

**SWITCHING SYSTEMS MANAGEMENT  
 COMMON CHANNEL INTEROFFICE SIGNALING  
 SYSTEM DESCRIPTION**

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1. INTRODUCTION

1.01 Common Channel Interoffice Signaling (CCIS) is a system for exchanging signaling information (ie, routing, control, and supervisory information) between processor equipped switching systems over a network separate from the voice message path. This section shall provide a general description of the CCIS network currently being developed. The subsequent documents in Dial Facilities Management Practices (DFMP) Section 18 shall address the machine administrator's responsibilities for the management of the CCIS signaling network signal transfer points (STPs). The procedures for administering the CCIS voice message network shall be addressed in those DFMP sections covering the management of the toll switching machines in the intertoll network.

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

1.03 The title for each figure includes a number(s) in parentheses which identifies the paragraph(s) in which the figure is referenced.

1.04 CCIS is a method of signaling between processor-equipped switching systems which are interconnected by a network of signaling links. All signaling information to control call setup, take down, error control, and network control are exchanged between switching system processors via signaling links. CCIS is currently being developed for use with No. 4 ESS and No. 4A Crossbar equipped with the Electronic Translator System (ETS) and the Peripheral Bus Computer (PBC). The CCIS system will be extended to other processor equipped switching systems such as No. 1 ESS in the future.

1.05 The broad service and technical advantages of CCIS over currently used inband signaling are as follows:

(a) **Signaling Speed:** Because CCIS passes signals at much higher speeds, calls can be set up and taken down faster. This has the effect of reducing post dialing delays to the calling customer. In addition, the holding time of trunks and switching equipment is reduced, leading to more efficient use.

(b) **Information Capacity:** CCIS design provides capacity for the transmission of more signaling information than conventional signaling systems. Routing and control information is included in the basic address message, and subsequent control and supervisory information may be transmitted in additional messages.

(c) **Two-Way Signaling:** CCIS uses a separate 4-wire signaling link and signals may be transmitted in both directions simultaneously. Signaling may also take place during the period of conversation on the trunk.

(d) **Separate Channel:** Interaction between voice and signaling, such as *talk-off* (disconnect of the trunk by voice), is eliminated. The possibility of fraud by simulation of inband signals is reduced and will be eliminated on an all CCIS network. Also eliminated will be mass seizures resulting from loss of inband tone signals (SF) due to carrier failure.

(e) **International Traffic:** It is expected that international telephone traffic will make extensive use of the International Telegraph and Telephone Consultative Committee (CCITT) No. 6 signaling format in the future. Nominal format changes and minor adaptations will be required to efficiently integrate CCITT No. 6 with CCIS.

(f) **Flexibility:** Within the CCIS message signal structure there is considerable latitude and flexibility for the possible use of signaling information for services not yet defined.

(g) **Reliability:** CCIS provides more reliable transfer of address information than present methods offer.

2. SYSTEM DESCRIPTION

A. Signaling Link

2.01 With CCIS, both the single frequency (SF) unit and the multifrequency (MF) equipment are replaced by a signaling link between the processors. The signaling link is designed to carry signaling for many trunks, as opposed to SF signaling which requires an SF unit on every trunk. Fig. 1 depicts current systems using inband signaling, and Fig. 2 depicts the CCIS signaling format. As shown in Fig. 2, the signaling link consists of two signaling terminals, two modulator/demodulator units (modems) and a voice-frequency link (VFL). The signaling terminals serve to store both the outgoing signal messages awaiting transmission and the incoming signal messages until ready to be processed. The signaling terminals also perform error control and retransmission of messages found to be in error. The modem provides a digital/analog interface between the terminal and the VFL. The terminal access circuit (TAC) provides access for the processor to the various signaling links through an interface with the terminals.

B. Signaling Network

2.02 The CCIS system is designed to operate in two basic signaling modes referred to as the associated and nonassociated modes. The simplest and most direct form of CCIS is the direct signaling link between the processors of all CCIS-equipped switching offices having interconnecting trunks. This is referred to as associated signaling. Although an associated (direct) signaling link is shown in Fig. 2, in most instances the signaling information will be routed through one or two signal transfer points (STPs) to concentrate the signaling for a large number of trunk groups into a few signaling paths. This is known as nonassociated signaling. The STPs serve as signal message switching centers, sorting and redirecting the signal messages from incoming to outgoing signal link. In the CCIS signaling network, the nation is divided into ten signaling regions, which have been chosen to correspond to the existing ten regions of the direct distance dialing (DDD) hierarchy. All CCIS-equipped switching offices within a switching region will concentrate the signaling traffic for all the CCIS trunks to the two STPs in each region as shown below. No signaling link switching is involved—only the transfer of the signal message.

DDD REGIONS	DESIGNATED STP'S (2 Per Region)
Norway	Indianapolis 1, Omaha 1
Dallas	Dallas 1, Oklahoma City 2
Rockdale	Atlanta 1, Birmingham 1
Sacramento	Oakland 3, Sacramento
San Bernardino	Anaheim 1, Los Angeles 2
Pittsburgh	Columbus 2, Detroit 1
White Plains	Boston 9, White Plains 2
Wayne	Wayne 1, Richmond 1
St Louis	St Louis 1, Kansas City 1
Denver	Denver 1, Salt Lake 1

2.03 Studies have shown that it is not economical to provide CCIS for all candidate trunk groups on an associated basis because of resulting light loading of signaling links. **Fully associated (F)** links may prove economical between switching offices with a sufficiently large number of interconnecting trunks.

2.04 The basic (nonduplicated) CCIS signaling network is shown in Fig. 3. For simplicity reasons only two CCIS switching offices (SOs) are shown in each of two regions. Each switching office (SO) within a region concentrates its signaling traffic for CCIS trunks on a few well loaded pairs of **access (A)** links to an STP. Each "A" link pair can concentrate the signaling for approximately 3000 equivalent 2-way CCIS trunks between each SO and the STP. Between the regions a number of **bridge (B)** links interconnect the STPs. This network can be generalized to represent many SOs and signaling regions by imagining (a) an "A" link between each STP and each SO in a region and (b) a "B" link from each STP (two STPs per region) to the STPs in all other signaling regions.

2.05 From Fig. 3, for example, signaling from SO1 to SO2 (for trunk group TG1) would be sent to access link A1 to STP1, where it would be forwarded, after translation, on link A2 to SO2. Interregional signaling would involve two STPs. Thus signaling from SO1 to SO3 (for trunk group TG2) would be sent on access link A1 to STP1, then forwarded on bridge link B1 to STP2, and finally sent over access link A3 to SO3.

2.06 In some cases a CCIS switching office in one region may have sufficient trunks to

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CCIS offices in other regions to justify a direct signaling link to the STP of another region. Such a signaling link, known as an **extension (E)** link, is introduced to save processing capacity at a bypassed STP and construction costs associated with facilities and terminal hardware. This is shown as signaling link E1 in Fig. 3.

**2.07** In the example used in Fig. 3, no backup or alternate routes are shown for protection against the failure of signaling links or STPs. For example, if signaling link A1 should fail, switching office SO1 would be isolated from the system. Thus large areas of the network could be left without signaling should an STP or signaling link fail. For this reason two STPs are in each region and all signaling paths will be fully duplicated.

### C. Signaling Network Capacity

**2.08** The full load capacity of a signaling link is approximately 3,000 equivalent 2-way trunks, utilizing a data link speed of 2400 bits per second and assuming a busy hour call attempt rate of 10 per CCIS trunk. (five each way on a 2-way trunk). To insure adequate protection against failure, the signaling links are provided in pairs with the load divided between the paired links. A toll office having 3,000 equivalent 2-way CCIS trunks would connect to the signaling network via a single pair of A links, one to each STP in its region. An additional A-link pair would be provided for each 3,000 equivalent 2-way CCIS trunks. Each A-link pair functions as an autonomous unit, having no operational interaction such as failure backup with subsequently added A-link pairs.

**2.09** The interregional quad of links forms a functional unit serving approximately 6,000 trunks between two signaling regions. Additional quads would be added for each increment of 6,000 CCIS interregional trunks.

### D. Initial Implementation

**2.10** All No. 4 ESS machines will be equipped with CCIS as they are installed. The 4A/ETS machines equipped with a Peripheral Bus Computer (PBC) may be installed with CCIS or modified in the field. ***The PBC is a prerequisite to CCIS in the 4A/ETS because of generic dependencies and measurement requirements.*** (There are other prerequisites in addition to PBC,

such as providing additional memory capacity through IGFET memory additions.)

**2.11** The installation of an STP pair is required in each signaling region prior to introduction of CCIS on any switching machine in that region. The STP program by design will make use of spare processor capacity of existing 4A/ETS systems and will allow early introduction of a nonassociated switching network. The 4A STP is designed to have no interface with its associated switching machine. The 4A/ETS which shares its processor with the STP function cannot use CCIS signaling for its trunks because of processor real time limits and generic design.

**2.12** The initial CCIS signaling network consists primarily of "nonassociated" signaling links and STPs, and it is divided into ten signaling regions. The existing boundaries of the message network regions are utilized in the initial structure of this system.

