MOBILE TELEPHONE SWITCHING OFFICE, CELL SITE, AND SUBSCRIBER UNIT SYSTEM DESCRIPTION 1A *ESS*™ SWITCH *AUTOPLEX*™ SYSTEM 100 CELLULAR TELECOMMUNICATIONS SYSTEM

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1. GENERAL

This AT&T practice describes the operation and major characteristics of the AUTOPLEX System 100 (System 100).

This practice is a general reissue. New subjects added to this document include:

- Addendum Issue 1 supplement
- Cellular Networking (1AE9.03 Feature)
- Inter-MTSO (Inter-System) Data Link
- Inter-MTSO (Inter-System) Voice Trunks
- Inter-MTSO Handoff
- System Features.

A glossary of terms and a listing of abbreviations and acronyms are provided in Section 13 of this practice.

The purpose of this practice is to provide an overall understanding of the System 100. System 100 provides customers with a dependable, good conversational quality, mobile telephone system that has a large subscriber capacity due to its cellular design.

2. SYSTEM 100 OVERVIEW

2.1 Cellular Telecommunications System

System 100 is a cellular telecommunications system that provides a wide range of network services to individuals and individual customer groups. Standard service provides voice communication between subscriber units and also between subscriber units and land line telephones.

Each mobile unit is registered in a particular geographical region, called the CGSA (Cellular Geographic Service Area) within which the radio channels of the system operate. Throughout the CGSA, in strategic positions, are fixed facilities containing radio and control equipment called cell sites. Each cell site provides a radio link to any mobile unit within the cell site's transmitting range. Electronic switching is performed for the System 100 by a modified 1A ESS switch called the MTSO (Mobile Telephone Switching Office), Fig. 1.

The MTSOs, cell sites, subscriber units, cell site voice trunks, and cell site data links make up the primary system in the CGSA. The primary system is a term used to distinguish these hardware elements from support facilities within the CGSA. One or more class 5 switching offices, called NIP (Network Interface Points), are interconnected to the primary system by voice trunk facilities. An NIP allows the mobile customer access to the DDD (Direct Distance Dialing) network. When operator assistance is required, the call can be routed through a local cellular operator position (Fig. 1).

The maximum number of cell sites connected to one MTSO is approximately 226. Each cell site is connected to its MTSO by one or two cell site data links and up to a maximum of 96 cell site voice trunks. These data links and voice trunks are leased from local operating companies. Cell sites and subscriber units are connected to each other by a radio link that includes voice and setup channels (Fig. 1).

Current and future service demands require an efficient use of available radio spectrum. The System 100 achieves this by reusing radio channels. This is done by structuring the CGSA into a honeycomb of hexagonal shaped cell sites. Patterns, depending on phase of growth, are made with the hex shapes and each cell site is assigned different channel sets. By repeating the pattern in an CGSA, it is then possible for many customers to occupy the same frequency at the same time. Co-channel interference is maintained at acceptable levels by planning sufficient distance between cell sites that have the same channel sets.

Growth is possible for an CGSA in both area and capacity. Area growth is satisfied by the geographical expansion of the CGSA through additions of cells beyond the existing coverage boundary. Capacity increase is handled by a process called cell splitting, whereby cells are added within the CGSA by subdividing existing cells into smaller cells by raising the handoff threshold, thus reducing the area of coverage in each new cell.

