

COMMON CHANNEL INTEROFFICE SIGNALING INTERTOLL SIGNALING LINKS

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1. GENERAL

1.01 This section is issued to describe the method of planning and updating network requirements for Common Channel Interoffice Signaling (CCIS) Links. It prescribes the coordination of installation of signal links and their administration in the network. The method of operation and the equipment arrangements are explained. Although the CCIS Network Administration Center (CNAC) is responsible for computing the number of links required, and for assigning trunks to them, major responsibilities also reside with the network design engineers and the network administrators. Their need to understand the methods used by CNAC is basic. It is expected that this document will provide a common ground for such understanding. Individual responsibilities of the network design engineer, the network administrator, and CNAC are provided in the last three parts of this practice. This practice does not cover:

- Engineering of CCITT #6 links
- Engineering for Direct Signaling traffic (such as that generated by the CCIS Inward WATS service), which is automatically distributed over all available A or B links connecting to the desired destination

- Engineering of Input/Output processor channels, which could conceivably replace the present CCIS terminals in No. 4 ESS and No. 1/1A ESS systems.

1.02 Whenever this section is reissued, the reason for its reissue will be listed in this paragraph.

1.03 References in this section to methods, planning, data requirements, service levels, and equipment quantities are based on American Telephone and Telegraph Company recommendations.

BACKGROUND

1.04 CCIS is a method of signaling between processor-equipped switching systems over a network of signal links. This system separates the signaling from the message transmission path, identifies ineffective attempt conditions prior to establishing a trunk connection, and passes signals at a much higher speed than conventional signaling. All of these features provide higher utilization of trunk groups for messages. All addresses and supervisory signaling information for call setup and release, start of billing, error control [retransmission of invalid signal units (SUs)], and network control are exchanged between processors via signal links. "Talk-off" due to interaction between voice and supervisory signals is eliminated. Present voice bandwidth restrictions required to obtain compatibility of data operation with single frequency (SF) signaling are also eliminated. Simulated frequency fraud (blue box) is reduced. Its complete elimination is possible with an all CCIS network. Also eliminated are massive sender seizures due to loss of SF tone during facility failures.

1.05 Single frequency (SF) and multifrequency (MF) signaling equipments are not needed since they are replaced by signal links. One signal link conveys the signals for many trunks as opposed to SF signaling, which requires an SF unit at both ends of every trunk. Figure 1 illustrates inband signaling (SF and MF); Fig. 2 illustrates CCIS signaling.

2. METHOD OF OPERATION

A. General

2.01 Signaling for telephone message traffic is the passing forward and backward of

information needed to establish, bill, and disconnect calls. Common Channel Interoffice Signaling (CCIS) uses a digital data flow to transmit the intelligence needed to:

- Direct the seizing, interconnecting, controlling, and release of trunk circuits in the message network
- Select the correct route or alternate route, in-chain or out-of-chain, the correct end office, and the correct called party line
- Supervise the start and end of billing
- Initiate the sending of ineffective attempt signals
- Trigger the blocking and unblocking of trunks for maintenance or trouble.

2.02 With CCIS, the voice path is checked for continuity and for proper transmission levels prior to the setup of each call. This provides an improved grade of service.

2.03 In its simplest form, CCIS requires direct signal links to connect each processor-equipped CCIS switching system with every other CCIS switching system to which it has a direct trunk group. This is referred to as "associated signaling," ie, the signaling link is associated with a specific trunk group.

2.04 In normal practice, signaling for a large number of trunk groups which terminate on a processor type switching system is concentrated onto a few (CCIS) signal links and directed to the two Signal Transfer Points (STPs) that serve the network region. These STPs, as the name implies, route signals to the proper destination.

2.05 Signal links are 2-way synchronous data channels. Link terminal equipment at each end sends and receives data at 2400 bits per second.

B. Signal Format

2.06 The basic data word used in CCIS is the Signal Unit (SU). An SU is 28 bits long: a 20-bit field for signaling information, and an 8-bit field for error detection. Signal units are grouped into blocks of 12. All 12 in a block are always

filled. The first 11 units contain signaling information; when no signaling information is available for transmission, a Synchronization Signal Unit (SYU) is transmitted to maintain synchronization. The twelfth unit is always an Acknowledgment Control Signal Unit (ACU) coded to indicate the number of the block in which it is included, the number of the block being acknowledged, and whether or not each of the 11 signal units of the block was received without error.

2.07 Signal messages are one or more signal units in length, depending on the amount of information being transmitted. Lone Signal Units (LSUs) generally are used for specific control information (eg, answers), while Multiunit Messages (MUMs) generally are used for passing address information (eg, digits).

2.08 The format for an LSU (Fig. 3) contains a trunk label which identifies the trunk being served, as well as information requesting action or providing acknowledgment of actions completed. The trunk label is made up of two fields: a band number, which identifies a subgroup of up to 16 trunks, and a trunk label number which identifies the specific trunk.

2.09 Multiunit Messages can be in one of two different forms:

- (a) **Initial Address Message (IAM):** Used to establish a call, provide trunk identification, routing instructions, and called digits
- (b) **Miscellaneous Multiunit Messages (MUM):** Used for direct signaling messages, telephone signals that occur infrequently, network management messages, and subsequent address messages (international transit only).

2.10 For a more detailed description of signaling message structure, refer to Section 333-200-101.

C. Network Structure

2.11 The CCIS network structure is shown in Fig. 4. Each processor-controlled toll switching system, or Switching Office (SO), has one or more pairs of access (A) links to associated region STPs. These are composed of an odd and an even-numbered A link, with the odd-numbered link connecting to the odd-numbered STP, and the even-numbered link to the even-numbered STP.

2.12 CCIS traffic is divided equally between the two links of each pair, by assignment of trunks to signal links. Trunks in a trunk group are split into subgroups of 16 trunks. Each subgroup is assigned a band number and, within the band, the trunks are assigned in numerical order to trunk labels. A particular band is assigned to one pair of links. In the No. 4A/ETS and the No. 1/1A ESS, signals associated with the even-numbered trunks normally are sent on the off-numbered link, and signals associated with odd-numbered trunks normally are sent on the even-numbered links. In the No. 4 ESS, signals associated with the middle 8 of the 16 trunk numbers in a band normally are sent on the odd-numbered link, while those associated with the first four and last four trunk numbers normally are sent on the even-numbered link.

2.13 Each STP in a region has one or more pairs of "bridge" (B) links between it and each distant region (See Fig. 4). At the STP, the signal load is divided, with part going to one of the distant STPs and the remainder to the other STP. Together, the two STPs of a region have two or more B-link pairs to each of the other regions. The four basic links (B1, B2, B3, and B4), which make up the two pairs, are referred to as a *quad*. In addition, the STPs within a region are connected by "cross" (C) links, which are used primarily to exchange link status information. Under certain link failure conditions, C links are used temporarily as backup paths for message signals.

2.14 Where there are sufficient trunks between a switching office in one region and the offices in another region, a dedicated pair of signal links may be provided directly to the STPs of the other region. Such signal links are known as "extension" (E) links. Timely provision of E links may postpone the need to install additional A or B links, and permit the saving of processor capacity and terminal frame space at the bypassed STP pair.

2.15 In some cases, there may be a trunk group between two switching offices (SOs) large enough to justify direct signal links between them. This type of signal link is known as a "fully associated" (F) link. The two SOs may be in the same or in different regions. Timely provision of F links may postpone the need to install additional A or B links, and permit the saving of processing capacity and terminal frame space in the bypassed

STP pairs; or, in case the offices are in different regions, in the bypassed STP pairs. F links may be required between all Regional Centers, and for selected large intraregional final trunk groups, in order to enhance network survivability.

2.16 The A link pairs from a switching office have the capacity for several thousand CCIS trunks and can serve many different CCIS trunk groups. Interregional signals from all A links to an STP are concentrated onto B links which interconnect with each of the STPs in all regions, thus forming a signal network. B links are designed with the same signal unit (SU) capacity as A links. The quad, which is composed of four B links, has twice the SU capacity of a pair of A links.

2.17 The ten regions of the country which comprise the message network are geographically the same regions referred to for CCIS. The regions are numbered 0 through 9. Each region has two Signal Transfer Points (STPs). The control (or even) STP is numbered 0, and its mate (the odd STP) is numbered 1. The region and STP numbers are:

<u>REGION</u>	<u>CONTROL STP-0</u>	<u>MATE STP-1</u>
0-Sacramento	Sacramento	Oakland
1-San Bernardino	Anaheim	Los Angeles
2-Denver	Denver	Albuquerque
3-Dallas	Dallas	Oklahoma City
4-St. Louis	Kansas City	St. Louis
5-Norway	Omaha	Indianapolis
6-Rockdale	Atlanta	Birmingham
7-Pittsburgh	Detroit	Columbus
8-Wayne	Wayne	Richmond
9-White Plains	White Plains	Boston

2.18 The control STP mentioned in paragraph 2.11 is the regional control office. Regional control offices are responsible for coordinating the administration and maintenance of the regional signaling network and for the direct control of C links. Information covering the control plan, other link control office assignments, and specific control responsibilities may be found in Section 010-430-501.

2.19 The signal link control office is responsible for the overall maintenance of the link, for the availability of the links for service, and for all activities which could affect the links. Normally, the signal link control office will be arranged to

obtain traffic measurements for signal links. The responsibility for obtaining measurements on the various types of links is as follows:

Type Link	Measurement Responsibility
A	Switching Office
B	*Designated by CNAC
C	Regional Control Office
E	Switching Office
F	Determined by trunk control.

*For each quad of B links, the STP pair at one end is designated to have the responsibility for obtaining measurements for that quad. Each of the STPs in the pair obtains measurements for the two B links terminated on it. The measurement responsibilities are distributed among the various STPs to balance the work load and to allow for the measurement limitations of the two types of STP. Stand-alone STPs can measure a maximum of 40 signal link groups (SLG), and nonstand-alone STPs can measure a maximum of 20. An SLG is a group of from one to eight links which are engineered as a unit, and for which data must be totaled.

D. Automatic Transfer—Failure Conditions

2.20 To ensure the existence of a signal path in the event of link failure, automatic transfer to the mate link is provided. The signal terminal (Fig. 2) monitors signal transmission, and, if either a total failure or excessive signal errors are detected, a transfer to the mate signal link is initiated. When an A link fails, all signal units to the failed links are rerouted on the mate A link (Fig. 4). Likewise, SUs for a failed B link will be rerouted onto the mate B link. Signal units arriving at an STP for transmittal over either a failed A link or a failed B link pair will be rerouted over the C link for a period of about three minutes. At the end of this period, the distant processors will be instructed to route only through the mate STP. Signaling traffic is restored to the regular route after the trouble clears. Any SU interrupted due to the failure will be retransmitted.

2.21 To minimize signal delay due to link failure conditions, Signaling Network Management

Signals are used to pass link status information among STPs and SOs. Upon being alerted to a link failure, the network reconfigures itself to bypass the failure, if possible. The accuracy and consistency of these control signals is audited periodically and, where necessary, signals are retransmitted. This audit also is initiated when an incorrect network control state is detected, or when a failed signal link recovers.

2.22 To ensure that a link has sufficient capacity to handle the entire signal load directed to it in case of failure by the mate, the normal planned load is limited to 50 percent, or less, of the load it is capable of handling.

2.23 As an additional safeguard, dual voice frequency links (VFLs) are provided for each A, E, or F link. In the event of an A, E, or F link failure, SUs are directed to the mate link as stated in paragraph 2.14. However, should the processor localize the trouble to the VFL, the standby VFL is switched into the link, replacing the regular one (Fig. 2). The switch arrangement is part of the modem. The A, E, or F link is then tested and, if good, restored to service. Ideally, each of the four facilities used for a pair of links should be on different facility routes, to decrease the possibility of simultaneous outages. Because there are four B links between regions, any two of which can carry the entire load, B links are not provided with dual VFLs.

2.24 In addition to the Signaling Network Management Signals described in paragraph 2.21, signaling network overload controls are provided to help prevent overtaxing the real-time capacity of STP processors, or the overflowing of message buffering for signal links. In a properly engineered network, these conditions should be rare. When necessary, these control signals cause the rerouting of signal traffic, or the reduction in new message traffic.

E. Error Detection and Correction

2.25 The signal terminal receives, via the Terminal Access Circuit (TAC), signal messages consisting of one or more Signal Units (SUs) that were generated by the switching system processor, usually in response to telephone calls. The SUs are stored in a transmit buffer according to priority level. Each SU of a block of 12 remains in this buffer until it has been transmitted. At that

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time, it is stored in the transmit record table until the terminal receives acknowledgment from the distant office that all SUs have been correctly received. When ready to be transmitted, each SU, in priority order, has eight check bits added and is passed to a modem for analog transmission. At the other end of the link, a modem converts the SU back to digital form, and relays the digits to the receive portion of the signal terminal. Here, error checking is performed on the SUs, using the eight error check bits. Error-free SUs, minus check bits, are stored in the receiver buffer of the terminal until all SUs in the block of 12 have been received without error.

2.26 Correction of data-link-caused errors is accomplished by retransmission of the faulty SU after identification by the Acknowledgment Control Unit.

F. Trunk Assignment

2.27 The signal path for an interregional trunk consists of the A link from a switching system in one region to the home STP, the interconnecting B link to the distant STP, and the A link to the switching system in the other region (See Fig. 5). Signals within a region are transferred, by the STP, directly from one A link to another.

2.28 The theoretical assignment capacity of each link pair, or quad, is 8192 trunks, divided into 512 bands, each consisting of 16 trunks; 511 bands are assignable. The 512th band is used for test trunks. When there is more than one pair of A links at a given SO, the several subgroups, or bands of 16 trunks, in a particular trunk group, may be assigned to either the same link pair or to different link pairs. The same assignment principle applies when more than one quad exists between two regions.

2.29 Each message trunk is assigned a band number for each set of signal links used. Therefore, the specific signal path for a trunk defines not only the particular signal links and STPs, but also the set of bands, one for each link, making up the signal path. Figure 5 indicates a basic signal path with the band assignments. They are as follows:

SIGNAL PATH #1, SO-A TO SO-B

SECTION	FACILITY	ASSIGNMENT
Term. A-STP	Pair 1	Band 6
STP-STEP	Quad 1	Band 3
STP-Term. B	Pair 1	Band 7

3. EQUIPMENT ARRANGEMENTS

A. Terminal Group Frame

3.01 The CCIS terminal group frame is a 4-bay complex containing signal terminal units, with data modems for up to 16 signal links plus duplicated Terminal Access Circuitry (TAC) for communication between the terminal unit and either the Switching Office (SO) processor, or the Signal Transfer Point (STP) processor. At a No. 4A/ETS, the generic program restricts the ability to access to 14 terminals. The present view shows this to be adequate for all future needs. Figure 2 shows a complete signal link. Section 212-807-101 covers the 4A/ETS signal terminal group and VFL circuit.