**2.13** During early CCIS implementation, the STP program will be resident in offices utilizing existing ETS processor capacity. With this design a pair of STPs may transfer signaling messages for 750,000 trunk attempts during the busy hour, while also providing complete backup for each other. At the same time the 4A/ETS will be able to process 135,000 attempts per hour, or its normal full load.

### E. Planned Network Structure

**2.14** The planned network structure is shown in Fig. 4. In addition to previously described "A" and "B" links, each STP is to be connected to the **mate** STP in its own region by **cross (C)** links and to the mate STP in all other regions by additional "B" links. The four links B11, B12, B21, and B22 between two regions are referred to as a **quad**. Intraregional signaling traffic can be transmitted on any of four paths comprising "A" and "C" links. Thus signaling from SO1 to SO2 could be sent via (A11, STP1-1, A21) or (A12, STP1-2, A22) or (A11, STP1-1, C1, STP1-2, A22) or (A12, STP1-2, C1, STP1-1, A21). Similarly, it can be demonstrated that interregional signaling traffic has available 16 possible paths. Signaling traffic is routed over a "C" link only under link failure conditions. Although only one "C" link is shown per STP pair for illustrative purposes, two (minimum) are always provided.

**2.15** Another factor entering into the configuration of the planned network structure is the number of CCIS links in series in the signaling path for a given trunk group, or equivalently, the number of STPs in the path. Each STP processes signal units from an input link to an output link, adding delay. The addition of many STPs in the signaling path could cause signaling delay to become excessive. For example, slow return of the *answer* signal could cause interaction with inband single-frequency (SF) signaling systems serving conventional trunks in the overall connection, with a resultant interruption of the voice path which may cause *clipping* of the initial response of the called customer. Therefore, limits regarding the number of tandem nonassociated links, or STPs, in the signaling path of a trunk group are required. ***This limit is set at two STPs in the normal or primary path, with four allowed under failure conditions.***

#### F. Automatic Transfer—Failure Conditions

**2.16** To insure continuity of signaling transmission, provision is made for automatic transfer to a designated link in the event of failure. The signaling terminal monitors signaling reception continuously and either a total failure or excessive signal errors will initiate transfer to the paired signal link. When an “A” link fails, all affected outgoing signaling at the SO is routed on the mate “A” link. Similarly, signal units for a failed B11 link will be routed on the B12 link. Signal units arriving at an STP for failed “A” link or “B” link pairs will route to the mate STP over the “C” links.

**2.17** In the event of “A” link or simultaneous B11 and B12 link failures at an STP, less signal transmission delay would have been incurred if the signaling traffic had been sent directly to the mate STP. Additionally, if the “C” link failed, as well as the “A” or B11 and B12 links, no outgoing signal path would have existed for the received signals at the STP. To minimize this type of delay, network management signals are utilized to communicate link status among STPs and CCIS switching offices allowing the network to reconfigure itself to bypass link or STP failure conditions. The status of the signaling link is determined at the STPs and transmitted to appropriate switching offices and STPs for automatic reconfiguration.

**2.18** In a normal or nonfailure condition, diversity of the signaling system is established by loading STPs and links to 50 percent or less of their capacity. This insures, in the event of link or STP failures, half of the capacity will be available to assume the transferred load.

**2.19** In addition to the automatic transfer of signaling from failed signaling links, dual voice frequency links (VFLs) are provided—one spare per “A” link. If an “A” link should fail, the signaling is directed to the mate link. If trouble is detected on the VFL, the spare VFL is automatically switched into the signaling link and tested, thereby restoring it to service.

**2.20** A continuity check of the voice path is provided in switching offices to test the selected trunk during call setup. The sensitivity of this check, which is superior to the implied check obtained with conventional inband signaling systems, will provide an improved grade of service.

### 3. INITIAL CCIS FEATURES

**3.01** The advantages of CCIS in signaling speed, signal capacity, and flexibility permit the introduction of many new signaling/switching features. These new features (generally unavailable with conventional signaling systems) will be beneficial to both customers and operating companies. It is anticipated that new features will grow in number and usefulness as the CCIS network grows and its application spreads to local ESS offices and Traffic Service Position Systems (TSPSs).

**3.02** The paragraphs that follow contain those features currently being planned for the initial installations of CCIS in the toll network, along with a brief description of each.

**3.03 *Additional Routing Information***—This additional routing information will be part of the Initial Address Message (IAM) which contains the trunk identity and all the address digits. It includes the following:

- (a) ***Nature-of-Trunk Indicator***—Used to indicate whether a satellite trunk is in the connection and as such can be used by switching systems, via routing constraints, to preclude two satellite trunks on a given connection.

(b) **Out-of-Chain Routing Indicator**—Used to indicate whether a given call has been routed in chain or out of chain.

(c) **Link-Out-of-Chain Indicator**—Used to distinguish between out-of-chain status on a directly connected incoming trunk or on some previous trunk. The combination of the previous two indicators [(1) and (2)] can be used to show whether a given call has departed from normal hierarchal routing patterns. On that basis, they can control subsequent routing to eliminate circular and shuttle routing (frequently called ring-around-the-rosy).

**3.04 CCIS History Indicator**—This will be used to indicate whether a given call has been served by CCIS on all previous links of a built-up connection. Initially, it will be used on domestic toll links in conjunction with the international inbound routing category (discussed under **Routing Category**) to differentiate between (a) those calls requiring audible signals (for no circuit or reorder) to indicate ineffective attempts (not CCIS all the way) and (b) those calls on which data messages can be used (CCIS all the way). The use of electrical signals permits the release of the connection and the application of the audible signals at, in the case described, the originating outgoing international exchange.

**3.05 Calling Party Category**—This will be used to indicate either the call source (eg, unknown source, ordinary operator, or ordinary calling customer) or call type, such as test call. Call source information will be useful in applications which require discrimination between operator- and customer-originated calls for screening or other purposes.

**3.06 Routing Category**—This will be used to indicate the type of call, such as ordinary intertoll, international outbound, international inbound, or international transmit. The latter routing category, international transmit, will be especially useful because it will provide the necessary discriminating information to permit handling international transit traffic over domestic trunk groups between international switching centers.

**3.07 Ineffective Attempt Signals**—Several data messages transmitted in the backward direction, such as trunk congestion, switching congestion, address incomplete, vacant number,

and call failure, are used in place of audible tones or announcements. By use of these messages, a switching system close to the call source can release the connection ahead and provide an appropriate audible signal or recorded announcement to the calling customer. This feature eliminates wasted trunk holding time for ineffective attempts. Data messages should also simplify the process of identifying ineffective attempts for subsequent analysis.

**3.08 Trunk Blocking-Unblocking Signals**—By means of these signals, CCIS trunks can be blocked by maintenance personnel to remove them from outgoing service at the distant end. The ability to make a distant trunk busy facilitates testing of that trunk and reduces the need for coordination between testboards. The blocking signal can be initiated on a trunk that is in use. The trunk, in this case, will be blocked when the call terminates. Blocking of a trunk is automatic on failure of the continuity check (3.10). An unblocking signal is provided to restore the trunk to service. Maintenance personnel at each end of the trunk are notified when a trunk is taken out of service.

**3.09 Elimination of Trunk Guard Timing**—Another signal transmitted in the backward direction, release guard, eliminates trunk guard timing at the outgoing end of a trunk. The receipt of the release guard signal, which is sent in response to the disconnect signal subsequent to making the trunk idle, is positive indication that the trunk is available for a new call.

**3.10 Continuity Check**—CCIS-equipped offices perform a continuity check of the selected trunk during call setup. If the terminating office is a 4-wire switching system, the originating processor attaches a 2010-Hz transceiver to the selected trunk concurrent with sending the Initial Address Message (IAM). The distant office, upon receipt of the IAM, connects the receive side of the trunk to the transmit side through a zero-loss loop. If the terminating office is a 2-wire No. 1 ESS, the originating office transmits 1780 Hz. The terminating office, upon receipt of the IAM, attaches a transponder to the incoming trunk and returns 2010 Hz upon recognition of the 1780-Hz tone. In either case, the originating office checks the level of the returning tone to verify that transmission loss is within acceptable limits. The sensitivity of this check, which is superior to the implied check

obtained with conventional inband signaling systems, will provide an improved grade of service. If the check fails, a second trunk is selected, the failed trunk is automatically blocked, and a special test call is initiated to repeat the test. If the second test passes, the trunk is automatically unblocked. A second failure will initiate a teletypewritten maintenance request.

**3.11 Repeat Attempt Capability**—With CCIS, provisions are made to rapidly initiate a repeat attempt at the outgoing end, when required, such as on detection of a continuity check failure. If glare is detected, the noncontrol end backs off, processes the incoming call on that trunk, and repeats the outgoing attempt on another trunk.

#### 4. EQUIPMENT DESCRIPTION

##### A. No. 4 Electronic Switching System

**4.01** The basic design of the No. 4 ESS includes CCIS capabilities from a software standpoint. Hardware circuits required in addition to existing equipment are CCIS terminals, voice path continuity check transceiver, and continuity check transceiver test circuits.

