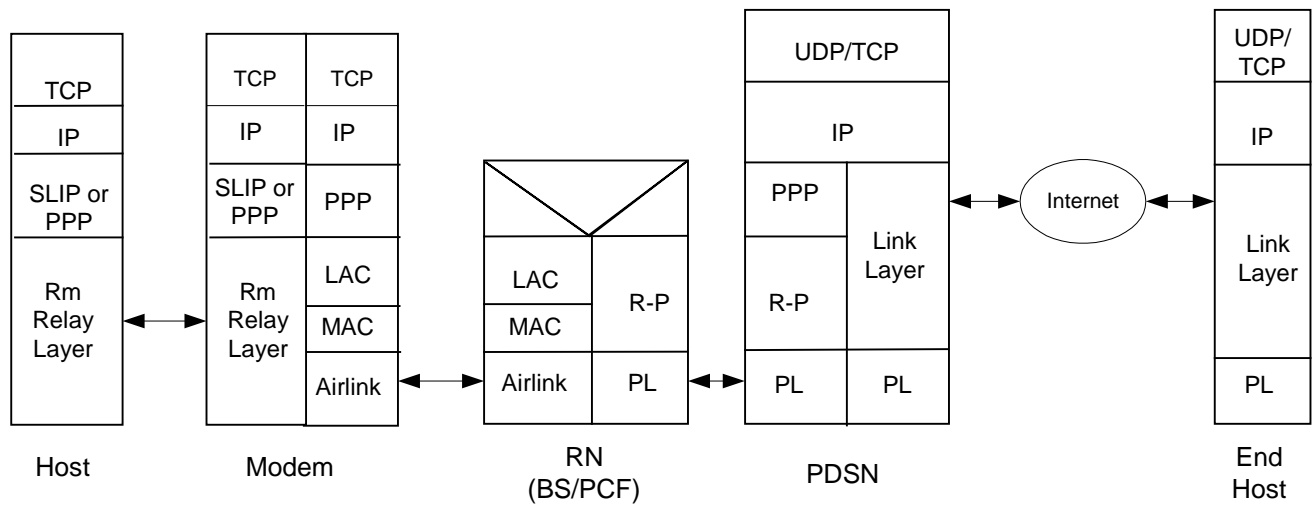
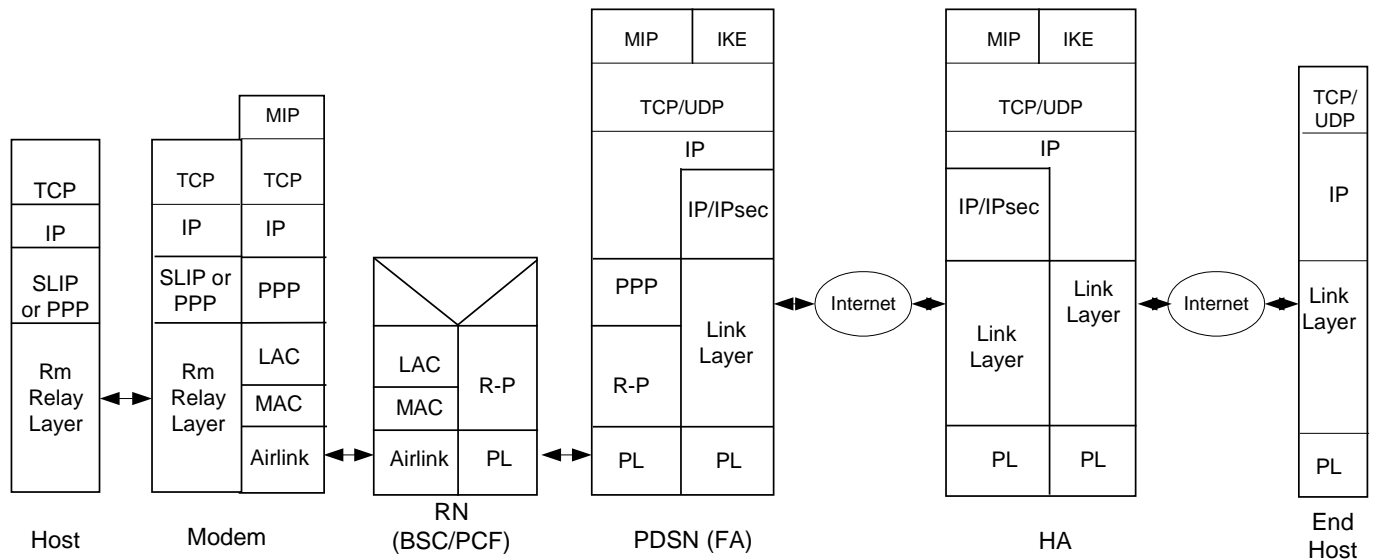


