ELECTRONIC TANDEM SWITCHING
SOFTWARE DESCRIPTION
2-WIRE NO. 1/1A ELECTRONIC SWITCHING SYSTEM

CONTENTS PAGE

CONTENTS PAGE

CONTENTS PAGE

CONTENTS PAGE

1. GENERAL

INTRODUCTION

1.01 The Electronic Tandem Switching (ETS) feature software package consists of a group of programs which enable a No. 1/1A Electronic Switching System (ESS) to serve as a tandem office in a centrex network. It gives centrex customers additional flexibility by allowing them to control station features and routing of calls. It also provides information to the customer about the status of the network and of individual calls. These features enable customers to administer their network for maximum efficiency and economy.

1.02 When this section is reissued, the reason for reissue will be given in this paragraph.

1.03 Part 6 of this section provides a list of abbreviations and acronyms used in this section. Part 7 provides a list of references for further information.

PURPOSE OF THE ETS SOFTWARE

1.04 The ETS software provides stored program control of the routing of centrex calls. It also provides information and a degree of control to centrex customers to help them to administer their network.

1.05 The ETS allows a customer to specify the routing of calls in order to obtain less expensive routing whenever possible. Additionally, all calls may be monitored for accounting purposes. In order to minimize costs and to allow efficient use of the network, the ETS feature provides the ability to deny calling features from some centrex lines entirely, or to deny the use of those features only at certain times. For centrex customers with several locations, the ETS feature provides a private network for efficient and economical communications between customer locations.

SCOPE OF SECTION

1.06 This section provides an introduction to the ETS software for a No. 1/1A ESS office. Fea-

tures through the 1E7 (for No. 1 ESS) and 1AE7 (for No. 1A ESS) generics are covered.

2. PROGRAM ORGANIZATION

2.01 The various ETS programs perform three main functions:

- Routing
- Handling customer control inputs
- Providing administrative information.

These functions are described in detail within this section.

2.02 Within each of the three main functions listed above there are several subfeatures. The general relationship of the ETS features to the other call processing functions is shown in Fig. 1. Subfeature interfaces are shown in Fig. 2 and 3.

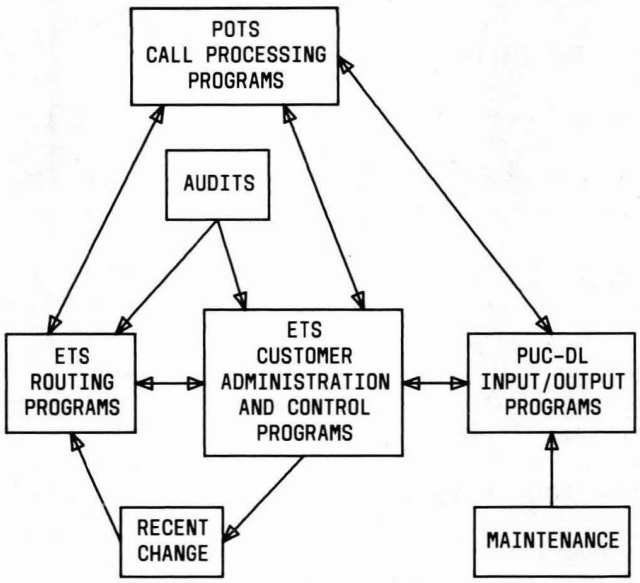


Fig. 1—ETS Feature Interfaces

2.03 Most of the ETS features are implemented by inserting hooks and adding new subroutines to existing pidents. Some of the major types of pidents including ETS routines are:

- General call processing
- Centrex call processing
- Digit analysis
- Automatic message accounting
- Data link interface
- Recent change
- Queue handling
- Translations.

Table A lists the feature packages required for implementing ETS. Table B lists some of the major pidents containing ETS routines.

3. GENERAL DESCRIPTION

ETS CONFIGURATIONS

3.01 The ETS is a software package that enables a No. 1/1A ESS office to serve as a tandem switch for centrex calls. It may be used in several different configurations. There may be only one ESS with one or more private branch exchanges (PBXs) or centrexes connected. See Fig. 4 for an example of this configuration. In that case, ETS serves primarily to enhance PBX or centrex features by providing improved administration, control, and data. The ETS may also be used as part of an Electronic Tandem Network (ETN) where several centrex systems are connected to different ESSs to form a private network over a wide geographic area. For example, a company with offices in several cities may use an ETN for a private communications network. Tandem switches in an ETN may include both ESSs with ETS and DIMENSION® PBXs with similar features. See Fig. 5 for an example of this configuration.

UNIFORM NUMBERING PLAN

3.02 The ETS uses a uniform numbering (UN) plan. Under this plan, the customer dials an ETS access code (typically "8") plus 7 digits to reach

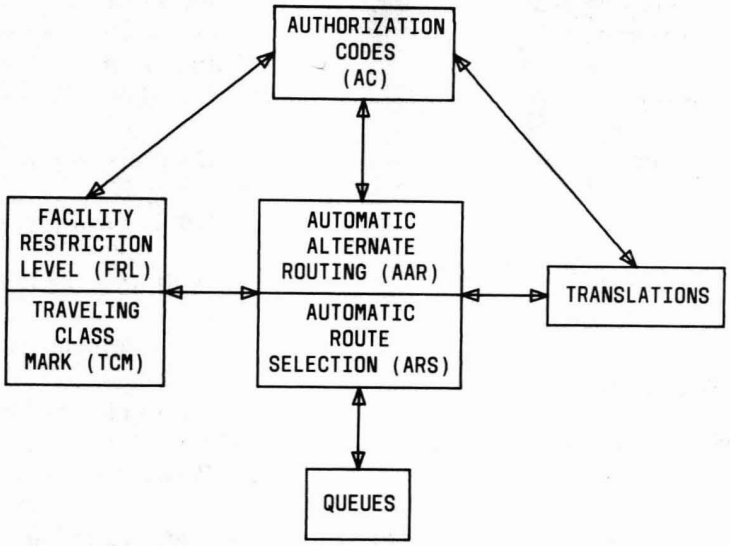


Fig. 2—Dependencies of ETS Routing Function

other stations in the private network, or 10 digits for calls to off-network stations. The 7-digit number is a private network number. The last 4 digits of the private number are always the same as the last 4 digits of the normal 10-digit public number.

DIALING PLAN

3.03 The dialing plan for ETS customers is shown in Fig. 6. The first digit is an ETS access code. After getting dial tone from the ESS, the customer may optionally dial an account code. Then the desired number, 7 or 10 digits, is dialed. If an authorization code is required, recall dial tone (three short bursts of tone, then steady) is returned and the authorization code is collected. The account code and authorization code are discussed in more detail later.

ETS HARDWARE

3.04 Administration and control information is passed between the ESS and the customer premises via a data link. The ESS interfaces to the data link via a peripheral unit controller (PUC) and a synchronous or asynchronous line interface unit (LIU). The equipment at the customer premises will vary depending on which features have been purchased. Equipment will typically include either a local customer administration terminal (LCAT) or customer administration and control system (CACS), and an attendant telephone set. Many customers will have a 93A or a 94A customer premises system (CPS) tape drive.

RECENT CHANGE

3.05 Recent change (RC) messages are available to build or change the translations data used by ETS. For information on these messages, see the Recent Change sections listed in Part 7, References.

3.06 The control messages available to ETS customers also produce RC data. There is a limit on how much RC data the customer will be allowed to produce, to provide administration of RC resources. If the RC area is full or nearly full, a warning message is printed on the central office TTY.