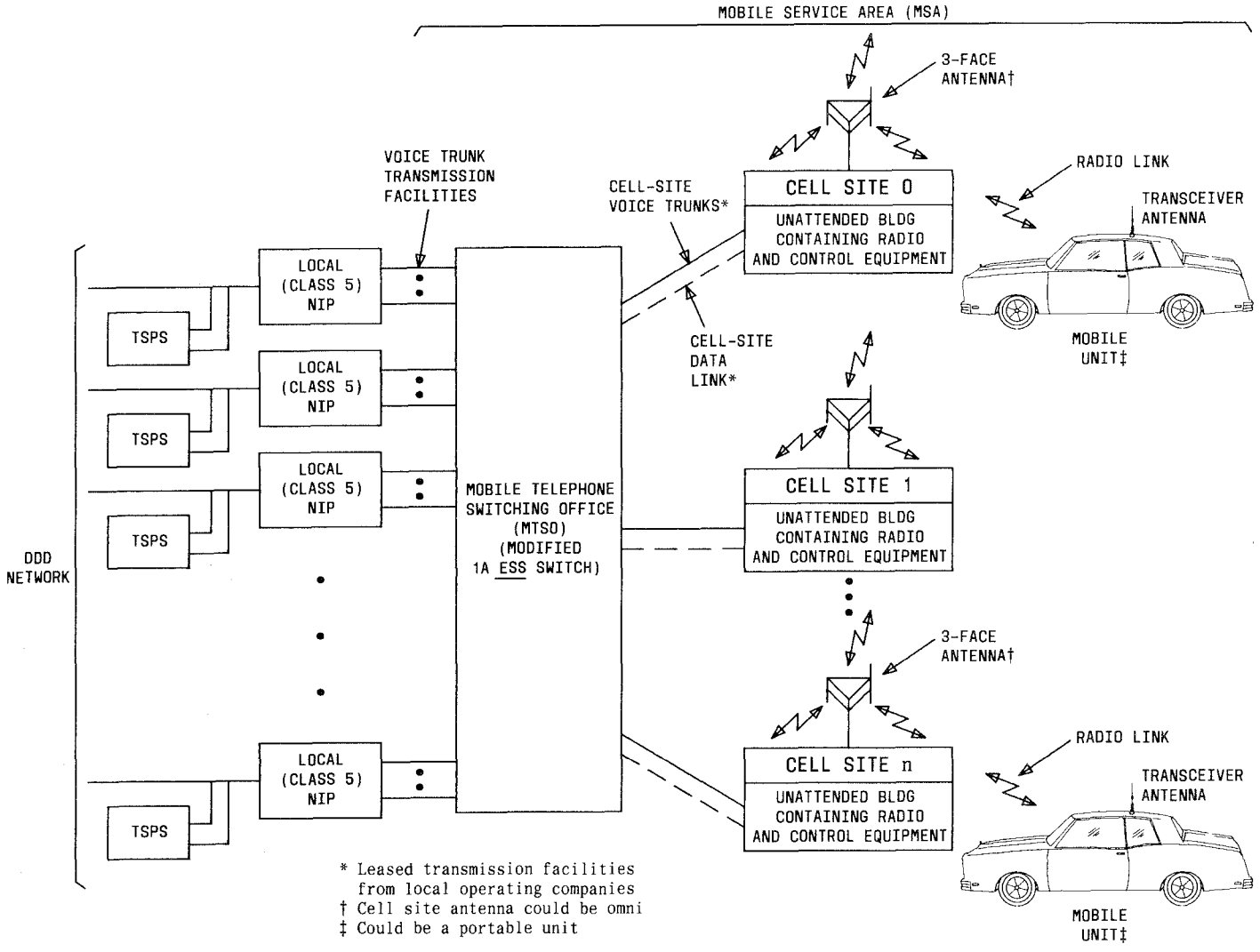


Fig. 1 — Primary System Interfaced to DDD Network

2.2 Switching Hierarchy

The primary system of the System 100 occupies a position below class 5 in the switching hierarchy (Fig. 2). DNs (Directory Numbers) for subscriber units are assigned from within the local exchanges (network interface points) associated with the System 100. The interconnection of the MTSO and network interface points is similar to that used with a PBX. The MTSO also makes use of the existing capabilities in the network interface points.

2.3 Control Center

The ACC (System 100 Control Center) is an optional facility that has 24-hour responsibility to monitor and maintain one or more CGSAs. The design of an ACC is based on a No. 2 Switching Control Center that provides display, control, and alerting functions to remotely operate a MTSO. Tasks of the ACC include surveillance, analysis, testing, repair, and recovery of software and hardware in all MTSOs and cell sites. This center is also responsible for the administration and dispatching of the work force and the tracking of installation and growth activities in the CGSAs.