Figure 35 shows the protocol diagram for Packet Network Model with Mobile IP.

Figure 35: IS2000 Packet Network Model with Mobile IP



### Implementation detail

#### *Snoop function*

Network model requires two stacks on the modem alone. An efficient implementation of network model replaces the two stacks on the modem with a 'snoop' function, which examines the packets as they pass through the handset and uses the information found to invoke callback functions to perform various actions. The 'snoop' function allows Mobile IP related function to be handled locally on the modem.

#### *MIP Transparent to Host Device*

A laptop/PDA without a Mobile IP client communicates to the wireless modem in network model. In this mode, the wireless modem handles all the Mobile IP packets. The laptop/PDA has a PPP link that terminates at the wireless modem and the modem forwards packets on its PPP link to the network. The laptop/PDA gets its IP address via IPCP from the wireless modem after the modem gets it from the Home Agent using Mobile IP registration.

#### *User Profiles*

User profiles contain user and Mobile IP session-specific information. A user may have one profile to access the general internet and one profile to access the corporate network. Multiple NAIs can be requested for the same wireless device. A Sprint PCS user can enter his/her NAI and password from any Sprint PCS terminal and have access to the internet. The wireless modem stores up to 6 user profiles in NVM that can be configured to store Mobile IP parameters such as NAI, MN-AAA shared

secret and SPI, MN-HA shared secret and SPI, Home Agent address, Home Address, and so on.

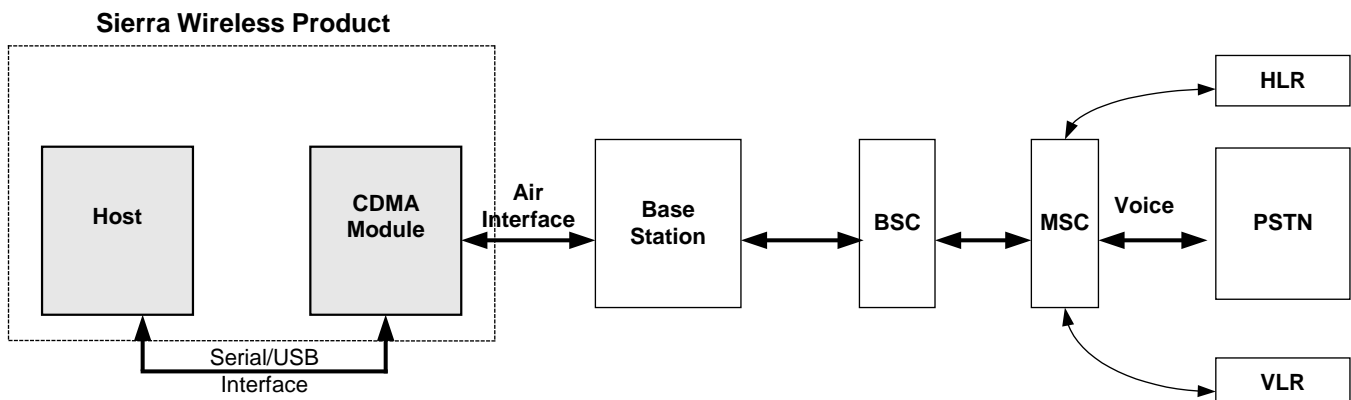
**Dynamic Home Agent IP address**

If the home agent IP address is 0.0.0.0, the mobile is assigned a dynamic home agent. It uses the assigned home agent address in subsequent re-registrations of that mobile IP session. However, the mobile does not save home agent address in NV.