**4.02** The No. 4 ESS can accommodate up to 16 terminal group frames for a total signaling capacity of 128 pairs of terminals. Each terminal group frame is a 4-bay complex and consists of the signal terminal units and data modems (TM0—TM15) for up to 16 signaling links, as well as the duplicated Terminal Access Circuitry (TAC).

**4.03** CCIS trunk circuits will be provided initially by utilizing A6 channel banks and attenuator pads, with and without echo suppressors. No SF units are required.

**4.04** A block diagram showing the equipment involved in CCIS calls through the No. 4 ESS is shown in Fig. 5.

##### B. No. 1 Electronic Switching System

**4.05** CCIS will be available for the No. 1 ESS toll and combined local/toll offices with a minimum of new equipment designs required. The heart of the system will be a modified version of the terminal frame used with the 4A/ETS CCIS system.

**4.06** Specific modification to the No. 1 ESS for CCIS adaptability is not known at this time. The basic CCIS hardware required consists of (a) the terminal group frame equipped with terminal units required at approximately 3000 equivalent 2-way CCIS trunks per pair and (b) the continuity check transceiver and associated test circuits. A simplified block diagram of a No. 1 ESS office with CCIS features is shown in Fig. 6.

##### C. No. 4A/ETS CCIS Switching Offices

**4.07** The application of CCIS in 4A switching offices requires major new hardware additions to the ETS electronic frame complex including the terminal group frame, the distributor and scanner (DAS) frame and the insulated gate field effect transistor (IGFET) store frame. In the 4A electromechanical area, the continuity check transceivers and the CCIS intraoffice trunk test circuit are also required. New CCIS trunks and outpulsing equipment may be provided for all or part of the CCIS trunk equipment, or conventional trunks and senders may be modified for either MF or CCIS signaling. A simplified block diagram indicating new and modified equipment required is shown in Fig. 7.

**4.08** All CCIS candidate offices must be arranged for sender retrieval and marker speedup operations, although it is expected that all 4A/ETS offices will have implemented these features prior to CCIS.

**4.09** Modification will also be required in the outgoing link frames, markers, senders, decoder connectors, decoder channels, marker connectors, incoming sender register test frame (ISRT), the decoder marker test and trouble recorder frame, and the automatically directed outgoing intertoll trunk test frame (ADOIT) or outgoing trunk testing system (OTTS). Trunk transmission maintenance requires the addition of intertoll manual test frame (IMTF) test positions or the modification of existing IMTFs for CCIS testing.

**4.10** Existing 2-way, incoming and outgoing MF intertoll trunk relay equipments may be modified to function in either the MF or CCIS mode under the control of a trunk mounted selector switch. New plug-in conventional trunks now under development will also be convertible by cabling the associated trunk frame appearances to the DAS frame and either replacing the conventional

plug-in trunk with a new CCIS unit or reconfiguring the unit for CCIS operation by means of option plugs on the printed wiring board. Incoming and 2-way trunks which are converting to CCIS operation must be served by senders that are modified to serve as outpulsers. Trunk modification is recommended whenever a significant number of MF trunks become permanently surplus, since the cost of modification is substantially less than new trunks and outpulsing equipment.

**4.11** The 4A/CCIS terminal frame is a 4-bay complex consisting of the signaling terminal units and data modems (TM0—TM15) for up to 16 signaling links as well as the duplicated terminal access circuitry (TAC). Most 4A switching offices will require only a partially equipped basic frame since each pair of signal terminals will carry signaling for approximately 3,000 equivalent 2-way CCIS trunks.

**D. No. 4A/ETS PBC Signal Transfer Point**

**4.12** The signal transfer point (STP) feature developed for application in exhausted 4A/ETS machines is designed to have minimum interface, both software and hardware with the host switching machine. Therefore, there are no connections between the 4A crossbar frames and the STP equipment. The major interconnections are located in the ETS peripheral unit area. Because of this limited interface, there are no prerequisites for STP installation other than a PBC-equipped ETS with the most current generic and the additional IGFET memory capacity.

**4.13** There are no system modifications, additional features, or data recompilation required for installation of the 4A/STP feature. Power plant enhancement may be required, and test appearances at existing trunk test frames for CCIS voice frequency links must be provided. A basic STP functional system diagram is shown in Fig. 8 without the duplication of buses and controllers. New ETS and PBC generic programs are required to include the STP features.

**5. NETWORK SIGNALING FORMAT**

**A. Data Message Format**

**5.01** In the CCIS system the basic data word is the signal unit (SU). A signal unit is 28 bits long, with the last eight bits used for error

checking. Therefore, each signal unit contains a 20-bit field used for transmitting information. These signal units are grouped into blocks of 12 to be transmitted on the signaling link. Only the first 11 signal units contain signaling information. The twelfth SU of each block is an acknowledgement unit (ACU), coded to indicate the member of its block, the block being acknowledged, and containing the acknowledgement bits indicating whether each of the 11 signal units of the block being acknowledged was received without error. Error-free messages are used without delay by the processor, while a retransmission is requested for those messages found in error. When no signal messages are being transmitted, a synchronization signal unit (SYU) is transmitted to maintain synchronization.

**5.02** CCIS messages can be one or more signal units in length, depending on the quantity of information to be sent. Single unit messages, referred to as lone signal units (LSUs), are generally used for specific control information (eg, answer), whereas, multiunit messages (MUM) are generally used for passing address information (ie, digits).

**5.03** Fig. 9 shows the format fields for a lone signal unit and a miscellaneous multiunit message. The heading and signal information fields of the LSU contain information on the action the LSU is requesting. The trunk label is used to identify the trunk being served. The trunk label is subdivided into two fields: (a) a band number, one [or more] of which is associated with a trunk group and which is used in determining the routing of the message in the signaling network, and (b) a trunk number which identifies a specific trunk. The initial signal unit (ISU) of the miscellaneous multiunit message has a unique heading code which identifies it as an initial signal unit and an ISU code which identifies the message as a miscellaneous multiunit message. The length indicator gives a count of how many subsequent signal units (SSUs) may be expected. A unique heading code is used to identify a subsequent signal unit. The first subsequent signal unit of a miscellaneous multiunit message has a message category to identify the type of miscellaneous multiunit message. The miscellaneous multiunit message may be used for telephone signals, network management messages, and to furnish a special (header) message for routing signals via C links between intraregional signal transfer points.

**5.04** An example of the structure of an initial address message for a 7-digit call is illustrated in Fig. 10A. The ISU contains the trunk identity in the label of the ISU. The first SSU contains a 16-bit field containing routing information which may be used for transmission of unique information related to the call. The second and third SSUs contain the 7-digit NXX-XXXX address. Most of the more common call types can be accommodated without furnishing full routing information shown in Fig. 10B. In this case, the initial address message (IAM) contains abbreviated routing information which is equivalent to a specific full routing information combination. This feature reduces by one the number of signal units necessary to encode an initial address message.

**5.05** Fig. 11 illustrates the initial address message and lone signal units associated with a routine 10-digit call and the actions performed at the originating and terminating CCIS offices. Some messages (eg, network management) relate to trunk groups or subgroups and thus do not require the use of the trunk number in the label. In those messages, the trunk number field may be used to carry other signal information.

**5.06** Those features presently planned for CCIS are coded into the format. Adequate allowance for new features is available in the format which will be coded as the features are defined and plans developed.

## **B. Signaling Network Routing Procedures**

**5.07** As mentioned previously, all telephone signaling messages contain a trunk label identifying the specific trunk by a combination band and trunk number. Labels will be assigned by the CCIS Assignment and Planning Center (CAPC) for the switching offices in such a way that all trunks with the same band number will be part of the same trunk group. In this way, routing at the STPs can be done using only the band number.

**5.08** Signal routing at the STPs is done in the following way. All incoming and outgoing links at the STPs will be assigned a **terminal number**. Furthermore, each STP will have stored in memory a **Band Translation** table for each "A" and "B" link pair. Given the number of the link on which a message was received and the band number contained in the message label, the

associated table gives the number of the desired outgoing link and an outgoing band number. The action taken by the STPs is as follows. When a message is received, the STP determines the incoming band and link number; using the appropriate band translation table, the STP determines the outgoing band and link number. The STP then replaces the received band number in the message label with a new band number and transmits this modified message on the indicated outgoing link.

**5.09** Note from the previous discussion that only the processors at the two ends of a link need agree on which band number is assigned to a given trunk. This is important in regard to the required length of the band labels since, in general, the links on which a message enters and leaves an STP will carry signaling for different sets of trunks.

**5.10** Under normal conditions, both the SO originating a signaling message and the first encountered STP (for interregional traffic) will have a choice of outgoing links to the desired SO (see Fig. 4). Delays in the input buffers of the signaling terminals are directly related to the traffic load on the link; therefore, to minimize delay, the loads on "A" link pairs and on the four links of a quad should be balanced as much as possible. This will be accomplished in the following way. At the originating office, one of the bits in the trunk number part of the label is examined. All trunk messages for which this bit is "1" will be sent on one "A" link and all other messages on the other "A" link. Since trunk numbers are not examined at the STPs, outgoing interregional messages at the STPs will be divided among the "B" links according to the value of a low order bit in the band number part of the label.

