4ESS Switch
Signaling System 7
User's Guide

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Chapter 2 Feature Description

Overview of Signaling System 7

Introduction

This chapter describes the structure and function of the Signaling System 7 (SS7). The SS7 is an out-of-band signaling protocol that sends signaling information over signaling links that are separate from the voice path.

Signaling Protocol

A signaling protocol is a set of rules or procedures that govern the handling and routing of signaling messages between nodes in a signaling network. The protocol specifies issues such as electrical characteristics, data flow control, data and message routing, call setup, call supervision, user permissions, encryption, and error detection and correction for each type of message. The SS7 protocol dictates the method for formatting, handling, and routing, a signaling message within an SS7 network.

SS7 Signaling Protocol

The exchange of information (that is, signaling messages) in the SS7 network is based on a protocol model adopted by the International Telecommunication Union — Telecommunication Standardization Sector (ITU -T). The model, known as the Open Systems Interconnection (OSI) reference model, is divided into seven layers that establish the connection and exchange of signaling messages between users. The SS7 Signaling protocol is also compatible with the American National Standard Institute (ANSI) Signaling System No. 7.

The SS7 signaling protocol has a modular and functional structure as shown in Table 2-1 on the next page. The wide scope of the protocol requires that it include a large diversity of functions to provide a foundation for existing and future applications.

Continued on next page

Overview of Signaling System 7, Continued

Table 2-1 OSI Reference Model

The following table shows the OSI reference model:

Table 2-1	
Layer	**Function**
7 Application	Establishes an end-to-end flow control, where information required by the user is generated
6 Presentation	Transforms the syntax of messages to meet the requirements of the user
5 Session	Manages the communication sessions between users when the service is not collectionless
4 Transport	Provides end-user to end-user transfer of information, relieving the user of concern for the transfer details
3 Network	Directs signaling messages to the proper links and provides network management
2 Data Link	Ensures the reliability of the signaling link by providing error detection and recovery
1 Physical	Defines the electrical, physical, and functional characteristics of the signaling link

Signaling System 7 Structure

The SS7 protocol can be described using the OSI reference model. However, the SS7 signaling protocol is a 4-level model, or more accurately, a 4-part model. The parts are as follows:

- Message Transfer Part
- Signaling Connection Control Part
- ISDN - User Part
- Transaction Capabilities Application Part

Continued on next page

Overview of Signaling System 7, Continued

SS7 Protocol and LEC Services

The purpose of the SS7 signaling protocol is to route signaling messages based on destination addresses. It uses 56 kbps data links, supported by the Common Network Interface (CNI) ring in Lucent Technologies signaling point products, to transmit the signaling messages through the network. Figure 2-1 shows the relationship between the SS7 4-part signaling protocol and typical services provided in the Local Exchange Carrier SS7 network.

Message Transfer Point

The Message Transfer Part (MTP) controls the signaling links and the transfer of signaling messages across them (the functions of layers 1 through 3 of the OSI reference model).

Signaling Connection Control Point

The Signaling Connection Control Part (SCCP) provides end-to-end logical signaling. This includes some functions in layer 3, as well as the functions of layer 4 of the OSI reference model.

ISDN - User Part (ISUP)

The Integrated Services Digital Network-User Part (ISUP) provides signaling for basic telephone service. This includes control of circuit-related network connections (trunks).

Transaction Capabilities Application Part (TCAP)

The Transaction Capabilities Application Part (TCAP) provides the framework to control the transfer of non-circuit-related information using SCCP for transport.

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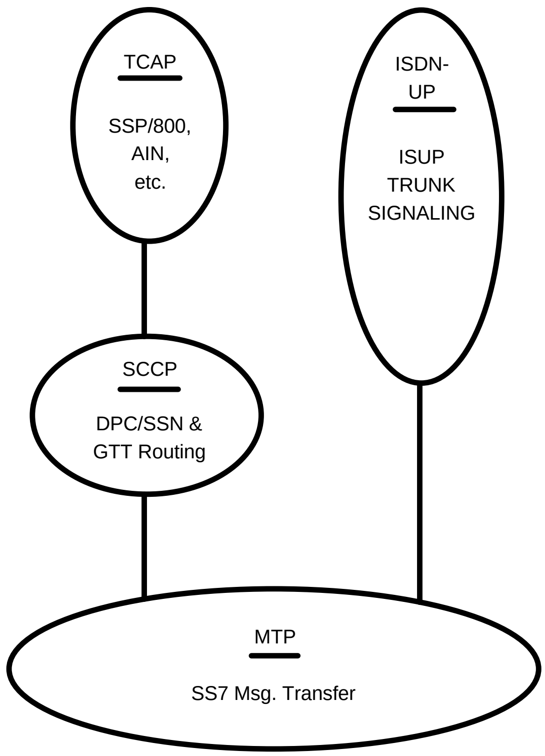
Overview of Signaling System 7, Continued

Figure 2-1. SS7 Service Feature Summary

This figure illustrates an SS7 Service feature summary.



LEGEND:

AIN - Advanced Intelligent Network
DPC - Destination Point Code
GTT - Global Title Translation
ISUP - Integrated Services Digital Network - User Part
SSP - Service Switching Point
SSN - Subsystem Number

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Message Transfer Part

Overview

The overall function of the SS7 MTP is to serve as a connectionless (logical) transport system. The MTP provides reliable transfer of signaling messages between user or application functions. The term user refers to any functional entity that uses the basic transport capability provided by the MTP. For example, one user is the ISDN User Part which provides basic telephone service. The SS7 MTP consists of three levels:

- SS7 MTP Level 1 Signaling Link
- SS7 MTP Level 2 Signaling Data Link Control
- SS7 MTP Level 3 Signaling Network.

The MTP levels 1, 2, and 3 correspond, respectively, to the OSI reference model layers 1, 2, and part of 3.

MTP Level 1

The SS7 MTP level 1 (Signaling data link) constitutes the lowest functional level of SS7 signaling protocol. A Signaling data link is a bi-directional transmission path comprised of two data channels operating together in opposite directions at the same data rate. The signaling data link operates at 56 kbps.

MTP Level 2

The Signaling link level (MTP level 2), together with the Signaling data link level (MTP level 1) as the bearer, provide a Signaling Link (SLK) for reliable transfer of signaling messages between two directly connected signaling points in an SS7 network. Signaling messages are transferred over an SLK in variable length signal units. The signal units include control information for proper operation of an SLK and signaling information.

The SS7 Signaling Data Link Control functions include the following:

- Signal unit delimination
- Signal unit alignment
- Error detection
- Error correction
- Initial alignment
- Signaling link error monitoring
- Congestion control.

Continued on next page

Message Transfer Part, Continued

MTP Level 3

The SS7 MTP level 3 (signaling network) ensures the reliable transfer of signaling messages from origination to destination, even in the event of a signaling link and /or Signal Transfer Point (STP) failure. The signaling network functions include actions and procedures necessary to inform signaling points in an SS7 network of a network fault and to route signaling messages around the fault to their destination. The signaling network functions are divided into two categories:

- Signaling Message Handling
- Signaling Network Management.

The Signaling Message Handling function consists of message routing, discrimination, and distribution. When a signaling message is received from SS7 level 4 (an outgoing message), the message routing function determines which signaling link transports the signaling message. When two or more signaling links are used to carry signaling message traffic to a given destination, the signaling messages are distributed among them by the load-sharing function.

Digital Signaling Links

Data is exchanged throughout the SS7 network over digital signaling links. The signaling links connect to SS7 nodes on the CNI ring. Arrangements are made throughout the SS7 network to ensure the reliable exchange of data during the presence of signaling link transmission disturbances or network failures.

All A-links in a CNI-equipped office are duplicated. One signaling linkset is assigned to each of the two STPs in a region. Each signaling link is designed to operate normally at 40% capacity and function in a load-sharing manner. If the volume of data increases to over 40 percent, an additional pair of signaling links must be added to handle the load. In the event of a signaling link failure, the mate signaling link supports the total load until the failing link can be restored.

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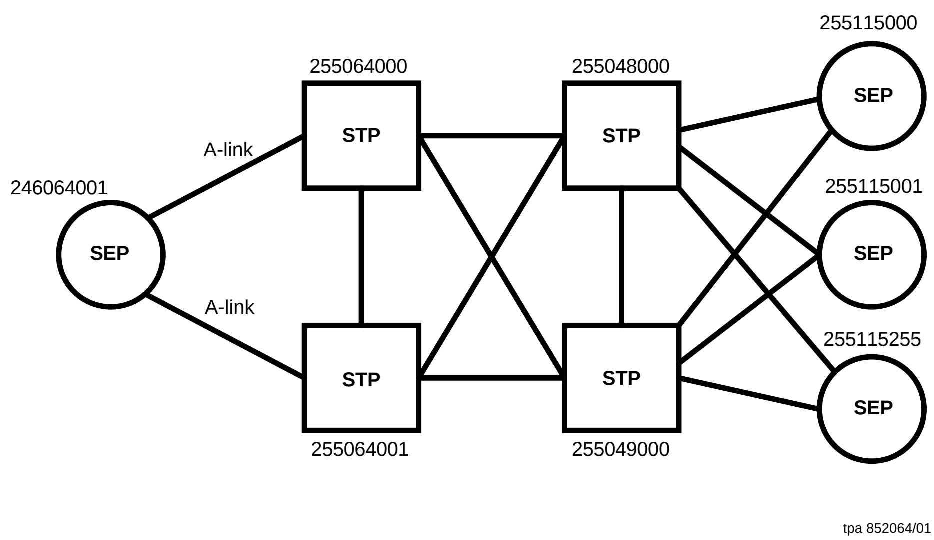
Message Transfer Part, Continued

Duplicate Routing

In addition to signaling links being duplicated, mated STPs contain identical routing data. This duplication of routing data further expands the reliability of the signaling link section. The SS7 network signal link (A,B, and C links) and STP configurations provide a multiple combination of paths that information can travel. However, if all signaling links to an office fail, the office becomes isolated and cannot perform SS7 network functions. Under this condition, the local STPs broadcast a message over the network indicating that the office is isolated and no traffic should be sent to the office.

Figure 2-2. Typical A-Link Set Routing

The following is an illustration of A-link Set Routing.



ISDN User Part (ISUP)

ISDN User Part (ISUP)

ISUP is a message driven protocol. Each part of a call is processed by the receipt or generation of specific messages. Each message is composed of specific parameters some of which are required and some optional.

The messages can be classified as Call Setup/Teardown (Table A) and Circuit Control/Test (Table B). The referenced table shows the required and possible optional parameters associated with each message.

The ISUP protocol can be used in two typical scenarios. The first is for intraLATA and/or intranetwork calls. The intranetwork calls can be between different local carriers but within the same LATA. The second is for interLATA calls to Interexchange Carriers (IXC's). These are called Network Interconnect calls. Table A shows the messages for both cases. The call messages are basically the same with NI calls using additional messages and parameters as marked in that table. See the call flow section for the usage of these messages.

Continued on next page

ISDN User Part (ISUP), Continued

Table A

ISDN-UP Messages and Parameter												
	Call Setup & Teardown Messages											
Parameters	**CRA***	**CRM***	**IAM**	**COT**	**ACM**	**EXM***	**ANM**	**CPG**	**REL**	**RLC**	**SUS**	**RES**
Message type	M	M	M	M	M	M	M	M	M	M	M	M
End of optional parameter*			O		O	O	O	O	O		O	O
Access transport			O		O		O	O	O		O	O
Automatic congestion level									O			
Backward call indicators					M		O	O				
Called party number			M									
Calling part number			O									
Calling party’s category			M									
Carrier selection information			O									
Cause indication					O			O	M			
Charge number			O									
Continuity indicators				M								
Event information								M				
Forward call indicators			M									
Generic address†			O									
Nature of connection ind.		M	M									
Optional backward call ind.					O			O				
Originating line information			O									
Outgoing trunk group number						O						
Range and status												
Suspend/resume indicators											M	M
Transit network selection			O									
User service information			M									
User-to-user indicator			O		O		O	O				
User-to-user information			O		O		O	O	O			

M = Mandatory O = Optional

CRA= Circuit reservation ack.
CRM= Circuit reservation
IAM= Initial address message
COT= Continuity
ACM= Address completion
EXM= Exit
ANM= Answer
CPG= Call progress
REL= Release
RLC= Release Complete
SUS= Suspend
RES= Resume

* Used for internetwork calls only
† Type of Address must be for user-provided CPN (00000011)

Continued on next page

ISDN User Part (ISUP), Continued

Table B

ISDN-UP Messages and Parameter																			
	Circuit Control/Test Messages																		
Parameter	**CVR**	**CVT**	**CCR**	**RSC**	**LPA**	**BLO**	**UBL**	**UCIC**	**BLA**	**UBA**	**CGB**	**CGU**	**CGBA**	**CGUA**	**GRS**	**CRA**	**CQM**	**CQR**	**CFN**
Message Type	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
End of optional parameter	O																		
Circuit group char. ind.	M																		
Circuit grp. sup. msg. type											M	M	M	M					
Circuit identification name	O																		
Circuit state indicator																		M	
Circuit validation resp. ind.	M																		
Common language location ID	O																		
Range and status											M	M	M	M	M	M	M	M	

M = Mandatory O = Optional

CVR= Circuit validation test resp.
CVT = Circuit validation test
CCR = Continuity check request
RSC = Reset circuit
LPA = Loop back attachment ack.
BLO = Blocking

UBL= Unblocking
UCIC = Unequipped circuit ID code
BLA = Blocking ack.
UBA = Unblock ack.
CGB = Circuit group blocking
CGU= Circuit group unblocking

CGBA = Circuit group blocking ack.
CGUA = Circuit grp. unblocking ack.
GRS = Group reset
GRA= Circuit group reset ack
CQM= Circuit group query
CQR= Circuit group query resp
CFN = Confusion

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Network Interconnect

Background

Before equal access, the *4ESS*™ Switch could only access other carriers using Multifrequency (MF) signaling.

When equal access was implemented, the Local Access and Transport Area (LATA) concept was developed. Inter-LATA signaling soon followed when MF signaling was modified to allow call set-up routing to an Interexchange Carrier (IXC) for inter-LATA calls. This modified form of MF signaling is known as Equal Access Multifrequency (EAMF) signaling.

EAMF

EAMF signaling is a multistage in-band signaling protocol that sends signaling information on the same trunk as the voice path. Multistage EAMF signaling is slow, and is limited in the signaling information sent.

Introduction of ISUP Protocol

When the SS7 ISUP protocol was introduced, it provided basic intranetwork signaling, but was not capable of crossing network boundaries. EAMF signaling was still required for inter-LATA calls. The SS7 ISUP protocol gave greater flexibility and capacity that was required to support the Integrated Services Digital Network (ISDN) feature. SS7 ISUP protocol was expanded to allow internetwork SS7 ISUP signaling.

SS7 ISUP Network Interconnect Feature Description

The SS7 ISUP Network Interconnect feature provides an SS7 ISUP interface between LECs and the IXC. Network Interconnect allows ISUP signaling to cross network boundaries; and it also provides the interworking of EAMF to ISUP and ISUP to EAMF at the Access Tandem (AT) offices. This capability is intended to eventually replace existing MF and EAMF signaling for communication between carriers.

Network interconnect is independent of signaling network architecture. The ISUP protocol layer uses the SS7 signaling network for message transport via the MTP protocol layer. Figure 2-2 shows the typical network interconnect architecture.

Continued on next page

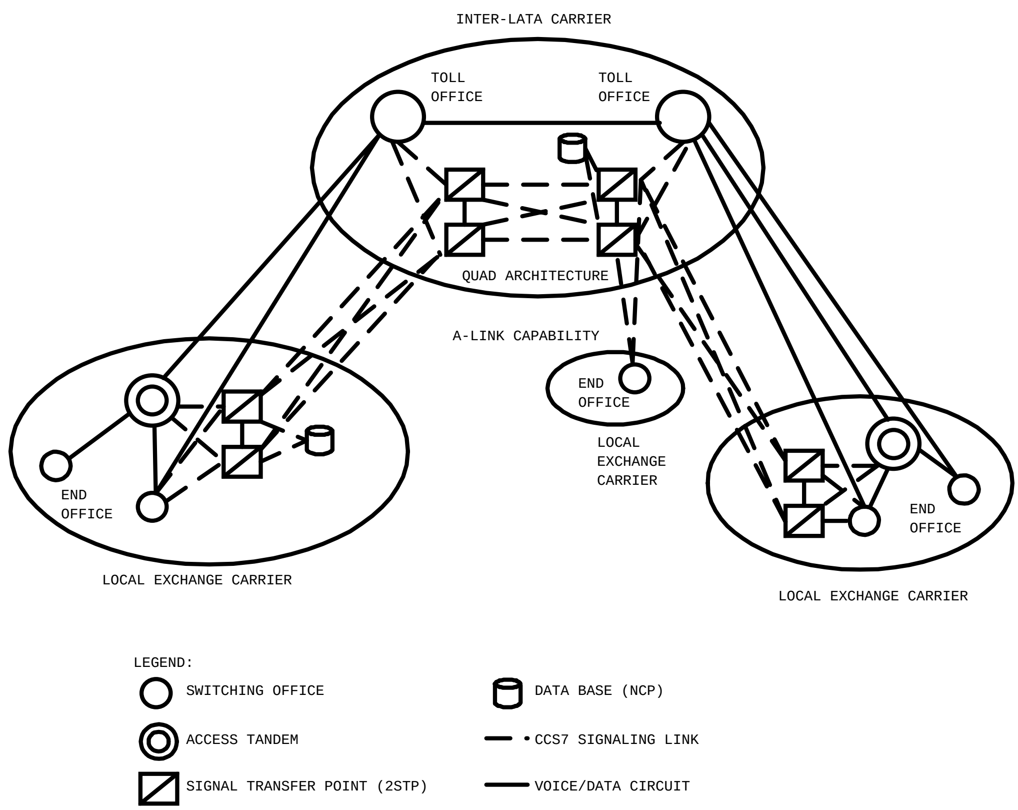
Network Interconnect, Continued

SS7 ISUP Network Interconnect Feature Description, Continued

The ISUP protocol upgrade portion of this feature contains changes to the protocol to further align with Bell Communications Research technical references, and new standards formats and procedures. The *4ESS* Switch will pass fields that it used to hardcode such as forward call indicators, backward call indicators, cause and location in backward releases. Also, new parameters and fields will be generated or passed such as charge number, automatic congestion control, charge number transition, and the optional inclusion of the Routing Information Indicator (RII) parameter.

Figure 2-2. Typical Network Interconnect Architecture

This figure shows typical Network Interconnect architecture.



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Tone and Announcement Treatment

Tone and Announcement Treatment

If during call setup [before sending Address Complete Message (ACM)] the connection cannot be completed or maintained, a "Tone/Announcement (T/A) treatment" is initiated. One form of this treatment is the return of an SS7 Release (REL) message with a cause indicator explaining why the call could not be completed. Another form of treatment is an inband T/A.

Routing to Announcement

Whether an inband T/A is provided or a REL message is sent for failures detected in the *4ESS* Switch itself will depend on three factors:

1. whether the incoming IAM crossed a network boundary,
2. whether or not the incoming trunk is an SS7 trunk, and
3. whether an Address Complete Message (ACM) has been sent to the incoming switch.

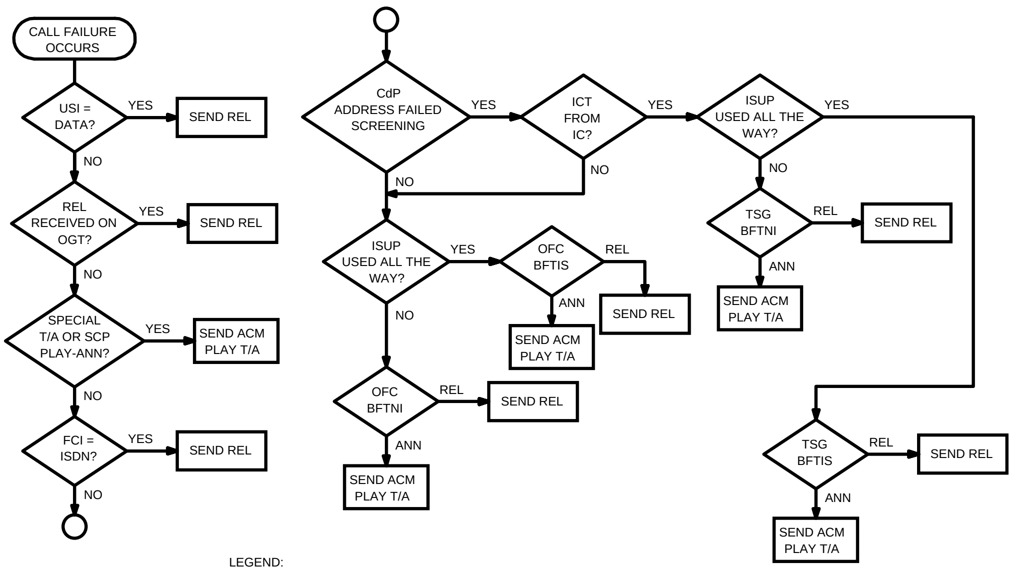
Note:
Provided that the incoming trunk was an SS7 trunk, the *4ESS* Switch will pass through any REL message received from a subsequent (terminating) switch to the incoming switch. If the incoming trunk is not an SS7 trunk and a REL message has been received from the terminating connection indicating a failed call attempt, the *4ESS* Switch will provide inband T/A.

Continued on next page

Tone and Announcement Treatment, Continued

Figure 2-3. *4ESS* Switch Call Failure Treatment at LEC Access Tandem

This figure, which applies to both interlata and Network Interconnect calls, indicates the decisions that will take place depending on the conditions indicated. The incoming trunk is SS7.



LEGEND:

ACM	Address Complete Message
ANN	Announcement
BFTIS	Backward Failure Treatment ISUP All The Way
BFTNI	Backward Failure Treatment Not ISUP All The Way
CdP	Called Party Number
FCI	Forward Call Indicator
IC	Interexchange Carrier
ICT	Incoming Trunk
ISDN	Integrated Services Digital Network
ISUP	ISDN User Part
OFC	Office Option
OGT	Outgoing Trunk
REL	Release
SCP	Service Control Point
T/A	Tones and Announcements
USI	User Service Information

Continued on next page

Tone and Announcement Treatment, Continued

Table C

This table presents the mapping from cause to Tone/Announcement. For further details about call failure handling, see *Call Irregularities Handbook* (234-010-315).

Cause Value	Domestic Treatment (Note2)
1 unallocated number	VCA
2 no route to specific transit network	VCA
3 no route to destination	VCA
4 send special information tone	T
5 misdialed trunk prefx	N/A for US
16 normal clearing	T (Note 1)
17 user busy	BT
18 no user responding	ROA
21 call rejected	ROA
22 number changed	VCA
27 destination out of service	ROA
28 address incomplete	VCA
31 normal, unspecified (classes 000 and 001)	T (Note 1)
34 no circuit available	NCA/NCC
38 network out of order	ROA
41 temporary failure	ROA
42 switching equipment congestion	ROA
44 requested channel not available	ROA
45 preemption	T
47 resource unavailable	unspecified
57 bearer capability not authorized	VCA
58 bearer capability not currently available	VCA
63 service/option not available	unspecified
65 bearer/capability not implemented	VCA
66 channel type not implemented	VCA
70 only restricted digital information bearer capability is available	VCA

Continued on next page

Tone and Announcement Treatment, Continued

Table C (continued)

Cause Value	Domestic Treatment (Note 2)
79 service/option not implemented	unspecified
81 invalid call reference value	VCA
88 incompatible destination	VCA
95 invalid message, unspecified	VCA
97 message type non-existent or not implemented	ROA
99 parameter non-existent or not implemented	ROA
100 invalid parameter contents	ROA
111 protocol error	unspecified
127 interworking	unspecified

BT = busy tone (60 IPM) NCC = no circuit to carrier
NCA = all circuit busy T = reorder tone (120 IPM)
ROA = call did not go through VCA = unable to complete

Notes:
1. If release is before ACM
2. Reorder tone may be provided in place of any announcement

Additional Features

Introduction

Since the implementation of SS7, additional features have been developed to interact with SS7. They include the following:

- 085 Generic Address Parameter
- 120 Handling Additional TR-394 Exception
- 122 Coding Standard Field of the Cause Parameter
- 156 Completion of Transmission Path
- 247/344 Full Point Code Routing (FPCR) and E-Link Access Features
- 158 Routing Based on Speech and 3.1 kHz Bearer Capability
- 401 SS7 Trunk Signaling Interface for Cellular Type 2A Connection
- 403 CCIS2WRE Field Enhancements in Recent Change (RC)
- 405 Feature Group - D Carrier Identification Code Expansion Cause Transparency Feature
- 406 Carrier Identification Parameter Feature
- 408 3.1-kHz Enhancement Switch Options Feature

Descriptions of these features follow.

Generic Address Parameter Feature (#085)

The Generic Address Parameter (GAP) feature provides the capability to transport a non-validated, user-provided Calling Party Number (CPN). This feature is important for supporting an end-to-end internetwork operation. Without the GAP feature, user-provided numbers such as ISDN Numbering Plan number or a Private Numbering Plan number, which are non-validated numbers, are dropped.

Before the incorporation of Network Interconnect, the *4ESS* Switch could only transport one network-validated CPN. A non-validated number, that is, a CPN that is either not screened by the network or is screened and fails the screening process, was dropped. Now the network-validated CPN is transported to and from the LEC in the CPN parameter, and the non-validated CPN is transported in the GAP.

Continued on next page

Additional Features, Continued

Handling Additional TR-394 Exceptions Feature (#120)

This feature complies with Bellcore TR-394 exceptions that deal with handling ISUP calls at an AT and supporting consistent protocol handling in the LEC networks. Compliance is provided for the following three exceptions:

- Calling Party Category Parameter
- Interworking Cause
- Backward Call Indicator (BCI) for Test Calls.

Calling Part Category Parameter

This exception pertains to the coding of the Calling Party Category parameter at an AT Switch where interworking from MF to ISUP signaling occurs. Prior to the implementation of this feature, the Calling Party Category parameter in the outgoing Initial Address Message (IAM) was coded "ordinary calling subscriber."

This feature changes the coding to either "customer" or "unknown." The setting is based either on a check of a type of trunk (TOT) table or on whether equal access is available on the Incoming Trunk (ICT). For an End Office or Tandem Connecting (ETC) trunk or an Other Common Carrier (OCC) trunk, the Calling Party Category parameter is set to “unknown." If this is a substituted number (that is, a new routing number received from a data base), then the Calling Party Category parameter is set to "customer."

Continued on next page

Additional Features, Continued

Handling Additional TR-394 Exceptions Feature (#120)

Interworking Cause

This exception also pertains to a *4ESS* Switch that is serving as an AT where MF to ISUP interworking occurs. The exception defines how the *4ESS* Switch will respond when the following conditions exist:

a. An on-hook disconnect signal is received on the incoming circuit before receiving either a release (REL) message or a suspend (SUS) message for the outgoing circuit.

b. An IAM has already been sent on the outgoing circuit.

For condition **a**, the *4ESS* Switch idles the incoming circuit and returns an on-hook signal.

For condition **b**, the *4ESS* Switch sends a REL message for the outgoing circuit with the Cause parameter coded as follows:
- The Cause value is "interworking unspecified" (1111111).
- The location is "local network" (0010).

Prior to the incorporation of this feature, when a forward REL message was sent in interworking cases, the Cause value was "normal clearing."

Backward Call Indicator (BCI) for Test Calls

This exception pertains to the coding of BCI for incoming test calls on ISUP circuits that terminate on a *4ESS* Switch.

If an incoming test call on an ISUP circuit terminates at a *4ESS* Switch, and an address complete message (ACM) is sent on the incoming circuit, the BCI parameter is coded as follows:

- The Interworking Indicator is coded "no interworking encountered" (0). (This was previously coded "interworking encountered.")
- The ISUP indicator is coded "ISDN User Part used all the way" (1). (This was previously coded "ISDN User Part not used all the way.")
- If the test circuit is available and free, the Called Party Status Indicator is coded "subscriber free" (01). (This was previously coded "no indication.")

Continued on next page

Additional Features, Continued

Coding Standard Field of the Cause Parameter Feature (#122)

The ISUP Cause parameter contains a 2-bit Coding Standard field that can have the following values:

- 00 International Telecommunication Union (ITU) standard (formerly CCITT standard)
- 01 Reserved for other international standards
- 10 American National Standards Institute (ANSI) standard
- 11 Reserved

Before the incorporation of this feature, the only value in the Coding Standard field that the *4ESS* Switch recognized and generated was 00, CCITT standard. All the Cause values that were implemented, for example, "no circuit," "user busy," etc., were related to the CCITT coding standard.

Now end offices implement services that define Cause values that relate to other values in the Coding Standard field, for example, ANSI standard.

When necessary, failure indications must be sent to calling parties using these new services. This feature gives the *4ESS* Switch the capability to pass unchanged all Coding Standard values or to play a default announcement.

Continued on next page

Additional Features, Continued

Completion of Transmission Path Feature (#156)

This feature eliminates possible fraudulent use of the network by delaying the completion of the transmission path until the answer indication is received. Prior to this feature, the possibility existed that users could make data calls and pass data between the receipt of the Address Complete Message (ACM) and the Answer Message (ANM). By disconnecting the call prior to receiving an answer, users could pass data through the network and not be billed for the call. (An AMA record is generated when ANM is received.) By waiting until ANM is received to complete the transmission path on data calls, this possible fraudulent use of the network is eliminated.

This feature allows ISUP outgoing calls to set up the transmission path at a different time from the receipt of the ACM. A pre-ACM Call Progress (CPG) message also causes the transmission path to be set up if it is indicated that there is interworking or that inband information may be available. For data calls, however, the setup of the transmission path is delayed until ANM is received, as long as the setup has not been requested by a previous CPG or ACM message.

Continued on next page

Additional Features, Continued

Full Point Code Routing (FPCR) and E-Link Access Feature (#247/344)

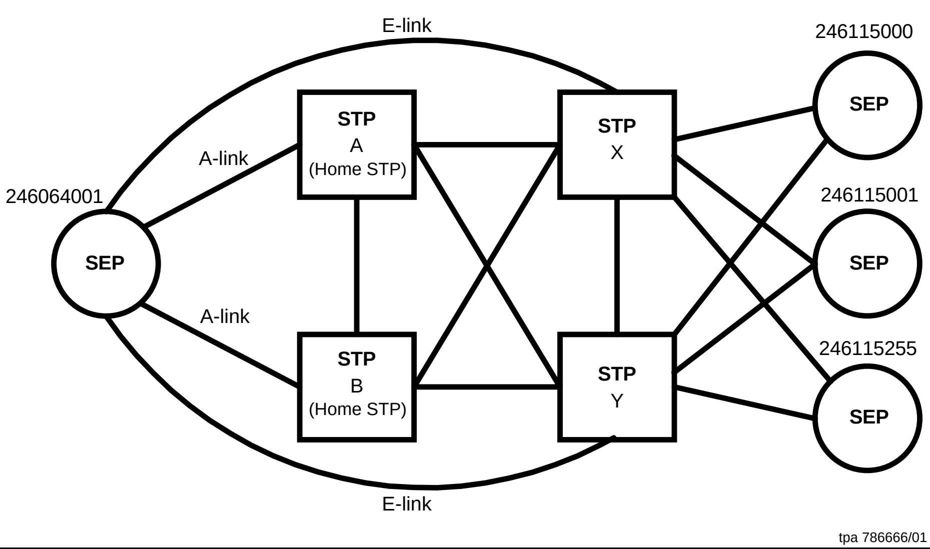
E-link access is the connection of signaling links between the signaling end points (SEPs) and the non-home STP.

The following are some of the advantages of having E-links in the network:

- E-links provide the CNI with the ability to specify additional signaling routes to any signaling point. Up to three signaling routes can be specified: a primary route and two alternate routes.
- If an A-link set fails, E-links can be used as backups and vice versa.
- E-links improve network reliability by providing additional destination routes. The possibility of a Signaling End Point (SEP) being isolated from the network is minimized.
- With E-links, traffic can be switched between A-links and E-links for network reconfiguration.
- Traffic can be routed directly to non-home Signaling Transfer Point (STP) pairs, thereby reducing the number of intermediate STPs that are involved in a call. This process speeds up call setup which improves network performance and network utilization.

Figure 2-4. A-Link and E-Link Routing

E-link access is shown in Figure 2-4.



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Additional Features, Continued

Full Point Code Routing (FPCR) and E-Link Access Feature (#247/344), Continued

Effective Use of E-links

In order to make the most effective use of E-links, Full Point Code Routing (FPCR) is required. A point code is a unique 9-digit number that is assigned to every signaling point in the SS7 network. See Figure 2-4.

A point code is really the address that is used to transfer signaling information in the network. Routing labels of an SS7 message use point codes to identify the origination of the message and the destination of the message.

There is a specific structure to point codes. The first three digits of the point code identify the network, the second three digits identify the cluster, and the last three digits identify the member. A cluster identifies groups of signaling points in a network, and a member identifies the individual signaling points within a network cluster.

In the past, *4ESS* Switch routing was limited to network or cluster routing. Only the first 6 digits of the point code were used. As the name implies, full point code routing uses all 9 digits of the point code. By using the full point code, a switch can route to 5,079 members. After the FPCR feature is installed, the restriction that members of a cluster must have the same routes does not apply.

E-links are installed and provisioned as a pair of link sets from an SEP to any other STP pair. The physical interface on the CNI ring for E-links is identical to the interface for A-links. See document 234-100-120 for further details.

Continued on next page

Additional Features, Continued

Full Point Code Routing (FPCR) and E-Link Access Feature (#247/344), Continued

Functional characteristics of E-links include the following:

- All Signaling System Number 7 (SS7) data link interfaces that support A-links also support E-links.
- Signaling End Point (SEP) supports E-links to at least two OTHER STP pairs.
- Each SEP supports a maximum total of 16 combined link sets.
- E-links simultaneously support direct routing and back-up routing of traffic to different DPCs.
- The total number of routes to be supported per DPC is three (one primary and two alternates).
- A-link or E-link sets can be provisioned as primary or alternate per destination.
- The primary link set for a given point code can be the alternate link set for other point codes.
- The number of intranetwork populated and unpopulated clusters supported is 160 (128 populated and 32 unpopulated).

Alternate Link Set Routing

Alternate routing to available back-up link sets is done when signaling points are unavailable over higher priority routes. Alternate routing can occur

- when a primary link set(s) fails.
- when the STP mated pair connected to the primary route fails.
- when one link set fails and the STP not connected to the failed link set also fails.
- under route unavailability or traffic diversion conditions indicated by Transfer Prohibited (TFP) or Transfer Cluster Prohibited (TCP) Signaling Route Management (SRM) messages.

Continued on next page

Additional Features, Continued

Routing Based on Speech and 3.1-kHz Bearer Capability Feature (#158)

Prior to this feature, the speech and 3.1-kHz audio values of the information transfer capability of the User Service Information (USI) parameter in an Initial Address Message could not be distinguished when routing calls. Calls with information transfer capability coded "speech" allow certain treatments such as Time Assignment Speech Interpolation (TASI) and Low Bit Rate Voice (LBRV) encoding. However, these treatments do not ensure the integrity of the bit stream, which could obstruct the quality of voiceband data traffic such as facsimiles and modems. On the other hand, the 3.1-kHz audio calls apply to voiceband data where it is important to maintain the integrity of the bit stream. Therefore, TASI and LBRV encoding are no longer permitted on trunks that carry voiceband data.

This feature allows the LEC network to differentiate the routing of voice calls from the routing of 3.1-kHz audio calls. This is accomplished by a new manual subsequent digit treatment, V31K, that is used to route calls based on the information transfer capability of the Bearer Capability.

Calls with information transfer capability of 3.1-kHz audio (10000) on an ISUP incoming trunk and incoming voice calls on multifrequency trunks should only be routed over 3.1-kHz audio, 56-kbps, or 64-kbps trunks. If the information transfer capability of the USI is coded "speech" (00000) on an ISUP incoming trunk, the outgoing call may be routed over a speech trunk. The requirements specify that a speech call can be routed over a 3.1-kHz, 56-kbps, or 64-kbps trunk; but a 3.1-kHz audio call cannot be routed over a speech trunk.

At an access tandem, the information transfer capability in the USI is coded "3.1-kHz audio" if one of the following two conditions occurs:

- Incoming call is a voice call (POTS Domain); the incoming trunk is multifrequency; and the outgoing trunk is ISUP

- Incoming and outgoing trunks are ISUP; and a 3.1-kHz call is received.

Continued on next page

Additional Features, Continued

SS7 Trunk Signaling Interface for Cellular Type 2A Connection Feature (#401)

Prior to this feature, only MF signaling could be used over a Type 2A connection between a *4ESS* Access Tandem (AT) Switch and a Cellular Mobile Carrier (CMC). This feature provides a trunk signaling interface that allows SS7 signaling, in addition to MF signaling, over a Type 2A connection between a *4ESS* AT Switch and a CMC.

With this feature, the cellular Type 2A connection between a CMC and a *4ESS* AT Switch will support SS7 signaling for LATA Feature Group B calls, inter-LATA Feature Group D calls, and intra-LATA calls.

The use of SS7 signaling offers a number of important advantages including reduced call setup time and the recording of Service Switching Point (SSP) 800 calls. It also permits the interchange of internetwork data messages, which facilitate the use of enhanced services, nationwide roaming, and fraud reduction.

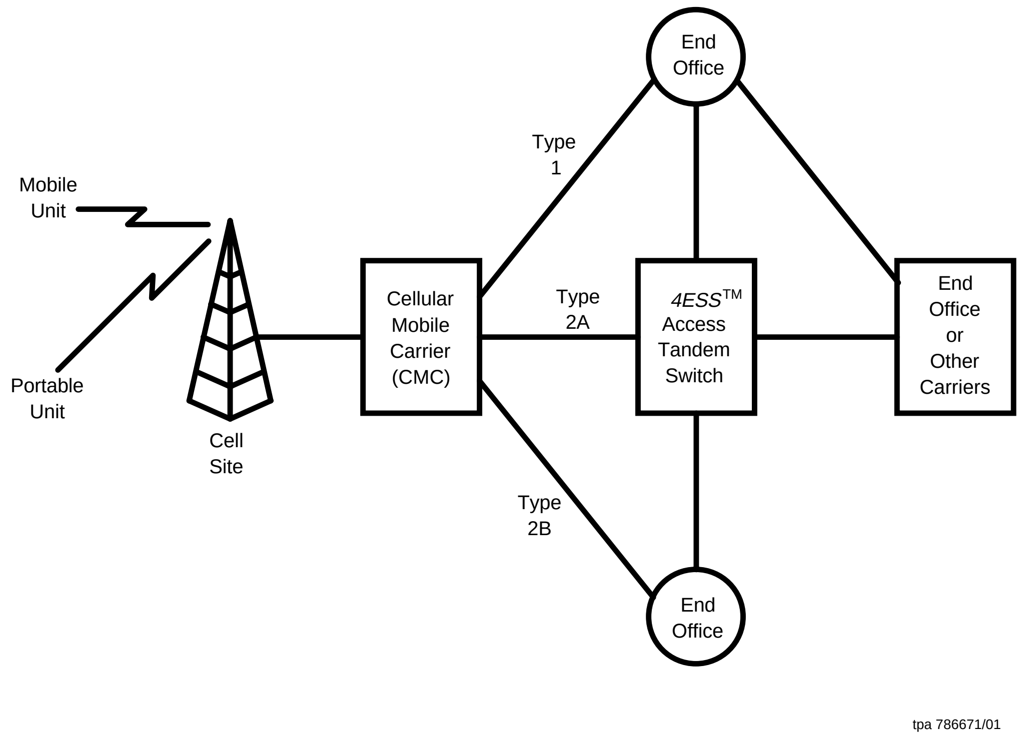
As shown in Figure 2-5, CMCs provide mobile telephone service to mobile customers via radio links from cell sites connected to mobile telephone switching offices. An interconnection (or interface) is required to allow the mobile customers to be able to send and receive telephone calls with land-based telephone customers and customers of other CMCs.

Continued on next page

Additional Features, Continued

Figure 2-5. Cellular Mobile Carrier Connections

This figure shows Cellular Mobile Carrier connections.



Continued on next page

Additional Features, Continued

SS7 Trunk Signaling Interface for Cellular Type 2A Connection Feature (#401), Continued

Inter-connections

Three types of interconnections are provided:

- A Type 1 interconnection is a connection through a LEC end office (EO). It provides connection to and from lines, inter-LATA carriers, and other CMCs that have terminations within the LATA.
- A Type 2A interconnection is a connection to a LEC *4ESS* Access Tandem Switch. It provides connections to and from the EOs, inter-LATA carriers, and other CMCs that have terminations within the LATA. The routing and signaling from the CMC are identical to the routing and signaling provided by equal access end office (EAEO) connections. With this type of connection, there are:
  - no line treatments
  - no operator services (using operator services signaling), and
  - N11 codes are **not** routed by the CMC to the *4ESS* Access Tandem Switch.
- A Type 2B interconnection is a connection to a LEC EO that provides connections only to and from directory numbers served by that EO. A Type 2B interconnection is generally used by a CMC in conjunction with a Type 2A interconnection.

Only Type 2A is affected by this feature. As described above and shown in Figure 2-5, Type 1 and Type 2B are for reference.

Continued on next page

Additional Features, Continued

CCIS2WRE Field Enhancements in Recent Change (RC) Feature (#403)

During the replacement process, when LEC customers replace their *1A ESS*™ Switches connected to *4ESS* Switches with *5ESS*® Switches, they have to manually put all trunks in a disabled state, remove them, change the CCIS2WRE field, add the trunks back, and activate them. This process is time-consuming, error-prone, and service-affecting.

The CCIS2WRE Field Enhancement in RC feature makes it possible to change the CCIS2WRE field without disabling or removing the trunks. Only a single change to the CCIS2WRE characteristic has to be made for each Trunk Subgroup (TSG) being converted, and the Digital Interface Frame is initialized automatically.

Feature Group-D Carrier Identification Code Expansion Cause Transparency Feature (#405)

The Feature Group-D (FG-D) Carrier Identification Code (CIC) Expansion Cause Transparency feature changes the ISUP cause value sent by the *4ESS* Access Tandem Switch to the LEC end office if the expected number of digits is not received. This feature is an enhancement to Feature 161, FG-D CIC Expansion, which was released in 4E18, Release 1.

A call can fail because the number of digits received in the Transit Network Selection (TNS) parameter does not match the number of CIC digits allowed on the Trunk Subgroup (TSG). The specific causes of the failure are as follows:

- A 4-digit CIC is received and the incoming TSG only allows 3 digits
- A 3-digit CIC is received and the incoming TSG only allows 4 digits.

Currently, the cause value is 100. With the activation of this feature, the cause value will change to 91, Invalid Transit Network Selection.

Continued on next page

Additional Features, Continued

Carrier Identification Parameter (CIP) Feature (#406)

The Carrier Identification Parameter (CIP) feature provides the capability to consolidate trunk groups from the LEC end offices or Access Tandems (ATs) to Interexchange Carriers (IXCs). This is necessary to deliver Carrier Identification Code (CIC) information associated with individual calls to the IXC. Trunk group consolidation allows for more efficient use of LEC-to-IXC trunking. The CIC associated with each call is carried by the CIP in the Initial Address Message (IAM) during call setup. The CIP is delivered to the IXC in a forward direction to indicate the originator's CIC. LEC switches using directly connected IXC trunk groups include the CIP in an outgoing IAM on a per-trunk group, per- CIC value, IXC subscription basis. This process allows independent control of each CIC value per each trunk group.