3.02 The CCIS terminal basic frame consists of two bays. In No. 4 ESS offices (Fig. 6) and No. 4A/ETS offices (Fig. 7), the basic frame may contain up to six terminal-modem units and TACs. In No. 1/1A ESS offices, the basic frame may contain up to eight terminal modem units and TACs (Fig. 8).

3.03 Additional terminals are obtained through the provision of one or two supplementary bays. The terminal basic frame, plus supplementary bays, constitute a terminal group. A complete terminal group provides 16 terminals. As stated in paragraph 3.01, due to a generic program limitation, No. 4A ETS cannot use more than 14 terminals. If supplementary frames are not provided initially, space adjacent to the basic frame must be reserved for future additions.

3.04 Signal terminal units must be provided in numerical order within a terminal group. The basic frame must be fully equipped before providing the first supplementary frame. The first supplementary frame also must be fully equipped before adding the second supplementary frame. The first supplementary frame will be placed to the left of the basic frames, as viewed from the front, and the second supplementary frame to the right.

3.05 International Telegraph and Telephone Consultative Committee—No. 6 (CCITT #6) terminals are not interchangeable with CCIS signal terminals. No. 4 ESS offices having international circuits requiring CCITT #6 signal link terminals should identify the two types of terminals separately. Planning for future link terminal requirements should include the provision of the proper type of terminals, CCIS or CCITT #6.

3.06 The terminal unit itself is a small, special-purpose, stored program processor which maintains data communications over the signal link. It provides buffering between itself and the switching system processor for SUs which have been received and are waiting to be transmitted. Synchronization, error detection, retransmission of signal units received in error, plus acknowledgment of correctly received signal units, are also independently handled by the terminal units.

3.07 Modems are analog-digital interface devices and are included as part of the terminal. The modem is a Data Set (DS) 201D, intended for Bell System internal use for this function and for use with the Traffic Service Position System (TSPS).

B. Voice Frequency Link Access Unit

3.08 The voice frequency link access unit is used to provide the transfer point through which the idle Voice Frequency Link (VFL) can be connected to dedicated test jacks. It also provides the ability to make VFL loop-back tests from the STP. The actual transfer of the signal terminal and modem from one VFL to the other is accomplished in the modem. The VFL access unit is located in the signal link circuit between the modem and the VFL facility in No. 4A/ESS STPs and SOs, and in No. 1 ESS SOs. The No. 4 ESS does not use a VFL access unit; the regular and reserve VFLs are connected semipermanently, on a "nailed-up" connection, through the time division network. The regular VFL is connected to the modem, while the reserve can be switched to a passive loop-back termination, or to a designated 51A position for manual test.

3.09 In the No. 4A/ETS SO, two VFL access units may be mounted on the ETS miscellaneous frame. Each access unit has mounting positions

for eight VFL access circuit packs and, when fully equipped, will serve four A link pairs.

3.10 The VFL access frame, capable of mounting up to eight VFL access units, is provided at STPs only. A maximum of four frames, handling up to 128 link pairs, may be installed in any STP. Each access unit has mounting positions for eight VFL access circuit packs. The VFL access unit is designed for two access circuits per A link, since A links consist of two transmission facilities. Where the VFL access unit is used for B links, only one access circuit pack is provided per B link.

4. DETERMINATION OF CAPACITIES AND EQUIPMENT REQUIREMENTS

A. Load-Service Relationship

4.01 Three factors were considered as possible limitations for link loading: answer signal delay, call setup time, and terminal queue length. Each factor is discussed separately in the following paragraphs.

Answer Signal Delay

4.02 Until the introduction of answer signal break-in, answer signal delay limited link loading to about 50 percent occupancy. All terminals are now programmed for answer signal break-in, which means that the terminal will process answer signals in between the signal units of a multiunit message, thus serving answer signals almost as soon as they arrive, and making the answer signal queuing delay negligible even at very high occupancies.

Call Setup Time

4.03 The call setup time interval, although not measured, begins when the Initial Address Message (IAM) is placed in the terminal queue of the originating office, and ends when the terminating office places the address complete signal in its terminal queue. (See Sections 333-200-100 and 333-200-201 for a more complete description of the signaling process and the signaling structures.) The following table provides a comparison of call setup times for calls not using CCIS, calls with CCIS between toll offices, and calls using CCIS from originating end office to completing end office.

CALL SETUP TIME (SECONDS)

	TYPICAL MINIMUM	TYPICAL MAXIMUM	OBJECTIVE
Without CCIS	7.0	15.0	10.0
Toll CCIS Only	4.0	5.2	—
CCIS End-to-End	0.675	1.825	2.0

4.04 Call setup time increases only slightly as link occupancy increases up to an occupancy of about 50 percent, and thereafter increases more rapidly. The difference between call setup time at 50 and 70 percent occupancy is about 250 milliseconds. Since terminal queue length will limit link loading to 70 percent occupancy or less, call setup time can be considered as nonlimiting.

Terminal Queue Length

4.05 The standard CCIS terminal link list structure, or terminal queue, is composed of 16 lists. All signal units awaiting transmission are stored in six different lists, one for each of six transmit priorities. The signal units received and waiting to be sent to the central processor, via the Terminal Access Circuit (TAC), are stored in two different lists, one for each of two receive priorities. One list is the Reserve list. One list is the Miscellaneous Multiunit Message Hopper. Three lists are used for maintenance, and three lists are used for spares.

4.06 The terminal queue consists of 98 words, each of which can store one signal unit. Twenty of the words are kept in a reserve list. The remaining 78 words of the queue are available to store messages waiting for transmission, and to hold messages received. When the 78th signal unit arrives in the queue, the reserve list is automatically attached, expanding the queue to 98 words. Exceeding the 78th word is known as **buffer overload**. When the total 98 words are exceeded, the condition is called **buffer overflow**. Signals arriving at the queue when it is full are lost, and the calls generating those signals are routed to reorder. The reserve queue remains attached until the entire transmit queue is completely emptied.

4.07 When the 78 SU threshold is exceeded, traffic overload controls are applied. These consist of sending instructions to processors at all offices which normally direct calls to trunks associated with the link involved to stop selecting

those trunks for a short period of time. Since, under normal traffic conditions, it is undesirable to restrict traffic in this manner, the proper number of signal links to handle busy-hour traffic should be provided. To do so requires determining the number of SUs the link can carry during the busy hour without filling the queue to 78. Since call-related SUs are generated by the trunks, it becomes necessary to determine how many trunks will generate that number of SUs. The number of SUs varies with traffic characteristics, peakedness, and occupancy.

B. Traffic Characteristics

4.08 Pre-CCIS traffic studies show that an average of ten attempts per trunk is experienced in the overall network with single frequency (SF) signaling. These attempts are divided between the two directions on a 2-way trunk, as determined by traffic needs. Since CCIS reduces the nonconversation time per call, attempts per CCIS trunk may prove to be higher than ten. This could reduce the number of message trunks served by a signal link. The network administrator should be aware of this and be able to provide the average call attempts per CCIS trunk for the switching system, when requested (see paragraph 7.07).

4.09 Small intertoll trunk groups usually are composed of 2-way trunks. Larger trunk groups usually include 1-way trunks in each direction in addition to the 2-way trunks. Since 2-way trunks may be selected from either end and since traffic is usually equal in each direction, a 2-way trunk is considered to handle one-half the outgoing attempts that a 1-way trunk does. Therefore, for planning purposes, a 2-way trunk is considered as one-half of an equivalent 1-way trunk in each direction. Selection of trunks is made first from the 1-way outgoing trunk subgroup and, if none are idle, from the 2-way subgroup. Particular trunk groups have call patterns which may vary considerably from other groups. In the case of a trunk group between point A and point B, the busy-hour calling rate could be approximately equal in each direction, or it could be always greater from the A end than the B end. It could be greater during the day busy hour, but less during the evening busy hour than the B end; and it could be greater in the busy hour during some seasons of the year, but less during other seasons than the B end. A typical average outgoing call generates 5 to 7 SUs in the outgoing direction (IAM = 3 to 5, continuity

acknowledgment signal = 1, and clear forward signal = 1), and 3 SUs in the inward direction (address complete = 1, release guard = 1, answer = 0.7, and clear back = 0.3). (See Fig. 9.) The reverse is true for an incoming call.

4.10 The link channel in the direction of the highest volume of originating calls will have a higher SU load and should be used in determining the number of links to be provided. Consider, also, that some calls require seven digits and generate IAMs requiring 3 or 4 SUs, and other calls require 10 digits and generate IAMs of 4 or 5 SUs.

C. Occupancy

4.11 Transmission over signal links is at the rate of 2400 bits/second. Since each signal unit always contains 28 bits, there are 308,571 signal units transmitted per hour. One signal unit in each block of 12 is always used as an acknowledgment control unit (ACU). Because it is not used for message information, the ACU is not included in computing occupancy. Consequently, total message-related signal units possible in an hour are 11/12 of 308,571 or 282,857. TOTAL message-related SUs/hr =

$$\frac{3600 \text{ Seconds} \times 2400 \text{ Bits/Second}}{28 \text{ Bits/SU}} \times \frac{11}{12} = 282,857$$

Occupancy is the percent of time the link is in use, or the ratio of the number of information carrying signal units (either of the peg count measurements labeled TOT INSU or TOT OGSU) to the total number of signal units possible in the hour (282,857).

$$\text{Occupancy} = \frac{\text{TOT INSU or TOT OGSU}}{282,857}$$

D. Peakedness of Offered Load

4.12 Peakedness is covered in detail in Section 780-400-340. As the name implies, peakedness in the bunching up, or peaking, of traffic for very

short intervals. Because of these variations in the traffic offered, the ability to carry similar volumes of traffic varies with the peakedness. Peakedness is of concern especially during the busy hour.

4.13 One of the assumptions underlying traffic theory is that calls are originated at random. Peakedness is the variance-to-mean ratio of the offered traffic. When the variance is equal to the mean, the peakedness factor is one and the traffic is considered random. Traffic with a variance-to-mean ratio, or peakedness factor of less than one, is called *smooth*. First-routed traffic is random traffic and alternate-routed traffic, which is usually in bursts, is called *peaked*. Peaked traffic has a variance-to-mean ratio, or peakedness factor, greater than one.

4.14 The following illustration is included to further define peakedness. When signal units (SUs) arrive at random intervals, the number of queue spaces required varies from moment to moment. With a mean of 50 SUs, there could be, at times, as many as 70 in the queue and, at times, only 30 as shown.

	SIGNAL UNITS			
			78	
			70	
			60	
PEAKED	RANDOM	SMOOTH	50	MEAN
			40	
			30	
			20	
			10	

Random traffic such as this would have a peakedness of 1. When SUs arrive at more regular intervals, the number of queue spaces occupied varies much less. Still, with a mean of 50 SUs, there may be as many as 60 in the queue, or as few as 40. This type of traffic is called *smooth* and would have a peakedness less than 1. At another time, the SUs may arrive in flurries, followed by short periods with few SUs arriving. The number of queue spaces required may be as many as 78, or as few

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as 22. This type of traffic is called **peaked**, and the value of peakedness is greater than 1. It is important to understand that the values used are for illustration only.

4.15 The capacity of a signal link, corresponding to the queue length service objective, is affected inversely by peakedness as illustrated by the following table:

<u>PEAKEDNESS</u>	<u>CAPACITY IN OCCUPANCY</u>
1.0	0.65
1.25	0.625
1.5	0.6
1.75	0.575
2.0	0.55
2.25	0.525
2.5	0.5
2.75	0.475
3.0	0.45

4.16 Since occupancy is the percent of actual message signal units to the total number of signal units possible in an hour, the capacity of the signal link (in signal units) can be computed for the various peakedness factors, or for the occupancy ratio. The following is an expansion of the previous table and includes the hourly capacity in signal units.

<u>PEAKEDNESS</u>	<u>OCCUPANCY RATIO</u>	<u>HOURLY CAPACITY IN SIGNAL UNITS</u>
0.6	0.69	195,000
0.7	0.68	192,000
0.75	0.675	191,000
0.8	0.67	190,000
0.9	0.66	187,000
1.0	0.65	184,000
1.1	0.64	181,000
1.2	0.63	178,000
1.25	0.625	177,000
1.3	0.62	175,000
1.4	0.61	173,000
1.5	0.6	170,000
1.6	0.59	167,000
1.7	0.58	164,000
1.75	0.575	163,000
1.8	0.57	161,000
1.9	0.56	158,000
2.0	0.55	156,000
2.1	0.54	153,000
2.2	0.53	150,000
2.25	0.525	148,000
2.3	0.52	147,000
2.4	0.51	144,000
2.5	0.5	141,000
2.6	0.49	139,000
2.7	0.48	136,000
2.75	0.475	134,000
2.8	0.47	133,000
2.9	0.46	130,000
3.0	0.45	127,000

As the table indicates, occupancy must be reduced as peakedness increases, or the queue length of 78 signal units will be exceeded.

E. Engineering Considerations

4.17 To provide uninterrupted service, redundancy is built into the signal link network, both in the STPs and in the links. Should an A, E, or F link fail, the entire signal load is directed to the paired link by the processor. Should a B link fail, its signal load is directed to the mate B link of that STP. If a second B link should fail, the entire load will be picked up by the other two B links of the quad. This may result in one B link from each of the STPs of the region being used, or it may result in the traffic being handled on both B links of the STP. To provide this ability,

the engineering capacity of a link in normal service is considered to be one-half of the load it is capable of handling.

4.18 The maximum number of trunks that can be assigned to a particular pair of A, E, or F signal links, without exceeding the 78 signal-unit terminal queue length, will depend upon the number of attempts per trunk, the peakedness of the traffic, and the number of signal units per attempt.

