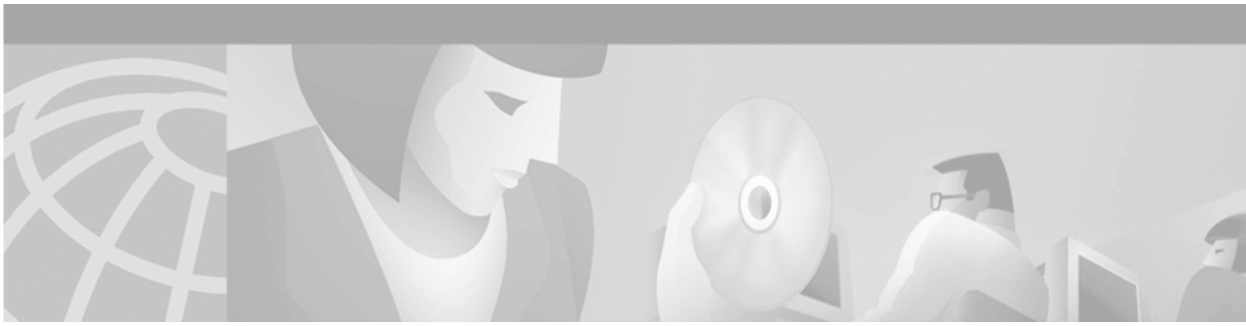

Preface

Objective

Cisco VCO/4K Supervision and Call Progress Tone Detection provides detailed information for application developers to define and control supervision processing within their VCO/4K applications. This information is focused on general network supervision processing, and does not include information pertinent to SS7 system configurations. For information pertaining to SS7 operations, refer to the appropriate ANSI or ITU SS7 manual for the VCO/4K.

Audience

This manual is intended for all personnel responsible for VCO/4K system application development.

Document Organization

This book is divided into the following chapters:

- Chapter 1, "Network Signaling Overview," provides a fundamental understanding of network signaling, describing the various signaling formats. Basic signal types are defined and applied to a simple call example to illustrate when and where they occur during a call.
- Chapter 2, "Supervision Processing," demonstrates the system's relationship to the network based on the system application and establishes basic terminology used throughout this document. General call processing by the system is illustrated with emphasis placed on supervision signaling and processing.
- Chapter 3, "Call Supervision Signaling and Supervision Timing," describes the generation/detection of call supervision signaling (seizure, wink, hook flash, answer supervision and disconnect) for each network interface type. Supervision timers for grace timing, guard timing and other uses are also explained.
- Chapter 4, "Call Progress Tones," discusses the tone generation capabilities of the system and how the system recognizes call progress tones. Call Progress Analysis (CPA) topics, including allocation and processing information, system administration support and application/template download procedures are also presented.

- Chapter 5, "Answer Supervision Template Processing," explains the interaction between supervision control outpulse rules and answer supervision templates. Supervision template condition tokens are defined and a brief example demonstrates outpulse rule and answer supervision template processing. Guidelines for designing templates are also discussed.
- Chapter 6, "Call Examples," provides detailed models that demonstrate various aspects of call supervision processing on the system. Each example identifies the interactions between the system, a host computer and connected equipment.

Document Conventions

This guide uses the following conventions:

Note Means *reader take note*. Notes contain helpful suggestions or references to material not covered in the manual.

Tips Means *the following information will help you solve a problem*. The tips information might not be troubleshooting or even an action, but could be useful information.

Caution Means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.

Warning **Means *danger*. You are in a situation that could cause bodily injury. Before you work on any equipment, you must be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. To see translated versions of the warning, refer to the *Regulatory Compliance and Safety* document that accompanied the device.**

Related Documentation

Refer to the following documents that apply to your Cisco VCO/4K configuration:

- *Cisco VCO/4K System Software Version 5.n(n) Release Notes*
- *Cisco VCO/4K System Administrator's Guide*
- *Cisco VCO/4K System Messages*
- *Cisco VCO/4K Software Installation Guide*
- *Cisco VCO/4K Hardware Installation Guide*
- *Cisco VCO/4K Card Technical Descriptions*
- *Cisco VCO/4K Standard Programming Reference*
- *Cisco VCO/4K Extended Programming Reference*
- *Cisco VCO/4K Ethernet Guide*

- Product supplements for optional software, including:
  - *Cisco VCO/4K Management Information Base (MIB) Reference*
  - *Cisco VCO/4K ASIST Programming Reference*
  - *Cisco VCO/4K TeleRouter Reference Guide*
  - *Cisco VCO/4K ISDN Supplement*
  - *Cisco VCO/4K IPRC Supplement*

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Technical Assistance Center

The Cisco TAC website is available to all customers who need technical assistance with a Cisco product or technology that is under warranty or covered by a maintenance contract.

Contacting TAC by Using the Cisco TAC Website

If you have a priority level 3 (P3) or priority level 4 (P4) problem, contact TAC by going to the TAC website:

http://www.cisco.com/tac

P3 and P4 level problems are defined as follows:

- P3—Your network performance is degraded. Network functionality is noticeably impaired, but most business operations continue.
- P4—You need information or assistance on Cisco product capabilities, product installation, or basic product configuration.

In each of the above cases, use the Cisco TAC website to quickly find answers to your questions.

To register for Cisco.com, go to the following website:

http://www.cisco.com/register/

If you cannot resolve your technical issue by using the TAC online resources, Cisco.com registered users can open a case online by using the TAC Case Open tool at the following website:

http://www.cisco.com/tac/caseopen

Contacting TAC by Telephone

If you have a priority level 1(P1) or priority level 2 (P2) problem, contact TAC by telephone and immediately open a case. To obtain a directory of toll-free numbers for your country, go to the following website:

http://www.cisco.com/warp/public/687/Directory/DirTAC.shtml

P1 and P2 level problems are defined as follows:

- P1—Your production network is down, causing a critical impact to business operations if service is not restored quickly. No workaround is available.
- P2—Your production network is severely degraded, affecting significant aspects of your business operations. No workaround is available.

CHAPTER 1

Network Signaling Overview

This chapter provides a fundamental understanding of network signaling and establishes standard terminology used throughout this document. The topics covered in this chapter are:

- Signaling events in the network
- Digital signaling interfaces and framing techniques
- Digital signaling formats (D3/D4)
- Signal exchange/sequences in the network

Note This information focuses on general network supervision processing, and does not include information pertinent to SS7 system configurations. For information pertaining to SS7 operations, refer to the appropriate ANSI or ITU SS7 manual for the VCO/4K.

Signaling Events in the Network

Signaling events occurring during network call processing may be divided into two basic categories: address signaling and supervisory signaling.

Address Signaling

Address signaling is the means by which a subscriber or switching system inputs dialed number information into the network. In some applications, the telephone equipment outputs automatic number identification (ANI) information into the network following an off-hook. Typically address signaling is accomplished by dial pulsing or by in-band signaling with DTMF and MF tones. This information must often be transmitted over several links in the switched network to establish a voice path between the caller and the called party.

Note This document discusses supervision signaling surrounding the collection and transmitting of address information. Techniques and formats specific to address signaling, however, are beyond the scope of this document and are not examined in detail.

Supervisory Signaling

Supervision information may be indicated using both in-band and out-of-band supervisory signals. Supervisory signaling is divided into three categories: call supervision, alert signaling and call progress tones.

Call Supervision

Call supervision detects or changes the state or condition of a line or trunk (via out-of-band signaling). There are two possible supervised conditions: on-hook and off-hook. On-hook means telephone equipment is idle; off-hook occurs when telephone equipment is active.

When a line/trunk goes off-hook, it is interpreted as a *seizure* by the system, and the line/trunk's operating state goes from idle to active. Both ends of a voice path must be off-hook for two-way communication to occur. If one end of the path goes on-hook and the other remains off-hook, the voice path becomes unidirectional (near- or far-end disconnect). The calling party can input control information to dial another number. When both ends of the path go on-hook, the voice path is torn down in the network.

Brief changes in the on-hook/off-hook status of a line or trunk (*wink* or *hook flash* signals) are also viewed as call supervision signals in this document. Seizures, wink and hook flash signals, and answer conditions are discussed in Chapter 3, "Call Supervision Signaling and Supervision Timing."

Alert Signaling

The most familiar alert signal is power ringing, which notifies a called party of an incoming call. Ringing is initiated by applying ring voltage (50 to 130 V @ 20/30 Hz) to the line or trunk (out-of-band signaling). Ring voltage is normally obtained from a ring generator which is wired to the switching system. The far end central office provides audible ringback (an in-band call progress tone) toward the calling party to indicate that ring voltage has been applied to the circuit.

Power ringing is discussed Chapter 3, "Call Supervision Signaling and Supervision Timing." Audible ringback tone is grouped with other call progress tones and is discussed in Chapter 4, "Call Progress Tones."

Call Progress Tones

Signals in this category include audible tones that indicate the progress of a telephone call to a calling party. The Bell system uses a Precise Tone Plan consisting of four frequencies: 350 Hz, 440 Hz, 480 Hz and 620 Hz. Call progress tones consist of these frequencies (either single or paired frequencies) and specific temporal patterns (cadences). The most common call progress tones are as follows:

- *Dial tone*—Indicates that the CO is ready to except digits from the subscriber. The dial tone can be removed from the line when the first digit is detected.
- *Busy tone*—Indicates that the called line has been reached but it is engaged in another call.
- *Reorder tone*—Indicates that the local switching paths to the calling office or equipment serving the customer are busy or that a toll circuit is not available.
- *Special Information Tones (SITs)*—Indicate special network conditions encountered in both the Local Exchange Carrier (LEC) and Inter-Exchange Carrier (IXC) networks.
- *Audible Ringback*—Returned to the calling party to indicate that the called line has been reached and ringing has started. Refer to Chapter 4, "Call Progress Tones," for information on generating and detecting call progress tones with the system.

Digital Signaling Interfaces

The VCO/4K can directly interface with T1 digital carrier systems operating at a DSX 1 level. Each T1 span supports twenty-four 56-Kbps voice channels and complies with Bell System DSX 1 specifications for transmission at 1.544 Mbps. Transmission over T1 circuits is bidirectional, involving both a transmit (Tx) and receive (Rx) data stream.

For complete descriptions of digital interfaces, refer to:

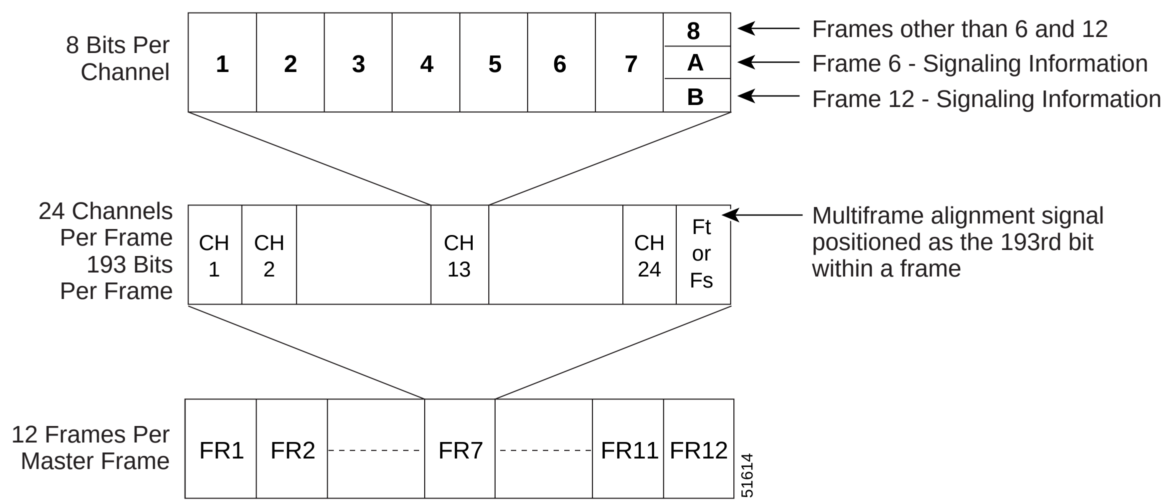
- Bellcore PUB 43801, *Digital Channel Bank D Requirements and Objectives*
- AT&T PUB 62411, *ACCUNET T1.5 Service Description and Interface Specifications*
- AMERICAN NATIONAL STANDARD for Telecommunication: *Standards for DS1, DS1C, DS2 and DS3 Levels of the Digital Hierarchy*

DS-1 Bit Streams

The DS-1 1.544-Mbps bit stream transmits 24 separate channels of pulse code modulation (PCM) voice or digital data. Each channel is transmitted 8 bits at a time. All 24 channels are grouped together to form a group of 192 bits. For synchronization (framing) purposes, every group of 192 bits ends with a framing bit. The 193 bits constitute a frame and twelve frames are grouped together to form a master frame.

Under D3/D4 format, every sixth or twelfth frame of the master frame contains signaling information. The signaling information pertaining to each channel is presented in bit 8. Figure 1-1 shows the framing schedule for DS-1, D3 format digital transmission.

Figure 1-1 DS-1, D3 Format Framing



D3/D4 Signaling

The D3/D4 format for DS-1 (1.544 Mbps) bit streams assigns every sixth and twelfth frame as a "signaling" frame, wherein the eighth bit of each 8-bit channel sample (the Least Significant Bit) is reserved for signaling. These bits are designated "A" (sixth frame) and "B" (twelfth frame).

Bit stream "signaling" frame locations are delineated by the framing-bit sequence. This sequence [100011011100] repeats every twelve frames; the bold framing bit in the sequence informs the terminal that this frame contains signaling data on the eighth bit of each channel (this technique is known as bit-robbing). The twelve frames comprising one full framing sequence are often referred to as a superframe.

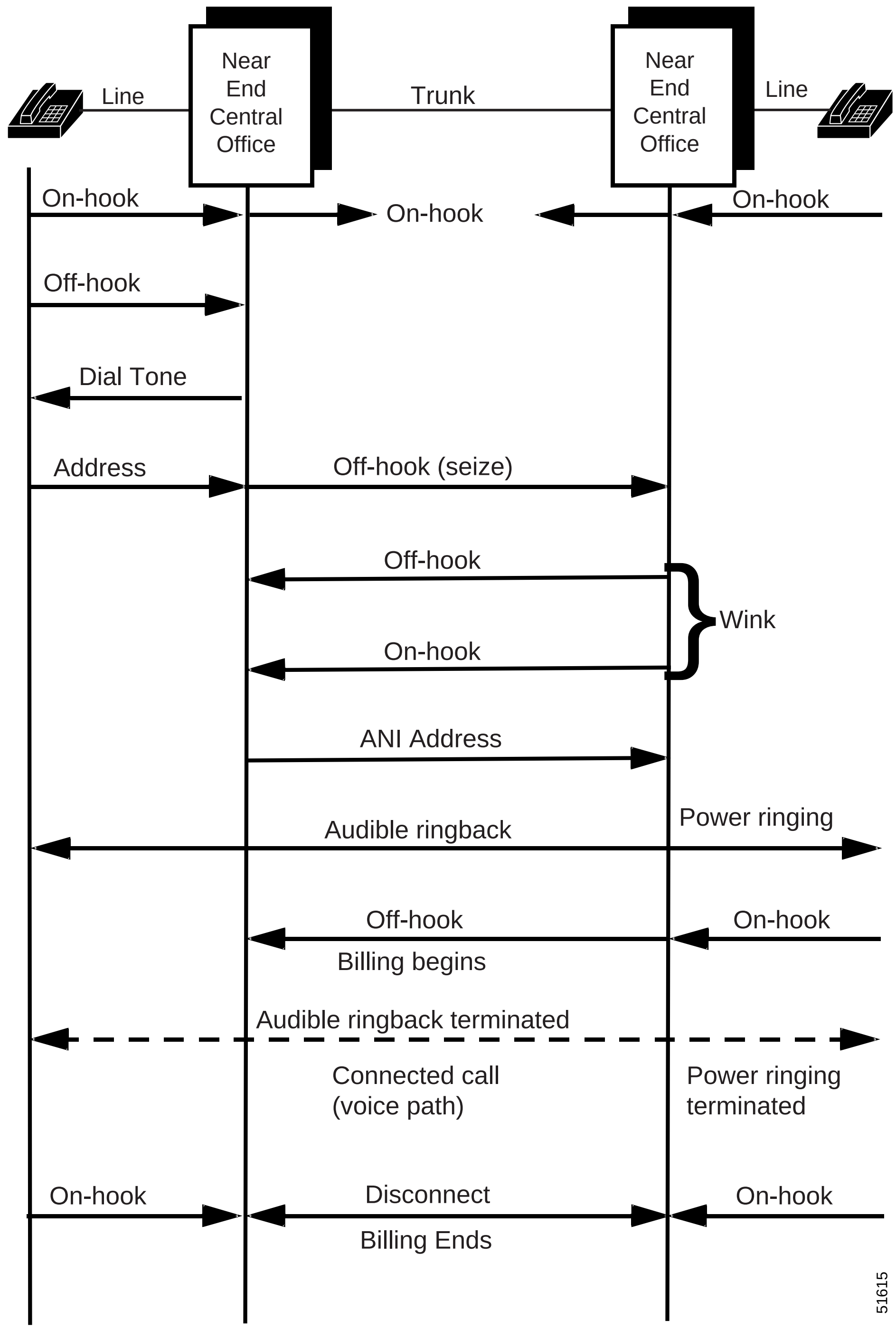
The T1 interface uses the equivalent of E+M two-state signaling for supervision control. The signaling bits in the Rx data stream correspond to the states of the E lead, while the signaling bits in the Tx data stream represent M lead states. Interoffice supervision is primarily conveyed via the "A" bits in both Rx and Tx directions. The "B" bits in the Rx data streams are not currently interpreted by the systems.