Each MTSO is interfaced to the ACC by the AMAS (System 100 Maintenance and Administration System) and three dedicated communication channels (Fig. 3). These channels are as follows:

- Maintenance
- APS (Attached Processor System)
- E2A Telemetry.

The AMAS feature is an on-line OSS (Operational Support System) software package at the ACC. For more information on the AMAS and interface channels, refer to AT&T Practices 231-200-020 and 231-290-601.

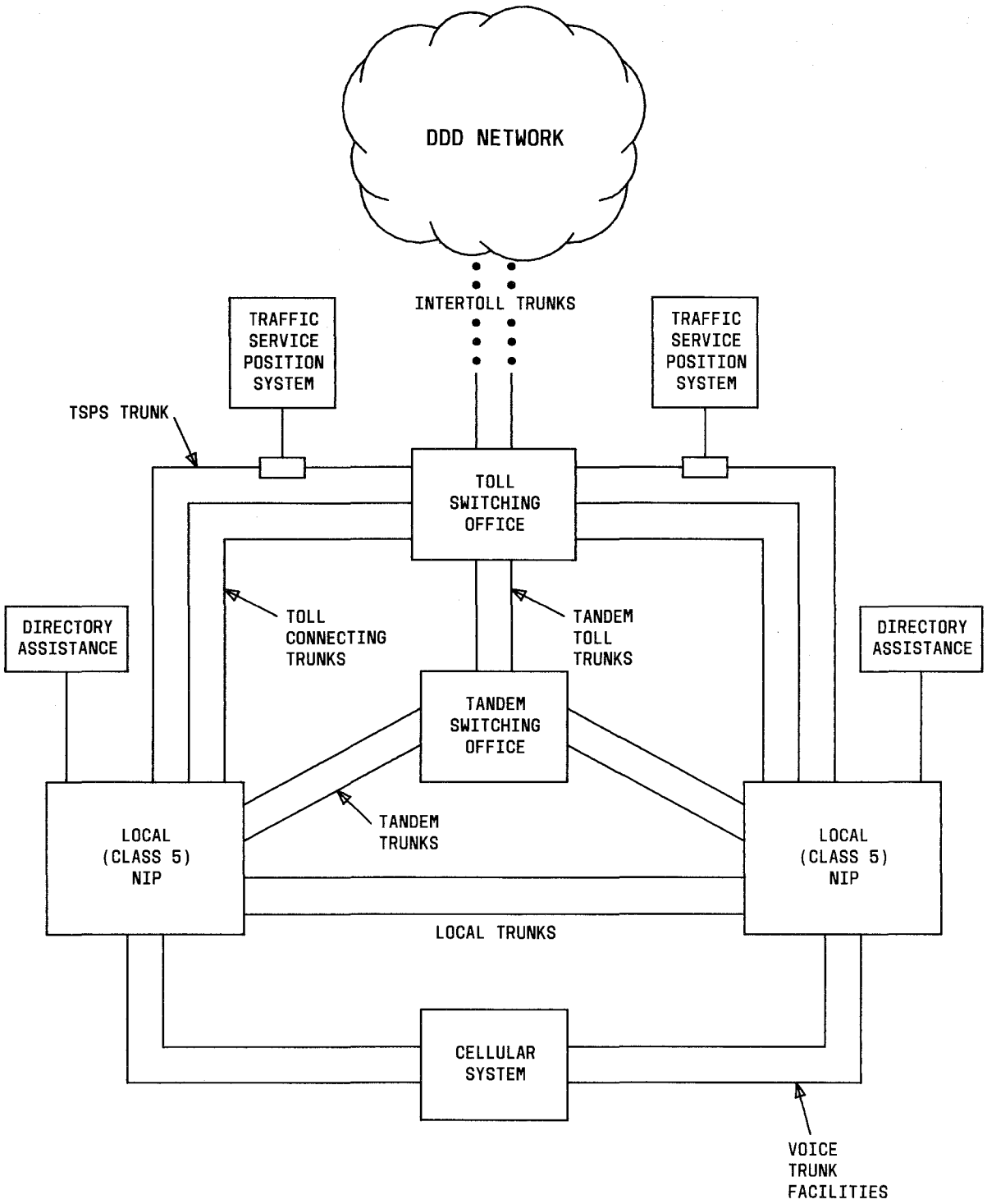


Fig. 2 — Switching Hierarchy Block Diagram

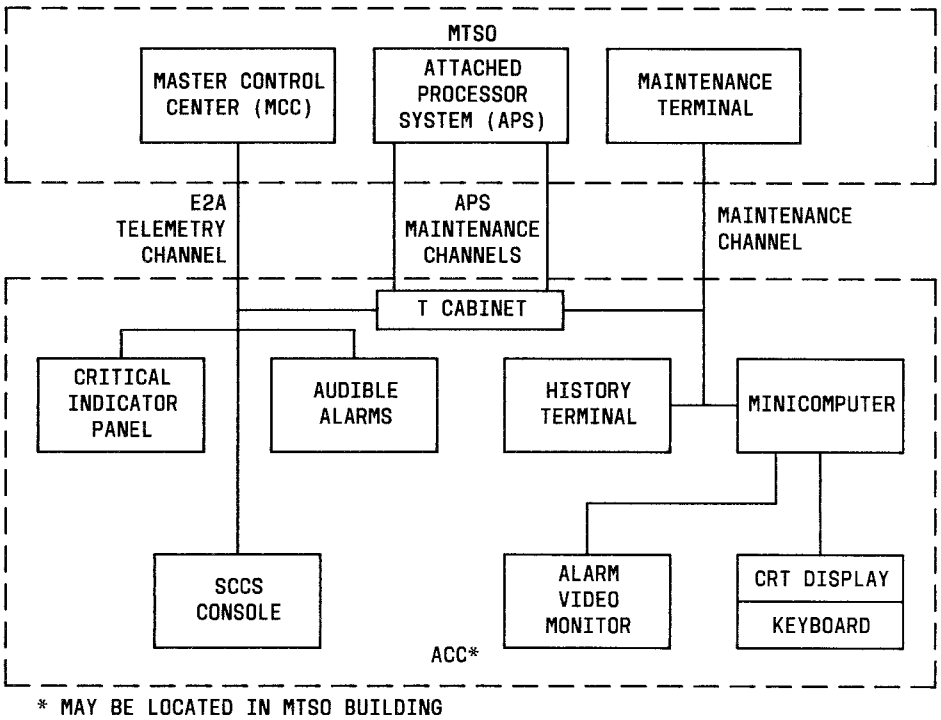


Fig. 3 — ACC/MTSO Channel Interface

3. SYSTEM 100 OPERATION

3.1 Call Processing

Call processing for System 100 includes network routing and call sequence.

3.1.1 Network Routing

3.1.1.1 Intra-MTSO

Mobile-originated calls into the land telephone network are outpulsed from the MTSO using MF (multifrequency) signaling. The MTSO selects and seizes the outgoing trunk to the NIP. It begins outpulsing the called digits after the NIP sends a start pulse or wink signal. The wink is a momentary battery reversal on the trunk. Answer and disconnect supervision signals are returned from the NIP to the MTSO allowing charging records to be made.

On land-to-mobile calls, the NIP outpulses the called mobile telephone number to the MTSO also using MF. The MTSO returns answer and disconnect supervision signals back to the NIP.

The MTSO routes calls within the primary system into the wire-line network. The simplest call routing is the mobile-to-mobile call in the same CGSA (Cellular Geographic Service Area) [Fig. 4 (a)]. The MTSO receives the dialed digits from the calling mobile, determines that the called number is another mobile, and completes the connection to that called mobile. None of the NIPs are involved.