## **C. Signaling Network Overload Controls**

**5.11** In addition to the signaling network controls, there will exist signaling network overload controls to help prevent overtaxing the real-time capacity of STP processors or the overflowing of the available message buffering for signaling links. Either event should be rare on a properly engineered network. These control signals cause the rerouting of signaling traffic or the reduction of new telephone traffic, if necessary, depending on the location of the overload and the condition of the other elements of the network.

#### D. Provisions For CCIS Switching Office Congestion, Failure, and Recovery

5.12 The dynamic overload control (DOC) equipment in each switching office constantly monitors machine congestion levels within the switcher. When any level of congestion, MC1 (SQL), MC2 (SQH), or MC3 (processor failure) is sensed, a DOC signal is transmitted over the "A" links to one of the STPs serving that switching office. The STP responds to the signal by composing and broadcasting a DOC1, DOC2, or DOC3 message to each distant switching office where controls to the affected office are desired. These messages are transmitted over "B" or "D" links to distant STPs, which in turn transmit them over their "A" links to the proper switching offices. As these messages are received, the distant switching offices respond by applying the preprogrammed controls for that level to their trunk group to the affected switching office.

5.13 When a switcher begins to recover from a state of congestion, its DOC equipment will sense the change to a lower level (MC3 to MC2) and will cause a "Remove DOC3" and "Broadcast DOC2" to be sent. This will cause each distant switching office to change from its MC3 level of control to its MC2 level. When the overloaded switcher has recovered fully, it will cause a "Remove DOC1" and "Broadcast DOC0" to be sent, causing all controls to be removed.

5.14 When a CCIS switching office experiences a serious processor failure, the CCIS terminals at that office signal the STPs in the signaling network to cut off all CCIS signaling traffic to that office. The STPs then notify all offices with CCIS trunks to the failed office of the failure. This allows appropriate rerouting or cancellation of telephone traffic. During the process of recovery, certain trunks may have to be initialized (all trunks in the case of manual intervention in connection with Phase 4 recovery action of an ESS office). For non-CCIS trunks, this is achieved by the return of the on-hook condition on the trunks which ultimately forces the trunks to be idle at both ends. For CCIS trunks, special signals and signaling procedures are used to achieve this end. CCIS telephone traffic to the recovered office may continue to be withheld, if desired, while these housekeeping actions take place.

5.15 The network reaction to an STP processor failure, initiated by the link terminals at the failed STP, is to route signals in the same manner as if all links to the failed STP were simultaneously failed.

#### 6. GENERAL DESCRIPTION OF THE CCIS SWITCHING FUNCTION

6.01 Basic switching functions are, in general, invariant with the type of signaling system utilized. Such basic functions as address analysis, routing, trunk seizure, forwarding of the address, supervision, and control are essential to call processing. With CCIS, however, the increased signaling information transfer leads to an expansion of these basic functions creating a more versatile and efficient method of processing calls.

6.02 Fig. 11 illustrates the initial address message and lone signal units associated with a routine 10-digit call and the actions performed at the originating and terminating CCIS office. Note that a continuity check is performed as part of the normal call setup signaling sequence.

6.03 For simplicity, Fig. 11 does not break down the *other routing information* field in the initial address message. It should be clearly understood, however, that all routing with CCIS is no longer exclusively based on analyzing the digits of the called number, but on analysis of the other routing information contained in the initial address message as well. As previously described, in-chain (or out-of-chain) indicators, nature-of-trunk indicators, calling party category, and routing category influence the selection of an outgoing route. Similarly, added backward signals such as release guard (shown in Fig. 11) and ineffective attempt indicators require added call processing beyond that required with conventional signaling systems. These signals lead to more efficient use of the trunking network. To illustrate this latter expansion of functions, if trunk or equipment congestion is encountered at an incoming CCIS office, the appropriate congestion signal is sent to the originating CCIS office. On receipt of this signal at an intermediate office, the forward connection is released (disconnect signal sent) and the signal relayed to the originating CCIS office. At this office, the disconnect signal is sent and the appropriate audible tone or announcement is sent back to the originating customer.

**6.04** Although the signaling links have built-in error control by error detection and retransmission, occasionally an undetected error will occur. This is expected to occur only once in approximately  $10^8$  (100 million) signal units. In addition, the error control method will occasionally allow messages to get out of sequence. Safeguards, in the form of processor reasonableness checks, are provided by the system to make CCIS a more reliable signaling system than any others now in service.

## **7. ADMINISTRATION OF THE SIGNALING NETWORK**

**7.01** As the CCIS network grows, planning for this growth becomes increasingly important. Too, the day-to-day administration of the network becomes a larger and more complex job as the network grows in size and complexity.

**7.02** For trunk forecasting requirements to be properly analyzed, procedures have to be implemented that will give adequate administrative controls. A centralized approach will provide these controls in an economical and efficient manner. The CCIS Assignment and Planning Center (CAPC), operated by AT&T Long Lines, will perform these activities. Two functional activities must be performed by the CAPC. These functional activities are planning analysis and current administration.

### **A. Planning Analysis**

**7.03** This activity will analyze the CCIS requirements as indicated by the Bell System and Independent Telephone Companies trunk forecasts. It will show where additional data link facilities and STPs are based on the estimate of the number of trunks each link pair can handle without causing a deterioration in service. It will also show when they are needed to meet the forecasted requirements of the message network. The results of this analysis will then be forwarded to the appropriate carrier and equipment engineers for action.

**7.04** The value of a CAPC is enhanced by the fact that multiple engineering entities cannot identify the total load impact on equipment or carrier facilities of the interregional quad. By having the CAPC analyze all the forecasts and comparing them with the existing CCIS network, a more thorough analysis can be made. Also, the CAPC will be in a better position to know the current and planned condition of the CCIS network.

It should know of any impact the network might suffer due to new toll switching systems being added, as well as any rehomeing or conversion activity. It should also be able to insure that good diversity is maintained. It is felt that, under supervision of a centralized group, proper administration can be given to the planning analysis portion of CCIS.

### **B. Current Administration**

**7.05** This functional job is concerned with the day-to-day activities of CCIS administration. This function has been called *Current Administration* because it deals with the day-to-day job. It will react to the current Long Lines and Associated Company requirements. The primary responsibilities of this job will be the assigning of labels, bands, and signal paths, as well as maintaining their respective files.

**7.06** This CAPC function will enable a close evaluation of how the links, quads, and equipment are being loaded. Proper administration is vital to the successful and economical growth of the CCIS network. The group will work with the Long Lines circuit layout people in coordinating the CCIS assignment job with the makeup of associated circuit orders. Label and band numbers pertaining to associated company requirements will be given directly to the concerned groups by the CAPC.

## **8. MAINTENANCE**

### **A. Overall Control and Coordination**

**8.01** The maintenance control and coordination of the CCIS signaling network and its parts will generally follow the plan in use today in the Bell System and commonly referred to as the Control Office Plan. Inherent in the plan is a hierarchy of maintenance control and assignment of responsibilities to insure orderly administration and maintenance of the network.

**8.02** Included in the plan is the designation of one of the CCIS offices on each signaling link as the Plant Control Office. This office is responsible for the overall maintenance of the link and for the coordination of all activities which may affect the serviceability of the link.

SECTION 18a

8.03 Each signaling link is divided into smaller components for assignment of subcontrol and repair responsibilities. These are the Terminal/Modem (T/M) combinations at each CCIS office and the interconnecting VFL.

**B. Areas of Maintenance Responsibility in CCIS-Equipped Offices**

8.04 Since a CCIS signaling link is a communication path between two switching or signaling processors, logically it puts the responsibility for the overall link in the area of other switching maintenance functions (that is, the Maintenance Operations Center [MOC], or the equivalent, in the CCIS-equipped office). This could be the overall plant control of the link or the supporting role of the noncontrol office.

8.05 To assist the MOC in its responsibilities, the Trunk Operations Center has a subcontrol responsibility for the VFL portion of the signaling link. The Trunk Operations Center operates in parallel support of the MOC, that is, as the overall plant control or noncontrol end of the VFL.

8.06 Further allocation of maintenance responsibility within a typical CCIS-equipped office is described as follows:

(a) **Switching Equipment Maintenance**— Includes all equipment from the processor

through and including the signaling terminals and modems or digital interface units. Test access circuits for VFL access where used are also included.

(b) **Terminal Equipment Maintenance**— Includes all transmission equipment such as pads, gain devices, equalizers (if used), and any other equipment not classed as switching equipment or transmission systems. This terminal equipment is considered to be a part of the VFL.

(c) **Transmission Systems Maintenance**— Includes all equipment considered to be part of the transmission facility portion of the VFL.

8.07 Variations from the typical office will no doubt exist. Smaller offices may combine switching and terminal equipment maintenance forces. The physical location of T/M equipment in some offices may be such that terminal equipment maintenance forces may do the actual repair work. However, the functional control will always reside in the MOC area.