Signal Exchange in the Network

The types and sequences of signals exchanged between connected equipment varies according to equipment type, service/application provided, point of time during the call, and other variables. During application development, signaling requirements are normally defined in the early stages or even before any work is performed. Figure 1-2 illustrates the signaling sequence during a plain old telephone service (POTS) subscriber call. The calling party goes off-hook, receives dial tone, and dials address digits. The near-end CO collects the digits and seizes out on an outgoing trunk to the far end CO. When the far-end CO is ready to receive the forwarded digits, it sends a wink signal to the near-end CO, which then outpulses the address digits. The far-end CO rings the called party's phone and supplies audible ringback to the calling party.

When the called party goes off-hook, the far-end CO sends answer supervision to the near-end CO. The power ringing and audible ringback are terminated and a stable call is established between the two parties. Either party can end the connection by going on-hook; the network circuit is then torn down.

Figure 1-2 Network Call Signaling Sequence



CHAPTER 2

Supervision Processing

This chapter provides an overview of VCO/4K call and supervision processing. The functions of Class of Service (COS), inpulse and outpulse rules, and answer supervision templates are summarized and tied together in a general call flow example. This chapter also establishes the system's relationship to connected equipment, and explains standard terminology.

For more information on call and supervision processing, refer to the following chapters:

- Chapter 3, “Call Supervision Signaling and Supervision Timing”
- Chapter 4, “Call Progress Tones”
- Chapter 5, “Answer Supervision Template Processing”

Equipment Interfaces

Because of its flexible architecture, the VCO/4K can be connected to a wide variety of telecommunication equipment. Depending upon the equipment to which it is connected, system interfaces, called “ports,” can be discussed in general terms. These terms describe how a port is used in an application and handled by the system software. *Incoming* and *outgoing* describe a port's relation to the call flow through the system. Three types of implementations—*line-side*, *trunk-side*, and *mixed*—indicate the position of the VCO/4K relative to the central office (CO) and connected equipment.

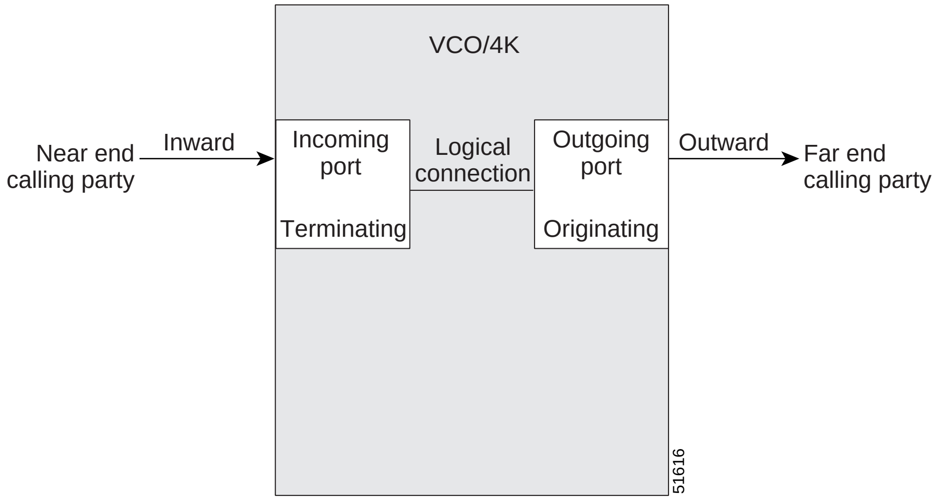
Incoming and Outgoing Ports

The terms used to describe signaling and supervision throughout this document relate to the direction of the call flow. Calls initiated outside the VCO/4K enter the system on *incoming ports*. The system initiates calls out of the system over *outgoing ports*. Incoming ports are sometimes referred to as *terminating* connections, while outgoing ports provide *originating* connections.

Using the simple call scenario in Chapter 1, “Network Signaling Overview,” the call attempt from the calling party causes an inward seizure on a system incoming port (call seizures are defined in Chapter 3, “Call Supervision Signaling and Supervision Timing”). The system then selects an outgoing port to route the call to the called party and seizes outward.

The system establishes a complete call path between both parties using a logical connection to link the incoming and outgoing ports. Because the equipment connected to the system may be automated equipment rather than human parties, the general terms *near end* and *far end* equipment are used. Each of these terms and their relationship to the call flow through the system are summarized in Figure 2-1.

Figure 2-1 Call Flow Terminology

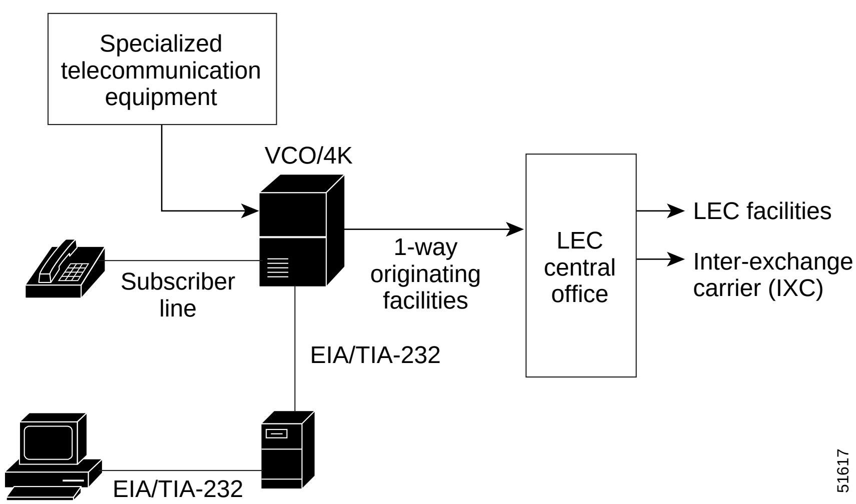


Line-side and Trunk-side Implementation

A system implementation defines the positioning of the VCO/4K in reference to the central office (CO). The system can be equipped with hardware components and software feature packages that support a desired implementation. The process of selecting the proper components is called configuring the system. A system can be configured for line-side, trunk-side and mixed.

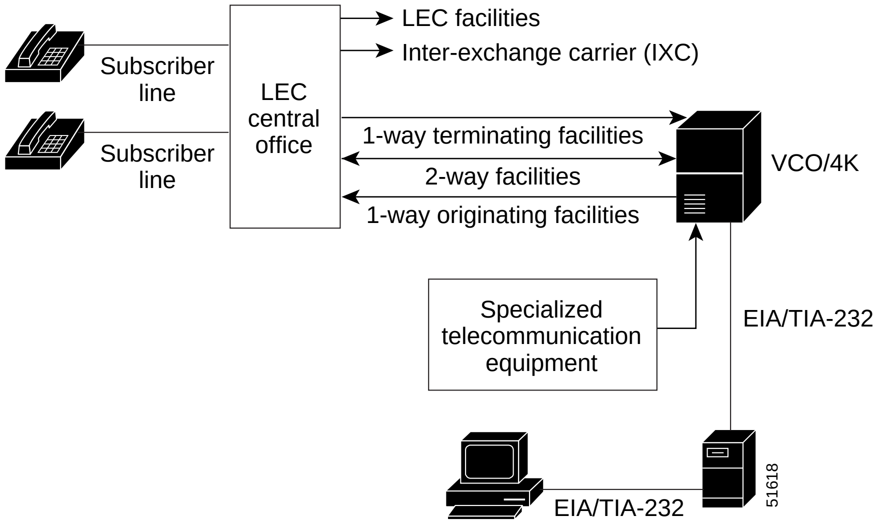
A line-side implementation indicates that the system is positioned between telephone stations or other pieces of ancillary equipment and the CO. Line-side implementation implies that the system sits in front of the CO (see Figure 2-2). One-way originating facilities link the system to the CO.

Figure 2-2 Line-side Implementation



A trunk-side implementation means that the telephone stations are routed through the CO before being directed over trunks to the system for processing. Trunk-side implementation implies that the system sits behind the CO (see Figure 2-3). One-way terminating and originating, and/or two-way facilities link the system to the CO.

Figure 2-3 Trunk-side Implementation



The system can also be configured for mixed line-side and trunk-side implementation. Some telephone stations can be directly connected to the system while others are also routed through a CO to the system.

System Call Processing

Call processing within the system is accomplished using the information stored in the system database. Host commands may initiate system actions and host reports provide overall tracking of call handling, whereas step-by-step call processing is performed at the system level.

The key instructions for call processing on a port-by-port, call-by-call basis are defined in the following areas:

- *Class of Service (COS)*—Determines if a system port is used for incoming or outgoing calls and whether it always remains active (always off-hook) or becomes idle (on-hook). These options are assigned to all line and trunk ports on network interface cards.
- *Inpulse and Outpulse Rules*—Defined via system administration. Actions are represented by tokens; up to 16 tokens can be used in each rule. Rules can be "called" like subroutines in a command or, in the case of inpulse rules, executed by default when an incoming port seizes inward. In general, inpulse rules control collection and signaling functions for incoming ports, while outpulse rules pass routing information and control supervision processing on outgoing ports. Depending on the application, however, rules of either type may be executed on both incoming and outgoing ports.
- *Answer Supervision Templates*—Defined via system administration. Used by outpulse rules for precise definition of progress tone and supervision detection processing.

Class of Service

Class of Service (COS) is a set of operating characteristics that you assign to a network interface circuit (line/trunk port). The COS mark is entered into the system database and determines how a port can be used in a call. Table 2-1 summarizes the COS marks supported by the system.

Table 2-1 Class of Service Options

COS	Description
O	Originating—Calls originating from the system; outgoing calls initiated by host command.
T	Terminating—Calls terminating at the system; incoming calls initiated by actions outside the system.
2	2-Way—Calls originating from the system or calls terminating at the system; outgoing calls initiated by host command, incoming calls initiated by outside actions.
AO	Always Off Hook and Originating—Calls originating from the system, port goes off hook at system reset and remains off hook; outgoing calls initiated by host command.
AT	Always Off Hook and Terminating—Calls terminating at the system, port goes off hook at system reset and remains off hook; incoming calls initiated by outside actions or forced by host command.
A2	Always Off Hook and 2-Way—Calls originating from the system or calls terminating at the system, port goes off hook at system reset and remains off hook; outgoing calls initiated by host command, incoming calls initiated by outside actions or forced by host command.

Always off hook marks accommodate station equipment that is not capable of going on hook or remains off hook much of the time (such as operator/attendant stations). System call processing also uses internal COS marks for ports designated as 2-way, ports involved in a call using a virtual port, or any line/trunk port involved in a conference. Refer to the *Cisco VCO/4K System Administrator's Guide* for more information on standard and internal COS options.

Inpulse Rules

An inpulse rule is a list of tokens defined by an application designer. Up to 16 tokens can be used to condition a trunk to wait for supervision events; collect MF, DTMF, or Dial Pulse (DP) digits; and store received digit fields in an internal system call record. An inpulse rule can also specify to execute an outpulse rule as part of inpulse rule processing; when the outpulse rule has been completed, processing continues. Categories of inpulse rules and their meanings are as follows:

- Reporting Control—Determines when change of state and address signaling for an incoming port are reported to the host.
- Signaling Mode—Indicates that incoming digits for collection are either MF, DTMF, or DP.
- Digit Collection Setup—Defines the conditions for digit collection.
- Digit Collection—Enables the appropriate receiver (as indicated by the Signaling Mode token) and specifies the digit field in which digits are stored.
- Supervision Control—Presents in-band or out-of-band signaling to connected equipment (answerable, wink, hook flash, tone, or voice prompt) or waits a specified length of time before continuing rule processing.

- Processing Control—Allows construction of rules with more than 16 tokens and processing of an outpulse rule.
- Prompt/Record Control—Prompt and record control for the IPRC.

Outpulse Rules

An outpulse rule is a listing of tokens defined by an application designer. Up to 16 tokens can be used to condition a trunk to wait for supervision events, and outpulse MF/DTMF digits. An outpulse rule can also specify to execute an inpulse rule as part of outpulse rule processing; when the inpulse rule has been completed, processing continues. Categories of outpulse rules and their meanings are as follows:

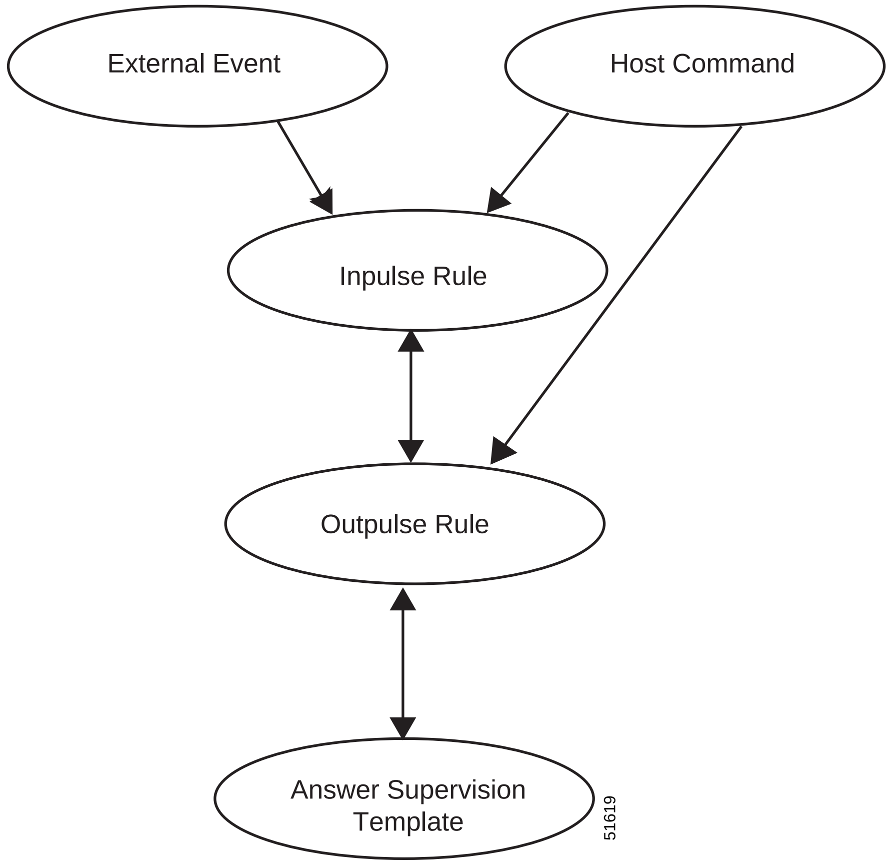
- Reporting Control—Notifies the host of supervision events detected on an outgoing or incoming port (note that reporting for individual signaling events specified by WAIT SUP [xx] and FINAL SUP [xx] tokens is controlled by template processing).
- Signaling Mode—Determines the type of outpulse signaling required.
- Supervision Control—Conditions the port to detect and respond to answer supervision events before continuing with rule processing. Indicates which configurable answer supervision template or preconfigured template to use for supervision.
- Digit Field—Determines when and what digits or tones are outpulsed.
- Processing Control—Allows construction of rules with more than 16 tokens and processing of an inpulse rule.