Prior to this feature, trunks were usually arranged so that trunk groups used between a LEC end office or LEC AT and the individual IXCs were dedicated to one CIC. The trunk groups were not to be shared by calls associated with multiple CICs. With this feature, the CIP is available to an IXC for all calls that involve an IXC.

3.1-kHz Enhancement: Switch Options Feature (#408)

The 3.1-kHz Enhancement: Switch Options feature enables a *4ESS* Switch LEC office to control the encoding of the Information Transfer Capability (ITC) field in the User Service Information (USI) parameter of ISUP IAM.

This feature is required as a result of problems introduced by Bellcore Technical Requirement (TR) 448, which called for the ITC field to be encoded as 3.1 kHz when the Incoming Trunk was MF and the Outgoing Trunk was ISUP. That requirement, which was implemented in 4E17R1 as Feature 158, resulted in lost calls in some instances.

Subsequent to TR 448, Bellcore released a change to TR 317 Issue 3 requiring a set of options for proper encoding of the ITC field for this situation.

This feature includes the use of an office indicator and a trunk indicator to determine how the ITC should be encoded in the USI parameter when the incoming trunk is MF and the outgoing trunk is ISUP.

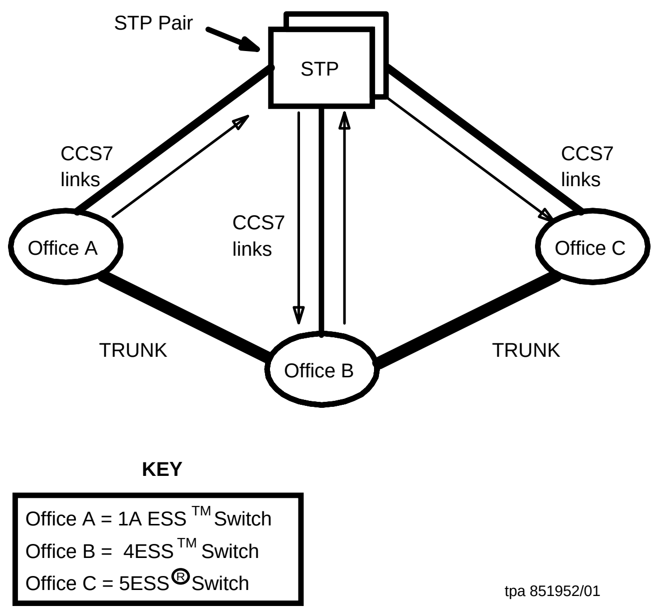
Chapter 3 Call Flow

Overview of ISUP Call Processing

Introduction

With its protocol structure, signaling routing mechanisms, variable message lengths, and higher data transfer rate, Integrated Services Digital Network User Part (ISUP) signaling offers many advantages over Per-Trunk Signaling (PTS). Examples of PTS are Multifrequency (MF) and Dial Pulse (DP) signaling. However, it is important to note that the improvements are related primarily to signaling and services. Plain Old Telephone Service (POTS) call processing functions (for example, address analysis, screening, routing, trunk selection, digit conversion, and alerting) are the same as those used in PTS. Calls are still routed in stages as shown in Figure 3-1, 3-2, 3-3.

Figure 3-1. ISUP Call Setup in the SS7 Network



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Overview of ISUP Call Processing, Continued

Figure 3-2. Talking State in the SS7 Network

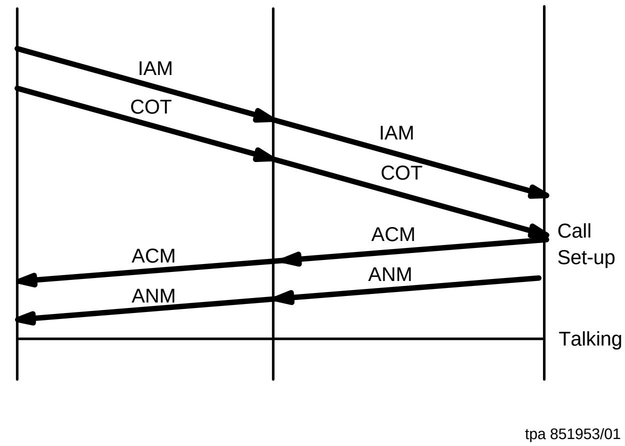
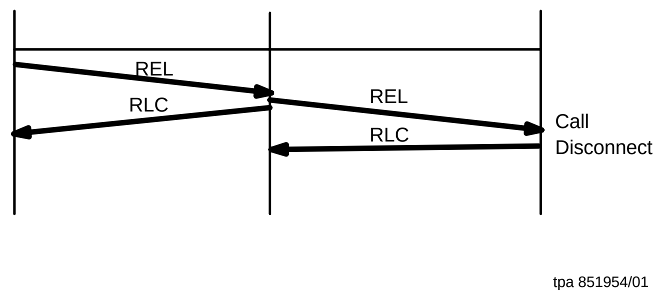


Figure 3-3. ISUP Call disconnect in the SS7 Network



Call Flow Description

For the following description, refer to Figure 3-1. Assume a basic interoffice voice call, originating from Office **A** and terminating at Office **C**, via Tandem Office **B**, is to be made. Notice that with ISUP signaling, all signaling messages are relayed through one or more Signaling Transfer Points (STPs).

After Office **A** receives the called number from the originating party, routing for the call is determined using internal translations (as in PTS). An Initial Address Message (IAM) containing the routing digits (plus additional data) is then sent via one of the STPs to Tandem Office **B** for a selected ISUP circuit. This circuit is uniquely identified by a Trunk Circuit Identification Code (TCIC), and the Point Codes of Offices **A** and **B**. All ISUP messages include a TCIC identifying the related circuit/trunk.

Continued on next page

Overview of ISUP Call Processing, Continued

Voice Path Assurance

Since ISUP does not signal through the actual speech path, it is necessary to ensure that acceptable transmission can occur. A voice continuity, or Voice Path Assurance (VPA) test, can be requested in the Initial Address Message (IAM) on the outgoing circuit. Results of the test (success or failure) are sent by originating Office **A** in a Continuity Message (COT) to Tandem Office **B**.

Note:
In this example, the call setup sequence includes a continuity test. Note that the continuity test can be performed on a sampling basis.

Office B Functions

On receipt of the IAM, Office **B** handles the VPA request and then examines the called party address. Digit deletion/prefixing and routing are again determined using internal translations. Office B then formats an IAM for a selected ISUP outgoing circuit and sends the message via an STP to terminating Office **C**.

Note:
The intermediate office (in this case B) can either send the formatted IAM immediately after the incoming IAM is received, or wait until the incoming continuity check procedure is completed.

Continued on next page

Overview of ISUP Call Processing, Continued

Talk State Is Established

The IAM contains the TCIC associated with the outgoing circuit. Finally, regardless of whether or not Office **A** requested a VPA test on the incoming circuit, Office **B** may request a VPA test on the outgoing circuit. The calling party number is available to Office **C** which has an option that allows the number to be displayed.

An Address Complete Message (ACM) is sent by Office **C** to Office **B** acknowledging that the address information has been received at the terminating end office and that the called party line is idle. At this point, Office **C** provides audible ringing on the incoming trunk and rings the terminating line.

Meanwhile, Office **B** immediately passes the ACM to Office **A**, and the interoffice call path is established. An Answer Message (ANM) corresponding to the answer used in MF signaling is initiated when the ring trip (off-hook on the terminating line) occurs.

Disconnect

Assuming the calling party disconnects first, a Release (REL) message is sent from Office **A** to Office **B**. The REL message is then sent to Office **C**. Simultaneously, the switch path from Office **A** to Office **B** is disconnected, and a Release Complete (RLC) message is returned to Office **A**. On receipt of the REL at Office C, the switch path from Office **B** to Office **C** is released and an RLC is returned to Office **B**.

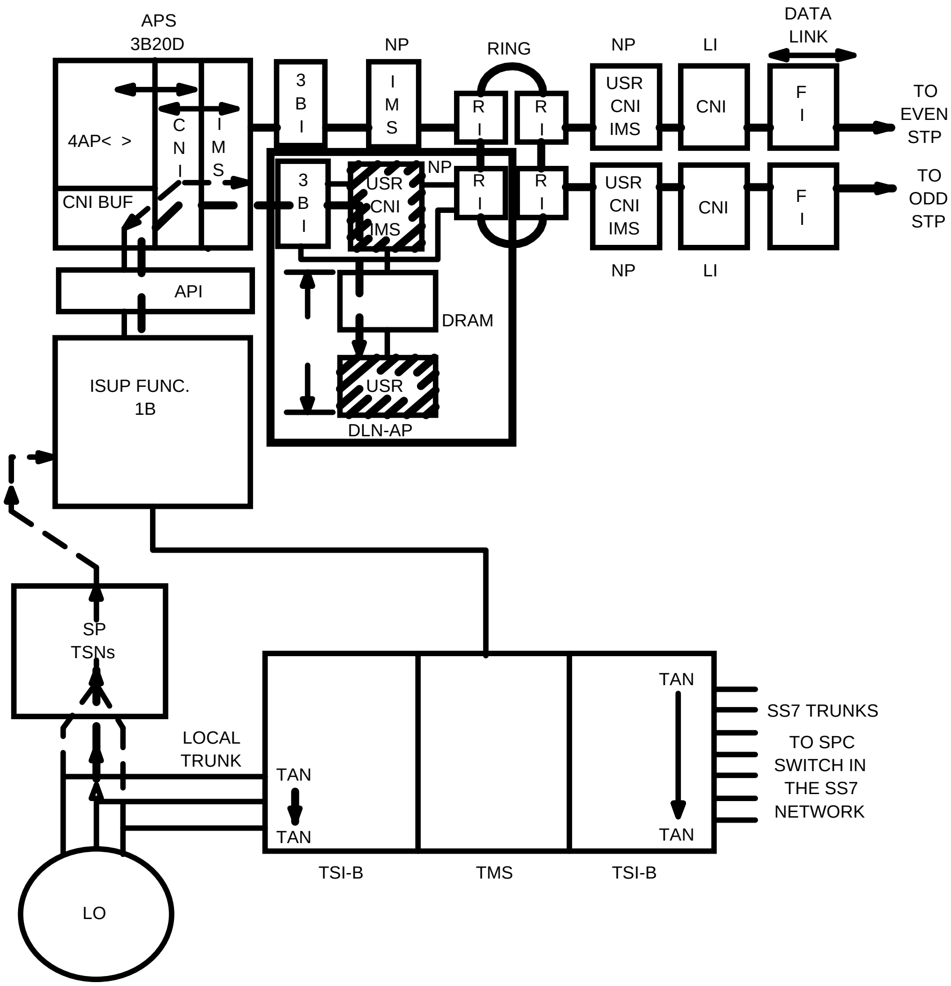
Note:
A similar procedure is followed if a POTS called party initiates the release. The only difference is that a Suspend (SUS) message is returned from Office C to Office A first. Office A then proceeds as above.

Continued on next page

Overview of ISUP Call Processing, Continued

Figure 3-4. ISUP Signaling System No. 7 Call Processing Diagram

The ISDN-UP of the SS7 protocol is used for SS7 connection-oriented messages. The following is an illustration of a layout of the equipment involved in processing a call for SS7 trunks.



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Overview of ISUP Call Processing, Continued

Call From a Local Switching Office Over an SS7 Trunk

The following describes a call from an originating office terminating over a SS7 trunk to another office in the SS7 network.

1. Assume that an incoming call is recognized at the *4ESS* Switch over a local trunk. The associated Signaling Processor (SP) collects the digits received over the local using the Trunk Scanner Number (TSN) assigned to the trunk. When all the digits are collected, the SP sends the dialed digits to the 1B processor for translation.

2. For this example, assume that the 1B translation identifies the outgoing trunk group as SS7 trunks. Since the outgoing trunk is a SS7 type, the 1B processor ISUP formats the message and sends it to the Data Link Node (DLN) via the Attached Processor Interface (API) and CNI-Circular Buffer (CNIBUF).

3. The ISUP - IAM received by the DLN contains the TSN of the associated outgoing Trunk Appearance Number (TAN) and the dialed telephone company Binary Coded Decimal (BCD) digits. The message also contains the ISUP message type, nature of connection, and other information as shown in Figure 3-4.

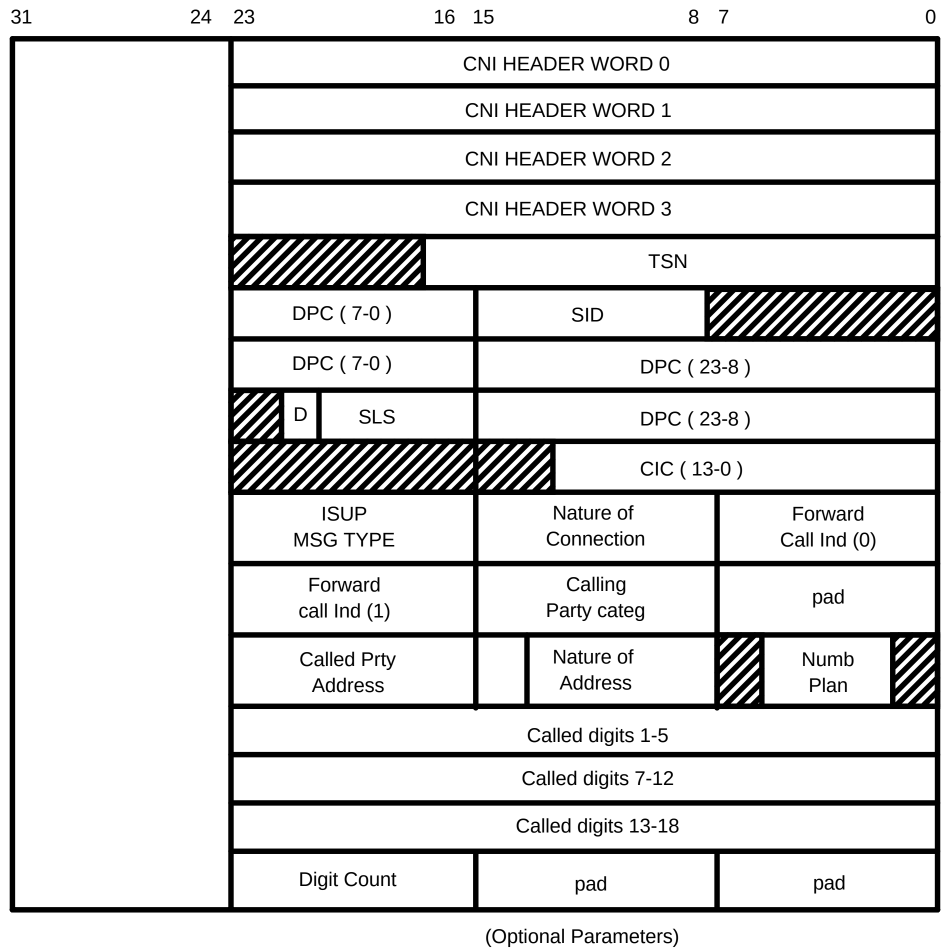
   The Direct Link Node-Attached Processor (DLN-AP) translates the TSN into a destination point code for routing the message over the Common Channel Signaling (CCS) network and a Circuit Identification Code (CIC) to identify the trunk at the far-end switching office. Note that the ISUP 1B format uses a 24-bit word (0 through 23) and has bits 24 through 31 added as a pad for messages from the 1B to the 3B computer. (Refer to Figure 3-5.)

Continued on next page

Overview of ISUP Call Processing, Continued

Figure 3-5. ISUP 1B Format—IAM

The following is an illustration of ISUP 1B Format — IAM.



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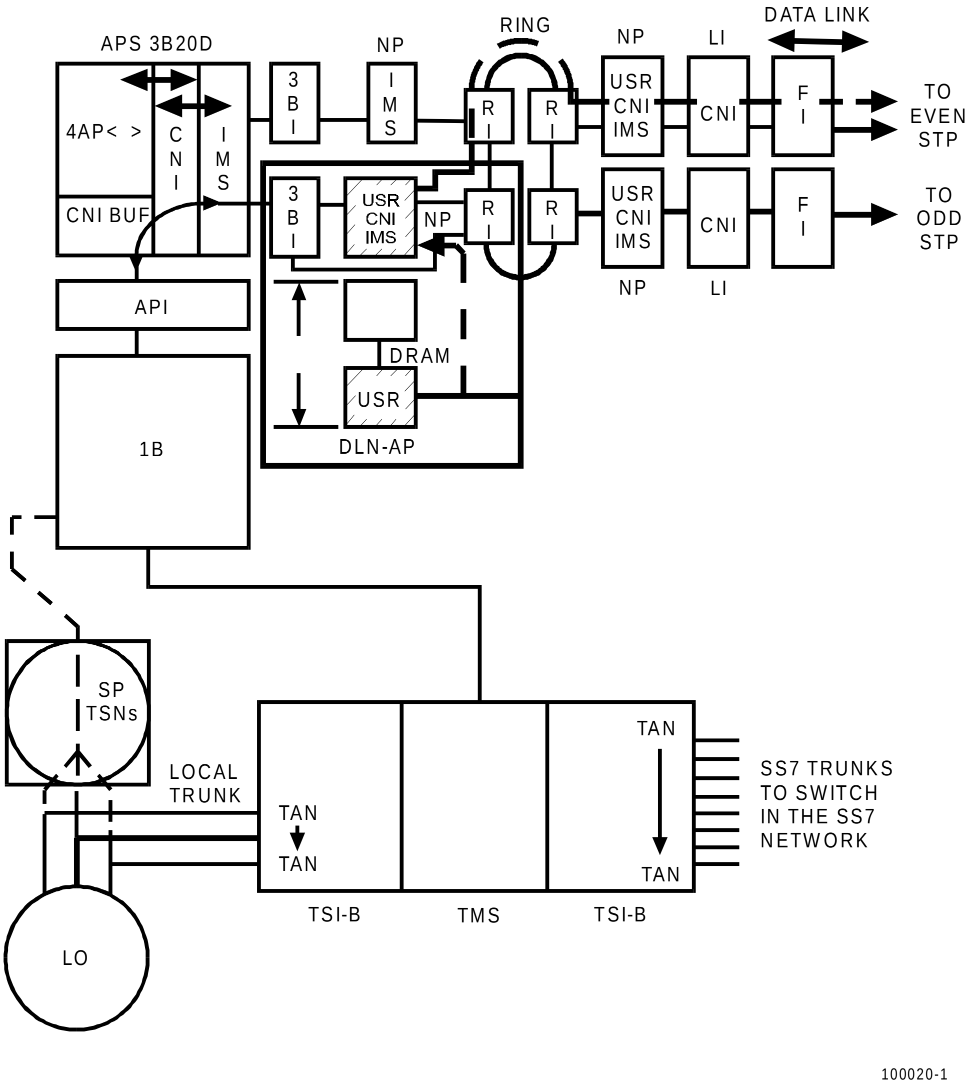
Overview of ISUP Call Processing, Continued

Figure 3-6. DLN-AP Translation of TSN for SS7 Call Processing

The following is an illustration of DLN-AP Translation of TSN.



Local Switching, Continued

4. After the DLN-AP translates the TSN into a Data Processing Center (DPC) a CIC, DLN-AP then reformats the SS7 message into a 32-bit word format as shown in Figure 3-6.

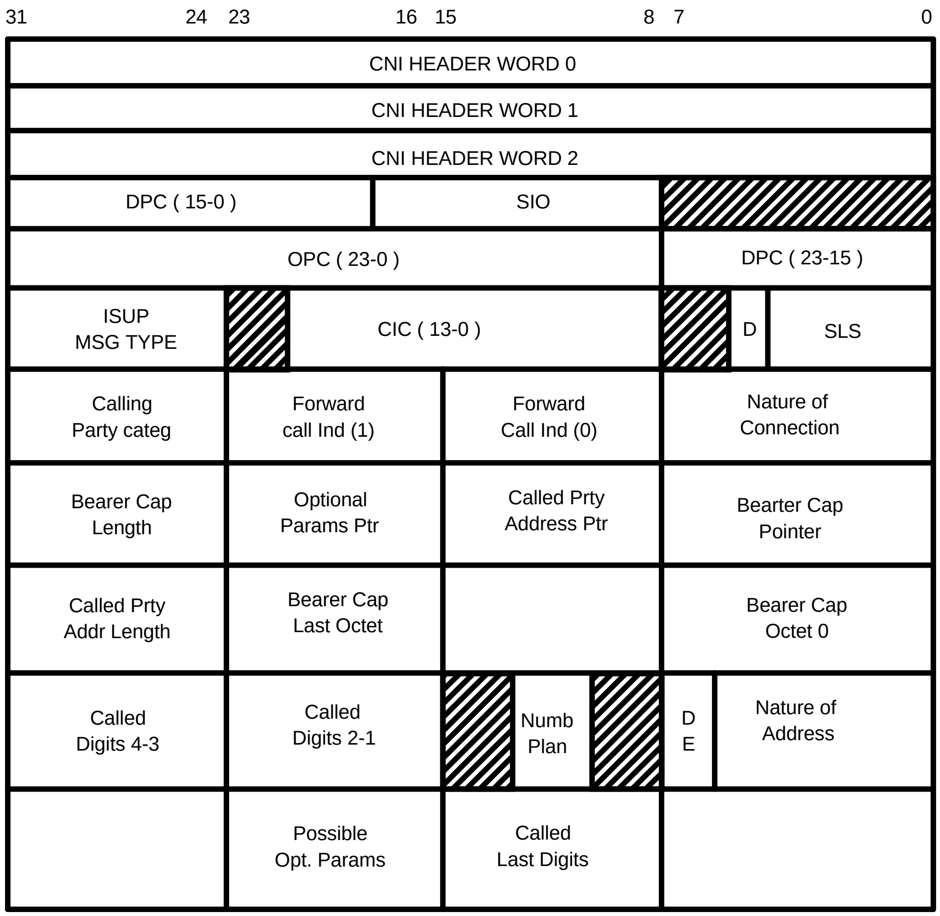
   The DLN also uses the Signaling Link Selection (SLS) field to specify the outgoing SS7 link for transmission. The Message Transfer Part (MTP) function of the CNI software in the DLN uses the SLS field to perform load balancing over the available SS7 links.

Continued on next page

Overview of ISUP Call Processing, Continued

Figure 3-7. ISUP — Initial Address Message for SS7 Routing

The following is an Illustration of an ISUP Initial Address Message.



Continued on next page

Overview of ISUP Call Processing, Continued

Local Switching, Continued

5. Once the outgoing SS7 link is determined, the CNI software writes the Ring Node Address (RNA) address of the outgoing link. The IMS software transports the message around the ring from the DLN to the designated SS7 node. The CNI software transmits the message over the signaling link to the STP.

   Various messages are required during an ISUP call setup. The ISUP MSG TYPE field is used to identify one of the following types:
   - ISUP - IAM (initial address message)
   - ISUP - ACM (Address Complete Message)
   - ISUP - REL (release message)
   - ISUP - ANS (answer message)

6. The preceding ISUP message types are routed in the same manner as described for the IAM call process. However, different functions are performed by the 1B processor for each message type (for example, continuity tests, etc.).

7. When subsequent ISUP messages are received from the far-end switch via the STP, the SS7 node routes the message to the DLN. The DLN translates the Originating Point Code (OPC) and CIC into a TSN related to the IAM message for that particular call setup. Since the IAM contains the DPC and OPC, the terminating switch uses the OPC as a DPC for routing the subsequent messages back to the originating office. Therefore, the DLN can relate all subsequent messages to the initial IAM message transmitted. (Refer to Figure 3-7.)

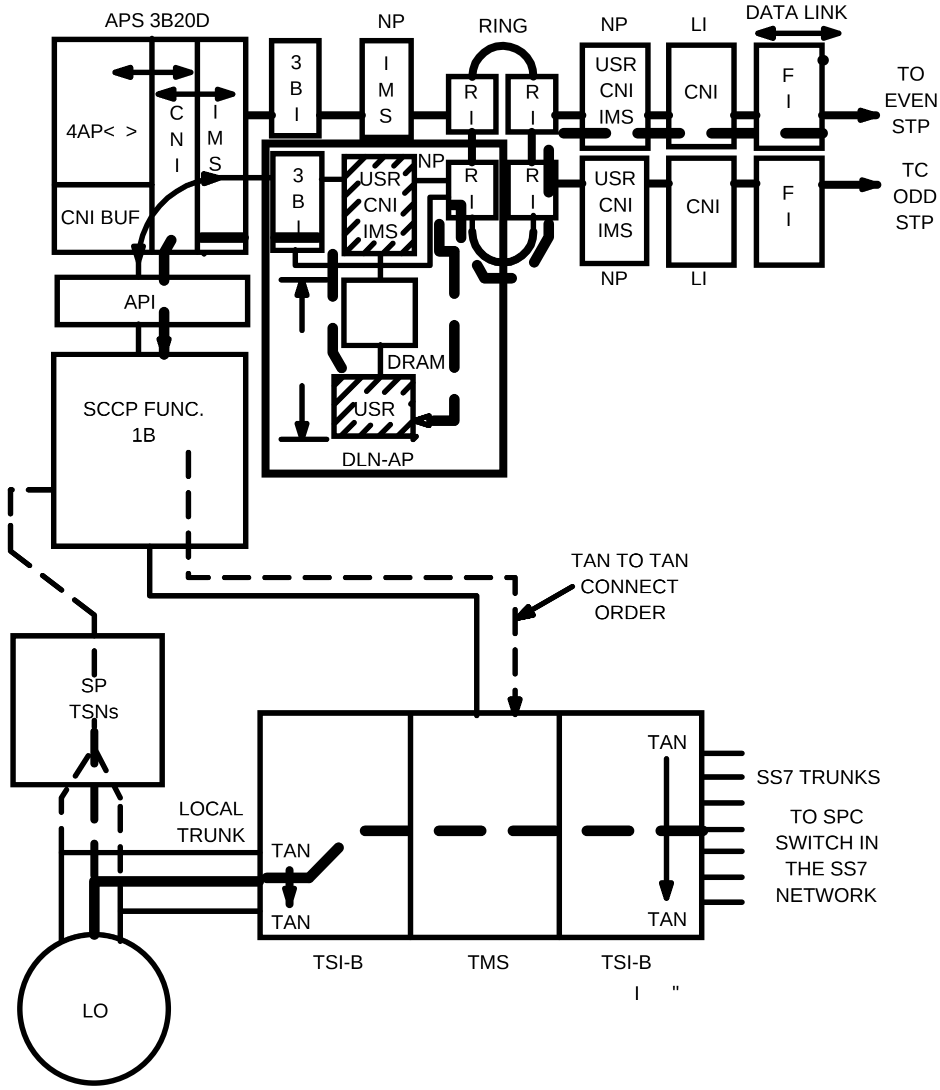
8. When the TSN has been translated by the DLN, a 24-bit word ISUP message is formatted and sent to the 1B for processing. During an ISUP call setup, the originating office puts up the trunk connection to perform the continuity test, if required. If the test is successful and the ANS message is received from the terminating office, the TAN-to-TAN trunk connection is made at both ends. (Refer to Figure 3-8.)

Continued on next page

Overview of ISUP Call Processing, Continued

Figure 3-8. OPC and CIC Translated to TSN During SS7 Call Processing

The following is an illustration of OPC and CIC Translated to TSN.



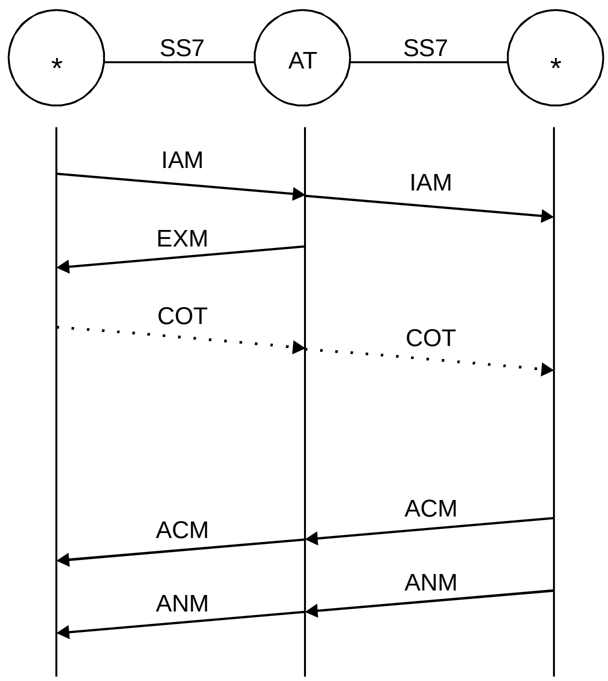
Overview of Network Interconnect Call Processing

NI Call Flow

SS7 begins an inter-LATA/international call by sending a basic intranetwork Initial Address Message (IAM) with network interconnect specific information added, for the selected outgoing circuit. Information specific to network interconnect shows the routing, carrier, and charging information. Figure 3-9 shows the basic indirect SS7 network interconnect call set-up sequence.

Figure 3-9. Network Interconnect Call Flow in the SS7 Network

The following is an illustration of the Network Interconnect Call Flow in the SS7 Network.



LEGEND:
ACM = Address Complete Message
ANM = Answer Message
AT = Access Tandem
COT = Continuity Message
EXM = Exit Message
IAM = Initial Address Message
*May be end office or Inter-LATA/International Toll Office.
Exit Message only applies in end office to AT communication.

Continue on next page

Overview of Network Interconnect Call Processing, Continued

SS7 EAEO to *4ESS* Switch SS7 Access Tandem

The Equal Access End Office (EAEO) selects a circuit for routing, marks the circuit busy, and then formulates an IAM. The IAM is formulated per EO specifications and is not discussed here.

The IAM that is sent to the Access Tandem (AT) must always include the Transit Network Selection (TNS) parameter.

The circuit code within the TNS parameter is coded by agreement between the Local Exchange Carrier (LEC) and the connecting IXC for international calls or within the LEC for domestic calls.

***4ESS* Switch SS7 Access Tandem to IXC SS7 Switch**

The presence of the TNS parameter in the received IAM indicates that a network interconnect call is requested. This also indicates that the call should be routed to an IXC.

The following network interconnect signaling messages are used:

- IAM Received on Incoming Trunk
- IAM Sent on Outgoing Trunk
- EXM Sent on Incoming Trunk.

Continued on next page

Overview of Network Interconnect Call Processing, Continued

IAM Received on Incoming Trunk

On receiving an IAM from the SS7 EAEO, the following parameters are examined specifically for a network interconnect call:

- **Transit Network Selection Parameter**: This parameter contains the main routing information necessary to complete a network interconnect call to the IXC.
- **Called Party Address Parameter**: The "Nature of Address" field routes information (specifically identifies international or domestic routing) and indicates the type of network interconnect call being processed.
- **User Service Information Parameter**: This parameter indicates the type of transmission medium required for the call connection and can be used optionally for routing.

Continued on next page

Overview of Network Interconnect Call Processing, Continued

Transit Network Selection Parameter

The contents of the Transit Network Selection parameter are summarized as follows:

- Type of Network Identification Field must be set to "National Network Identification" indicating that national standards are used. This setting is expected and is not examined by the AT.
- Network Identification Plan Field must be set to "Carrier Identification Code with Circuit Code" indicating that the network interconnect equivalents to EAMF "0ZZ" and "XXX/XXXX" (for inter- LATA calls) or "1NX/1N'X" and "XXX/XXXX" (international call) are contained in this parameter. This setting is expected and is not examined by the AT.
- Network Identification Field contains the 3/4-digit carrier identification code (the EAMF "XXX/XXXX") and circuit code subfield necessary to route the call to the IXC, if the "Network Identification Plan" field shows "Carrier Identification Code with Circuit Code."

Called Party Address Parameter

This field is screened for valid inter-LATA and international cases. On receipt of an invalid "Nature of Address," the call fails and is then released.

Continued on next page

Overview of Network Interconnect Call Processing, Continued

User Service Information Parameter

The User Service Information Parameter (USIP) parameter indicates the type of transmission medium required for the call connection and can be used optionally for routing. On receipt, this parameter is screened for compatibility. If compatibility is not possible, the call is rejected. The following fields must be set as suggested; otherwise, no further call processing is allowed:

- Coding Standard: “CCITT Standard”
- Information Transfer Capability: “Speech,” “3 kHz audio,” “restricted digital information,” or “unrestricted information”
- Transfer Mode: “Circuit Mode”
- Information Transfer Rate: “64kbits/s restricted or unrestricted”
- Multiplier or Layer Identification: “User information layer protocol 1" at “56kbits/s.”

The remaining parameters in the received IAM are handled the same as in intra-LATA ISUP calls.

Continued on next page

Overview of Network Interconnect Call Processing, Continued

IAM Sent on Outgoing Trunk

After completion of the continuity check process on the incoming trunk (when applicable), the call is routed to the IXC via a selected outgoing trunk. The system does not wait for a COT complete message on the incoming trunk before picking the outgoing trunk. A new IAM is formatted and sent to the IXC. The TNS parameter is passed with the outgoing IAM only in international network interconnect signaling; otherwise, it is deleted. All other recognized and standardized information is passed through the AT.

If glare is encountered on the outgoing trunk after the IAM is sent, two basic outcomes are possible:

- When the call leaving the AT has priority, the IAM just received (on the same trunk) is simply ignored and the outgoing call continues as in normal non-glare cases, or

- When the glaring call has control, the outgoing call must yield to the incoming call and the outgoing call must be reattempted using another trunk.

Continued on next page

Overview of Network Interconnect Call Processing, Continued

Exit Message Sent on Incoming Trunk

After the outgoing IAM is sent, the EXM is returned to the EAEO (only in SS7 to connections) for the incoming trunk. This can occur either before or after completion of continuity check on the outgoing trunk. The EXM is sent on the incoming trunk shortly after the outgoing trunk IAM is sent. This may occur after a specified delay. Receipt of the EXM by the EAEO indicates when carrier connect time occurs. The EXM also provides the trunk group number of the trunk used between the AT and the IXC.

If a reattempt is necessary (because of glare, continuity check failure, etc.) on the outgoing trunk, two scenarios are possible.

- If the EXM has yet to be returned it is updated to include the trunk group number of the newly selected trunk when retrying the call.
- If the EXM has already been returned, no additional EXM is sent. The EAEO uses the trunk group number provided in the initial EXM, which may or may not be the same as the retry trunk group number.

Should the call fail after seizing the outgoing trunk (because of repeated glare, continuity check failure, receipt of REL, etc.), the EXM must be returned before any REL message is sent for the AT incoming trunk.

EAMF to SS7 Network Interconnect Call

Introduction

When SS7 connectivity exists from the AT to the IXC but not from the EAEO to the AT, EAMF to SS7 interworkings occurs for inter-LATA and international calls. Figure 3-10 and Figure 3-11 show the basic EAMF to SS7 network interconnect call set-up sequence.

After the AT receives the first EAMF stage of signaling on the incoming trunk, code interpretation is performed and an appropriate outgoing trunk is seized. The outgoing trunk now uses the SS7 protocol, and the following network interconnect signaling messages are used:

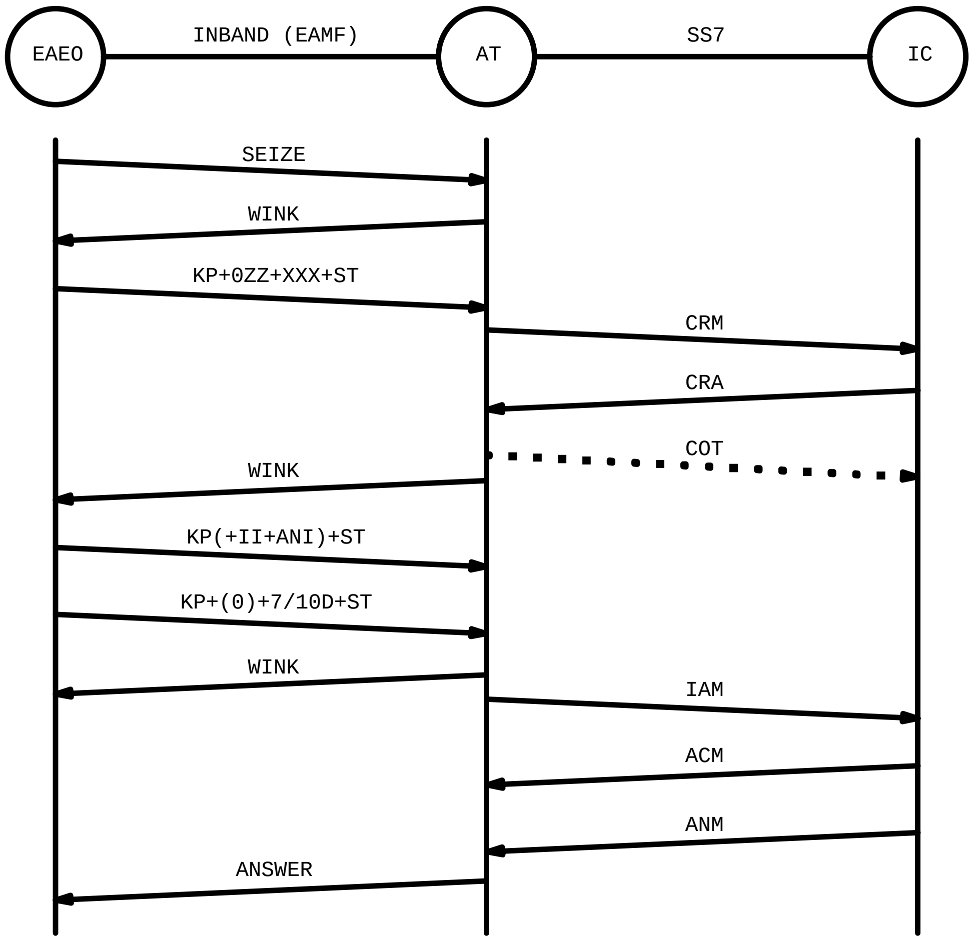
- Circuit Reservation Message (CRM)
- Circuit Reservation Acknowledgment (CRA)
- Continuity Message Sent on Outgoing Trunk (COT)
- IAM Sent on Outgoing Trunk.

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

Figure 3-10. Basic EAMF to SS7 Network Interconnect Call (Domestic)

The following is an illustration of basic domestic EAMF to SS7 network interconnect call set-up sequence.



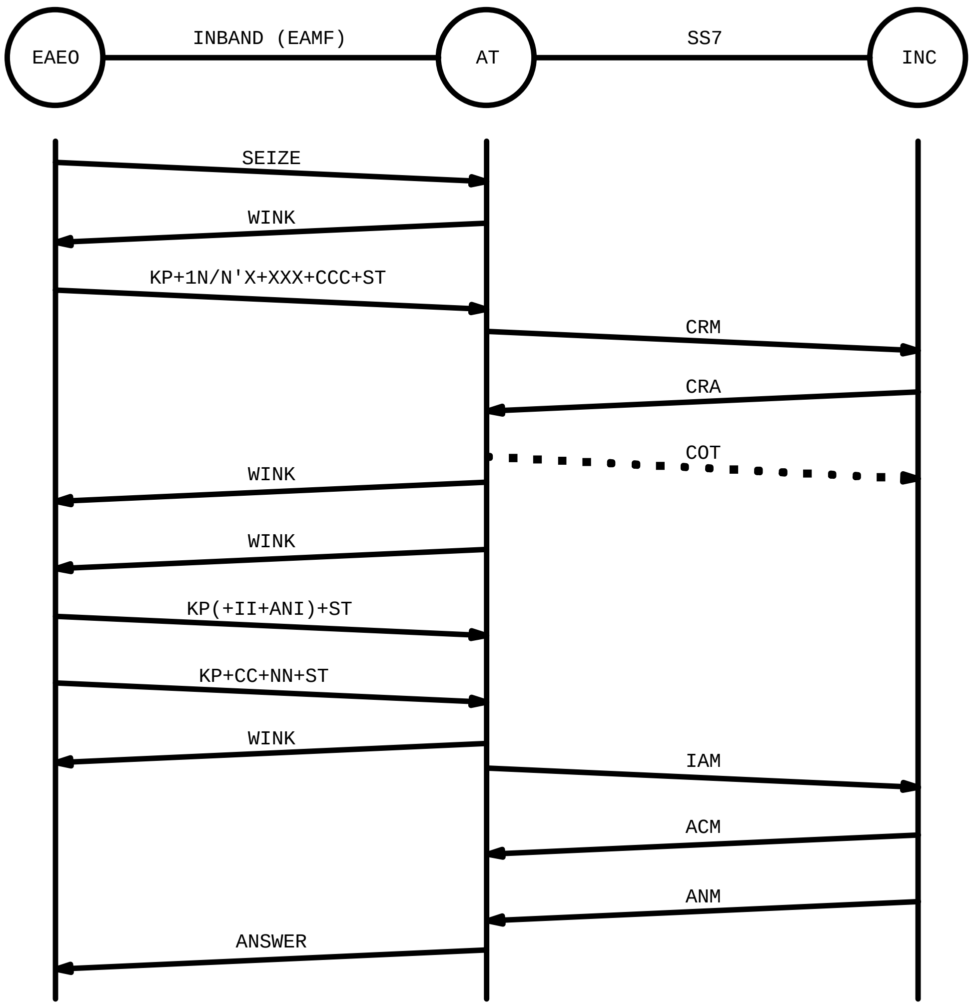
LEGEND:
ACM = ADDRESS COMPLETE MESSAGE
ANM = ANSWER MESSAGE
AT = ACCESS TANDEM
COT = CONTINUITY MESSAGE
CRA = CIRCUIT RESERVATION ACKNOWLEDGE
CRM = CIRCUIT RESERVATION
EAEO = EXCHANGE ACCESS END OFFICE
EAMF = EXCHANGE ACCESS MULTIFREQUENCY
IAM = INITIAL ADDRESS MESSAGE
IC = INTER-LATA CARRIER

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

Figure 3-11. Basic EAMF to SS7 Network Interconnect Call (International)

The following is an illustration of basic international EAMF to SS7 network interconnect call set-up sequence.



LEGEND:
ACM = ADDRESS COMPLETE MESSAGE
ANM = ANSWER MESSAGE
AT = ACCESS TANDEM
COT = CONTINUITY MESSAGE
CRA = CIRCUIT RESERVATION ACKNOWLEDGE
CRM = CIRCUIT RESERVATION
EAEO = EXCHANGE ACCESS END OFFICE
EAMF = EXCHANGE ACCESS MULTIFREQUENCY
IAM = INITIAL ADDRESS MESSAGE
INC = INTERNATIONAL CARRIER

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

CRM Sent on Outgoing Trunk

The first EAMF signaling stage received on the incoming trunk contains information necessary to route the network interconnect call correctly. It contains the “0ZZ+XXX/XXXX” for inter-LATA signaling or the “1NX/1N'X+XXX/XXXX+CCC/01R” for international signaling. After this first EAMF stage is received, the new CRM is sent to reserve the SS7 trunk between the AT and the IXC while waiting for the remaining EAMF signaling stages to arrive on the incoming trunk. The CRM contains the mandatory Nature of Connection Indicators parameter that indicates whether a continuity check should be performed, a satellite is present in the call path, and whether an echo suppresser is active on the particular trunk. The settings of these fields are set similar to the Nature of Connections parameter of the intra-LATA IAM.