4.19 Although peakedness cannot be measured directly, it can be estimated from three parameters: link occupancy, average message length (in signal units), and the number of transitions. A transition is the change from a noninformation carrying signal unit to an information carrying signal unit. Since the terminal transmits all the signals of a multiunit message sequentially, the longer the average message length, the lower the probability that the next space will be occupied by a synchronization signal unit. A message consisting of four signal units cannot have a transition—once the message has begun—until after the four signal units. If a message contains three signal units, however, the transition could occur after the three signal units; the greater the length of the average message, the lower the number of translations.

4.20 The relationship between peakedness and the three measured parameters has been derived analytically and is incorporated into the CCIS Link Assignment and Servicing System (CLASS), a computer program resident at the CCIS Network Administration Center (CNAC).

4.21 A set of tables (Fig. 10) has been developed through which peakedness of the traffic on a pair of links can be determined manually. The tables have been arranged with a section for each of the various occupancies. Since occupancy is computed by dividing a signal unit count by 282,857, the signal-unit count corresponding to each occupancy is also shown. In each table, the numbers of transitions are listed vertically on the left side, and the average length of the signal messages, in signal units, horizontally across the top. The peakedness value can be found where the line, for the number of transitions experienced, intersects the average message length column. Interpolation is required to determine peakedness for transition quantities, average message lengths, or occupancies between the values listed.

F. Traffic Data Counts

4.22 The Machine Load and Service Summary (MLSS) for No. 4 ESS and No. 1/1A ESS toll CCIS offices (Fig. 11 shows the CCIS signal link portion of a typical MLSS) and the CCIS Summary Report (CCSR) from No. 4A/ETS offices (Fig. 12) provide the traffic data for network administration. A Load Distribution Report (Fig. 13) provides the busy hours for types of equipment, and a Load Service Report (Fig. 14) provides a 15 high-day rolling data record and an average 10 high-day summary for engineering signal links. Figure 15 is a glossary for all three reports. The following measurements are obtained from the terminal, and most of them are summarized by individual links as well as by link pair totals.

IN IAM	Incoming IAMs
OG IAM	Outgoing IAMs
IN ANS	Incoming Answers
OG ANS	Outgoing Answers
TOT INSU	Total Incoming Signal Units
TOT OGSU	Total Outgoing Signal Units
TOT IN MSG	Total Incoming Messages
TOT OG MSG	Total Outgoing Messages
TOT IN TSN	Total Incoming Transitions
TOT OG TSN	Total Outgoing Transitions.

Determining Link Requirements

4.23 The outgoing and incoming SUs required to establish, disconnect, and provide supervision for a call are carried by the separate channels, transmit and receive, that comprise a link. Each outgoing call generates an initial address message (IAM), a clear forward signal, and a continuity signal in the outgoing, or forward, direction. The same call will generate an address complete and a release guard signal, and may generate clear-back and answer signals in the incoming, or backward, direction. Answer and clear-back are not generated on every call attempt. An answer signal is generated only when the called party answers; a clear-back is returned only when the called party hangs up

first. Ineffective network attempts (ie, machine and facility congestion, reorders, or vacant codes) will affect the quantity of SUs transmitted.

4.24 There can be sizable differences in traffic volume in each direction, resulting in a higher attempt ratio for one direction. Consequently, the occupancy of a signal link must be computed separately for each direction to insure that signal link provision is based on the direction carrying the highest number of SUs per hour. This direction is used in determining the quantity of message trunks to be assigned to the link.

4.25 Initial CCIS link engineering requires knowledge of the characteristics of the trunk groups assigned to signal links, including types of trunks (1-way, or 2-way), attempts per equivalent 1-way trunk, and the quantity of SUs anticipated in each direction. Attempts per equivalent trunk are obtained by converting trunk group peg-count data to equivalent 1-way trunk data for all trunk groups to be modified to CCIS operation.

4.26 A flowchart (Fig. 16) illustrates the process used by the CCIS Network Administration Center (CNAC), by the network design engineer, and by the network administrator in planning for and implementing the signal link provision. This includes the assigning of trunk groups to the links. Entry to the flowchart begins on the left, with the decision to use CCIS in the office. Consequently, a list of offices is developed, with their service dates, for which CCIS is planned. The current Trunk Forecast (TF) for the planning period is also input at this time.

4.27 The TF and the list of proposed CCIS offices, with their service dates, are melded in the Planning and Analysis System. Network Administrators for new offices, or offices to be modified to CCIS, which will have 2,000 or more CCIS trunks, should provide the average attempts per circuit for all CCIS trunks for the switching system busy hour if, and when, requested by CNAC. This information is input to the CCIS Assignment System (CAS). The link loading is developed and input to the Planning and Analysis System, and an updated trunk and link forecast (M1974I and M1974K1) produced for all CCIS offices. Copies of each are forwarded to the operating companies for review. Conditions which may require modification of the forecast are reported to CNAC, and agreement to such changes reached. The changes are input

manually into CLASS for inclusion into subsequent runs. Since the current M1974K1 cannot be updated at this time, an updated link requirement list of A, B, C, E, and F links is developed by making the changes manually.

4.28 The updated link requirement list is forwarded to the network design engineers to provide basic data on the numbers of each type of link needed and the required dates. The network design engineer is responsible for either placing, or requesting the placing, of link terminal equipment orders, and for insuring that the terminals are available on the required date. The updated link requirement list is also input into the CCIS Assignment System (CAS), a part of the CLASS system. CAS assigns CCIS trunks to the various links. The Signal Link Trunk Assignment Report is one of the outputs and is available to the network administrators.

4.29 The network administrator is responsible for reviewing the link terminal equipment order for adequacy and timeliness, for monitoring the progress of the installation to ensure that the schedule is maintained, and for coordinating the cutover of new links and/or the modification of trunk groups to CCIS without detriment to service (see Part 7).

4.30 Link busy hours are obtainable from the Load Distribution Report (LDR). As covered in paragraph 4.22, signal link data for the busy hours are in the Machine Load and Service Summary (MLSS). This data should be analyzed by the network administrator for reasonableness. If it is not reasonable, corrective action should be taken. The MLSS data for busy days is consolidated into the Load Service Report (LSR), providing data to make up the 15-busiest-hours-of-the-year summary, plus an average of the 10 busiest hours. The signal link data from the LSR should be forwarded, monthly, to CNAC. At switching systems where dial-up ports are provided, CNAC may extract the data through these ports.

4.31 The network administrator is responsible for comparing link pair loads with their designed capacity. This should be done, weekly, by plotting the loads on a graph, as described in paragraph 7.07. The resulting curve, over a period of time, can be projected to obtain an estimated exhaust date for the link pair.

4.32 Should additional links be required when no order to add links exists, or should an existing order add links later than the estimated link pair exhaust date, the network design engineer should be notified. If the network design engineer is not aware of a schedule for additional link pairs, a consultation should be made with CNAC on relief plans for the office. Link relief is planned at CNAC through the use of CLASS.

4.33 As an aid to the network design engineer in computing peakedness, capacities, and exhaust dates for a particular signal link pair grouping, or cross-section, several worksheets are provided. Since signal link pairs are provided to handle the heaviest traffic load, regardless of direction, the worksheets permit computations for both directions of traffic.

Determination of Peakedness—Worksheet

4.34 The first requirement in computing signal link pair capacity is the determination of the peakedness of the traffic loads, for both directions, on the cross-sections involved. The table for determining peakedness, Fig. 10, has been provided for set values of occupancy, transitions, and average message lengths. For intermediate values, interpolation must be used. A worksheet, Fig. 17, is provided for making such interpolations. To help in understanding how it is used, a worksheet, Fig. 18, shows the computations for the outgoing direction. The computations are explained below.

4.35 The various data required in computing peakedness are obtained from the 10 busiest day averages of the Load Service Report (LSR) (Fig. 14) for the links involved. The values of occupancy, transitions, and average message length (TOTAL SIGNAL UNITS/MESSAGE—Fig. 14) in SUs are entered at the top of Sheet 1 of the worksheet. In the example used (Fig. 18), arbitrary values are given. Occupancy is 140,000 outgoing, transitions are 52,000 outgoing, and average message length is 1.34 outgoing.

4.36 Where the accuracy of the value of peakedness is not essential, such as in the case of making a rough estimate of signal link capacity, it can be determined in the following manner. Using the values given in paragraph 4.35 and referring to the table (Fig. 10, Page 1) under the Occupancy—Signal Units column, it can be seen that the given, or actual, value, 140,000, is not

shown; however, a value above (142,000) and a value below (130,000) are shown. Each of these occupancy values has a subsection of the table shown under it. The transition value, 52,000, also is not shown. However, a value above (56,000) and one below (49,000) can be found in each of the two occupancy subsections previously mentioned. Next, in the column for the 10 high-day average message length (AML), 1.34 is looked for but is not found. However, the value above (1.50) and the one below (1.25) are found. In the 1.50 AML column, peakedness is 2.2 and 1.9 for 130,000 SUs and 2.2 and 2.0 for 142,000 SUs. In the 1.25 AML column, peakedness is 2.6 and 2.3 for 130,000 SUs and 2.6 and 2.4 for 142,000 SUs. A judgment estimate of the mean of these values of peakedness would place the peakedness of the signal traffic in the vicinity of 2.2.

4.37 Where a more accurate estimate of the peakedness is desired, completing the worksheet (Fig. 17) should provide it. To do this, refer to the completed worksheet (Fig. 18); the values covered in paragraph 4.34 can be seen entered in the top part of Sheet 1. The occupancy value has been entered again as the *actual* value on line 1, transitions on line 5, and AML on line 9 (Part I of the worksheet).

4.38 As previously mentioned, the worksheet permits computing peakedness for both the incoming and outgoing channels. However, only the computations for the outgoing channel will be discussed for this example. Referring to Fig. 10, two subsections (occupancy) are used, the one below (130,000) the actual value of occupancy (140,000) and the one higher (142,000). The lower value is entered on line 2, and the higher on line 3. Within these two subsections of the table dedicated to these occupancy value subsections of the table, the numbers of transitions are located, one below (49,000) the actual (52,000) and one above (56,000). These are entered on lines 6 and 7, respectively. Finally, the columns for the AML values below (1.25) and above (1.50) the actual value (1.34) are located, and these values entered on lines 10 and 11, respectively.

4.39 Next, the interpolation ratio, or the percentage of the difference between the lower and the higher values that the actual value is, for each of the three categories, is computed in accordance with the equation on line 4 for occupancy, line 8

for transitions, and line 12 for average message length (AML).

4.40 Part II of the worksheet is arranged to guide the interpolation of each of the three categories: AML—Subsection A, Transitions—Subsection B, and Occupancy—Subsection C, using the interpolation ratios developed in Part I and resulting in the development of peakedness, adjusted from the given values of the table (Fig. 10) to the actual values of the 10 busiest days' values. The top of Page 2 is for the incoming channels of the signal link pairs; the bottom is for the outgoing channels. The number of signal units of occupancy (Fig. 10) lower (130,000) than the 10 busiest days' quantity (140,000) is entered on the left, while the higher than the 10 busiest days' quantity (142,000) is entered on the right at the top of the outgoing part of the worksheet. Below the two occupancy values are four columns. The two left-hand columns are for computation of data relative to the lower occupancy value, and the two right-hand columns relate to the higher occupancy value. The first and third columns relate to the lower (49,000) than actual (52,000) transitions (from line 6 of Page 1), while the second and fourth relate to the higher (56,000) number (line 7 of Page 1), (130,000) and (142,000) of the table (Fig. 10), the peakedness value 2.6 is obtained from the lower occupancy (130,000) subsection, at the intersection of the lower transitions line (49,000) and the lower AML column (1.25). This is entered on line 14, in the first column. Similarly, peakedness values are entered in the other columns for line 14. Each value on line 14 is obtained from the lower AML value (1.25) column of Fig. 10. Line 14's second column peakedness (2.3) is obtained from Fig. 10 at the intersection of the (1.25) column and the higher transitions (56,000) line in the lower (130,000) occupancy subsection. Line 14's third column peakedness (2.6) and fourth column peakedness (2.4) are obtained from Fig. 10 at the 1.25 column's intersection, in the higher (142,000) occupancy subsection, with the lower (49,000) transitions line and higher (56,000) transitions line, respectively. Line 15 peakedness values are obtained in a similar manner but from the higher (1.5) AML column.

4.41 As indicated by the minus sign, line 15 values are subtracted from line 14, and the differences entered on line 16. The interpolation ratios (from line 12, page 1) are entered on line 17, and, as indicated by the multiplication sign, are multiplied with line 16. The products are entered

on lines 18 and 20, as adjustments to be made to peakedness. Therefore, the peakedness of the lower values of AML (line 14) are entered on line 19, and, as indicated by the minus signs, the adjustments (line 20) are subtracted from them. The remainders (line 21) are the values of peakedness adjusted to actual average message length (AML).

4.42 Subsection B covers the development of peakedness adjusted to the actual transitions through interpolation. In this subsection, the outgoing channel's data are developed. There are two columns under each direction of signaling to permit the development of the adjustment of peakedness to the 10 busiest days' numbers of transitions for the occupancy value lower than the actual 10 busiest days' transitions on line 22, and higher than the actual 10 busiest days' transitions on line 23. Line 23 is subtracted from line 22, and the remainder entered on line 24. The remainder is multiplied by the interpolation ratios (line 25) developed earlier (line 8); the products (line 26) are the adjustments to be made to peakedness (line 27), a reentry of line 22. The adjustments (line 26) are reentered on line 28 to permit subtracting from line 27. The remainder (line 29) is the peakedness adjusted to the actual 10 busiest days' AML and transitions.

4.43 Subsection C covers the computation of the peakedness for the outgoing channel by adjusting the peakedness values developed in subsections A and B to the value for the 10 busiest days' occupancies. The peakedness (adjusted to 10 busiest days' AML and transitions, line 29) for the higher value of occupancy is entered on line 30, and for the lower value on line 31. Subtracting line 31 from line 30 provides the difference (line 32) which is multiplied by the extrapolation ratio (line 33), and results in the adjustment to be made to peakedness (line 34). This is added to the peakedness of the lower value of occupancy (line 35). The sum of the two (line 36) is the peakedness for the 10 busiest days' average message length, transitions, and occupancy.

Signal Link Capacity and Exhaust

4.44 The network design engineer should be able to determine the adequacy of signal link capacity in a cross-section, and to estimate the date that additional signal link pairs will be required. A worksheet (Fig. 19) is provided to aid in the computations. Section I of the worksheet is used

for each signal link pair. Total signal link cross-section computations are made on Section II of the worksheet. In many cases, there will be only one link pair in the cross section, and one worksheet will suffice. Where more than one link pair exists, Section II on the worksheet for the last link pair computed in the cross section should be used.