Answer Supervision Templates

Supervision processing is performed by a combination of supervision control outpulse rule tokens and answer supervision templates. The outpulse rule tokens WAIT SUP [xx] and FINAL SUP [xx] are used for intermediate supervision and final supervision, respectively. During outpulse rule processing, these tokens call specific answer supervision templates in much the same way a command calls a rule. The templates indicate which signaling events may be detected and the system response to each event. When an event is detected, the system response specified in the template is performed; the supervision control outpulse rule token is satisfied and rule processing continues.

Template processing fits within the standard system call processing hierarchy (see Figure 2-4). Outpulse rule processing begins when a DO ORULE token is executed in an inpulse rule, or when an Outgoing Port Control ($69) or Incoming Port Control ($6A) command specifies an outpulse rule. WAIT SUP [xx] tokens cause outpulse rule processing to wait while answer supervision template processing takes place. When template processing ends, outpulse rule processing continues. FINAL SUP [xx] tokens act as setup tokens and do not suspend outpulse rule processing. These tokens define final supervision template processing after outpulse rule processing ends. Answer supervision templates and their interaction with outpulse rules are discussed in Chapter 6, “Call Examples.”

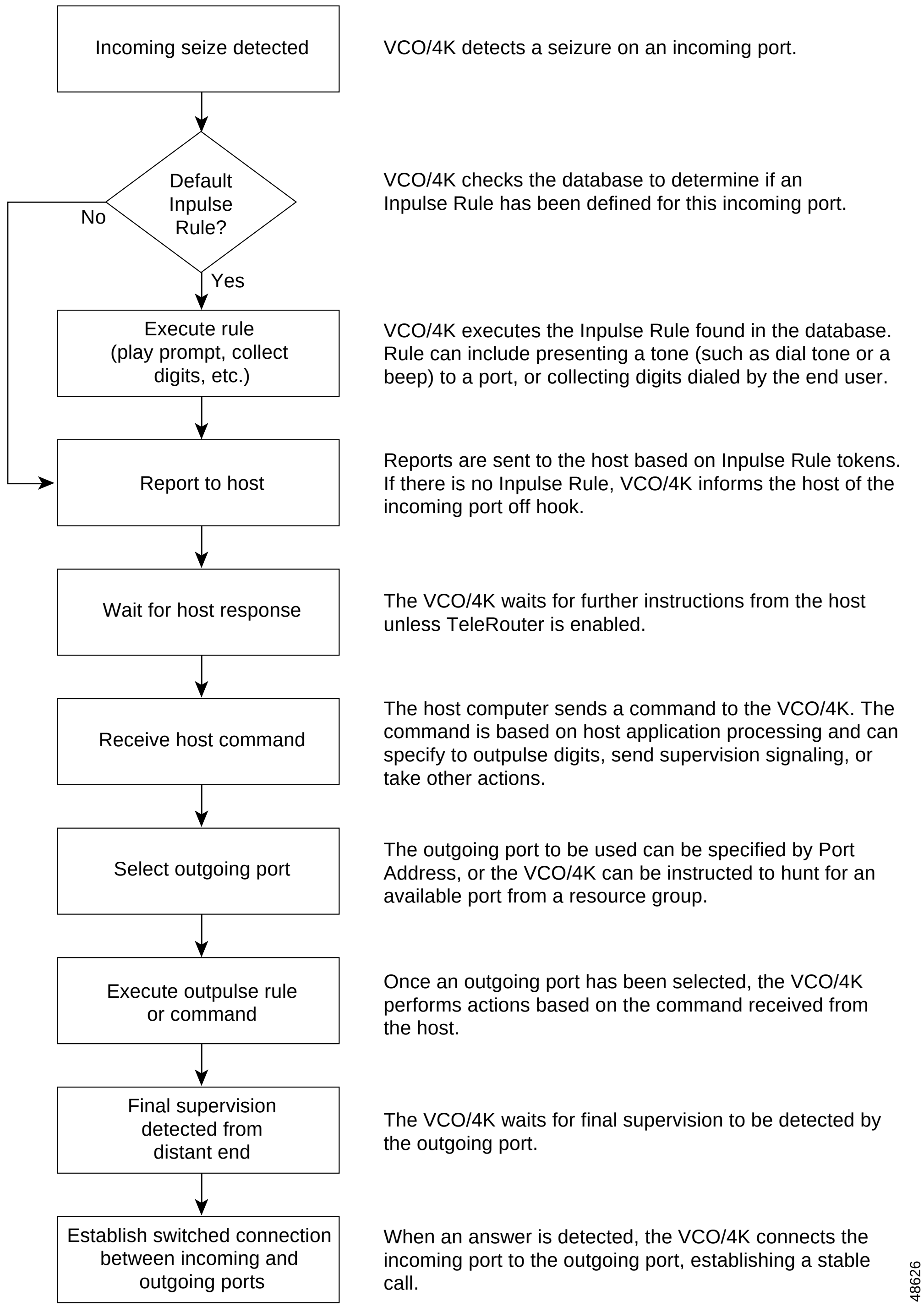
Figure 2-4 Processing Hierarchy



General Call Flow

A typical call involves a logical connection between two network interface circuits. The signaling generated and detected by the system that controls the handling of this connection is called supervision processing. This general call flow and the portions of the flow involving supervision processing are shown in Figure 2-5.

Figure 2-5 General Call Flow



When an incoming port seizes inward, the system attempts to create a logical connection between this port and an outgoing port. If a default inpulse rule is defined for the incoming port, this rule may contain tokens which send supervision signals toward the near-end connected equipment. Supervision signaling in this case usually requests additional information from the incoming equipment for processing the call.

Based on the system application, the host may issue commands, request reports, and execute inpulse and outpulse rules during the course of call processing. In most cases, the host will issue a resource control command that selects an outgoing port and executes an outpulse rule. The outpulse rule seizes out on an outgoing line/trunk and waits to detect supervision signals from the far end. Answer supervision templates, specified by tokens in the outpulse rule, are processed during this waiting period. Each template contains a set of system responses to the detection of certain supervision signals.

The signals detected during answer supervision template processing may be call supervision signals (changes in the on-hook/off-hook status of the connected equipment) or audible call progress tones. The templates also allow expiration of supervision timers to affect supervision processing. Collectively, supervision signals, tones and timers are referred to as supervision events.

Template processing can occur during both intermediate and final supervision periods.

Intermediate supervision, in standard network terms, refers to all supervision signaling prior to final answer. Intermediate supervision normally determines if the equipment at the far end can respond to the call; this supervision precedes system actions such as digit outpulsing.

Final supervision refers to any supervision event that indicates the far end has answered the call (usually causing answerback to be passed to the near end and initiating billing).

In most cases, intermediate supervision detection occurs during outpulse rule processing; the wait for final supervision takes place after rule processing completes. However, the flexibility of answer supervision templates allows you to make the detection of any supervision event generate answerback, initiate billing, and end rule processing at any point during the call.

Once the system detects a supervision event that identifies a far-end answer, the system establishes a stable call. A stable call involves a logical connection between the incoming and outgoing port, and a voice path between the near end and far end.

Call Supervision Signaling and Supervision Timing

Call supervision signals relate to the on-hook and off-hook status of a port and its associated line or trunk. On-hook means that the connected equipment is idle; off-hook indicates that the connected equipment is active. When equipment at one end of a network arrangement goes off-hook, this state change is conveyed over lines/trunks to the far-end connected equipment in the form of a seizure. When an inward seizure into the system is detected, call processing normally directs the system to seize an outgoing port and attempts to a create a logical connection between the two ports.

During supervision processing, the system may briefly change the port's on-hook/off-hook status (creating either a wink or hook flash) to signal the connected equipment. When the outgoing port becomes active (off-hook), the incoming port is considered answered and a stable call is established. Supervision timers may interact with call supervision signals during supervision processing. When the equipment at either end goes on-hook, disconnect processing occurs and the call is torn down throughout the network.

Call Supervision Signals

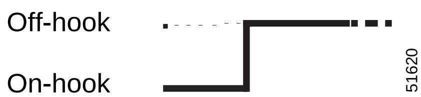
This section describes the following signals: seizure, wink/hook flash, answer, and disconnect.

Seizure

Seizures are signals between connected equipment requesting service, and are the first step in establishing a stable call. In the circuit-switched network, a series of seizures creates a signaling path between network components, allowing supervision signaling to and from the parties at either end. In terms of system applications, seizures involve physical state changes in the line/trunk circuit between a system and connected equipment. The nature of this state change depends on the circuit type. For example, seizing a T1 port establishes a data signaling path. Seize effects for each line/trunk type are discussed in the "Network Interface Port Supervision Capabilities" section on page 3-4.

Figure 3-1 shows a seizure state change.

Figure 3-1 Seizure State Change



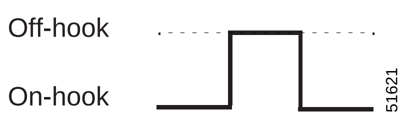
Inward seizures occur when connected equipment goes off-hook. Outward seizures are performed during outpulse rule processing via a SEIZE token. Normally, the host issues an Outgoing Port Control ($69) command that either hunts an outgoing port from a resource group or selects it by port address. This $69 command also calls an outpulse rule which contains a SEIZE token. The outgoing port is seized when this token is processed. Once a port is seized, it cannot be allocated to another call until it is released by call disconnect or Permanent Signal processing. Depending on resource group and physical configurations, line/trunk circuits are susceptible to “glare” conditions. Glare occurs in cases of simultaneous seizures, when an incoming line seizes in on the same port that the system seizes outward. When glare is detected, host reports are generated indicating a glare condition (refer to the “Supervision Event Reporting” section on page 5-6 for supervision reporting information).

Wink/Hook Flash

In the network, wink signals are normally used in conjunction with address signaling. A wink may indicate that the distant end is ready to receive autopsied address digits or as a positive acknowledgment that all address digits were received. During call processing, the system can generate a wink on an incoming port to request digits, or it can wait to detect a wink before outpulsing digits on an outgoing port.

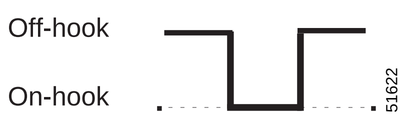
A wink is a brief off-hook/on-hook signal on an unanswered (on- hook) circuit as shown in Figure 3-2. Because winks are generally associated with digit collection and outpulsing prior to final answer, wink generation/detection normally takes place during intermediate supervision.

Figure 3-2 Wink State Change



Hook flash signals are similar to winks, but occur after a port is physically answered (off-hook). A hook flash indicates a change in the status of the call (depending on the application) and consists of a brief on-hook/off-hook signal (as shown in Figure 3-3).

Figure 3-3 Hook Flash State Change



The nature and duration of these signals varies between line/trunk types. General wink and hook flash generation and detection capabilities for the T1 card type are shown in Table 3-1. Wink and hook flash characteristics for T1 card I/O modules are provided in the “Network Interface Port Supervision Capabilities” section on page 3-4.

Table 3-1 Wink and Hook Flash Detection and Generation

	Wink		Hook Flash	
Card Type	Generate	Detect	Generate	Detect
T1	Yes	Yes	Yes	No

Answer

Answer supervision indicates when connected equipment has become active and a two-way signaling/voice path exists. In general network scenarios, answer supervision is passed backward (from the far end to the near end) to indicate that the called party has answered and to start billing. At the system level, when the system detects answer supervision on an outgoing port, it establishes a stable call between the incoming and outgoing ports. The system can also answer an incoming call before connecting the incoming and outgoing ports.

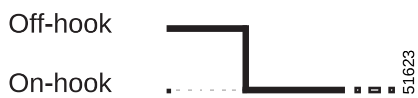
The system can both detect and generate answer supervision. The system detects answer supervision in the form of either out-of-band or in-band signaling. True answer occurs when the far end goes off-hook and is indicated by out-of-band signaling. Answer supervision template processing allows detection of other supervision events (such as in-band call progress tones) to determine when a port is considered answered. Refer to Chapter 5, “Answer Supervision Template Processing,” for more information.

Generating answer supervision over the incoming port is known as *answerback*. Answerback is passed back through the public network until it reaches the local CO (LEC) for the calling party. When the CO equipment detects answerback, it begins billing the subscriber for a completed call. (Billing considerations are discussed in Chapter 5, “Answer Supervision Template Processing.”) The system controls answerback signaling using inpulse rules and answer supervision templates. Sending answerback using an ANSWER inpulse rule token is discussed in the “Answerback” section on page 3-6. Refer to the “Answer Supervision Template Processing” section on page 5-3 for information on sending answerback during answer supervision template processing.

Disconnect

Call disconnect occurs when the equipment at either end goes on-hook (see Figure 3-4). The call path through the network is torn down and the resources/network components involved in the call are returned to their idle state.

Figure 3-4 Disconnect State Change



Commands used in system call setup, such as the Incoming Port Control ($6A) and Outgoing Port Control ($69) commands, can specify processing to be performed for the ports in a call when the call is torn down. Call teardown can occur in response to either an external event or host command. An external event, such as an on-hook or error condition, triggers processing based on the call setup conditions and the port's COS. When a command is used for call teardown, the processing is generally specified in the command.

Reorder processing and *Permanent Signal processing* are ways of forcing an off-hook port to disconnect. The system attempts to release the port connection (if allowed by the hardware type) at the beginning of Permanent Signal processing. Both Reorder and Permanent Signal processing prompt the caller to hang up using fast busy tone. Although Reorder processing can overflow into Permanent Signal processing, certain error conditions bypass Reorder and enter Permanent Signal processing directly. Reorder or Permanent Signal processing is not performed for any port with COS = A. Ports with COS = A are set directly to CP_IDLE.

Reorder processing is terminated when the port goes on-hook. If the port is still off-hook after 15 seconds, a physical release is performed and the port starts through Permanent Signal processing.

Permanent Signal processing begins with the system performing a physical release on the port. At this time, the port is set to listen to quiet for 30 seconds. If no on-hook is detected after 30 seconds, the port is set to listen to reorder tone for 15 seconds. If on-hook still has not been detected after 15 seconds, the port is set to listen to quiet until it goes on-hook or the system is reset. When the port goes on-hook, either during or at the end of Permanent Signal processing, it is idled and available for allocation to a new call.

Once a port goes on-hook, it remains idle for a brief period before becoming available for allocation; this delay period is known as *guard timing*. The length of this guard time varies between interface port types (refer to the "Guard Timing" section on page 3-8 for additional information).

Network Interface Port Supervision Capabilities

Network interface circuits provide incoming and outgoing interfaces between the system and the switched network. The switched network includes central office (CO) trunks, trunks from other common carriers, other switching equipment, and voice equipment such as telephones, voice storage devices, and synthetic speech generators.

Each equipment type has distinct physical characteristics. These characteristics dictate which system network interface circuit is used in connecting to the equipment. The VCO/4K supports both T1 and E1 digital interfaces. For detailed information pertaining to the interface requirements of these interfaces, refer to the *Cisco VCO/4K Card Technical Descriptions.*

T1 I/O Module

The VCO/4K can directly interface with T1 digital carrier systems operating at a DSX-1 level. Each T1 span supports twenty-four 56-Kbps voice channels and complies with Bell System DS-1 specifications for transmission at 1.544 Mbps. Each T1 span carries a receive (to the T1 card) and a transmit (from the T1 card) data stream. Supervision signaling on T1 I/O modules is the equivalent of E+M two-state signaling.

Seizure

Incoming T1 ports seize in by setting the A signaling bit to 1 in the Rx (receive) data stream. The system seizes out on an outgoing T1 port by sending 1 signaling bits in the Tx (transmit) data stream.

Wink/Hook Flash

T1 ports can both generate and detect wink signals. When a T1 port generates a wink, it transmits a 1 signaling bit toward the connected equipment for 250 ms. T1 ports detect wink signals when they receive 1 signaling bits for a period between 110 ms and 350 ms.

Hook flash signals are generated by transmitting 0 signaling bits toward the connected equipment for 250 ms. T1 circuits do not detect hook flash.

Answer Supervision

When the connected equipment on the outgoing side answers, it sends a 1 signaling bit over the Rx data stream. The system generates answerback by sending a 1 signaling bit in the Tx data stream on the incoming port.

Call Disconnect

When the A signaling bit in the Rx stream from either end changes to a 0 for 30 ms or more, the system disconnects the call.