4. ROUTING FUNCTIONS

GENERAL

4.01 Any phone call can normally be sent over several different paths. For ETS calls, the route chosen is based on a route list. For any geographic area, there may be one or more possible routes given in the route list. When a customer accesses ETS and dials a number, the ETS software performs a digit translation to determine which route list is appropriate for the call. It then refers to the list for access to the first choice route. If the first choice route is available, it is seized and used to serve the call. If it is un-

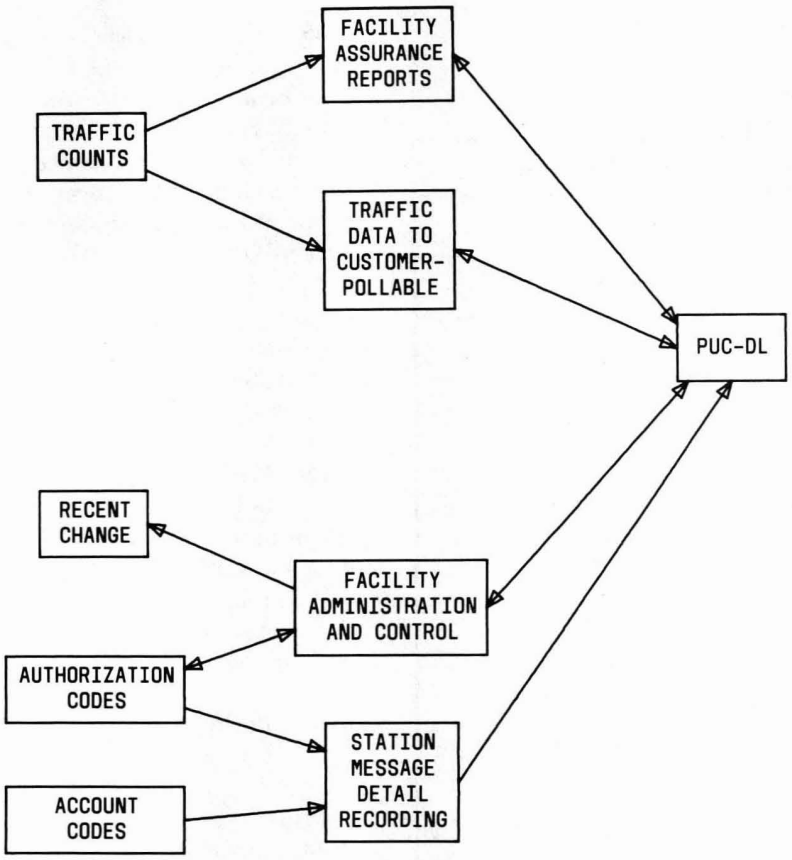


Fig. 3—Dependencies of ETS Administration and Control Functions

available, other choices may be available. Figure 7 provides a flowchart of routing functions. Details are given in the following paragraphs.

4.02 Each ETS customer may purchase up to three route patterns for off-network calls. There is only one route pattern for on-network calls. Each route pattern consists of a group of route lists. There is a route list for each geographic area, giving possible routes to that area. Only one pattern is active at any given time. The active pattern is determined by time of day and day of week as preselected by the customer. The customer can also activate an alternate pattern with a command from a terminal at the customer's premises. In this way the customer can take advantage of varying rates and traffic levels.

4.03 There are two similar features which provide for routing calls using route lists. Automatic route selection (ARS) handles off-network calls (dialed as 10 digits). Automatic alternate routing (AAR) handles on-network calls (dialed as 7 digits). The AAR can have up to four routes per route list. These routes would typically include facilities such as tie trunks, which would give the most direct and inexpensive route to the distant node in the ETN. The ARS may have up to ten possible routes per route list. These routes may include both real and simulated facilities.

4.04 Translation routines are used to determine whether the call is on- or off-network and to select and index into the route list. The route list entry points to a first choice route. If that route is available, it is seized and used to serve the call. If it is unavailable, the programs will continue to search the list for an alternate route until one of the following occurs:

(a) An idle facility is found.

TABLE A

ETS FEATURE PACKAGES

FEATURE GROUP	FEATURE PACKAGE
CFPF	CFPF
CFCO	CFCO
CFPN	CFPN
CTRF	CTRF OPSW
ETS	ACRB BQRS BTRK CCI DDDT DLUP ECAC EMDR ETS ETSQ PTRF QPRI RLST WOPI
IAC	ACS CLOG RCAD
PUC	DIAL PUC
PUCDL	PUCDL
SCOF	SCOF
TCM	TCM
LHTO	LHTO

(b) All routes in the list have been tried and found busy.

(c) Further searching is prohibited by the facility restriction level (FRL) or the inhibit alternate route hunt indicator.

4.05 With the 1E6/1AE6 generic, there is one 3-digit translator for each route pattern. There may be a maximum of three route patterns per customer. The current route pattern in effect is determined from the alternate route table and used to decide which of the three translators to use. The appropriate 3-digit translator is indexed by the first three digits dialed, either area code or office code. Each 3-digit translator entry points to either a route list or to a 6-digit foreign area translator (FAT) which then points to a route list. The route list contains information on the various possible routes to use for the call.

4.06 With the 1E7/1AE7 generic, there is only one 3-digit translator per customer. Each entry in the 3-digit translator points to the appropriate ARS or AAR route list. The route pattern currently in effect is then determined and used to index the route list to obtain the information on possible routes to use for the call.

4.07 Both the 1E6/1AE6 and 1E7/1AE7 translation methods yield identical results and can coexist in an office. However, the 1E7/1AE7 method provides more efficient use of memory. The 3- and 6-digit translators are done by routines TR3DAM and TR60PT respectively in pident TRBD.

ALTERNATE ROUTE TABLES

4.08 If the customer has purchased more than one route pattern, a program is entered every 15 minutes to determine which pattern should currently be active. It does this by consulting a table which lists which route pattern to use for each 15-minute period of each day of the week. It also checks to see if a customer override is currently in effect. This optional override allows the customer to specify a table other than the one which would be selected automatically. Whichever table is to be used is then activated.

FACILITY RESTRICTION LEVEL

4.09 Each centrex station can be given a facility restriction level. This is a digit from 0 to 7 which is used to determine which routes in the route list may be used by the calling station. Each outgoing facility in a route list also has an FRL associated with it. An outgoing facility will only be eligible to serve a call if the FRL of the originating station is greater than or equal to the FRL of the outgoing facility. For example, a call with an FRL of 7 may be

TABLE B

PIDENTS CONTAINING ETS ROUTINES

PIDENT	DESCRIPTION
ADDX	Dialed additions for centrex
AMAC	AMA data accumulation
CFGR	Customer facility group register routines
CGTB	Carrier group alarm, trunk make busy
CHGD	Scanpoint change director
CTRF	Customer traffic data
CX1X	1XX tandem tie line
CXIC	Trunk digit analysis for centrex lines
CXOR	Originating digit analysis for centrex
DLUP	ETS dial up data link control
DPOP	Dial pulse outpulsing control
ECAC	Customer control and status
ICAL	Digit analysis for trunks
MDRO	Message detail record output
NMTG	Network management trunk group controls
ORDL	Originating digit analysis for lines
PTRF	ETS customer pollable traffic data
PUIO	PUC DL input/output
QAPR	Queue administration and processing
QCIA	Queue customer interface and audit
QEDA	Queue entry and destination assignment
QSIF	Queue state information features
QTRK	Terminate to trunk facilities
QWAT	Queuing for WATS
RCCX	Recent change: Centrex common block
RCEI	Recent change: EPSCS customer common block
RCFV	Recent change: Call forwarding
RCLI	Recent change: Line translations
RCRL	Recent change: Route list routing
RCSF	Recent change: Simulated facilities
RCTG	Recent change: Trunk group
RCTS	Recent change: Recent change tables
RCUP	Recent change: Recent change update
RCXD	Recent change: Centrex digit interpretation
SAQU	Variable length queue and timing list audit
SARG	Call register audit
TAND	Tandem connections program
TFCL	Traffic count collection
TFQR	Quarter-hour traffic data administration
TRBD	Basic digit analysis and conversion
TRBL	Basic line and directory number
TRBT	Basic trunk translations
TRCD	Centrex digit analysis
TRCT	Centrex trunk
TTxx	TTY output messages
TVBD	Verify basic digit analysis
TVBL	Verify basic line and directory number
TXFR	Temporary transfer
YAHA	Seize and release routines, L-, J-, and T-bit administration