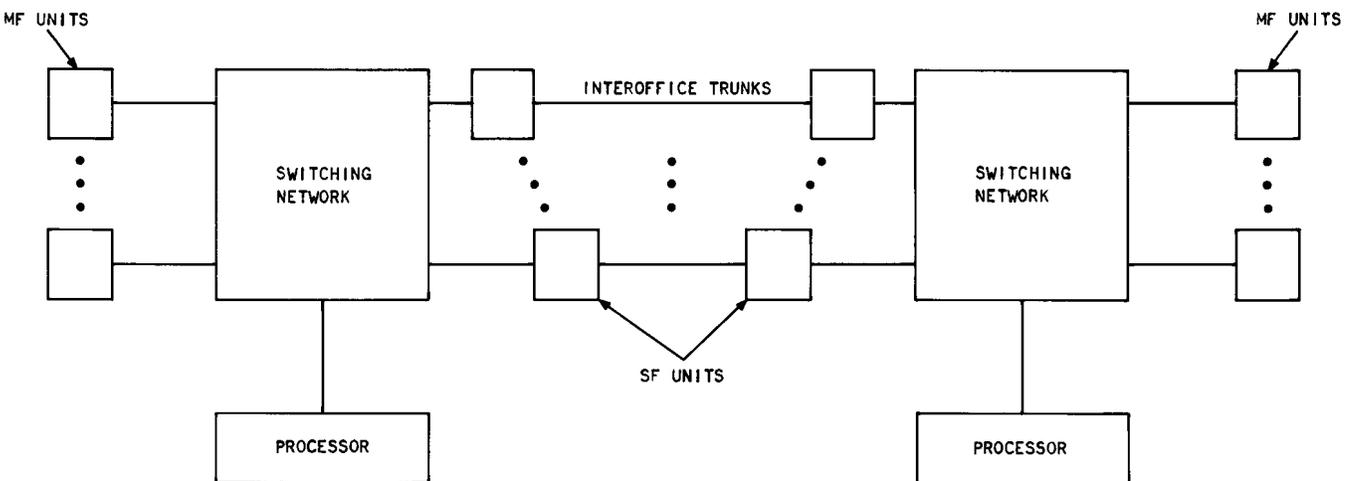


Fig. 1—Block Diagram of Inband Signaling (2.01)

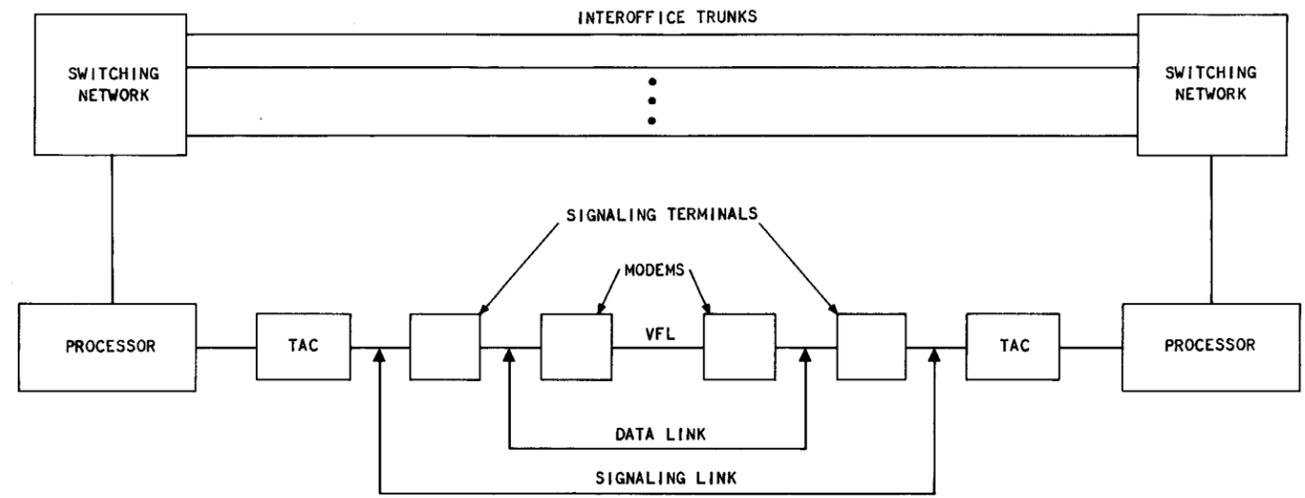


Fig. 2—Block Diagram of CCIS Signaling (2.01 and 2.02)

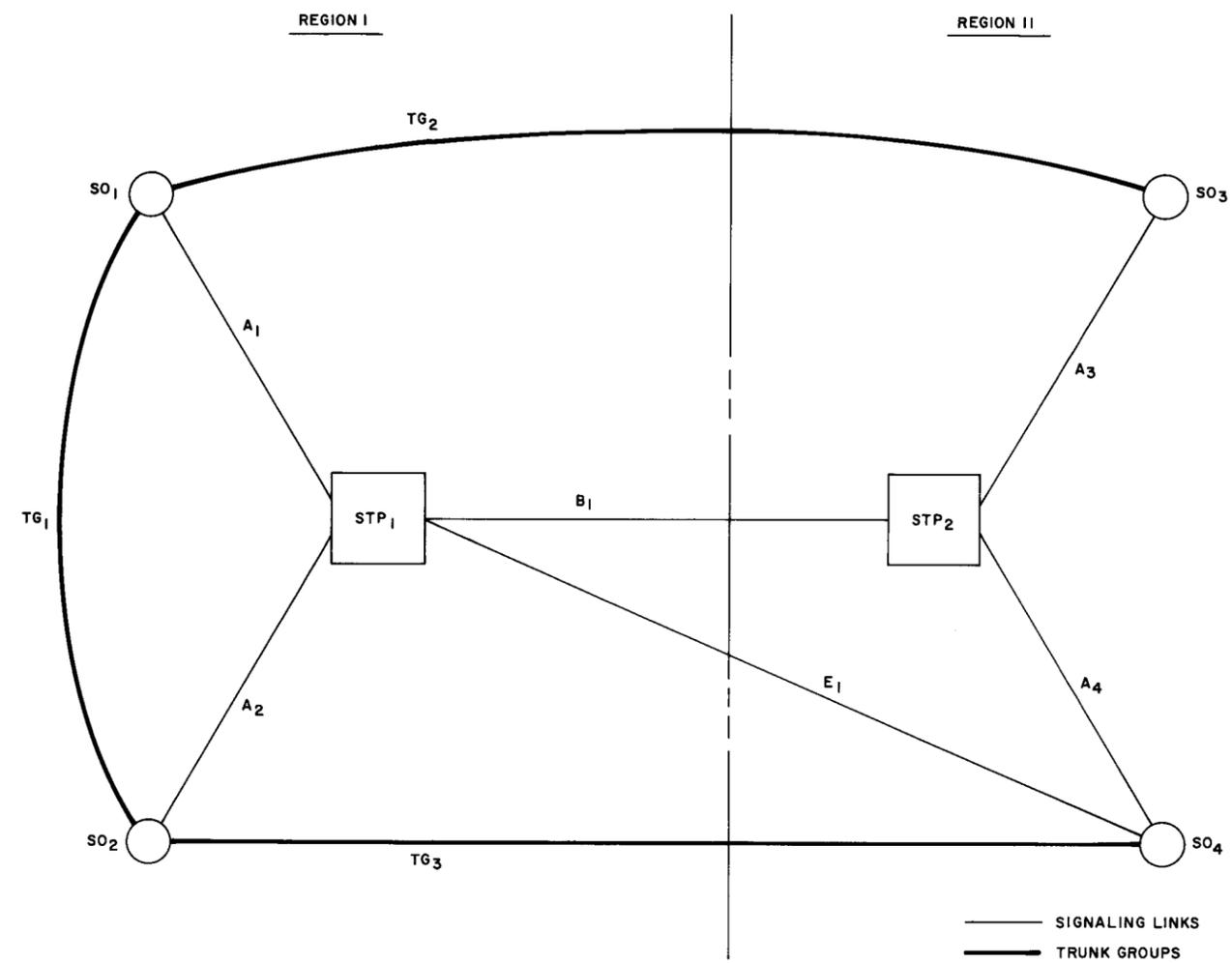


Fig. 3—Block Diagram of Basic CCIS Signaling Network (2.04, 2.05, 2.06, and 2.07)