Call Supervision Processing

The generation and detection of call supervision signals falls under the control of inpulse and outpulse rule processing. Seizures are performed by SEIZE outpulse rule tokens. Wink, hook flash and answerback generation is controlled by inpulse rule tokens. Wink, hook flash, and answer supervision detection is handled by a combination supervision control outpulse rule tokens and answer supervision templates.

Inpulse Rule Processing

WINK NOW and WINK ENAB tokens produce wink and hook flash signals on ports during inpulse rule processing. The system immediately generates a wink or hook flash when a WINK NOW token is encountered during inpulse rule processing. WINK ENAB tokens are used with IP ANI and IP FIELD [xx] digit collection tokens. When rule processing encounters an IP ANI or IP FIELD [xx] token, the system enables the MF or DTMF digit receiver in the call's resource chain. A WINK ENAB token in the rule causes a wink or hook flash signal when the receiver is enabled.

Default inpulse rules (executed when incoming ports seize in) generate signals on the incoming port. However, WINK NOW and WINK ENAB tokens in inpulse rules called during outpulse rule processing (DO IRULE token in the outpulse rule) generate signals on the outgoing port. Interactions between inpulse and outpulse rules are discussed in the *Cisco VCO/4K System Administrator's Guide*.

Wink/Hook Flash

For on-hook T1 circuits, executing a WINK NOW or WINK ENAB token provides a wink signal on the port. WINK NOW and WINK ENAB tokens generate a hook flash on off-hook T1 circuits.

Answerback

ANSWER tokens supply answer supervision over the incoming port. This token is ignored if the port executing the rule has an outgoing class of service. Executing an ANSWER inpulse rule token performs the same action as when an ANSBK or ANSREP condition token is processed in an answer supervision template (refer to Chapter 5, "Answer Supervision Template Processing," for details on answer supervision template processing).

Audible Signals

In conjunction with call supervision signals, inpulse rules can provide audible supervision signaling to callers in the form of call progress tones and voice prompts. Call progress tone generation using TONE NOW [xx] tokens is discussed in Chapter 4, "Tone Generation." Available voice prompts presented by SPEAK [xx] tokens are listed in the *Cisco VCO/4K System Administrator's Guide*.

Note SPEAK [xx] tokens may interfere with supervision signaling. Application developers should set up delays during inpulse rule processing when a WINK ENAB or WINK NOW immediately follows one or more SPEAK [xx] tokens. Insert a WAIT TIME 1 token between the final SPEAK [xx] token and the WINK NOW or WINK ENAB token. Refer to the "Supervision Timing" section on page 3-6 for more information on delay timing.

Outpulse Rule Processing

Supervision control outpulse rule tokens perform outward seizures and define supervision processing based on answer supervision templates.

Seizure

SEIZE tokens perform outward seizures on outgoing trunks. Although a resource control command (such as a $69 or $6A) can select an outgoing port and begin outpulse rule processing for the port, the port remains unseized until a SEIZE token is executed. SEIZE tokens should precede any supervision control tokens (WAIT SUP [xx] or FINAL SUP [xx] tokens) in the rule. If the outgoing port is already seized, the token is ignored (additional SEIZE tokens are ignored after the initial seizure).

Wink/Hook Flash

WAIT SUP [xx] and FINAL SUP [xx] tokens provide detection and processing for wink and hook flash signals as well as answer supervision, applying the supervision templates established using the Answer Supervision Template utility. The additional data entry fields in these tokens specify the template to process.

Supervision Timing

Applications can use supervision timers for two basic purposes: creating pauses during inpulse and outpulse rule processing (delay timing), and continuing call processing if supervision is not detected within an acceptable time (supervision error or grace timing). Delay, supervision, error, and grace timers are all under the control of the application and may be modified via system administration. Additional timers used during disconnect processing, known as guard timers, affect resource allocation. These timers are set by the system software and cannot be changed.

Delay Timing

Connected equipment may require delays during inpulse and outpulse rule processing. WAIT TIME [xx] tokens in inpulse rules cause rule processing to pause for 1 to 10 seconds. For brief delays during outpulse rule processing, WAIT TIME [xx] tokens suspend rule processing for 250 ms to 2.5 seconds. For instructions on using WAIT TIME [xx] tokens in inpulse and outpulse rules, refer to the *Cisco VCO/4K System Administrator's Guide*.

Supervision Error Timing

TIME SUP [xx] outpulse rule tokens control supervision error timers. These tokens specify the time limit allowed for expected supervision events to be detected during answer supervision template processing. TIME SUP [xx] tokens should immediately precede WAIT SUP [xx] and FINAL SUP [xx] supervision control tokens. Depending on the Time event field setting (ERROR or FAIL) in the specified answer supervision template, the timer's expiration may indicate either a recoverable supervision error or a complete call failure. The additional data entry field of the TIME SUP [xx] token specifies the timer limit (1 to 60) in seconds. Refer to Chapter 5, “Answer Supervision Template Processing,” for more information on using TIME SUP [xx] tokens.

Grace Timing

TIME SUP [xx] outpulse rule tokens may also be used for grace timing. Grace timers provide time for a change in the system to occur; when the timer expires, the system assumes the change occurred or event occurred (even if no change/event was detected) and acts accordingly.

Grace timing is useful in supervision processing when it is uncertain whether an answer supervision event (such as true answer or voice) will occur, due to the types of equipment involved or unusual circumstances surrounding the call scenario. Instead of waiting for a positive indication of answer, template processing watches for the absence of negative indicators (SITs, reorder tone, or busy tone). When a grace timer expires for an outgoing port, the system considers the port answered and assumes the incoming and outgoing ports are involved in a stable call (regardless of the on-hook/off-hook status of the ports).

TIME SUP [xx] tokens should immediately precede a WAIT SUP [xx] or FINAL SUP [xx] supervision control tokens. When the system begins processing the template specified in the supervision control token, the timer starts. If the timer expires and the condition token in the template's Time field is ANSBK or ANSREP, answerback is sent to the incoming port and the system establishes a stable call between the ports.

Refer to Chapter 5, “Answer Supervision Template Processing,” for more information on TIME SUP [xx] outpulse rule tokens and answer supervision templates.

Guard Timing

To prevent allocation conflicts and internal processing errors, the system places ports into a guarded state for a brief period after their deallocation. This period is known as guard timing. For example, network interface ports enter CP_GARD (guard) state after call disconnect, before transitioning to CP_IDLE. During guard timing, the port cannot be allocated to another call.

The guard timer value for the T1 I/O card type is listed in Table 3-2.

Table 3-2 Guard Timer Values

Card Type	Value
T1 I/O Module	800 ms

CHAPTER 4

Call Progress Tones

Call progress tone signals provide information regarding the status or progress of a call to customers, operators, and connected equipment. In circuit-associated signaling, these audible tones are transmitted over the voice path within the frequency limits of the voice band. The four most common call progress tones are:

- Dial tone
- Busy tone
- Audible ringback
- Reorder tone

The VCO/4K generates a full range of call progress tones via Service Platform Cards (SPCs) configured for DTG operation. Call progress tone detection is performed by SPCs configured for call progress analysis (CPA). In addition to the standard tones above, the CPA can be used to detect several other audible signals, including:

- Cessation of ringback
- Presencecessation of voice
- Special Information Tones (SITs)
- Pager cue tones

Collectively, call progress tones and these other audible signals are referred to as call progress events.

Tone Generation

The system generates call progress tones as specified by inpulse and outpulse rule processing and command processing. A full range of single and combination tones is supported; however, only four tones (dial tone, busy tone, audible ringback and reorder tone) are discussed here in detail. Refer to the *Cisco VCO/4K System Administrator's Guide* for complete information about tone generation.

Inpulse Rule Processing

TONE NOW [xx], TONE ENAB [xx], and TONE FDIG [xx] inpulse rule tokens generate call progress tones during rule processing. The system presents the tone specified in the token's data entry field to the incoming port. Fifty-three system tones are available, including all DTMF and MF digits.
TONE NOW [xx], TONE ENAB [xx], and TONE FDIG [xx] values for the four primary call progress tones are shown in Table 4-1.

Table 4-1 Call Progress Tone Values for Inpulse Rules

Tone Value	Tone
3	Dial tone
17	Audible ringback
18	Busy tone
19	Reorder tone

When a TONE NOW token is processed, the port listens to the call progress tone indefinitely unless another TONE NOW token is encountered (such as TONE NOW 1, setting the port to listen to Quiet). Inpulse rule processing immediately continues once tone generation begins, and succeeding tokens (other than another TONE NOW) do not interfere with the tone.

TONE ENAB and TONE FDIG tokens are used in conjunction with MF/DTMF digit collection. When a TONE ENAB token is processed, the port listens to the call progress tone once the MF or DTMF receiver in the call's resource chain is enabled (receivers are enabled when an IP ANI [xx] or IP FIELD [xx] token is encountered). A TONE FDIG token presents a standard system tone to the port when the first digit is detected by a DTMF receiver (useful for going from dial tone to quiet when the user starts dialing). In both cases, inpulse rule processing immediately continues once tone generation begins, and the port listens to the call progress tone indefinitely unless a TONE NOW token is processed.

Command Processing

The Voice Path Control ($66) command can establish a voice path between an incoming or outgoing port and a system tone. System tones are classified as senders, and are designated by port address in the B address bytes in the command. Refer to the Voice Path Control [$66] command section in the *Cisco VCO/4K Standard Programming Reference* or *Cisco VCO/4K Extended Programming Reference.* A complete listing of system tones and their corresponding port addresses is contained in Appendix E of these manuals. Port addresses for the four primary call progress tones are shown in Table 4-2.

Table 4-2 Port Addresses for Primary Call Progress Tones

Port Address	Tone
$04 C2	Dial tone
$04 D0	Audible ringback
$04 D1	Busy tone
$04 D2	Reorder tone

The voice path between the port and system tone remains until a second $66 command tears downs the path or sets the port to listen to another tone. Because the $66 command does not affect call states or linkages, it is not recommended for use in call processing.

Call Progress Analysis

Detection of call progress events over standard system network interface circuits is performed by the SPC's CPA modules. Resource Allocation is controlled by a combination of supervision control outpulse rule tokens and answer supervision templates. Executing an outpulse rule containing a supervision control token can cause a CPA port to monitor the voice path between two ports involved in a call. Based on the configuration of the answer supervision template, the system reports specific call progress events detected during the call.

Tone Detection

Call progress tone generation/detection in the network is generally based on a Precise Tone Plan. In the plan, four distinctive tones are used singly or in combination to produce unique progress tone signals. These tones are 350 Hz, 440 Hz, 480 Hz and 620 Hz. Each call progress tone is defined by the frequencies used and a specific on/off temporal pattern.

The SPC's CPA functions detect four standard call progress tones (dial tone, busy tone, audible ringback, and reorder tone), human voice, Special Information Tones (SITs) and pager cues tones collectively. These signals are known as call progress events. Characteristics for the call progress events are shown in Table 4-3.

Table 4-3 Call Progress Event Characteristics

Name	Frequencies (Hz)	Temporal Pattern	Event Reported After
Dial Tone	350 + 440	Steady tone	Approximately 0.75 seconds
Busy Tone	480 + 620	0.5 seconds on/ 0.5 seconds off	2 cycles of precise, 3 cycles of nonprecise
Audible Ringback: *Detection*	440 + 480	2 seconds on/ 4 seconds off	2 cycles of precise or nonprecise
Audible Ringback: *Cessation*	—	—	3 to 6.5 seconds after ringback detected
Reorder	480 + 620	0.25 seconds on/ 0.25 seconds off	2 cycles of precise, 3 cycles of nonprecise
Voice: *Detection*	200 to 3400	—	Approximately 0.25 to 0.50 seconds
Voice: *Cessation*	—	—	Approximately 0.5 to 1.0 seconds after voice detected
Special Information Tones (SITs)	See Table 4-4.	See Table 4-4.	Approximately 0.25 to 0.75 seconds
Pager Cue Tones	1400	3 to 4 tones at 0.1 to 0.125 intervals	2 cycles of precise or any pattern of 1400-Hz signals

Dial Tone

Dial tone indicates that the CO is ready to accept digits from the subscriber. In the precise tone plan, dial tone consists of 350 Hz plus 440 Hz. The system reports the presence of precise dial tone after approximately 0.75 seconds of steady tone. Nonprecise dial tone is reported after the system detects a burst of raw energy lasting for approximately 3 seconds.

Busy Tone

Busy tone indicates that the called line has been reached but it is engaged in another call. In the precise tone plan, busy tone consists of 480 Hz plus 620 Hz interrupted at 60 ipm (interruptions per minute) with a 0.5 seconds on/0.5 seconds off temporal pattern. The system reports the presence of precise busy tone after approximately two cycles of this pattern. Nonprecise busy tone is reported after three cycles.

Audible Ringback

Audible ringback (ring tone) is returned to the calling party to indicate that the called line has been reached and power ringing has started. In the precise tone plan, audible ringback consists of 440 Hz plus 480 Hz with a 2 seconds on/4 seconds off temporal pattern. The system reports the presence of precise audible ringback after two cycles of this pattern.

Outdated equipment in some areas may produce nonprecise, or dirty ringback. Nonprecise ringback is reported after two cycles of a 1 to 2.5 seconds on, 2.5 to 4.5 seconds off pattern of raw energy.

Note The system may report dirty ringback as voice detection (unless voice detection is ignored in the answer supervision template used). You should determine the quality of the call progress tones produced by connected equipment during the development phase and configure templates accordingly.

The system reports ringback cessation after 3 to 6.5 seconds of silence once ringback has been detected (depending at what point in the ringback cycle the CPA starts listening).

Reorder

Reorder (Fast Busy) tone indicates that the local switching paths to the calling office or equipment serving the customer are busy or that a toll circuit is not available. In the precise tone plan, reorder consists of 480 Hz plus 620 Hz interrupted at 120 ipm (interruptions per minute) with a 0.25 seconds on/0.25 seconds off temporal pattern. The system reports the presence of precise reorder tone after two cycles of this pattern. Nnonprecise reorder tone is reported after three cycles.

Reorder tone is also used by the system to force ports to idle during call disconnect. Disconnect processing is discussed in Chapter 3, “Call Supervision Signaling and Supervision Timing.”

Voice

Voice detection has multiple uses in supervision processing. The CPA can be used to detect voice as an answer condition, and also to detect machine-generated announcements that may indicate an error condition. The system reports the presence of voice after approximately 0.25 to 0.5 seconds of continuous human speech falling within the 200-Hz to 3400-Hz voiceband (although the network only guarantees voice performance between 300 Hz to 800 Hz).

Once voice detection has been reported, the CPA cannot recognize voice again for a 4-second period. Applications requiring multiple instances of voice detection must allow for a 4-second pause between detection attempts.

The system reports voice cessation after approximately 0.5 to 1.0 seconds of silence once the presence of voice has been detected. Applications must also allow for a 4-second pause between voice cessation detection attempts. Because the system responds to such small samples of voice presence/cessation, applications employing voice cessation should be designed to respond to single spoken words or voice prompts.

Special Information Tones

Special Information Tones (SITs) indicate network conditions encountered in both the Local Exchange Carrier (LEC) and Inter-Exchange Carrier (IXC) networks. The tones alert the caller that a machine-generated announcement follows (this announcement describes the network condition). Each SIT consists of a precise three-tone sequence: the first tone is either 913.8 Hz or 985.2 Hz, the second tone is either 1370.6 Hz or 1428.5 Hz, and the third is always 1776.7 Hz. The duration of the first and second tones can be either 274 ms or 380 ms, while the duration of the third remains a constant 380 ms.

The CPA does not distinguish between the four different SITs. Because the first and second tones vary in frequency and duration, the CPA focuses on the third tone for SIT detection. The system reports the presence of a SIT after detecting approximately 0.25 to 0.75 seconds of a 1776.7-Hz signal. The names, descriptions and characteristics of the four most common SITs are summarized in Table 4-4.

Table 4-4 Special Information Tones (SITs)

		First Tone Frequency Duration		Second Tone Frequency Duration		Third Tone Frequency Duration	
Name	**Description**	**(Hz)**	**(ms)**	**(Hz)**	**(ms)**	**(Hz)**	**(ms)**
NC[1]	No circuit found	985.2	380	1428.5	380	1776.7	380
IC	Operator intercept	913.8	274	1370.6	274	1776.7	380
VC	Vacant circuit (nonregistered number)	985.2	380	1370.6	274	1776.7	380
RO[1]	Reorder (system busy)	913.8	274	1428.5	380	1776.7	380

1. Tone frequencies shown indicate conditions that are the responsibility of the BOC intra-LATA carrier. Conditions occuring on inter-LATA carriers generate SITs with different first and second tone frequencies. The system treats both categories (BOC and inter-LATA) of SITs identically.