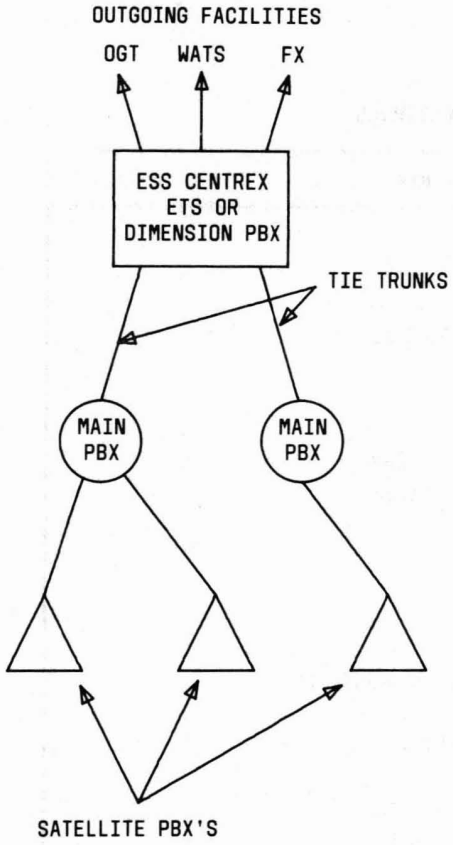
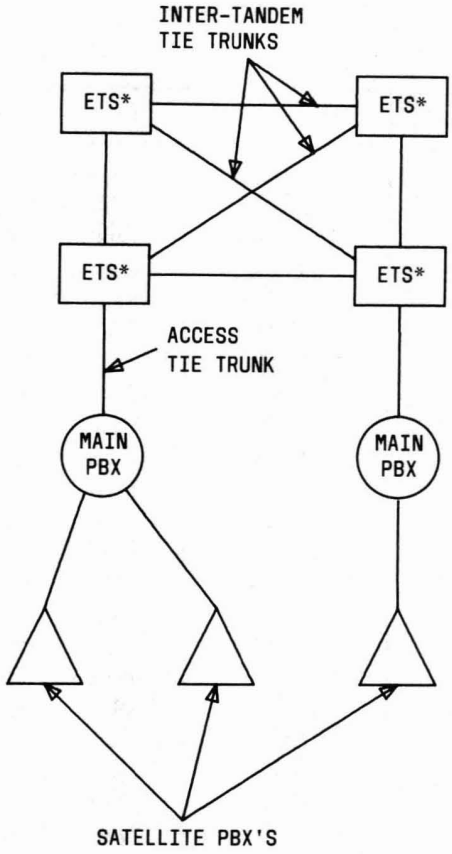


Fig. 4—Typical ETS Configuration



* MAY BE EITHER A 1/1A ESS WITH ETS OR A DIMENSION PBX WITH ETS.

Fig. 5—Typical ETS Tandem Network

able to use any route on the list, while a call with an FRL of 2 will only be able to use outgoing facilities with an FRL of 0, 1, or 2.

4.10 An FRL is assigned to each collocated station, incoming access trunk group, centrex tie trunk group, and intertandem trunk group. The FRL for a collocated station is stored in the private network option word (PNOW) in the auxiliary block for the LEN translator.

4.11 In order to further restrict access to facilities at specific times, the customer may activate an alternate FRL table by typing a command from CACS or LCAT. When this alternate table is active, each FRL effectively has a new value. For example, all calls which have an FRL of 7 could be changed to receive treatment as if they had an FRL of 5. The alternate table is activated by routine ECCPAT. When a call is originated, routine ECAFRL, which is called by TRBD and CX1X, determines the proper FRL to use for the call. These routines are located in pident ECAC.

TRAVELING CLASS MARK

4.12 If a call must go through more than one ETN office, an extra digit may be outpulsed after the called number. This extra digit, known as the traveling class mark (TCM) is used by the distant office for routing. It is sent using the same signaling method as is used to send the called number (dial pulse, multifrequency, or TOUCH-TONE® service signaling). The TCM normally has the same value as the FRL of the originating station, but may be derived from the authorization code, if one was dialed. If no TCM is sent, the call is processed at the distant end using the FRL of the incoming trunk.

AUTHORIZATION CODES

4.13 Authorization codes (ACs) may be required to complete certain calls. The decision on

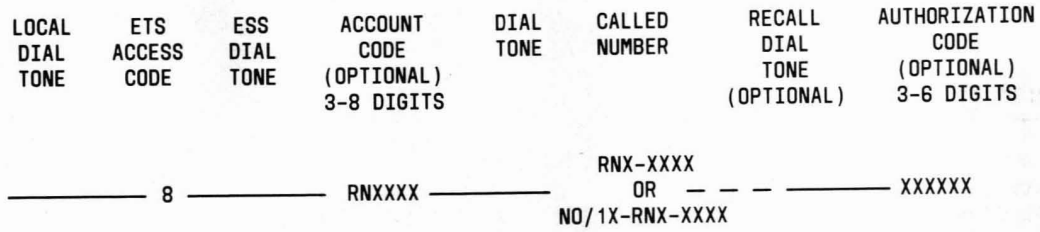


Fig. 6—ETS Dialing Plan Using Uniform Numbering

whether an AC is required is based on the first three digits dialed and the particular station originating the call. Typical restrictions are:

- No network calls allowed
- Selected network calls allowed
- All network calls allowed
- Some off-network calls allowed
- All calls allowed.

4.14 When a call is dialed, routine TR3DAM or TR6OPT in TRBD checks to see if the AC bit is set in the supplementary call identification word (SCIW). If it is set, the originating station requires an AC for calls to the location indicated by the first three digits of the called number. Recall dial tone is returned and a digit receiver is attached to collect the 3- to 6-digit AC. When an AC is collected, its associated FRL is used for routing the call. If an alternate FRL table is active, the alternate FRL will be used. If the AC collected is invalid, the call is sent to reorder tone.

4.15 The ACs used by ETS are stored in a table in ascending order as a list of ACs and corresponding FRLs. Both an AC and its FRL can be changed by the customer. However, due to the way the ACs are stored, an AC can only be changed to another number between the next smaller AC and the next larger AC. The range of possible values to which a particular AC can be changed is determined by routine TRDBND in TRBD. An AC is changed by routine TRCHAC, and an FRL is changed by TRCACF, both in TRBD. These routines will be called when a customer requests a change in authorization codes or facility restriction levels via CACS or LCAT.

QUEUES

4.16 If no route is available, the call may be placed on a queue for the first route in the list, if the customer has purchased queuing. If queuing is not available, reorder is returned.

4.17 Queues are available on a per route basis. Each queue may be divided into routine and priority sections. Routine queues may be either off-hook queues (OHQs) or ringback queues (RBQs), and serve only incoming calls to collocated stations. The priority section is always an OHQ and serves facilities as listed in Table C.

4.18 Routine MISTRM in QAPR determines whether a call should be placed on an OHQ or an RBQ and determines if there is room on the queue. A queue register is then seized by routine YASZQR in YAHA. Routine queue registers are loaded by QALONQ in QAPR.