Since the CRM is the first message to be sent out on the SS7 outgoing trunk, there is a possibility of glare occurring. Glare can occur when an IAM is received after sending out the CRM. If the outgoing trunk has control when glare occurs, the received IAM is ignored and the outgoing call proceeds normally. If the outgoing trunk does not have control, it must back down and accept the incoming call. The original outgoing call must now be retried on another SS7 outgoing trunk.

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

CRA Received from Outgoing Trunk

After sending the CRM, receipt of the CRA indicates that the trunk to the IXC has been successfully reserved, and the call may proceed. This corresponds to the receipt of the first wink from the carrier. If no continuity check is being performed on this outgoing trunk or if the continuity check has already been completed, a wink is generated on the EAMF incoming trunk when the CRA is received. This wink indicates the beginning of carrier connect time. However, if a continuity check is in progress, it must be completed before the wink is generated on the EAMF incoming trunk.

For inter-LATA signaling, this wink triggers the EAMF EAEO to begin outpulsing the second stage of signaling. Typically, the "KP+[II+ANI]+ST+KP+(0)+7/10D+ST" is sent by the EAEO at this point.

For international signaling, the first wink from the carrier is optional; this is based on an existing AT incoming trunk group option. If this first wink is used, a second wink is returned after a specified delay following the first wink. This second wink or second start dial corresponds to when the international gateway is ready to receive in-band information in EAMF signaling. It also triggers the EAMF EAEO to begin outpulsing the second stage of international digits to the AT. Typically, the "KP+[II+ANI]+ST+KP+CC+NN+LN+ or +XXXXXX+ST" is sent by the EAEO at this point. If the first wink from the carrier is not required, the AT generates the second start dial wink immediately at the point where the first wink is normally sent and is prepared to receive the second stage of digits from the EAMF EAEO. Here, the second start dial wink is used as the indication of carrier connect time.

If the CRA is not received within the specified time, another trunk to the IXC is seized and the outpulsing attempt retried.

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

Continuity Message Sent on Outgoing Trunk

A continuity check procedure is performed to verify the integrity of the speech path, after the CRM is sent when appropriate. This procedure is the same as that used in intra-LATA ISUP calls, except, it occurs after CRM instead of after IAM. On successful completion of the continuity check, the AT sends a COT message to the IXC and returns the appropriate wink(s).

If the continuity check procedure fails, the failing trunk is handled by existing trunk maintenance procedures. The call itself is then retried on another trunk. Since the initial carrier wink has not been generated on the incoming trunk, the newly chosen trunk could use either SS7 or Equal Access Multifrequency (EAMF) signaling without affecting the call status at the EAMF EAEO. Thus, the retried call could be another EAMF to SS7 network interconnect interworking call or it could use EAMF signaling all the way to the carrier.

IAM Sent on Outgoing Trunk

After the second stage of digits are collected on the EAMF incoming trunk, the AT formats and sends an IAM on the SS7 outgoing trunk to the IXC. When the IAM is sent, an acknowledgment wink is transmitted to the EAMF EAEO on the incoming trunk (about 200ms), after a short delay The IAM sent is similar to the intra-LATA IAM during PTS to SS7 interworking, with the following differences:

- **Tandem Network Selection Parameter**: This parameter is only included by the AT in the outgoing IAM for international signaling, When EAMF to SS7 interworking occurs.   This parameter contains the “XXX/XXXX” and “1NX/1N'X” information received on the EAMF incoming trunk during the first stage of international signaling from the EAEO.

- **Charge Number Parameter**: This parameter is included in the IAM sent on the SS7 outgoing trunk only if II+ANI was received on the EAMF incoming trunk.

- **Originating Line Information Parameter**: The OLI parameter is included in the IAM sent on the SS7 outgoing trunk only if II+ANI was received on the EAMF incoming trunk. The coding is the binary equivalent of the II digits received.

SS7 to EAMF Network Interconnect Call

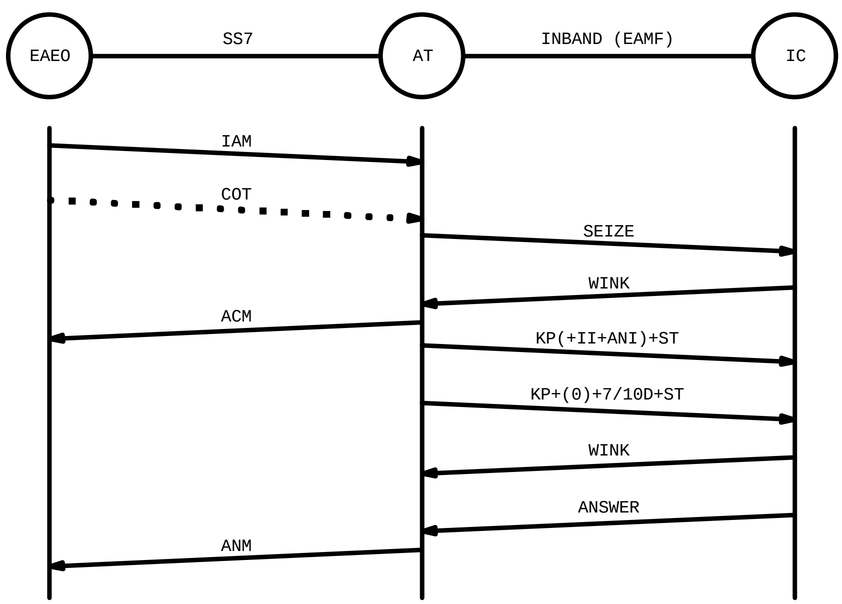
Introduction

When SS7 connectivity exists from the EAEO to the AT, but not from the AT to the IXC, SS7 to EAMF interworking occurs for inter-LATA and international calls. Figure 3-12 and Figure 3-13 show the basic SS7 network interconnect to EAMF call set-up sequence. The presence of the TNS parameter in the IAM received at the tandem office incoming trunk indicates that an network interconnect call is requested. This also shows that the call should be routed to an IXC. The outgoing trunk uses the EAMF protocol and the following network interconnect signaling message is sent:

- IAM Received on Incoming Trunk.

Figure 3-12. Basic SS7 Network Interconnect to EAMF (Domestic)

The following is an illustration of the basic domestic SS7 network interconnect to EAMF call set-up sequence.

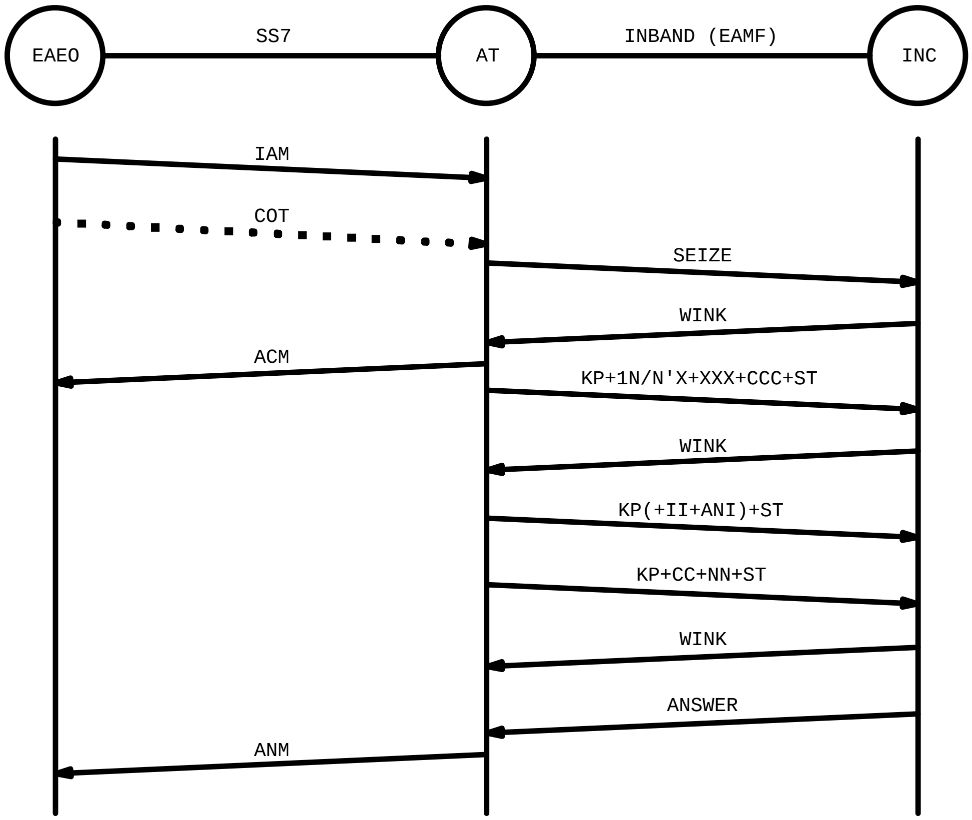


LEGEND:
ACM = ADDRESS COMPLETE MESSAGE
ANM = ANSWER MESSAGE
AT = ACCESS TANDEM
COT = CONTINUITY MESSAGE
EAEO = EXCHANGE ACCESS END OFFICE
EAMF = EXCHANGE ACCESS MULTIFREQUENCY
IAM = INITIAL ADDRESS MESSAGE
IC = INTER-LATA CARRIER

SS7 to EAMF Network Interconnect Call, Continued

Figure 3-13. Basic SS7 Network Interconnect to EAMF (International)

The following is an illustration of the basic international SS7 network interconnect to EAMF call set-up sequence.



LEGEND:
ACM = ADDRESS COMPLETE MESSAGE
ANM = ANSWER MESSAGE
AT = ACCESS TANDEM
COT = CONTINUITY MESSAGE
EAEO = EXCHANGE ACCESS END OFFICE
EAMF = EXCHANGE ACCESS MULTIFREQUENCY
IAM = INITIAL ADDRESS MESSAGE
INC = INTERNATIONAL CARRIER

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

IAM Received on Incoming Trunk

On receiving the IAM, verification of relevant information contained within the IAM is performed as described on page 3-14. When applicable, a continuity check is performed on the incoming trunk before an appropriate outgoing trunk is chosen to the IXC.

At this point, the IAM has provided the AT with all the information necessary to route the call. The AT uses the "XXX/XXXX" digits, "Nature of Address," "Circuit Code," and optionally, the "User Service Information" in the TNS parameter with possible incoming trunk information to select the appropriate route to the IXC. An in-band seize signal is then sent on the chosen trunk to the IXC. After the carrier acknowledgment wink is received from the IXC, the AT sends an ACM to the SS7 EAEO to show carrier connect time.

After the ACM is returned, the address information necessary to route the call is sent on the EAMF outgoing trunk as follows.

- If the TNS parameter indicates that inter-LATA signaling is being used, the AT sends a single stage of address information to the IXC using the EAMF protocol.
- If international signaling is being used, two stages of address information, as defined under the EAMF protocol, is sent instead. The information outpulsed on the EAMF outgoing trunk is directly related to the information contained in the received IAM.

Terminating 4ESS Switch Access Tandem Inband to SS7 Network Interconnect Call

Introduction

When SS7 connectivity exists from the terminating AT to the end office, but not from the IXC to the terminating AT, inband to SS7 interworking occurs. Figure 3-14 shows the basic inband to SS7 call set-up sequence.

When the terminating AT receives the initial seizure from the IXC, it returns a wink on the incoming trunk. After the IXC receives a wink from the AT, it outpulses the address information to the AT. If the call is to be routed to an end office, the AT performs circuit selection to determine if interworking with SS7 applies.

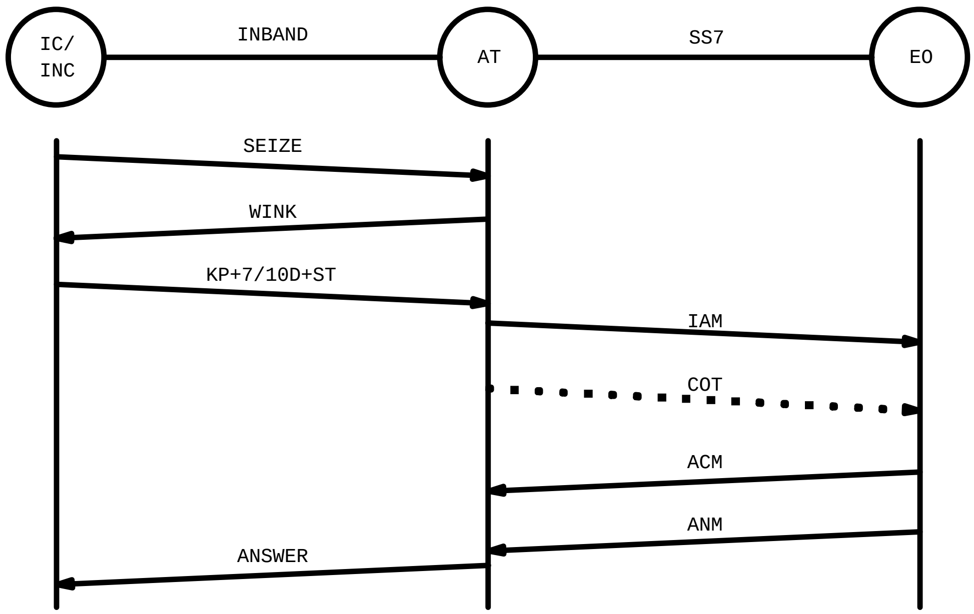
On receiving the address information, the AT makes the selected outgoing trunk busy and formulates an IAM. The terminating AT proceeds with call processing using SS7 intra-LATA signaling.

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

Figure 3-14. Basic Inband to SS7 Call

Following is an illustration of basic inband to SS7 call set-up sequence.




```
LEGEND:
   ACM = ADDRESS COMPLETE MESSAGE
   ANM = ANSWER MESSAGE
    AT = ACCESS TANDEM
   COT = CONTINUITY MESSAGE
     EO = END OFFICE
   IAM = INITIAL ADDRESS MESSAGE
   IC/INC = INTER-LATA/INTERNATIONAL CARRIER
```

SS7 to Inband Network Interconnect Call

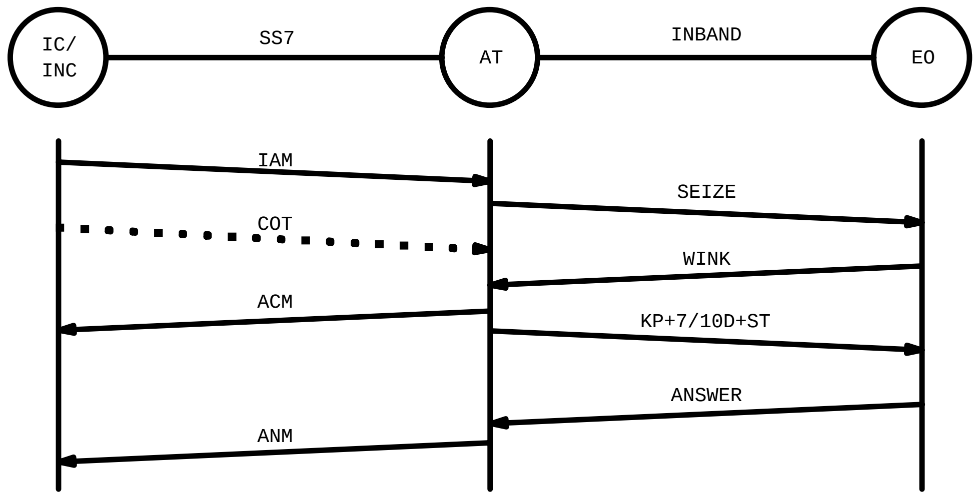
When SS7 connectivity exists from the IXC to the AT, but not from the AT to the EO, SS7 to inband interworking occurs. Figure 3-15 shows the basic SS7 network interconnect to inband call set-up sequence.

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

Figure 3-15. Basic SS7 Network Interconnect to Inband Call

The following is an illustration of the basic SS7 network interconnect to inband call set-up sequence.



LEGEND:
ACM = ADDRESS COMPLETE MESSAGE
ANM = ANSWER MESSAGE
AT = ACCESS TANDEM
COT = CONTINUITY MESSAGE
EO = END OFFICE
IAM = INITIAL ADDRESS MESSAGE
IC/INC = INTER-LATA/INTERNATIONAL CARRIER

IAM Received on Incoming Trunk

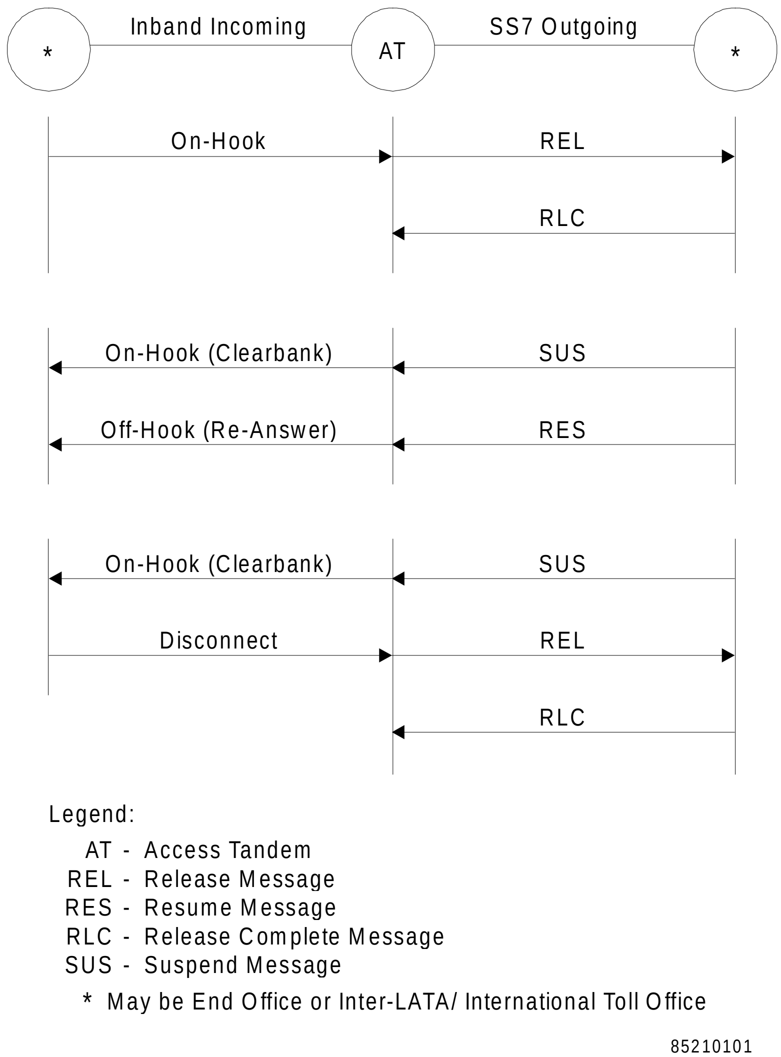
On receiving the IAM, if the call is to be routed to an EO, the terminating AT performs circuit selection based on the called number and the transmission medium requirement(s) in the User Service Information Parameter. This determines if interworking with inband signaling applies. When applicable, a continuity check is performed on the incoming trunk.

After receiving a wink from the EO and the continuity check successfully completes (if performed), the AT sends an ACM to the IXC on the incoming trunk. The ACM prompts the completion of the transmission path at the preceding switches. At this point, the AT outpulses the address information (7/10D) contained in the IAM on the outgoing trunk.

Release Treatments

Figure 3-16. Release Treatment for EAMF to SS7

The following is an illustration of the release treatment for incoming Equal Access Multifrequency (EAMF) to a outgoing SS7 network interconnect call.



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Release Treatments, Continued

Incoming EAMF to Outgoing SS7 Network Interconnect

The AT should be prepared to receive an on-hook disconnect signal on the incoming circuit at any time after the initial seizure of that circuit. It should be prepared to receive a REL or a SUS for the outgoing circuit at any time after it has received an ANM for that circuit.

If the AT receives an on-hook disconnect signal on the incoming circuit before receiving either a REL or SUS for the outgoing circuit, it idles the incoming circuit and returns an on-hook supervision signal on the incoming circuit. If the AT has already sent the IAM for the outgoing circuit, the AT releases the outgoing circuit and sends a REL for that circuit.

If the AT receives a REL for the outgoing circuit before a SUS, it releases and idles the outgoing circuit and returns a RLC for that circuit. If the cause value in the received REL is “normal release,” the AT also sends an on-hook disconnect signal on the incoming circuit.

If the AT receives a SUS with suspend/resume indicator coded to indicate “network initiated” for the outgoing circuit after having already received an ANM for that circuit, it places an on-hook disconnect signal on the incoming circuit for the call. The AT is not disconnect the circuit connection until it receives an on-hook supervision signal on the incoming circuit or a REL for the outgoing circuit.

If, after receiving a SUS indicating “network initiated” for the outgoing circuit and before receiving an on-hook supervision signal on the incoming circuit or a REL for the outgoing circuit, the AT receives a RES with a “network initiated” indication, the AT sends an off-hook signal on the incoming circuit.

If, after receiving a SUS, an on-hook supervision signal is received for the incoming circuit before a RES or REL is received for the outgoing circuit, the AT idles the incoming circuit, releases the outgoing circuit, and proceeds with the sending of a REL for the outgoing circuit.

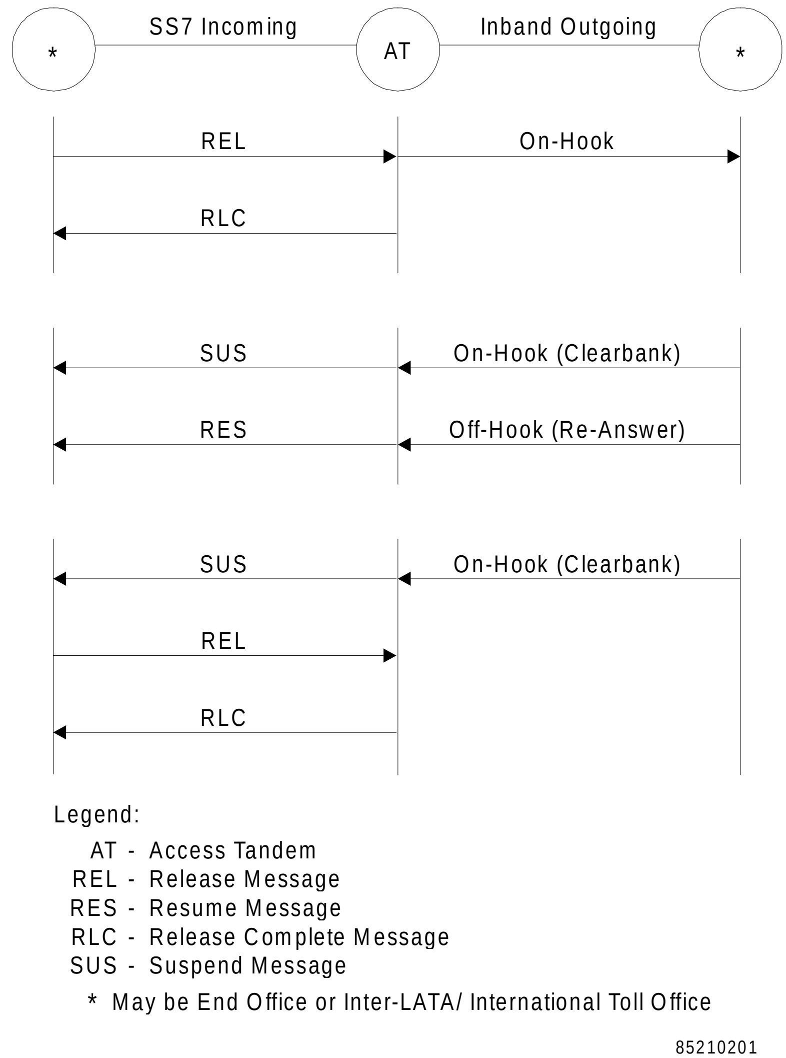
If, after receiving a SUS, a REL is received before an on-hook supervision signal, the AT idles the outgoing circuit and sends a RLC for the circuit. The incoming circuit is idle when on-hook supervision is received.

Continued on next page

Release Treatments, Continued

Figure 3-17. Release Treatment for SS7 to EAMF

The following is an illustration of the release treatment for incoming SS7 to a outgoing EAMF network interconnect call.



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Release Treatments, Continued

Incoming SS7 to Outgoing EAMF Network Interconnect

The AT should be prepared to recognize the REL for the incoming circuit at any time after receiving an IAM for the circuit. In addition, the AT should be prepared to recognize a disconnect signal on the outgoing circuit once answer supervision has been detected.

If the AT receives a REL for the incoming circuit, it releases and idles the incoming circuit and sends a RLC. The RLC contains the same OPC, DPC, CIC and Signaling Link Selection (SLS) as any ACM that preceded it for the same call. The AT sends an on-hook disconnect signal on the outgoing circuit. On reception of an on-hook supervision signal for the outgoing circuit, the AT sets a guard timer. The AT idles the outgoing circuit when the guard timer expires.

If the AT receives an on-hook disconnect signal on the outgoing circuit before receiving a REL for the incoming circuit, it formulates and sends a SUS for the incoming circuit. This SUS contains the same OPC, DPC, CIC and SLS as did the ACM that preceded it. The suspend/resume indicators parameter is coded to “network initiated.” When the AT sends the SUS it should set a SUS timer and wait for either a REL from the switch at the far end of the incoming circuit or an off-hook on the outgoing circuit.

If an off-hook is received on the outgoing circuit before a REL is received for the incoming circuit and while the SUS timer is still active, the AT cancels the SUS timer, reconnects the transmission path and sends a RES to the switch at the far end of the incoming circuit.

If a REL is received for the incoming circuit before, or simultaneously with, an off-hook on the outgoing circuit and while the SUS timer is still active, the AT cancels the timer, idles the incoming circuit, and sends the RLC for the incoming circuit. The RLC should contain the OPC, DPC, CIC and SLS of the ANM that preceded it for the same call. The AT also sends an on-hook supervision signal on the outgoing circuit and sets a guard timer. The AT idles the outgoing circuit when the guard timer expires.

Continued on next page

Release Treatments, Continued

Incoming SS7 to Outgoing EAMF Network Interconnect, Continued

If the SUS timer expires before either an off-hook on the outgoing circuit or a REL for the incoming circuit is received, the interworking switch releases the incoming circuit by sending a REL for the circuit. The REL should have the same SLS as the SUS that preceded it.

The AT also sends an on-hook supervision signal on the outgoing circuit and sets a guard timer. The AT idles the outgoing circuit when the guard timer expires.

Timing Requirements

Various timers associated with SS7 ISUP call set-up and release procedures are the same as those for intranetwork calls. Timers that are specific to internetwork calls are as follows:

- Tcrm: This timer defines the timing value (3 seconds) used for the time awaiting a Circuit Reservation Acknowledgment (CRA) or REL message after sending a Circuit Reservation Message (CRM).
- Tcra: This timer defines the timing value (20-25 seconds) used for the time awaiting an IAM or REL message after sending a CRA message.
- Ttrd: This timer defines the timing value (14-16 seconds) used for the time awaiting a Resume (RES) or REL message after sending a SUS message.

Call Flow of Additional Features

Additional Features

This section describes the call flow of each additional feature where there is alteration to the basic SS7 call flow. The following features are affected:

085 Generic Address Parameter

122 Coding Standard Field of the Cause Parameter

156 Completion of Transmission Path

157 Handling Confusion Messages

158 Routing Based on Speech and 3.1-kHz Bearer Capability

Generic Address Parameter (GAP) Feature (#085)

The Generic Address Parameter (GAP) format is similar to the CPN parameter format; however, the GAP format includes a "type of address" field that defines what the parameter is. This field can have four different values: a dialed number, a destination number, "CPN, user-provided, screening failed," or "CPN, user-provided, not screened." However, only two types of addresses are recognized in this field:

- "CPN, user-provided, screening failed."
- "CPN, user-provided, not screened."

A GAP with either of these values in the address field is passed; a GAP with any other value is passed as an "unrecognized parameter."

Handling of GAP Through the Network

Tandem Switch

A tandem switch passes the GAP without modification. If the tandem switch is acting as a Service Switching Point (SSP), a GAP with anything other than a user-provided CPN in the "type of address" field is handled as an "unrecognized parameter."

Continued on next page

Call Flow of Additional Features, Continued

Coding Standard Field of the Cause Parameter Feature (#122)

This section describes how an ISUP Cause parameter is processed at a *4ESS* Switch.

ISUP-to-ISUP

ISUP-to-ISUP interworking at an intermediate switch has the following effects on the Cause parameter:

- The value of the received Coding Standard indicator is passed unchanged.
- If the Coding Standard indicator is "ITU standard," the Cause value is passed and/or recoded per existing procedures. If the Coding Standard indicator is something other than "ITU standard," the Cause value is passed unchanged.
- The Location value is passed and/or recoded per existing procedures.

Cause Parameter and Playing Tone/Announcement

The Coding Standard field of the Cause parameter is examined at an originating or intermediate switch when the following conditions exist:

- REL message is received for the Outgoing Trunk (OGT) prior to receiving the address complete message (ACM).
- A tone and/or announcement is to be played at the *4ESS* Switch.

If the Coding Standard value is "ITU standard," there is no change in the way the tone and/or announcement is determined. For any other value of the Coding Standard, the cause is treated as ITU standard value "interworking, unspecified" (1111111) with location "unknown" (1010).

- The Cause value is mapped to reorder tone for domestic calls.

Continued on next page

Call Flow of Additional Features, Continued

Completion of Transmission Path Feature (#156)

The transmission path is completed in both directions for all calls, upon the receipt of a CPG message, with one of the following:

- The interworking indicator, bit I, of the backward call indicator (BCI) parameter coded “interworking encountered.”
- A CPG message with the user-network interaction indicator, bit H, of the optional backward call indicator (OBCI) parameter coded “user-network interaction occurs, cut-through of bearer channel in both directions.

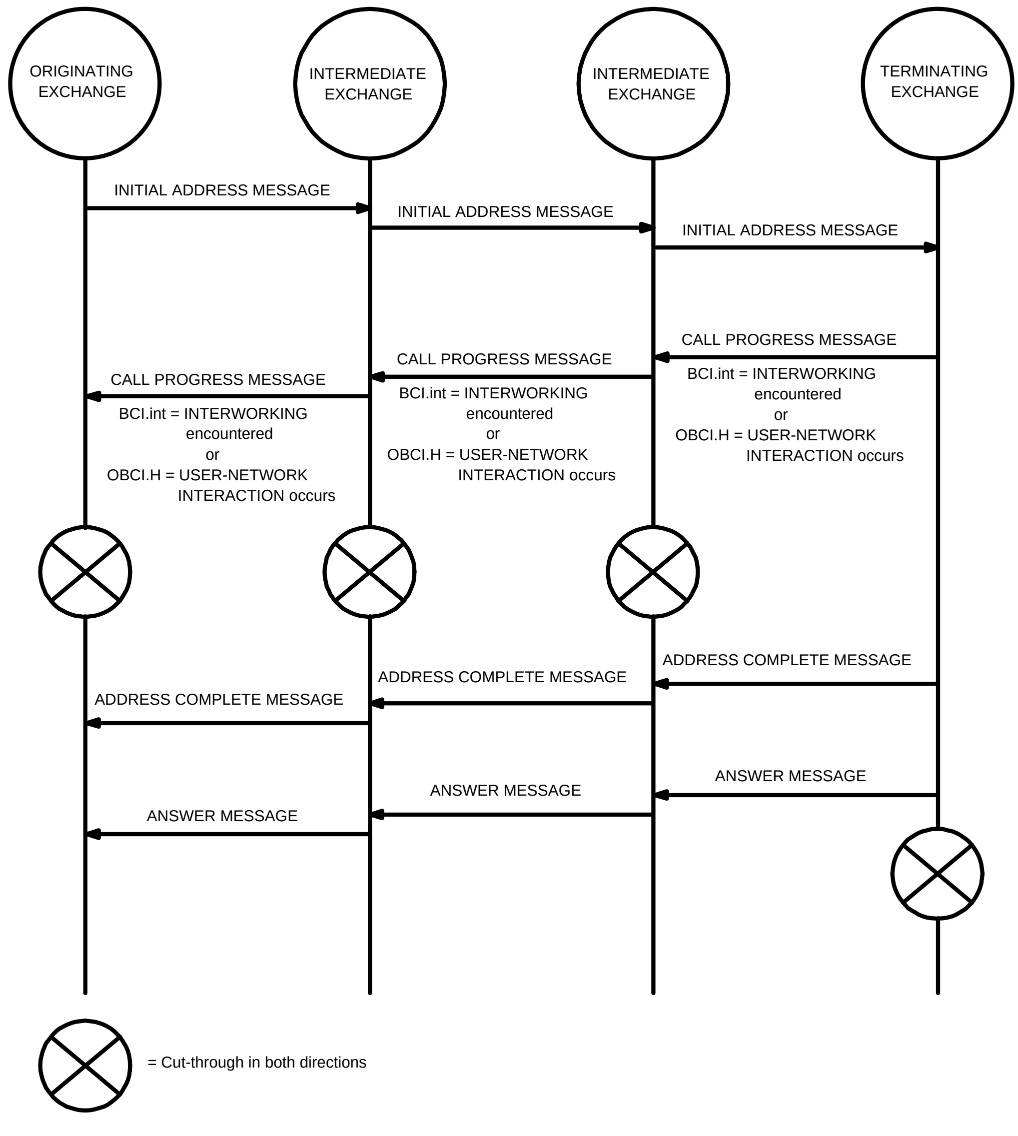
Figure 3-18 shows a transmission completion path for all calls with an unexpected case where User Network Interaction (UNI) occurs or interworking is encountered, and CPG is sent from the terminating end.

Continued on next page

Call Flow of Additional Features, Continued

Figure 3-18. Unexpected Case

The following is an illustration showing the completion of a transmission path for all calls — Unexpected Case: UNI Occurs or Interworking is Encountered, and CPG is Returned.



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Call Flow of Additional Features, Continued

Cut-Through Procedures at Tandem Exchange

If a CPG message causing cut-through is received before an ACM at an exchange, the ACM timer remains on awaiting an ACM. On receipt of an ACM, after the transmission path has been completed in both directions, the existing procedures with the exception of cut-through, are followed.

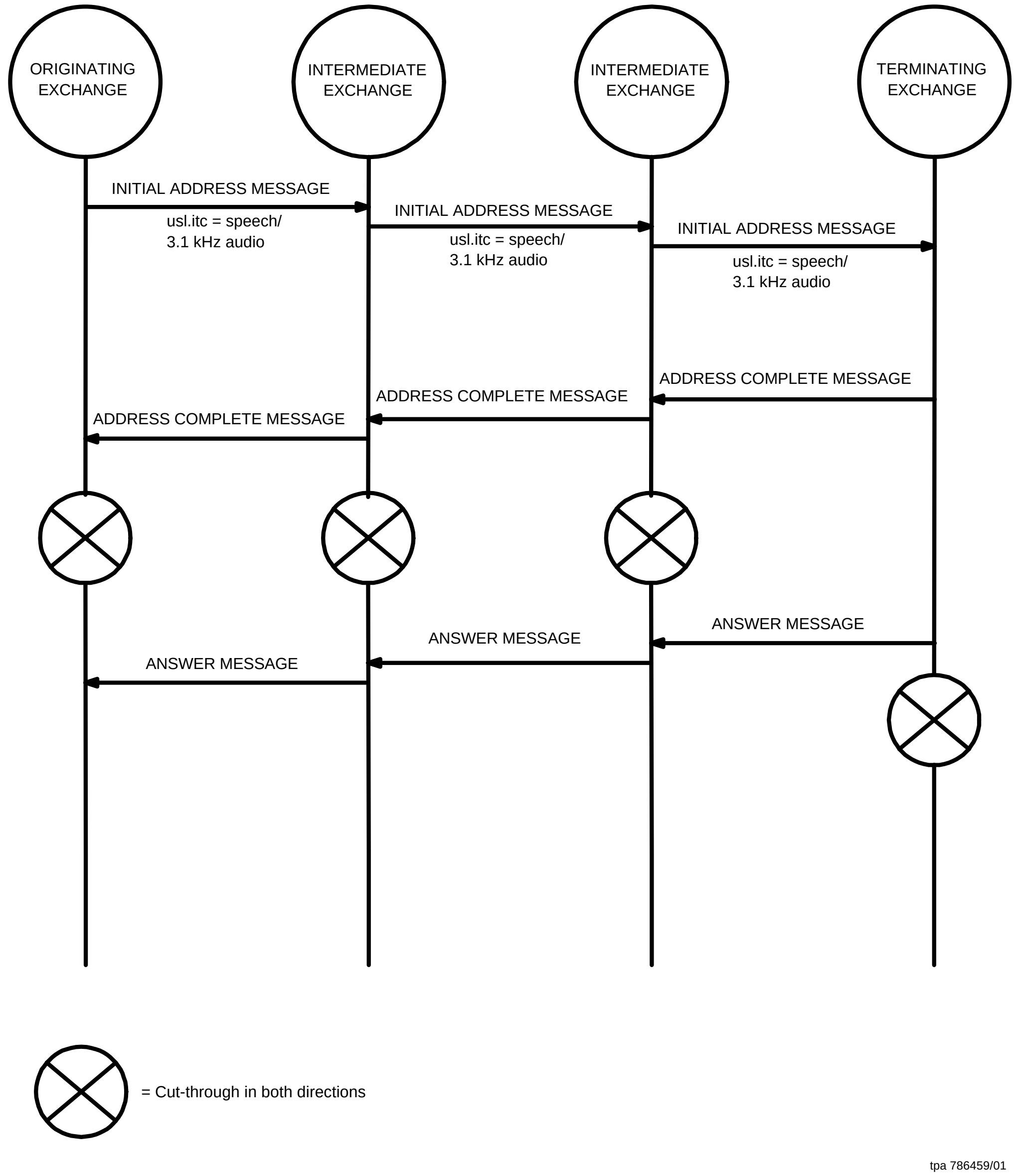
For the setting of the information transfer capability field of the user service information (USI) parameter of "speech" or "3.1-kHz audio", the transmission path is completed in both directions on receipt of the first of either an ACM or ANM, unless a previous CPG message has already triggered the cut-through. Figure 3-19 shows a transmission path completion for 3.1-kHz audio and speech calls on a normal call setup where the first backward message received is the ACM. Figure 3-20 shows a transmission path completion for calls on a normal call setup with fast connect, where the first backward message received is an ANM.

Continued on next page

Call Flow of Additional Features, Continued

Figure 3-19. Normal Call Setup

The following shows the Completion of Transmission Path for 3.1-kHz Audio and Speech Calls — Normal Call Setup: First Backward Message is ACM.



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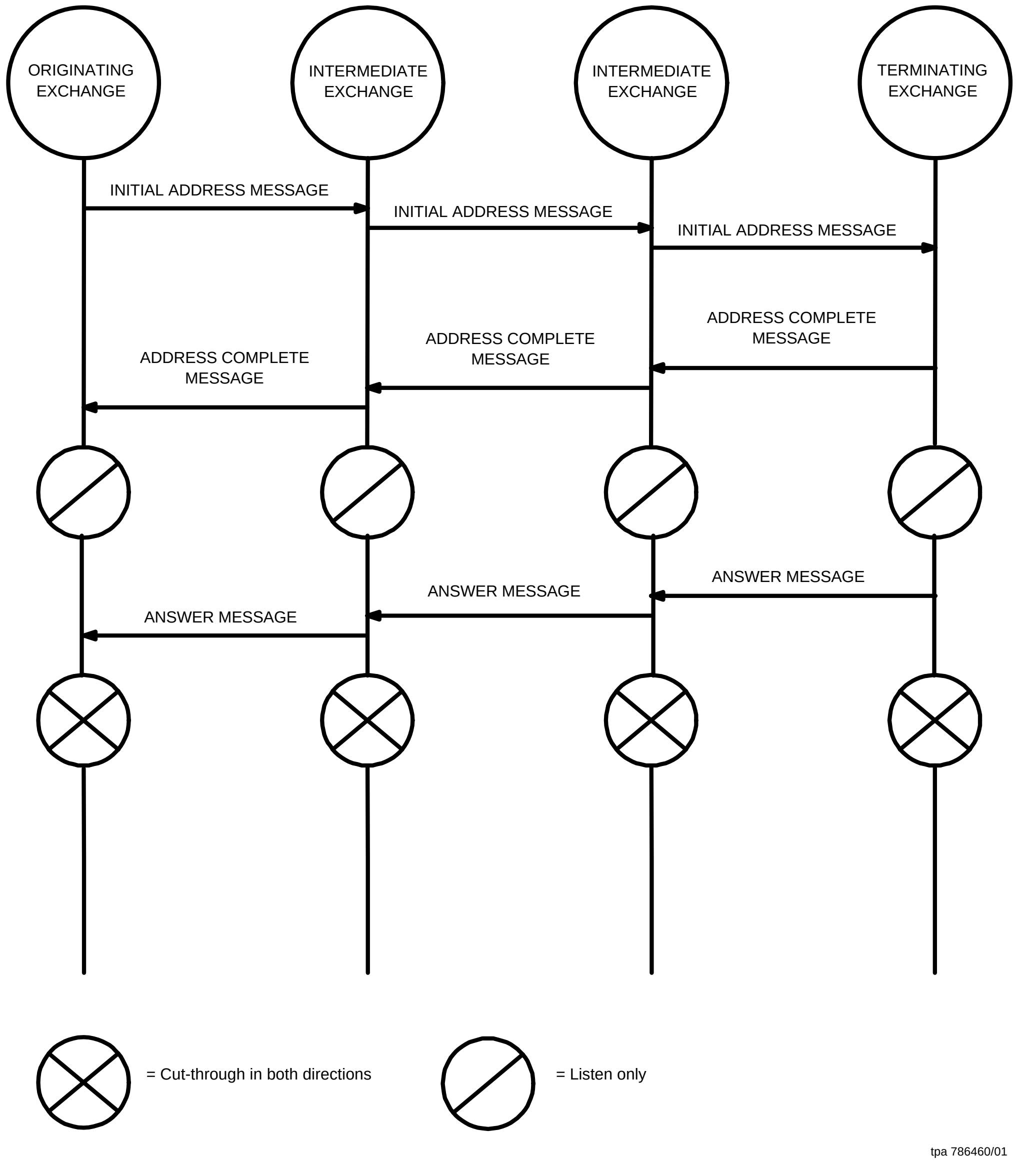
Call Flow of Additional Features, Continued

Figure 3-20. Normal Call Setup 2

The following is an illustration of a Normal Call Setup.



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Call Flow of Additional Features, Continued

Information Transfer Capabilities

For the setting of the information transfer capability field of the USI parameter of "unrestricted digital information" or "restricted digital information", the transmission path is completed in both directions on the receipt of the ACM but only if it contains one of the following:

- An "interworking encountered" coding in the interworking indicator, bit I, of the BCI parameter.
- The user-network interaction indicator, bit H, of the OBCI parameter coded "user network interaction occurs, cut-through of bearer channel in both directions."