## Voice services

The MC5728V Mini Card supports both EVRC (Rate Set 1) and 13KQCELP (Rate Set 2) vocoders. An EVRC call is Service Option 3. A 13KQCELP call is Service Option 32768. Figure 36 shows the network components for voice services.

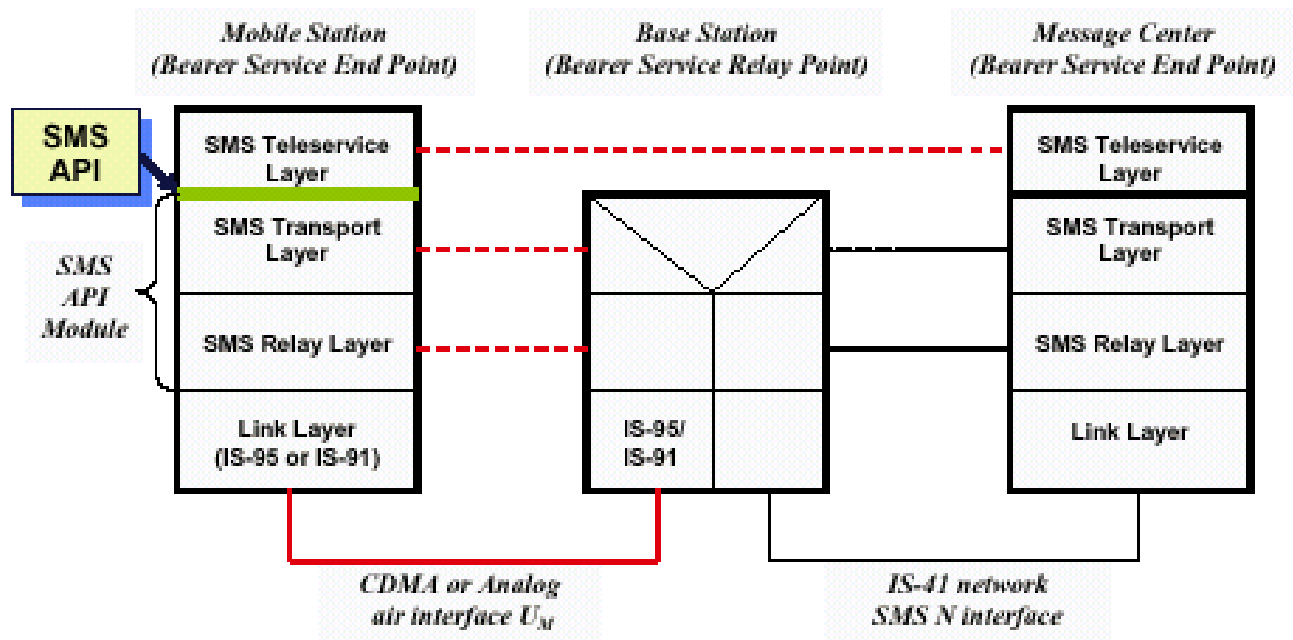
Figure 36: Network components for voice services



## SMS services

The SMS protocol stack is shown in Figure 37.

Figure 37: SMS protocol stack



The SMS Teleservice layer is implemented on the host, which provides duplicate detection, message alert, display and storage of SMS messages.

Three teleservice types are supported:

- Paging
- Messaging
- Voice mail [notification](#).