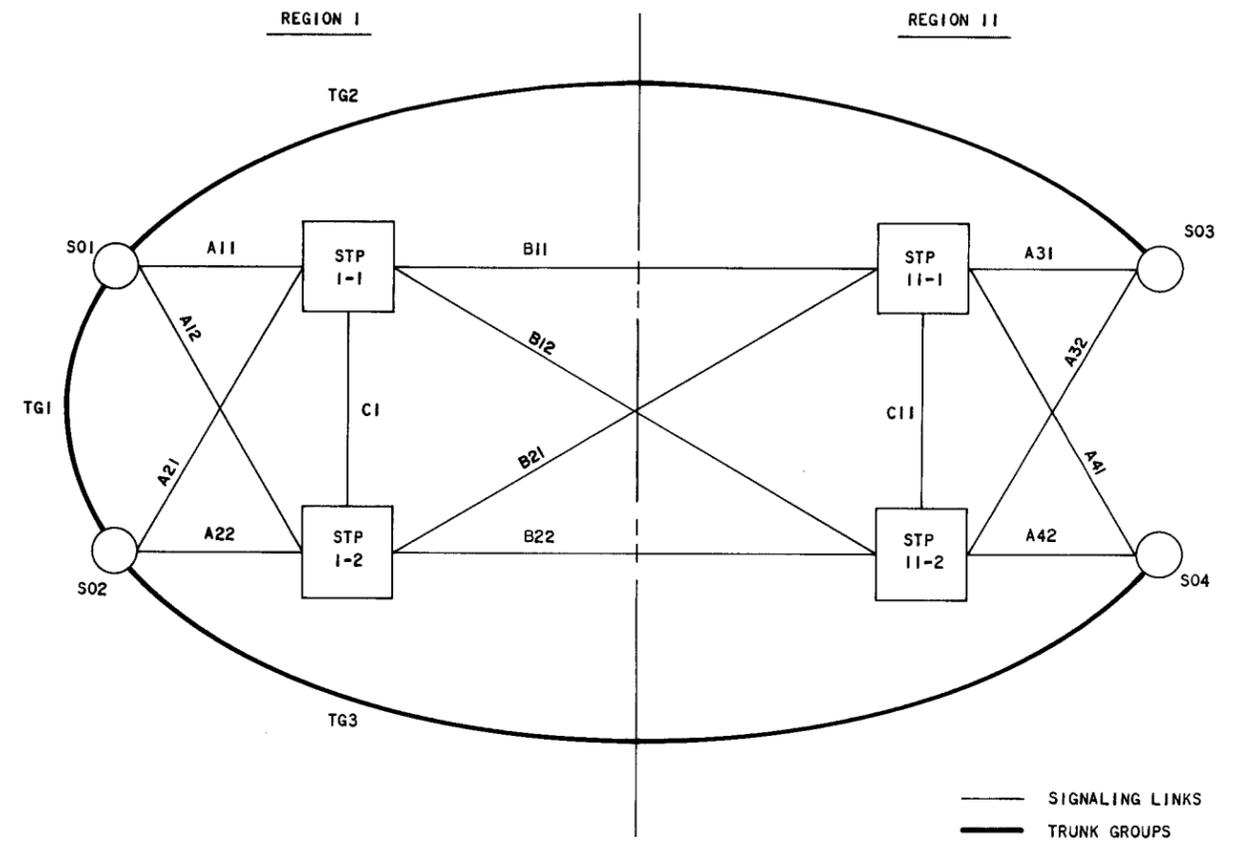


Fig. 4—Block Diagram of CCIS Planned Network Structure (2.14 and 5.10)

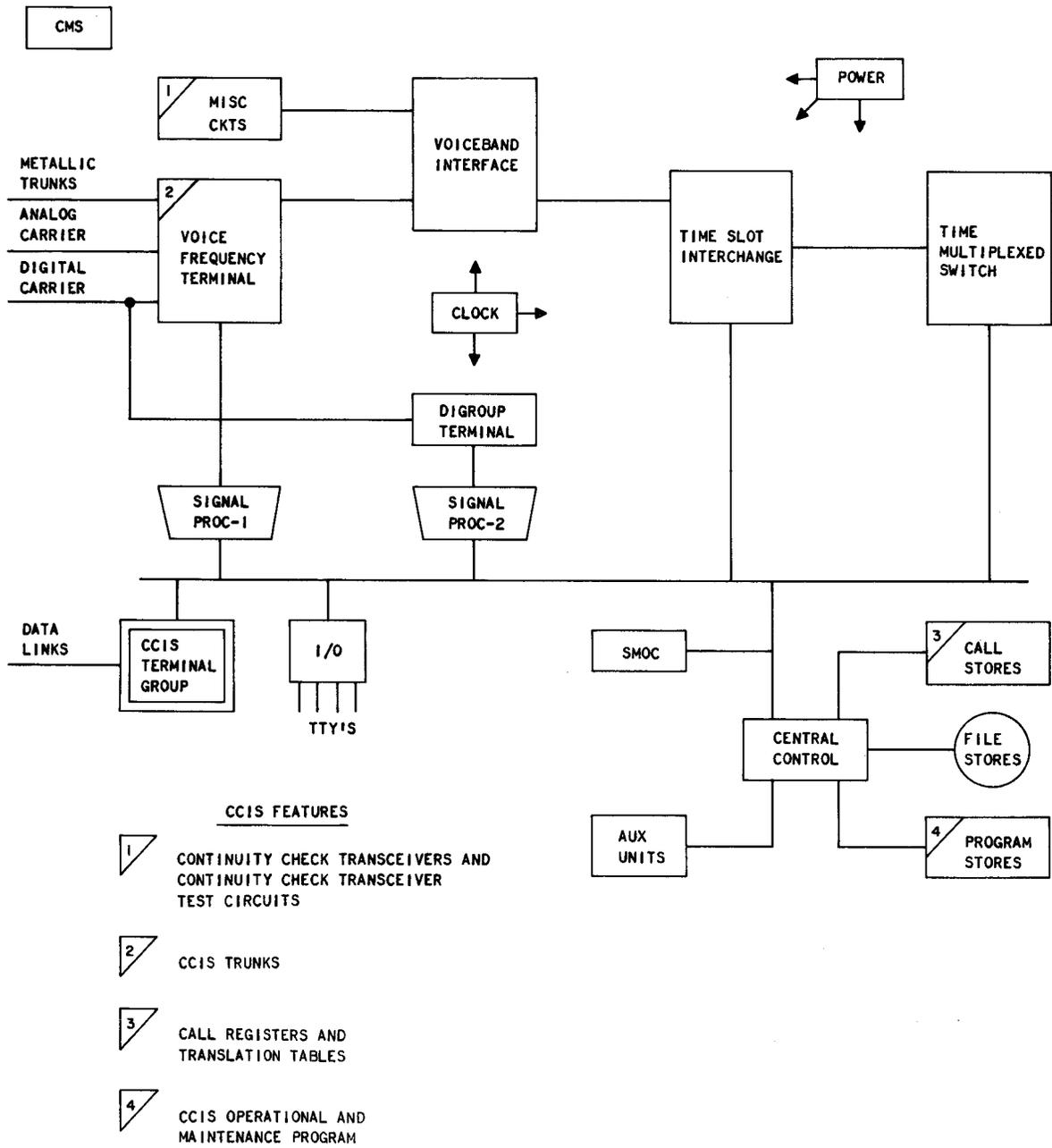


Fig. 5—No. 4 ESS CCIS Block Diagram (4.04)

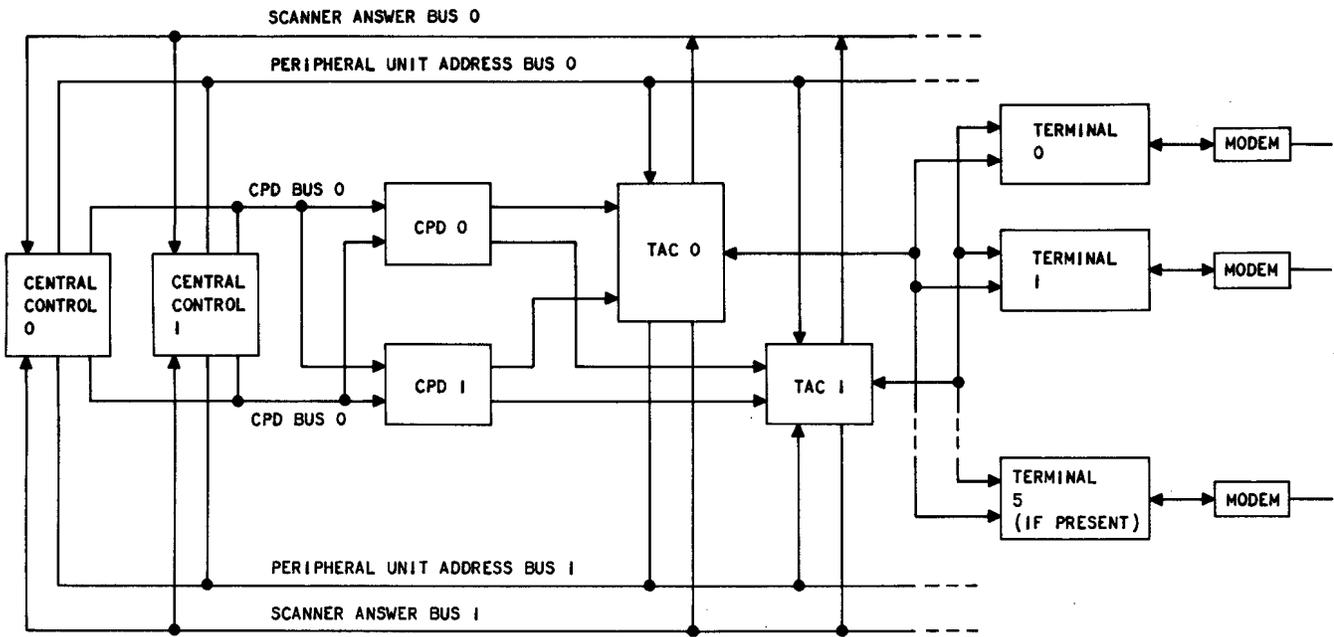


Fig. 6—No. 1 ESS CCIS Block Diagram (4.06)