4.19 Whenever a queued for facility becomes available, QAABQ1 in QAPR is called to remove the call register from the queue, and the call is completed over the idle facility. When there are routine calls on the queue, service protection timing is started by QATOSP in QAPR. If there is a priority call waiting when a facility becomes available, a check is made to see if service protection timing has expired. If it has not, a priority call is served. If it has expired, one more priority call is served, but the next idle facility will be given to a routine call. Service protection timing is then reset. This assures that routine calls receive periodic service even if the priority queue is never empty. The service protection timing is chosen to provide an acceptable grade of service to both priority and routine calls.

4.20 The customer may specify a maximum amount of time a call may be on queue. This

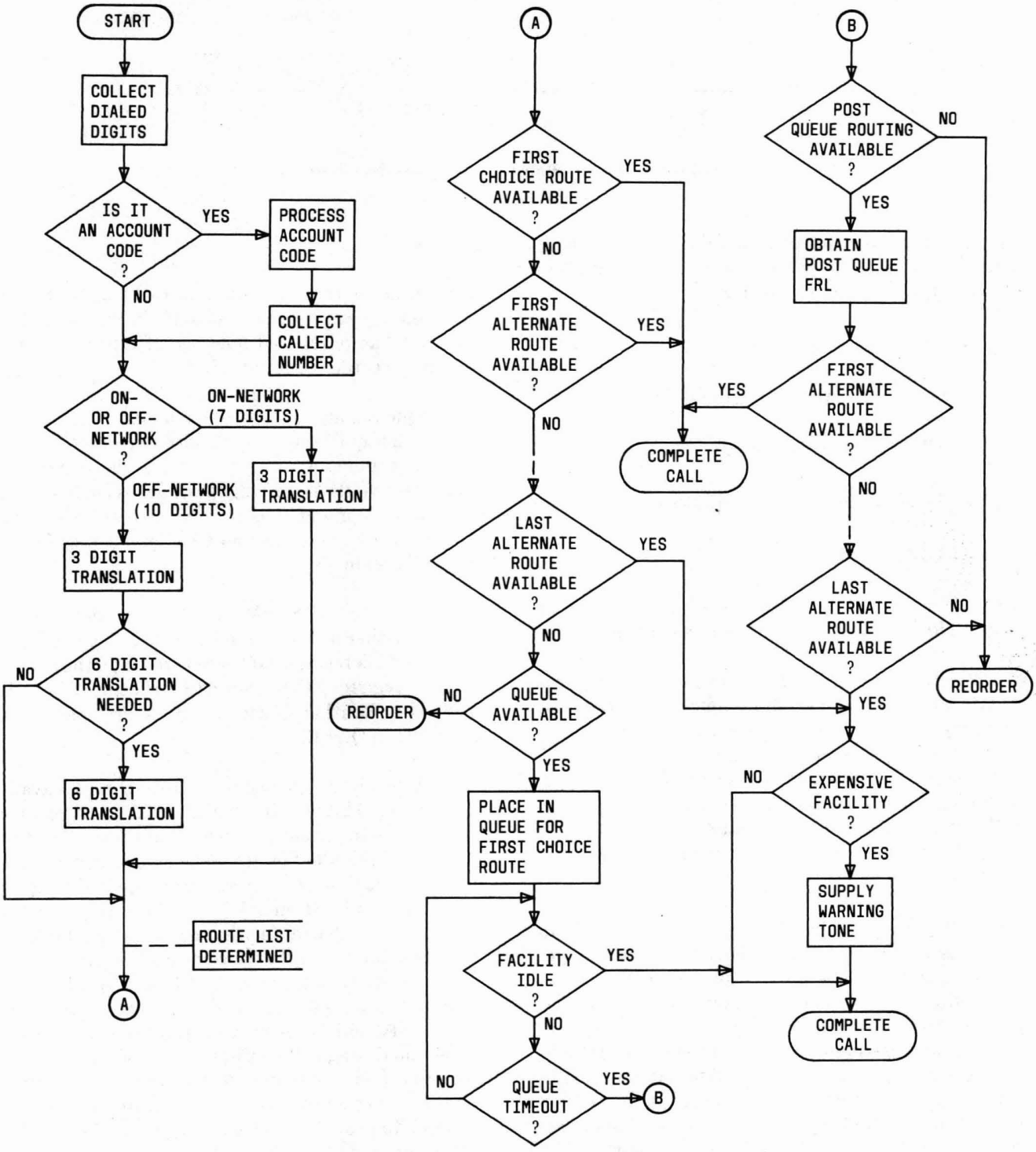


Fig. 7—ETS Routing and Queuing Using ARS/AAR — Flowchart

TABLE C

FACILITIES ASSOCIATED WITH ETS PRIORITY QUEUES

INCOMING FACILITIES	OUTGOING FACILITIES
Collocated stations	Intertandem trunks
Attendant console	Off-network access trunks
Centrex tie trunks	Centrex tie trunks
Access trunk	Simulated OUTWATS
Intertandem trunks	Local off-network access lines (LONALs)

time-out period may be different for the priority and routine sections and may vary from 0 to 4094 seconds or be infinite (no time-out). Treatment of calls which time out on queue is discussed in following paragraphs.

A. Off-hook Queue Operation

4.21 When all routes in a route list are busy, the call may be placed on an OHQ if all of the following conditions are met:

- The incoming facility does not have queuing inhibited.
- The first choice route has a queue associated with it.
- Queuing is allowed for all trunks involved.
- There is room on the queue.

If any of these conditions are not met, the customer is sent reorder.

4.22 Customer-supplied music or announcement may be sent while a call is on queue. This music or announcement is established by QTMIL in QTAL for lines and by ADDAMI in ADDA for add-on calls. A call will remain on the queue until one of the following occurs:

- The queued-for facility is reported to be idle.
- The customer abandons.
- The queue entry times.

In the first case, the queue register is unloaded by routines in QTRK and the idle facility is seized and used to serve the call. If the customer abandons, the queue register is removed from the queue by QABONQ in QAPR and the call is dropped. If the entry times out, a check is made to see if post-queue routing is allowed. If it is, the current FRL is compared to the post-queue FRL and the call hunts through the route list using whichever FRL is better. If an idle facility is found, it is used. If not, reorder is returned. Reorder is also returned if post-queue routing is not allowed. It is possible that the route chosen for post-queue routing will be marked "expensive." In this case, the expensive route warning tone (see further details below) is returned by QSIF.

Major OHQ Pidents

4.23 The pidents containing routines that load calls onto an OHQ include CXOR, QAPR, ICAL, and QTAL. Calls are removed from the queue by routines in QTRK. Expensive route warning tone is supplied by routines in QSIF and ADPB.

B. Ringback Queue Operation

4.24 When a customer requests to be put on an RBQ, the following conditions must be met:

- The desired facility is unavailable.
- Ringback queuing is offered for the desired facility.
- The originating party is permitted on an RBQ.
- There is room on the RBQ.
- The originating party does not have any other call on any RBQ.

If any of these conditions are not met, the call is sent reorder. If not, confirmation tone (three short bursts of tone) is returned, a queue register is seized and linked to the originating register, and timing is started by RBQQDIS. If the customer goes on-hook within 5 seconds, the originating register is released and the queue register is placed on the RBQ. If not, the registers are released and reorder is sent. The call remains on the queue until the facility becomes available or the queue entry times out. This time-out period may be different than that for the OHQ. If an RBQ entry times out, the call is dropped.

4.25 Every 6 seconds, a D-level entry is made to QTETSD in QTRK, which attempts to serve

the queue. If the facility becomes idle and the originating station is not busy, the originating station is sent a distinctive ring by ACRB in ACBC. If the line is busy, several more attempts, about 1 minute apart, are made before dropping the call. When a customer is rung back, they must go off-hook within three-to-four ringing cycles or the call is dropped. If the customer goes off-hook within the specified time, the call is completed over the facility that became idle.