4.45 The first entry to be made in Section I of the worksheet is the peakedness of the traffic on the link pair in each direction. This was computed earlier (paragraphs 4.34 through 4.43) and entered on line 1 (Fig. 20 is an example of the method of using the worksheet). The capacity of the signal links in SUs is obtained by looking in the table in paragraph 4.16 for the peakedness, entered on line 1. Should the peakedness be a value between those given in the table, the capacity for the next higher value of peakedness should be used. The signal link pair capacity so obtained should be entered on line 2, together with the peakedness value used.

4.46 The 10 busiest days' total signal link load in SUs (from the LSR) is entered on line 3, and the call-related (CRL) 10 busiest days' SUs are entered on line 4. The percent that the CRL SUs represent of the total SUs (line 4 ÷ line 3) is computed and entered on line 5. Next, the CRL capacity of the signal link pair is computed (line 2 × line 5) and entered on line 6. The total number of equivalent 1-way trunks (from the LSR) is entered on line 7. This quantity is divided into the CRL SUs of line 4, producing the CRL SUs per average equivalent 1-way trunk (line 8).

4.47 When computations are complete for all signal link pairs in the cross section, Section II of the worksheet for the last pair is used to combine the data into the cross-section totals. The first entry in Section II is the number of link pairs in the cross section (line 9). Next, the call related (CRL) capacity of the cross section is entered (line 10). This is obtained by adding the CRL capacities (line 6) of all link pairs in the cross section. The 10 busiest days' CRL SUs in the cross section (line 11) is an addition of all line 4s in the cross section. All line 7s, total equivalent 1-way trunks, are combined and their sum entered on line 12. An average of the CRL SUs per average equivalent 1-way trunks (line 8) for all signal link pairs in the cross section is compiled and divided into the CRL SU capacity (line 10). The quotient is entered on line 13. Next, the office growth rate in

equivalent 1-way trunks (line 14) is determined, either by computing historical growth, or by analysis of trunk forecasts. The equivalent 1-way trunks in the cross section (line 12) are compounded at the growth rate (line 14) until line 12 exceeds line 13. This provides the number of years to exhaust for determining the projected exhaust date (line 15).

5. CCIS NETWORK ADMINISTRATION CENTER (CNAC) RESPONSIBILITIES

5.01 The Common Channel Interoffices Signaling (CCIS) Network Administration Center (CNAC) has primary responsibility for the planning for, and administration of, the CCIS network:

- (a) To accommodate new CCIS trunk groups
- (b) To provide for the normal growth of working CCIS trunk groups.

5.02 CNAC is responsible for ensuring the orderly integration of new CCIS developments into the existing network, and for making rearrangements of the CCIS network that may be necessary in its evolution.

5.03 CNAC is responsible for providing all CCIS terminal, band, and label assignments. This includes engineering for, and verification of, proper link diversity, and assignment of signal paths for specific message circuits (ie, terminal, band, and label).

5.04 All STP assignments are made by CNAC. Updating each STP's data base is a responsibility of CNAC. The data base is updated through the issuance of either recent change notices or new data base tapes to the network administrator. CNAC is responsible for the maintenance of records covering all installed and planned-for CCIS link equipment, and of records covering all assignments referred to in previous paragraphs.

5.05 CCIS traffic data from the Load Service Report (LSR) should be analyzed for validity by each SO and STP network administrator. This data is forwarded to CNAC in accordance with schedules provided by CNAC. CNAC is responsible for determining actual signal link requirements through the comparison of the link forecasts with link load growths and traffic characteristics obtained from current and historic traffic data.

5.06 CNAC is responsible for ensuring that signal link circuit orders are issued in accordance with the following schedule:

- Initial "A" Links—At least 8 months prior to the switching office service date
- Initial "B" Links—At least 3 months prior to the STP service date
- Growth Links—At least 8 months prior to the required date.

5.07 CNAC is provided with various Electronic Data Processing (EDP) systems to assist in the engineering, assignment, and administration of the CCIS network. Included in these systems are: the Planning and Analysis System, the Schedule of Cutover/Conversion (SOCC), the Signal Path Assignment and Record Keeping System (SPARKS), and the CCIS Link Assignment and Servicing System (CLASS).

5.08 The Planning and Analysis System uses a batch processor, which is run semiannually, and provides a number of planning outputs, by year, for a 5-year period. It uses the trunk forecasts from all Operating Telephone Companies, including Long Lines, as inputs. The Planning and Analysis System also uses a Switching Office Conversion/STP Table to determine the cutovers and the CCIS conversions in each year for the 5-year period. This table is updated by CNAC with information from SOCC and from the No. 4A/4E forecast (M953) of new switching offices. The Planning and Analysis System outputs are:

- CCIS Signal Path Requirements
- CCIS Candidate Trunks by Switching Office
- CCIS Signal Path Band/Trunk Summary
- CCIS Planning and Analysis System Total Link Facilities
- CCIS Network Terminal Requirements/Region
- Magnetic data tape of each Operating Company signal link requirements, which are input into the Long Lines Trunk Forecasting System.

5.09 The Schedule of Cutover/Conversions (SOCC) program is in Long Lines' 8600 MUSIC system (McGill University System for Interactive Computing). It provides a 4-year forecast, by year, of the switching system cutover dates, specific trunk group quantities, and CCIS conversion dates. The trunk groups are shown with trunk quantities, by type and direction, of transmission. A total, by office, is also given. Inputs to the program are the Trunk Forecasts by all OTCs, including Long Lines and the No. 4A/4E forecast (M953) of new switching offices. An offshoot of SOCC is the Operations Schedule of Cutovers/Conversions (OSOCC), which is used to schedule the CCIS trunk conversion activities for specific days.

5.10 The Signal Path Assignment and Record Keeping System (SPARKS) is also in Long Lines' 8600 MUSIC system. It contains all CCIS network assignments. Its replacement, by the CCIS Assignment System (CAS), is planned for early 1979. SPARKS can be dial accessed by users with the proper identification and password. The outputs of SPARKS are:

- The STP Switching Office List (STPSWL) is a list of all signal paths assigned to all trunk groups at a particular switching office.
- The STP List (STPLST) is a list of signal paths assigned to a specific trunk group at a particular switching office.
- The Switching Office Label (SWLBL) is a list of translation data for an individual switching office by trunk group, type, and direction. It provides terminal, band, label, and circuit number information.
- The Trunk Group Label (TGLBL) is a list of translation data for an individual trunk group, by type and direction. It includes the terminal, band, label, and circuit number.

5.11 The CCIS Link Assignment and Servicing System (CLASS) is on Long Lines' 8600 MUSIC system, and is run monthly. CLASS uses trunk forecasts, plus current and historic traffic data. It computes the traffic loads, the peakedness of traffic loads, and the capacities of existing links. It also computes the numbers of new links required, and whether "E" or "F" links should be provided.

5.12 More detailed information covering the CNAC responsibilities in the development of signal link quantities, in signal link assignment and in the administration of the CCIS network, can be found in Section 333-200-027.

6. NETWORK DESIGN RESPONSIBILITIES

6.01 The efficient operation of the CCIS network is dependent on the coordinated effort of the network administrators and network design engineers of each Operating Telephone company (OTC) and the CCIS Network Administration Center (CNAC). It is essential that each company provide the necessary equipment, installed and working, at the scheduled time, and that required CCIS traffic data is forwarded to CNAC.

6.02 The network design engineer is responsible for computing accurate final forecasts of trunk groups, including the number of trunks in each group and their direction of operation. These should be forwarded by the network design engineer to CNAC, using the Business Information Systems Trunk Forecasting System (BIS/TFS) forecast output. Two other formats may be used on an interim basis. These are: the CCIS Planning and Input form, and the Long Lines Trunk Forecast (TF) mechanized output. Operating Telephone companies unable to meet one of these format requirements are responsible for either modifying their own programs accordingly, or completing manual input forms for each forecast (see Section 010-430-102).

6.03 The M1974I form (CCIS Candidate Trunks by Switching Office) and the M1974KI form (CCIS Total Signal Link Facility Requirements) are outputs of the Planning and Analysis System at CNAC (Fig. 16). The report for each switching system will be forwarded to the OTC responsible. It should be carefully reviewed by the network design engineer, and discrepancies or changes required by the OTC should be referred to CNAC. Such changes, as are agreed upon, can be made manually by CNAC, and an updated link requirement list issued (see paragraph 4.27). A tape of each OTC's signal link requirements is also an output of the Planning and Analysis System, and is provided to the OTC.

6.04 Based on the resulting updated link requirements list, orders should be placed for the signal terminal equipment early enough to be available for the required service date. The network design

engineer should respond to requests for assistance from the network administrator, or network maintenance, for expediting the installation or for making such changes as may be needed to ensure the proper terminal equipment at the required date.

6.05 Should the network administrator detect the probability that available signal links will exhaust prior to planned relief dates (see paragraphs 4.31 and 7.07), the network design engineer is responsible for reviewing the problem with CNAC and, if necessary, recommending relief action. Should the network design engineer wish to compute the peakedness of traffic, the capacity, or the exhaust date of a particular signal link cross-section, refer to paragraphs 4.23 through 4.47 of this practice.

7. NETWORK ADMINISTRATION RESPONSIBILITIES

7.01 The network administrators are responsible for:

- (1) Reviewing and recommending changes to Network Design CCIS Orders, where necessary
- (2) Monitoring service in the office
- (3) Coordinating CCIS installation and circuit order activities
- (4) Collecting, analyzing, and distributing CCIS traffic data.

They are also responsible for the effects their switching systems have on the CCIS network.

7.02 Orders and specifications covering the installation of signal link terminal equipment (Fig. 16) should be reviewed to ensure that no omissions or errors exist, and that the schedule provides additional links in time for their need (see paragraph 4.28). Existing trunk and signal link forecasts provide information on quantities to be expected, and the anticipated date they will be needed.

7.03 The establishing of new signal links, the modification of trunk groups to CCIS, and the start-up of new trunk groups should be preplanned well in advance and closely coordinated. All steps required to ensure continuity of service should be taken. The network administrator is responsible

for the administrative part of establishing or changing signal links and/or trunk groups.

7.04 The network administrator should ensure that all CCIS traffic data gathering equipment, including data links, are functioning properly.

7.05 The network administrator is responsible for analyzing Machine Load and Service Summaries (MLSS) (Fig. 11), CCIS Summary Reports (CCSR) (Fig. 12), Load Distribution Reports (LDR) (Fig. 13), and Load Service Reports (LSR) (Fig. 14). Improper or faulty data should be investigated and the problem corrected as soon as feasible. The network administrator for new switching systems, or systems being modified to CCIS, may be requested to provide CNAC with the attempts per circuit per hour (ACH) for each CCIS planned trunk group.

7.06 Trunk assignments from the Signal Link Trunk Assignment Report (see paragraph 4.27) should be reviewed and any irregularities

referred to CNAC. Unless otherwise authorized by CNAC, all assignments should be adhered to.

7.07 Link loads on each signal link pair should be graphed weekly, using the highest busy hour of each week (see paragraph 4.31). The link load growth rate will develop on the graph over a period of time. An estimated exhaust date for the link pair can be determined by projecting the graph ahead to the point it reaches full load capacity. The full load capacity for each link pair can be obtained from the CNAC CLASS Output Report. This report has notes specifying uses for the other portions of the report. Adjustments should be made to the graph to compensate for the added link load from known modification of trunk groups to CCIS, and for the introduction of new trunk groups planned during the growth period. Should the exhaust appear to occur before the planned addition of terminal equipment, and no other plans for relief are known, the network design engineer should be alerted.