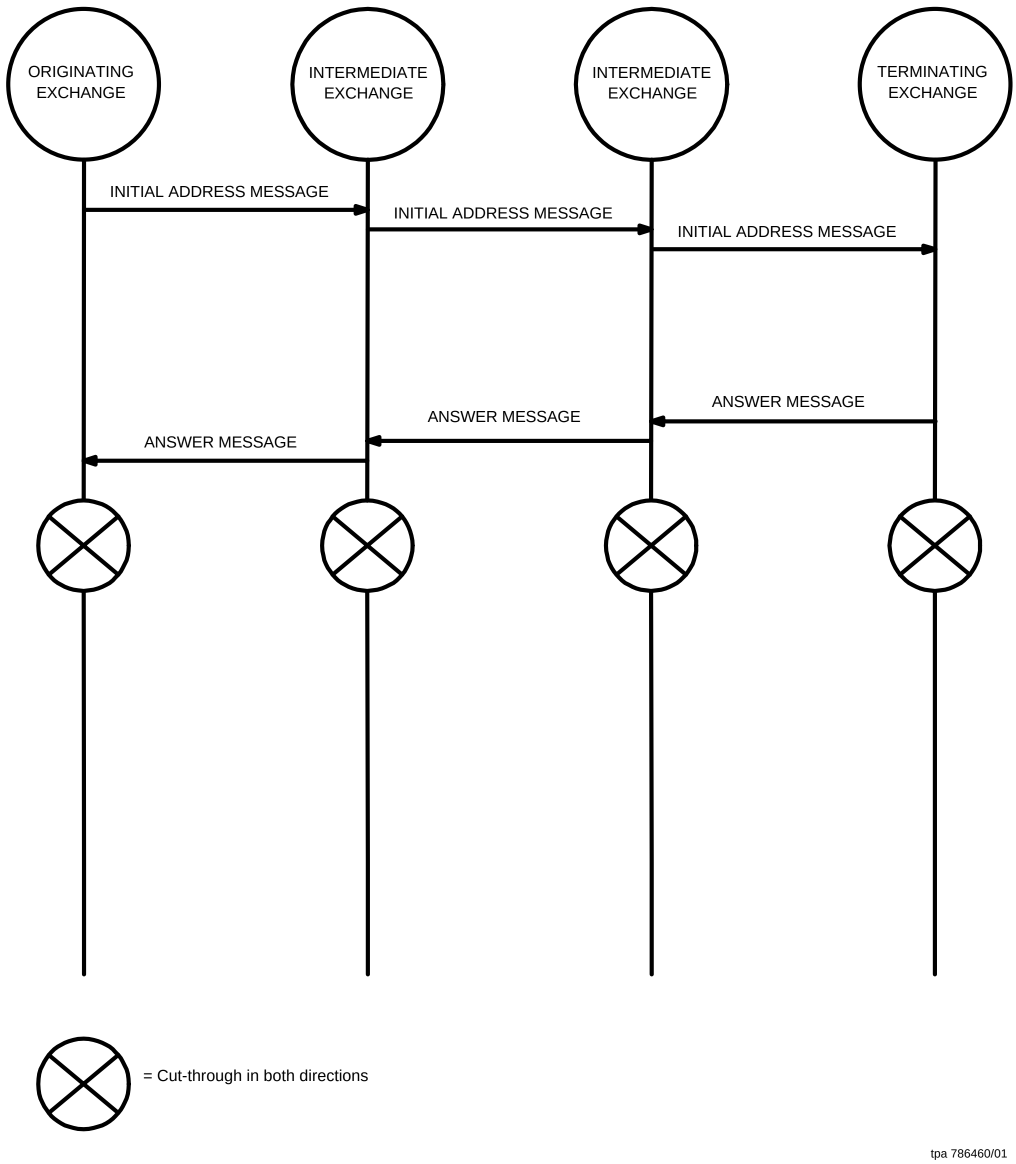
This occurs unless a previous CPG has already triggered the cut-through. Otherwise, completion of transmission path occurs at the receipt of the ANM. (Refer to the following Figures 3-21 and 3-22.)

Continued on next page

Call Flow of Additional Features, Continued

Figure 3-21. Normal Call Setup: No Interworking Encountered and No UNI Occurs

The following is an illustration of “Completion of Transmission Path for All Calls —Normal Call Setup: No Interworking Encountered and No UNI Occurs.”



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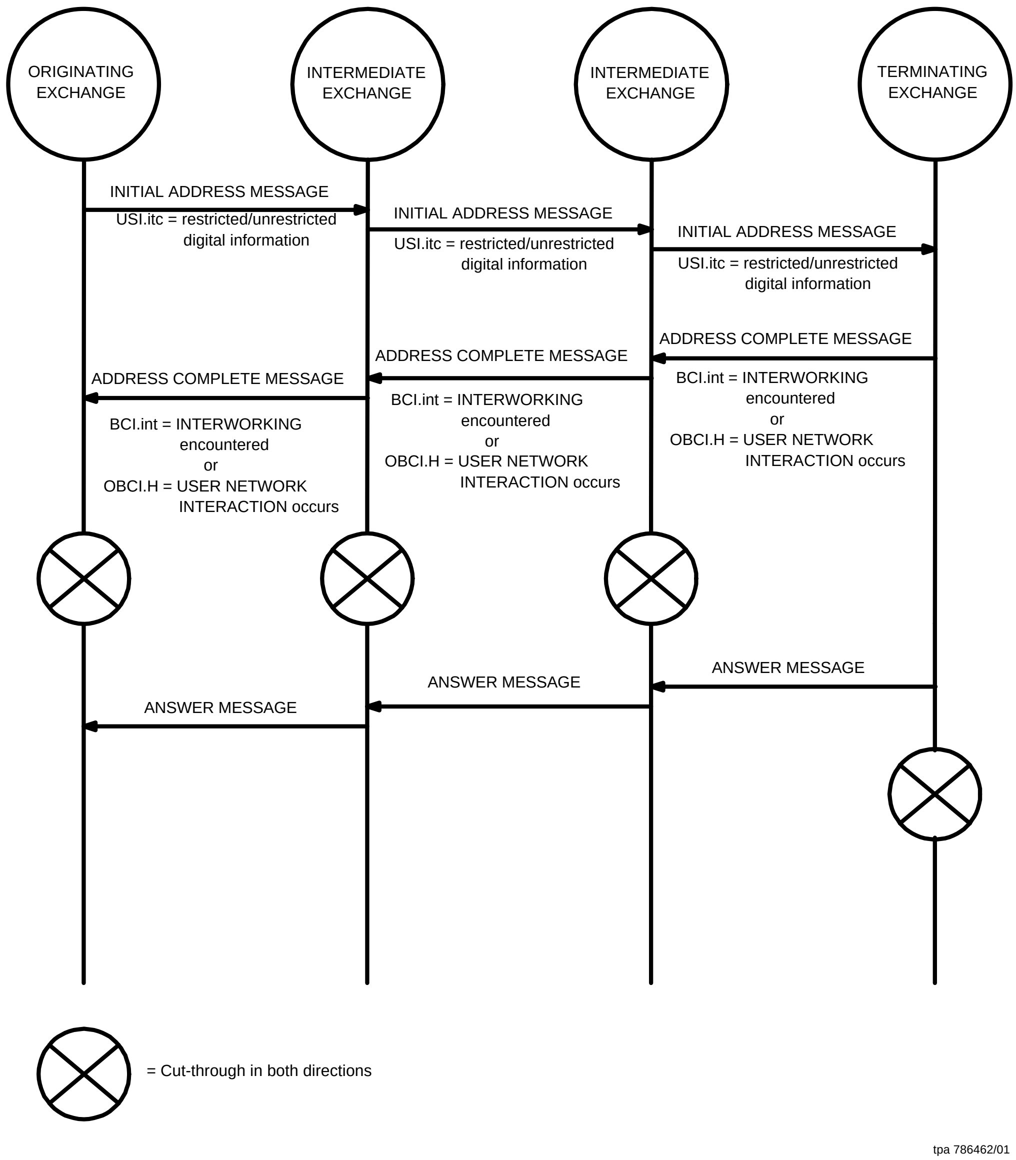
Call Flow of Additional Features, Continued

Figure 3-22. Normal Call Setup: No Interworking Encountered and No UNI Occurs

The following is an illustration of "Completion of Transmission Path for Data Calls — Normal Call Setup: UNI Occurs or Interworking is Encountered, and ACM is Returned."



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Call Flow of Additional Features, Continued

Final Handling

A message that may trigger a cut-through, that is, an ACM, ANM, or a CPG with an indication of interworking or user-network interaction, is never sent until all continuity checks on previous circuits or the outgoing circuit for the call connection are successfully completed. If one of these messages is received before the completion of the continuity check, the call is terminated (Final Handling Code 1497) with cause value "temporary failure", which is consistent with current practices on receipt of an ACM under similar circumstances.

Continued on next page

Call Flow of Additional Features, Continued

Note:
In the event that the toll fraud feature is turned on at the originating access tandem for the outgoing trunk group, the toll fraud feature takes precedence over the new cut-through requirements.

Interworking Exchanges

At an interworking exchange where the incoming circuit is not Common Channel Signaling System 7 (CCS7) supported but the outgoing circuit is, a CPG with an indication of "interworking encountered" or "user-network interaction", received before an ACM, causes a cut-through with no other change in the usual message sequence for nontest calls. For test calls, a CPG received prior to an ACM with an indication of "interworking encountered" or "user-network interaction" is disregarded.

At an interworking exchange where the incoming circuit is not CCS7 supported but the outgoing circuit is, completion of the transmission path is delayed for a data call until the receipt of an ANM. Unless, an ACM with "interworking encountered" or "user-network interaction" indication causes cut-through of the transmission path, or a previous CPG has already triggered the cut-through. The path is cut through at the interworking exchange upon the receipt of an ACM, regardless of its coding, for a 3.1-kHz audio or speech call.

Continued on next page

Call Flow of Additional Features, Continued

Handling Confusion Messages Feature (#157)

The purpose of generating a CFN message is to indicate to a sending switch that it sent a message that was not recognized by a receiving *4ESS* Switch. A CFN message is generated when a *4ESS* Switch receives an unrecognized message, but a confusion message is not generated when the switch receives unrecognized parameters or parameter values. A CFN message can be sent either in the forward or backward direction, but it can never be relayed at an access tandem switch. Also, a CFN message is never sent in response to a received CFN message.

If a CFN message needs to be sent, the sending is controlled by a new trunk block bit, Send Confusion (SCFN). For End Office or Tandem Connecting (ETC), Other Carrier Connecting (OCC), or Local Carrier Connecting (LCC) trunks, the default for SCFN is set to allow the sending of CFN messages. For other types of trunks, the default for SCFN indicates not to send a CFN message. The unrecognized message is always discarded at the receiving switch.

The definition of “unrecognized” includes all messages that are not implemented plus all network specific messages at the LEC or AT&T Network Interconnect (NI) boundary. The network specific messages are those messages encoded with 1111 in the upper bits of the message type octet.

The CFN message includes the cause indicators’ parameters with a cause value of “message type nonexistent or not implemented” (value 97), and location of “local network” (value 0010), followed by a diagnostic field containing the message type code of the received message. For a LCC type of trunk, location is set to “transit network” (value 0011). The priority of CFN in the message transfer part service information octet is set to 1. When a CFN message is sent or received, two new office counts are pegged. These are scheduled on an hourly report.

Continued on next page

Call Flow of Additional Features, Continued

Routing Based on Speech and 3.1-kHz Bearer Capability Feature (#158)

A new field in the Call Register is used to determine routing when the manual subsequent digit treatment is V31K.

This field is initialized for all calls to indicate “3.1 kHz” (value = 0). The ISUP incoming trunk handler sets this new field to indicate “speech” when the information transfer capability field in the Bearer Capability parameter indicates “speech.”

With this feature, the ISUP outgoing trunk handler populates the information transfer capability in the Bearer Capability parameter based on the following options:

- If the incoming trunk is multifrequency, and the call is a voice call, the information transfer capability is set to “3.1 kHz.”
- If the incoming trunk is ISUP, then it copies the information transfer capability received on the incoming trunk to the information transfer capability sent on the outgoing trunk.

When routing the call, if a manual subsequent digit treatment of V31K is encountered by translations, the call is routed based on the new Call Register field that indicates that the call is a speech or 3.1-kHz call. All 3-digit translation routines handles the new manual subsequent digit type of V31K.

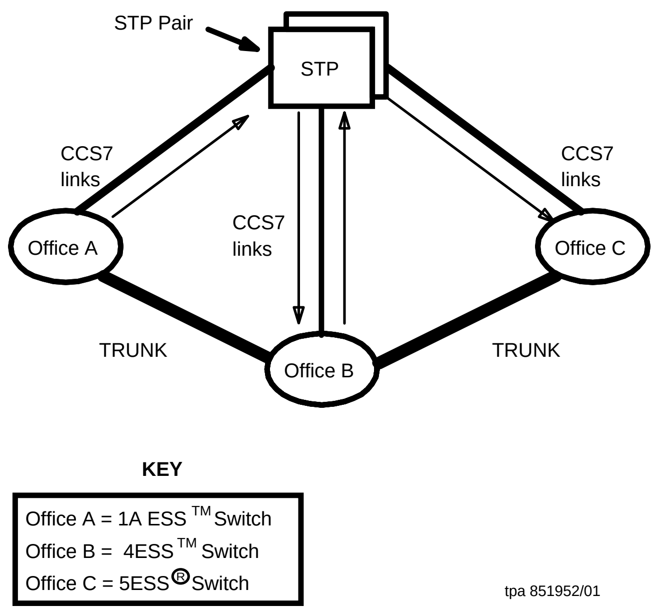
Chapter 3 Call Flow

Overview of ISUP Call Processing

Introduction

With its protocol structure, signaling routing mechanisms, variable message lengths, and higher data transfer rate, Integrated Services Digital Network User Part (ISUP) signaling offers many advantages over Per-Trunk Signaling (PTS). Examples of PTS are Multifrequency (MF) and Dial Pulse (DP) signaling. However, it is important to note that the improvements are related primarily to signaling and services. Plain Old Telephone Service (POTS) call processing functions (for example, address analysis, screening, routing, trunk selection, digit conversion, and alerting) are the same as those used in PTS. Calls are still routed in stages as shown in Figure 3-1, 3-2, 3-3.

Figure 3-1. ISUP Call Setup in the SS7 Network



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Overview of ISUP Call Processing, Continued

Figure 3-2. Talking State in the SS7 Network

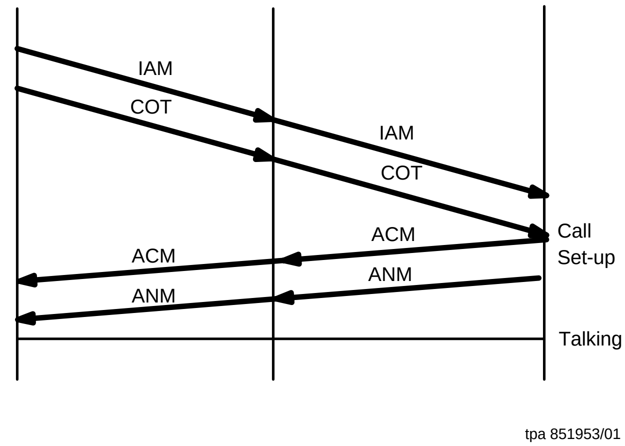
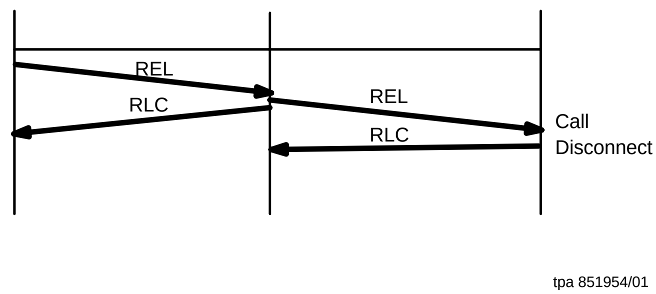


Figure 3-3. ISUP Call disconnect in the SS7 Network



Call Flow Description

For the following description, refer to Figure 3-1. Assume a basic interoffice voice call, originating from Office **A** and terminating at Office **C**, via Tandem Office **B**, is to be made. Notice that with ISUP signaling, all signaling messages are relayed through one or more Signaling Transfer Points (STPs).

After Office **A** receives the called number from the originating party, routing for the call is determined using internal translations (as in PTS). An Initial Address Message (IAM) containing the routing digits (plus additional data) is then sent via one of the STPs to Tandem Office **B** for a selected ISUP circuit. This circuit is uniquely identified by a Trunk Circuit Identification Code (TCIC), and the Point Codes of Offices **A** and **B**. All ISUP messages include a TCIC identifying the related circuit/trunk.

Continued on next page

Overview of ISUP Call Processing, Continued

Voice Path Assurance

Since ISUP does not signal through the actual speech path, it is necessary to ensure that acceptable transmission can occur. A voice continuity, or Voice Path Assurance (VPA) test, can be requested in the Initial Address Message (IAM) on the outgoing circuit. Results of the test (success or failure) are sent by originating Office **A** in a Continuity Message (COT) to Tandem Office **B**.

Note:
In this example, the call setup sequence includes a continuity test. Note that the continuity test can be performed on a sampling basis.

Office B Functions

On receipt of the IAM, Office **B** handles the VPA request and then examines the called party address. Digit deletion/prefixing and routing are again determined using internal translations. Office B then formats an IAM for a selected ISUP outgoing circuit and sends the message via an STP to terminating Office **C**.

Note:
The intermediate office (in this case B) can either send the formatted IAM immediately after the incoming IAM is received, or wait until the incoming continuity check procedure is completed.

Continued on next page

Overview of ISUP Call Processing, Continued

Talk State Is Established

The IAM contains the TCIC associated with the outgoing circuit. Finally, regardless of whether or not Office **A** requested a VPA test on the incoming circuit, Office **B** may request a VPA test on the outgoing circuit. The calling party number is available to Office **C** which has an option that allows the number to be displayed.

An Address Complete Message (ACM) is sent by Office **C** to Office **B** acknowledging that the address information has been received at the terminating end office and that the called party line is idle. At this point, Office **C** provides audible ringing on the incoming trunk and rings the terminating line.

Meanwhile, Office **B** immediately passes the ACM to Office **A**, and the interoffice call path is established. An Answer Message (ANM) corresponding to the answer used in MF signaling is initiated when the ring trip (off-hook on the terminating line) occurs.

Disconnect

Assuming the calling party disconnects first, a Release (REL) message is sent from Office **A** to Office **B**. The REL message is then sent to Office **C**. Simultaneously, the switch path from Office **A** to Office **B** is disconnected, and a Release Complete (RLC) message is returned to Office **A**. On receipt of the REL at Office C, the switch path from Office **B** to Office **C** is released and an RLC is returned to Office **B**.

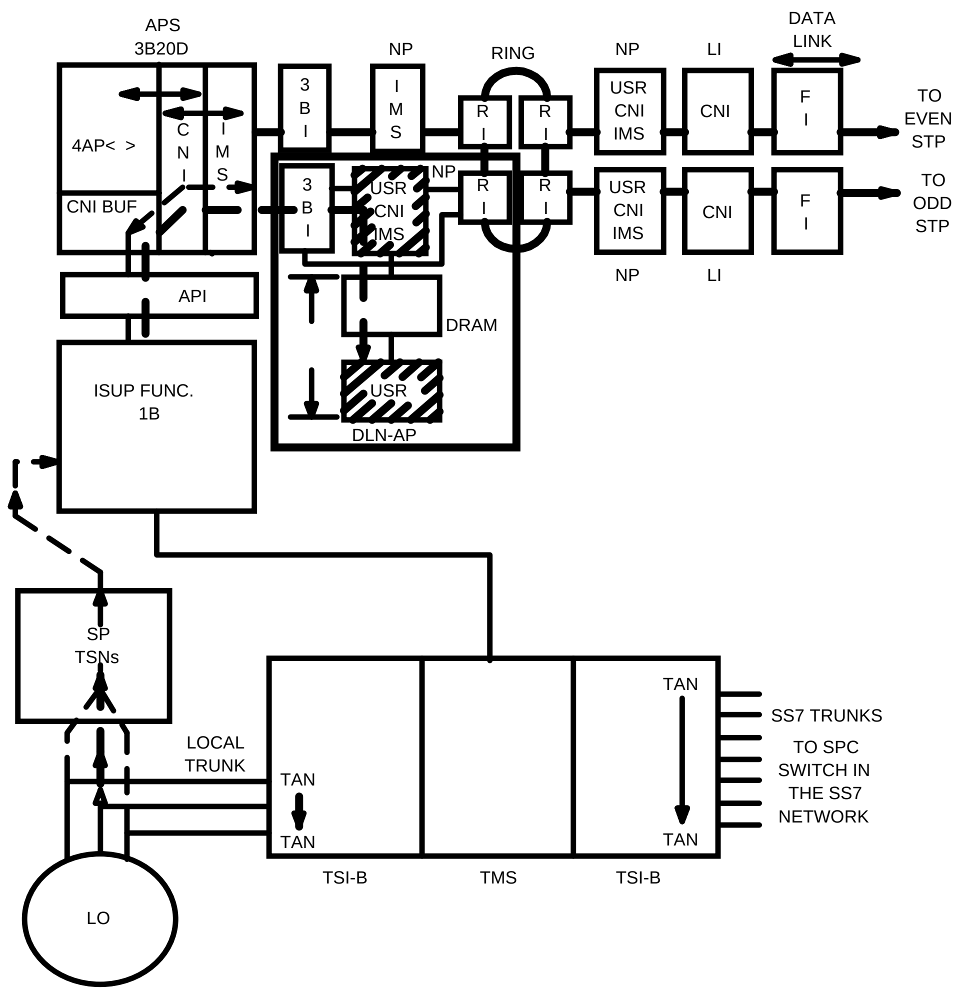
Note:
A similar procedure is followed if a POTS called party initiates the release. The only difference is that a Suspend (SUS) message is returned from Office C to Office A first. Office A then proceeds as above.

Continued on next page

Overview of ISUP Call Processing, Continued

Figure 3-4. ISUP Signaling System No. 7 Call Processing Diagram

The ISDN-UP of the SS7 protocol is used for SS7 connection-oriented messages. The following is an illustration of a layout of the equipment involved in processing a call for SS7 trunks.



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Overview of ISUP Call Processing, Continued

Call From a Local Switching Office Over an SS7 Trunk

The following describes a call from an originating office terminating over a SS7 trunk to another office in the SS7 network.

1. Assume that an incoming call is recognized at the *4ESS* Switch over a local trunk. The associated Signaling Processor (SP) collects the digits received over the local using the Trunk Scanner Number (TSN) assigned to the trunk. When all the digits are collected, the SP sends the dialed digits to the 1B processor for translation.

2. For this example, assume that the 1B translation identifies the outgoing trunk group as SS7 trunks. Since the outgoing trunk is a SS7 type, the 1B processor ISUP formats the message and sends it to the Data Link Node (DLN) via the Attached Processor Interface (API) and CNI-Circular Buffer (CNIBUF).

3. The ISUP - IAM received by the DLN contains the TSN of the associated outgoing Trunk Appearance Number (TAN) and the dialed telephone company Binary Coded Decimal (BCD) digits. The message also contains the ISUP message type, nature of connection, and other information as shown in Figure 3-4.

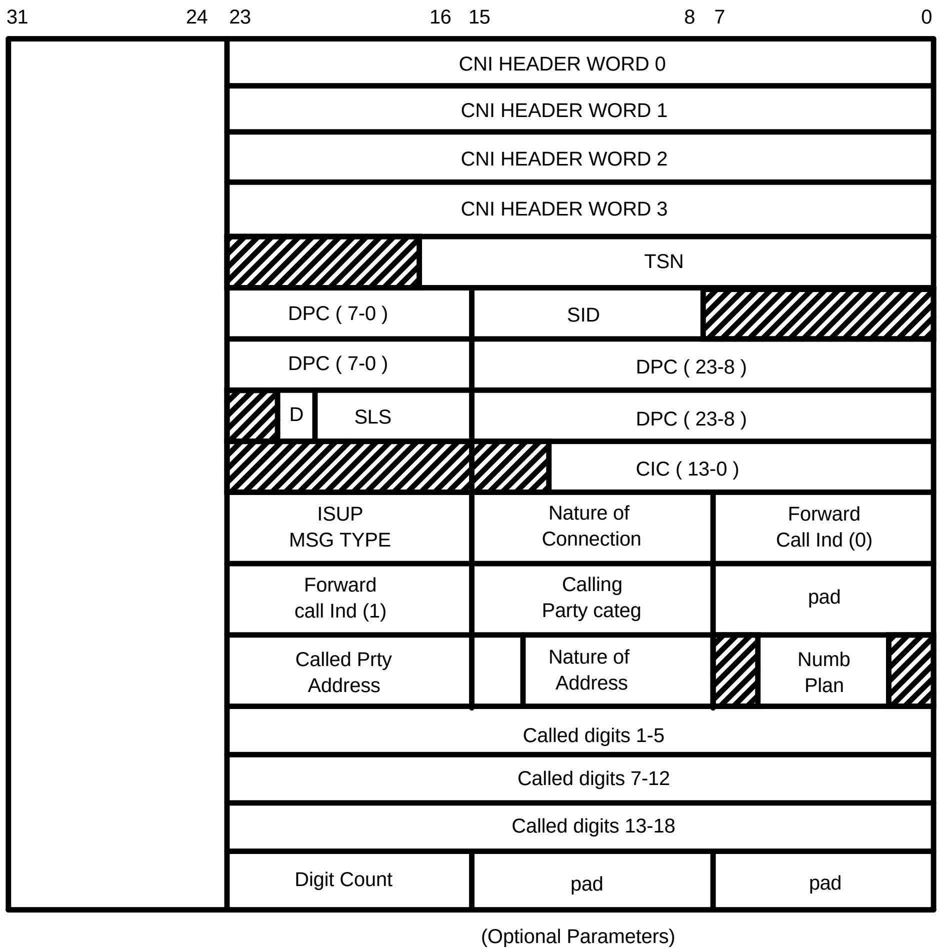
   The Direct Link Node-Attached Processor (DLN-AP) translates the TSN into a destination point code for routing the message over the Common Channel Signaling (CCS) network and a Circuit Identification Code (CIC) to identify the trunk at the far-end switching office. Note that the ISUP 1B format uses a 24-bit word (0 through 23) and has bits 24 through 31 added as a pad for messages from the 1B to the 3B computer. (Refer to Figure 3-5.)

Continued on next page

Overview of ISUP Call Processing, Continued

Figure 3-5. ISUP 1B Format—IAM

The following is an illustration of ISUP 1B Format — IAM.



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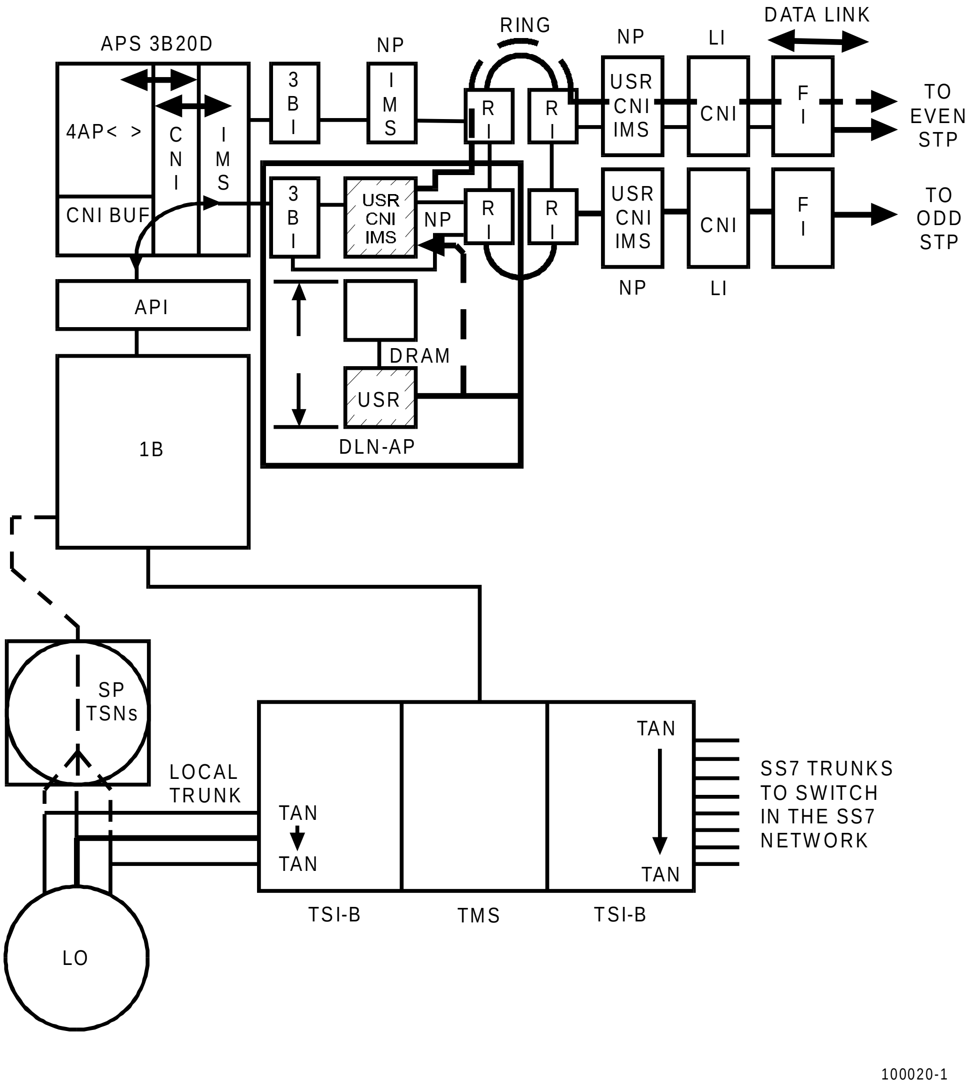
Overview of ISUP Call Processing, Continued

Figure 3-6. DLN-AP Translation of TSN for SS7 Call Processing

The following is an illustration of DLN-AP Translation of TSN.



Local Switching, Continued

4. After the DLN-AP translates the TSN into a Data Processing Center (DPC) a CIC, DLN-AP then reformats the SS7 message into a 32-bit word format as shown in Figure 3-6.

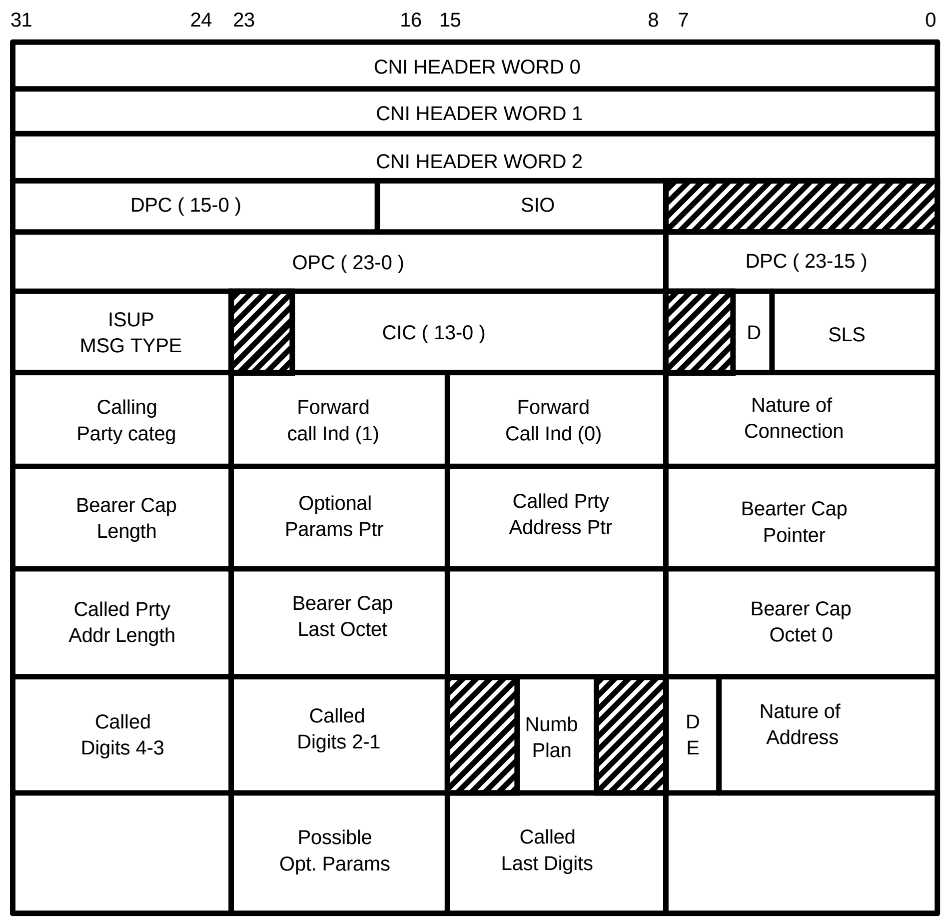
   The DLN also uses the Signaling Link Selection (SLS) field to specify the outgoing SS7 link for transmission. The Message Transfer Part (MTP) function of the CNI software in the DLN uses the SLS field to perform load balancing over the available SS7 links.

Continued on next page

Overview of ISUP Call Processing, Continued

Figure 3-7. ISUP — Initial Address Message for SS7 Routing

The following is an Illustration of an ISUP Initial Address Message.



Continued on next page

Overview of ISUP Call Processing, Continued

Local Switching, Continued

5. Once the outgoing SS7 link is determined, the CNI software writes the Ring Node Address (RNA) address of the outgoing link. The IMS software transports the message around the ring from the DLN to the designated SS7 node. The CNI software transmits the message over the signaling link to the STP.

   Various messages are required during an ISUP call setup. The ISUP MSG TYPE field is used to identify one of the following types:
   - ISUP - IAM (initial address message)
   - ISUP - ACM (Address Complete Message)
   - ISUP - REL (release message)
   - ISUP - ANS (answer message)

6. The preceding ISUP message types are routed in the same manner as described for the IAM call process. However, different functions are performed by the 1B processor for each message type (for example, continuity tests, etc.).

7. When subsequent ISUP messages are received from the far-end switch via the STP, the SS7 node routes the message to the DLN. The DLN translates the Originating Point Code (OPC) and CIC into a TSN related to the IAM message for that particular call setup. Since the IAM contains the DPC and OPC, the terminating switch uses the OPC as a DPC for routing the subsequent messages back to the originating office. Therefore, the DLN can relate all subsequent messages to the initial IAM message transmitted. (Refer to Figure 3-7.)

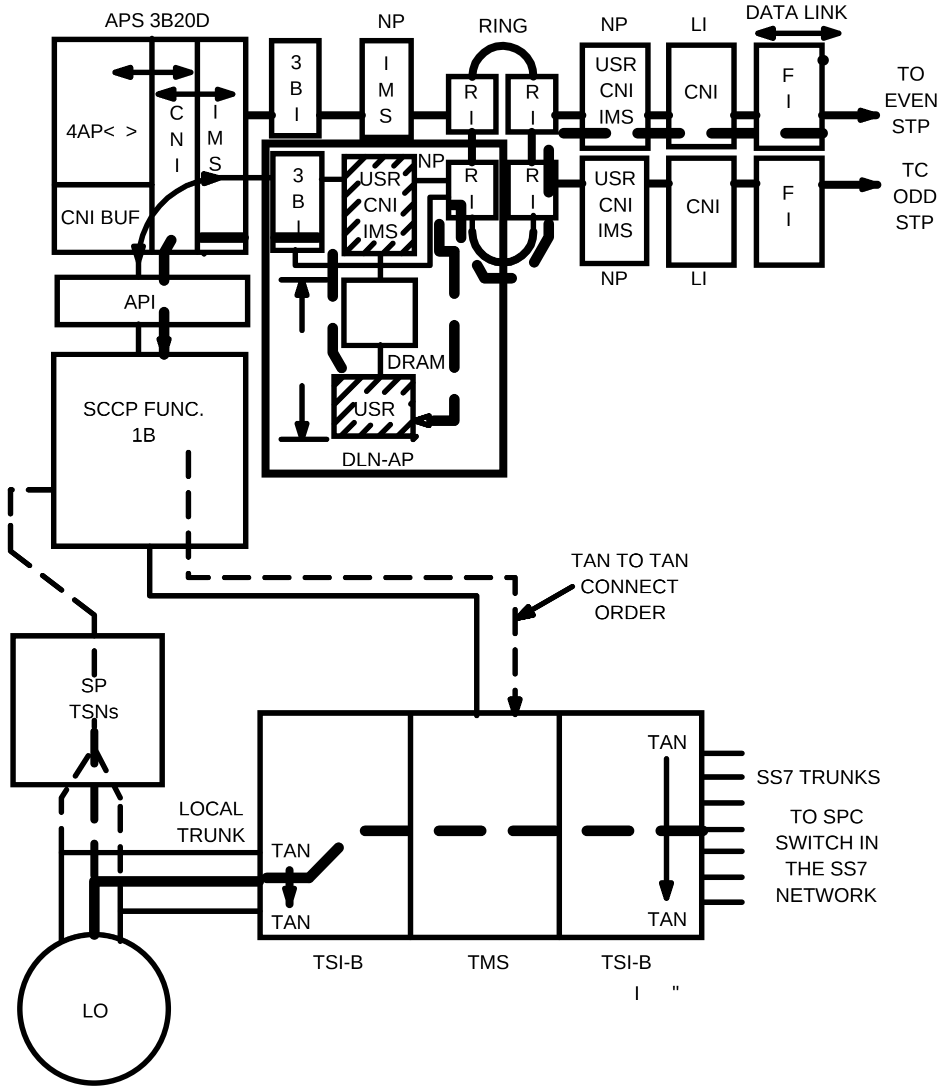
8. When the TSN has been translated by the DLN, a 24-bit word ISUP message is formatted and sent to the 1B for processing. During an ISUP call setup, the originating office puts up the trunk connection to perform the continuity test, if required. If the test is successful and the ANS message is received from the terminating office, the TAN-to-TAN trunk connection is made at both ends. (Refer to Figure 3-8.)

Continued on next page

Overview of ISUP Call Processing, Continued

Figure 3-8. OPC and CIC Translated to TSN During SS7 Call Processing

The following is an illustration of OPC and CIC Translated to TSN.



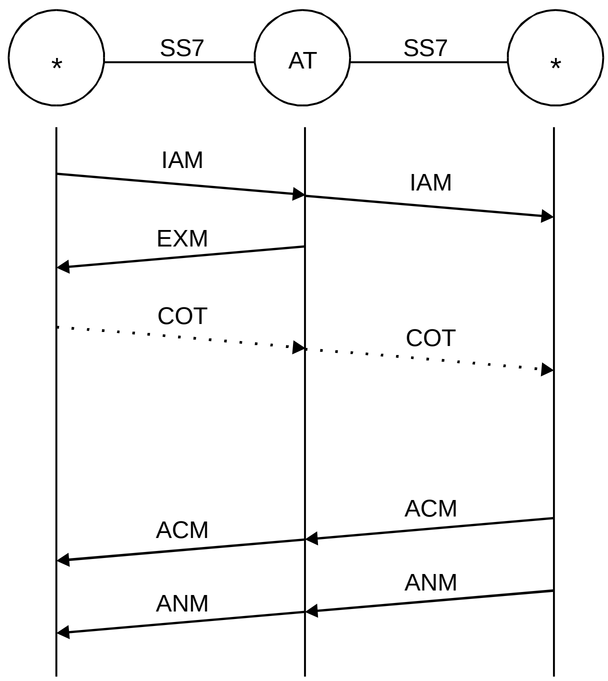
Overview of Network Interconnect Call Processing

NI Call Flow

SS7 begins an inter-LATA/international call by sending a basic intranetwork Initial Address Message (IAM) with network interconnect specific information added, for the selected outgoing circuit. Information specific to network interconnect shows the routing, carrier, and charging information. Figure 3-9 shows the basic indirect SS7 network interconnect call set-up sequence.

Figure 3-9. Network Interconnect Call Flow in the SS7 Network

The following is an illustration of the Network Interconnect Call Flow in the SS7 Network.



LEGEND:
ACM = Address Complete Message
ANM = Answer Message
AT = Access Tandem
COT = Continuity Message
EXM = Exit Message
IAM = Initial Address Message
*May be end office or Inter-LATA/International Toll Office.
Exit Message only applies in end office to AT communication.

Continue on next page

Overview of Network Interconnect Call Processing, Continued

SS7 EAEO to *4ESS* Switch SS7 Access Tandem

The Equal Access End Office (EAEO) selects a circuit for routing, marks the circuit busy, and then formulates an IAM. The IAM is formulated per EO specifications and is not discussed here.

The IAM that is sent to the Access Tandem (AT) must always include the Transit Network Selection (TNS) parameter.

The circuit code within the TNS parameter is coded by agreement between the Local Exchange Carrier (LEC) and the connecting IXC for international calls or within the LEC for domestic calls.

***4ESS* Switch SS7 Access Tandem to IXC SS7 Switch**

The presence of the TNS parameter in the received IAM indicates that a network interconnect call is requested. This also indicates that the call should be routed to an IXC.

The following network interconnect signaling messages are used:

- IAM Received on Incoming Trunk
- IAM Sent on Outgoing Trunk
- EXM Sent on Incoming Trunk.

Continued on next page

Overview of Network Interconnect Call Processing, Continued

IAM Received on Incoming Trunk

On receiving an IAM from the SS7 EAEO, the following parameters are examined specifically for a network interconnect call:

- **Transit Network Selection Parameter**: This parameter contains the main routing information necessary to complete a network interconnect call to the IXC.
- **Called Party Address Parameter**: The "Nature of Address" field routes information (specifically identifies international or domestic routing) and indicates the type of network interconnect call being processed.
- **User Service Information Parameter**: This parameter indicates the type of transmission medium required for the call connection and can be used optionally for routing.

Continued on next page

Overview of Network Interconnect Call Processing, Continued

Transit Network Selection Parameter

The contents of the Transit Network Selection parameter are summarized as follows:

- Type of Network Identification Field must be set to “National Network Identification” indicating that national standards are used. This setting is expected and is not examined by the AT.
- Network Identification Plan Field must be set to “Carrier Identification Code with Circuit Code” indicating that the network interconnect equivalents to EAMF “0ZZ” and “XXX/XXXX” (for inter- LATA calls) or “1NX/1N'X” and “XXX/XXXX” (international call) are contained in this parameter. This setting is expected and is not examined by the AT.
- Network Identification Field contains the 3/4-digit carrier identification code (the EAMF “XXX/XXXX”) and circuit code subfield necessary to route the call to the IXC, if the “Network Identification Plan” field shows “Carrier Identification Code with Circuit Code.”

Called Party Address Parameter

This field is screened for valid inter-LATA and international cases. On receipt of an invalid “Nature of Address,” the call fails and is then released.

Continued on next page

Overview of Network Interconnect Call Processing, Continued

User Service Information Parameter

The User Service Information Parameter (USIP) parameter indicates the type of transmission medium required for the call connection and can be used optionally for routing. On receipt, this parameter is screened for compatibility. If compatibility is not possible, the call is rejected. The following fields must be set as suggested; otherwise, no further call processing is allowed:

- Coding Standard: "CCITT Standard"
- Information Transfer Capability: "Speech," "3 kHz audio," "restricted digital information," or "unrestricted information"
- Transfer Mode: "Circuit Mode"
- Information Transfer Rate: "64kbits/s restricted or unrestricted"
- Multiplier or Layer Identification: "User information layer protocol 1" at "56kbits/s."