4.26 A customer may request information on the status of their RBQ call by dialing an access code. If this request is received, all the ringback queues in the office are searched. If the requesting station has a call on the queue, recall dial tone is returned; otherwise, reorder is returned.

Major RBQ Pidents

4.27 The major pidents that contain RBQ routines include: CXOR, CXSF, ORDL, QEDA, QSIF, QTAL, QTRK, QWAT, YAHA, and YMGR.

EXPENSIVE ROUTE WARNING TONE

4.28 The last route in a route list, if it is a simulated facility, may be marked "expensive." If this route is the only one available, a 1-second expensive route warning tone is sent to the calling station via the SD-1A218-01 tone circuit. The calling party then has the option of hanging up and trying later, in order to avoid the higher cost route. This mark is made on a per route list basis, so that a given route may be marked "expensive" on one list but not on another.

SELECTIVE CUSTOMER CONTROL OF FACILITIES

4.29 The selective customer control of facilities (SCCOF) feature provides an ETS attendant with the capability to make an individual facility group unavailable to outgoing traffic. The attendant may deny access to a facility group by operating a locking key located at or near the attendant position. The feature is deactivated by releasing the key.

4.30 There must be one key for each facility group to be controlled. Each key is associated with a master scanner scan point. The SCCOF scan points are monitored by supervisory scans. When a change in state is detected, the master scanner number is used by routine TRMSNA in CHGD to obtain information to determine what facility group is associated with the particular SCCOF key that was operated and what data items to set or reset.

4.31 When an SCCOF key is activated, an outgoing load control item in the corresponding trunk group head cell and a trunk group skip indicator in the trunk group annex are set. If the facility is a simulated facility, a simulated facility group skip item is set. When the SCCOF key is released, these items are reset. The bits are set and reset by routines SCOFON and SCOFOF respectively in pident CGTB.

4.32 When an ETS customer originates an outgoing call, the trunk group or simulated facility group that is to be used to serve the call is checked by CHKSCOF or CHKSCOF1 in TRBT to determine if the group has the SCCOF feature. If not, call processing proceeds normally. If it does have the SCCOF feature, the outgoing load control indicator is checked. If it is not set, call processing will proceed normally. If it is set, the trunk group skip indicator (or simulated facility group skip indicator) must also be checked since the outgoing load control bit can also be set by network management. If the skip indicator is also set, the call will go over an alternate route or to overflow.

4.33 If an SCCOF controlled trunk group has a trunk group busy lamp, it is necessary to light or extinguish the lamp when the SCCOF feature is activated or deactivated. Routine TRGNAA determines if there is a lamp present. If there is, routine TRENPS determines the centrex number which is used by CXTBON and CXTBOF in pident CXKY to light or extinguish the appropriate lamp.

4.34 The SCCOF feature takes precedence over ETS queuing when both are active on a facility group. When SCCOF is activated, calls will not queue and will not alternate route according to the post-queue route list. Queuing is turned off by CXSCOF in CXOR.

CALL FORWARDING VARIABLE VIA PRIVATE FACILITIES

A. General

4.35 The call forwarding variable via private facilities (CFPF) feature is available in 1E7, 1AE7, and later generics. This feature allows all incoming calls to a given station to be forwarded or redirected to another station. The other station may be either on- or off-network.

4.36 The CFPF feature is divided into two parts: calls forwarded from collocated stations and

calls forwarded from noncollocated stations. Collocated means that the tandem switch also serves as the business service switch for the ETS customer. If business service is provided by a separate switch, this is referred to as noncollocated. For the collocated switch, the information dialed by the customer is collected directly by the tandem switch. In the noncollocated case, the information must be collected by the business switch, then transmitted to the tandem switch. The CFPF feature does not apply to noncollocated satellite centrex customer stations.

B. CFPF Activation

4.37 In order to activate CFPF, the customer must dial an activation code before dialing the ETS access code. The activation code is typically three digits long. The rest of the dialing follows the normal ETS dialing plan, with optional account code, the directory number of the station to be forwarded to, and the authorization code if required. If the calling station already has CFPF activated, reorder is returned. The tandem or business switch collects all digits dialed, providing dial tone when required. When all digits have been collected and found to be valid, confirmation tone (three short bursts of tone) is returned. If the customer remains off-hook, an activation call is placed to the station to which calls are to be forwarded. This allows the customer to notify the station of the forwarding and verify that they dialed the correct number. This call will be placed using AAR/ARS and, if necessary, may be placed on a queue. If the activation call cannot be placed for some reason, reorder tone is returned, or the call is given standard intercept treatment.

4.38 When a customer requests CFPF activation, a 6-word customer originated recent change (CORC) block is seized. It is used to store the ETS access code, the directory number of the station to be forwarded to, and the account code and authorization code if dialed. A CORC02 message is printed on the customer originated recent change log (CLOG).

4.39 For noncollocated customers, if the customer has the AC feature, an AC will be required for forwarding to an off-network station. At the customer's option, an AC may also be required for forwarding to some on-network stations.

4.40 When a CFPF activation call is originated from an ETS station, routine GET_TPT will seize, link, and initialize a call forwarding register. The first 3 digits received are analyzed by TXOACK to determine if they represent an optional account code or the directory number of the station to which calls are to be forwarded. If the number of account code digits expected (NACDE) is greater than zero and the first digit is equal to the lead account code digit (LACD) and the second digit is not 0 or 1, the dialed number is assumed to be an account code. The account code is stored in the 6-word CORC block by TXOAEN. The COL7 collects a 7-digit directory number. If a 10-digit number is dialed, routine TXCC7 is invoked to collect the additional 3 digits. Authorization code indicators are checked to determine if an authorization code is required. If so, routine GETAC will apply recall dial tone and collect the first 3 digits. Since the authorization code may vary from 3 to 6 digits in length, 5-second timing is initiated by TXSTVT to wait for additional digits. Additional digits are collected by TXRTTX which also reinvokes the timing routine TXSTVT if less than 6 digits have been collected. If the 5-second timing expires, an end-of-dialing digit (#) is received, or 6 digits are received, TXOFTM is called to stop timing. Routine ETSPN builds the 6-word CORC block, returns confirmation tone, and places the activation call.

C. CFPF Operation

4.41 When a call comes into a station having CFPF activated, routines in CXOR and TXFR are used to determine where the call is to be routed. The call is then routed to the distant station using AAR/ARS. If an AC was dialed at CFPF activation time, its FRL is used for routing all forwarded calls. An account code dialed at activation time will also be associated with all forwarded calls. A CFPF call will have a service feature code value of 2, which will be included in the expanded message detail recording records.

D. CFPF Deactivation

4.42 The customer can deactivate CFPF by dialing an access code. When the ESS detects this code, confirmation tone is returned to the customer and the CORC block containing the information for forwarding is released.

5. CUSTOMER ADMINISTRATION AND CONTROL FUNCTIONS

GENERAL

5.01 The ETS has provision for several optional features which give the customer considerable

information about and control of the system. These include:

- Traffic Data to Customer—Pollable
- Facility Assurance Reports
- Station Message Detail Recording
- Facility Administration and Control.

These features are described in the following paragraphs.

5.02 These features require that information be passed between the ESS and the customer's premises. This is done over a data link (DL). The DL interfaces with the ESS via a peripheral unit controller (PUC) and a line interface unit (LIU). The equipment at the customer's premises is typically a local customer administration terminal (LCAT) or a customer administration and control system (CACS). The LCAT is simply a terminal, while the CACS includes a DIMENSION (telecommunications switching apparatus) 400 processor and additional peripheral equipment. The CACS and LCAT operate at 300 baud and are used to send or receive facility administration and control messages or to request traffic reports. Customers with Station Message Detail Recording or the Expanded Message Detail Recording feature must also have a 93 or 94A customer premises system (CPS) tape drive. The CPS operates at 2400 baud. Figure 8 shows DL facilities and interfaces.