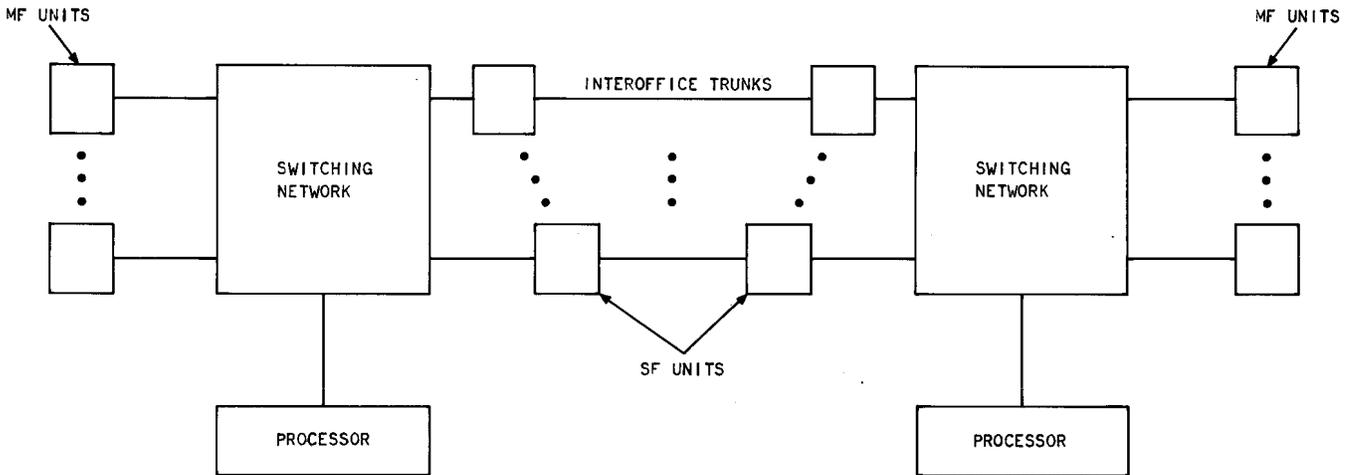


Fig. 1—Block Diagram of Inband Signaling

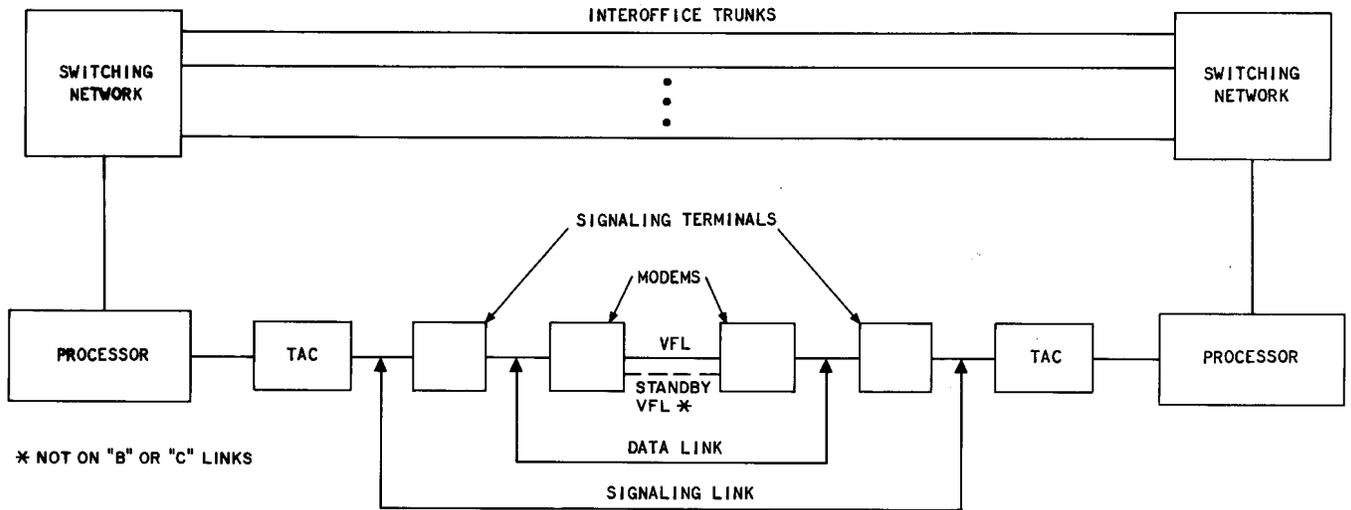


Fig. 2—Block Diagram of CCIS Signaling

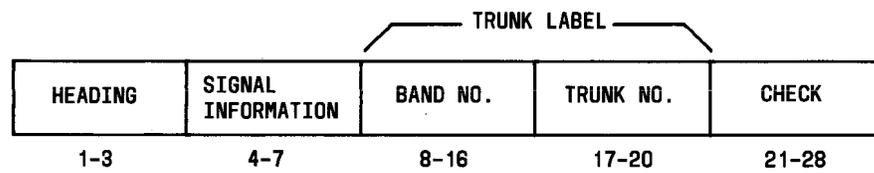


Fig. 3—Lone Signal Unit (LSU)

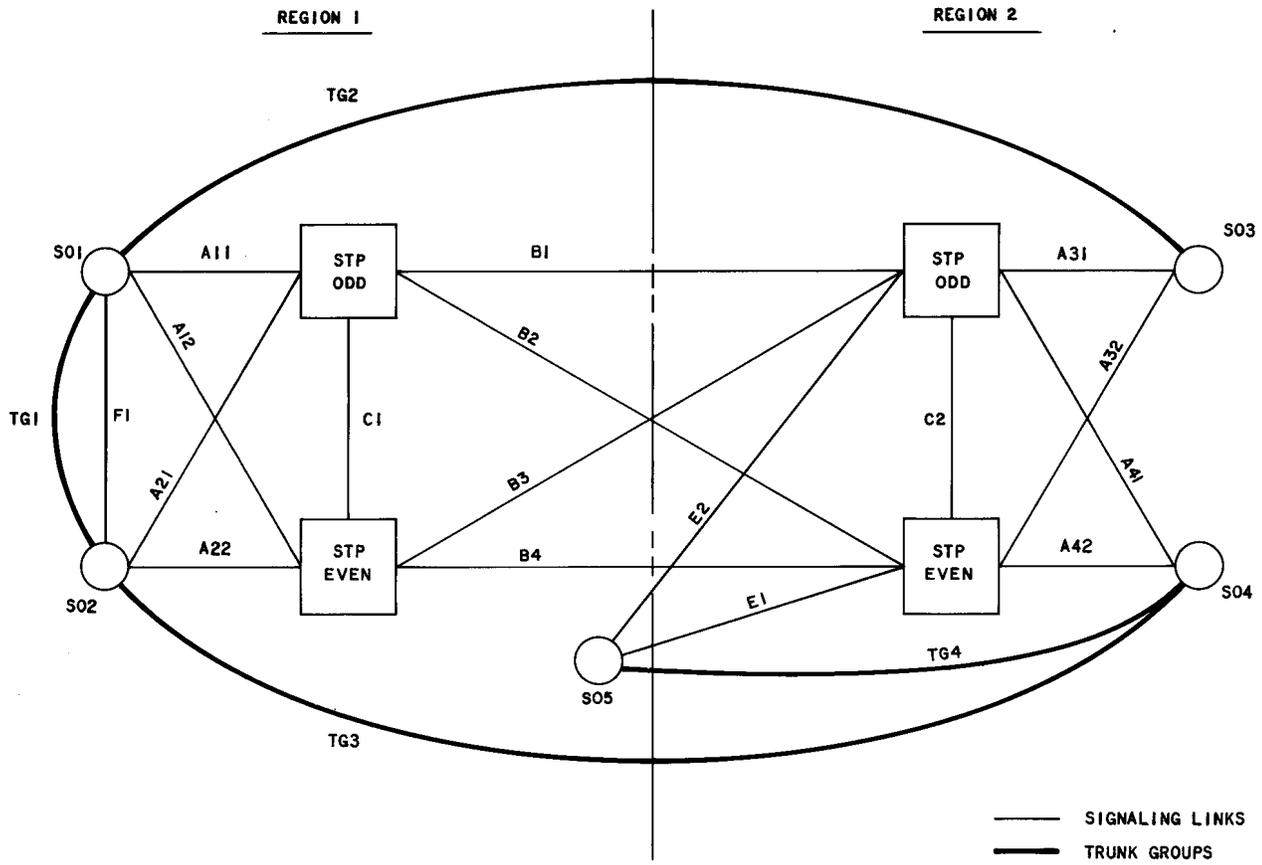


Fig. 4—Block Diagram of CCIS Network Structure

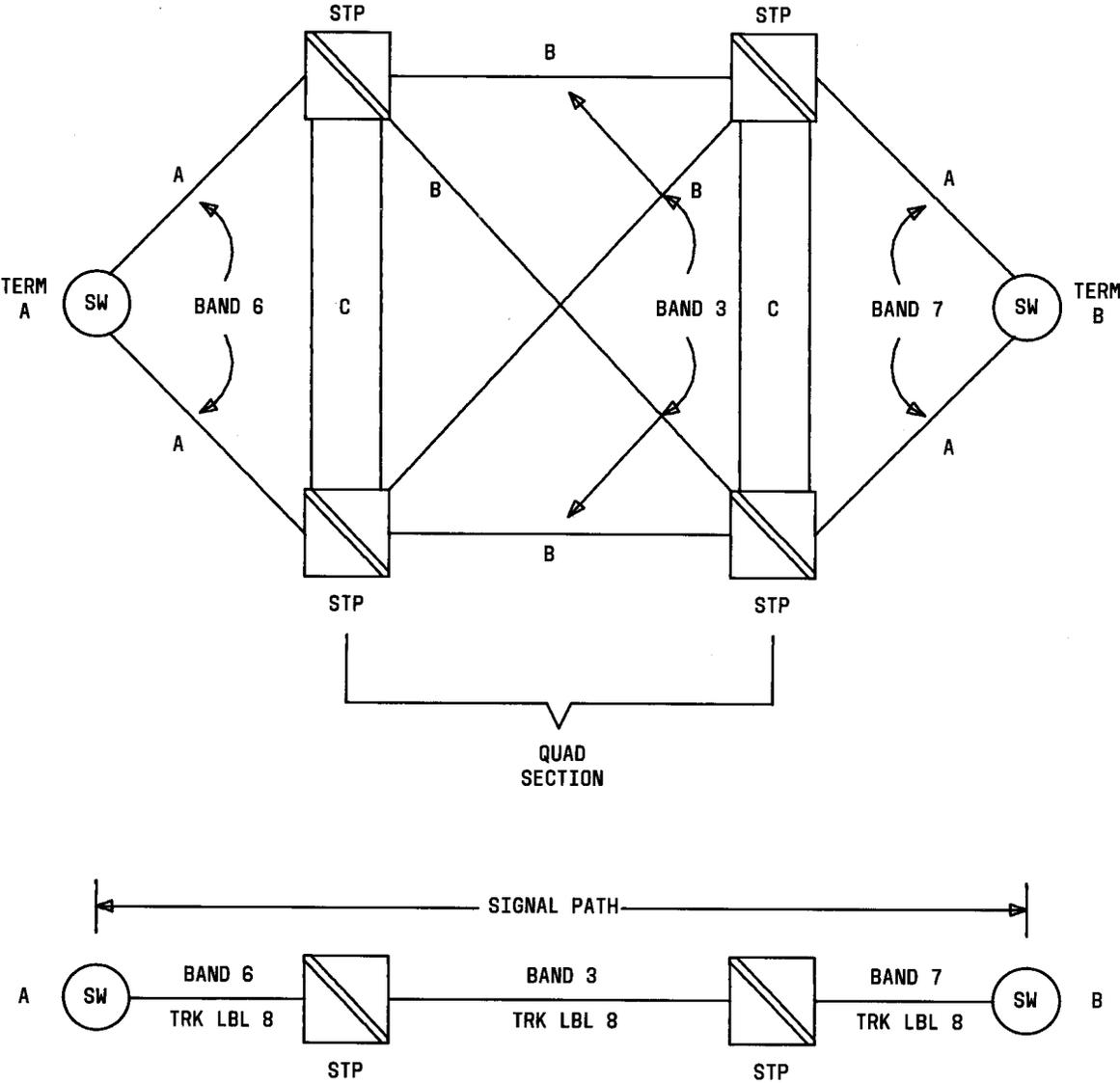


Fig. 5—Basic CCIS Interregional Signal Path Configuration

TM 10	BUS 0	BUS 1	TM 15
TM 9	TAC 0	TAC 1	TM 14
TM 8	TM 2	TM 5	TM 13
	CONT PANEL	CONT PANEL	
BAFFLE	PWR CONT	PWR CONT	BAFFLE
	BAFFLE	BAFFLE	
TM 7	TM 1	TM 4	TM 12
TM 6	TM 0	TM 3	TM 11
			BAFFLE
P.S.	P.S.	P.S.	P.S.
P.S.	P.S.	P.S.	P.S.
	F.P.	F.P.	

SUPPLEMENTARY
FRAME 2'-2"

BASIC FRAME
4'-4"

SUPPLEMENTARY
FRAME 2'-2"

