APPENDIX A

Service Circuit Channel Requirements

This appendix provides guidelines to help you determine the number of DTMF Receiver channels (SPC-DTMF), MF Receiver channels (SPC-MF, displays as SPC-MFRC) and/or Integrated Prompt/Record Card (IPRC) channels required to maintain a desired grade of service in a variety of VCO/4K system configurations.

Note Because of the complexity and variability in conference calls, this appendix does not address the number of Conference channels (SPC-CONF) required in a VCO/4K application.

This appendix also does not address the number of Call Progress Tone Analyzer ports needed (SPC-CPA).

To account for SPC/SRM and IPRC redundancy, you may need to multiply the number of service circuit channels determined here by a factor of 2.

Estimating Average SPC-DTMF and SPC-MF Channel Total Hold Time

Use the following guidelines to determine your SPC-DTMF and SPC-MF channel requirements:

1. Determine the number of channels needed depending on the SPC-DTMF and SPC-MF requirements of the application. SPC-DTMFs and SPC-MFs are required when the network interface span, configured for in-band signaling, passes digits inbound.
2. To determine the number of receiver channels required in a particular application, use traffic tables which assume constant holding times with lost calls delayed (refer to the “Service Circuits and Traffic Tables” section on page A-3).
3. Setup and holding times (or total hold time) for VCO/4K receiver channels must consider the following variables:
   - In host-controlled applications, the polling time over the communications links, as well as the number of command/report exchanges per call must be factored into the setup time.
   - Setup time varies with grade of service; as the amount of traffic through the system increases, setup time will increase. A timeout occurs if a receiver port cannot be obtained within 3 seconds after receipt of the appropriate command by the VCO/4K.
   - Receivers are generally attached for the duration of an inpulse rule, except where both DTMF and MF receivers are used in the same rule.
   - Receivers can be attached and held indefinitely via host command.

- In many host applications, receiver channels are used in tandem with voice prompts. The receivers tend to remain attached during the setup and holding times for the voice prompt(s). Thus the total holding time for a receiver channel must include the setup time and holding times for IPRC circuits and prompts (refer to the "Estimating Average IPRC Channel Total Hold Time" section on page A-2).

4. Use the most conservative estimate for holding time when using traffic tables to estimate the number of circuits required.

Note The best way to determine setup and holding times is to run simulated traffic through a VCO/4K host application system using the desired call scenario. Accuracy in determining the average holding time will vary directly with the number of simulations and traffic loads.

Estimating Average IPRC Channel Total Hold Time

Each VCO/4K system optionally equipped with voice prompting may include at least two IPRCs (64 or 128 channels each). The second IPRC may be added to the system for load-sharing redundancy. If an IPRC should fail, the system will continue to provide voice announcements as long as the other IPRCs remain functional. If more than 128 IPRC channels are needed, you must add a second set of cards.

Note The VCO/4K system design limits the number of IPRC cards to 8 (four sets of cards).

The key factors in determining the number of IPRC channels in a VCO/4K system are to estimate the number of anticipated calls per hour and to estimate the message time per call scenario.

1. To determine the number of IPRC channels required in a particular application, use traffic tables which assume constant holding times with lost calls delayed (refer to the "Service Circuits and Traffic Tables" section on page A-3).
2. Use the most conservative estimate for holding time when using traffic tables to estimate the number of circuits required.

Note The best way to determine setup and holding times is to run simulated traffic through a VCO/4K host application system using the desired call scenario. Accuracy in determining the average holding time will vary directly with the number of simulations and traffic loads.

The number of voice prompts required per call is reasonably constant, if you assume:

- A 15 to 25 percent margin of error for retries due to a caller's improper entry of information.
- The typical call scenario is consistently applied to all calls made through the system.

Setup and holding times for IPRC channels must take into account a number of variables:

- In host-controlled applications, the polling time over the communications links, as well as the number of command/report exchanges per call scenario must be factored into the setup time.
- Setup time varies with grade of service; as the amount of traffic through the system increases, setup time will increase. A timeout occurs if an IPRC port cannot be obtained within 3 seconds after receipt of the appropriate command by the VCO/4K.
- IPRC circuits are generally attached for the duration of an inpulse rule.

Note For assistance in determining anticipated traffic and VCO/4K service circuit requirements, contact your Cisco Systems Sales Engineer.

VCO/4K Subrate Switch Requirements

The VCO/4K system requires only one Subrate Switch Card (SSC).You can add a second SSC for redundancy. The system does not support more than two SSC cards.

Service Circuits and Traffic Tables

Traffic tables are not provided in this appendix. The information in this appendix, combined with your estimates of anticipated traffic on a group of channels, enables you to use traffic tables. Although you may obtain the recommended traffic tables from a variety of sources, the tables referred to in this appendix are in Theodore Frankel's *ABC Of the Telephone: Traffic Series – Tables For Traffic Management And Design.* See the "Related Documentation" section on page viii.

The tables in Frankel's publication are computer derived and preceded by a detailed explanation of their contents and range of parameters. The book also includes general descriptions of traffic characteristics, examples of the application of traffic tables to practical applications, and a selected bibliography on traffic engineering.

Traffic Management and Design Overview

When determining the number of service circuit channels for your system, ensure that all traffic estimates reflect the volume of traffic anticipated during the system's *busy hour.* Traffic volume is measured in a numeric value. This value indicates the average number of simultaneously existing calls.

The Erlang is the basic unit of measurement for traffic used in traffic tables. One Erlang (60 minutes) is the equivalent of 36 CCS (hundred call seconds) per busy hour.