Pager Cue Tones

Pager cue tones are used by pager terminal equipment to signal callers or connected equipment to enter the callback number (this number is then transmitted to the paged party). Most pager terminal equipment manufacturers use a 3- or 4-tone burst of 1400 Hz at 100- to 125-ms intervals. The system identifies three cycles of 1400 Hz at these approximate intervals as pager cue tones.

To accommodate varying terminal equipment signals, tone bursts of 1400 Hz in a variety of patterns are also reported as pager cue tones. Voice prompts sometimes accompany pager cue tones to provide instructions. Detecting combinations of prompts and tones is performed by configuring an answer supervision template to respond to both voice detection and pager cue tone detection (refer to Chapter 5, "Answer Supervision Template Processing," for additional information on template design).

Allocation and Processing

When an outpulse rule is processed during call processing, the system performs a lookahead at the rule to determine if a CPA port should be allocated to a call. If the outpulse rule includes a WAIT SUP [xx] or FINAL SUP [xx] token, the system examines the answer supervision template specified in the token's additional data entry field. Templates with condition tokens assigned to call progress tone and/or voice events cause a CPA port to be allocated to the call (placed in the call's resource chain). Refer to Chapter 5, “Answer Supervision Template Processing” for more information on supervision control outpulse rule tokens and answer supervision templates.

Command Processing

When an Outgoing Port Control ($69) command is executed that specifies an outpulse rule requiring tone detection, a CPA port is selected from the resource group and allocated to the call when rule processing begins. If no CPA ports are available, the $69 command is returned to the host with a network status byte value of $3A, followed by a Resource Limitation ($D6) report (reported only for the first resource limitation encountered until the condition has been cleared).

Rule Processing

When inpulse rule processing encounters a DO ORULE token, call processing performs a lookahead to determine if a CPA port is required. If so, the CPA port is selected from the resource group and allocated to the call when outpulse rule processing begins. If no CPA ports are available, the inpulse rule is aborted. An Inpulse Rule Complete ($DD) report is generated indicating the rule was aborted because no CPA ports were available, followed by a Resource Limitation ($D6) report (for the first resource limitation encountered until the condition has been cleared).

Enabling CPA Ports

The CPA port is enabled (begins detecting or reporting events) when the WAIT SUP [xx] or FINAL SUP [xx] token is encountered and remains enabled until template processing ends or the calling party goes on-hook. Generally, the CPA is released when outpulse rule processing has ended and the outgoing port is considered to be answered (which may occur immediately after the rule ends as determined by the template processed). If, at the end of the outpulse rule, the port is not considered answered, a FINAL SUP A token is processed automatically. When the port is considered to be answered, the CPA port is released.

System Administration Support

Add SPC cards to the system database using the system administration Card Maintenance menu. This menu can also be used to deactivate/activate each of the CPA ports on the card. When an SPC is added, the system controller assigns the first available contiguous block of port addresses to the card.

As with all other service circuits, all CPA ports must be added to a single resource group to be used for call processing. System administration allows only one resource group to be created for each service circuit type.

A minor alarm condition is set when all CPA ports go out-of-service (No Call Progress Analyzers Present). Additional logfile, printer, and on-screen messages are provided for CPA support. These messages are listed in the *Cisco VCO/4K System Administrator's Guide*.

CPA ports are compatible with the Set Up Path, Card Display, Port Display, Test Service Circuits and Monitor Call Progress Tones diagnostic utilities. When used to set up a voice path, the CPA must be used as a receiver only. The Call Progress Tone Monitor screen allows a CPA port to monitor the call progress tones during an active call, specifying the signaling events detected. Refer to the *Cisco VCO/4K System Administrator's Guide* for instructions on using these menus and utilities.

Application and Template Downloads

To perform call progress tone detection, the SPCs must be configured for CPA operation. For more information concerning this configuration process, refer to the *Cisco VCO/4K Card Technical Descriptions*.

CHAPTER 5

Answer Supervision Template Processing

VCO/4K system administrators control supervision processing by using the VCO/4K master console to configure a combination of supervision control outpulse rule tokens and supervision templates. Outpulse rule tokens invoke either answer (in-band) or ISDN (D-channel signaling) supervision on a port.

Outpulse Rule Token Processing

Five outpulse rule tokens determine supervision control processing: ANS SUP [xx], ISDN SUP [xx], WAIT SUP, FINAL SUP, and TME SUP [xx].

Outpulse rules containing WAIT SUP and FINAL SUP tokens may cause a call progress analyzer (CPA) port to be allocated to the call chain. If the template specified by the outpulse rule token requires detection of in-band call progress tones, a CPA port is allocated to the call at the beginning of rule processing.

The following sections provide detailed processing information for each supervision control outpulse rule token.

ANS SUP [xx]

The ANS SUP [xx] token designates a specific answer supervision template for processing (in-band) answer supervision events. The ANS SUP [xx] token functions as a setup token for subsequent WAIT SUP or FINAL SUP tokens. When the system encounters this token, call processing stores the number of the answer supervision template for later processing. The additional data entry field specifies the supervision template. The value for the additional data entry field can be a number from 1 to 24, or the letters A or W. The letters A or W are used for preconfigured templates for true answer and wink supervision. The ANS SUP [xx] token can be used in conjunction with the ISDN SUP [xx] token to provide concurrent supervision of both in-band and ISDN signaling events.

ISDN SUP [xx]

The ISDN SUP [xx] token designates a specific ISDN supervision template for processing ISDN D-channel signaling events. The ISDN SUP [xx] token functions as a setup token for subsequent WAIT SUP or FINAL SUP tokens. When the system encounters this token, call processing stores the number of the ISDN supervision template for later processing. The additional data entry field specifies the supervision template. The value for the additional data entry field can be a number from 1 to 24. The ISDN SUP [xx] token can be used in conjunction with the ANS SUP [xx] token to provide concurrent supervision of both in-band and ISDN signaling events.

WAIT SUP

The WAIT SUP token invokes intermediate supervision during outpulse rule processing, according to the events in the previously specified template. When this token is executed, outpulse rule processing pauses while answer supervision template processing and/or ISDN supervision template processing begins for the specified templates. If a supervision event is detected that successfully ends template processing (based on template configuration), the WAIT SUP token is satisfied and outpulse rule processing resumes.

If a supervision event is detected that indicates a supervision error or call failure, rule processing is aborted.

The supervision template to be used in WAIT SUP processing is determined by previous ANS SUP [xx] and/or ISDN SUP [xx] tokens. See the “ANS SUP [xx]” section on page 5-1 and the “ISDN SUP [xx]” section on page 5-1.

FINAL SUP

The FINAL SUP token invokes final supervision during outpulse rule processing, according to the events in the previously specified template. When outpulse rule processing ends, final supervision processing begins for the template(s) specified by the preceding ANS SUP [xx] and/or ISDN SUP [xx] tokens. Final supervision processing continues until a supervision event is detected that ends template processing. Resources attached to the call, such as receivers, are released once outpulse rule processing ends. However, if an accompanying ANS SUP [xx] template requires call progress tone detection, a CPA port remains allocated to the call.

TIME SUP [xx]

A TIME SUP [xx] token works in conjunction with ANS SUP [xx], ISDN SUP [xx], WAIT SUP, and FINAL SUP tokens to perform grace or supervision timing. This token should immediately precede a WAIT SUP or FINAL SUP token in an outpulse rule. The additional data entry field of the TIME SUP [xx] token specifies the timer's duration (1 to 60) in seconds. The system response to the timer's expiration is indicated by the Answer Supervision or ISDN Supervision Template identified by the accompanying WAIT SUP or FINAL SUP token. If the timer expires during template processing, the system performs the action specified by the condition token in the template's Time event field.

When a TIME SUP [xx] token is executed, a system timer is set. The timer starts when template processing begins. If the timer expires before another supervision event is detected (one that ends rule processing), the system responds to the expiration as indicated by the condition token assigned to the Time event template field. The TIME SUP [xx] token functions as a grace timer when the condition token specified in the Time field is OK, OKREP, ANSBK or ANSREP. The timer expiration can also indicate a call failure or supervision error (FAIL or ERROR condition token in the Time event field).

Answer Supervision Template Processing

Each answer supervision template is a set of system responses to the detection of specific supervision events. Supervision events include detection of call progress tones such as dial tone, ringback (detection and cessation), busy tone, reorder, special information tones (SITs), and pager cue tones, and the detection of presence or cessation of voice. Wink, hook flash, and true answer signaling events also fall under the category of supervision events.

Using the templates, system administrators can indicate which supervision events may be detected during call processing. Condition tokens assigned to each event in a template specify the system's response when a particular event is detected. Call processing applies the templates when it waits for intermediate and final supervision. When a supervision event is detected, the system references the template and performs the action specified by the condition token assigned to the event's field. When the system responds to the event, the supervision control outpulse rule token is satisfied and rule processing continues.

Eight condition tokens specify individual system responses (or combinations of responses) to a supervision event. Condition tokens are specified for each signaling event to be detected. Events not assigned condition tokens (set to the IGNORE token) are disregarded during template processing. Events marked with condition tokens that end template processing satisfy a WAIT SUP or FINAL SUP outpulse rule token when detected. Only events marked with a REP condition token fail to end template processing. Processing continues until an event marked with one of the seven other condition tokens is detected or a supervision/grace timer expires (TIME SUP [xx] token in the outpulse rule).

Condition Tokens

One of eight condition tokens can be assigned to each supervision event in each template. The same condition token can be assigned to as many events as required. For example, in a particular call scenario, the detection of busy tone, reorder tone, and SITs may indicate a call failure. A FAIL token can be assigned to the event field for all three of these call progress tones.

Condition tokens are discussed below in functional order. Combination tokens such as OKREP and ANSREP are paired with the tokens OK and ANSBK, respectively. Each subsection describes the token's affect on template processing and report generation, and provides general usage guidelines.

REP

Supervision events marked with REP tokens are reported to the host when detected but do not end template processing. An Outgoing Port Change of State ($DA) or Incoming Port Change of State ($DB) report is generated containing one of two Change byte codes (10 or 80) and the appropriate Answer Supervision code for the event. Template processing continues until an event marked with another type of condition token is detected. REP tokens function the same for both intermediate and final supervision.

Events assigned REP tokens can be used to inform the host of a call's progress without interfering with outpulse rule processing. For example, REP tokens can signal the host when to begin billing for services such as voice mail. REP tokens are also useful in experimental answer supervision templates to determine the supervision events that may be encountered in a particular call scenario and the order in which they occur.

OK and OKREP

Supervision events marked with OK tokens end template processing when detected but are not reported to the host. When the event is detected during intermediate supervision, the WAIT SUP outpulse rule token is satisfied and rule processing continues. When the event is detected during final supervision (after an outpulse rule containing a FINAL SUP setup token), template processing ends. However, the port is only considered answered if the OK token was assigned to the Answer event field.

Events assigned OK tokens require detection for outpulse rule processing to continue, but do not need to be reported to the host (reducing host link traffic). This condition token is commonly assigned to events such as dial tone in intermediate supervision templates (called by a WAIT SUP outpulse rule token). The event must be detected before outpulsing digits, for example.

Events assigned OKREP tokens are handled similarly to OK tokens, but also generate a report to the host.

ANSBK and ANSREP

Supervision events marked with ANSBK tokens end template processing when detected and cause the system to answer back over the incoming port (assuming it has not already been answered). No report is sent to the host when the event occurs. When the event is detected and answerback sent, a WAIT SUP outpulse rule token is satisfied and rule processing continues. Because the outgoing port is considered answered when answerback is sent, the call automatically goes to stable state when outpulse rule processing completes (unless a FINAL SUP token is specified).

Events assigned ANSBK tokens may serve as both intermediate and final supervision. When ANSBK tokens are used in a template called by a WAIT SUP outpulse rule token, a FINAL SUP token is not necessary (assuming the WAIT SUP can only be satisfied by an event assigned ANSBK or ANSREP). ANSBK tokens can be assigned to the Time event field for grace timing during supervision processing. Because answerback signals initiate billing during network calls, ANSBK tokens should be assigned carefully.

Events assigned ANSREP tokens are handled similarly to ANSBK tokens, but also generate a report to the host.

ERROR

Specifies that the signaling event should be treated as a supervision error and causes a rehunt for another outgoing port if the outgoing resource group is configured for rehunting. The error count for the outgoing port is incremented, and an Outgoing Port Change of State ($DA) report is generated indicating a supervision error and status of rehunt. Template processing ends and the outpulse rule is aborted. The incoming port is left in CP_SETUP state if no rehunt is performed. If a rehunt is performed successfully, outpulse rule processing starts again on the new outgoing port.

Note The rehunt threshold assigned to the outgoing resource group may affect call processing if multiple supervision errors are detected during a call attempt. If the number of supervision errors exceeds the rehunt threshold, the system considers the call attempt as failed (call failures are discussed in the “FAIL” section on page 5-5). Rehunt thresholds are set via the Smart Console.

ERROR events should be assigned to supervision events that are unexpected during supervision processing but are not fatal. For example, assigning an ERROR token to Reorder tone manages situations where the system encounters a bad trunk circuit. If the outgoing resource group is configured for rehunting, another trunk circuit is selected and the call continues without host intervention.

FAIL

Specifies that the signaling event indicates a failed call. The outgoing port is removed from the call (no rehunt performed) and the incoming port is left in setup. An Outgoing Port Change of State ($DA) report is generated indicating a failed call attempt. Template processing ends when the event is detected and the outpulse rule is aborted. FAIL events indicate that the call cannot be completed regardless of whether another outgoing port is selected. FAIL tokens are frequently assigned to busy tone, SITs (identifying an invalid dialed number or a number that requires a 1 for long-distance service, for example) and supervision timing (ring/no answer.)

QUIT

Specifies that the signaling event causes outpulse rule processing to abort. Template processing ends, and the outgoing port returns to the state it was in prior to outpulse rule processing (CP_IDLE, CP_ATT, CP_SETUP or CP_STAB) but is not removed from the call. An Outgoing Port Change of State ($DA) report is generated, indicating an outpulse rule failure. The QUIT condition can occur any time during outpulse rule processing, even after the port is considered answered. QUIT tokens are similar to FAIL tokens, but differ in that the call retains the outgoing port when the token is processed. These tokens are designed especially for use in conjunction with supervision timers that begin after a call becomes stable.

Preconfigured Templates

In addition to the 24 configurable templates, three preconfigured templates exist for simple wink and answer supervision scenarios that do not require call progress tone detection. When used with WAIT SUP tokens, these templates wait for wink and true answer (respectively) during intermediate supervision. When used with a FINAL SUP outpulse rule token, the true answer template waits for true answer during final supervision. The supervision events and system responses for the three templates are shown in Table 5-1.

Table 5-1 Preconfigured Template Settings

Outpulse Rule Token	Event	Condition Token
ANS SUP W / WAIT SUP	Wink	OK
	Answer	ERROR
	Time	ERROR
ANS SUP A / WAIT SUP	Wink	ERROR
	Answer	ANSBK
	Time	ERROR
ANS SUP A / FINAL SUP	Wink	ERROR
	Answer	ANSREP
	Time	ANSREP

ANS SUP W is satisfied when a wink signal is detected, and treats the detection of true answer or the expiration of the supervision timer as supervision errors. ANS SUP A sends answerback when true answer is detected and treats the detection of a wink or the timer expiration as supervision errors. Both of the preconfigured templates require a specific supervision event for rule processing to continue. The ANS SUP A / FINAL SUP combination, however, reacts to either the detection of true answer or the expiration of a grace timer by sending answerback over the incoming port. A wink detected during this template processing indicates a supervision error.

Note Because answerback signals usually initiate billing, carefully consider when answerback should be sent during a call. If the answerback configuration of the ANS SUP A / FINAL SUP combination is not appropriate for a particular application, you must create and specify another template for final supervision.

Preconfigured templates are not displayed and cannot be changed or deleted by system administration. The other eight signaling events (dial tone, ringback, etc.) are not detected when a preconfigured template is used. No CPA is required to process these templates. A TIME SUP [xx] token must precede a preconfigured outpulse rule token in the rule for the timer expiration response (condition token in the Time event field) to be performed.