PUC-DL MESSAGE RECEPTION

5.03 The PUC-DL can receive messages from the customer's CACS or LCAT. The PUC-DL message reception programs effectively have two parts: a log-on sequence, and message handling. The log-on sequence consists of the following:

(1) Ringing detection

(2) Carrier detection

(3) Identification as CACS or LCAT

(4) Security code reception and validity checking.

The sending and receiving of messages is under the control of pidents DLUP and PUIO.

5.04 After the log-on is complete, several things may occur which would cause the PUC to send a special control message to the ESS, eg, carrier lost or a request from the distant end to cancel the cur-

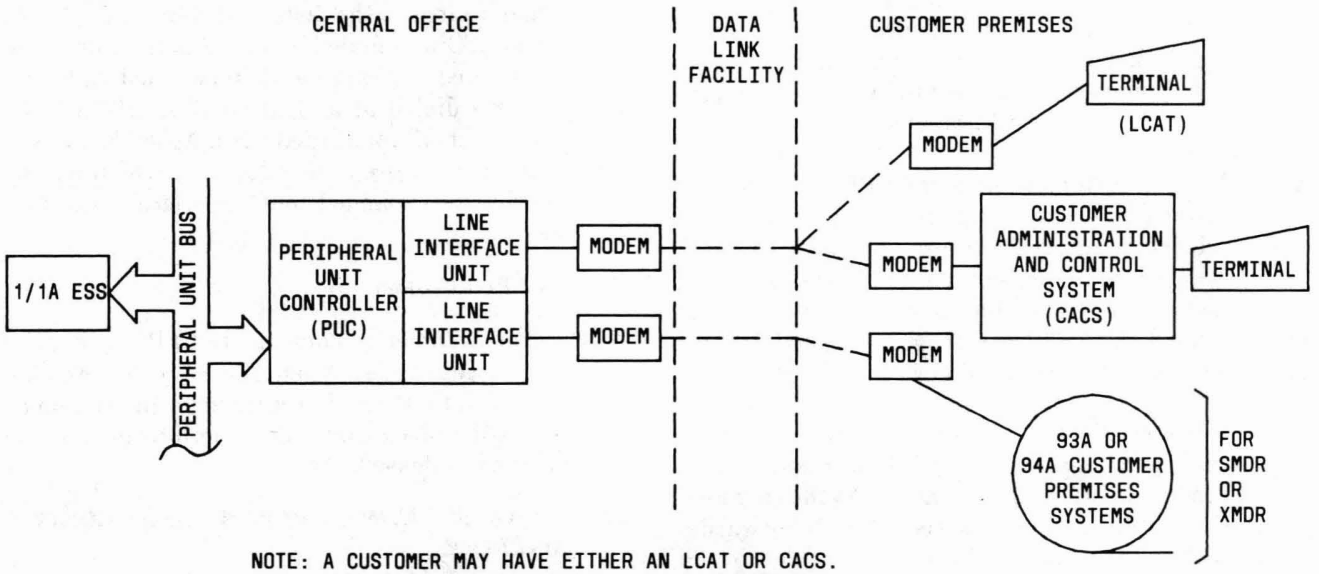


Fig. 8—PUC-DL Facilities and Interfaces

rent input line. If a complete message is received, it is checked for syntax errors. If there are none, the message is sent to the central control for further processing and execution. If errors are found, a syntax error message is sent to the customer.

5.05 Once the ESS receives a message, programs further analyze the message to determine exactly what was requested. They take whatever action is required, such as to look up requested information. Any message which must be sent to the customer is formatted and passed to the PUC-DL input/output (I/O) routines in DLUP. These I/O routines send the message to the PUC. The PUC contains a microprocessor which converts the message to a form suitable for sending over the DL to the customer.

5.06 During heavy DL usage, messages may be queued. If they cannot be sent within 10 to 20 seconds, the records are lost.

MAINTENANCE AND ERROR HANDLING

5.07 There are a number of checks made to assure that data sent between the ESS and the customer premises are received without errors. There are also techniques used to try to correct errors when they do occur. These are discussed in the following paragraphs.

A. Duplication

5.08 The PUC has fully duplicated controllers. If one fails, it will be taken out of service and its backup used instead. This is done automatically under software control.

B. Parity

5.09 Each character of data sent includes a parity bit. If a parity error is detected, a message is sent back reporting the error so that the message can be sent again.

C. Error Counts and Messages

5.10 If there are sending problems from the PUC, such as repeated parity error reports, an error count is incremented by the PUC. If this count exceeds a threshold, a message is printed on the TTY. If a problem occurs which is so severe that a message cannot be sent, an abort bit is set by the PUC to inform the central control. Before sending a message, the central control checks this bit to see if the previous message was sent successfully. If it was not, message sending is halted until the problem can be cleared.

D. Maintenance Messages

5.11 Maintenance messages are sent periodically to the 93A or 94A customer premises system. When the 93A or 94A receives a maintenance message (which is identified by a special maintenance header), it compares the received message with its permanent copy. If there is a mismatch, it requests that the message be sent again. After two or three failures, the trouble is reported on the central office TTY. Short maintenance messages are sent several times a day and a long message is sent once a day at a low traffic time (eg, midnight). These messages may also be requested by maintenance personnel when a problem is suspected.

TRAFFIC DATA TO CUSTOMER—POLLABLE (PTRF)

5.12 The ESS maintains various counts which are available to the customer. These are obtained by dialing up the DL from the CACS or LCAT and entering a request. This is normally done on a daily or hourly basis. The schedule is established in the ESS translations per customer requirements. The schedule intervals may be changed by service order. The CACS can provide traffic data at designated intervals or the customer may manually poll for data. Measurements may be made in 15-minute increments and may be maintained on a total or peak basis at the customer's option. These counts are normally reset after they have been sent to the customer. The operating telephone company may also obtain the information by using the CTR message, but in that case the counts are not reset.

5.13 Counts maintained by the ESS which are available to the customer include:

(a) Trunk and simulated facility usage

- Incoming peg count
- Outgoing peg count
- Total usage
- Overflow to reorder/queue
- Maintenance usage.

(b) Queues

- Peg count
- Overflow
- Abandons
- Time outs.

Table D gives a summary of when the various counts are pegged.

5.14 The CACS can receive additional information including:

- Number of collection periods passed since the last poll
- Indication of major or minor changes made since the last poll
- Customer id
- Traffic template which describes the format of traffic data sent.

This information is not available to an LCAT.

5.15 If the counts are being updated when a request is received, a message is sent by SECT4 to inform the customer to try again later.

5.16 The traffic data programs have three main functions:

- Pegging the counts
- Processing the data (totalizing, etc)
- Outputting data to the customer.

5.17 The various counts are pegged by pident CTRF. Pident TFCL is entered every 100 seconds to totalize counts and pident TFQR is entered every 15 minutes to provide totals for quarter-hour summaries. Data is outputted to the customer by DLQST in pident DLUP which is called by pident PTRF.

5.18 When SCCOF is active, no traffic counts for the facility group or queue associated with the facility group are pegged by calls attempting to access that group. Calls in the talking state when control was activated will continue to peg usage counts until they are disconnected. Calls on queue when SCCOF is activated will continue to peg queue counts until they are abandoned or time-out.

5.19 The customer has the ability to receive peak traffic data. The customer may identify one or more traffic counts as a "master" count. Each master count can have zero or more "slave" counts associated with it. At the end of each collection period, the value of each master count is compared with its previous peak value. If the current value exceeds its previous peak value, the current value replaces the previous peak value. The value of each associated slave count is also replaced by the value it has at the time its master count is found to have a new peak value. The only restriction is that a given count for a given facility may appear only once on the customer's traffic report. On the customer's output, counts are marked as master, slave, or hourly.