SMS Transport Layer and layers below it are implemented on the modem. SMS Transport Layer performs decoding, message processing and delivery.

SMS Relay layer is the logical interface between Transport Layer and Link Layer.

Link Layer is via CDMA IS-95, which demodulates paging and traffic channel messages depending on the states of wireless module to receive SMS messages. Mobile terminated SMS messages are received as 'data burst messages' over the CDMA air link. When mobile is in standby mode (demodulating the paging channel), SMS messages that are broadcast over the paging channel can be received. SMS messages can also be directed to the mobile when it is in talk mode (on traffic channel).

## Implementation detail

SMS Messages are saved on the Host. There is no limit on the number of messages the SMS application can store. Host should allow messages be hot-synced back to the PC for backup. This approach has three main advantages over saving SMS on modem:

- Host has more available memory.
- When manipulating already received messages (remove, read, sort, extract embedded phone numbers, etc), host does not need to send any host interface messages to modem since all messages are stored on host. Host-modem interface messages are minimized.
- Modem does not need to be woken up when user manipulates the already received messages. Modem power consumption is minimized.

Modem sends the MT SMS message to the host. After host stores the message successfully, modem removes the message from its NVM.

When modem receives a Mobile Terminated SMS, modem stores the message temporarily and sends deliver acknowledgement back to the base station. This allows the deliver acknowledgement to be sent back within 2 seconds as required. However, this does not guarantee that host is able to store this message, because the host may be in a non-functioning state (e.g. host may be powered off). The modem can hold a maximum of ten SMS messages.

## OTASP services

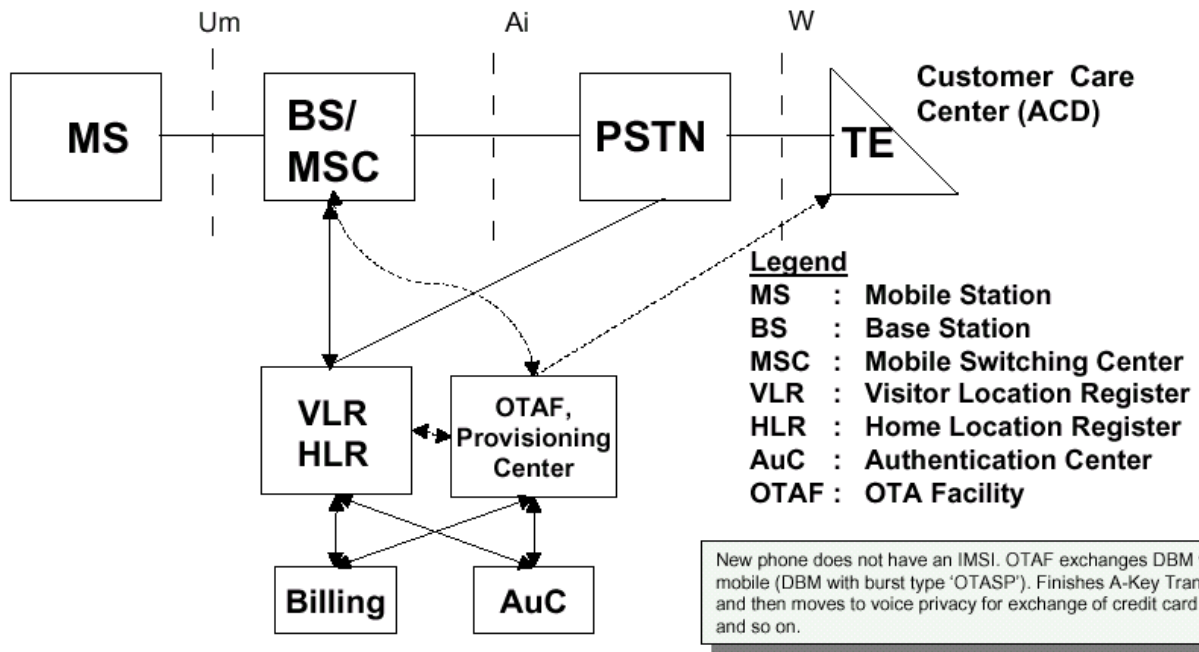
The Mini Card supports both Over-the-Air Service Provisioning (OTASP) and Over-the-Air Parameter Administration (OTAPA) as defined in IS-683-A. OTAPA is network-initiated rather than end-user initiated.