The remaining parameters in the received IAM are handled the same as in intra-LATA ISUP calls.

Continued on next page

Overview of Network Interconnect Call Processing, Continued

IAM Sent on Outgoing Trunk

After completion of the continuity check process on the incoming trunk (when applicable), the call is routed to the IXC via a selected outgoing trunk. The system does not wait for a COT complete message on the incoming trunk before picking the outgoing trunk. A new IAM is formatted and sent to the IXC. The TNS parameter is passed with the outgoing IAM only in international network interconnect signaling; otherwise, it is deleted. All other recognized and standardized information is passed through the AT.

If glare is encountered on the outgoing trunk after the IAM is sent, two basic outcomes are possible:

- When the call leaving the AT has priority, the IAM just received (on the same trunk) is simply ignored and the outgoing call continues as in normal non-glare cases, or
- When the glaring call has control, the outgoing call must yield to the incoming call and the outgoing call must be reattempted using another trunk.

Continued on next page

Overview of Network Interconnect Call Processing, Continued

Exit Message Sent on Incoming Trunk

After the outgoing IAM is sent, the EXM is returned to the EAEO (only in SS7 to connections) for the incoming trunk. This can occur either before or after completion of continuity check on the outgoing trunk. The EXM is sent on the incoming trunk shortly after the outgoing trunk IAM is sent. This may occur after a specified delay. Receipt of the EXM by the EAEO indicates when carrier connect time occurs. The EXM also provides the trunk group number of the trunk used between the AT and the IXC.

If a reattempt is necessary (because of glare, continuity check failure, etc.) on the outgoing trunk, two scenarios are possible.

- If the EXM has yet to be returned it is updated to include the trunk group number of the newly selected trunk when retrying the call.
- If the EXM has already been returned, no additional EXM is sent. The EAEO uses the trunk group number provided in the initial EXM, which may or may not be the same as the retry trunk group number.

Should the call fail after seizing the outgoing trunk (because of repeated glare, continuity check failure, receipt of REL, etc.), the EXM must be returned before any REL message is sent for the AT incoming trunk.

EAMF to SS7 Network Interconnect Call

Introduction

When SS7 connectivity exists from the AT to the IXC but not from the EAEO to the AT, EAMF to SS7 interworkings occurs for inter-LATA and international calls. Figure 3-10 and Figure 3-11 show the basic EAMF to SS7 network interconnect call set-up sequence.

After the AT receives the first EAMF stage of signaling on the incoming trunk, code interpretation is performed and an appropriate outgoing trunk is seized. The outgoing trunk now uses the SS7 protocol, and the following network interconnect signaling messages are used:

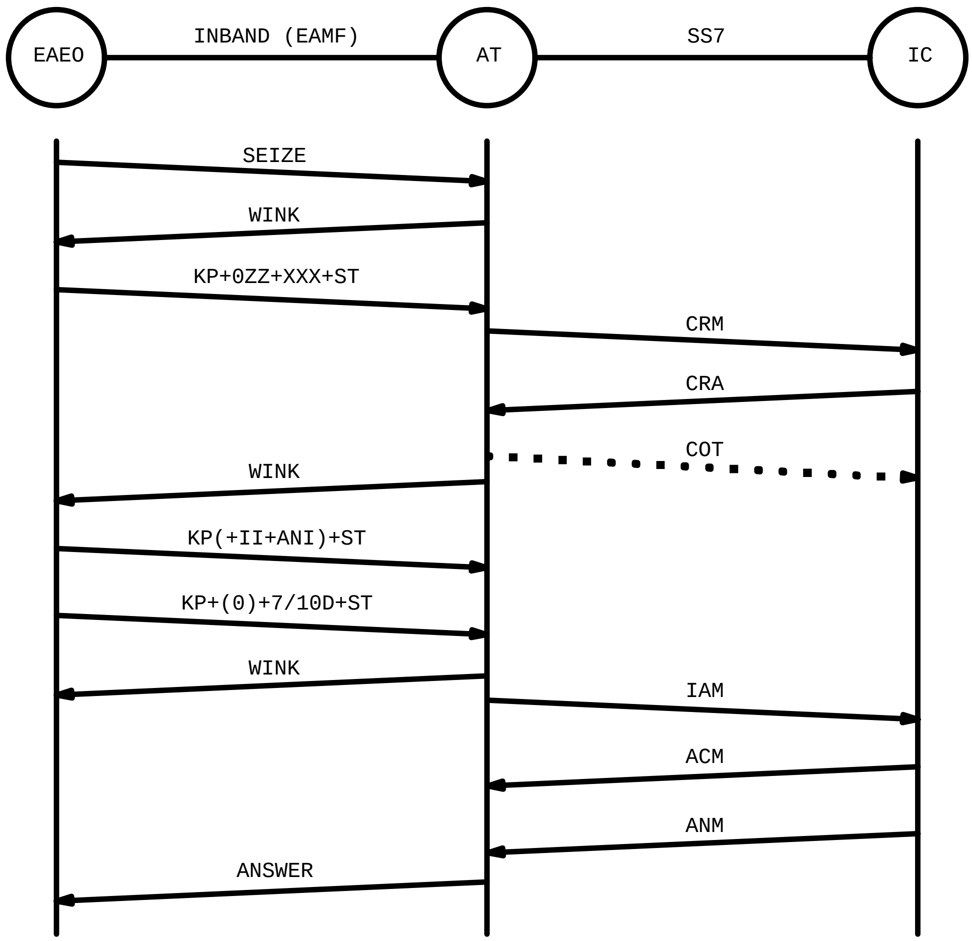
- Circuit Reservation Message (CRM)
- Circuit Reservation Acknowledgment (CRA)
- Continuity Message Sent on Outgoing Trunk (COT)
- IAM Sent on Outgoing Trunk.

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

Figure 3-10. Basic EAMF to SS7 Network Interconnect Call (Domestic)

The following is an illustration of basic domestic EAMF to SS7 network interconnect call set-up sequence.



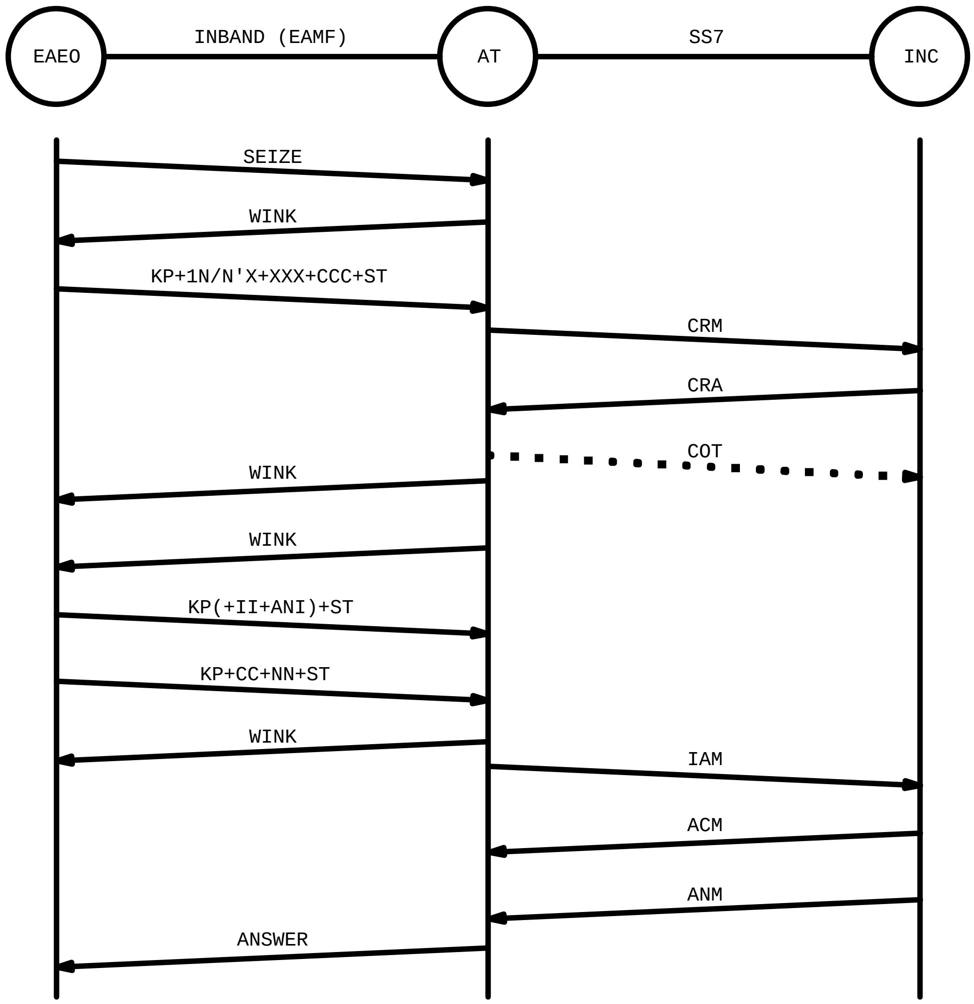
LEGEND:
ACM = ADDRESS COMPLETE MESSAGE
ANM = ANSWER MESSAGE
AT = ACCESS TANDEM
COT = CONTINUITY MESSAGE
CRA = CIRCUIT RESERVATION ACKNOWLEDGE
CRM = CIRCUIT RESERVATION
EAEO = EXCHANGE ACCESS END OFFICE
EAMF = EXCHANGE ACCESS MULTIFREQUENCY
IAM = INITIAL ADDRESS MESSAGE
IC = INTER-LATA CARRIER

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

Figure 3-11. Basic EAMF to SS7 Network Interconnect Call (International)

The following is an illustration of basic international EAMF to SS7 network interconnect call set-up sequence.



LEGEND:
ACM = ADDRESS COMPLETE MESSAGE
ANM = ANSWER MESSAGE
AT = ACCESS TANDEM
COT = CONTINUITY MESSAGE
CRA = CIRCUIT RESERVATION ACKNOWLEDGE
CRM = CIRCUIT RESERVATION
EAEO = EXCHANGE ACCESS END OFFICE
EAMF = EXCHANGE ACCESS MULTIFREQUENCY
IAM = INITIAL ADDRESS MESSAGE
INC = INTERNATIONAL CARRIER

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

CRM Sent on Outgoing Trunk

The first EAMF signaling stage received on the incoming trunk contains information necessary to route the network interconnect call correctly. It contains the “0ZZ+XXX/XXXX” for inter-LATA signaling or the “1NX/1N'X+XXX/XXXX+CCC/01R” for international signaling. After this first EAMF stage is received, the new CRM is sent to reserve the SS7 trunk between the AT and the IXC while waiting for the remaining EAMF signaling stages to arrive on the incoming trunk. The CRM contains the mandatory Nature of Connection Indicators parameter that indicates whether a continuity check should be performed, a satellite is present in the call path, and whether an echo suppresser is active on the particular trunk. The settings of these fields are set similar to the Nature of Connections parameter of the intra-LATA IAM.

Since the CRM is the first message to be sent out on the SS7 outgoing trunk, there is a possibility of glare occurring. Glare can occur when an IAM is received after sending out the CRM. If the outgoing trunk has control when glare occurs, the received IAM is ignored and the outgoing call proceeds normally. If the outgoing trunk does not have control, it must back down and accept the incoming call. The original outgoing call must now be retried on another SS7 outgoing trunk.

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

CRA Received from Outgoing Trunk

After sending the CRM, receipt of the CRA indicates that the trunk to the IXC has been successfully reserved, and the call may proceed. This corresponds to the receipt of the first wink from the carrier. If no continuity check is being performed on this outgoing trunk or if the continuity check has already been completed, a wink is generated on the EAMF incoming trunk when the CRA is received. This wink indicates the beginning of carrier connect time. However, if a continuity check is in progress, it must be completed before the wink is generated on the EAMF incoming trunk.

For inter-LATA signaling, this wink triggers the EAMF EAEO to begin outpulsing the second stage of signaling. Typically, the "KP+[II+ANI]+ST+KP+(0)+7/10D+ST" is sent by the EAEO at this point.

For international signaling, the first wink from the carrier is optional; this is based on an existing AT incoming trunk group option. If this first wink is used, a second wink is returned after a specified delay following the first wink. This second wink or second start dial corresponds to when the international gateway is ready to receive in-band information in EAMF signaling. It also triggers the EAMF EAEO to begin outpulsing the second stage of international digits to the AT. Typically, the "KP+[II+ANI]+ST+KP+CC+NN+LN+ or +XXXXXX+ST" is sent by the EAEO at this point. If the first wink from the carrier is not required, the AT generates the second start dial wink immediately at the point where the first wink is normally sent and is prepared to receive the second stage of digits from the EAMF EAEO. Here, the second start dial wink is used as the indication of carrier connect time.

If the CRA is not received within the specified time, another trunk to the IXC is seized and the outpulsing attempt retried.

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

Continuity Message Sent on Outgoing Trunk

A continuity check procedure is performed to verify the integrity of the speech path, after the CRM is sent when appropriate. This procedure is the same as that used in intra-LATA ISUP calls, except, it occurs after CRM instead of after IAM. On successful completion of the continuity check, the AT sends a COT message to the IXC and returns the appropriate wink(s).

If the continuity check procedure fails, the failing trunk is handled by existing trunk maintenance procedures. The call itself is then retried on another trunk. Since the initial carrier wink has not been generated on the incoming trunk, the newly chosen trunk could use either SS7 or Equal Access Multifrequency (EAMF) signaling without affecting the call status at the EAMF EAEO. Thus, the retried call could be another EAMF to SS7 network interconnect interworking call or it could use EAMF signaling all the way to the carrier.

IAM Sent on Outgoing Trunk

After the second stage of digits are collected on the EAMF incoming trunk, the AT formats and sends an IAM on the SS7 outgoing trunk to the IXC. When the IAM is sent, an acknowledgment wink is transmitted to the EAMF EAEO on the incoming trunk (about 200ms), after a short delay The IAM sent is similar to the intra-LATA IAM during PTS to SS7 interworking, with the following differences:

- **Tandem Network Selection Parameter**: This parameter is only included by the AT in the outgoing IAM for international signaling, When EAMF to SS7 interworking occurs. This parameter contains the “XXX/XXXX” and “1NX/1N'X” information received on the EAMF incoming trunk during the first stage of international signaling from the EAEO.

- **Charge Number Parameter**: This parameter is included in the IAM sent on the SS7 outgoing trunk only if II+ANI was received on the EAMF incoming trunk.

- **Originating Line Information Parameter**: The OLI parameter is included in the IAM sent on the SS7 outgoing trunk only if II+ANI was received on the EAMF incoming trunk. The coding is the binary equivalent of the II digits received.

SS7 to EAMF Network Interconnect Call

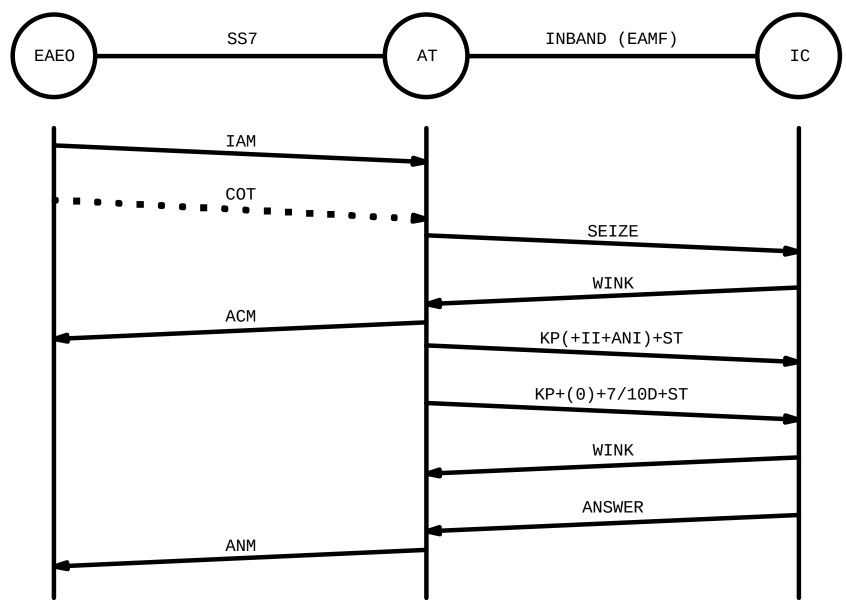
Introduction

When SS7 connectivity exists from the EAEO to the AT, but not from the AT to the IXC, SS7 to EAMF interworking occurs for inter-LATA and international calls. Figure 3-12 and Figure 3-13 show the basic SS7 network interconnect to EAMF call set-up sequence. The presence of the TNS parameter in the IAM received at the tandem office incoming trunk indicates that an network interconnect call is requested. This also shows that the call should be routed to an IXC. The outgoing trunk uses the EAMF protocol and the following network interconnect signaling message is sent:

- IAM Received on Incoming Trunk.

Figure 3-12. Basic SS7 Network Interconnect to EAMF (Domestic)

The following is an illustration of the basic domestic SS7 network interconnect to EAMF call set-up sequence.

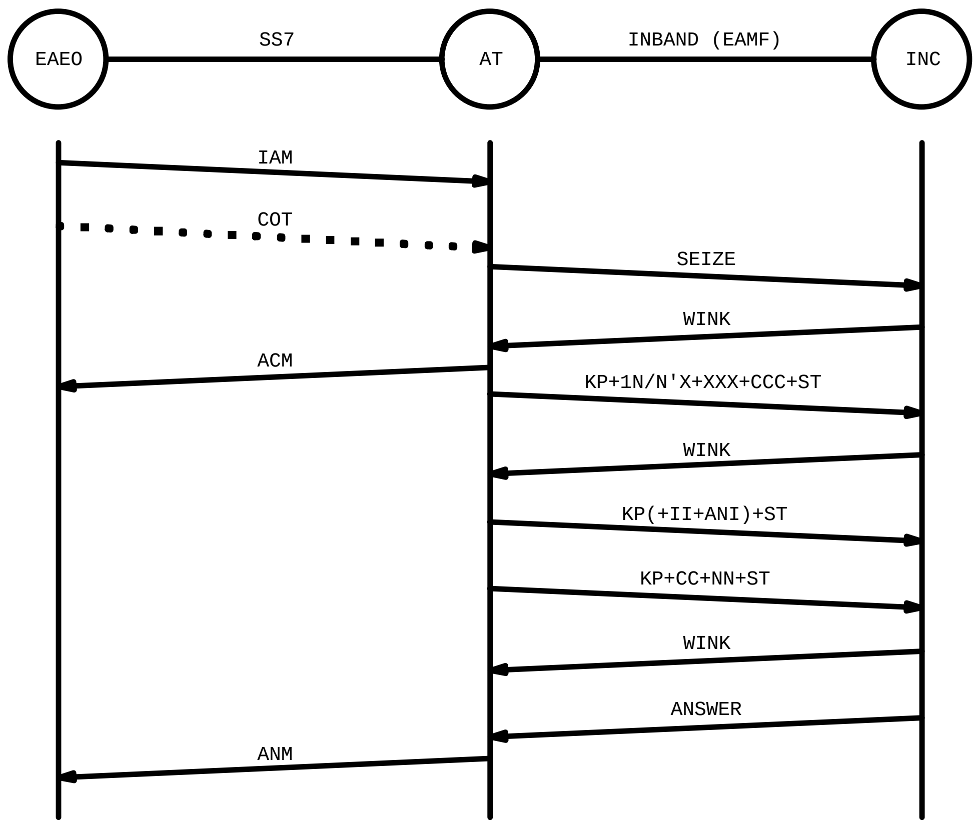


LEGEND:
ACM = ADDRESS COMPLETE MESSAGE
ANM = ANSWER MESSAGE
AT = ACCESS TANDEM
COT = CONTINUITY MESSAGE
EAEO = EXCHANGE ACCESS END OFFICE
EAMF = EXCHANGE ACCESS MULTIFREQUENCY
IAM = INITIAL ADDRESS MESSAGE
IC = INTER-LATA CARRIER

SS7 to EAMF Network Interconnect Call, Continued

Figure 3-13. Basic SS7 Network Interconnect to EAMF (International)

The following is an illustration of the basic international SS7 network interconnect to EAMF call set-up sequence.



LEGEND:
ACM = ADDRESS COMPLETE MESSAGE
ANM = ANSWER MESSAGE
AT = ACCESS TANDEM
COT = CONTINUITY MESSAGE
EAEO = EXCHANGE ACCESS END OFFICE
EAMF = EXCHANGE ACCESS MULTIFREQUENCY
IAM = INITIAL ADDRESS MESSAGE
INC = INTERNATIONAL CARRIER

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

IAM Received on Incoming Trunk

On receiving the IAM, verification of relevant information contained within the IAM is performed as described on page 3-14. When applicable, a continuity check is performed on the incoming trunk before an appropriate outgoing trunk is chosen to the IXC.

At this point, the IAM has provided the AT with all the information necessary to route the call. The AT uses the “XXX/XXXX” digits, “Nature of Address,” “Circuit Code,” and optionally, the “User Service Information” in the TNS parameter with possible incoming trunk information to select the appropriate route to the IXC. An in-band seize signal is then sent on the chosen trunk to the IXC. After the carrier acknowledgment wink is received from the IXC, the AT sends an ACM to the SS7 EAEO to show carrier connect time.

After the ACM is returned, the address information necessary to route the call is sent on the EAMF outgoing trunk as follows.

- If the TNS parameter indicates that inter-LATA signaling is being used, the AT sends a single stage of address information to the IXC using the EAMF protocol.

- If international signaling is being used, two stages of address information, as defined under the EAMF protocol, is sent instead. The information outpulsed on the EAMF outgoing trunk is directly related to the information contained in the received IAM.

Terminating 4ESS Switch Access Tandem Inband to SS7 Network Interconnect Call

Introduction

When SS7 connectivity exists from the terminating AT to the end office, but not from the IXC to the terminating AT, inband to SS7 interworking occurs. Figure 3-14 shows the basic inband to SS7 call set-up sequence.

When the terminating AT receives the initial seizure from the IXC, it returns a wink on the incoming trunk. After the IXC receives a wink from the AT, it outpulses the address information to the AT. If the call is to be routed to an end office, the AT performs circuit selection to determine if interworking with SS7 applies.

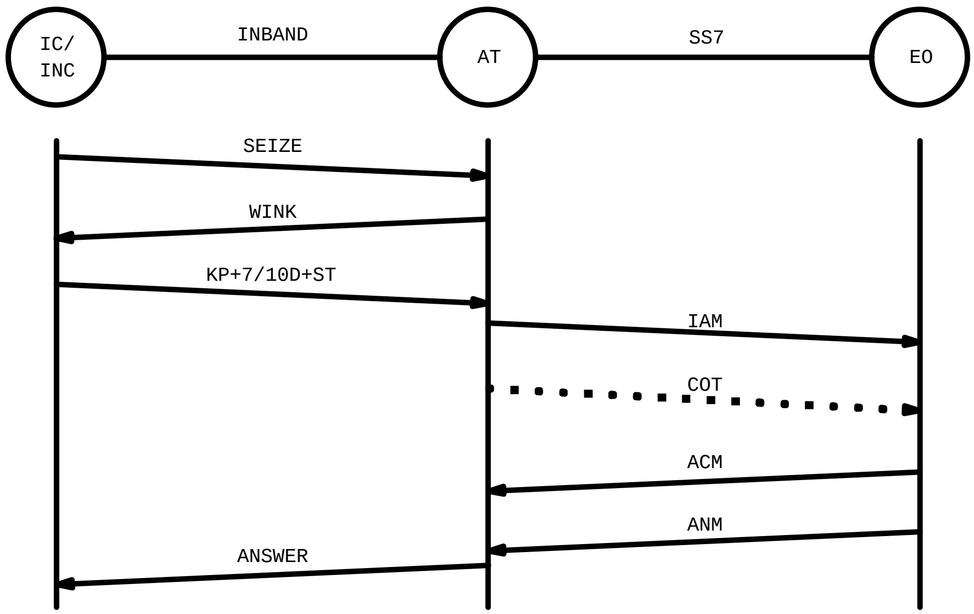
On receiving the address information, the AT makes the selected outgoing trunk busy and formulates an IAM. The terminating AT proceeds with call processing using SS7 intra-LATA signaling.

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

Figure 3-14. Basic Inband to SS7 Call

Following is an illustration of basic inband to SS7 call set-up sequence.



LEGEND:
ACM = ADDRESS COMPLETE MESSAGE
ANM = ANSWER MESSAGE
AT = ACCESS TANDEM
COT = CONTINUITY MESSAGE
EO = END OFFICE
IAM = INITIAL ADDRESS MESSAGE
IC/INC = INTER-LATA/INTERNATIONAL CARRIER

SS7 to Inband Network Interconnect Call

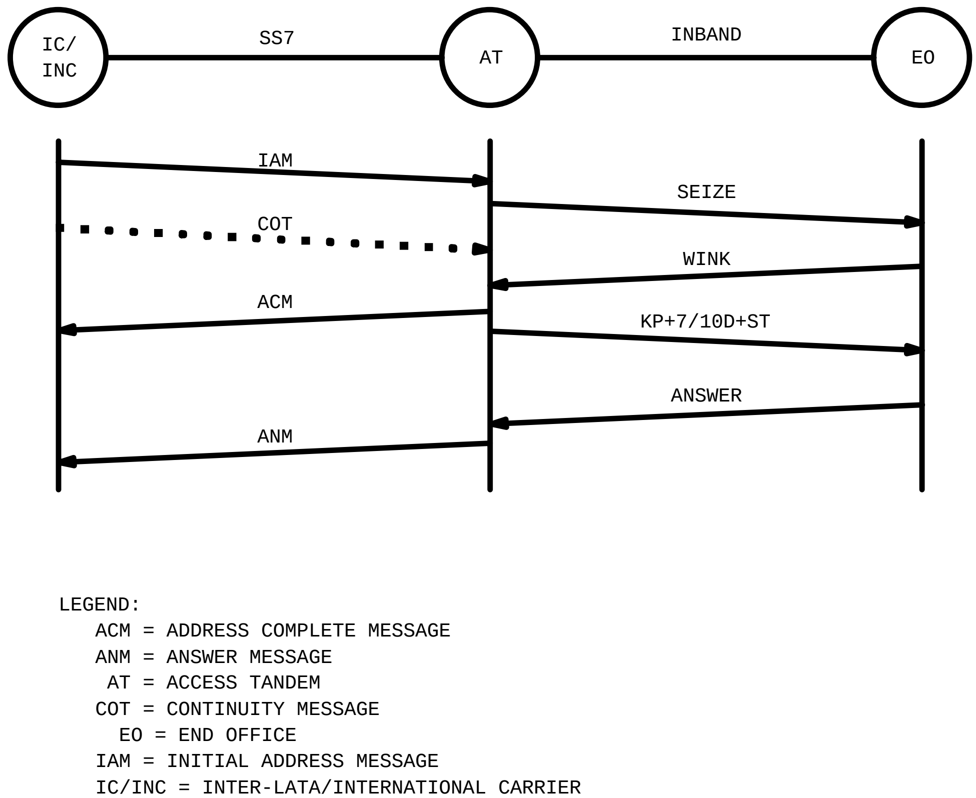
When SS7 connectivity exists from the IXC to the AT, but not from the AT to the EO, SS7 to inband interworking occurs. Figure 3-15 shows the basic SS7 network interconnect to inband call set-up sequence.

Continued on next page

EAMF to SS7 Network Interconnect Call, Continued

Figure 3-15. Basic SS7 Network Interconnect to Inband Call

The following is an illustration of the basic SS7 network interconnect to inband call set-up sequence.



IAM Received on Incoming Trunk

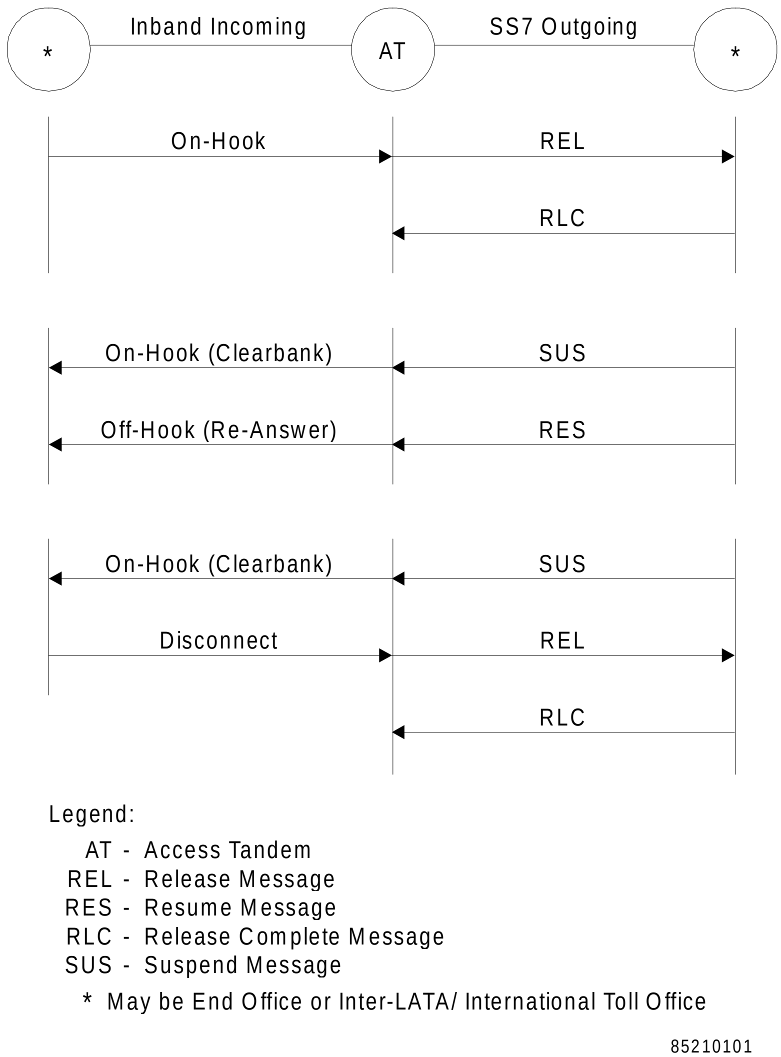
On receiving the IAM, if the call is to be routed to an EO, the terminating AT performs circuit selection based on the called number and the transmission medium requirement(s) in the User Service Information Parameter. This determines if interworking with inband signaling applies. When applicable, a continuity check is performed on the incoming trunk.

After receiving a wink from the EO and the continuity check successfully completes (if performed), the AT sends an ACM to the IXC on the incoming trunk. The ACM prompts the completion of the transmission path at the preceding switches. At this point, the AT outpulses the address information (7/10D) contained in the IAM on the outgoing trunk.

Release Treatments

Figure 3-16. Release Treatment for EAMF to SS7

The following is an illustration of the release treatment for incoming Equal Access Multifrequency (EAMF) to a outgoing SS7 network interconnect call.



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Release Treatments, Continued

Incoming EAMF to Outgoing SS7 Network Interconnect

The AT should be prepared to receive an on-hook disconnect signal on the incoming circuit at any time after the initial seizure of that circuit. It should be prepared to receive a REL or a SUS for the outgoing circuit at any time after it has received an ANM for that circuit.

If the AT receives an on-hook disconnect signal on the incoming circuit before receiving either a REL or SUS for the outgoing circuit, it idles the incoming circuit and returns an on-hook supervision signal on the incoming circuit. If the AT has already sent the IAM for the outgoing circuit, the AT releases the outgoing circuit and sends a REL for that circuit.

If the AT receives a REL for the outgoing circuit before a SUS, it releases and idles the outgoing circuit and returns a RLC for that circuit. If the cause value in the received REL is “normal release,” the AT also sends an on-hook disconnect signal on the incoming circuit.

If the AT receives a SUS with suspend/resume indicator coded to indicate “network initiated” for the outgoing circuit after having already received an ANM for that circuit, it places an on-hook disconnect signal on the incoming circuit for the call. The AT is not disconnect the circuit connection until it receives an on-hook supervision signal on the incoming circuit or a REL for the outgoing circuit.

If, after receiving a SUS indicating “network initiated” for the outgoing circuit and before receiving an on-hook supervision signal on the incoming circuit or a REL for the outgoing circuit, the AT receives a RES with a “network initiated” indication, the AT sends an off-hook signal on the incoming circuit.

If, after receiving a SUS, an on-hook supervision signal is received for the incoming circuit before a RES or REL is received for the outgoing circuit, the AT idles the incoming circuit, releases the outgoing circuit, and proceeds with the sending of a REL for the outgoing circuit.

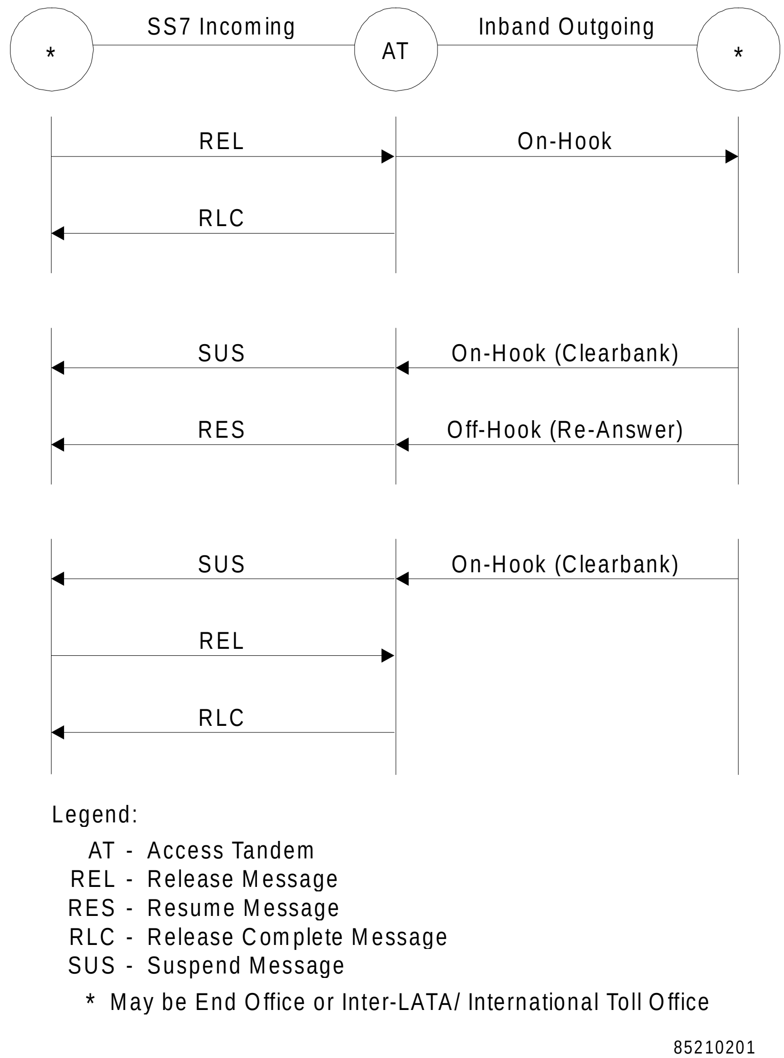
If, after receiving a SUS, a REL is received before an on-hook supervision signal, the AT idles the outgoing circuit and sends a RLC for the circuit. The incoming circuit is idle when on-hook supervision is received.

Continued on next page

Release Treatments, Continued

Figure 3-17. Release Treatment for SS7 to EAMF

The following is an illustration of the release treatment for incoming SS7 to a outgoing EAMF network interconnect call.



Continued on next page

Release Treatments, Continued

Incoming SS7 to Outgoing EAMF Network Interconnect

The AT should be prepared to recognize the REL for the incoming circuit at any time after receiving an IAM for the circuit. In addition, the AT should be prepared to recognize a disconnect signal on the outgoing circuit once answer supervision has been detected.

If the AT receives a REL for the incoming circuit, it releases and idles the incoming circuit and sends a RLC. The RLC contains the same OPC, DPC, CIC and Signaling Link Selection (SLS) as any ACM that preceded it for the same call. The AT sends an on-hook disconnect signal on the outgoing circuit. On reception of an on-hook supervision signal for the outgoing circuit, the AT sets a guard timer. The AT idles the outgoing circuit when the guard timer expires.

If the AT receives an on-hook disconnect signal on the outgoing circuit before receiving a REL for the incoming circuit, it formulates and sends a SUS for the incoming circuit. This SUS contains the same OPC, DPC, CIC and SLS as did the ACM that preceded it. The suspend/resume indicators parameter is coded to “network initiated.” When the AT sends the SUS it should set a SUS timer and wait for either a REL from the switch at the far end of the incoming circuit or an off-hook on the outgoing circuit.

If an off-hook is received on the outgoing circuit before a REL is received for the incoming circuit and while the SUS timer is still active, the AT cancels the SUS timer, reconnects the transmission path and sends a RES to the switch at the far end of the incoming circuit.

If a REL is received for the incoming circuit before, or simultaneously with, an off-hook on the outgoing circuit and while the SUS timer is still active, the AT cancels the timer, idles the incoming circuit, and sends the RLC for the incoming circuit. The RLC should contain the OPC, DPC, CIC and SLS of the ANM that preceded it for the same call. The AT also sends an on-hook supervision signal on the outgoing circuit and sets a guard timer. The AT idles the outgoing circuit when the guard timer expires.

Continued on next page

Release Treatments, Continued

Incoming SS7 to Outgoing EAMF Network Interconnect, Continued

If the SUS timer expires before either an off-hook on the outgoing circuit or a REL for the incoming circuit is received, the interworking switch releases the incoming circuit by sending a REL for the circuit. The REL should have the same SLS as the SUS that preceded it.

The AT also sends an on-hook supervision signal on the outgoing circuit and sets a guard timer. The AT idles the outgoing circuit when the guard timer expires.

Timing Requirements

Various timers associated with SS7 ISUP call set-up and release procedures are the same as those for intranetwork calls. Timers that are specific to internetwork calls are as follows:

- Tcrm: This timer defines the timing value (3 seconds) used for the time awaiting a Circuit Reservation Acknowledgment (CRA) or REL message after sending a Circuit Reservation Message (CRM).

- Tcra: This timer defines the timing value (20-25 seconds) used for the time awaiting an IAM or REL message after sending a CRA message.

- Ttrd: This timer defines the timing value (14-16 seconds) used for the time awaiting a Resume (RES) or REL message after sending a SUS message.

Call Flow of Additional Features

Additional Features

This section describes the call flow of each additional feature where there is alteration to the basic SS7 call flow. The following features are affected:

085 Generic Address Parameter

122 Coding Standard Field of the Cause Parameter

156 Completion of Transmission Path

157 Handling Confusion Messages

158 Routing Based on Speech and 3.1-kHz Bearer Capability

Generic Address Parameter (GAP) Feature (#085)

The Generic Address Parameter (GAP) format is similar to the CPN parameter format; however, the GAP format includes a "type of address" field that defines what the parameter is. This field can have four different values: a dialed number, a destination number, "CPN, user-provided, screening failed," or "CPN, user-provided, not screened." However, only two types of addresses are recognized in this field:

- "CPN, user-provided, screening failed."
- "CPN, user-provided, not screened."

A GAP with either of these values in the address field is passed; a GAP with any other value is passed as an "unrecognized parameter."

Handling of GAP Through the Network

Tandem Switch

A tandem switch passes the GAP without modification. If the tandem switch is acting as a Service Switching Point (SSP), a GAP with anything other than a user-provided CPN in the "type of address" field is handled as an "unrecognized parameter."

Continued on next page

Call Flow of Additional Features, Continued

Coding Standard Field of the Cause Parameter Feature (#122)

This section describes how an ISUP Cause parameter is processed at a *4ESS* Switch.

ISUP-to-ISUP

ISUP-to-ISUP interworking at an intermediate switch has the following effects on the Cause parameter:

- The value of the received Coding Standard indicator is passed unchanged.
- If the Coding Standard indicator is "ITU standard," the Cause value is passed and/or recoded per existing procedures. If the Coding Standard indicator is something other than "ITU standard," the Cause value is passed unchanged.
- The Location value is passed and/or recoded per existing procedures.

Cause Parameter and Playing Tone/Announcement

The Coding Standard field of the Cause parameter is examined at an originating or intermediate switch when the following conditions exist:

- REL message is received for the Outgoing Trunk (OGT) prior to receiving the address complete message (ACM).
- A tone and/or announcement is to be played at the *4ESS* Switch.

If the Coding Standard value is "ITU standard," there is no change in the way the tone and/or announcement is determined. For any other value of the Coding Standard, the cause is treated as ITU standard value "interworking, unspecified" (1111111) with location "unknown" (1010).

- The Cause value is mapped to reorder tone for domestic calls.

Continued on next page

Call Flow of Additional Features, Continued

Completion of Transmission Path Feature (#156)

The transmission path is completed in both directions for all calls, upon the receipt of a CPG message, with one of the following:

- The interworking indicator, bit I, of the backward call indicator (BCI) parameter coded "interworking encountered."
- A CPG message with the user-network interaction indicator, bit H, of the optional backward call indicator (OBCI) parameter coded "user-network interaction occurs, cut-through of bearer channel in both directions.

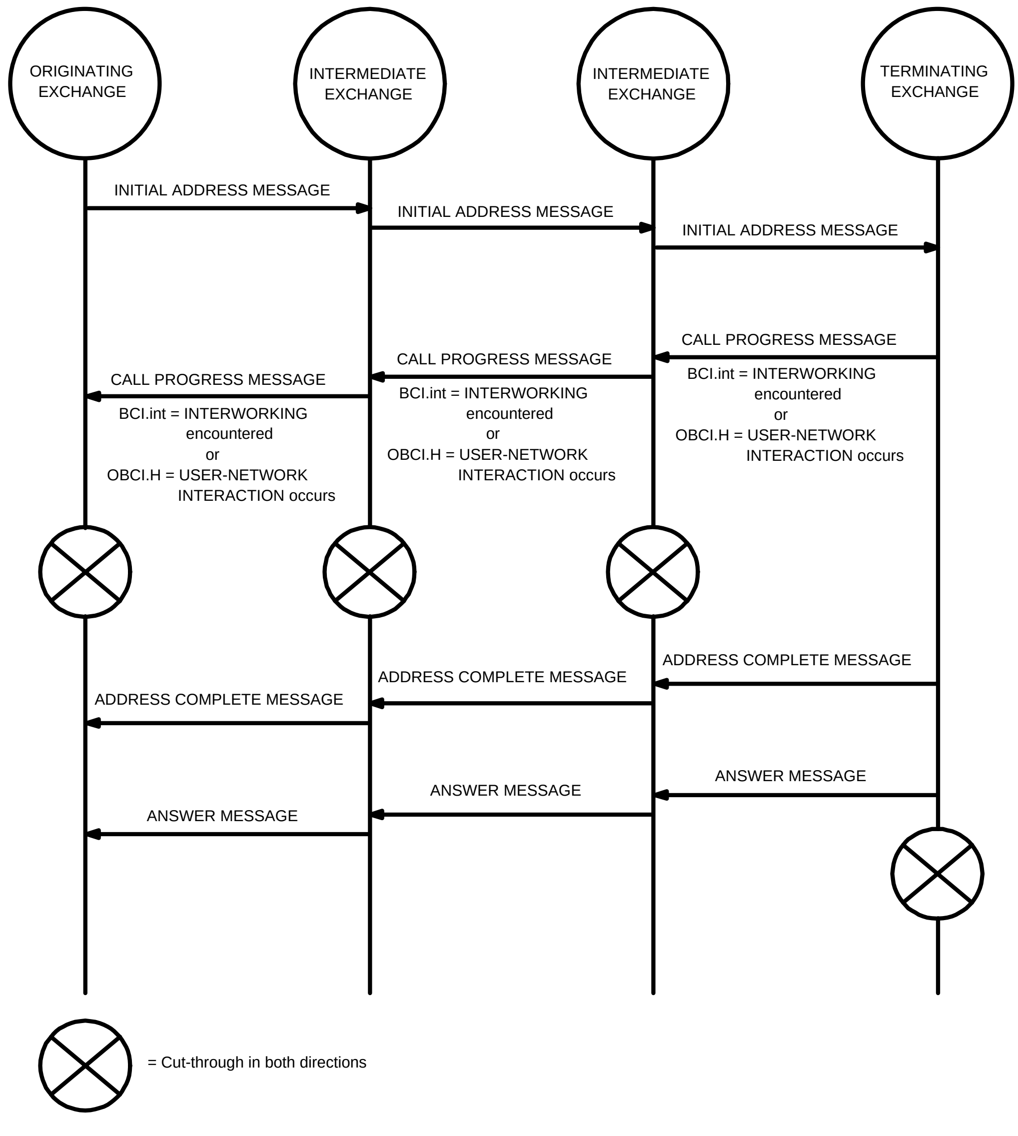
Figure 3-18 shows a transmission completion path for all calls with an unexpected case where User Network Interaction (UNI) occurs or interworking is encountered, and CPG is sent from the terminating end.