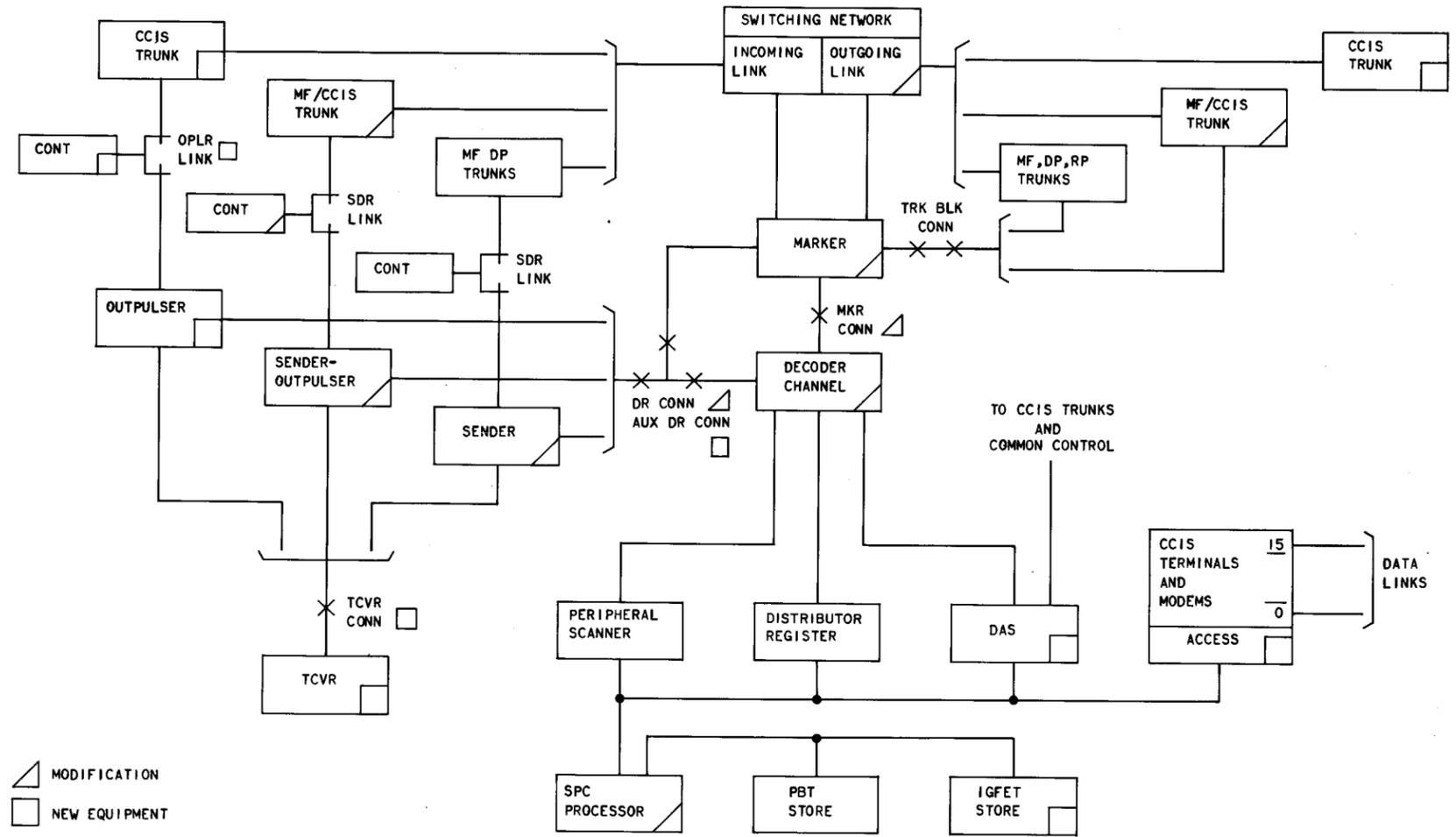


Fig. 7—No. 4A/ETS CCIS Application Schematic (4.07)

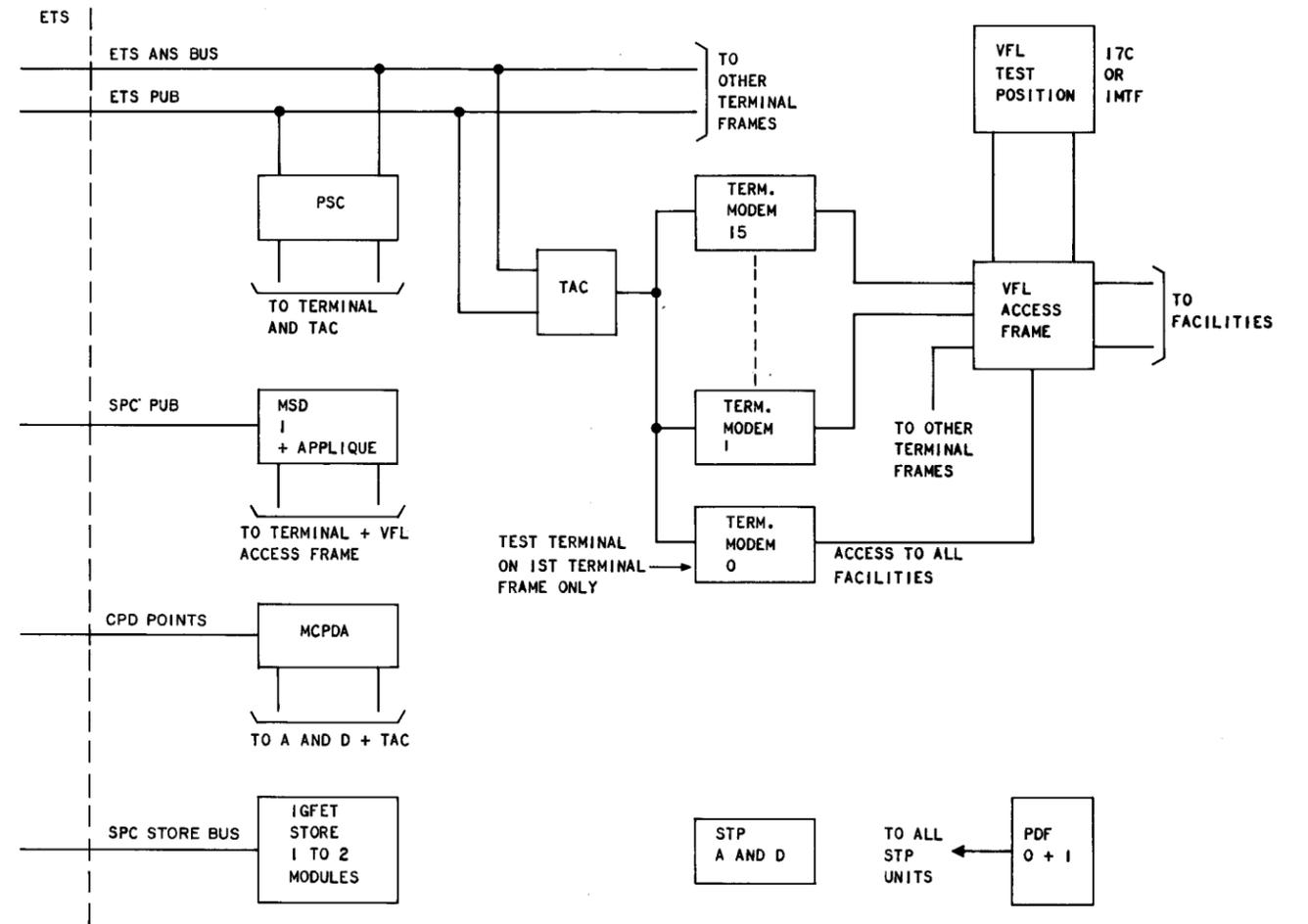
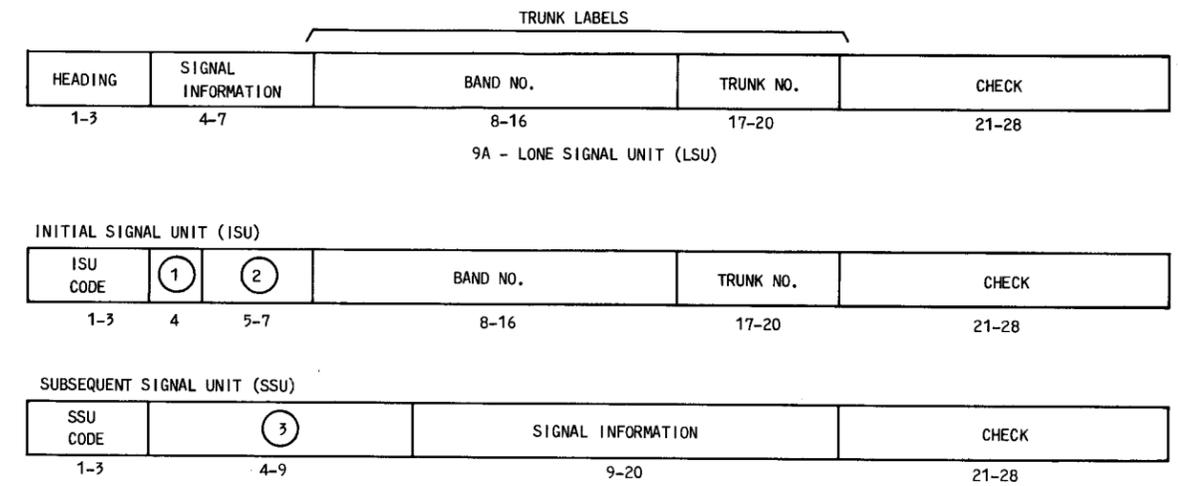