OTASP is a protocol for programming phones over-the-air using the IS-95 Data Burst Messages. This allows phones to be sold with no specific identity. The Sierra Wireless activation software detects the un-activated device upon power up and prompts the user to activate the Mini Card by making a call. During the OTASP call, the user is connected to a service representative for the carrier providing the service (customer care center). User's personal information is collected by the representative and verified by Authentication Center (AuC) during the call. The phone is then activated over-the-air via OTASP.

OTASP performs the following functions:

- NAM parameters downloaded over the air
- Preferred Roaming list downloaded over the air
- Service Programming Lock downloaded over the air
- A-Key downloaded over the air
- Re-authentication

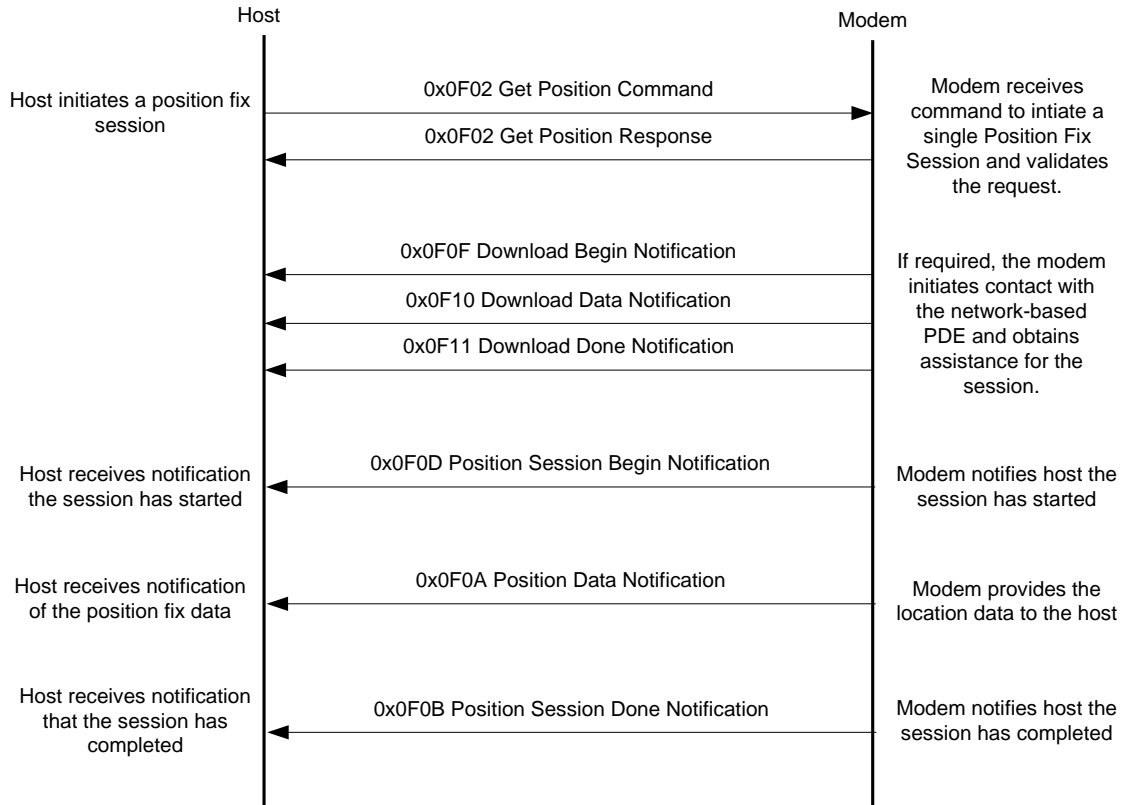
The network elements supporting OTASP are shown in Figure 38.  
 Figure 38: Network components for OTASP