Continued on next page

Call Flow of Additional Features, Continued

Figure 3-18. Unexpected Case

The following is an illustration showing the completion of a transmission path for all calls — Unexpected Case: UNI Occurs or Interworking is Encountered, and CPG is Returned.



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Call Flow of Additional Features, Continued

Cut-Through Procedures at Tandem Exchange

If a CPG message causing cut-through is received before an ACM at an exchange, the ACM timer remains on awaiting an ACM. On receipt of an ACM, after the transmission path has been completed in both directions, the existing procedures with the exception of cut-through, are followed.

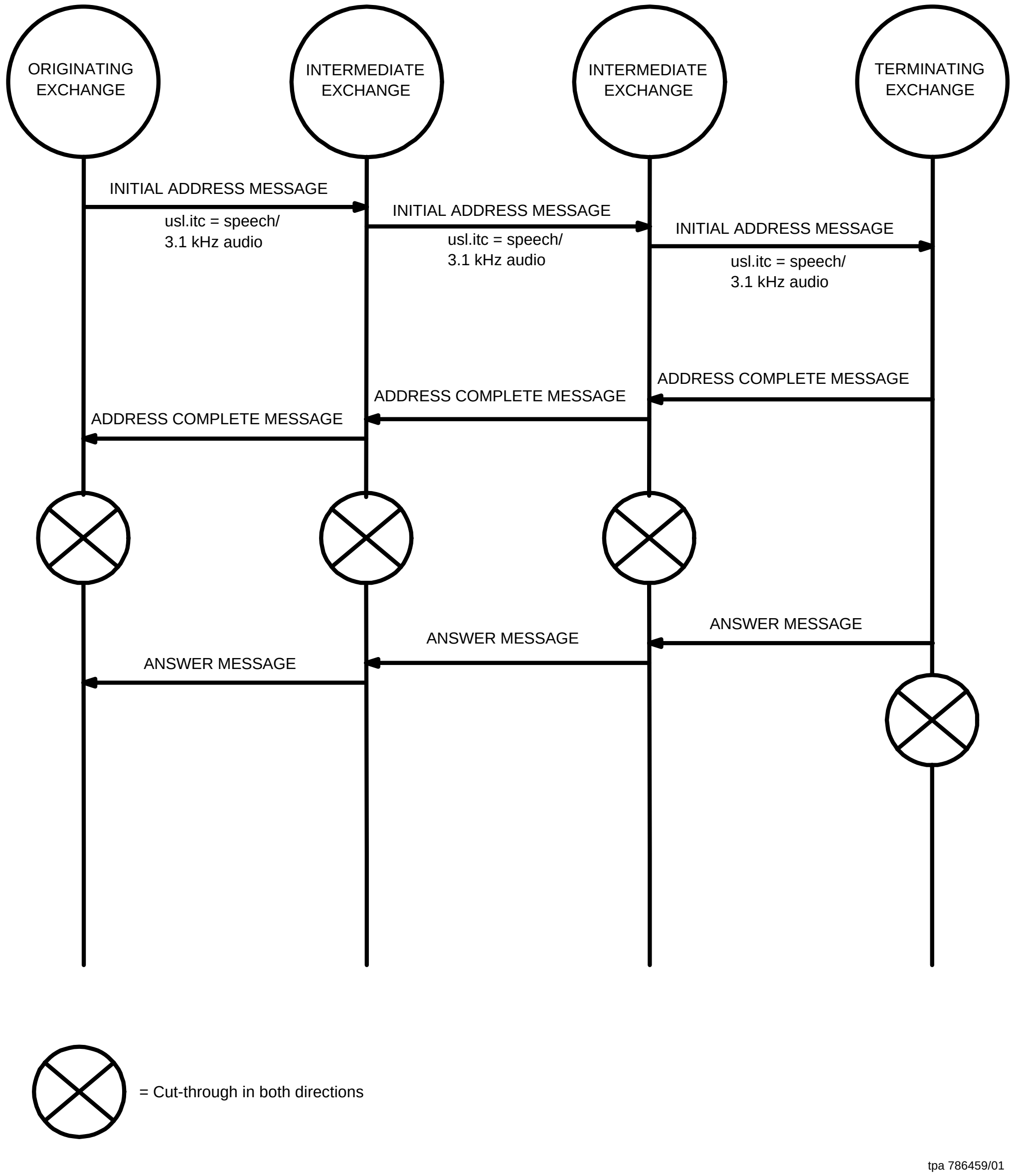
For the setting of the information transfer capability field of the user service information (USI) parameter of “speech” or “3.1-kHz audio”, the transmission path is completed in both directions on receipt of the first of either an ACM or ANM, unless a previous CPG message has already triggered the cut-through. Figure 3-19 shows a transmission path completion for 3.1-kHz audio and speech calls on a normal call setup where the first backward message received is the ACM. Figure 3-20 shows a transmission path completion for calls on a normal call setup with fast connect, where the first backward message received is an ANM.

Continued on next page

Call Flow of Additional Features, Continued

Figure 3-19. Normal Call Setup

The following shows the Completion of Transmission Path for 3.1-kHz Audio and Speech Calls — Normal Call Setup: First Backward Message is ACM.



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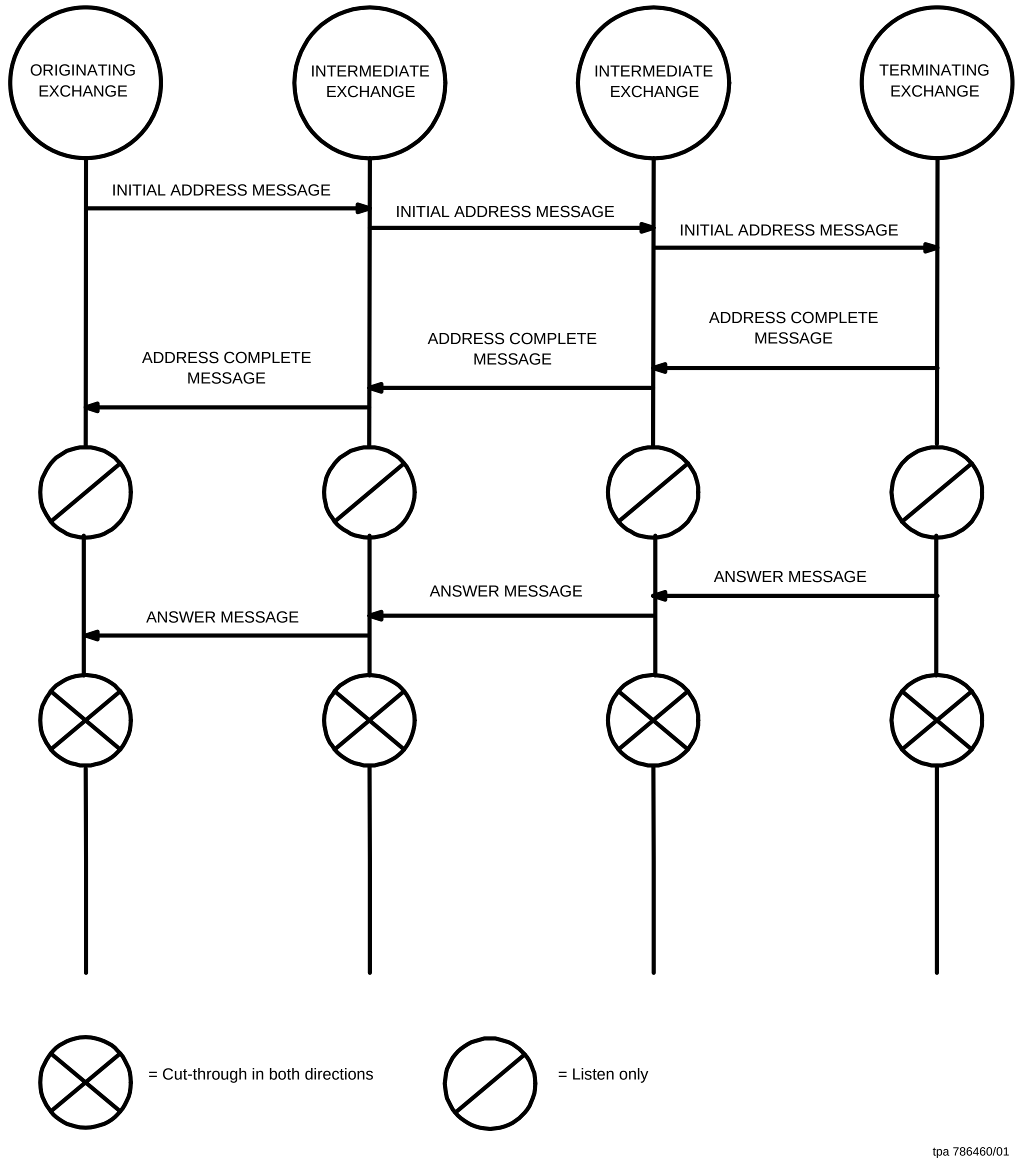
Call Flow of Additional Features, Continued

Figure 3-20. Normal Call Setup 2

The following is an illustration of a Normal Call Setup.



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Call Flow of Additional Features, Continued

Information Transfer Capabilities

For the setting of the information transfer capability field of the USI parameter of “unrestricted digital information” or “restricted digital information”, the transmission path is completed in both directions on the receipt of the ACM but only if it contains one of the following:

- An “interworking encountered” coding in the interworking indicator, bit I, of the BCI parameter.
- The user-network interaction indicator, bit H, of the OBCI parameter coded “user network interaction occurs, cut-through of bearer channel in both directions.”

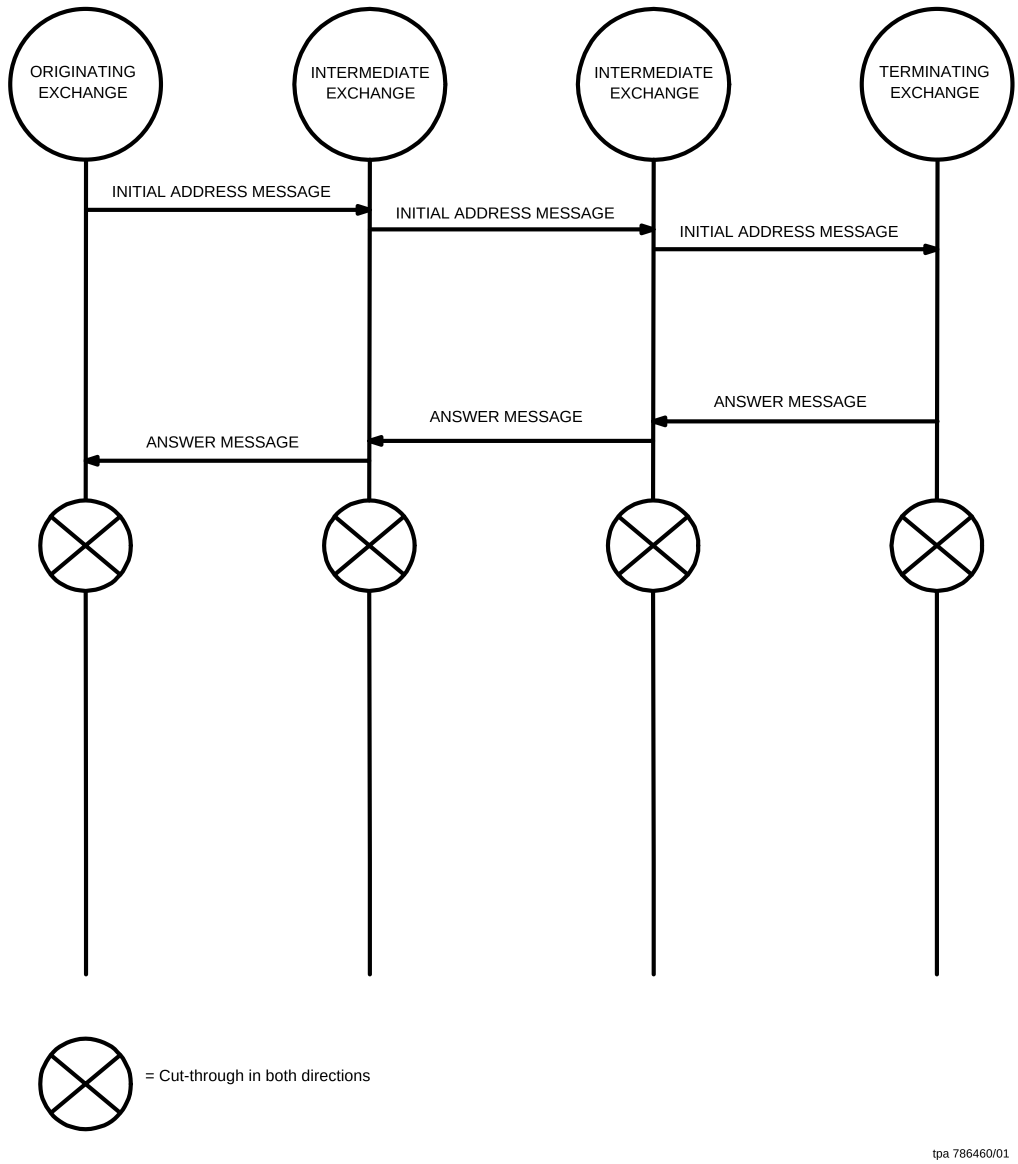
This occurs unless a previous CPG has already triggered the cut-through. Otherwise, completion of transmission path occurs at the receipt of the ANM. (Refer to the following Figures 3-21 and 3-22.)

Continued on next page

Call Flow of Additional Features, Continued

Figure 3-21. Normal Call Setup: No Interworking Encountered and No UNI Occurs

The following is an illustration of “Completion of Transmission Path for All Calls —Normal Call Setup: No Interworking Encountered and No UNI Occurs.”



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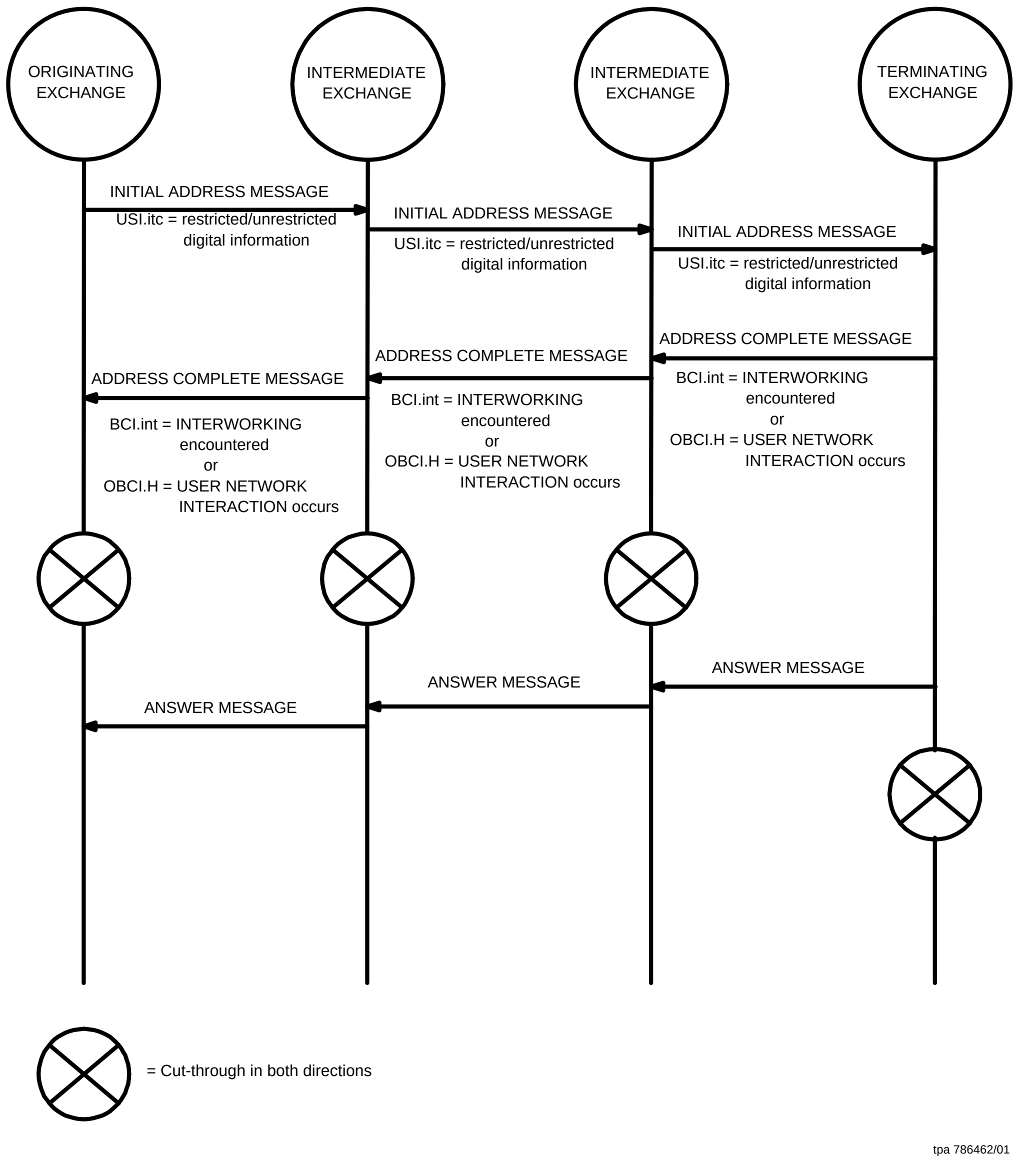
Call Flow of Additional Features, Continued

Figure 3-22. Normal Call Setup: No Interworking Encountered and No UNI Occurs

The following is an illustration of "Completion of Transmission Path for Data Calls — Normal Call Setup: UNI Occurs or Interworking is Encountered, and ACM is Returned."



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Call Flow of Additional Features, Continued

Final Handling

A message that may trigger a cut-through, that is, an ACM, ANM, or a CPG with an indication of interworking or user-network interaction, is never sent until all continuity checks on previous circuits or the outgoing circuit for the call connection are successfully completed. If one of these messages is received before the completion of the continuity check, the call is terminated (Final Handling Code 1497) with cause value “temporary failure”, which is consistent with current practices on receipt of an ACM under similar circumstances.

Continued on next page

Call Flow of Additional Features, Continued

Note:
In the event that the toll fraud feature is turned on at the originating access tandem for the outgoing trunk group, the toll fraud feature takes precedence over the new cut-through requirements.

Interworking Exchanges

At an interworking exchange where the incoming circuit is not Common Channel Signaling System 7 (CCS7) supported but the outgoing circuit is, a CPG with an indication of “interworking encountered” or “user-network interaction”, received before an ACM, causes a cut-through with no other change in the usual message sequence for nontest calls. For test calls, a CPG received prior to an ACM with an indication of “interworking encountered” or “user-network interaction” is disregarded.

At an interworking exchange where the incoming circuit is not CCS7 supported but the outgoing circuit is, completion of the transmission path is delayed for a data call until the receipt of an ANM. Unless, an ACM with “interworking encountered” or “user-network interaction” indication causes cut-through of the transmission path, or a previous CPG has already triggered the cut-through. The path is cut through at the interworking exchange upon the receipt of an ACM, regardless of its coding, for a 3.1-kHz audio or speech call.

Continued on next page

Call Flow of Additional Features, Continued

Handling Confusion Messages Feature (#157)

The purpose of generating a CFN message is to indicate to a sending switch that it sent a message that was not recognized by a receiving *4ESS* Switch. A CFN message is generated when a *4ESS* Switch receives an unrecognized message, but a confusion message is not generated when the switch receives unrecognized parameters or parameter values. A CFN message can be sent either in the forward or backward direction, but it can never be relayed at an access tandem switch. Also, a CFN message is never sent in response to a received CFN message.

If a CFN message needs to be sent, the sending is controlled by a new trunk block bit, Send Confusion (SCFN). For End Office or Tandem Connecting (ETC), Other Carrier Connecting (OCC), or Local Carrier Connecting (LCC) trunks, the default for SCFN is set to allow the sending of CFN messages. For other types of trunks, the default for SCFN indicates not to send a CFN message. The unrecognized message is always discarded at the receiving switch.

The definition of "unrecognized" includes all messages that are not implemented plus all network specific messages at the LEC or AT&T Network Interconnect (NI) boundary. The network specific messages are those messages encoded with 1111 in the upper bits of the message type octet.

The CFN message includes the cause indicators' parameters with a cause value of "message type nonexistent or not implemented" (value 97), and location of "local network" (value 0010), followed by a diagnostic field containing the message type code of the received message. For a LCC type of trunk, location is set to "transit network" (value 0011). The priority of CFN in the message transfer part service information octet is set to 1. When a CFN message is sent or received, two new office counts are pegged. These are scheduled on an hourly report.

Continued on next page

Call Flow of Additional Features, Continued

Routing Based on Speech and 3.1-kHz Bearer Capability Feature (#158)

A new field in the Call Register is used to determine routing when the manual subsequent digit treatment is V31K.

This field is initialized for all calls to indicate “3.1 kHz” (value = 0). The ISUP incoming trunk handler sets this new field to indicate “speech” when the information transfer capability field in the Bearer Capability parameter indicates “speech.”

With this feature, the ISUP outgoing trunk handler populates the information transfer capability in the Bearer Capability parameter based on the following options:

- If the incoming trunk is multifrequency, and the call is a voice call, the information transfer capability is set to “3.1 kHz.”
- If the incoming trunk is ISUP, then it copies the information transfer capability received on the incoming trunk to the information transfer capability sent on the outgoing trunk.

When routing the call, if a manual subsequent digit treatment of V31K is encountered by translations, the call is routed based on the new Call Register field that indicates that the call is a speech or 3.1-kHz call. All 3-digit translation routines handles the new manual subsequent digit type of V31K.

Chapter 4 Provisioning

Overview

Introduction

The purpose of this chapter is to provide the information necessary to provision the SS7 Network on the *4ESS*™ Switch.

Integrated Services Digital Network–User Part (ISUP) signaling can initiate, set up, supervise, and disconnect basic interoffice Signaling System 7 (SS7) calls. This is accomplished by sending and receiving signaling messages through the SS7 network (Figure 4-1).

Data Requirements

The ISUP signaling messages are circuit-related and provide information that puts SS7 trunks into valid states for call processing and trunk maintenance. Successful execution of call processing and trunk maintenance functions requires certain elements of the SS7 trunk-related data be consistent among connecting switches in the Local Exchange Carrier (LEC) network.

In addition, routing of circuit-related signaling messages requires consistency throughout the network for some key switches and Common Network Interface (CNI) data values. This includes Point Code (PC), Trunk Circuit Identification Code (TCIC), Common Language* CLLI code, Voice Path Assurance (VPA) Type and Rate, Frequency of Testing, Glare Control, Hunt Direction, Link Data, Cluster Data, and Selected Timers.

Example

An example of a LEC network configuration using Lucent Technologies products is shown in Figure 4-1. This example and associated data are used throughout this chapter.

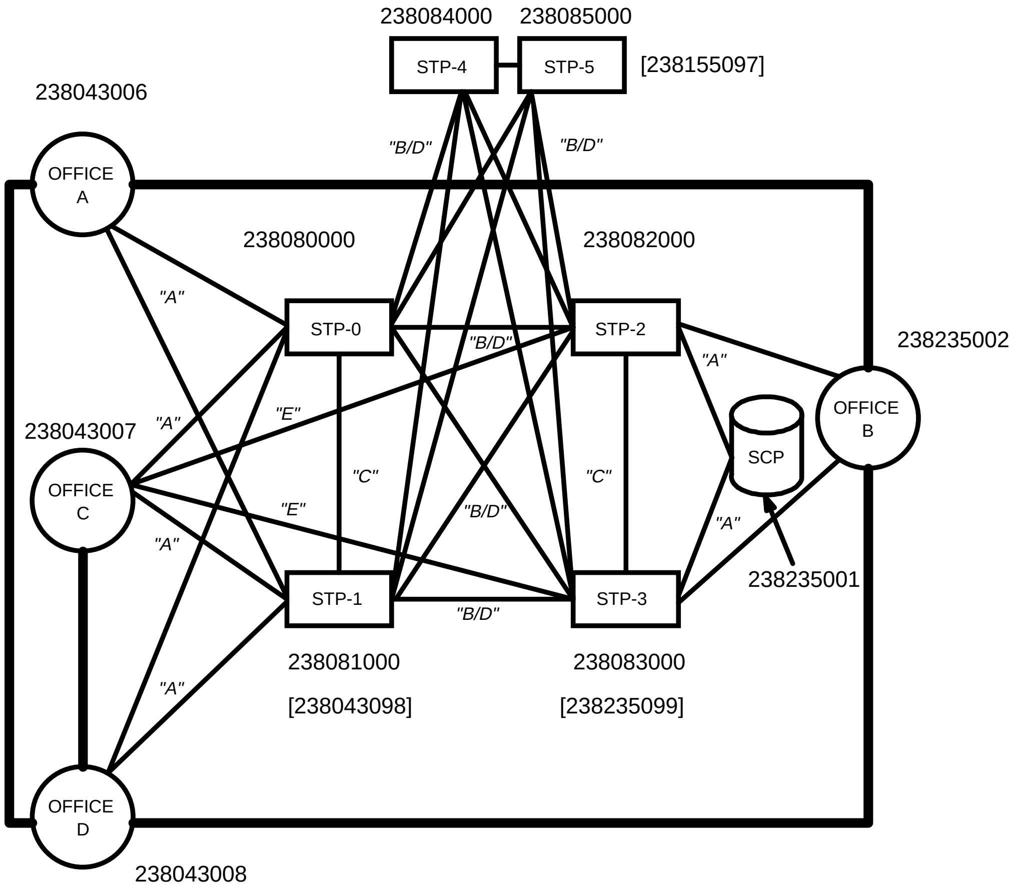
Continued on next page

* Common Language is a registered trademark and CLEI, CLLI, CLCI, and CLFI are trademarks of Bell Communications Research, Inc.

Overview, Continued

Figure 4-1. Sample LEC Network Configuration

Following is an example of a LEC Network Configuration.



"B/D" links may be called "B" or "D" links as locally preferred.

KEY

Office A = 1A ESS™ Switch	"C" = Cross Links
Office B = 4ESS™ Switch	"D" = Diagonal Links
Office C = 5ESS® Switch	"E" = Extended Access Links
Office D = Other Vendor Switch	(thin line) SS7 Links
"A" = Access Links	(thick line) Voice and Data Trunks
"B" = Bridge Links	[ ] Capability Code For Mated Pairs

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Overview, Continued

Network Impact on CNI Lucent Technologies Switch Products

Much of the data applicable to Per-Trunk Signaling (PTS) is still valid for ISUP. However, the introduction of the SS7 has resulted in the development of some new translation structures and requires population of these translation structures with information that affects network functionality.

For example, CNI data relates to functions provided by the CNI ring. It is separate from office specific data stored in the switch. In a *4ESS* Switch, CNI data resides in an Attached Processor System (APS).

The functionality of the SS7 network-based features depends on both the existence and consistency of key office and CNI data, as well as STP data values. The following sections identify these data elements and explain from the network perspective the usage of the data and how the items should be populated.

A summary of the required Recent Change (RC) views/functions is shown in Table 4-A and Table 4-B. The “Office” data type relates to the trunks and the “CNI” data type relates to the signaling links.

Table 4-A

The following table contains Recent Change Views/ Functions for Consistent ISUP Data.

Consistency Item	Data Type	***4ESS* Switch**
Point Codes Trunk Circuit Ident. Code (TCIC)	Office Office	RC: TSG RC: TRK RC: TSG RC: TRK
CLLI* Code	Office	RC:TSG RC:TRK
VPA	Office	RC:TRK RC:TSG
Glare	Office	RC:TSG
Hunt Direction	Office	RC:TSG
* Common Language is a registered trademark and CLEI, CLLI, CLCI, and CLFI are trademarks of Bell Communications Research Inc.		

Continued on next page

Overview, Continued

Table 4-B

The following table contains Recent Change Views/ Functions for Signaling Data.

Consistency Item	Data Type	*4ESS* Switch
Point Codes	CNI	OFDATA LKDATA
CLLI Code	CNI	OFDATA LKDATA
Cluster Data	CNI	CLSROUT* ROUTE**
Link Data	CNI	LKDATA
* Only for cluster routing ** For Alternate e-links		

Elements of an SS7 Network

SS7 Network

A SS7 network allows signaling information to be transmitted between Signaling Points (SPs). For example, between the *4ESS* Switch and other Lucent Technologies switches and Signaling Transfer Points (STPs), and other vendor switches. This signaling information controls basic interswitch calls and handles calling features such as Service Switching Point (SSP) 800 Service.

Note:
For the purposes of this document, the terms “switch” and “switching system” include the SS7-related functions provided by the CNI.

Signaling Links

The transmission of signaling messages is accomplished via digital Signaling Links (SLKs) which are separate from the channels over which voice and data communications are transmitted. These signaling messages can originate from a Lucent Technologies switch using a CNI to provide access to the SS7 signaling network.

Messages are routed over SLKs to an STP. The STP, acting as a specialized packet switch, routes signaling messages to outgoing SLKs based on DPC. From there, they are routed to a Signaling Processor (SP), another switch, another STP, or a Service Control Point (SCP).

The SCP is a centralized data base that provides special call routing instructions needed for some SS7-based features.

Note:
This section is only an introduction to SS7 Networks and does not include all possible options for using SS7 signaling. For a detailed specification of SS7, refer to TR-NWT-000246, Bell Communications Research Specifications of Signaling System Number 7.

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Elements of an SS7 Network, Continued

STPs

As Illustrated in Figure 4-1, STPs are engineered in mated pairs. “A” (Access) links connect switches to each STP of a local (home) pair. Communication and routing between a mated pair occur via “C” (Cross) links. The mated pair concept provides reliability in the network; if one STP fails, the other is capable of handling all the traffic routed to the pair.

Engineering of links from the switches to each of the STPs also allows a switch to continue signaling should an STP become inaccessible. The STPs can also process Global Title Translation (GTT) requests and handle low level link and link-routing SS7 messages.

Mated Pairs

Frequently, a LEC network is configured using a multiple pair arrangement of STPs. Here, local and remote mated pairs perform routing functions. “B” (Bridge) or “D” (Diagonal) links connect the mated pairs (see Note).

The LECs with hierarchical networks interconnect local STPs to regional STPs with “D” links. “E” (Extended Access) links connect a Lucent Technologies switch to each STP of a Remote pair to provide additional network reliability. Pairs of STPs of the same level are interconnected with “B” links. The “A”, “B”, “C”, “D”, and “E” links transfer data at a rate of 56 kbps.

Note:
LECs with hierarchical networks interconnect local STPs to regional STPs with “D” links. Pairs of STPs of the same level are interconnected with “B” links.

Point Code Assignments

Definition and Use in the SS7 Network

Point Codes (PCs) are the means by which signaling points in the SS7 network are uniquely identified. These signaling points could be switches, Signaling Transfer Points (STPs), Service Control Points (SCPs), and so forth. The PCs provide the address information (for example, identification of originating and terminating point) that is used to route signaling messages throughout the network. Each switch stores Point Code data in its respective translation structures to identify the far-end offices to which its SS7 trunk facilities are connected. (All SS7 network nodes require Point Code data for signaling routing.) Because of these critical roles, LECs must ensure that Point Code assignments are both correct and unique within their network.

ANSI Bellcore Convention

While there are several standards for Point Code format, LECs should use the American National Standards Institute (ANSI) Bellcore convention. For further information on this requirement, refer to TR-NWT-000246, Bell Communications Research Specifications of Signaling System Number 7. Each Point Code is a 9-digit representation having three subfields:

- 3-digit network identifier
- 3-digit cluster number
- 3-digit cluster member number.

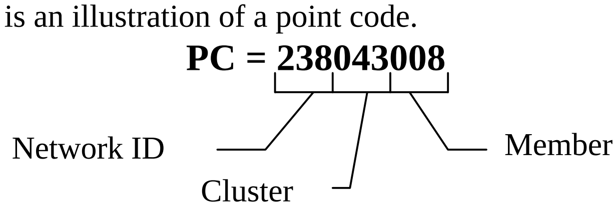
In a *4ESS* Switch, enter ANSI as the PC format on RC-TSG Forms.

Network Identifier

The Network Identifier (NID) is assigned by the network administrator (Bellcore). In large networks, both the Cluster and Cluster Member numbers are assigned by the LEC network signaling administrator. In small networks, the Cluster number is assigned by Bellcore. An example of a 9-digit Point Code is shown in Figure 4-2.

Figure 4-2. Point Code Example

The following is an illustration of a point code.



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Point Code Assignments, Continued

Other Point Code Data

In addition to NID, Cluster, and Cluster Member, several other terms are used when populating Point Code data. Near-end, local, and originating are terms often used synonymously when referencing the "Home" switch or local signaling point. Similarly, far-end, destination, and terminating are three terms used when referencing a connecting switch or signaling point.

Sources of Point Code Information

Point Code information is stored in SS7 translation data structures. For the *4ESS* Switch, the far-end PCs are assigned on a trunk subgroup basis. However, all trunk subgroups to the same switch must have the same PC.

Point Code information is also stored in the CNI data bases, as well as in data bases of other Network Elements (for example, TPs and SCPs). To provide signaling message routing, CNI Point Code data identifies:

- the specific LEC network involved.
- the local signaling point (switch or STP).
- the signaling point at the far-end of the SLKs (that is, the PCs of the local STPs.

When populating PC data, refer to Table 4-A for a summary of the recent changes.

Continued on next page

Point Code Assignments, Continued

Requirements for Populating Point Code Data

Besides adhering to the ANSI format convention, LECs need to adhere to the following requirements when populating Point Code information:

1. The Point Code that other network signaling points use to reference a given switch, STP, or SCP must agree with the Point Code that the given switch, STP, or SCP uses to identify itself. Capability codes for STPs are an exception to this rule.

2. The value of the NID, as assigned by Bellcore, must fall within the range of 3001 to 254 to be valid. However, the assigned value is indicative of the network type. Small networks use NID 001 through 004; large networks use the range 006 through 254. NID 005 is reserved for Point Code blocks.

3. For large networks, the value of the Cluster number must fall within the range of 3000 to 255. For small networks, the valid range is 3001 to 255 as assigned by Bellcore.

4. The value of the Cluster Member number must fall within the range 000 to 255. Other network elements must be assigned a nonzero value for Cluster Members.

Table 4-C

This table shows an example of populating Point Code values for ISUP routing in the sample LEC network configuration shown in Figure 4-1.

Signaling Point	Local PC	PCs in SS7 Trunk Translations	PCs in CNI Data Base
Office B *4ESS* Switch	238235002	Office D = 238040008 Office A = 238043006	NID = 238 Far End PCs: 238082000

Common Language Location Identification Code Assignments

Definition and Use in SS7 Network

The CLLI codes are similar to Point Codes in that they are used as a means to uniquely identify switches, STPs, and SCPs in the network. However, unlike Point Codes, CLLI codes are not used for routing signaling messages. Instead, they provide a mnemonic identification of switches and signaling points that is particularly useful in reports and in trunk diagnostics.

Each CLLI code is assigned by the network administrator and consists of an 11-character field. The character field is divided into four subfields as shown below. The first four characters represent the city or place, the next two characters identify the state, the next two characters represent the building identifier, and the last three characters represent the company or building subdivision. The Place and State must be alphabetic while the Building and Subdivision can be alphanumeric. The CLLI code format is described in greater detail in 795-100-100, CLLI Code Description.

The CLLI code field must be populated; companies that do not usually use the CLLI code concept must choose a reasonable 11-character value for the field.

The term near-end CLLI code is synonymous with local CLLI code. Likewise, the term far-end CLLI code is synonymous with far CLLI code.

Sources of CLLI Code Information

For the *4ESS* Switch, the far-end CLLI code for trunks is stored in translation structures as part of the Circuit Identification Number (CIN). The CIN of a SS7 trunk circuit is verified as part of the ISUP circuit validation test.

When populating CLLI code data, refer to Table 4-A for a summary of the recent changes.

Continued on next page

Common Language Location Identification Code Assignments, Continued

Requirements for Populating CLLI Code Values

In addition to adhering to the format conventions specified for the CLLI code, the CLLI code that a given switch, STP, or SCP uses to identify itself is to agree with the CLLI code that other signaling points in the network use to reference a particular switch, STP, or SCP. Changes to CLLI codes are not to be made arbitrarily.

The CLLI codes must always be the CLLI code of the actual network element (switch, STP, or SCP) and not the CLLI code of other elements in the network (for example, Point of Presence).

Special Considerations

A *4ESS* Switch trunk group, which consists of all the trunks between the *4ESS* Switch and a connecting switch, is defined by its CIN. The CIN in turn is based on the CLLI codes of the two connecting switches.

Note that there is only one Point Code allowed for a CIN. Multiple CLLI codes for a subdivision of trunks to the same Point Code cause recent change failures when building trunk subgroups.

Link and Linkset Data

Signaling Data Link

A Signaling Link (SLK) is a 56-kbps data link that connects two signaling points in an SS7 network for the purpose of SS7 signaling.

Because ISUP signaling messages are routed from a switch over an SLK to an STP, then from the STP over another SLK to another switch or STP, link information must be defined in the switches and STPs data bases.

Data Consistency

Successful routing and link operation require that link data between the switch and STP agree. Specifically, data consistency is required in eight data elements:

1. **Linkset and Combined Linkset** —A signaling Linkset (LS) consists of all SS7 SLKs between two particular signaling points. For example, all SLKs between a switch and an STP are assigned a single LS. The LS is an arbitrary unique number at the signaling point, but not unique in the network.

   The term Combined Linkset (CLS) refers to all the SS7 SLKs from switch to the local pair of STPs or all the SS7 SLKs from an STP to another pair of STPs. All the signaling links from a switch to the local STP must have the same CLS value. The CLS value is unique to a signaling point, but is not unique in the network.

   The *4ESS* Switch uses a numerical value in the range of **1-255** to identify LSs and the CLS.

2. **Point Codes —** The ANSI Point Codes are used to define the signaling points at the near-end and far-end of each SLK. The far-end Point Codes must agree with the locally specified values. For the specific requirements, refer to the "Point Code Assignments" in this chapter.

3. **CLLI Codes —** Similar to Point Codes, CLLI codes are mnemonic identifiers of the signaling points at the end of an SLK. The far-end CLLI codes must agree with the locally specified values. For the specific requirements, refer to the "CLLI Code Assignments" in this chapter.

Continued on next page

Link and Linkset Data, Continued

Data Consistency, Continued

4. **Signaling Link Code** (SLC) — The signaling link code is a numeric value that a signaling point assigns each SLK within an SS7 linkset. Link information resides in each CNI data base.

   Each SLK has a unique SLC within its linkset, while the SLC value assigned to the SLK at the near-end switch must agree with the SLC value assigned at the far-end STP. The identification of the linkset is different.

5. **Link Type** — Link type defines which of the valid types of SLKs is used between the near-end and far-end entities.

6. **Link Speed** — Link speed identifies the rate at which signaling messages are sent over the SLK. CNI supports 56 kbps for SS7 signaling.

7. **Encryption** — This option identifies whether or not the SLK encrypts (codes) signaling messages. A special link interface pack is required. However, the LEC network does not use this feature. Therefore, the encryption field should be set to a nonencrypted value (refer to Table 4-D).

8. **STP Even/Odd Indications** — The *4ESS* Switch internally makes the even/odd association based on the value of the cluster field of the STPs. This implies that the STPs adjacent to the *4ESS* Switch must have even or odd cluster assignments.

Valid LEC values for the Linkset/Combination Linkset, SLC, Link Type, Link Speed, and Encryption are shown in Table 4-D.

Table 4-D

This table contains Link/Linkset Data.

Data Item	*4ESS* Switch
Linkset	1-255
Signaling Link Code (LS Member)	0-15
Link Type (refer to Table 4-E)	A,E
Link Speed	56000
Encryption	NO

Continued on next page

Link and Linkset Data, Continued

Link Type Value Definition

The link type field is populated on the types of signaling points at both ends of the link, as shown in Table 4-E.

Table 4-E

This table contains Link Type to Signaling Point data.

Signaling Points at Each End	Link Type
A switch and a local STP	A
An STP and an SCP	A
A Local STP and a Local STP (Nonmated)	B
Mated STPs	C
A Local STP and Regional STP	D
Gateway STP to Gateway STP	D
A switch and a nonlocal STP	E

Verifying Data

Activation of an SLK verifies the SLC, Origination Point Code, Destination Point Code, Link Speed, and Encryption. It does not verify the CLLI code or Link Type.

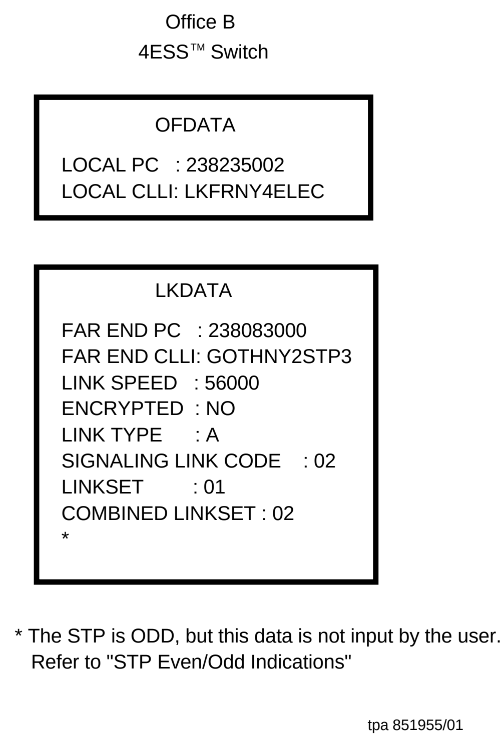
Figure 4-3 shows some of the required link node data. The network shown in Figure 4-1 is used as an example. The remaining data is entered in a like manner.