The following characteristics govern calls into a telecommunications system:

- Relative number of users
- Holding time (elapsed time each call will occupy the DS0 port)
- Servers (number of talking paths available in one group to handle calls offered to them)
- Efficiency of the group of paths that handles the calls

These factors interact to produce the system's grade of service. The industry-standard acceptable grade of service is one to three calls per one hundred finding DS0 ports unavailable.

Traffic tables offer a means for determining the number of service circuits or channel DS0s needed to carry a given volume of traffic in relation to a stated probability of loss. This probability of loss reflects the likelihood that the caller will encounter the all-circuits-busy or unavailable tone.

The assumptions on which busy hour traffic formulas appropriate for VCO/4K systems are based include:

- All calls originate at random (with reference to time).
- Users generate their calls independently of each other.
- Expected traffic density is the same for every user.

- Number of sources is significantly large–approaches infinity.
- A call failing to immediately find a server enters a FIFO (first-in, first-out) queue until one becomes available. When one becomes available, the server is seized and held for a full holding time (lost calls delayed).
- Holding times are constant and equal.

Theodore Frankel's book includes a Master Flow Chart for selecting the proper traffic tables. The path to be followed for VCO systems is as follows:

- Traffic Theory
- Lost Calls Delayed
- Delay Theory
- Constant holding time distribution
- Serve queue first in first out
- Crommelin-Pollaczek
- Tables 8 through 10

The following notations are used in the traffic tables:

A = (calls per hour X holding time (in seconds))/3600 sec/hr = Erlangs

N = Number of servers in a full availability group

L = Number of originating traffic sources

h = Holding time in seconds for which a server is occupied by a call

P = Probability of loss (blocking delay)

P(>0) = Probability of delay greater than *0*

P(>t) = Probability of delay greater than *t*

t = Multiple of holding time *h*

D1 = Average delay on all calls

D2 = Average delay on calls delayed, expressed as multiple of holding time *h*

a = Traffic per source, Erlang

The number of users is assumed to be large (infinite sources), and the probability of any user originating a call is assumed to be the same as that of any other user (equal traffic density per source).

VCO/4K Traffic Engineering Example

The number of network interface channels (DS0s) and/or service circuit resource channels (such as DTMF) needed for the VCO in question to successfully service a given market area is a function of the following:

- The incoming call rate, expressed as a Busy Hour Call (BHC) Rate, that the VCO/4K will be handling.
- The duration of time the service circuit channel is required to complete a call setup transaction. For example, in the case of a DTMF channel, the duration of time for which a DTMF channel is required to complete a call setup transaction is a function of the number of digits to be collected at the beginning of the call.

- The Grade of Service (blocking factor). Usually this is 1% blocking, or P01 Grade of Service, but may be more or less stringent depending upon the requirements of environment.

Two options are shown. The first option assumes a specified BHC rate. The second option assumes a specific number of DS0 channels.

Option 1: Calculating the Required Number of MF or DTMF Channels

Note These calculations assume a specified BHC rate.

MF Channels

Step 1 Use the following equation to calculate the number of MF Erlangs:

MF Erlangs = BHC/3600/MFAHT, where MFAHT is the Average Hold Time for an MF channel expressed in seconds. A common MFAHT is in the range of 6 to 10 seconds.

Step 2 Go into the Erlang tables to convert erlangs to quantity of MF channels.

Step 3 Go to Chapter 1.

DTMF Channels

Step 1 Use the following equation to calculate the number of DTMF Erlangs:

DTMF Erlangs = BHC/3600/DTMFAHT, where DTMFAHT is the Average Hold Time for a DTMF channel expressed in seconds. A common DTMFAHT is in the range of 20 seconds.

Step 2 Go into the Erlang tables to convert erlangs to quantity of DTMF channels.

Step 3 Go to Chapter 1.

Option 2: Calculating the Required Number of MF or DTMF Channels

Note These calculations assume a specified number of network interface channels (DS0s).

Step 1 You need to first make an assumption as to the average hold time for an MF or DTMF channel.

Step 2 Convert network interface channels to Erlangs, and then, using 1% Grade of Service (blocking), by trial and error, use the Erlang tables to identify which Erlang value is representative of the number of ports. Pick an Erlang number that corresponds to 3% to 6% less than the number of network interface channels you need.

Step 3 Make an assumption as to the Average Call Hold Time (ACHT) for the application and express that in seconds; that is, 3 minutes (180 sec), unless you have been specifically given this information.

Step 4 Use the following equation to convert Erlangs to Busy Hour Calls (BHC):

BHC = Erlangs X 3600/ACHT

Step 5 Now that you have the incoming call rate expressed in BHC Rate, you can use this to begin calculating the number of MF or DTMF channels required.

MF Channels

Step 1 Use the following equation to calculate the number of MF Erlangs:

MF Erlangs = BHC/3600/MFAHT, where MFAHT is the Average Hold Time for an MF channel expressed in seconds. A common MFAHT is in the range of 6 to 10 seconds.

Step 2 Go into the Erlang tables to convert erlangs to quantity of MF channels.

Step 3 Go to Chapter 1.

DTMF Channels

Step 1 Use the following equation to calculate the number of DTMF Erlangs:

DTMF Erlangs = BHC/3600/DTMFAHT, where DTMFAHT is the Average Hold Time for an MF channel expressed in seconds. A common DTMFAHT is in the range of 20 seconds.

Step 2 Go into the Erlang tables to convert erlangs to quantity of DTMF channels.

Step 3 Go to Chapter 1.