Fig. 6—No. 4 ESS CCIS Terminal Group Frame

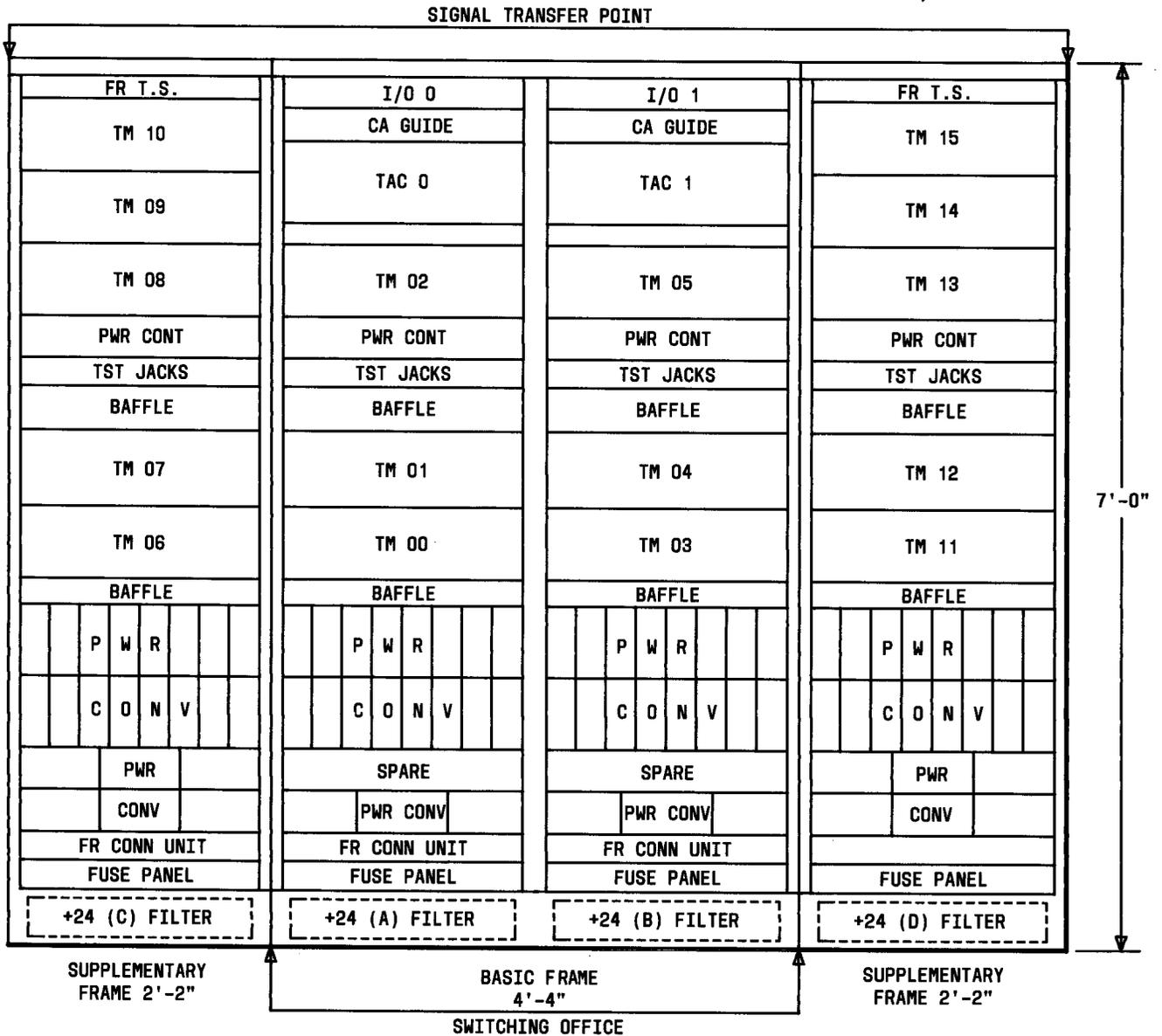


Fig. 7—No. 4A/ETS CCIS Terminal Group Frame

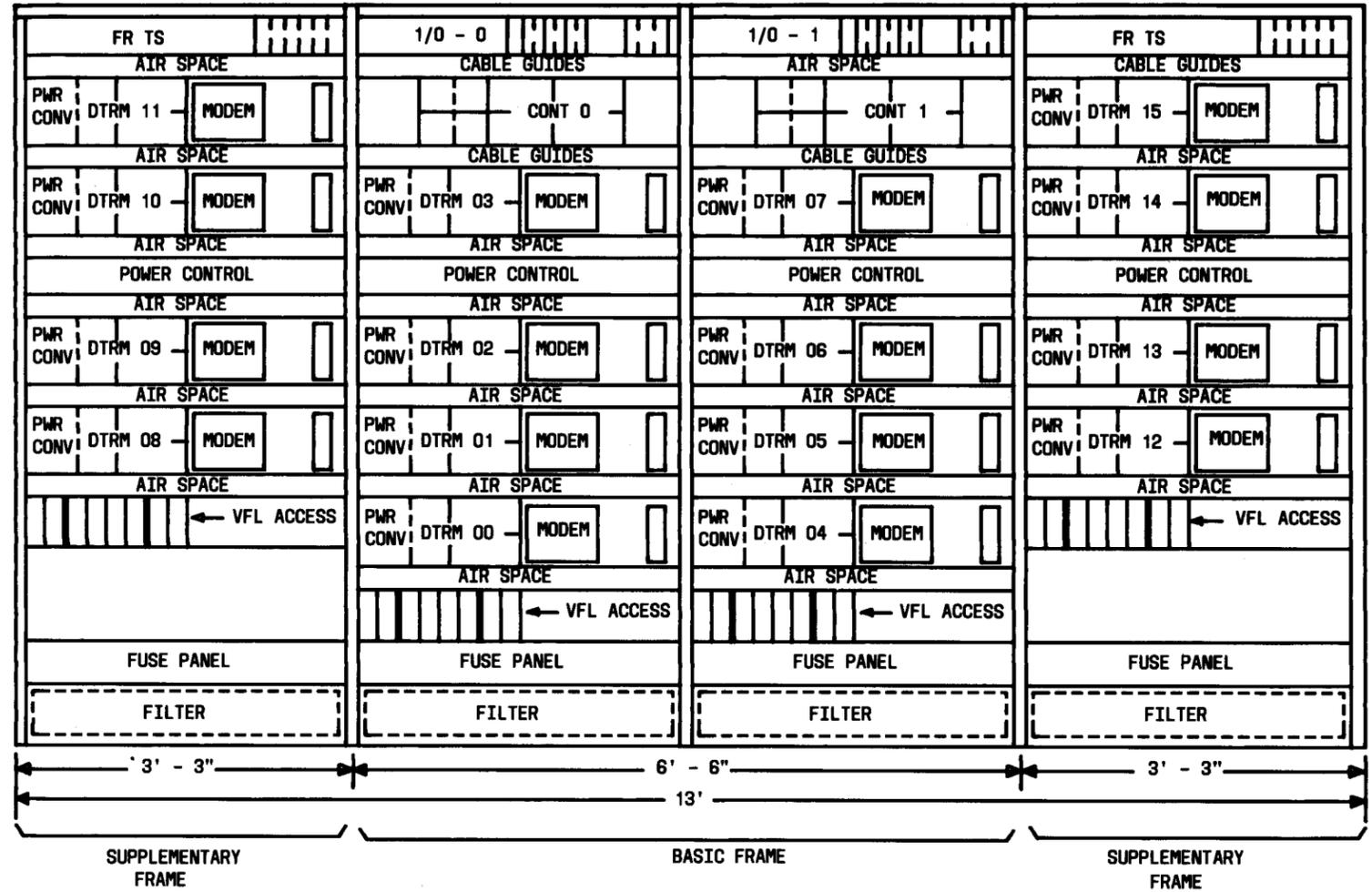
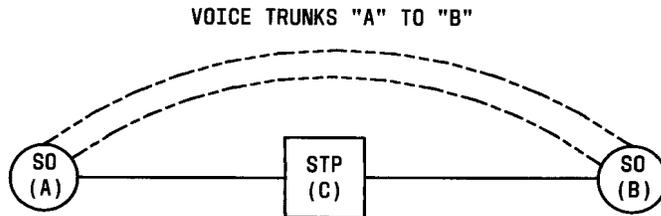


Fig. 8—No. 1/1A ESS Toll CCIS Terminal Group Frame



CCIS SIGNAL	SUs GENERATED PER CALL		SUs GENERATED PER CALL	
	ATTEMPT ORIGINATING AT		ATTEMPT ORIGINATING AT	
	SO (A)	STP (C)	SO (A)	STP (C)
INITIAL ADDRESS MESSAGE (IAM)	3 TO 5 (NOTE 1)			3 TO 5
ADDRESS COMPLETE (ADC)		1	1	
CONTINUITY (COT)	1			1
ANSWER (ANC)		.7 (NOTE 2)	.7 (NOTE 2)	
CLEAR BACK (CBI)		.3 (NOTE 3)	.3 (NOTE 3)	
CLEAR FORWARD (CLF)	1			1
RELEASE GUARD (RLG)		1	1	

NOTES:

1. AN IAM FOR A 7-DIGIT CALL REQUIRES 3 OR 4 SUs, AND AN IAM FOR A 10-DIGIT CALL REQUIRES 4 OR 5 SUs, DEPENDING ON WHETHER FULL OR ABBREVIATED ROUTING IS USED.
2. PERCENT OF CCIS CALLS ANSWERED.
3. PERCENT OF CCIS CALLS ON WHICH CLEAR BACK IS SENT. (SENT ONLY WHEN CALLED PARTY HANGS UP FIRST).

Fig. 9—Typical CCIS Signaling Sequence and SUs Generated Per Call

SECTION 333-200-060

OCCUPANCY		TRANSI- TIONS	AVERAGE MESSAGE LENGTH						
PERCENTAGE	SIGNAL UNITS		1.25	1.50	1.75	2.00	2.25	2.50	2.75
		PEAKEDNESS							
0.37	105,000	19,000	3.0	3.0	3.0	3.0	3.0	2.7	2.3
		25,000	3.0	3.0	3.0	2.7	2.5	2.1	1.6
		32,000	3.0	2.9	2.7	2.3	1.9	1.5	1.2
		37,000	3.0	2.7	2.2	1.7	1.3	1.2	1.1
		43,000	2.7	2.3	1.7	1.4	1.1	1.0	1.0
		49,000	2.4	1.8	1.2	1.1	1.0	1.0	1.0
		56,000	1.9	1.4	1.1	1.0	1.0	1.0	1.0
		64,000	1.4	1.1	1.0	1.0	1.0	1.0	1.0
		74,000	1.1	1.0	1.0	1.0	1.0	1.0	1.0
0.420	118,000	19,000	3.0	3.0	3.0	3.0	2.9	2.6	2.3
		25,000	3.0	3.0	3.0	2.7	2.5	2.1	1.8
		32,000	3.0	2.9	2.7	2.4	2.0	1.7	1.3
		37,000	3.0	2.8	2.3	1.9	1.5	1.3	1.1
		43,000	2.8	2.4	1.9	1.6	1.3	1.1	1.0
		49,000	2.5	2.0	1.4	1.3	1.1	1.0	1.0
		56,000	2.1	1.6	1.3	1.1	1.0	1.0	1.0
		64,000	1.7	1.3	1.1	1.1	1.0	1.0	1.0
		74,000	1.5	1.2	1.0	1.0	1.0	1.0	1.0
0.46	130,000	19,000	3.0	3.0	3.0	2.9	2.9	2.6	2.4
		25,000	3.0	3.0	3.0	2.7	2.5	2.2	1.9
		32,000	3.0	2.9	2.7	2.4	2.1	1.8	1.5
		37,000	3.0	2.8	2.4	2.1	1.8	1.4	1.1
		43,000	2.8	2.5	2.0	1.7	1.4	1.2	1.1
		49,000	2.6	2.2	1.7	1.4	1.1	1.1	1.0
		56,000	2.3	1.9	1.4	1.2	1.0	1.0	1.0
		64,000	2.0	1.6	1.2	1.1	1.0	1.0	1.0
		74,000	1.7	1.3	1.0	1.0	1.0	1.0	1.0
0.50	142,000	19,000	3.0	3.0	3.0	2.9	2.8	2.6	2.3
		25,000	3.0	3.0	2.9	2.7	2.5	2.2	2.0
		32,000	3.0	2.9	2.7	2.4	2.2	1.9	1.6
		37,000	3.0	2.8	2.4	2.1	1.9	1.5	1.2
		43,000	2.8	2.5	2.1	1.8	1.5	1.3	1.1
		49,000	2.6	2.2	1.8	1.5	1.2	1.1	1.0
		56,000	2.4	2.0	1.6	1.3	1.1	1.0	1.0
		64,000	2.1	1.7	1.3	1.2	1.0	1.0	1.0
		74,000	1.9	1.5	1.1	1.1	1.0	1.0	1.0

Fig. 10—Converting Occupancy, Transitions, and Average Message Length into Peakedness (Sheet 1 of 2)

OCCUPANCY		TRANSI- TIONS	AVERAGE MESSAGE LENGTH						
PERCENTAGE	SIGNAL UNITS		1.25	1.50	1.75	2.00	2.25	2.50	2.75
		PEAKEDNESS							
0.55	155,000	19,000	3.0	3.0	3.0	2.9	2.7	2.5	2.3
		25,000	3.0	3.0	2.9	2.7	2.5	2.2	2.0
		32,000	3.0	2.9	2.6	2.4	2.2	1.9	1.7
		37,000	2.9	2.7	2.4	2.2	1.9	1.6	1.3
		43,000	2.8	2.5	2.2	1.9	1.6	1.4	1.2
		49,000	2.6	2.3	1.9	1.6	1.4	1.2	1.1
		56,000	2.4	2.0	1.7	1.4	1.2	1.1	1.0
		64,000	2.2	1.8	1.4	1.2	1.0	1.0	1.0
		68,000	2.0	1.6	1.2	1.1	1.0	1.0	1.0
		74,000	1.7	1.4	1.1	1.1	1.0	1.0	1.0
0.59	167,000	19,000	3.0	3.0	3.0	2.8	2.6	2.5	2.3
		25,000	3.0	2.9	2.8	2.6	2.4	2.2	2.0
		32,000	3.0	2.9	2.6	2.4	2.2	2.0	1.7
		37,000	2.9	2.7	2.4	2.2	2.0	1.7	1.5
		43,000	2.8	2.5	2.2	2.0	1.7	1.5	1.2
		49,000	2.6	2.3	2.0	1.7	1.5	1.3	1.1
		56,000	2.4	2.1	1.8	1.5	1.3	1.1	1.0
		64,000	2.2	1.9	1.6	1.3	1.0	1.0	1.0
		68,000	2.0	1.7	1.4	1.2	1.0	1.0	1.0
		74,000	1.8	1.5	1.2	1.1	1.0	1.0	1.0
0.64	179,000	19,000	3.0	3.0	2.9	2.7	2.6	2.4	2.2
		25,000	3.0	2.9	2.7	2.5	2.4	2.2	2.0
		32,000	2.9	2.8	2.5	2.3	2.2	2.0	1.8
		37,000	2.8	2.6	2.3	2.2	2.0	1.8	1.5
		43,000	2.7	2.4	2.2	2.0	1.8	1.5	1.3
		49,000	2.5	2.3	2.0	1.8	1.6	1.3	1.1
		56,000	2.4	2.1	1.8	1.6	1.4	1.2	1.1
		64,000	2.2	1.9	1.6	1.4	1.1	1.1	1.0
		68,000	2.0	1.8	1.5	1.3	1.1	1.0	1.0
		74,000	1.9	1.6	1.3	1.2	1.0	1.0	1.0
0.68	191,000	19,000	3.0	2.9	2.8	2.6	2.5	2.3	2.2
		25,000	2.9	2.8	2.6	2.5	2.3	2.2	2.0
		32,000	2.9	2.7	2.5	2.3	2.1	2.0	1.8
		37,000	2.7	2.5	2.3	2.1	2.0	1.8	1.6
		43,000	2.6	2.4	2.1	2.0	1.8	1.6	1.4
		49,000	2.5	2.2	2.0	1.8	1.6	1.4	1.2
		56,000	2.3	2.1	1.8	1.6	1.4	1.3	1.1
		64,000	2.2	1.9	1.7	1.5	1.3	1.1	1.0
		68,000	2.1	1.8	1.5	1.3	1.1	1.1	1.0
		74,000	1.9	1.7	1.4	1.2	1.0	1.0	1.0

Fig. 10—Converting Occupancy, Transitions, and Average Message Length into Peakedness (Sheet 2 of 2)

REPORT: MACHINE LOAD AND SERVICE SUMMARY				MLSS	OFFICE:				
PERIOD:			PAGE	DATE:					
CCIS TERMINALS		INCOMING							
<u>LINE</u>	<u>TGR-TER</u>	<u>TOT INC SU</u>	<u>%INC OCC</u>	<u>INC SU/MSG</u>	<u>TOT IN TSN</u>	<u>INC MISC MUM</u>	<u>INIAM</u>	<u>OGANS</u>	<u>%OG COMP</u>
5									
10									
15	SL-PR								
20									
25									
30	SL-PR								
35									
40									
45	SL-PR								
50									
55									
60	SL-PR								
65									
70									
75	SL-PR								
80									
85									
90	SL-PR								
95									
100									
105	SL-PR								
110									
115									
120	SL-PR								
125	AVG								

Fig. 11—Machine Load and Service Summary for No. 1 and No. 4 ESS (Sheet 1 of 2)

REPORT: MACHINE LOAD AND SERVICE SUMMARY MLSS OFFICE:
 PERIOD: PAGE DATE:
 CCIS TERMINALS OUTGOING

<u>LINE</u>	<u>TGR- TER</u>	<u>TOT OG SU</u>	<u>%OG OCC</u>	<u>OG SU/ MSG</u>	<u>TOT OG TSN</u>	<u>OG MISC MUM</u>	<u>OGIAM</u>	<u>INANS</u>	<u>%OG COMP</u>
5									
10									
15	SL-PR								
20									
25									
30	SL-PR								
35									
40									
45	SL-PR								
50									
55									
60	SL-PR								
65									
70									
75	SL-PR								
80									
85									
90	SL-PR								
95									
100									
105	SL-PR								
110									
115									
120	SL-PR								
125	AVG								

	CCIS TRUNK ASSIGNMENTS												
	<u>TGR- TER</u>	<u>1WIN</u>	<u>1WOUT</u>	<u>2W</u>	<u>E1WIN</u>	<u>ATT/ E1WI</u>	<u>E1WO</u>	<u>ATT/ E1WO</u>	<u>BUF OVLD</u>	<u>% OVLD</u>	<u>BUF OFL</u>	<u>AUT TRF</u>	<u>MTG USG SECS</u>
130													
135													
140													
145													
150													
155													
160													
165													
170													
175													
180													
185													
190													
195													
200													
205													

Fig. 11—Machine Load and Service Summary for No. 1 and No. 4 ESS (Sheet 2 of 2)

Note: CCIS Summary Report (CCSR) for No. 4A/ETS in process of development by the Bell Telephone Laboratories.