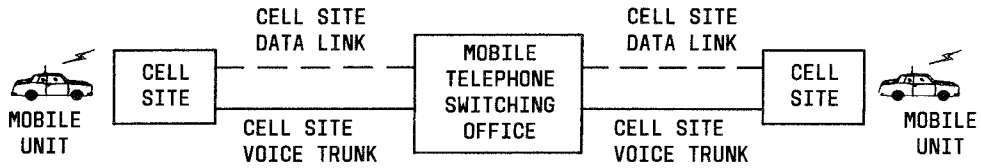
On direct-dialed, mobile-to-land calls [Fig. 4(b)], the MTSO routes the call into the land telephone network through one of the network interface points. Routing tables stored in the MTSO provide the association between the called number and the proper network interface point to be used. For standard calls, the directory number of the calling mobile does not influence the routing. Exceptions to this would be operator assistance, emergency service, and repair service.

Land subscribers can directly dial calls to mobiles. Since mobile directory numbers are assigned from those available in local exchanges, there is a correspondence between each mobile and a particular network interface point. The land telephone network directs calls to the network interface point serving the exchange of the called number without knowing the call is to a mobile. Upon receiving such a call, the network interface point connects the call to a direct trunk to the MTSO which, in turn, completes the connection to the mobile. The network routing for a land-to-mobile call is similar to the mobile-to-land call [Fig. 4(b)].

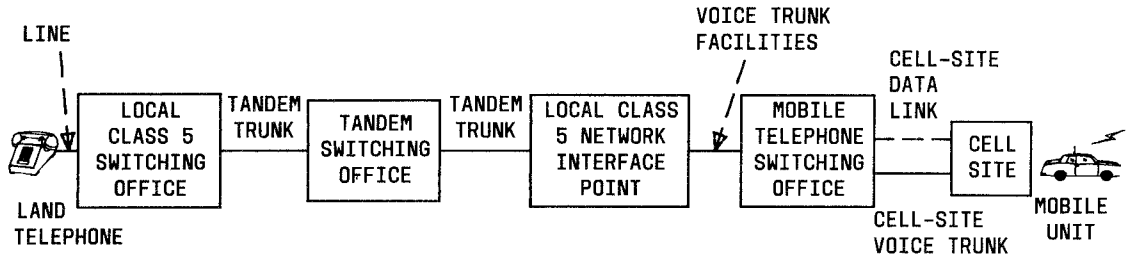
Operator-assisted and service calls (e.g., repair service) can also be dialed from a mobile. The MTSO does not have direct trunks to operator or service bureau positions. Instead it makes use of those services already available in the network interface points. On mobile-to-land/mobile operator assisted [Fig. 4(c)] calls, the MTSO routes the call to a network interface point which connects the call to operator and service position trunks.

3.1.1.2 Inter-MTSO

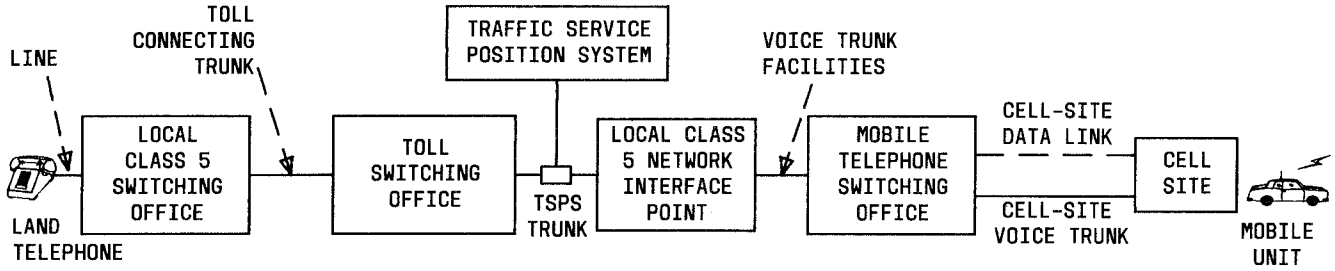
CN (Cellular Networking) feature is required when networking between two or more MTSOs. Fig. 4(d) through (e) shows two MTSOs networked, each interconnected with inter-MTSO data links and voice trunks. For additional information on CN, refer to AT&T Practice 231-290-619.