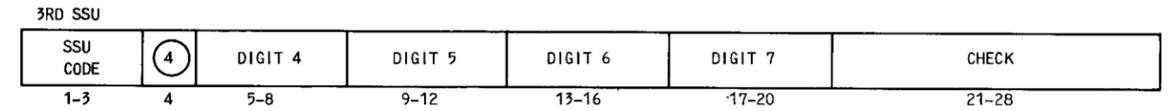
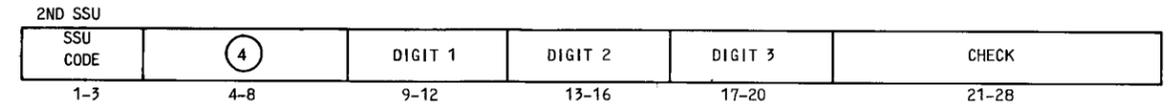
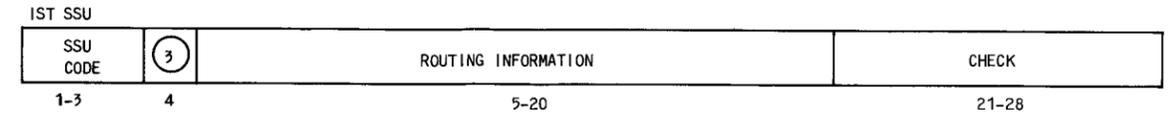
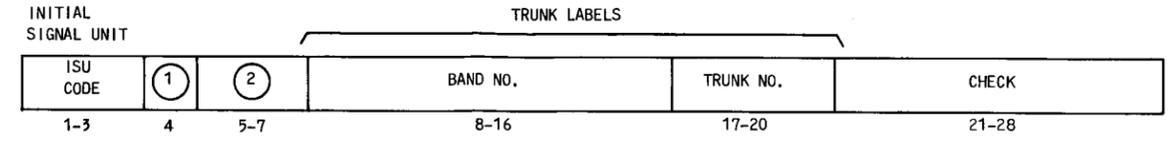
Fig. 8—Functional Diagram of No. 4A/ETS Signal Transfer Point (4.13)



- NOTES:
- ① ISU TYPE INDICATOR
  - ② LENGTH INDICATOR
  - ③ MESSAGE CATEGORY

9B - MISCELLANEOUS MULTIUNIT MESSAGE (MUM)

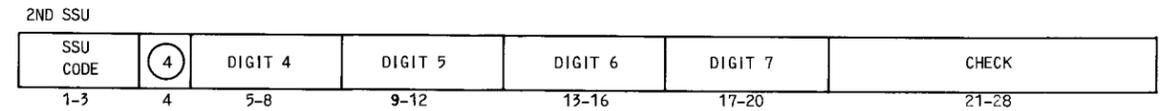
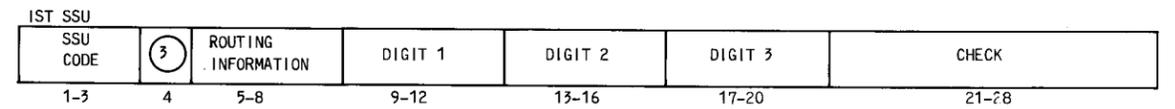
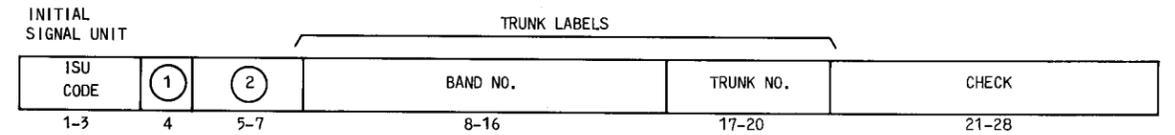
Fig. 9—Signal Unit Formats (5.03)



NOTES:

- ① ISU TYPE INDICATOR - (IAM)
- ② LENGTH INDICATOR (IE: SSU'S)
- ③ FULL ROUTING INFORMATION INDICATOR
- ④ NO INFORMATION - ALL "0'S"

10A - INITIAL ADDRESS MESSAGE (WITH FULL ROUTING INFORMATION)



NOTES:

- ① ISU TYPE INDICATOR - (IAM)
- ② LENGTH INDICATOR (IE: 2 SSU'S)
- ③ ABBREVIATED ROUTING INFORMATION INDICATOR
- ④ NO INFORMATION - "0'S"

10B - INITIAL ADDRESS MESSAGE (WITHOUT FULL ROUTING INFORMATION)

Fig. 10—Initial Address Message Formats (5.04)

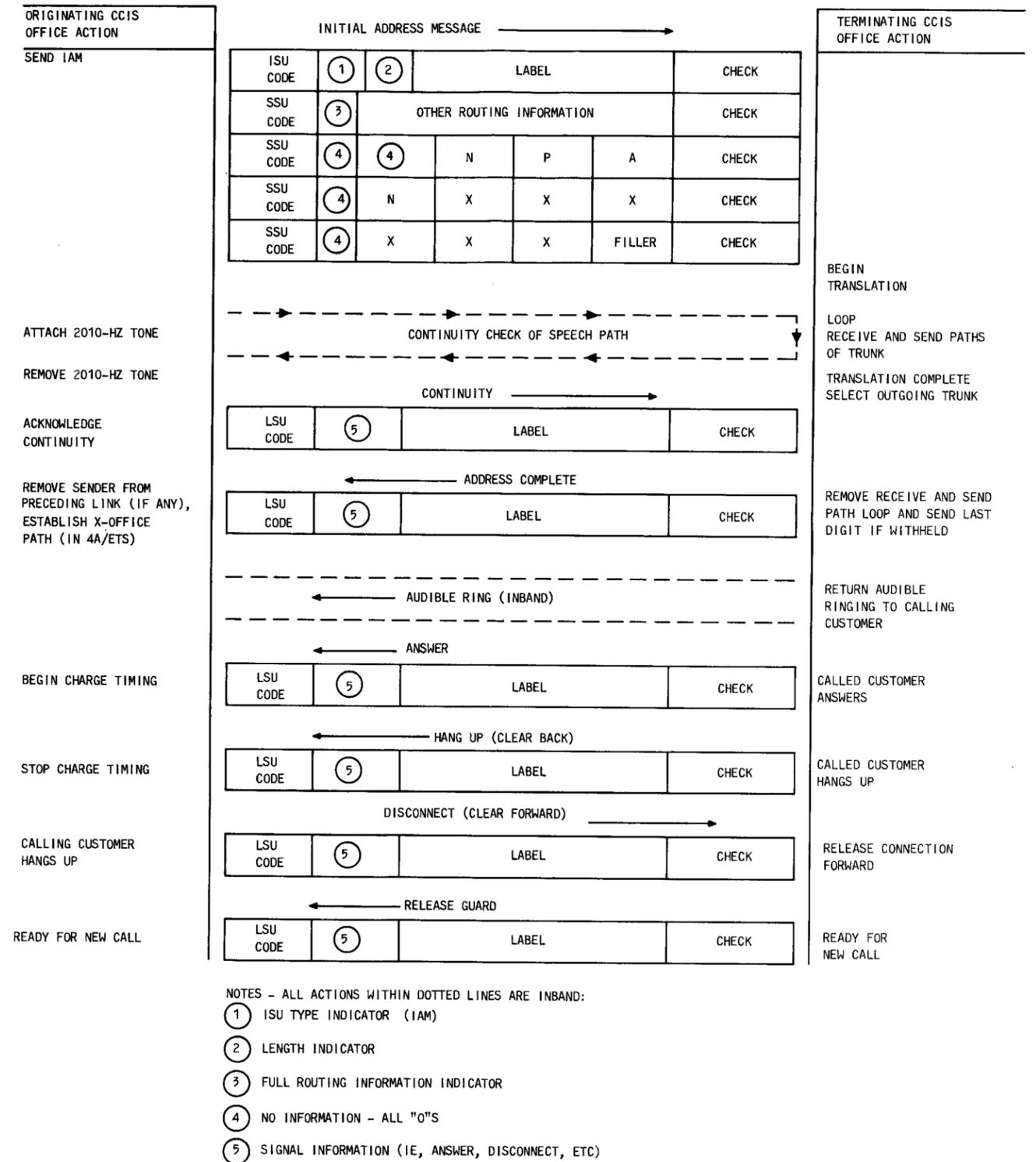


Fig. 11—Generalized Signal Sequence—10-Digit CCIS Call (5.05, 6.02, and 6.03)