Fig. 12—CCIS Summary Report (CCSR) for No. 4A/ETS (To be Supplied)

REPORT, LOAD DISTRIBUTION

DATE: []
 ACCUMULATION PERIOD: []-[]
 CCIS TERMINAL PAIRS PAGE

OFFICE: []
 ENGR PERIOD: [] TO []
 ENGD CAPACITY: [].[]%
 PLANNED UTILIZATION: [].[]%

INCOMING TOTAL SIGNAL UNITS [000]
 SIGNAL LINK PAIRS [FRAME-00]

	00-01		02-03		04-05		06-07		08-09		10-11		12-13		14-15	
	TOT #															
HOUR	SU	H <														
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Fig. 13—Load Distribution Report (Sheet 1 of 2)

REPORT, LOAD SERVICE
 DATE:
 ACCUMULATION PERIOD:
 CCIS TERMINAL PAIRS:
 PAGE 1 OF 2

OFFICE:
 ENGR PERIOD:
 ENGD CAPACITY:
 PLANNED UTILIZATION:

15 HIGH DAYS				TERMINAL PAIR INCOMING							
<u>HOUR</u>	<u>DATE</u>	<u>*</u>	<u>TOT INCSU</u>	<u>%INC OCC</u>	<u>%OG OCC</u>	<u>INC IAM</u>	<u>%INC COMP</u>	<u>E1WI</u>	<u>ATT/ E1WI</u>	<u>(000) TOT TSN</u>	<u>INC SU/ MSG</u>

AVERAGE OF 10 BUSIEST DAYS

3 BUSIEST MONTHS' AVERAGE

AVERAGE OF 3 BUSIEST MONTHS

REMAINING MONTHS' AVERAGES

Fig. 14—Load-Service Report for all CCIS Offices (Sheet 1 of 2)

SECTION 333-200-060

REPORT, LOAD SERVICE
 DATE:
 ACCUMULATION PERIOD:
 CCIS TERMINAL PAIRS
 PAGE 2 OF 2

OFFICE:
 ENGR PERIOD:
 ENGD CAPACITY:
 PLANNED UTILIZATION:

15 HIGH DAYS		TERMINAL PAIR OUTGOING										
<u>HOUR</u>	<u>DATE</u>	<u>TOT</u>	<u>%OG</u>			<u>%INC</u>	<u>OG</u>	<u>%OG</u>		<u>ATT/</u>	<u>(000)</u>	<u>OG</u>
		<u>* OGSU</u>	<u>OCC</u>			<u>OCC</u>	<u>IAM</u>	<u>COMP</u>	<u>E1WO</u>	<u>E1WO</u>	<u>TSN</u>	<u>SU/</u>
												<u>MSG</u>

AVERAGE OF 10 BUSIEST DAYS

3 BUSIEST MONTHS' AVERAGE

AVERAGE OF 3 BUSIEST MONTHS

REMAINING MONTHS' AVERAGE

Fig. 14—Load-Service Report for all CCIS Offices (Sheet 2 of 2)

NO. 4 ESS: GLOSSARY FOR MLSS, LDR, LSR, AND MLSS EXCEPTION REPORTING

ACCEPT	Accepted
ADDR CNT	Address Count
AIF	ANI Office Failure
AMA	Automatic Message Accounting
AMA CALL	AMA Call Record
AMA TAPE	AMA Tape Block
ANF	ANI Number Failure
ANI	Automatic Number Identification
ANI Q CCS	DP ANI MF Receiver Q Usage
ANI Q COUNT	DP ANI MF Receiver Q Peg Count
ANI Q HT, DP MFR Q HT	DP ANI MF Receiver Q Holding Time
ANN + TONES	Announcements + Tones
ATT	Attempts
AUT TFR	Automatic Transfers
AVG OCC	Average Occupancy
BCF	Band Check Failure
BLC	Base Level Cycle
BUF OFL	Buffer Overflow
CAMA	Centralized Automatic Message Accounting
CAMA OP Q	CAMA Operator Queue
CAMA POS	CAMA Position
CAMA SVC	CAMA Service
CCIS	Common Channel Interoffice Signaling
CCIS ACC	CCIS Acceptable
CCIS XCVR MT	CCIS Transceiver, Maintenance
CCIS XCVR SV	CCIS Transceiver, Service
CCITT5	International Telephone and Consultive Committee Type 5 Signaling
CCITT6	International Telephone and Consultive Committee Type 6 Signaling
CCS	Hundred Call Seconds (Usage)
CCS CAP	Usage Capacity
CCS/EQV	Usage Per Equivalent One-Way Trunk
CGF IMA	Carrier Group Failure, Ineffective Machine Attempts
CGF LC	Carrier Group Failure, Lost Calls
CKTS + Q	Circuits + Queue
CPE	CAMA Position Error
CNT	Count
CR, CALL REG	Call Register
CR CCS	Call Register Usage
CR PEG COUNT	Call Register Peg Count
CRL IN SU	Call-Related Incoming Signal Units
CST	CAMA Seizure Time-out
CT/ET	Count Per Equivalent One-Way Trunk
CTR	CAMA Position Report

Fig. 15—Glossary (Sheet 1 of 5)

NO. 4 ESS: GLOSSARY FOR MLSS, LDR, LSR, AND MLSS EXCEPTION REPORTING (Contd)

DISC	Disconnects
DISK RQ	Disk Requests
DP	Dial Pulse
DP ACC	DP Acceptable
DP CR Q CCS	DP Call Register Queue Usage
DPCR Q HT	DP Call Register Queue Holding Time
DP CR Q OVF	DP Call Register Queue Overflow
DP CR Q PC	DP Call Register Queue Peg Count
DP FSA	DP False Start Abandons
DP PSTO	DP Permanent Signal Time-Out
DP-DD	DP Delay Dial
DP-IS	DP Immediate Start
DP MFR Q, DP ANI MF RCVR Q	DP ANI MF Receiver Queue
DPDLOST	DP Digits Lost
DPIWLF	DP Incoming Work List Full
DPOWLF	DP Outgoing Work List Full
DRR1	Disk Request Register, Community One
DRR2	Disk Request Register, Community Zero
8 DIGT W/O CR, DP8DIG W/OCR	DP Queue Eighth Digit Without Call Register
E1WT-I	Equivalent One-Way Trunks Incoming
E1WT-O	Equivalent One-Way Trunks Outgoing
E1WTK	Equivalent One-Way Trunks
FCL	Free Calls
HIPRI Q	High Priority Queue
HIPRI Q HT	High Priority Queue Holding Time
HT	Holding Time
INANS	Incoming Answers
IN CMP RTE	Incoming Completion Rate
IN IAM	Incoming Initial Address Message
IN SU/MSG	Incoming Signal Units per Message
INC CALL	Incoming Call
INC DP CALL	Incoming DP Calls
INC DP SEIZ	Incoming DP Seizures
INC MF CALL	Incoming MF Calls
INC MF SEIZ	Incoming MF Seizure
INC XOFC CNT	Incoming Cross-Office Count
INS	Installed
INTMCN	Intermachine
INTRA	Intraoffice — From Subtending Office to Subtending Office
INWAT BCF PC	INWATS Band Check Failure Peg Count
INWAT TER PC	INWATS Terminating Peg Count
INWATS	Inward Wide Area Telecommunications Service
IT	Intertoll
IOC	International Operating Center
IT OUT	Intertoll Outgoing

Fig. 15—Glossary (Sheet 2 of 5)

NO. 4 ESS: GLOSSARY FOR MLSS, LDR, LSR, AND MLSS EXCEPTION REPORTING (Contd)

LL-1	Number of Times Overload Control Program Entered Load Level 1
LL-2	Number of Times Overload Control Program Entered Load Level 2
LL-3	Number of Times Overload Control Program Entered Load Level 3
LC PRI Q	Low Priority Queue
MCA	Misrouted CAMA
MCF	Match Check Failure
MEAS	Measurement
MF	Multifrequency
MF ACC	MF Acceptable
MF CR PC	MF Call Register Peg Count
MF FSA	MF False Start Abandons
MF ORIG Q	MF Originating Queue
MF ORIG Q HT	MF Originating Queue Holding Time
MF PSTO	MF Permanent Signal Time-Out
MF RCVR MTC	MF Receiver, Maintenance
MF RCVR PC, MFR PC	MF Receiver Peg Count
MF RCVR SVC	MF Receiver, Service
MF TRMTR MTC	MF Transmitter, Maintenance
MF TRMTR Q	MF Transmitter Queue
MF TRMTR SVC	MF Transmitter, Service
MFR HT-ONI	MF Receiver HT-ONI Effect
MFR 2SDC Q	MF Receiver Second-Stage Digit-Collection Queue
MFT Q + SD	MF Transmitter Queue + Start Dial
MS AVG	Millisecond Average
MS USG	Millisecond Usage
MTC CCS, MTC USG	Maintenance Usage
MTC-ITRP	Maintenance Interrupt
NL-MAC, NL-MC	Number of Base Level Cycles in the Maintenance Administration Control
NL-NO	Number of Base Level Cycles Not in Overload
NL-SEG, NL-SG	Number of Base Level Cycles in Segment Control
# HI, #HI	Number of Days High
OFC	Office
OM FAIL	Output Message Failure
OM SUCC	Output Message Success
1W-IN	One-Way Trunks Incoming
1W-OUT	One-Way Trunks Outgoing
ONI	Operator Number Identification
ONI MFR	ONI MF Receiver
ONI PEG, ONI PC	ONI Peg Count
ORIG, OR	Originating
ORIG Q ABAN	MF Originating Queue Abandons

Fig. 15—Glossary (Sheet 3 of 5)

NO. 4 ESS: GLOSSARY FOR MLSS, LDR, LSR, AND MLSS EXCEPTION REPORTING (Contd)

ORIG Q CCS	MF Originating Queue Usage
ORIG Q COUNT, ORIG Q PC	MF Originating Queue Peg Count
CRIG Q HT	MF Originating Queue Holding Time
OP Q ABAN	CAMA Operator Queue Abandons
OP Q CCS	CAMA Operator Queue Usage
OP Q HT, CAMA OP Q HT	CAMA Operator Queue Holding Time
OUT MSG REG	Output Message Register
OUT RESP CNT	Outgoing Response Count
OGANS	Outgoing Answers
OG CMP RTE	Outgoing Completion Rate
OG IAM	Outgoing Initial Address Message
OG SU/MSG	Outgoing Signal Units per Message
OVFL	Overflow
OVL D PC	Overload Peg Count
PBC	Passed Band Check
PEG CNT	Peg Count
% ABAN	Percent Abandon
% DP CALL/SEIZ	Percent DP Incoming Calls to DP Incoming Seizures
% IN CRL OCC	Percent Incoming Call-Related Occupancy
% IN TOT OCC	Percent Incoming Total Occupancy
% INWATS BCF	Percent INWATS Band Check Failures
% MF CALL/SEIZ	Percent of MF Incoming Calls to MF Incoming Seizures
% MFR UTILZ	Percent MF Receiver Utilization
% OG CRL OCC	Percent Outgoing Call-Related Occupancy
% OG TOT OCC	Percent Outgoing Total Occupancy
% OVFL	Percent Overflow
% OVL D	Percent Overload
% POS UTILZ	Percent CAMA Position Utilization
% POS UT, % POS UTL	Percent Position Utilization
% PH IMA	Percent Path Hunt Ineffective Machine Attempts
% Q ENT FL	Percent Queue Entry Failures
% REQ	Percent Requests
% SVC UTL	Percent Service Utilization
% TOT	Percent Total
% UTIL, % UTILZ	Percent Utilization
PH FAIL	Patch Hunt Failure
PH HT	Path Hunt Holding Time
PH IMA	Path Hunt Ineffective Machine Attempts
PH SUCC	Path Hunt Success
POS CCS, ONI CCS	CAMA Position Usage
Q	Queue
Q ATTEMPT	Queue Attempts
Q EF, Q ENT FL	Queue Entry Failure
Q > 5 SEC	Number of Calls Waiting on Queue Greater than Five Seconds
Q % UTILZ	Queue Percent Utilization

Fig. 15—Glossary (Sheet 4 of 5)

NO. 4 ESS: GLOSSARY FOR MLSS, LDR, LSR, AND MLSS EXCEPTION REPORTING (Contd)

REJECT	Rejected
SD CCS	Usage of MF Calls Waiting for Start Dial
SD HT	Holding Time of MF Calls Waiting for Start Dial
SEC USG	Seconds Usage
SUCC	Success
SVC CCS	Service Usage
SVC COUNT	Service Peg Count
SVC HT	Service Holding Time
TERM	Terminating
TDNET	Time Division Network
TC	Toll Connecting
TC OUT	Toll Connecting Outgoing
THRU	Through
TOT CR CCS	Total Call Register Usage
TOTAL EIA	Total Equipment Ineffective Attempts
TOTAL IMA	Total Ineffective Machine Attempts
TOT INSU	Total Incoming Signal Units
TOT OGSU	Total Outgoing Signal Units
TOT SU	Total Signal Units
TOT TSN	Total Transitions
TRK MTC REG	Trunk Maintenance Register
TSPS PTO	Traffic Service Position System, Position Time-Out
2W	Two-Way Trunks
2W-IN	Two-Way Trunks Incoming
2W-OUT	Two-Way Trunks Outgoing
UNACC	Unacceptable
WCC	Wrong Calling Code
WKG ECV	Number of Equivalent One-Way Trunks Bidding for a Component