Supervision Event Reporting

Event reporting during answer supervision template processing is controlled by the condition token assigned to the event. Events marked with REP, OKREP, ANSREP, ERROR, FAIL and QUIT tokens generate host reports when detected. No reports are produced when events marked with OK or ANSBK are detected. Supervision processing information is distributed over four bytes in the Outgoing Port Change of State ($DA) and Incoming Port Change of State ($DB) reports. For more information on system commands and reports, refer to the *Cisco VCO/4K Extended Programming Reference.*

ISDN Supervision Template Processing

ISDN Supervision Templates are used to define a set of system responses to the detection of specific ISDN messages, such as ALERTING, CONNECT, PROGRESS, and CALL PROC (call proceeding).

ISDN condition tokens specify individual system responses to these messages, or events. These responses include reporting, propagation of the message to the incoming port, call failure, or error condition reporting.

ISDN calls are not marked stable when a template is executed unless the template has been designed for this purpose. The receipt of a CONNECT message causes the state of the port to go stable.

After the end of an outpulse rule and before receipt of a CONNECT message, the system reports all received D-channel messages to the host as supervision outside an outpulse rule (change byte = $08) in an ISDN Port Change of State ($EA) report. When the system receives an ISDN CONNECT message, the call is considered answered and changes to stable. The ISDN CONNECT message is also propagated back to the incoming port if the incoming port is not considered answered.

Condition Tokens

Ten condition tokens specify individual system responses, and combinations of responses, to a signaling event. Condition tokens also use the detection of the event as an indicator of error conditions and failed calls. Condition tokens are defined for each signaling event; events are disregarded when no token is defined for the event.

OK

Indicates that an event was detected during processing of the ISDN SUP [xx] outpulse rule token. The event is not reported to the host when it occurs. When the event is detected, the ISDN SUP [xx] token is satisfied and template processing ends. Outpulse rule processing continues with the token following the ISDN SUP [xx] until the rule completes or the call goes to stable state.

OKREP

Indicates that an event was detected during processing of the ISDN SUP [xx] outpulse rule token. An ISDN Port Change of State ($EA) report to the host is generated. When the event is detected, the ISDN SUP [xx] outpulse rule token is satisfied and template processing ends. Outpulse rule processing continues with the token following the ISDN SUP [xx] token until the rule completes or the call goes to stable state.

ANSBK

Valid only for the CONNECT event. Indicates that a CONNECT event was detected during processing of the ISDN SUP [xx] outpulse rule token and that answerback was sent to the incoming port (assuming it has not already been answered). The event is not reported to the host when it occurs. When the event is detected and answerback sent, the ISDN SUP [xx] outpulse rule token is satisfied and template processing ends. Outpulse rule processing continues with the token following the ISDN SUP [xx] token until the rule completes or the call goes to stable state. Because the outgoing port is considered answered when answer back is sent, the call automatically goes to stable state when outpulse rule processing completes. For ISDN-to-ISDN calls, answerback takes the form of a CONNECT event message generated for the incoming call. Use of this token provides the correct answer supervision of non-ISDN incoming calls.

ANSREP

Valid only for the CONNECT event. Indicates that the system detected a CONNECT event during processing of the ISDN SUP [xx] outpulse rule token and sent answerback to the incoming port (assuming it has not already been answered).

The system generates an ISDN Port Change of State ($EA) report to the host. When the event is detected and answerback sent, the ISDN SUP [xx] outpulse rule token is satisfied and template processing ends. Outpulse rule processing continues with the token following the ISDN SUP [xx] token until the rule completes, or the call goes to stable state. Because the outgoing port is considered answered when answerback is sent, the call automatically goes to stable state when outpulse rule processing completes. For ISDN-to-ISDN calls, answerback takes the form of a CONNECT event message generated for the incoming call.

Use of this token provides the correct answer supervision for non-ISDN incoming calls.

REP

Indicates that an event will be reported to the host when detected. An ISDN Port Change of State ($EA) report is generated containing the event indicator. Events marked with REP condition tokens do not satisfy an ISDN SUP [xx] outpulse rule token; template processing continues until an event marked with another type of condition token is detected.

ERROR and FAIL

Indicates that a signaling event has detected a failed call. The event is not considered a supervision error. The outgoing port is removed from the call and the incoming port is left in setup. The system generates an ISDN Port Change of State ($EA) report, indicating a failed call attempt. Template processing ends when the event is detected and the outpulse rule is aborted.

QUIT

Used to indicate that an event caused outpulse rule processing to abort. Template processing ends and the outgoing port returns to the state it was in prior to outpulse rule processing, but is not removed from the call. An ISDN Port Change of State ($EA) report is generated, indicating an outpulse rule failure. The QUIT condition token event can occur at any time during outpulse rule processing, even after the port is considered answered.

Designing Answer Supervision Templates

This section provides general usage guidelines and suggestions for designing answer supervision templates. These guidelines supply a basic approach for designing new supervision templates. Once an initial set of templates is created, you can easily modify templates to meet changing application requirements.

General Guidelines

Before designing answer supervision templates, you should first determine the supervision requirements of their application. These requirements are defined by the following:

- Equipment interfaces—Each piece of equipment in a switched connection (and the lines/trunks connecting them) can have different supervision capabilities. Out-of-band signaling between connected equipment reflects the protocol used. In-band signaling requires tone generators and receivers throughout the connection.
- Call signaling sequence—Supervision signals are used to set up and acknowledge other call processing actions (such as digit collections). Certain supervision signals normally occur in the early stages of a call attempt, while others indicate answer supervision used to complete the call. You should examine the necessary sequence of supervision signaling, and understand how these signals interact with other call processing actions.
- Billing considerations—In the public switched telephone network, answerback signals are normally used to initiate billing. The flexibility of supervision template processing provides developers with the ability to generate answerback at any point during a call. In addition, the detection of any supervision event (not just true answer) can generate answerback. Application developers and system administrators should clearly identify at which point in the call billing begins.

- Error handling—Supervision signals provide an early indication that a call will not succeed due to an error condition. You can link the detection of supervision events to system actions and can work around error conditions as needed.

Other considerations may also influence template design. You can use flowchart and reference table techniques in the early development stages. Flowcharts identify the sequence of supervision signals the system must generate and detect in specific call scenarios. Reference tables can be applied to resource tracking to indicate the network interfaces, service circuits, and other resources involved in a call scenario. Designers can compare the resources against the supervision signaling sequence to determine if the resource's generation and detection capabilities correctly match the signaling requirements.

For each call scenario, supervision events can be functionally grouped into three general categories:

- Expected supervision events processed autonomously by the system
- Expected supervision events that may cause host action
- Unexpected supervision events

You should first assign condition tokens to expected supervision events, signals that normally occur during a successful call attempt. The detection of an expected event allows call processing to continue, or in the case of final supervision, to create a stable call. Expected events may also trigger billing for the call. Two condition tokens, OK and ANSBK, control autonomous system processing of expected supervision events.

Autonomous Expected Events

OK tokens are best used in conjunction with intermediate supervision processing. When an event marked with an OK token is detected, supervision processing completes and call processing continues. No signaling is generated and the event is not reported to the host. OK tokens should be assigned to events that indicate an intermediate step in the completion of the call, such as detecting a wink or dial tone before outpulsing digits. OK tokens may also be used for final supervision. In a template used for final supervision, if an OK token is assigned to true answer, supervision processing ends and the system establishes a stable call.

ANSBK condition tokens perform two functions. When an event assigned an ANSBK token is detected, the system responds by:

- Generating answerback over the incoming port (the equivalent of executing an ANSWER inpulse rule token)
- Establishing a stable call

ANSBK tokens should be applied to templates used for final supervision processing. When assigned to true answer, ANSBK tokens can propagate answer supervision back to the near end service providers which often start billing the calling party when the near-end CO detects answerback. The detection of any supervision event, however, can generate answerback. By assigning ANSBK to Voice and ignoring true answer, for example, answerback is sent only when the far end goes off hook and voice is heard. You should consider two key factors before assigning ANSBK tokens:

- Interface and protocol requirements—Certain trunk interfaces require answer supervision before supervision signaling can take place for electrical reasons. The system may have to answer an incoming circuit of this type before seizing outward on another circuit. Designers should understand the limitations and requirements of the interfaces and protocols involved regarding answerback.
- Inappropriate answerback—In certain call scenarios, connected equipment may have already sent answerback to the near end before the call comes into the system. Also, some applications (such as operator services) do not require billing. In both of these cases, answerback should not be generated.

When an ANSBK token is assigned to the Time (timer expiration) field, the system performs grace timing on the outgoing port.

Events Causing Host Action

The detection of expected supervision events can also cause host action. REP, OKREP and ANSREP condition tokens generate reports, alerting the host of the supervision event detected and the system's response to the event. The host can either react to these reports by issuing additional commands affecting call processing or by simply recording this information for billing or tracking purposes. OKREP and ANSREP tokens perform the same actions as OK and ANSBK (respectively) while also producing a host report. REP tokens by themselves do not affect call processing, although the host may alter call handling based on their reports.

During the early stages of template design, you may assign REP tokens to various supervision events in a template and then apply the template to many experimental call scenarios. This test approach identifies possible occurrences of supervision events and also allows developers to test the report parsing functions of their host application.

The information contained in reports can allow the host to effectively direct the system when exception conditions occur. For example, assume the system detects a set of supervision events out of their expected sequence. The system may simply report the events without being aware that an error or exception condition has occurred. The host, however, can be programmed to anticipate the events in their proper order. When the host receives a report for an unexpected event, it can immediately identify the exception condition and issue commands to manage the situation. By placing this intelligence into their host, you can implement effective exception handling in their applications.

Unexpected Supervision Events

Two tokens, ERROR and FAIL, manage supervision error and call failure conditions. QUIT tokens control supervision processing when exception conditions occur.

ERROR tokens indicate that an error in the outgoing facility is preventing normal call processing. The system, however, can recover from this condition and normal processing can continue. ERROR tokens should be used for error cases that indicate problems with the specific line or trunk being used. For example, the detection of reorder tone may indicate a malfunctioning circuit. In this situation, an ERROR token assigned to reorder causes the system to abort the rule, rehunt another outgoing port (if the resource group is configured for rehunting) and retry outpulse rule and supervision processing on another circuit in order to complete the call. When assigned to the time (timer expiration) event, ERROR tokens control supervision error timing. ERROR tokens are useful in both intermediate and final supervision templates.

FAIL tokens manage more critical errors, applying to situations when call processing simply cannot complete. Unlike ERROR tokens, FAIL tokens do not cause a rehunt for another outgoing port. The most common assignment for FAIL tokens is busy tone processing when the call attempt fails because the far end is already engaged in another connection. Special Information Tones (SITs), indicating network conditions causing call failures, are also candidates for a FAIL token. These tones can indicate incorrect or invalid calling numbers, among other conditions. FAIL tokens used with supervision timers can limit the period the system waits for expected supervision events. For example, instead of waiting indefinitely for true answer, the system declares a call failure if the far end does not go off-hook within a specified period. FAIL tokens apply equally well to both intermediate and final supervision templates processing.

QUIT tokens are assigned to exception conditions; these conditions require host action but fall outside the boundaries of expected events, supervision errors, or call failures. QUIT tokens are designed especially for use in conjunction with supervision timing during intermediate supervision. When a supervision event assigned a QUIT token is detected, outpulse rule processing aborts as it does for ERROR and FAIL events but the outgoing port remains in the state it was in prior to rule processing. This allows the host to assume control of the call by issuing commands that start another outpulse rule, play voice prompts, or perform other functions.

Nonactive Template Fields

Event fields without specific action requirements use the IGNORE token. These fields represent one of two cases:

- Expected but unimportant supervision events
- Events that are inapplicable to the call scenario

Certain supervision events may occur during a call scenario without affecting call processing or providing significant information. Likewise, event fields for signals with no likelihood of occurring should also be set to IGNORE.

To optimize CPA processing performance, do not assign condition tokens to supervision events that will not occur during call processing, or those that do not affect call handling in any way. For example, assigning REP tokens to all template fields (other than for debugging or test purposes), including fields for events that will not occur or are insignificant, creates unnecessary host report processing overhead, lessens CPA efficiency, and can cause a CPA resource to be unnecessarily allocated to the call.

Outpulse Rule and Supervision Template Interaction

This section describes a simple call processing scenario. During call processing, an outpulse rule containing supervision control tokens for both intermediate supervision and final supervision is executed. This outpulse rule tokens and parameters are as follows:

- ANS SUP [xx] 1
- WAIT SUP
- OP DTMF
- OP FIELD [xx] 1
- TIME SUP [xx] 30
- ANS SUP [xx] 2
- FINAL SUP

At the start of rule processing, the system allocates an outpulse channel and a CPA port to the call's resource chain. When the WAIT SUP token is executed, the system compares signaling events detected by the CPA against the answer supervision template specified in the preceding ANS SUP [xx] token, in this case template #1 (see Table 5-2).

According to template #1, the expected intermediate supervision event is dial tone. When the CPA detects dial tone, the WAIT SUP token is satisfied and outpulse rule processing continues with the OP DTMF token. If busy, reorder or SIT tones are detected, the call is marked as a failed attempt and the outpulse rule is aborted. The detection of wink or true answer indicates a supervision error. The outpulse rule is aborted and a rehunt begins if the outgoing resource group is configured for rehunting. The detection of any other signaling events (ringback, voice, etc.) has no effect on call processing. No supervision timing is performed.

Assuming dial tone was detected, outpulse rule processing continues. The DTMF digits stored in digit field 1 are outpulsed (refer to the outpulse rule tokens and parameters listed above), and outpulse rule processing ends. The TIME SUP 30 token starts a 30-second grace timer when the FINAL SUP token is executed. Final supervision events are compared against answer supervision template #2 (see Table 5-3).

Template #2 supports a ring/no answer scenario with grace timing. If ringback is detected during the wait for final supervision, it is reported to the host but the FINAL SUP token is not satisfied. If busy tone or SIT tones are detected, the call is marked as a failed attempt and the outpulse rule is aborted. The detection of reorder tone or a wink indicates a supervision error; the outpulse rule is aborted and a rehunt begins if the outgoing resource group is configured for rehunting.

If ringback cessation or true answer is detected, the event is reported to the host and answerback is sent over the incoming port and the FINAL SUP token is satisfied. If the 30-second supervision timer expires before any other signaling events are detected, the port is answered back, a report is sent to the host, and the ports are set to stable state. Dial tone, voice detection/cessation, hook flash, and pager cue tone detection have no effect on call processing when answer supervision template #2 is used.

Table 5-2 Sample Answer Supervision Template #1

Template Field	Condition Token
Dial Tone	OK
Ring Back	IGNORE
Busy	FAIL
Reorder	FAIL
SIT Tones	FAIL
Ring Cess.	IGNORE
Voice Det.	IGNORE
Voice Cess.	IGNORE
Wink	ERR
Answer	ERR
Time	IGNORE
Hookflash	IGNORE
Pager Cue	IGNORE
ISUP Tone	IGNORE
ISUP Cess.	IGNORE

Table 5-3 Sample Answer Supervision Template #2

Template Field	Condition Token
Dial Tone	OK
Ring Back	REP
Busy	FAIL

Table 5-3 Sample Answer Supervision Template #2 (continued)

Template Field	Condition Token
Reorder	ERR
SIT Tones	FAIL
Ring Cess.	ANSREP
Voice Det.	IGNORE
Voice Cess.	IGNORE
Wink	ERR
Answer	ANSREP
Time	ANSREP
Hookflash	IGNORE
Pager Cue	IGNORE
ISUP Tone	IGNORE
ISUP Cess.	IGNORE

Call Examples

This chapter presents call processing examples that illustrate the interaction of inpulse and outpulse rules, answer supervision templates, and host commands/reports for a variety of applications. Each example begins with a brief explanation of the scenario, followed by a graphic representation of the call flow. These diagrams provide information on system processing and information flow between the system and host, and the system and connected equipment. Direction of information flow is indicated by an arrow under the message data. In situations involving supervision signaling over both incoming and outgoing ports, the diagrams indicate which piece of connected equipment is generating/receiving the signals by specifying incoming or outgoing in the connected equipment column.