5.20 Every 10 seconds, routine CTTBSY in CTRF is entered to scan each trunk to determine if it is idle, busy, maintenance busy, or on the high and wet list. Once a previously idle trunk is found busy, it is no longer scanned until the next collection period. Every two hours, beginning at 12:15 am, this information is used by CTNUTS to generate a list of trunks which were not used or were locked up on the high and wet list for the entire 2-hour period. This is the nonusage trunk scans/locked up trunk scans (NUTS/LUTS) list. If the customer requests this information, it is formatted and sent to the customer's terminal. The list includes the facility group number and member ID of each trunk on the list. The LUTS entries are marked with an asterisk.

5.21 If a facility group is held unavailable during an entire 2-hour period by SCCOF, the trunks in the trunk group will appear on the NUTS report.

STATION MESSAGE DETAIL RECORDING AND EXPANDED MESSAGE DETAIL RECORDING

A. General

5.22 The station message detail recording (SMDR) feature records considerable information about calls processed by ETS. This information can be used for accounting or cost control by the customer. The information is sent to the 93A or 94A customer premises system via data link and stored there

TABLE D

ETS TRAFFIC COUNTS

	PRIMARY FACILITY PEG	PRIMARY FACILITY OVERFLOW	OVERFLOW TO REORDER/ QUEUE	ALTERNATE FACILITY PEG	ALTERNATE FACILITY OVERFLOW	QUEUE PEG	QUEUE OVERFLOW	QUEUE ABANDON	QUEUE TIME OUT	COMPLETED CALL
Primary Facility Idle	1									•
Primary Busy, Alternate Idle	1	1		1						•
Route List Busy—No Queue	1	1	1	1	1					
Route List Busy—Queue Available	1	1	1	1	1	1				
Route List Busy—Queue Full	1	1	1	1	1	1	1			
Abandon On Queue	1	1	1	1	1	1		1		
Service Queue	2	1	1	1	1	1				•
Timeout—No Post Queue Route List	1	1	1	1	1	1			1	
Timeout—Primary Idle	2	1	1	1	1	1			1	•
Timeout—Primary Busy Alternate Idle	2	2	1	2	1	1			1	•
Timeout—Route List Busy	2	2	2	2	2	1			1	
Ringback—Answer	2	1	1	1	1	1				•
Ringback—Busy	1	1	1	1	1	1				
Ringback—No Answer	1	1	1	1	1	1				

on 9-track magnetic tape. The customer must have a Local Message Detail Recording System (LMDRS) or a Centralized Message Detail Recording System (CMDRS). The information is also used by the Bell System to assist in network design and maintenance.

5.23 In 1E6/1AE6, SMDR provides records for originating calls, terminating ETS calls, and ineffective attempts. Calls to collocated stations where only the extension is dialed are not recorded. With 1E7/1AE7, additional information is available with the expanded message detail recording (XMDR) feature. "Dial 9," outgoing WATS, noncollocated common control switching arrangement (CCSA), foreign exchange (FX), and tie trunk calls with '1xx' access codes may be included on XMDR records. The XMDR feature only includes originating calls and ineffective attempts. Table E lists the information available on SMDR and XMDR records, along with the number of digits in each record.

5.24 When a call originates from or terminates to an ETS station, the MDRO or MDRI bits in the Centrex Common Block are checked to determine if a record is to be made. For XMDR, an XMDR indicator bit must also be set; and, for "dial 9" calls, the XMDR90 bit must be set. Various hooks are inserted into pidents CX1C, CXOR, ORDL, and ICAL to check the status of these bits.

5.25 If it is determined that a record is to be made, a routine in pident AMAC is called to seize and initialize an appropriate automatic message accounting (AMA) register. Routine AMMD18 is used to seize and initialize an 18-word AMA register for SMDR originating calls. Routine AMMD13 is used to seize and initialize a 13-word AMA register for SMDR terminating calls. Routine AMXMNO is used to seize and initialize and 18-word AMA register for XMDR.

5.26 Hooks are inserted into the main call processing programs to save information at appropri-

TABLE E

INFORMATION CONTAINED IN SMDR AND XMDR RECORDS

ITEM	NUMBER OF BCD DIGITS IN SMDR RECORD (TYPE 01)	NUMBER OF BCD DIGITS IN XMDR RECORD (TYPE 05 OR 06)
Call event code	1	1
Service feature	1	1
End of dial time	7	N/A*
Time change	1	1
Answer time	7	7
ARS pattern	1	N/A*
Outgoing trunk ID	6	6
Called number	10	16
Facility restriction level	1	N/A*
Incoming trunk ID	6	6
Calling number	7	7
Authorization code	6	N/A*
Account code	8	8
End of outpulsing time	7	7
Midnights passed	1	1
Disconnect time	7	7
Access code	N/A*	5
Record type	2	2

* Indicates that the item is not included in the specified record type.

ate times in the AMA register, for example, at the end of digit reception, or end of outpulsing.

5.27 Records are formatted and sent to the customer by routines in pident MDRO. There are several different record types. All record types are outputted by routine MDOUTP. If a record cannot be sent to the PUC immediately, MDOUTP will place it on a queue. The queue will then be unloaded later by MDQSRV. Routine MDQSRV is run as an E-level job and will output a maximum of five message detail records per entry.

5.28 Record type 01 contains SMDR information about an originating call. The information contained in this record type is as listed in Table E.

5.29 Record type 02 contains SMDR information about a terminating call.

5.30 Record type 03 is a time change record for both SMDR and XMDR. When the ESS clock is changed, the old and new clock states are sent to ETS customers by routine MDTCHG.

5.31 Record type 04 is date information for both SMDR and XMDR. It is sent to the customer each midnight by routine MDDATE. This record includes an ESS identifier, the time, date, and a count of how many records have been lost either by the ESS or 93A CPS.

5.32 Record type 05 contains XMDR information for noncollocated CCSA, WATS, tie trunk, or FX calls. Record type 06 contains XMDR information for "dial 9" calls. Both record types have the same format and contain information as listed in Table E.

B. Account Codes

5.33 The customer may optionally have account codes. An account code is a number dialed before the called number. Optional account codes are recorded on SMDR records. Customer dialed account recording (CDAR) account codes may be included in XMDR records. The account code may be from 3 to 8 digits in length. The first digit of all account codes for a given customer is a unique Lead Account Code digit to indicate that an account code is being dialed. It must be chosen so as not to conflict with any on-network number (no on-network number can start with that digit). All account codes for any one customer must be of the same length. The second digit of the account code must not be 0 or 1, so that it will not conflict with a numbering plan area (NPA) code. This enables the call processing routines to recognize the dialed number as an account code, collect the proper number of digits, and record it. The Lead Account Code digit is not recorded on SMDR.

C. Call Event Codes

5.34 The call event code indicates how the call was disposed. The SMDR call event codes include:

- 0 — Completed directly
- 1 — Queued and completed
- 2 — Invalid NPA or NXX
- 3 — Invalid authorization code
- 4 — Insufficient FRL
- 5 — All facilities busy
- 6 — Abandoned on queue
- 7 — Timed out from queue
- 8 — Miscellaneous failure without queuing
- 9 — Miscellaneous failure after queuing.

Codes 0, 5, and 8 are also used for XMDR.

D. Service Feature Codes

5.35 The service feature code indicates that there were feature interactions on the call which affect the contents of the record.

(1) Station billing on attendant handled call applies.

(2) The record applies to the base to remote portion of a forwarded call.

(3) The call was routed to the attendant, due to the toll diversion feature (XMDR only).