Continued on next page

Link and Linkset Data, Continued

Figure 4-3. Example for Populating Link Node Data

Following is an example for Populating Link Node Data.



Cluster Data

Definition and Use in the SS7 Network

The signaling message routing capability of SS7 requires that cluster information be populated in the CNI data base for each cluster of (destination) signaling points in a given LEC network. It is this cluster data that provides the broad definition of how the network is configured to the CNI.

Specific to ISUP functionality, cluster data (the middle 3-digit subfield of the Point Code) must exist for each of the switches to which ISUP messages are routed, as well as for the local STPs that act as the transfer points for the messages.

The local CNI uses the cluster information to verify that ISUP messages are destined for a valid cluster and to select the appropriate outgoing linkset. The ISUP does not require knowledge of capability codes, nonlocal STPs, or STP clusters.

Sources of Cluster Data

Each CNI has a function or view that contains cluster information. When populating CNI cluster routing data, refer to Table 4-B for a summary of recent changes.

Continued on next page

Cluster Data, Continued

Switch Requirements for Populating Cluster Data

There are several considerations in assigning cluster values for ISUP signaling:

1. Cluster fields must be populated for each local STP. This cluster value must agree with the cluster subfield within the far-end STPs own local Point Code.

2. A cluster field is to be populated for the local switch.

3. Cluster fields must be populated for each switch where ISUP messages are to be routed.

4. The cluster value of a far-end switch is stored both in CNI data and as a part of the far end PC in the trunk translation data structures. These two cluster fields must be the same for a given far-end switch. This Point Code value must also agree with the far-end switch's own local Point Code.

Cluster tables are populated only once for a unique cluster value. If two far-end switches are located in the same cluster (the cluster values are equal), only one view/function must be populated.

Continued on next page

Cluster Data, Continued

Figure 4-4. Example For Populating Switch Cluster Data (Without ALSR and E Links)

Figures 4-4 and 4-5 show the cluster information required in the switches of the example network shown earlier in Figure 4-1. The following is an example for populating switch cluster data (without ALSR and E Links).

Office B
4ESS™ Switch

ROUTE	
NETWORK ID	238
CLUSTER ID	082
ROUTING FLAG	UPOPCLU
PRIMARY ROUTE	1
ALT 1 ROUTE	2
ALT 2 ROUTE	-

ROUTE	
NETWORK ID	238
CLUSTER	083
ROUTING FLAG	UPOPCLU
PRIMARY ROUTE	2
ALT 1 ROUTE	1
ALT 2 ROUTE	-

ROUTE	
NETWORK ID	238
CLUSTER	043
ROUTING FLAG	POPCLU
PRIMARY ROUTE	3

ROUTE	
NETWORK ID	238
CLUSTER	080
ROUTING FLAG	UPOPCLU
PRIMARY ROUTE	3

ROUTE	
NETWORK ID	238
CLUSTER	081
ROUTING FLAG	UPOPCLU
PRIMARY ROUTE	3

ROUTE	
NETWORK ID	238
CLUSTER	235
ROUTING FLAG	POPCLU
PRIMARY ROUTE	3

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Continued on next page

Cluster Data, Continued

Figure 4-5. Example For Populating Switch Cluster Data (With ALSR and E Links)

The following is an example for populating switch cluster data (with ALSR and E Links).

Office B
4ESS™ Switch

ROUTE	
NETWORK ID	238
CLUSTER ID	082
ROUTING FLAG	UPOPCLU
PRIMARY ROUTE	1
ALT 1 ROUTE	2
ALT 2 ROUTE	-

ROUTE	
NETWORK ID	238
CLUSTER	083
ROUTING FLAG	UPOPCLU
PRIMARY ROUTE	2
ALT 1 ROUTE	1
ALT 2 ROUTE	-

ROUTE	
NETWORK ID	238
CLUSTER	043
ROUTING FLAG	POPCLU
PRIMARY ROUTE	3

ROUTE	
NETWORK ID	238
CLUSTER	080
ROUTING FLAG	UPOPCLU
PRIMARY ROUTE	3

ROUTE	
NETWORK ID	238
CLUSTER	081
ROUTING FLAG	UPOPCLU
PRIMARY ROUTE	3

ROUTE	
NETWORK ID	238
CLUSTER	235
ROUTING FLAG	POPCLU
PRIMARY ROUTE	3

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Miscellaneous Consistency Considerations

Protocol Timer and Parameter Settings

Recent change modifications to CNI timer and parameter settings are to be made with caution. Changes to these values in translation structures can have significant impact on SS7 performance. This affects both STPs and other switches in the network. Adherence to the timer and parameter requirements specified in TR-NWT-000246, Bell Communication Research Specification of Signaling System Number 7, is recommended.

A summary of the default values for CNI timer and threshold settings is provided in Tables 4-F, 4-G, and 4-H.

The information concerning protocol timer and parameter settings, contained herein, may be found in *4ESS Switch TG-4 Translation Guide*, Division 12.

Continued on next page

Miscellaneous Consistency Considerations, Continued

Tables 4-F This table shows Lucent Technologies Recommended LEC Timer Settings.

Timer	Description	Setting (Seconds)
Q703-T1	Aligned/Ready condition	13.0
Q703-T2	Out-of-alignment status	11.5
Q703-T3	Aligned condition	11.5
Q703-T4N	Normal proving period	2.3
Q703-T4E	Emergency proving period	0.6
Q703-T5	Busy status transmission	0.08
Q703-T6	Supervision of busy state	3.0
Q703-T7	Excessive delay of acknowledgment	1.0
TS	Signaling Unit Error Rate Monitors (SUERM)* Threshold	64 (errors/sec.)
Q704-T1	Transmission delay following changeover	1.0
Q704-T2	Changeover acknowledgment	1.0
Q704-T3	Transmission delay following change back	1.0
Q704-T4	First attempt Change Back Acknowledgment (CBA)	1.0
Q704-T5	Subsequent attempts CBA	1.0
Q704-T6	Controlled rerouting transmission delay	1.0
Q704-T10	Wait to repeat Signaling Route Set Test (SRST) message	30.0
Q704-T12	Uninhibit acknowledgment	1.0
Q704-T13	Forced uninhibit acknowledgment	1.0
Q704-T14	Inhibit acknowledgment	3.0
Q704-T15	Transfer-controlled update	3.0
Q704-T16	Signaling-route-set congestion	1.4

* This is not a timer, but a timed-event counter.

Note:
Many of these timers may be set for one link, one linkset, or all linksets (office level).

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Miscellaneous Consistency Considerations, Continued

Table 4-G This table shows Lucent Technologies Recommended LEC Timer Settings.

Timer	Description	Setting (Seconds)
Q704-T17	Restart of initial alignment	1.0
Q704-T19	Timeout for attempting link activation	480.0
Q704-T20	Waiting to repeat local inhibit test	120.0
Q704-T21	Waiting to repeat remote inhibit test	120.0
Q707-T1 Q707-T2	Supervision timer for signaling link test acknowledge message Sending Signaling test message interval	10.0 (≥Q704-T6) 30.0
Q714-TSST	Delay between requests for subsystem status	30.0
Q714-TSOG	Waiting for grant for subsystem to go Out-of-Service (OOS)	30.0
Q714-TIGSST	Delay for subsystem between receiving grant for OOS and actually going OOS	30.0
Q714-TSRT	Interval between requests for subsystem routing status information	30.0
Note: These timers may be set on the basis of one or more of the following: one link, one linkset, or all linksests (office level).		

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Miscellaneous Consistency Considerations, Continued

Table 4-H This table shows Lucent Technologies Linkset Threshold Settings (CNI Congestion).

Thresholds*	Descriptions	Settings Bytes
cc_abt1†	Link Transmit Buffer Control-Abatement Threshold Level 1	820
cc_ths1†	Link Transmit Buffer Control-Onset Threshold Level 1	3072
cc_dis1†	Link Transmit Buffer Control-Discard Threshold Level 1	6042
cc_abt2†	Link Transmit Buffer Control-Abatement Threshold Level 2	7680
cc_ths2†	Link Transmit Buffer Control-Onset Threshold Level 2	8295
cc_dis2†	Link Transmit Buffer Control-Discard Threshold Level 2	10855
cc_abt3†	Link Transmit Buffer Control-Abatement Threshold Level 3	10855
cc_ths3†	Link Transmit Buffer Control-Onset Threshold Level 3	10956
cc_dis3†	Link Transmit Buffer Control-Discard Threshold Level 3	11571
* These thresholds may be set for one linkset or all linksets (office level). † The congestion threshold values (for abt_, ths_, dis_) are interdependent. Changes to one **MUST** be coordinated with the values, or changes to the values, of the others in the same level.		

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Miscellaneous Consistency Considerations, Continued

Switch Routing Limit Table

Five parameters (and values) set the limits for both Intranetwork and Internetwork SPs. The values are determined by the CNI; however, the values are set by the SP application and cannot be changed. These five values are shown in Table 4-I, for your information.

Table 4-I

This table contains Intranetwork and Internetwork Values.

# Define	***4ESS* Switch**
NDIRMAX	24
LPCLUMAX	128
NPCLUMAX	384
LPCMIN	231
NPCMIN	2769

Switch Routing Limits

The switch routing limits are defined as:

- Maximum Network (NDIRMAX)—The maximum number of Network Identifications (other than the local network) that can be defined on a per switch basis.
- Local Populated Cluster Maximum (LPCLUMAX)— The maximum number of clusters that can be assigned to remote routing (RPOPC) in the local network.
- Nonlocal Populated Cluster Maximum (NPCLUMAX) —The maximum number of clusters that can be assigned to remote routing (RPOPC) in all networks other than the local network (switch).
- Local Abnormal Members (LPCMIN)—The minimum number of members whose routing status can be concurrently maintained for the local network.
- Nonlocal Abnormal Members (NPCMIN)— The minimum number of members whose routing status can be concurrently maintained for all networks.

Trunk Circuit Identification Code Assignments

TCIC Assignments — Definition and Use in the SS7 Network

A Trunk Circuit Identification Code (TCIC) is a numeric value assigned to an SS7 trunk. Each trunk is uniquely identified by its TCIC and Point Code combination (Originating and Destination). In order for connecting switches to establish a voice path or run end-to-end trunk tests, it is critical that agreement exists on how the trunk is to be identified. The TCIC assignment must be identical in both offices for a given trunk circuit.

It is also important to note that TCIC assignment indirectly affects distribution of signaling message traffic over the SLKs. The TCIC assignment determines (via an algorithm) the value in the Signaling Link Select (SLS) field in the Message Transfer Part (MTP) routing label. The SLS field is used for determining load sharing between the signaling links in a linkset.

Sources of Trunk Circuit Identification Code Information

The TCIC information is stored in trunk translation structures on a per-trunk basis. When populating TCIC code data, refer to Table 4-A for a summary of the recent changes.

Requirements When One Connecting Switch Is a *4ESS* Switch

The *4ESS* Switch uses the Traffic Number to define the TCIC value. Offices connecting to a *4ESS* Switch must assign TCIC values to agree with the *4ESS* Switch assignment of traffic numbers.

Special Considerations

Do not leave gaps in TCIC assignments (that is, unassigned TCICs) in anticipation of facility or trunk group growth. When assigning TCICs, the valid trunk Circuit identification code range is 0 - 9999.

Note:
For the *4ESS* Switch, all TCICs in the range of 30 - 9999 are available; however, there is a convention used by the *4ESS* Switch Administrator that does not use TCICs ending in 97 to 100. There is nothing in the software or rules that enforces this convention.

Trunk Provisioning

Provisioning SS7 ISUP Trunks

To provision SS7 ISUP trunks the switch must first have an operational CNI ring. CNI routing data also must be entered for each Network Identifier and cluster of a switch to which the SS7 ISUP trunks are provisioned.

Note:
Although provisioning is separated in this section by function, the reader must not fall into the trap of addressing only one or two. The following functions must all be addressed when provisioning:

- **Basic Trunk Signaling**
- **Glare**
- **Voice Path Assurance**
- **VPA/Continuity Check Circuits**
- **Trunk Hunting**
- **Circuit Query**
- **Trunk Translation Test/Audit.**

Basic Trunk Signaling

The following section identifies the basic trunk signaling data that must be addressed for the *4ESS* Switch.

Table 4-J

Use recent change message **RC:TSG** to change trunk subgroup information. The following table identifies important fields for SS7 ISUP trunks.

Keyword	Description
PCF	This field specifies the Destination Point Code format. Recommended format is ``ANSI" for LEC switches.
DPC	This field specifies the Destination Point Code of the far-end switch.
TSG	This field identifies the particular trunk subgroup. It is comprised of the TCIC and Common Language CLLI code associated with the far-end switch.
TOT	This field specifies the type of SS7 trunk defined. Acceptable values include “ETC” (meaning End Office or Tandem Office Connecting trunk) or “OCC” (meaning Other Carrier Connecting trunk).
ISC	This field identifies the Incoming Signaling Characteristics. For SS7 2-way and 1-way incoming trunks, set to “ISUP”.
OSC	This field identifies the Outgoing Signaling Characteristics. For SS7 2-way and 1-way outgoing trunks, set to “ISUP”.

Continued on next page

Trunk Provisioning, Continued

Recent Change

Recent change message **RC:TRK** is used to add/change individual trunk characteristics. A field of particular importance for SS7 ISUP trunks is identified in Table 4-K.

Table 4-K

The following table contains recent change messages.

Keyboard	Description
FTFN	This field specifies the First Traffic Number of the far-end switch. The TCIC assigned to the same trunk at the far-end must be the same as the traffic number at the switch.

Glare

Glare is a condition that occurs when two connecting switches hunt and seize the same 2-way trunk simultaneously. In the event a glare condition occurs, both switches must know which one has control over the trunk. The glare parameters in the switches make this determination.

The glare parameters to be populated in the two switches are to be coordinated. Previously, glare was normally resolved with the higher numerical) Point Code switch controlling trunks with even trunk circuit identification codes (Odd/Even Rule). New additional options exist to control “all” or “none” of the trunk circuit identification codes. (Refer to the following paragraph and Tables 4L and 4M).

Glare settings are made on a trunk subgroup basis in the *4ESS* Switch. Table 4-L summarizes the necessary recent changes for populating glare data.

Requirements for treatment of glare are specified in TR-NWT-000317, Switch System Requirements for Call Control Using the Integrated Services Digital Network User Part, Bell Communications Research Specification of Signaling System 7. To comply with glare control based on the “Odd/Even” or the “All or None” Rules, refer to Table 4-L.

Continued on next page

Trunk Provisioning, Continued

Glare Control Input Requirements

For 1-way trunk groups, glare settings are not normally needed. For CVT Test purposes, outgoing trunks are all control; incoming trunks are non-control.

Table 4-L

The following table contains glare control based on the “Odd/Even” or the “All or None” Rules.

Office	Glare	Input Requirements
4ESS Switch	Odd/Even	If the near-end PC is lower, set GLARE = “O”. If the near-end PC is higher, set GLARE = “E”.
	All	GLARE = “A”
	None	GLARE = “N”

Note:
In the *4ESS* Switch, the data administrator must determine whether the near-end PC is higher or lower than the far-end PC using ANSI standard PC format.

Voice Path Assurance

Because SS7 does not signal through actual trunk circuits, Voice Path Assurance (VPA) tests are needed to ensure that transmission through the voice path is acceptable. Requirements for acceptable transmission are specified in TR-NWT-000317, Switch System Requirements for Call Control Using the Integrated Services Digital Network User Part (ISDN-UP), and TR-NWT-000246, Bell Communications Research Specifications of Signaling System 7. VPA tests, also called Continuity Checks, are initiated by the originating switch (which may be the local switch or a connecting switch) either manually or on a per-call basis.

Two data elements are associated with VPA: the VPA type and the VPA rate. The VPA type reflects the type of connecting (far-end) switch. The continuity tone frequency that is sent and detected is determined by the VPA type. Four-wire switches, such as the *4ESS* Switch, can detect a 2,010-Hz (± 8 Hz) tone and can send either a 1,780-Hz (± 30 Hz) or 2,010-Hz (±- 8 Hz) tone as shown in Table 4-M.

Two-wire switches (for example, a 1A ESS™ Switch or a 5ESS® Switch emulating a 2-wire switch) can send and receive both tones. Since LEC networks can be configured with both types of switches (2-wire and 4-wire), there are four possible VPA type combinations.

Continued on next page

Trunk Provisioning, Continued

Table 4-M

The following table contains VPA Test Frequencies for 2-Wire and 4-Wire Switches.

Near-End Switch	Far-End Switch	
	2-Wire	**4-Wire**
2-Wire	2,010 Hz sent 1,780 Hz returned	2,010 Hz sent, 1,780 Hz returned
4-Wire	1,780 Hz sent 2,010 Hz returned	2,010 Hz sent 2,010 Hz returned

VPA Rate

The VPA rate reflects the percentage of time VPA tests are required on a per-call basis. Normally, an interoffice SS7 call sends an Initial Address Message (IAM) to the connecting switch announcing a new call is being attempted. An indicator (bits DC of the nature-of-connection indicators parameter) in this IAM message requests that the far-end switch perform a VPA test on the trunk facility before call setup to ensure it is suitable for voice transmission.

The continuity tests are handled by special VPA test circuits. Because the tests require an available VPA test circuit and the need for VPA tests is dependent on the type of trunk facility, each switch offers options for the VPA rate (these options are described later in this chapter). The VPA test is allowed 2 seconds to succeed; if the test does not pass within 2 seconds, time-out (failure) will occur.

The VPA test circuits must be engineered to handle the combined usage for outgoing and incoming VPA tests. Outgoing VPA tests are based on the VPA rate of the local switch; incoming VPA tests are controlled by the connecting switch. Thus, the VPA rate also affects VPA test circuit usage in connecting switches.

***4ESS* Switch / VPA Data Specifics**

The VPA type in the *4ESS* Switch is populated on the trunk subgroup and rated on a trunk member basis. Table 4-N lists the RC input messages and their corresponding fields used to populate VPA data.

Continued on next page

Trunk Provisioning, Continued

Table 4-N The following table contains RC Messages for Populating VPA Data.

Keyword	Message	Description
RC:TRK	VCR	This field specifies the **cancellation rate** of the VPA test. This is the percentage of time VPA tests are canceled (that is, not requested) on a per-call basis. Valid entries are 100, 87, 50, or 0.
RC:TSG	XCPA	This field corresponds to the transceiver pad adjustment. Valid entries are 0, 1, 2, or 3. The correct entry is determined by comparing the highest ICL value assigned to a trunk in the Trunk Subgroup. DIGIT ICL APPLICATION PAD 0 0 loss trunk 5 dB 1 0.1 to 0.8 loss 3.5 dB 2 0.9 to 1.7 loss 1.8 dB 3 1.8 to 4.1 loss 0 dB
RC:TSG	CCIS2WIRE	This field corresponds to whether the far-end switch is a 2-wire or 4-wire switch. If the far-end switch is 2-wire, set this field to “Y”. If the far-end switch is 4-wire, set this field to “N”.

Guidelines for Populating VPA Data

VPA Type
When the far-end switch is a *4ESS* Switch, the VPA type must be 4-wire.

VPA Rate
To set specific VPA rates for SS7 trunk facilities, each switch must consider the trade-off between:

- the cost of the VPA test circuit and the additional time required for call setup.
- the reliability objectives (refer to table 4-O).

Continued on next page

Trunk Provisioning, Continued

Table 4-O

Table 4-O gives minimal VPA rate (or, in the case of the *4ESS* Switch, Cancellation Rate) guidelines based on the type of trunk facility.

Trunk/Circuit Type	*4ESS* Switch
UNALARMED	0% (= 100% test rate)
SOFTWARE CARRIER ALARMED	87% (= 12.5% TEST RATE)
HARDWARE CARRIER ALARMED — Analog switch or multiple spans w/o end-to-end alarms at switch	87% (= 12.5% TEST RATE)
HARDWARE CARRIER ALARMED—Digital end-to-end alarms	87% (= 12.5% TEST RATE)

Note:
These are minimum VPA guidelines. For other available VPA rates, check the appropriate translation guide. The rate must be consistent with the hardware equipped at each end of the trunk facility.

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Trunk Provisioning, Continued

VPA/ Continuity Check Circuits

The VPA circuits, sometimes called Continuity Check circuits, must be engineered to handle the combined usage for outgoing and incoming VPA tests. Outgoing VPA tests are based on the VPA rate of the originating switch, while incoming VPA tests are controlled by the far-end switch's VPA rate. The VPA test is a per call test whose rate can be adjusted. Hence, the VPA rate also affects VPA test circuit usage in connecting switches.

Engineering the appropriate quantity of VPA circuits depends on the quality of service each LEC is willing to provide to its customers. On the one hand, requiring a VPA test on every call ensures that the trunk transmission quality meets the minimum requirements, but also increases the call setup time and requires significantly more VPA circuits. On the other hand, performing a VPA test on one-out-of-every-eight calls reduces the quantity of VPA circuits needed, but also increases the probability that a call receives a trunk failing minimum transmission requirement. The ideal quantity is to be decided by each LEC data administrator. For guidelines in engineering the minimum number of VPA circuits, refer to the following documentation:

- *4ESS* 234-060-210, *4ESS* Switch Network Switching Engineering, Service and Miscellaneous Circuits

Once the initial quantity of VPA circuits has been determined, the network administrator must determine whether or not the quantity installed is sufficient for the VPA testing needs of the office. Table 4-P summarizes measurements to be used to determine if more VPA circuits are needed.

Table 4-P

The following table contains VPA Circuits Requirements.

Office Type	Report	Field Name	Description
4ESS Switch	Machine Service Report, Part 2 (MSR2)	ISUP XCVR	This measurement is the number of times that transceivers are not available for continuity tests.

Continued on next page

Trunk Provisioning, Continued

Usage and Overflow Monitoring

The LEC network administrator should periodically monitor the measurements shown in table 4-P to determine whether or not VPA testing is being denied due to lack of VPA circuits. The following two areas are to be monitored:

- **Usage** - In monitoring VPA circuit usage, the LEC network administrator should establish a usage threshold (for example, 70 percent) per the office busy hour. If the usage measurement continually exceeds (taking into account peak periods) this threshold, more VPA circuits should be engineered and installed.

- **Overflow** - In monitoring VPA circuit overflow, these counts should typically be zero (indicating every VPA test engaged the services of a VPA circuit) taking into account unusual peak periods. If these counts are consistently nonzero, the LEC network administrator should establish an overflow threshold needed to maintain a given degree of service. If the overflow trend is continually exceeding this threshold, more VPA circuits should be engineered and installed.

Trunk Hunting

Hunting for Idle Trunk

It is operationally important that hunting for an idle trunk be performed from opposite directions of the 2-way trunk facility to minimize the possibility of glare. To understand this, let us consider the example below where both switches perform a trunk hunt in the same direction.

The following conditions apply in the example:

a. There are **500** trunk members between the two offices.

b. Both offices start their hunt with trunk member **30** and forward hunt to the highest numerical trunk member until an idle trunk is found.

c. There are **409** trunks currently busy with conversations in progress.

d. Both offices attempt to originate a call at approximately the same instant.

If both offices attempted to seize trunk member **410** simultaneously, glare will occur. Appropriate glare control would resolve the problem allowing one office to seize trunk member **410** while the other office hunts for the next idle trunk member (that is, **411**). Every time calls originate from both offices simultaneously, this scenario is replayed.

The same situation holds true if both offices perform reverse trunk hunting from the highest numerical trunk member to the trunk member **30**.

To correct this situation, change Office **A** to forward hunting from trunk member **0** and Office **B** reverse hunting from the highest numerical trunk member. The probability of glare is greatly reduced. Only when all trunk members but one are busy is glare possible. Trunk hunting on 2-way trunks should always be performed in the opposite directions by the opposing ends of the trunk.

Continued on next page

Trunk Hunting, Continued

Table 4-Q

This table summarizes the necessary recent changes for populating trunk hunting data.

Office Type	Function View	Keyword/ Field	Description
4ESS Switch	RC:TSG	REV	If "Y" the hunt for an idle trunk starts with the highest numerical trunk member. Likewise, if "N" the hunt should be started at trunk member 0.

Special Considerations

The *4ESS* Switch TG-4 Translation Guide recommends that trunk hunt for 2-way trunk subgroups be based on the alphabetic value of the CLLI code. By this recommendation, the switch with the lower (alphabetical) CLLI code hunts in the reverse direction (**REV = "Y"**). Regardless of the convention, it is important **always** to hunt in opposite directions on each end of the trunk group.

In a SS7 network, trunk hunt and glare settings are independent. That is, the hunt direction does not affect glare resolution

Continued on next page

Trunk Hunting, Continued

4ESS Switch Access Tandem Call Failure Treatment

In the same offices as noted above, Inter-LATA treatment is offered by individual Trunk Subgroup (TSG).

The appropriate action (REL or T/A) is defined on an individual TSG basis in RC 100 Form. Two fields have been added to the TSG, "Backward Failure Treatment ISUP All The Way" (BFTIS) and "Backward Failure Treatment Not ISUP All The Way" (BFTNI), to achieve a more versatile treatment of an individual TSG.

- BFTIS — This field specifies the action to be taken on a failed call when ISUP signaling is used for the entire call. This field is checked only when the Incoming Signaling Characteristic (ISC) is ISUP and the Type of Trunk (TOT) is Other Carrier Connecting (OCC). Valid entries in this field are:
  - Blank or **REL —** Send release message with cause values.
  - **ANN —** Play appropriate announcement.
- BFTNI — This field specifies the action to be taken on a failed call when ISUP signaling is **NOT** for the entire call. Use this field only when the incoming trunk ISC is ISUP and the TOT is OCC. Valid entries in this field are:
  - Blank or **ANN** Play announcement.
  - **REL —** Send release message with cause value.

ISUP Indicators

Intra-LATA SS7 calls are handled based on the ISUP indicator in the incoming IAM and the office parameter values of BFTIS and BFTNI.

BFTIS and BFTNI were added to office parameters (ODA Form 406Z) to allow for consistent Intra-LATA call failure treatment at the office level. Field descriptions for BFTIS and BFTNI are the same as those described for TSG fields. Field values cannot be changed using RC forms. The treatment at office level is not dependent on the TOT being OCC (refer to Figure 4-5).

Note:
The appearance of "CdP Address Failed Screening" and "ICT from IC" checks indicate the existence of Network Interconnect (NI) functionality.

Engineering

Engineering Considerations

Continuity Check Transceivers (CCTs) are used for testing continuity of the circuit path before call set-up. Items to be considered when engineering CCTs are as follows:

- Voice Path Assurance (VPA) tests require circuits on both ends.
- Both ends must have enough circuits to handle the specified test rate.
- Translations must be set correctly for the type of switch on the other end.

Engineering Considerations for CNI Ring

Engineering considerations for the Common Network Interface (CNI) ring are as follows:

- Enough Common Channeling Signaling Number 7 (SS7) link nodes available for the amount of trunks using Integrated Services Digital Network User Part (ISUP) signaling.
- Enough Direct Link Nodes (DLNs) with proper memory size for the amount of trunks using ISUP signaling.

Type of Trunks

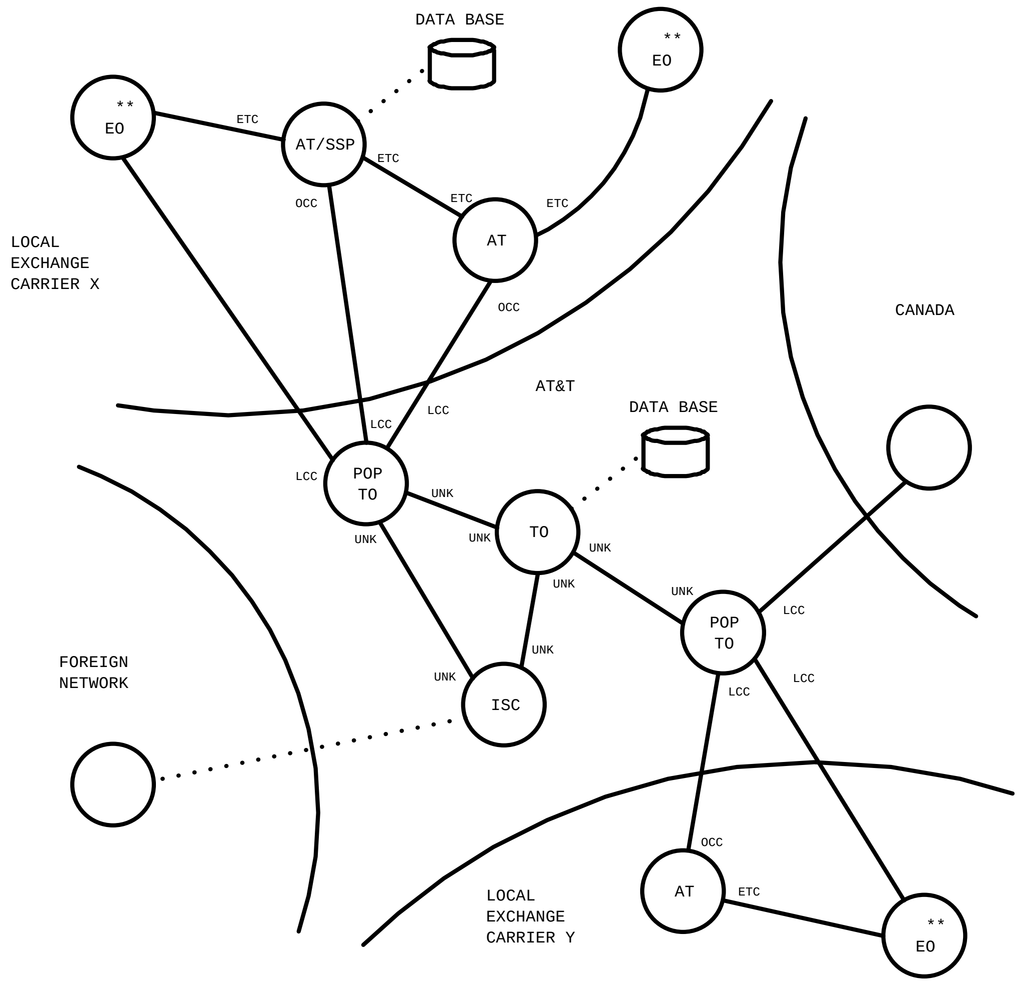
To determine switch type for network interconnect, the trunk subgroup field Type Of Trunk (TOT) will be used. Three new trunk types for network interconnect have been added (Refer to figure 4-6). The three new trunk types and when they are to be used are as follows:

- End Office or Tandem Connecting (ETC) — To be used in local tandems for trunks connecting to other tandems or end offices. Local *4ESS* Switches are to use this trunk type, even if not doing network interconnect. This trunk type will be changed automatically via ODA retrofit rules for all ISUP trunks at access tandems and service switching points.
- Other Carrier Connecting (OCC) — To be used in local access tandems for trunks connecting to toll offices.
- Local Carrier Connecting (LCC) — To be used in toll offices for trunks connecting to local tandems and end offices.

Continued on next page

Engineering, Continued

Figure 4-6 Following is an example of a Network Interconnect Trunk Configuration.



TYPE OF TRUNK

ETC - EO OR AT CONNECTING
OCC - OTHER CARRIER CONNECTING
LCC - LOCAL CARRIER CONNECTING
UNK - UNKNOWN - ALL OTHER VALUES

TYPE OF OFFICE

EO - END OFFICE**
AT - ACCESS TANDEM
SSP - SERVICE SWITCHING POINT
TO - TOLL OFFICE
ISC - INTERNATIONAL SWITCHING CENTER
** 4 ESS SWITCH CAN NOT BE EO

Continued on next page

Engineering, Continued

Trunk Considerations

The present working environment of equal access trunking, for the most part, consists of end office and Access Tandem (AT) to Interexchange Carrier (IXC) offices. The traffic numbering is usually not the same at both ends of the trunks. In some cases, the CLLI assignment is also different at each end of the group. Within the local exchange carrier network there are also some cases where the incoming and outgoing groups from the end office are assigned traffic numbers, however, the *4ESS* Switch AT has different numbers assigned because it cannot repeat numbers on trunk subgroups within the same trunk group.

Before the implementation of network interconnect, within a local exchange carrier network, the same Circuit Identification Codes (CICs) must be assigned at each end of all trunks. CICs are the actual traffic numbers assigned in the *4ESS* Switch. For some applications, where two trunk groups exist between two specific offices, the names must be changed to the same identity within a *4ESS* Switch to any other office. The Destination Point Code (DPC) assigned to a trunk subgroup can only be assigned to other trunk subgroups of the same trunk group. In addition, each switch operating in a SS7 network can only be assigned one unique DPC.

The new numbering scheme for SS7 trunks is left up to the individual local exchange carrier. With the assignment of each scheme, each company will have to reassign traffic numbers for all access trunking. All existing SS7 trunk subgroups in local exchange carrier owned *4ESS* Switch systems must be replaced by new trunk subgroup numbers that fit the new numbering assignments. Additional effort must be coordinated and executed to match the new trunking numbers (and names if required) Connect Vu. This activity constitutes “disconnects” and “adds” for the *4ESS* Switch.

The planning for the traffic number reassignment and reconstruction of trunk subgroups must include the awareness of trunk maintenance restrictions that must be tolerated for a specific period of time. This conversion process requires an extremely high level of coordination and inconvenience.

Provisioning for Additional Features

Additional Features

This section describes the provisioning for additional features where necessary. The features that are affected include:

- 085 Generic Address Parameter
- 156 Completion of Transmission Path
- 157 Handling Confusion (CFN) Messages
- 158 Routing Based on Speech and 3.1-kHz Bearer Capability
- 401 SS7 Trunk Signaling Interface for Cellular Type 2A Connection
- 406 Carrier Identification Parameter (CIP) Feature

Generic Address Parameter (GAP) Feature (#085)

Two new Office Data Assembler (ODA) tables, OD4ANIPARM and OD4NIIPARM, have been defined to specify ISUP parameter handling for intra-network and network-interconnect calls. (ISUP trunk handler programs use OD4ANIPARM for intra-network calls and OD4NIIPARM for network-interconnect calls.) Both tables are 256-word structures and are defined in Protected Simplexed Backed ODA (PSBO) memory.

Completion of Transmission Path Feature (#156)

This feature specifies when a transmission path should be connected for a call. Since a call register is held until answer for some data calls, an ODA defined timer is defined for this feature. The timer value as used by ISUP is stored in 10-millisecond increments as opposed to other existing Wait For Answer Timers (WFATs) that treat the data in 10-second increments. The WFATCTP word is populated from the WFATCTP field on the ODA 406Z form. The structure specifies the timer value for TPTIME, and this word is populated from the WFATCTP field. If the WFAT times out, the call is failed with Final Handling Code 1498. If the field is blank, binary zero is stored.

Continued on next page

Provisioning for Additional Features, Continued

Handling Confusion Messages Feature (#157)

A new trunk block bit Send Confusion (SCFN) has been defined that determines if received confusion messages are counted and if CFN messages are to be sent when an unimplemented message is received. Recent Change Forms 100, 101, 102, 107, 108, and 109 populate the SCFN field. If SCFN is populated with a "blank" or "N", then the CFN message is not sent. If SCFN is populated with a "Y", then the CFN message is sent.

The retrofit rules default SCFN to send a CFN message value when the type of trunk is ETC, OCC, or LCC. Therefore, this feature is turned on automatically for all LEC intra-LATA and NI boundary trunks and for all AT&T NI boundary trunks. For all other types of trunks, the SCFN default is not to send a confusion message (value = 0).

The SCFN field is present on the following Recent Change forms and related trunk subgroups:

- Form 100 Adding a new two-way trunk subgroup
- Form 101 Adding a new one way incoming trunk subgroup
- Form 102 Adding a new one-way outgoing trunk subgroup
- Form 107 Changing the characteristics of an existing two-way trunk subgroup
- Form 108 Changing the characteristics of an existing one-way incoming trunk subgroup
- Form 109 Changing the characteristics of an existing one-way outgoing trunk subgroup.

The following Verify forms include the SCFN field as output:

- Form 1a VER:TSG for two-way trunk subgroups
- Form 1b VER:TSG for one-way incoming trunk subgroup
- Form 1c VER:TSG for one-way outgoing trunk subgroups
- Form 11d VER:TSGLIST.

Continued on next page

Provisioning for Additional Features, Continued

Routing Based on Speech and 3.1-kHz Bearer Capability Feature (#158)

Since the purpose of this feature is to route calls differently based on whether the calls are speech or 3.1 kHz, different Routing Data Blocks (RDBs) need to be defined for these different calls. Using the manual subsequent digit type V31K, speech calls will point to RDBs that can include trunks that allow Time Assignment Speech Recognition (TASI) and Low Bit Rate Voice (LBRV) in addition to 3.1-kHz, 56-kbps, or 64-kbps trunks. The 3.1-kHz calls, however, will point to RDBs that include trunks that do not allow TASI and LBRV.

This feature is turned on by using either of the following ODA or 1A Processor Recent Change forms:

- ODA Forms: 403D, 403E, 403F, 403G, 403K, 403L, 403M, 403N, 403V

- Recent Change Forms: 300, 301, 302, 303, 304, 313, 314, 315, 316.

If the CALLTYP field is SDX, SD1, SD2, or SD3 on any of these ODA or Recent Change forms, the Additional Data 1 **(AD1)** field can be populated with **V31K**. When a V31K type of subsequent digit entry is used, index "0" is interpreted as 3.1 kHz and index "1" is interpreted as normal speed.

The following Verify forms are affected by this feature:

- Input Forms: 13a, 13b
  V31K is a valid input in the **ST1** and **ST2** fields.

- Input Forms: 13f, 13g, 13m
  V31K is a valid input in the **AD1** field.

- Output Forms: 3a, 3b, 3c, 3d, 3e, 3f, 3g, 3i, 3j, 3k, 3l, 3n, 3v, 3w, 3z, 3ab

V31K may be a valid output in the **AD1** field if the **CALLTYP** field is SDX, SD1, SD2, or SD3.

Office Data Administration

The Office Data Assembler (ODA)/Recent Change and Verify (RC/V) has created a new manual subsequent digit treatment, V31K, that is used to route speech and 3.1-kHz audio calls over different trunks.

Continued on next page

Provisioning for Additional Features, Continued

Turn On/Turn Off Mechanism

This feature is turned on by using either of the following Recent Change forms:

- Recent Change Forms: 300, 301, 302, 303, 304, 313, 314, 315, 316.

If the **CALLTYP** field is SDX, SD1, SD2, or SD3 on any of these Recent Change forms, the Additional Data 1 (**AD1**) field can be populated with **V31K**. When a V31K type of subsequent digit entry is used, index “0” is interpreted as 3.1 kHz and index “1” is interpreted as normal speed.

The following Verify forms are affected by this feature:

Input Forms: 13a, 13b
V31K is a valid input in the ST1 and ST2 fields.

Input Forms: 13f, 13g, 13m
V31K is a valid input in the AD1 field.

Output Forms: 3a, 3b, 3c, 3d, 3e, 3f, 3g, 3i, 3j, 3k, 3l, 3n, 3v, 3w, 3z, 3ab
V31K may be a valid output in the AD1 field if the CALLTYP field is SDX, SD1, SD2, or SD3.

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Provisioning for Additional Features, Continued

SS7 Trunk Signaling Interface for Cellular Type 2A Connection Feature (#401)

A population rule for Recent Change (RC) Forms 100, 101, 102, 107, 108 and 109 is affected by this feature.

With this feature, the population rule changes to:

If the FENCLASS is a Cellular Mobile Carrier (CMC), and then if ISC/OSC is not ISUP or the TOT is not ETCK, the form will fail.

FENCLASS must be CMC, FEND must be assigned. TOT must be ETZ . BN must be a 10-digit billing number for AMA Records.

Carrier Identification Parameter (CIP) Feature (#406)

This feature affects several data components in the *4ESS* Switch 1A/1B Processor, including Office Data Assembler (ODA) and Recent Change/Verify (RC/V).

Each Trunk Subgroup (TSG) between the AT and the IXC needs to be provisioned to indicate which CICs can be sent in the CIP to the IXC. This is determined by the agreement between the LEC and the IXCs. To provision the CICs per TSG, a new RC Form 113 is used.

Recent Change/Verify supports CIP on a TSG basis that indicates if the particular CIC value is subscribed by the IXC. The maximum number of CIC values that can be assigned to a TSG is 16. A 4-digit CIC with a leading zero is considered the same as a 3-digit CIC if the last three digits are identical.

An office parameter (F5) has been implemented to either allow or disallow the CIP during MF inband signaling to Signaling System 7 (SS7) at the AT. For MF-to-SS7 signaling, the AT includes the CIP parameter in the outgoing IAM based on certain options, the CIC value, and the selected outgoing TSG. The interaction between the office MF-to-SS7 interworking allowed option and the IXC's CIC subscription is depicted in Table 4-R. The office option default setting is "No." This office parameter is Recent Changeable via RC Form 809.

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Provisioning for Additional Features, Continued

Table 4R

This table shows MF-to-SS7 Interworking Allowed Option.

MF (xxx or xxxx) to SS7 (CIP) Interworking Allowed	CIC Subscribed for TSG	Send CIP
Yes	Yes	Yes
Yes	No	No
No	Yes	No
No	No	No

CIC Provisioning

To make the CIC provisioning work, the following conditions must be met:

- Outgoing Signaling Characteristic (OSC) must be Integrated Services Digital Network User Part (ISUP).
- Type of Trunk (TOT) must be Other Carrier Connecting (OCC).
- If the TSG is provisioned with ONCID=3 (the number of carrier identification digits to send), then all CICs must begin with a leading zero.
- The CIC entered must be a unique code.

Continued on next page

Provisioning for Additional Features, Continued

RC Forms Affected

RC Form 106
If a CIC list is provisioned for the TSG, RC Form 106 (Delete a TSG) submittal will fail. The CIC list must be deleted using RC Form 113 before the TSG can be deleted.

RC Form 113
Provisioning CICs per TSG can be done using the new RC Form 113. RC Form 113 does not have change capabilities. When new data (CICs) is entered on this form, the original data (CICs) on RC Form 113 defined for a specific TSG is replaced. This form asks for a TSG name and provides for a maximum of 16 4-digit CICs to be entered for that TSG. The TSG name must be already defined using RC 100 series forms. To delete a CIC list for a TSG, enter RC Form 113 with all the CIC fields blank.

Figure 4-8

This figure shows a sample RC Form 113.

```
Form 113          Replace Carrier Identification Code List
4E18 R4>

RC: TSG; CHG; OPT (CICS), - - -;                 BTFN  TOWN  ST  BL  FBS  NBS

ORNU - - - - -,                              TSG   - - - - - - - -   - -    - - - - -  - - -,

                        CIC    CIC    CIC    CIC
                        - - -,   - - -,   - - -,   - - -,
                        - - -,   - - -,   - - -,   - - -,
                        - - -,   - - -,   - - -,   - - -,
                        - - -,   - - -,   - - -,   - - -,

REMARKS  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - !
```

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Provisioning for Additional Features, Continued

CIC Provisioning

To make the CIC provisioning work, the following conditions must be met:

- Outgoing Signaling Characteristic (OSC) must be Integrated Services Digital Network User Part (ISUP).
- Type of Trunk (TOT) must be Other Carrier Connecting (OCC).
- If the TSG is provisioned with ONCID=3 (the number of carrier identification digits to send), then all CICs must begin with a leading zero.
- The CIC entered must be a unique code.