Note All of the following examples are constructed for the VCO/4K Standard Programming Mode. For more information about the VCO/4K Extended Programming Mode, refer to the *Cisco VCO/4K Extended Programming Reference*.

The resources used in these examples are summarized in Table 6-1.

Table 6-1 Resource Allocation for Call Examples

Port Type	Port Address Individual or Card Range	Resource Group		Class of Service (COS)	Default Inpulse Rule	Connected Equipment
		Number	Rehunt?			
ICC T1 I/O	$00 12 to $00 2A	11	—	T	1	Central Office
ICC T1 I/O	$00 34 to $00 4B	3	No	O	—	Central Office
ICC T1 I/O	$00 42 to $00 5A	2	Yes	O	—	Central Office
ICC T1 I/O	$00 8F	1	Yes	—	—	—
SPC CPA	$00 C5	8	Yes	—	—	—
Virtual	$80 01	$FE	—	—	—	—

Additional system configuration information, including inpulse rules, outpulse rules, and answer supervision templates used in each scenario, accompanies the text explanation.

Note These examples assume the Enable Digit Field Reporting feature flag is set to Y. This setting causes the digit field number to appear in the Optional Field Designator (byte offset 12) in all MF Digit ($D0) and DTMF Digit ($D1) reports.

Incoming Supervision

The example in this section illustrates a simple supervision signaling and digit collection scenario after an incoming seize on the trunk circuit at port address $00 13. This example involves both an MF collection (signaling information between COs, such as ANI) and DTMF collection (destination digits). A wink signal when the MF receiver is enabled alerts the near-end CO to send the MF digits. The system generates a dial tone after the DTMF receiver is enabled, prompting the calling party to dial the destination digits.

At the end of this example, the incoming call remains in setup state awaiting further host action. The default inpulse rule, rule #1, tokens and parameter values are as follows:

- REP EACH
- MF
- WINK ENAB
- IP ANI 7
- DTMF
- TONE ENAB
- DIGITS 10
- IP FIELD 1

The processing flow for this example is illustrated in Figure 6-1 and Figure 6-2.

Figure 6-1 Processing Flow for Incoming Supervision Example (Part 1 of 2)

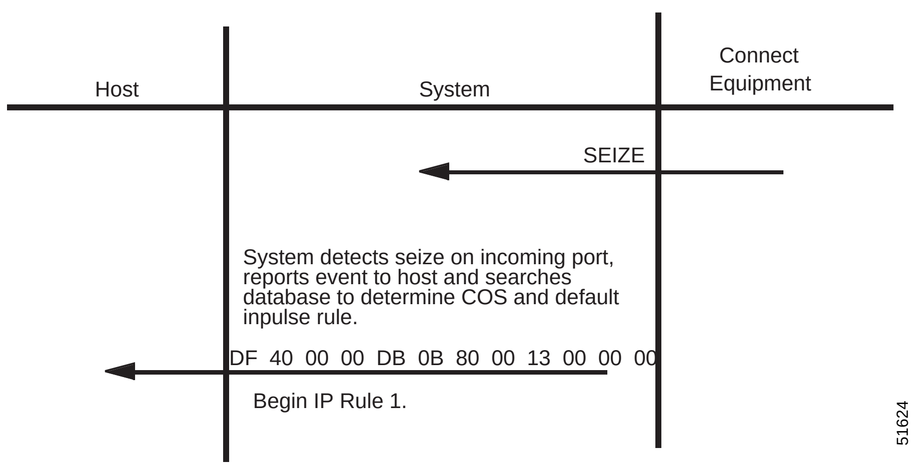
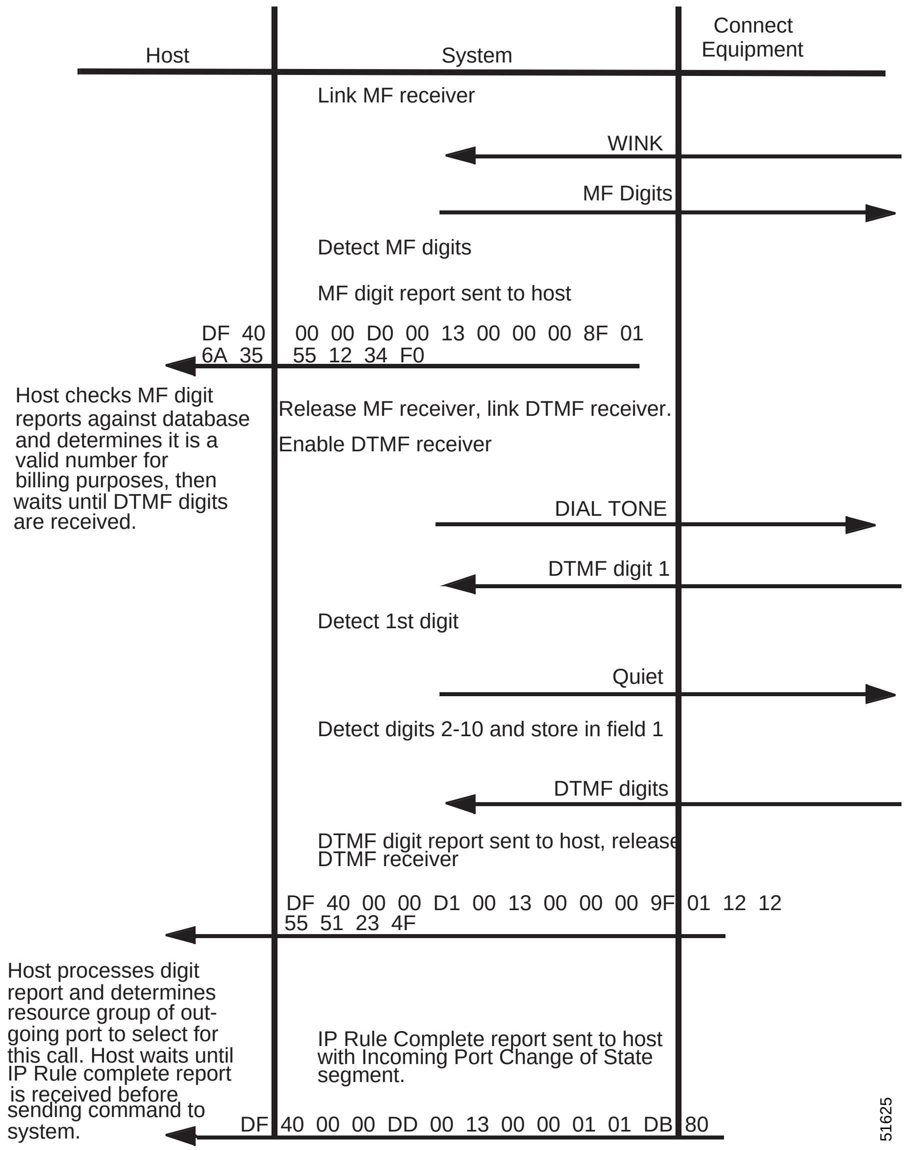


Figure 6-2 Processing Flow for Incoming Supervision Example (Part 2 of 2)



Supervision Timing

This section includes three variations of supervision timing: supervision error, call failure, and grace timing. The outpulse rules used in each scenario contain TIME SUP [xx] tokens which start supervision timers at the beginning of template processing.

Supervision Error Timing

The example in this section illustrates supervision error timing during intermediate supervision. Assume the system has processed an incoming seizure at port address $00 12 and performed a DTMF digit collection. Based on an Outgoing Port Control ($69) host command, the system hunts an outgoing port ($00 42) from Resource Group 2.

The expected supervision event for intermediate supervision is dial tone. (See answer supervision template #1 in Table 6-2.) The system waits 5 seconds to detect a dial tone before a timer expires. The expiration of the timer indicates a supervision error and causes a rehunt for another outgoing trunk. When the system successfully rehunts another outgoing port ($00 43) and detects a dial tone, the system outpulses the DTMF digits stored in Digit Field #1. Because no FINAL SUP token was specified in the rule and answerback was not generated during intermediate supervision processing, the system automatically processes an ANS SUP A / FINAL SUP template after rule processing completes.The command specifies to use outpulse rule #1, described as follows:

- SEIZE
- TIME SUP 5
- ANS SUP 1
- WAIT SUP
- OP DTMF
- OP FIELD 1

Table 6-2 Answer Supervision Template #1

Template Field	Condition Token
Dial Tone	OK
Ringback	—
Busy	FAIL
Reorder	FAIL
SIT Tones	FAIL
Ring Cess.	—
Voice Det.	—
Voice Cess.	—
Wink	ERROR
Answer	ERROR
Time	ERROR
Hookflash	—
Pager Queue	—

The processing flow for this example is illustrated in Figure 6-3 and Figure 6-4.

Figure 6-3 Processing Flow for Supervision Error Timing Example (Part 1 of 2)

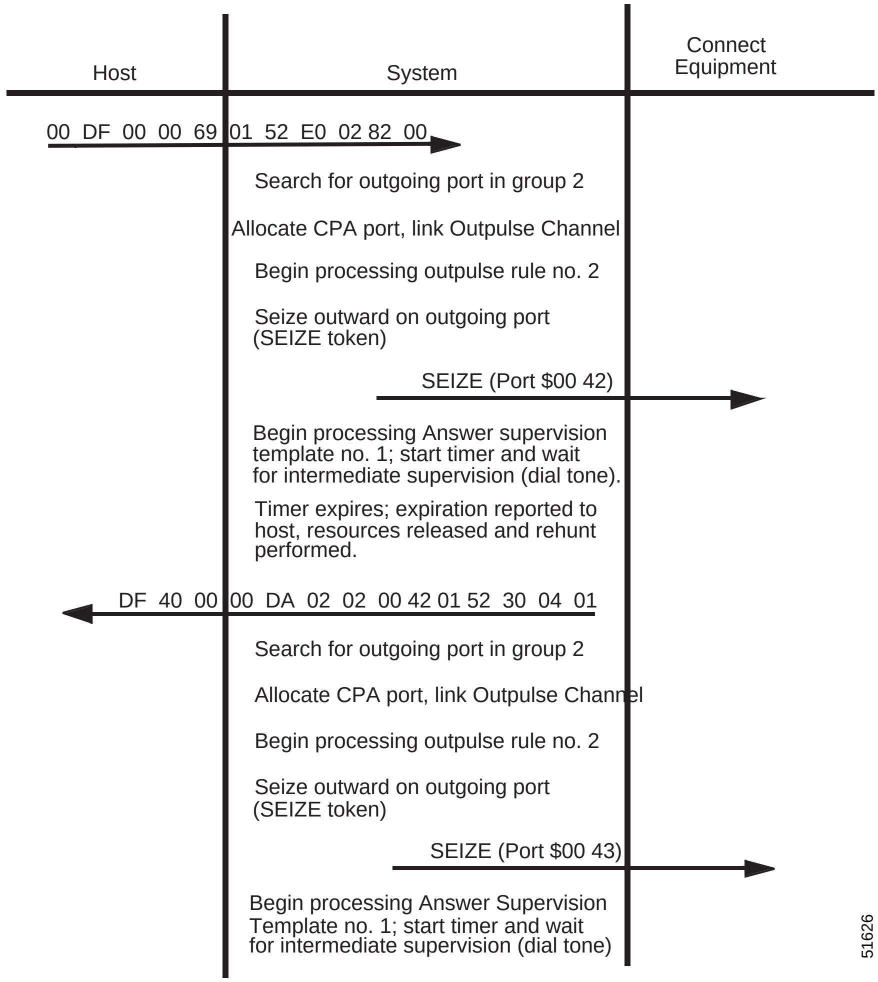
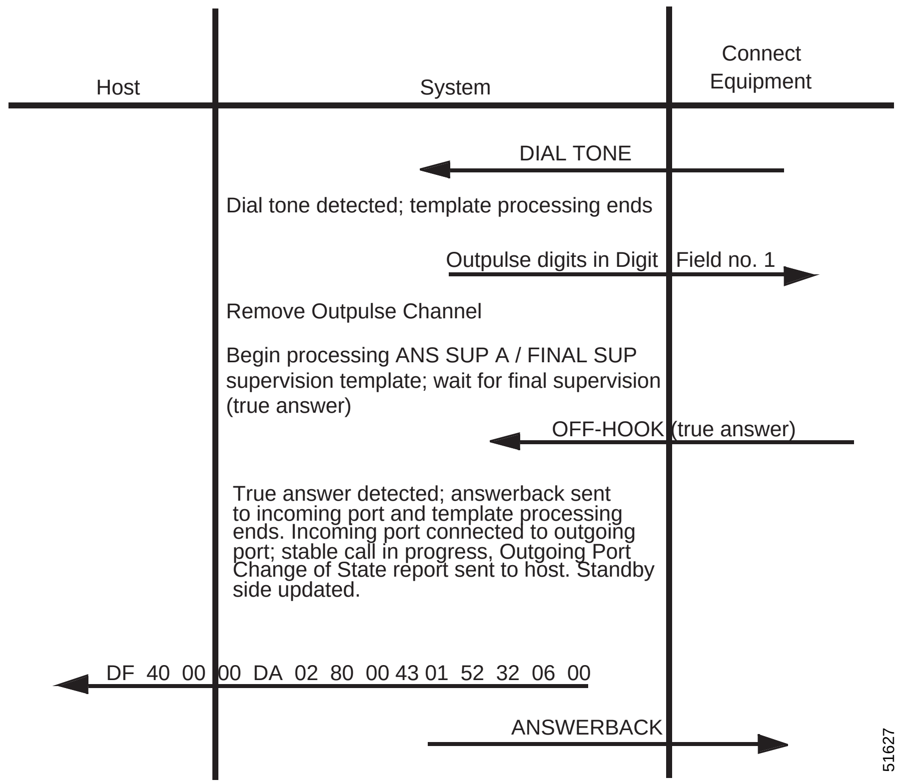


Figure 6-4 Processing Flow for Supervision Error Timing Example (Part 2 of 2)



Call Failure (Ring/No Answer)

The example in this section presents a situation when a timer expiration indicates a call failure. Assume the system has processed an incoming seizure at port address $00 12 and performed a DTMF digit collection. Based on an Outgoing Port Control ($69) host command, the system hunts an outgoing port ($00 35) from Resource Group 3.

The system seizes out on the outgoing port and waits for dial tone (answer supervision template #1). When the system detects dial tone, it outpulses the DTMF digits stored in Digit Field #1. Outpulse rule processing ends and final supervision processing begins. A 24-second timer runs while the system waits to detect true answer (answer supervision template #3—seeTable 6-3). The system detects audible ringback and reports it to the host. If the call is not answered after 4 or 5 rings (depending at what point in the ringback cycle the timer began), the timer expires and the call fails.