# Appendix H: LBS Application Note

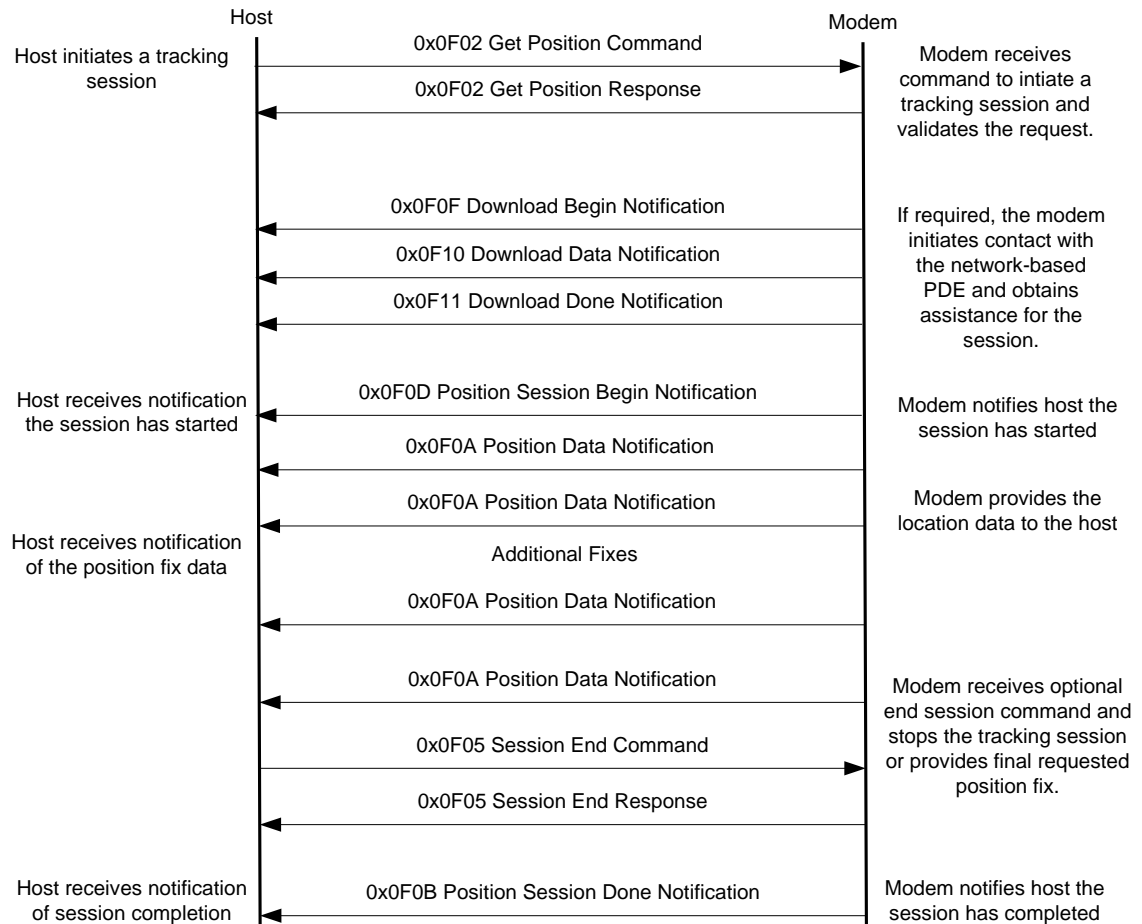
## Mobile Originated Single Position Fix Session

Figure 39: LBS single fix session



# Mobile Originated Position Tracking Session

Figure 40: LBS tracking session



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