ETS COMPATIBILITY WITH SMDR VIA THE REVENUE ACCOUNTING OFFICE (RAO)

5.36 With 1E7/1AE7, AMA information is available via the Revenue Accounting Office (RAO). Information which is available includes:

(a) Individual station billing for calls routed over the DDD network or via WATS facilities

(b) Nonbillable sample records for calls routed over FX trunks, centrex tie trunks, ETS access trunks, or ETS intertandem trunks

(c) The CCSA sample records for calls routed over a CCSA access network trunk.

Most of the routines for ETS-RAO compatibility are located in pident AMAC. Table F provides a list of the functions of the major routines used to provide ETS-RAO records.

5.37 When a route has been selected for a call, if the route list entry is marked for individual station billing, an AMA record will be made for RAO. The information is saved in a 13-word AMA register. The AMA register is initialized by AMLSZS or AMTSZS. Routine AMLSZS interfaces with CXOR and AMTSZS interfaces with CXIC.

5.38 If a call needs to be placed on a queue, some information needed for the RAO records would normally be lost. To retain this information, a holding AMA register is seized and initialized by routine ETHAMA. The holding AMA register contains the individual station billing number and a unique program tag.

5.39 If an ETS customer has the customer dialed account recording (CDAR) feature, individual station billing must be applied to each route list entry for compatibility with RAO. If both a CDAR AMA register and a holding AMA register would be

TABLE F

ETS-RAO ROUTINES

NAME	FUNCTION
HOLDING AMA REGISTER PROCESSING	
ETHAMA	Seize and initialize ETS holding AMA
ETSQBL	Post queue billable AMA actions
ETHCVB	Convert holding AMA to billable AMA
AMASM	Post queue sample AMA actions
HAMQBN	Holding AMA abandon from queue actions
MDR-RAO/CCSA SAMPLE AMA PROCESSING	
ETLSMPL	Sample AMA actions for line
ETTSMPL	Sample AMA actions for trunks
INIT/ICSLEN	Derive Individual Station Billing number for trunk originations
AMLSZS	Initialize 13-word AMA for lines and trunks (interfaces with CXOR)
AMTSZS	Initialize 13-word AMA for lines and trunks (interfaces with CXIC)
AMLCVS	Convert CDAR AMA into sample AMA for lines and trunks (inerfaces with CXOR)
AMTCVS	Convert CDAR AMA into sample AMA for lines and trunks (interfaces with CXIC)
AMFDAM	Search register link list for CDAR/MDR-RAO and holding AMA registers
AMDUNC	Set incomplete call attempt bit in MDR-RAO AMA

required for a call, the CDAR AMA register is converted into a holding AMA register, retaining the CDAR information.

5.40 When a call is routed off-network to a PBX, it is possible that answer supervision will not be returned. In order that these calls will be recorded by RAO, a record is made of all uncompleted call attempts. These calls are marked by routine AMDUNC.

5.41 At the conclusion of a call, the holding AMA register information is combined with other information to produce the RAO record by routine AMASM. Records are then output by INTP in pident AMAC. The ETS-RAO records have a service feature code of 19.

FACILITY ADMINISTRATION AND CONTROL

5.42 The ETS facility administration and control (ECAC) feature allows the customer to monitor the status of various items and change them as desired to quickly adjust to varying conditions. Items which can be requested for display include:

- Current route pattern in effect
- Queue status
- Alternate FRL status
- Authorization codes and associated FRLs
- Bounds for authorization codes
- ESS clock.

Messages can also be typed in to:

- Override the currently active route table either immediately or at some later time
- Activate/suspend queues
- Change ACs and FRLs
- Activate/suspend an alternate FRL table.

5.43 There are a number of basic message types. When a message is received by DLUP and PUIO, the first keyword or mnemonic is analyzed by pident ECAC to determine the basic type. This type is used to index a table of pointers to routines which either analyze the next word in the message or perform the requested action. Messages returned to the customer are formatted by routines in ECAC.

6. ABBREVIATIONS AND ACRONYMS

6.01 The following abbreviations and acronyms are used throughout this section.

AAR	Automatic Alternate Routing
AC	Authorization Code
AMA	Automatic Message Accounting
ARS	Automatic Route Selection
CACS	Customer Administration and Control System
CCSA	Common Control Switching Arrangement
CDAR	Customer Dialed Account Recording
CFPF	Call Forwarding Variable Via Private Facilities
CIW	Call Identification Word
CLOG	Customer Originated Recent Change LOG
CMDRS	Centralized Message Detail Recording System
CORC	Customer Originated Recent Change
CPS	Customer Premises System
DL	Data Link
ECAC	ETS Facility Administration and Control
ESS	Electronic Switching System
ETN	Electronic Tandem Network
ETS	Electronic Tandem Switching
FAT	Foreign Area Translator

FRL	Facility Restriction Level
FX	Foreign Exchange
LACD	Lead Account Code Digit
LCAT	Local Customer Administration Terminal
LEN	Line Equipment Number
LIU	Line Interface Unit
LMDRS	Local Message Detail Recording System
LUTS	Locked-up Trunk Scans
NACDE	Number of Account Code Digits Expected
NPA	Numbering Plan Area
NUTS	Nonusage Trunk Scans
OHQ	Off-Hook Queue
PBX	Private Branch Exchange
PNOW	Private Network Option Word
PTRF	Traffic data to customer — Pollable
PUC	Peripheral Unit Controller
RAO	Revenue Accounting Office
RBQ	Ringback Queue
RC	Recent Change
SCCOF	Selective Customer Control of Facilities
SCIW	Supplementary Call Identification Word
SFG	Simulated Facilities Group
SMDR	Station Message Detail Recording
TAMA	Tie line Automatic Message Accounting
TCM	Traveling Class Mark
WATS	Wide Area Telecommunications Service
XMDR	Expanded Message Detail Recording

7. REFERENCES

7.01 For further information consult the following:

(a) Pidents including ETS programs—See Table A for feature packages involved. See Table B for pidents.

(b) Section 231-045-105—Call Processing—POTS

(c) Section 231-045-106—Call Processing—Centrex

(d) Section 231-048-304—Rate and Route Translation Recent Change Formats for NOCNOG, DNHT, NOGRAC, RATPAT, DIGTRN, CCOL, RI, CHRGX, DITABS, TNDM, IDDD, TDXD, and RLST

(e) Section 231-048-307—Traffic Measurement Recent Change Formats for DIGTRN, TRFSLB, TRFLCU, TRFHC, TNCTX, CTRF, and NUTS

(f) Section 231-048-308—RC Formats for AC, ACTABL, CUSTCB, DALNK, DAMBI, DAMSK, DATER, ESCO, ESN, SAC, TCM, and TNESN

(g) Section 231-048-309—Centrex-CO/ESSX-1 Recent Change Formats for CTXCB, CTXDI, CTXEXR, CXDICH, DITABS, DLG, FLXDG, FLXRD, and FLXRS

(h) Section 231-048-312—LINE RC Formats for LINE, TWOPTY, MPTY, SCLIST, MLHG, ACT, CFV, VSS, and SIMFAC

(i) Section 231-048-348—Recent Change Implementation Procedures for Electronic Tandem Switching

(j) Section 231-090-074—Call Forwarding Variable Feature

(k) Section 231-090-135—User Dialed Authorization Codes (EPSCS and ETS)

(l) Section 231-090-138—Traveling Class Mark (EPSCS and ETS)

(m) Section 231-090-154—Electronic Tandem Switching Feature

(n) Section 231-090-162—Deluxe Queueing

(o) Section 231-090-163—Facility Administration and Control

(p) Section 231-090-166—Station Message Detail Recording to Customer Premises

(q) Section 231-090-168—Traffic Data to Customer—Pollable

(r) Section 231-090-169—Selective Customer Control of Facilities

(s) Section 231-090-340—Selected Traffic Data to Customer