The command uses outpulse rule #2, described as follows:

- SEIZE
- ANS SUP 1
- WAIT SUP
- OP DTMF
- OP FIELD 1
- TIME SUP 24
- ANS SUP 2

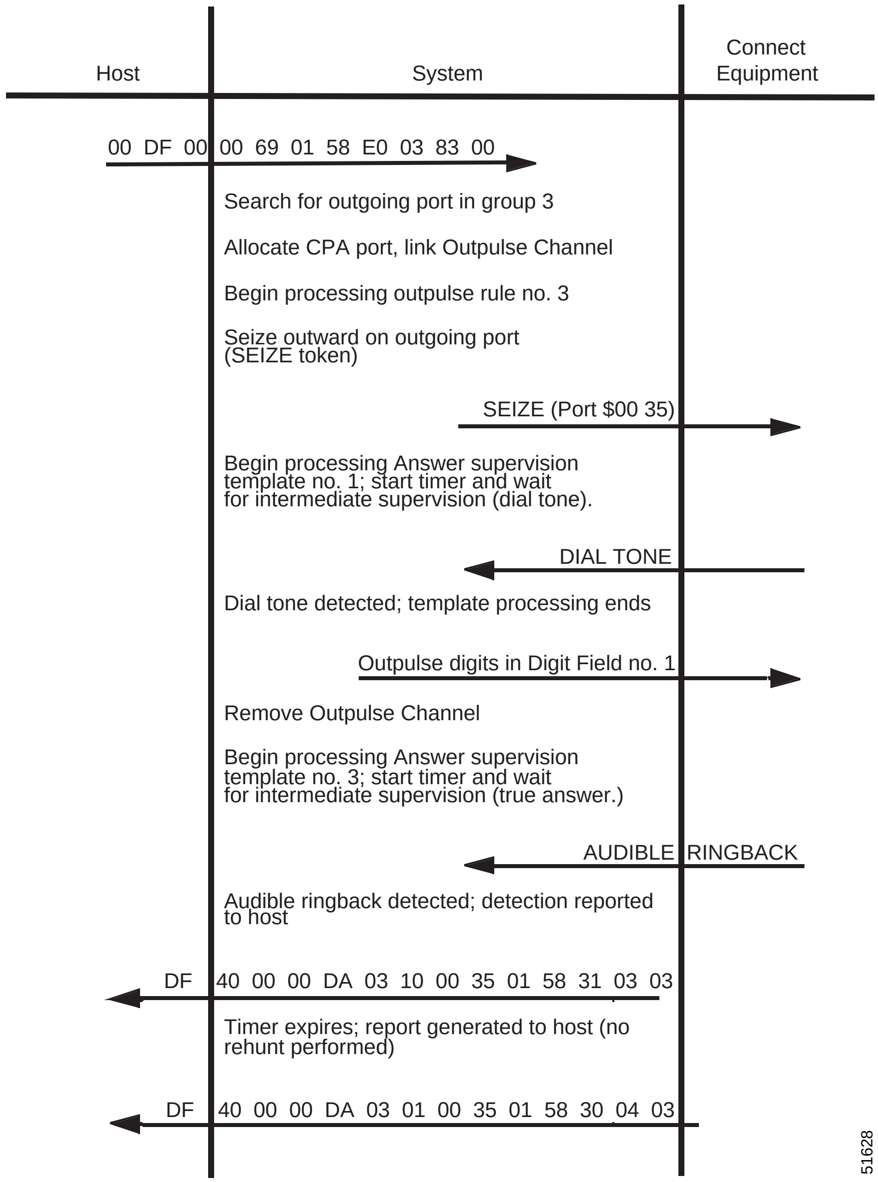
- FINAL SUP

Table 6-3 Answer Supervision Template #3

Template Field	Condition Token
Dial Tone	—
Ringback	REP
Busy	FAIL
Reorder	ERROR
SIT Tones	FAIL
Ring Cess.	—
Voice Det.	—
Voice Cess.	—
Wink	—
Answer	ANSREP
Time	FAIL
Hookflash	—
Pager Queue	—

The processing flow for this example is illustrated in Figure 6-5.

Figure 6-5 Processing Flow for Call Failure (Ring/No Answer) Example



Grace Timing

The example in this section illustrates the use of grace timing. Grace timers provide time for a supervision event to occur when the timer expires; the system assumes the event occurred (even if no event was detected) and acts accordingly.

For this scenario, assume the system has processed an incoming seizure at port address $00 12 and performed a DTMF digit collection. Based on an Outgoing Port Control ($69) host command, the system hunts an outgoing port ($00 34) from Resource Group 3.

The system seizes out on the outgoing port and waits for a wink signal (answer supervision template #3—see Table 6-3). When the system detects the wink (indicating that the far-end equipment is ready to receive digits), it outpulses the DTMF digits stored in Digit Field #1. Outpulse rule processing ends and final supervision processing begins. An 18-second timer runs while the system waits to detect true answer (answer supervision template #4—see Table 6-4). If either true answer is detected or the grace timer expires, the system considers the port answered and assumes the incoming and outgoing ports are involved in a stable call (regardless of the on-hook/off-hook status of the ports). The detection of either supervision event generates answerback over the incoming port.

The command specifies to use outpulse rule #3, described below:

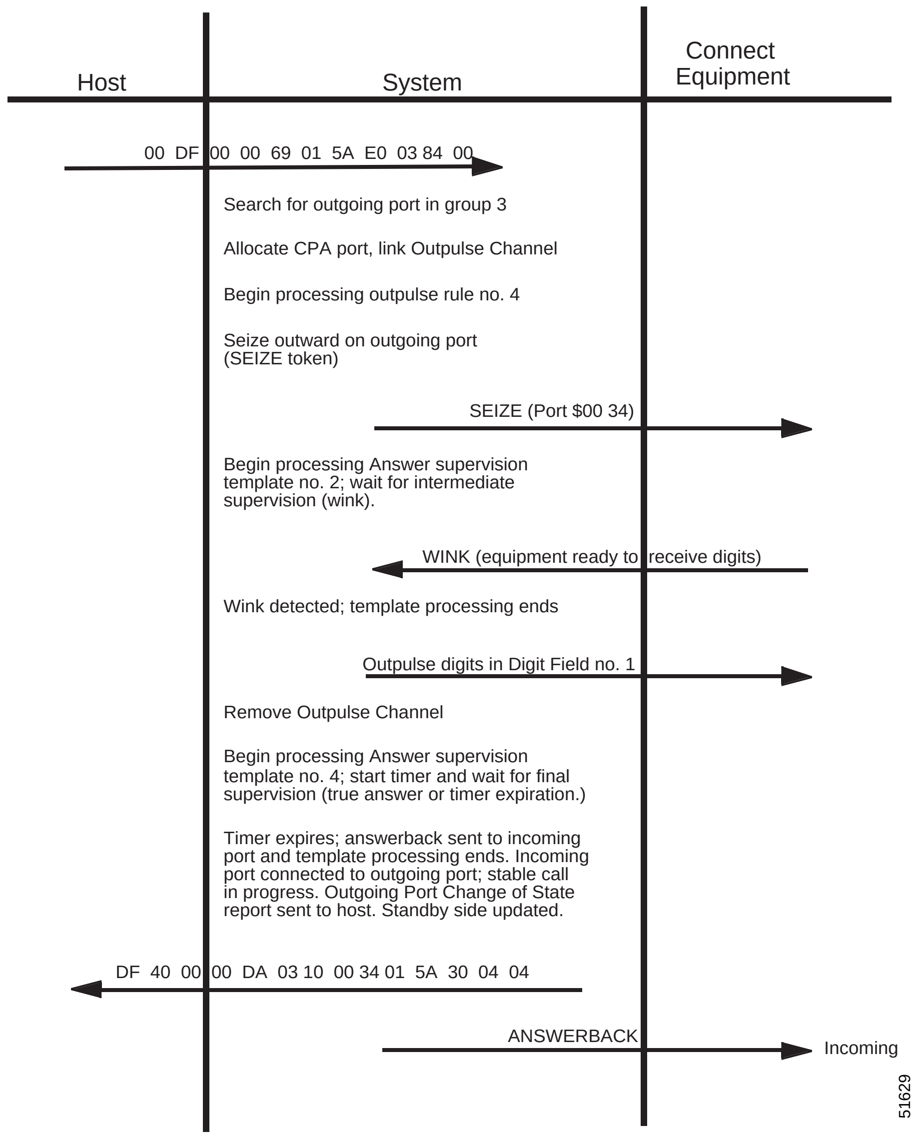
- SEIZE
- ANS SUP 2
- WAIT SUP
- OP DTMF
- OP FIELD 1
- TIME SUP 15
- ANS SUP 3
- FINAL SUP

Table 6-4 Answer Supervision Template #4

Template Field	Condition Token
Dial Tone	—
Ringback	—
Busy	FAIL
Reorder	ERROR
SIT Tones	FAIL
Ring Cess.	—
Voice Det.	—
Voice Cess.	—
Wink	ERROR
Answer	ANSREP
Time	ANSREP
Hookflash	—
Pager Queue	—

The processing flow for this example is illustrated in Figure 6-6.

Figure 6-6 Processing Flow for Grace Timing Example



Reorder/SIT Tones

The example in this section uses answer supervision template #2 (see Table 6-5) to demonstrate the system's handling of an error condition on an outgoing port.

Table 6-5 Answer Supervision Template #2

Template Field	Condition Token
Dial Tone	—
Ringback	ERROR
Busy	FAIL

Table 6-5 Answer Supervision Template #2 (continued)

Template Field	Condition Token
Reorder	ERROR
SIT Tones	FAIL
Ring Cess.	—
Voice Det.	—
Voice Cess.	—
Wink	OKREP
Answer	ERROR
Time	—
Hookflash	—
Pager Queue	—

The system responds to the detection of reorder and SIT tones without host intervention. For this scenario, assume the system has processed an incoming seize at port address $00 12 and performed a DTMF digit collection. Based on an Outgoing Port Control ($69) host command, the system hunts an outgoing port ($00 42) from resource group 2.

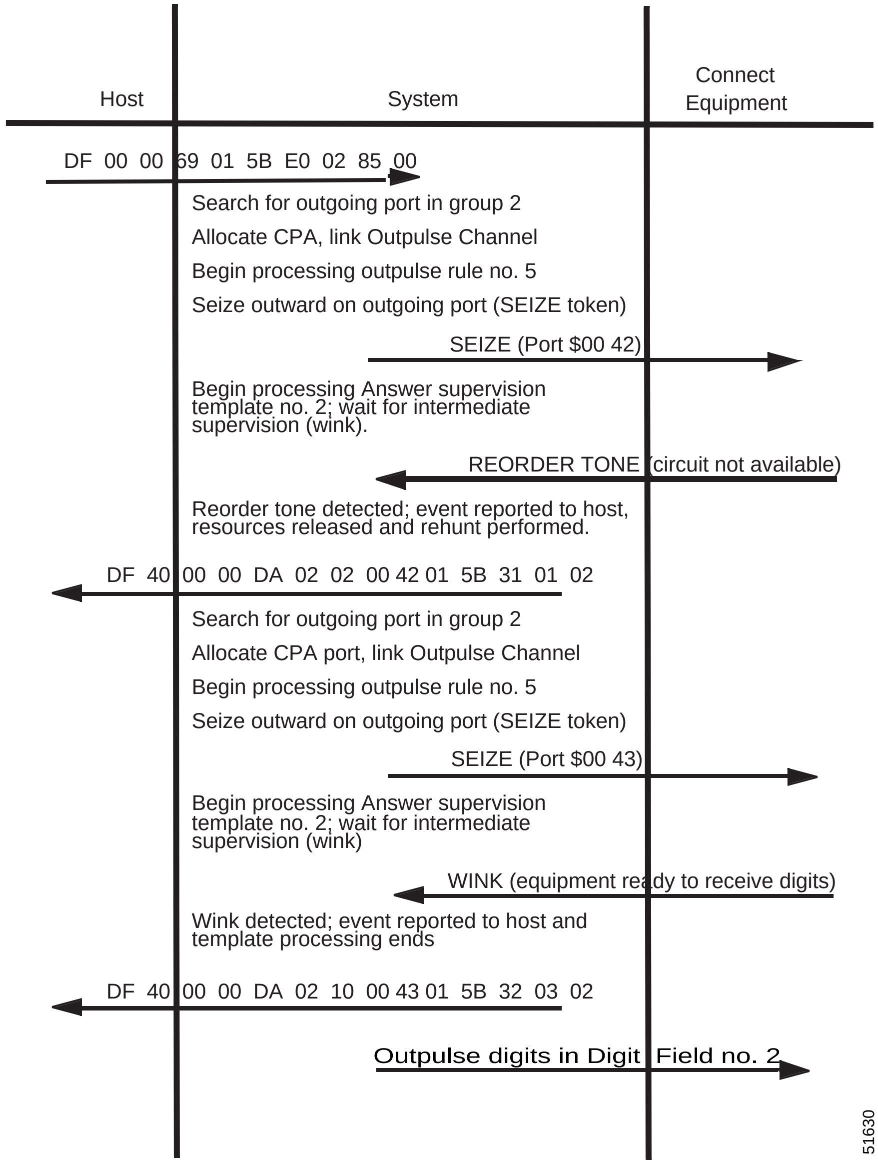
The system seizes out on the outgoing port to a CO and waits for a wink signal. However, the selected trunk circuit between this CO and the far end CO is disabled and is not available for outgoing calls. The connected CO sends reorder tone to the system to alert the system of the error condition. When the system detects reorder tone, it generates a report to the host indicating the circuit's condition and performs a rehunt.

The system rehunts from resource group 2 and attempts to complete the call on the port at $00 43. outpulse rule and template processing begins again. When the system successfully detects a wink over the new circuit, it outpulses the digits in Digit Field #2. The command specifies outpulse rule #4, described below:

- SEIZE
- ANS SUP 2
- WAIT SUP
- OP DTMF
- OP FIELD 2

The processing flow for this example is illustrated in Figure 6-7.

Figure 6-7 Processing Flow for Reorder/SIT Tones Example



Least Cost Routing

The example in this section illustrates the use of multiple intermediate supervision events during call processing. In this example, the system is being used to route calls to various Inter-Exchange Carriers. The system passes both calling party identification and destination numbers in MF form. The calling parties identification number is stored in the ANI field. The destination (called party) digits reside in Digit Field #2. Assume this information was obtained from an incoming port at $00 12. Based on an Outgoing Port Control ($69) host command, the system hunts an outgoing port ($00 42) from resource group 2.

The system seizes out on the outgoing port and waits for a wink signal using the preconfigured ANS SUP W template. When the system detects a wink, it outpulses the MF digits in ANI Digit Field (calling party ID). The system pauses for 0.5 seconds and then outpulses the destination digits in Digit Field #2. The system waits for another wink from the connected equipment (acknowledging the receipt of both sets of digits). Once the wink acknowledgment is received, outpulse rules processing ends and the system waits for answer supervision from the far end. The template allows for an early indication of busy conditions or network problems (SITs) before the call continues. The command specifies to use outpulse rule #6, described as follows:

- SEIZE
- ANS SUP W
- WAIT SUP
- OP DIGIT A, KP
- OP ANI
- OP DIGIT B, ST
- WAIT TIME 500
- OP DIGIT A, KP
- OP FIELD 2
- OP DIGIT B, ST
- ANS SUP W
- WAIT SUP
- ANS SUP 5
- FINAL SUP

Table 6-6 Answer Supervision Template #5

Template Field	Condition Token
Dial Tone	—
Ringback	—
Busy	FAIL
Reorder	ERROR
SIT Tones	FAIL
Ring Cess.	—
Voice Det.	—
Voice Cess.	—
Wink	—
Answer	ANS REP
Time	—
Hookflash	—
Pager Queue	—

The processing flow for this example is illustrated in Figure 6-8 and Figure 6-9.

Figure 6-8 Processing Flow for Least Cost Routing Example (Part 1 of 2)

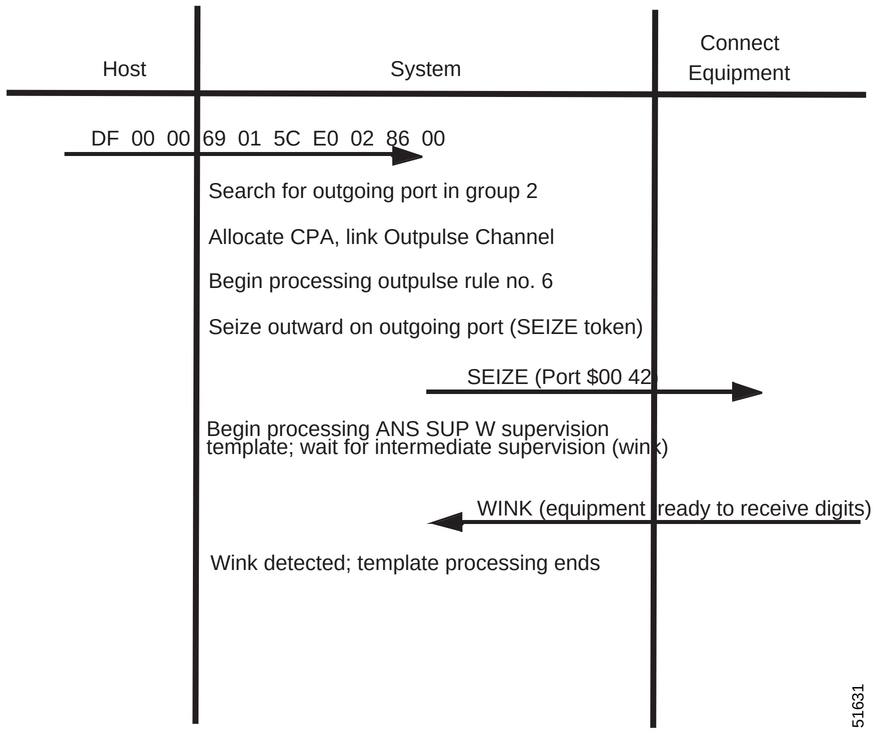


Figure 6-9 Processing Flow for Least Cost Routing Example (Part 2 of 2)