Fig. 15—Glossary (Sheet 5 of 5)

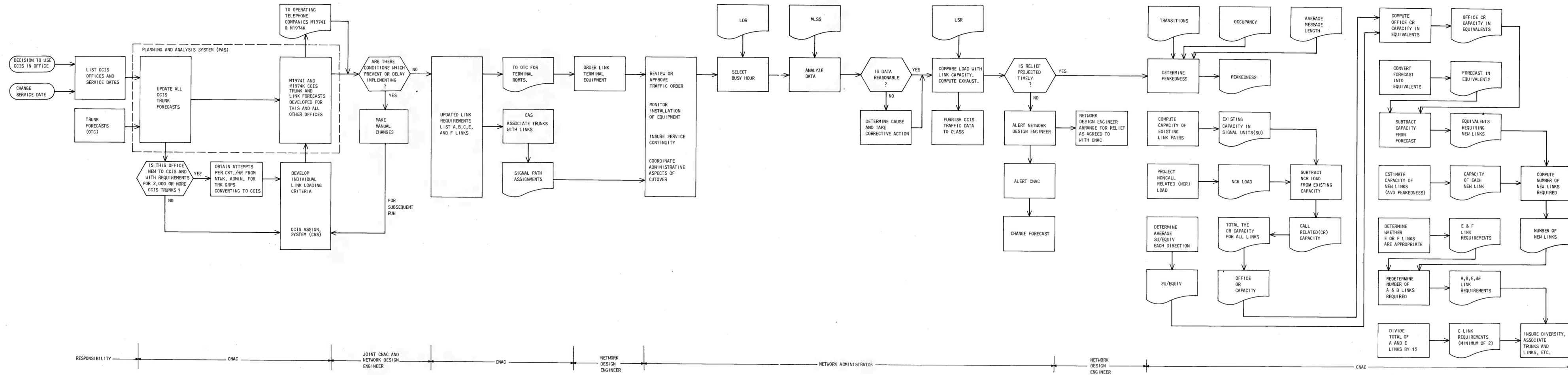


Fig. 16—Flow Chart—Planning and Implementation of CCIS Signal Links

DETERMINATION OF PEAKEDNESS THROUGH INTERPOLATION OF CONVERSION TABLE (FIG. 10)

Actual (10 highest day) values	<u>INCOMING</u>	<u>OUTGOING</u>
Occupancy	_____	_____
Transitions	_____	_____
Average Message Length (AML)	_____	_____
I. COMPUTATION OF INTERPOLATION RATIO		
A. OCCUPANCY (IN SIGNAL UNITS)		
<u>Line</u>		
1. Actual	_____	_____
2. Lower (Fig. 10, lower value of occupancy than actual)	_____	_____
3. Higher (Fig. 10, higher value of occupancy than actual)	_____	_____
4. Ratio = $\frac{\text{Actual (line 1) - Lower (line 2)}}{\text{Higher (line 3) - Lower (line 2)}} =$ _____ =	_____	_____ =
B. TRANSITIONS		
5. Actual	_____	_____
6. Lower (transition line, lower value than actual)	_____	_____
7. Higher (transition line, higher value than actual)	_____	_____
8. Ratio = $\frac{\text{Actual (line 5) - Lower (line 6)}}{\text{Higher (line 7) - Lower (line 6)}} =$ _____ =	_____	_____ =
C. AVERAGE MESSAGE LENGTH (AML)		
9. Actual	_____	_____
10. Lower (AML column, lower than actual)	_____	_____
11. Higher (AML column, higher than actual)	_____	_____
12. Ratio = $\frac{\text{Actual (line 9) - Lower (line 10)}}{\text{Higher (line 11) - Lower (line 10)}} =$ _____ =	_____	_____ =

Fig. 17—Peakedness Interpolation Worksheet (Sheet 1 of 3)

II. COMPUTATION OF PEAKEDNESS

A. INTERPOLATION OF AVERAGE MESSAGE LENGTH (AML)

INCOMING:	LOWER VALUE		HIGHER VALUE		
	OCCUPANCY: _____		_____		
	TRANSITIONS:	Lower Value	Higher Value	Lower Value	Higher Value
		_____	_____	_____	_____
<u>Line</u>					
13. Number of transitions		_____	_____	_____	_____
14. AML lower value		_____	_____	_____	_____
15. AML higher value	--	_____	_____	_____	_____
16. Difference		_____	_____	_____	_____
17. Interpolation ratio (line 12)	X	_____	X	_____	X
18. Adjustment		_____	_____	_____	_____
19. AML lower value (line 14)		_____	_____	_____	_____
20. Adjustment (line 18)	--	_____	_____	_____	_____
21. Peakedness (adjusted to actual AML)		_____	_____	_____	_____
OUTGOING:	LOWER VALUE		HIGHER VALUE		
	OCCUPANCY: _____		_____		
		_____	_____	_____	_____
13. Transitions		_____	_____	_____	_____
14. AML lower value		_____	_____	_____	_____
15. AML higher value	--	_____	_____	_____	_____
16. Difference		_____	_____	_____	_____
17. Interpolation ratio (line 12)	X	_____	X	_____	X
18. Adjustment		_____	_____	_____	_____
19. AML lower value (line 14)		_____	_____	_____	_____
20. Adjustment (line 18)	--	_____	_____	_____	_____
21. Peakedness (adjusted to actual AML)		_____	_____	_____	_____

Fig. 17—Peakedness Interpolation Worksheet (Sheet 2 of 3)

B. INTERPOLATION OF TRANSITIONS

	<u>INCOMING</u>		<u>OUTGOING</u>	
	<u>Lower Value</u>	<u>Higher Value</u>	<u>Lower Value</u>	<u>Higher Value</u>
OCCUPANCY:	_____	_____	_____	_____
<u>Line</u>				
22. Lower value (line 21)	_____	_____	_____	_____
23. Higher value (line 21)	-- _____	-- _____	-- _____	-- _____
24. Difference	_____	_____	_____	_____
25. Interpolation ratio (line 8)	X _____	X _____	X _____	X _____
26. Adjustment	_____	_____	_____	_____
27. Lower value (line 22)	_____	_____	_____	_____
28. Adjustment (line 26)	-- _____	-- _____	-- _____	-- _____
29. Peakedness (adjusted to actual AML and transitions)	_____	_____	_____	_____

C. INTERPOLATION OF OCCUPANCY

	<u>INCOMING</u>	<u>OUTGOING</u>
30. Higher value (line 29)	_____	_____
31. Lower value (line 29)	-- _____	-- _____
32. Difference	_____	_____
33. Interpolation ratio (line 4)	X _____	X _____
34. Adjustment	_____	_____
35. Lower value (line 31)	+ _____	+ _____
36. Peakedness (adjusted to actual AML, transitions, and occupancy)	_____	_____

Fig. 17—Peakedness Interpolation Worksheet (Sheet 3 of 3)

**DETERMINATION OF PEAKEDNESS THROUGH INTERPOLATION OF CONVERSION TABLE
(FIG. 10)**

Actual (10 highest day) values	<u>INCOMING</u>	<u>OUTGOING</u>
Occupancy	_____	<u>140,000</u>
Transitions	_____	<u>52,000</u>
Average Message Length (AML)	_____	<u>1.34</u>
I. COMPUTATION OF INTERPOLATION RATIO		
A. OCCUPANCY (IN SIGNAL UNITS)		
<u>Line</u>		
1. Actual	_____	<u>140,000</u>
2. Lower (Fig. 10, lower value of occupancy than actual)	_____	<u>130,000</u>
3. Higher (Fig. 10, higher value of occupancy than actual)	_____	<u>142,000</u>
4. Ratio = $\frac{\text{Actual (line 1) - Lower (line 2)}}{\text{Higher (line 3) - Lower (line 2)}} =$ _____ =	$\frac{10,000}{12,000} =$	0.833
B. TRANSITIONS		
5. Actual	_____	<u>52,000</u>
6. Lower (transition line, lower than actual)	_____	<u>49,000</u>
7. Higher (transition line, higher than actual)	_____	<u>56,000</u>
8. Ratio = $\frac{\text{Actual (line 5) - Lower (line 6)}}{\text{Higher (line 7) - Lower (line 6)}} =$ _____ =	$\frac{3,000}{7,000} =$	0.429
C. AVERAGE MESSAGE LENGTH (AML)		
9. Actual	_____	<u>1.34</u>
10. Lower (AML column, lower than actual)	_____	<u>1.25</u>
11. Higher (AML column, higher than actual)	_____	<u>1.50</u>
12. Ratio = $\frac{\text{Actual (line 9) - Lower (line 10)}}{\text{Higher (line 11) - Lower (line 10)}} =$ _____ =	$\frac{9}{25} =$	0.36

Fig. 18—Peakedness Interpolation Example (Sheet 1 of 3)

II. COMPUTATION OF PEAKEDNESS

A. INTERPOLATION OF AVERAGE MESSAGE LENGTH (AML)

Line	INCOMING:		LOWER VALUE		HIGHER VALUE	
	OCCUPANCY:		130,000		142,000	
	TRANSITIONS:		Lower Value	Higher Value	Lower Value	Higher Value
13. Number of transitions						
14. AML lower value						
15. AML higher value	--		--		--	
16. Difference						
17. Interpolation ratio (line 12)	X		X		X	
18. Adjustment						
19. AML lower value (line 14)						
20. Adjustment (line 18)	--		--		--	
21. Peakedness (line 19 - line 20 adjusted to actual AML)						
OUTGOING:						
	OCCUPANCY:		LOWER VALUE		HIGHER VALUE	
			130,000		142,000	
13. Transitions			49,000	56,000	49,000	56,000
14. AML lower value			2.6	2.3	2.6	2.4
15. AML higher value	--		-- 2.2	-- 1.9	-- 2.2	-- 2.0
16. Difference			0.4	0.4	0.4	0.4
17. Interpolation ratio (line 12)	X		X 0.36	X 0.36	X 0.36	X 0.36
18. Adjustment			0.144	0.144	0.144	0.144
19. AML lower value (line 14)			2.6	2.3	2.6	2.4
20. Adjustment (line 18)	--		-- 0.144	-- 0.144	-- 0.144	-- 0.144
21. Peakedness (line 19 - line 20 adjusted to actual AML)			2.46	2.16	2.46	2.26

Fig. 18—Peakedness Interpolation Example (Sheet 2 of 3)

SECTION 333-200-060

B. INTERPOLATION OF TRANSITIONS

	<u>INCOMING</u>		<u>OUTGOING</u>	
	<u>Lower Value</u>	<u>Higher Value</u>	<u>Lower Value</u>	<u>Higher Value</u>
OCCUPANCY:			130,000	142,000
<u>Line</u>				
22. Lower value (line 21)			2.46	2.46
23. Higher value (line 21)	-	-	2.16	2.26
24. Difference			0.30	0.20
25. Interpolation ratio (line 8)	X	X	0.429	0.429
26. Adjustment			0.1287	0.0858
27. Lower value (line 22)			2.46	2.46
28. Adjustment (line 26)	-	-	0.1287	0.0858
29. Peakedness (line 27 - line 28 adjusted to actual AML and transitions)			2.3313	2.3742

C. INTERPOLATION OF OCCUPANCY

	<u>INCOMING</u>	<u>OUTGOING</u>
30. Higher value (line 29)		2.3742
31. Lower value (line 29)	-	2.3313
32. Difference		0.0429
33. Interpolation ratio (line 4)	X	0.833
34. Adjustment		0.0357
35. Lower value (line 31)	+	2.3313
36. Peakedness (line 3 adjusted to actual AML, transitions, and occupancy)	(round to)	2.367 (round to 2.4)

Fig. 18—Peakedness Interpolation Example (Sheet 3 of 3)

SIGNAL LINK CAPACITIES AND EXHAUST – WORKSHEET

SECTION I – SIGNAL LINK PAIR _____ **DATE** _____

	INCOMING		OUTGOING	
	Peakedness	Capacity	Peakedness	Capacity
1. Peakedness:	_____	_____	_____	_____
2. Link Capacity (from table 4.16)	_____	_____	_____	_____
3. Total SUs (10 busiest days)		_____		_____
4. Call Related (CRL) SUs (10 busiest days)		_____		_____
5. Percent CRL		_____		_____
6. CRL Capacity		_____		_____
7. Total equivalent 1-way trunks		_____		_____
8. CRL SUs / average equiv. 1-way trunk		_____		_____

SECTION II – SIGNAL LINE CROSS-SECTION

	INCOMING	OUTGOING
9. Number of link pairs in cross-section	_____	_____
10. CRL SU capacity in cross-section	_____	_____
11. 10 busiest days CRL SUs in cross-section	_____	_____
12. 10 busiest days equiv. 1-way trunks in cross-section	_____	_____
13. Cross-section CRL capacity in equiv. 1-way trunks	_____	_____
14. Office growth rate in equiv. 1-way trunks	_____	_____
15. Projected exhaust date	_____	_____

Fig. 19—Signal Link Pair and Cross-Section Capacities Worksheet

SIGNAL LINK CAPACITIES AND EXHAUST – WORKSHEET

SECTION I – SIGNAL LINK PAIR CHICAGO 7-803 DATE 4-5-78

	INCOMING		OUTGOING	
	Peakedness	Capacity	Peakedness	Capacity
1. Peakedness:				
2. Link Capacity (from para. 4.16)			2.4	144,000
3. Total SUs (10 busiest days)				139,768
4. Call Related (CRL) SUs (10 busiest days)				135,560
5. Percent CRL				0.97
6. CRL Capacity				139,680
7. Total equivalent 1-way trunks				2,487
8. CRL SUs / average equiv. 1-way trunk				54.5

SECTION II – SIGNAL LINE CROSS-SECTION CHICAGO 7 - CHICAGO 8

	INCOMING	OUTGOING
9. Number of link pairs in cross-section		2
10. CRL SU capacity in cross-section		291,360
11. 10 busiest days CRL SUs in cross-section		276,533
12. 10 busiest days equiv. 1-way trunks in cross-section		3,830
13. Corss-section CRL capacity in equiv. 1-way trunks		5,297
14. Office growth rate in equiv. 1-way trunks		0.09
15. Projected exhaust date		1-1-82

Fig. 20—Signal Link Pair and Cross-Section Capacities Example