RC Form 113
The legal inputs for the CIC fields on RC Form 113 are 4-digit CICs (0000-9999) or blanks. This form accepts CICs only in the 4-digit format (xxxx). If a 3-digit CIC (xxx) is requested, it must be entered as 0xxx on the form. To delete one CIC for a particular TSG, reenter on RC Form 113 all other CICs except the one to be deleted.

Verify Forms Affected

Verify Form 16az

A new input, **CIP**, is added to the **MISC** field on Verify Form 16az. Also, a new keyword, **CIN** (Circuit Identification Name, also referred to as the TSG name), is supported when CIP is specified in the MISC field. Keyword CIN is not allowed for other inputs to the MISC field. The existing keyword, **NSN**, on Verify Form 16az is not allowed with CIP input to the MISC field. When the following command is entered, a list of assigned CICs for the TSG will be output:

VER:MISC CIP:CIN b!

Verify Form 1i

A new output message, **VER:TSG;OPT(CICS)**, is defined for displaying the assigned CICs for a TSG. This message verifies all CICs assigned to the TSG specified on the input message.

Continued on next page

Provisioning for Additional Features, Continued

Structures Affected

HT4TSG

A new index in HT4TSG, CINDX, has been added to word 15. This is the index into the new 2-level structure, HT4TSG_CICS, which contains the allowed number of CICs (maximum 16) per TSG. When RC Form 113 is entered, RC searches through HT4TSG_CICS for the first unassigned entry, populates the CICs in Telco Binary Code Decimal (BCD) format, and updates the CINDX in HT4TSG with the index to the entry. This index is retained by RC Forms 107-109, Change TSGs.

HT4TSG_CICS

When ODA Form 401J is entered, there must be a matching ODA Form 01A/401C with the same TSG name. ODA assigns the first available index in HT4TSG_CICS and populates the CICs entered on the form in this entry in Telco BCD format. ODA then updates CICS_SZ in word 0 of the entry with the number of non- blank CICs entered on the form and CINDX in HT4TSG with the index to the entry.

When RC Form 113 is entered, the RC gets the TSG number (TSGN) of the TSG. If the CINDX is unassigned, the RC will create a new entry in the first available space in HT4TSG_CICS and populate the CICs entered on the form in this entry in Telco BCD format. The RC then updates CICS_SZ in word 0 of the entry with the number of non-blank CICs entered on the form. The RC also updates CINDX with the index to the entry. If CINDX is nonzero in HT4TSG, the current entry indicated by CINDX is deleted and a new entry is built in HT4TSG_CICS.

OD4OFCCOPY

A new office indicator, OD4F5, has been defined in the existing OD4OFCCOPY to indicate if the CIP is to be included in the IAM during MF-to-SS7 signaling at the AT. This office indicator (OD4F5) is populated via the existing RC Form 809 (Change Feature Bits). The **FEATURE ITEM** field on RC Form 809 is set to **F5**. A "YES" entry in the **ON OR OFF** field means that the CIP is included in the IAM. A "NO" entry means that the CIP is not included in the IAM. Additionally, **VER:MISC ON/OFF** can be used to output the status of this F5 bit.

Continued on next page

Provisioning for Additional Features, Continued

Full Point Code Routing (FPCR) and E-Link Access Features (#247/344)

The FPCR and E-Link Access features are secured features that need to be purchased from AT&T. AT&T will provide provisioning instructions for these features when they are purchased.

Trunk Group Control of Signaling Bits Feature (#430)

This LEC feature provides a way for users of a *4ESS* Access Tandem Switch to control the state of unused signaling bits on a T1 trunk. Control may be desired when the far-end switch does not ignore these bits on ISDN-SS7 trunks because they are being operated in a clear data mode. Use of this feature can prevent false supervisory information from being passed onto a connecting switch.

The signaling bits controlled by this feature are referred to as AB bits, which are associated with Robbed Bit Signaling. In Robbed Bit Signaling, the AB bits are taken out of the data stream on selected frames to provide signaling information about a call on a trunk. There is no signaling such as AB bits on SS7 trunks. AB bits and similar information bits come from inband Multi-Frequency (MF) signaling. However, there is no standard procedure for provisioning converted SS7 trunks, and certain switching equipment cannot tolerate the bits used for signaling in MF to float, as each change of state is seen as a change of state on a call.

This feature addresses this problem by setting the Per-Channel Inhibit Signaling (PCIS) bits such that the trunks are put into a steady on-hook state. This prevents a far-end switch from seeing the bits fluctuate and cause unnecessary and possible excessive transitions that could lead to recovery action.

Recent Change (4E21 Generic)

If CODSC is set to Y, the TOT = OCC and the OSC = ISUP.

This feature does not activate if CODSC is set to N or if entries different from those listed above are used in the TOT or OSC fields.

The meaning for CODSC was changed to CPE Outgoing Disconnect/Reset SS7 Trunk Subgroup PCIS Bits.

Continued on next page

Provisioning for Additional Features, Continued

Routing Based on Speech and 3.1-kHz Bearer Capability Feature (#158)

This feature is turned on by using either of the following ODA or 1A Processor Recent Change forms:

- ODA Forms: 403D, 403E, 403F, 403G, 403K, 403L, 403M, 403N, 403V
- Recent Change Forms: 300, 301, 302, 303, 304, 313, 314, 315, 316.

If the CALLTYP field is SDX, SD1, SD2, or SD3 on any of these ODA or Recent Change forms, the Additional Data 1 **(AD1)** field can be populated with **V31K**. When a V31K type of subsequent digit entry is used, index "0" is interpreted as 3.1 kHz and index "1" is interpreted as normal speed.

The following Verify forms are affected by this feature:

- Input Forms: 13a, 13b
  V31K is a valid input in the **ST1** and **ST2** fields.
- Input Forms: 13f, 13g, 13m
  V31K is a valid input in the **AD1** field.
- Output Forms: 3a, 3b, 3c, 3d, 3e, 3f, 3g, 3i, 3j, 3k, 3l, 3n, 3v, 3w, 3z, 3ab
  V31K may be a valid output in the **AD1** field if the **CALLTYP** field is SDX, SD1, SD2, or SD3.

Chapter 5 Recording

Automatic Message Accounting Records

Introduction

The *4ESS*™ Switch generates Automatic Message Accounting (AMA) Records under certain conditions. See Table 5-1 below.

Table 5-1

Calls Terminating to a CMC over Type 2A Connection			
Originating From	Via *4ESS* Access Tandem		Terminating To
	Incoming AMA Call Code	Outgoing AMA Call Code	
CMC	066		LATA
CMC	066	134	FGB IC
CMC	066	110	FGD IC
CMC	066	141	SS 800 InterLATA
CMC	066	142	SS800 IntraLATA

Calls Terminating to a CMC over Type 2A Connection			
Originating From	Via *4ESS* Access Tandem		Terminating To
	Incoming AMA Call Code	Outgoing AMA Call Code	
LATA			CMC
FGB IC	135		CMC
FGD IC	119		CMC

Note:
All Feature B and Feature D calls generate call records regardless of whether they terminate at a Customer Measurement Collection (CMC).

AMA Records

The Signaling System 7 (SS7) Trunk Signaling Interface for Cellular Type 2A connection affects recording functions on the *4ESS* Switch.

Continued on next page

Automatic Message Accounting Records, Continued

SS7 Trunk Signaling Interface for Cellular Type 2A Connection Feature (#401)

The AMA recording areas affected by this feature are as follows:

- Normal billing records will be generated for all Customer Measurement Collection (CMC) calls using the SS7 signaling interface.
- For both intra-LATA and inter-LATA calls originating on a SS7 signaling interface, the Trunk Subgroup (TSG) billing number continues to be used to populate the Originating Numbering Plan Area (NPA) and Originating Number fields in the AMA record.
- For inter-LATA calls originating on a SS7 signaling interface, the Terminating NPA and Terminating Number fields in the AMA record are to be populated from data in the Called Party Number field in the Initial Address Message (IAM).
- For inter-LATA calls originating on a SS7 signaling interface, the IC/INC fields in the AMA record are populated with the XXX/XXXX as received in the Transit Network Selection (TNS) of the IAM.
- For CMC calls originating on a SS7 signaling interface, the recorded CMC connect time is the time that the IAM is received.
- Character 1 of AMA Table 83 is populated with the appropriate value that corresponds to the type of signaling connection as follows:
  - 2 = A non-SS7 signaling interface between an Interexchange Carrier (IXC) and an AT; and a non-SS7 signaling interface between an AT a CMC.
  - 4 = A SS7 signaling interface between an IXC and an AT; and a SS7 signaling interface between an AT and a CMC.
  - 5 = A non-SS7 signaling interface between an IXC and an AT; and a SS7 signaling interface between an AT and a CMC.
  - 6 = A SS7 signaling interface between an IXC and an AT; and a non-SS7 signaling interface between an AT and a CMC.
  - 9 = A signaling type not specified.

Chapter 6 Network Management

Overview

Introduction

When the circuit network is under stress due to traffic overload or major facility failure(s), network management controls must be initiated at common channel exchanges to maximize the efficiency of the network and to protect its integrity and security.

Automatic Congestion Control (ACC) automatically reduces the Signaling System (SS7) Integrated Services Digital Network User Part (ISUP) traffic load to a congested switch. This feature determines when an office is in congestion while SS7 is being used between offices. In response to an Initial Address Message (IAM), a congested office sends a Release (REL) or Address Complete Message (ACM).

Automatic Congestion Control Level (ACCL)

The SS7 message contains the Automatic Congestion Control Level (ACCL) parameter. The ACCL parameter has three possible values:

- Machine Congestion Level 0 (MC0) indicating no congestion
- Machine Congestion Level 1 (MC1) indicating minor congestion
- Machine Congestion Level 2 (MC2) indicating major congestion

Offices receiving and interpreting the ACCL parameter, throttle back on calls offered to the congested office.

Continued on next page

Overview, Continued

Table 6-A The following table contains Network Management Control Calculations for the *4ESS*™ Switch.

Resp Cat.	AC1 AR	AC1 DR	AC2 AR	AC2 DR	AC1 AR HTR	AC1 DR HTR	AC2 AR HTR	AC2 DR HTR
A	0	0	0	0	100	0	100	75
B	0	0	100	0	100	0	100	0
C	0	0	100	0	100	75	100	75
D	100	0	100	100	100	0	100	100
E	0	0	0	0	100	75	100	87
F	0	0	0	0	0	0	100	0
G	0	0	0	0	0	0	100	100
H	0	0	0	0	100	0	100	100
I	0	0	100	0	100	100	100	100
J	0	0	100	75	100	100	100	100
K	100	0	100	75	100	100	100	100
L	75	50	75	75	75	50	75	75
M	0	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0	0

Note:
Resp Cat. = Response Category
AC = Automatic Congestion Level Received
AR = Alternate Routed
DR = Direct Routed
HTR = Hard to Reach

Automatic Congestion Control Feature Parameters

ACC Features Parameters

The ACC feature parameters in a *4ESS* Switch can only be entered on a terminal attached to a network management channel. Throttling actions are viewed and specified on the network management CN02 (Control) page. The response categories are assigned on a trunk subgroup basis.

To prevent the *4ESS* Switch from sending ACCL to switches that are unable to interpret it, use the Network Management (NM) CN03 page. The control of ACCL is done on a trunk subgroup basis.

For further information see 234-101-020, *Network Management Display System.*

Activation

The switch determines if it is congested by an internal dynamic calculation having no user changeable parameters. Another switch (capable of processing the ACCL parameter) reduces traffic to the congested switch when it receives a REL message with an ACCL parameter value of MC1 or MC2. The following message is reported when a REL message with the ACCL parameter is received:

REPT: MCa DOC RECEIVED ON THIS TSG:

where **a** = 0, 1, or 2 for the congestion level.

Deactivation

For all switches, throttling is performed for 4 to 6 seconds unless additional REL messages with the ACCL parameter are received. If this occurs, throttling is performed according to the new ACC level for an additional 4 to 6 seconds. The 4- to 6-second interval cannot be changed by the user. The variation in the interval occurs because of the timing constraints.

Note:
If the new ACC level is MC0, the *4ESS* Switch immediately removes the throttling.

Continued on next page

Automatic Congestion Control Feature Parameters, Continued

Trunk Signaling with Abnormal Network Conditions

To determine the availability of the SS7 trunks, check the state of the SS7 signaling network. If the far-end switch is unavailable through the SS7 signaling network, all SS7 trunk groups that end at that switch are unavailable for traffic. This declaration may take one of the following forms:

- A Transfer Prohibited (TFP) message is received from each adjacent Signaling Transfer Point (STP) concerning the far-end node.
- The linkset to one of the adjacent STPs is out of service and a TFP message is received from the mate STP concerning the far-end switch.
- Both linksets to the adjacent STPs are out of service.
- A subsystem prohibited message is received concerning Subsystem 3 for the far-end switch. Subsystem 3 is the ISUP Subsystem.
- Transfer Control (TFC) message is received from an STP indicating Level 2 or 3 congestion for a far-end node.

Unavailable Far-end Switch

When the far-end switch is declared unavailable, one of the following events occurs:

- If alternate routing is not defined, the call is given Final Handling Treatment.
- If alternate routing is defined but not selected, the call is given reorder treatment.
- If alternate routing is defined and selected, the call is attempted over the alternate route.

The parts that follow describe the mechanism each switching application employs in dealing with far-end office unavailability.

Continued on next page

Automatic Congestion Control Feature Parameters, Continued

4ESS Switch in Abnormal Network Conditions

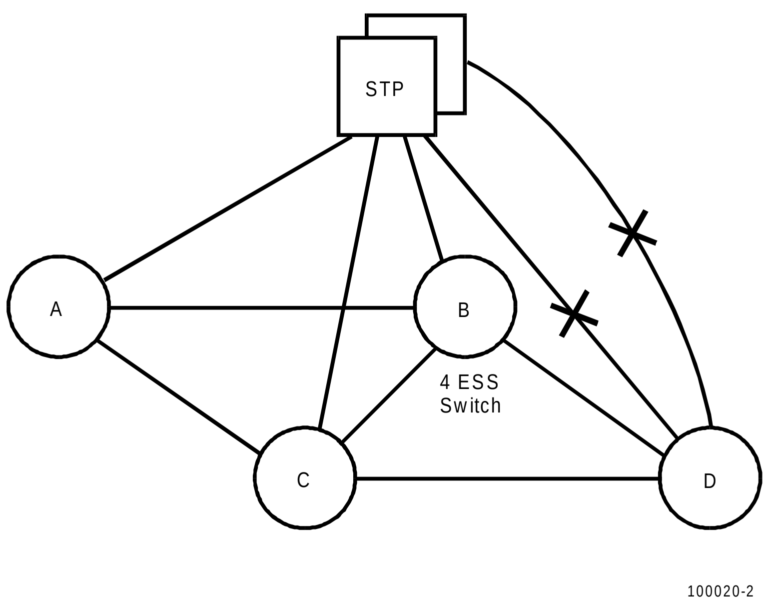
When a switch connected to a *4ESS* Switch (Figure 6-1) is declared SS7-signaling-inaccessible, an MC3 control is applied to all SS7 Trunk Subgroups (TSGs) to the connecting switch. The MC3 control specifies that "no trunk hunt" is to be done on this TSG. Essentially, each SS7 TSG in the routing data block is checked in the search for a voice path to the connecting switch. If an available TSG is found, call processing continues. Otherwise, the call is given appropriate final handling treatment.

When the office is declared SS7-signaling-accessible again, the MC3 control is removed and each SS7 TSG to the connecting switch is eligible for trunk hunting again.

Note:
Signaling link congestion Levels 2 and 3 do not affect the MC3 control.

Figure 6-1. Direct Trunks to an End Office With Overview to Another Local Tandem

The following is an illustration of direct trunks to an end office with overview to another local tandem.



Chapter 6 Network Management

Overview

Introduction

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Overview, Continued

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F	0	0	0	0	0	0	100	0
G	0	0	0	0	0	0	100	100
H	0	0	0	0	100	0	100	100
I	0	0	100	0	100	100	100	100
J	0	0	100	75	100	100	100	100
K	100	0	100	75	100	100	100	100
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Automatic Congestion Control Feature Parameters, Continued

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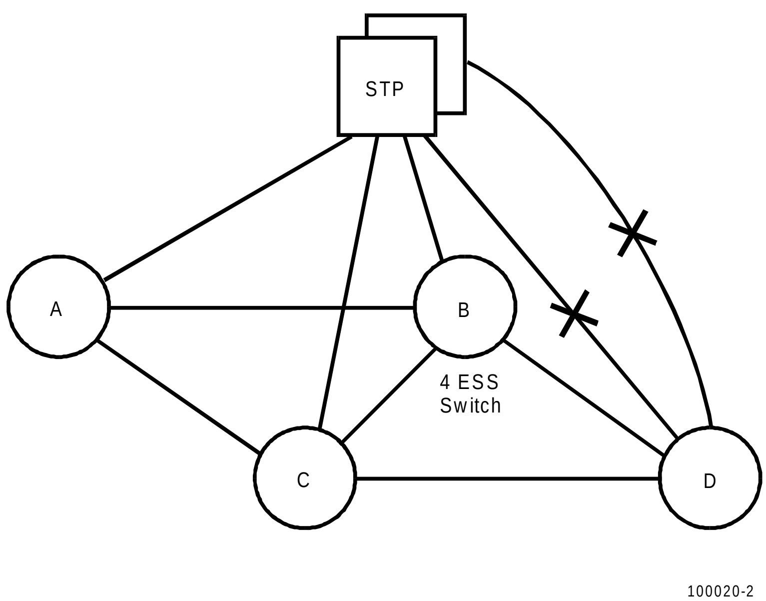

4ESS Switch
Signaling System 7
User's Guide

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Chapter 7 Measurements

Measurements and Maintenance

Introduction

The Common Network Interface (CNI) performance traffic reports consists of CNI and application measurement data. The CNI reports present measurement data in either a fixed or a flexible format. Reports that are fixed format and cannot be altered by the user. Individual sites may wish to use the flexible format feature to create reports for specific uses not adequately addressed by the fixed-format reports. Such reports may include application-specific measurement data collected by CNI. For information concerning the format options, refer to:

234-100-120, *Common Channel Signaling System —CNI 4ESS™ Switch*

SS7 Feature Measurements

SS7 Feature Measurements

This chapter summarizes the measurements for the following SS7 features:

- Integrated Services Digital Network User Part (ISUP)
- Network Interconnect (NI)

Additional Information

Additional information concerning the SS7 feature measurements can be found in *4ESS* Switch TG-4 Translation Guide.

ISUP Measurements

Table 7-A This table provides a listing of the ISUP feature traffic and plant measurements for the 4ESS Switch.

Type (Note)	Measurement	4ESS™ Switch MSC/OMC
1	Incoming ISUP Call Attempts	5/1 37/0
1	Outgoing ISUP Call Attempts	5/1 37/0
1	Continuity Tone Decoder Overflow	02
2 2	Switch Congestion Failures IMA-Backward Fail Message Originated	11/4 11/4
2	No Circuit Available Failures	36/12
2	REL Rec. w/ Switch Equipment Congestion	11/4
2	REL Rec. w/ Unallocated Number	11/4
2	REL Rec. w/ Temporary Failure	11/4
2	ACM Time-Out1	25/3
2	ISUP Call Failure Any Other Reason	45/0
3	Incoming Invalid Message Type	FHC
3	Unreasonable Message Received Out of Sequence Message on Call Setup	36/0
3	Unreasonable Message Type Received	FHC
3	Unsuccessful Call Attempts	NSPMP
3	Continuity Message Time-Out	36/0
3	Trunk Rehunts Started Detected Glare	11/0
4	Incoming Continuity Failure	36/0
4	Outgoing Continuity Failure	36/0
4	Trunk Rehunts Started - Unsatisfactory Response (COT)	36/0
4	Trunk Rehunts Started - For Any Other Reason Not COT or Glare	NSPMP
4	Unequipped CIC Sent	36/6
4	CCS7 Calls Cut Off In Stable State	MSR1
4	Switch Cutoff Calls	MSR1

Note:
The type codes are:
1. = No. of ISUP Message Call Attempts   3. = No. of Abnormal Events
2. = No. of ISUP Release Messages   4. = No. of Maintenance Actions

Network Interconnect (NI) Measurements

Table 7-B This table provides a listing of the Network Interconnect (NI) feature traffic and plant measurements for the *4ESS* Switch.

Type	Measurement	4ESS™ Switch MSC/OMC
1	EA Call Attempts at the Originating EAEO Routed Direct Outgoing Call Attempts to an IC/INC	NSPMP*
1	NI Call Attempts at the Originating EAEO Directly Connected to an IC/INC	170/000
Note: Type 1 = # ISUP Messages/Call Attempts * Reported at the Network Switching Performance Measurement Plan		

Continued on next page

Network Interconnect (NI) Measurements, Continued

Measurements

For network interconnect purposes, the ISUP measurements are separated from other protocols, displayed on the 30-minute report rather than the hourly report, and provided with new measurements required by the users.

The following list describes the required 30-minute network interface measurements:

- Total ISUP messages sent.
- Total ISUP messages received.
- Unreasonable messages received: This means that a switch received a known message in a call state when it does not expect such a message.
- Releases started because of abnormal conditions: This means that a switch received an REL that contained a cause other than “Normal Release.”
- Circuit blocked: A BLO message was received on an in-service trunk.
- Termination failure because of glare: The terminating terminal process encountered glare, backed out of the route request, and started a rehunt to another circuit.
- Continuity failure: The terminating terminal process attempted to run a continuity test and failed.
- Initiation of a trunk rehunt for any other reason: The terminating terminal process aborted and started a rehunt to another trunk for any reason other than glare or continuity failure.
- Total unsuccessful attempts: The terminating terminal process has failed to complete the ISUP call for any reason.

Continued on next page

Network Interconnect (NI) Measurements, Continued

Measurements Made at the Controlling Switch

The controlling switch is the forward most switch in the sequence, which is handling the call when the problem is encountered. A REL is issued to earlier switches in the call chain, but measurement counts are tallied only at the controlling switch. The following measurements are made at the controlling switch:

- Switching congestion: The switch has failed the call because of congestion or overload.
- No circuit available: The routing subsystem has sent a fail message back to the originating process showing that no circuit is available to route the call.
- Address incomplete: The switch has attempted to analyze the called party number in the incoming initial address message and has been unable to make sense of it.
- Temporary failure: The call has failed in the switch where the report is generated because of temporary failure.
- Unallocated Number: The switch tried to find the called party number and could not find it.
- Destination out-of-service: The switch completed trunk hunt and attempted to terminate at the chosen port, but when the switch tried to send the initial address message, the destination point code of the far-end switch was out of service and there is no alternate destination switch. This information is kept and may be consulted during circuit selection by the routing and terminal allocation subsystem.
- Other causes: The call has failed but the reason is not one of the above. This is a default case.

30-Minute Measurements

30-Minute Measurements

Table 7-C through Table 7-F summarizes the 30-minute measurement requirements.

Table 7-C

This table contains 30-Minute Report — ISUP Utilization data.

MEASUREMENTS	30-MINUTE REPORT	1-HOUR REPORT	WHERE TO COUNT	CAUSE VALUE
Total ISUP Messages Sent	Y	N	All Switches	N/A
Total ISUP Messages Received	Y	N	All Switches	N/A

Table 7-D

This table contains 30-Minute Report — ISUP Performance data.

MEASUREMENTS	30-MINUTE REPORT	1-HOUR REPORT	WHERE TO COUNT	CAUSE VALUE
Unreasonable Messages Received	Y	Y	At Occurring Switch (also MDII)	N/A
REL Initiated Due to Abnormal Conditions;	Y	Y	All Switches (count both directions) (also MDII)	N/A

Table 7-E

This table contains 30-Minute Report —ISUP Circuit Availability data.

MEASUREMENTS	30-MINUTE REPORT	1-HOUR REPORT	WHERE TO COUNT	CAUSE VALUE
Circuit Blocked	Y	N	At Occurring Switch (also MDII)	N/A
Termination Failure Due to Glare Continuity Failure	Y	Y	At Occurring Switch (when failure occurs regardless of number of tries)	N/A
Initiate Trunk Rehunt for Any Other Reason	Y	N	At Occurring Switch	N/A

Continued on next page

30-Minute Measurements, Continued

Table 7-F This table contains 30-Minute Report — ISUP End-to-End Connection Performance data.

MEASUREMENTS	30-MINUTE REPORTS	1-HOUR REPORT	WHERE TO COUNT	CAUSE VALUE
Total Unsuccessful Attempts	Y	N	All Switches (count until Address Complete Message is Received)	N/A
Switching Congestion	Y	N	At Occurring Switch (also MDII)	42
No Circuit Available	Y	N	At Occurring Switch (also MDII)	34
Address Incomplete	Y	Y	At Occurring Switch (also MDII)	28
Temporary Failure	Y	N	At Occurring Switch (also MDII)	41
Unallocated Number	Y	Y	At Occurring Switch (also MDII)	1
Busy	Y	N	At Occurring Switch	17
Destination Out of Service	Y	N	At Occurring Switch	27
Other Causes	Y	N	At Occurring Switch	Default cause value

24-Hour Plant Measurements

24-Hour Plant Measurements

The measurements that appear on the 24-hour plant measurement report also appear on a monthly report. Table K shows the items that are counted for each inter-LATA carrier or international carrier and reported on a per-office basis daily. Table L contains other 24-hour plant measurements reported, The expiration of timer for the call record assembler and the total incoming and outgoing machine detected interoffice interruptions for each SS7 trunk group is reported on a daily maintenance report. Only 20 trunk groups can be selected and reported at one time.

Table 7-G

This table contains Inter-LATA and International Carrier Measurements data.

ITEM	DESCRIPTION
Continuity Failure	Continuity failure after two attempts. (Counts are recorded at end office and access tandem.)
Total Incoming MDIIs	For SS7 trunk groups directly connected to an interexchange or international carrier. (Counts are made at end office and access tandem.)
Total Outgoing MDIIs	For SS7 trunk groups directly connected to an interexchange or international carrier. (Counts are made at end office and access tandem.)

Table 7-H

This table contains other 24-Hour Plant Measurements Data.

ITEM	DESCRIPTION
Timer for Call Reservation Acknowledgment	For SS7 trunk groups connected to a local exchange carrier access tandem. Counts of call reservation acknowledgment timer expirations at a gateway
Total Incoming MDIIs	For SS7 trunk groups connected to a local exchange carrier end office or access tandem. (Counts are made at a gateway toll office.)
Total Outgoing MDIIs	For SS7 trunk groups connected to a local exchange carrier end office or access tandem. (Counts are made at a gateway toll office.)

Operations

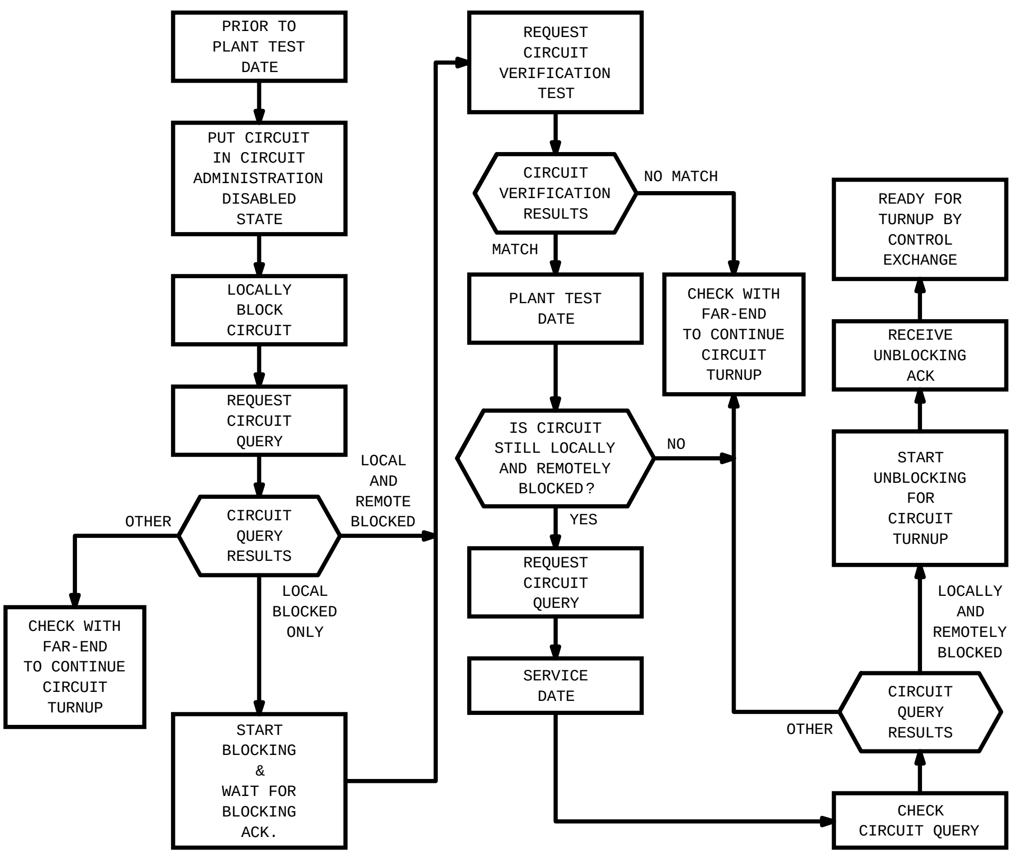
Circuit Turnup Procedure

The circuit turnup is performed by an automated procedure that minimizes the manual effort and the amount of manual end-to-end coordination required curing the testing interval and during turnup of the ISUP circuits for service. Using this procedure, entire circuit groups or facility groups can be turned up.

Before starting the circuit turnup procedure, routing verification test procedures for the signaling network must be completed and each circuit involved must have an exchange named as the control exchange by agreement. The procedure assumes that the near-end exchange has the circuit equipped and the far-end may or may not be equipped.

Figure 7-1

This figure illustrates the basic procedure followed at the noncontrol exchange to prepare a circuit for turnup by the control exchange.



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Operations, Continued

Turnup Procedures in a Noncontrol Exchange

The circuit is placed in a local circuit administration.disabled (CAD.DSA), or equivalent state after circuit data is loaded at the near-end to permit cross exchange testing. While in this state, the circuit validation test may be performed to ensure that the translation data at the noncontrol exchange is consistent with the control end.

After the cross exchange testing is completed, the near-end circuit maintenance state should be set to circuit administration- LO BLKD (locally blocked), or equivalent state. The circuit may be set to this state several days or weeks before the plant date for end-to-end testing. Since circuit query tests are performed daily, the maintenance state of a circuit may be changed even before the plant end-to-end testing date. Before the plant test date and as part of the end-to-end tests, the noncontrol end should make a circuit query to assure that the circuit state is consistent with the control end.

Blocked Circuit Query Replies

Figure 7-1 shows that only the locally and remotely blocked circuit query reply is acceptable. If a locally blocked response is received, the noncontrol end should respond with a blocking signal and expect a blocking acknowledgment signal in response. All other responses should be checked with the control exchange.

After end-to-end tests are completed, the noncontrol end starts a “Make Active” request in which the circuit administration attempts to remove the locally blocked state. The circuit will remain in a remotely blocked state as a result of the “Make Active” request at the noncontrol end. An unblocking message is sent to the control exchange and expects an unblocking acknowledgment from the control end.

Continued on next page

Operations, Continued

Control Exchange Turnup Procedures

The basic procedure for turning up a circuit is similar to that followed by the noncontrol exchange up to the Circuit Query reply during end-to-end testing, except the following:

- Before the plant test date, a mandatory circuit validation test is performed to insure consistency of data at both ends of the circuit.
- The Circuit query exchange during end-to-end testing ensures that the far-end of the circuit is remotely blocked.
- Continuity check is made to ensure that nothing has happened to the circuit since plant testing was completed.
- The circuit is made active by removing the circuit administration locally blocked state and sending an unblocking message to the noncontrol exchange.
- An unblocking acknowledgment signal must be received from the noncontrol exchange.

Turnup Aborted

The turnup is aborted if:

- a circuit validation test signifies inconsistency in circuit data.
- there is a wrong circuit query reply.
- a continuity check failure occurs at any point in the procedure.

Trunk Conversion

Manual Conversion

The PTS trunk conversion process involves deleting each trunk from the switch PTS trunk group and reinserting it in a new SS7 trunk group. The following guidelines should be followed before beginning the trunk conversion process:

- The CNI ring and signaling links to the STPs are operational and all tests have passed.
- The CNI office, link, and routing data views or functions are appropriately populated.
- The STPs are updated with the point codes and other data relating to the offices between which the trunks are connected.
- The office is properly engineered for Voice Path Assurance (VPA), or Continuity Check, circuits and these circuits are installed.
- Since the conversion is being done to trunks that are already in use, the trunk hardware must pass all tests and must be operational.
- The conversion of trunks or trunk groups requires coordination in both offices connected by the trunks so that both ends of the trunks are converted to SS7 at about the same time. If only one end of the trunk is converted, calls cannot complete and diagnostics fail.
- To avoid loss of traffic, the conversion should be made during a low traffic period.
- SS7 trunk data needs to be properly provisioned (for example, Glare, Trunk Hunting, and so forth).

Continued on next page

Trunk Conversion, Continued

Placing Trunk Into Service

Before placing the new SS7 trunk(s) into service, it is recommended that the following tests be performed:

- Run a trunk translations test for each trunk member. This test ensures that the far-end switch knows about the Trunk Circuit Identification Code (TCIC) value assigned to each trunk.
- Run a SS7 trunk query run for each trunk member. This essentially marks each trunk state blocked at both ends.
- Run a VPA (or Continuity Check) test for each trunk member. This tests the voice path for quality transmission.
- An operational test call should be placed over each trunk. If the trunk fails the test call, the problem is likely to be in the data of either the near-end or far-end office.

The section that follows includes application specific information about the manual trunk conversion process.

The *4ESS* Switch has two procedures for converting a TSG from MF to SS7 signaling. The procedures differ in whether the TSG remains in service or is removed from service during the conversion process.

For additional explanation of input/output and recent change messages referenced in these procedures, refer to the *4ESS* Switch IM-4B000-01 and OM-4B000-01 manuals and the TG-4 Translation Guide.

Continued on next page

Trunk Conversion, Continued

Trunk Subgroup Remains in Service

The following procedure applies when the TSG being manually converted from MF signaling to SS7 signaling remains in service during the conversion process.

1. Verify the TSG characteristics using the **VER:TSG** input message. This message provides the information for populating RC Form 100 in Step 4.

2. Verify the TSG member (trunk) assignments using the **VER:TRK** input message (**TAN** keyword). This message provides the detailed office assignments of each TSG member. The Traffic Number (TFN) and Trunk Appearance Number (TAN) are required when populating RC Form 203.

3. Verify the SS7 dynamic routing status in the 3B/CNI processor using OP:C7NET input message (**ROUTING** keyword) to ensure that the cluster being converted has CNI routing before proceeding any further.

4. Create a new TSG with ISUP signaling. Use of the appropriate RC form (See Table 7-I) depends on the directionality of the TSG.

5. The name of the new TSG should be the same as the old TSG except for the Near Building Subdivision. The Trunk Circuit Identification Code should equal the TFN of the TSG member. Other TSG characteristics deserving special attention include: PCF, DPC, TOT, ISC, OSC, CCIS2WIRE, XCPA, REV, GLARE, and EAS.

6. Verify the TSG characteristics using the **VER:TSG** input message.

7. Identify all of the Routing Data Blocks (RDBs) that contain the old TSG using the **VER:RDBLIST;ALL** input message (**CIN** keyword).

8. Add the new TSG to all the RDBs that contain the old TSG using RC Form 513. The new TSG should be installed above the old TSG in all the RDBs.

Continued on next page

Trunk Conversion, Continued

Trunk Subgroup Remains in Service, Continued

9. Verify all of the RDBs to ensure that the new TSG is added above the old TSG and that both TSGs have the same characteristics. The VER:RDB input message (RDBI keyword) should be used to accomplish this.

10. Coordinate the conversion with the far-end switch to ensure that they are ready to turn down the TSG members and proceed with the conversion.

11. Remove as many TSG members from service as allowed using the SET:TRKSTAT input message CAD.DSA and CIN keywords).

12. Remove the TSG members identified in Step 10 from the old TSG using RC Form 202.

13. Add the TSG members removed in Step 11 to the new TSG using RC Form 203.

14. Verify the TSG member assignments using the VER:TRK input message (TAN keyword).

15. Coordinate with the far-end switch before proceeding past this point. The far-end switch must be ready to test the members before you proceed.

16. Test the TSG members for correctness and workability for the following areas using the TEST:TRK input message:
    - Call Processing and Maintenance states: CIN and TQU keywords
    - Traffic Number, Office Name, and Trunk Glare: CIN and TIC keywords
    - Voice Path Assurance: CIN and CCK keywords.

17. Coordinate with the far-end switch and activate the members just added to the new TSG using the SET:TRKSTAT input message (ACT and CIN keywords).

18. Repeat Steps 9 through 16 for each group of TSG members to be converted. When all the members are activated in the new TSG you can proceed with the next steps.

Continued on next page

Trunk Conversion, Continued

Trunk Subgroup Remains in Service, Continued

19. Remove the old MF TSG from all of the RDBs using RC Form 514.

20. Delete the old MF TSG using RC Form 107.

21. If the ISUP TSG requires the name of the old TSG, change the new TSG name to the old TSG name using RC Form 802. This RC Form changes the TG name so the TSG must equal the TG. If the TSG is only part of the TG, you must create a second new ISUP TSG with the correct name and move all the members to it.

22. At this point, the TSG is converted from MF signaling to ISUP (that is, SS7) signaling. You are ready to proceed with the next TSG to be converted.

End of Procedure

Table 7-I

This table contains recent change data.

RC Form	Trunk Direction
100	2-way
101	1-way incoming
102	1-way outgoing

Continued on next page

Trunk Conversion, Continued

Trunk Subgroup Removed From Service

The following procedure applies when the TSG being manually converted from MF signaling to SS7 signaling is removed from service during the conversion process.

1. Verify the TSG characteristics using the VER:TSG input message. This message provides the information for populating RC Form 107 in Step 7.

2. Verify the TSG member assignments using the VER:TRK input message (TAN keyword). This message provides the detailed office assignments of each TSG member. The TFN and TAN are required when populating RC Form 203.

3. Verify the SS7 dynamic routing status in the 3B/CNI processor using the OP:C7NET input message (ROUTING keyword). We want to ensure that the cluster being converted has CNI routing before proceeding any further.

4. Coordinate the conversion with the far-end office whose trunks are being converted before proceeding any further.

5. Remove the TSG members from service (CAD.DSA State) using the SET:TRKSTAT input message (CAD.DSA keyword).

6. Using RC Form 202, remove the members from the TSG in order to change the signaling characteristics.

7. Change the TSG characteristics to indicate ISUP signaling. The TSG characteristics noting attention include: PCF, DPC, CIN, TOT, ISC, OSC, CCIS2WIRE, XCPA, REV, GLARE, and EAS. Use of the appropriate RC Form depends on the directionality of the TSG as shown in Table 2-I.

8. Verify the TSG characteristics using input message VER:TSG.

9. Add the members back to the TSG using RC Form 203.

10. Verify the TSG member assignments using the VER:TRK input message (TAN keyword).

Continued on next page

Trunk Conversion, Continued

Trunk Subgroup Removed From Service, Continue

11. Coordinate with the far-end switch before proceeding past this point. The far-end switch must be ready to test and activate the members before you proceed.

12. Test the TSG members for correctness and workability for the following areas using the TEST:TRK input message:

13. Call Processing and Maintenance states: CIN and TQU keywords

14. Traffic Number, Office Name, and Trunk Glare: CIN and TIC keywords

15. Voice Path Assurance: CIN and CCK keywords

16. Coordinate with the far-end switch and activate the TSG members using the SET:TRKSTAT input message (ACT, CIN, and TSG keywords).

17. At this point, the TSG is converted from MF signaling to ISUP (that is, SS7) signaling. You are ready to proceed with the next TSG to be converted.

End of Procedure.

Circuit Query

Overview

A circuit query, sometimes referred to as trunk query, verifies the consistency of the call processing trunk states and trunk maintenance states at both ends of a SS7 trunk. State consistency, however, does not imply that the states at both ends are identical. Circuit query checks the states at both ends of a trunk and determines if an acceptable state combination exists. If an unacceptable combination exists, the switch initiating the circuit query takes the necessary corrective action to put both ends into one of the valid state combinations.

For the *4ESS* Switch, circuit query settings are made on a per office basis. Audits 95 and 96 routinely query the whole office. Inhibiting the audits stops the queries from running.

Requirements

Requirements for circuit query are specified in TR-NWT-000317, Switch Systems Requirements for Call Control Using the Integrated Services Digital Network User Part, Bell Communications Research Specification of Signaling System 7.

Timing of Queries

Circuit query in the *4ESS* Switch is routinely performed several times per day as a function of office size, the number of trunks, and the available real time (Audit 95). In addition, one trunk in each subgroup is queried also as a function of office size, the number of trunks, and the available real time (Audit 96). To inhibit the queries, refer to the **INH:AUD** and **OP:AUDSTAT** messages in the IM-4B000-01, *4ESS Switch Input Message Manual*, and the OM-4B000-01, *4ESS Switch Output Message Manual*, respectively. Likewise, to allow the inhibited audits to execute, refer to the **ALW:AUD** and **OP:AUDSTAT** messages in the same documents as above, respectively.

Note:
The *4ESS* Switch Audit 96 can be manually executed with the **AUD:NUM** input message. The *4ESS* Switch Audit 95 cannot be manually demanded.

Continued on next page

Circuit Query, Continued

Trunk Translation Test

The trunk translation test, commonly known as the Circuit Validation Test (CVT), is a manual request used to ensure that connecting switches have consistent translation data in order to place a call over a specified circuit. The test does not use the actual physical trunk path during the test, but instead transmits the translation data between connecting switches through the SS7 signaling links. See the **TEST:TRK** … ;**TIC** messages in the IM-4B000-01, *4ESS Switch Input Message Manual*, and the OM-4B000-01, *4ESS Switch Output Message Manual*.

Trouble Shooting Tools

Trouble Shooting

For SS7 Trouble Shooting Tools see document 256-015-300.

Additional Features

Full Point Code Routing (FPCR) and E-Link Access Features (247/344)

The following new measurements have been added to the Signaling Network Performance Report - Part 1 and 2:

- The number of times traffic is diverted to a lower priority link set is collected on a link set basis as a result of either a rerouting or changeover procedure.
- The duration (in seconds) that traffic is diverted to a lower priority link set is collected on a link set basis. The duration begins on the first occurrence of any signaling traffic being diverted from a higher priority route to this link set (that was not previously handling alternate routed traffic) and ends when no alternate routed signaling traffic is being sent to the lower priority link set. (This could be an A-link or E-link set.)
- The measurements, which are reported by CNI, are collected every 5 minutes and are available on a 15 minute basis.