(a) MOBILE TO MOBILE CALL IN THE SAME CGSA (INTRA-MTSO)

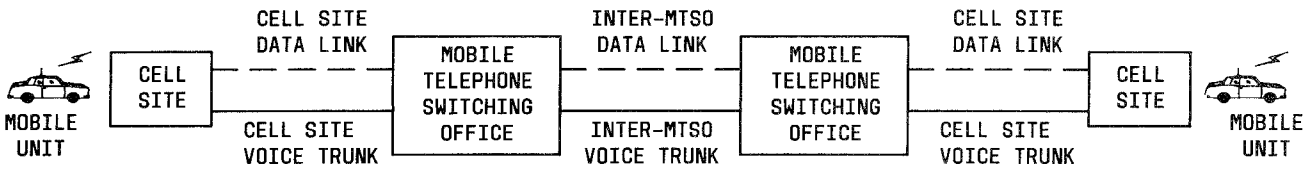


(b) TYPICAL MOBILE TO LAND OR LAND TO MOBILE CALL (INTRA-MTSO)

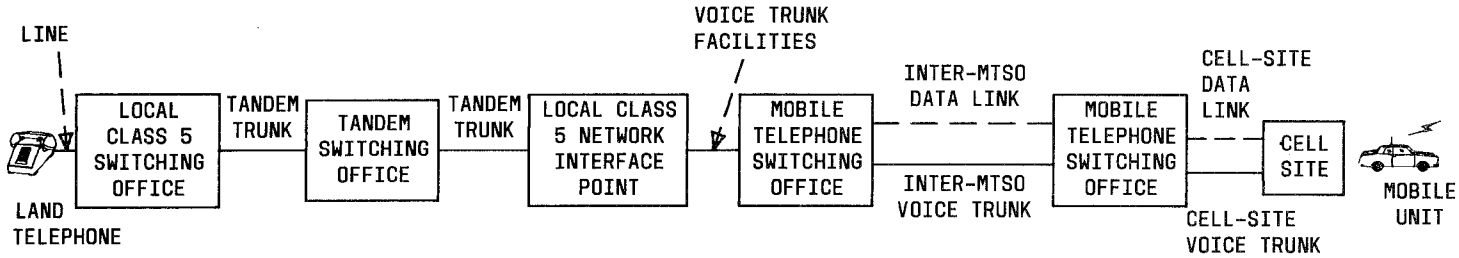


(c) TYPICAL MOBILE TO LAND/MOBILE OPERATOR ASSISTED (INTRA-MTSO)

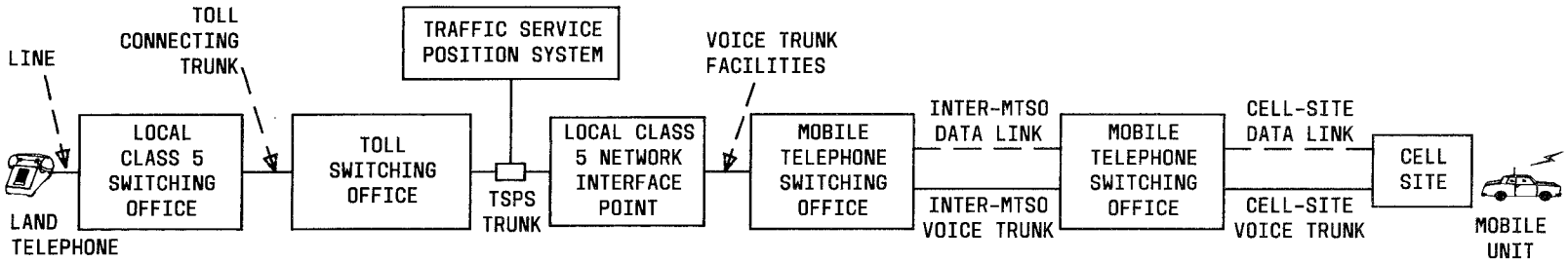
Fig. 4 — Networking Routing (Sheet 1 of 2)



(d) MOBILE TO MOBILE CALL IN TWO DIFFERENT CGSA's (INTER-MTSO)



(e) TYPICAL MOBILE TO LAND OR LAND TO MOBILE CALL (INTER-MTSO)



(f) TYPICAL MOBILE TO LAND/MOBILE OPERATOR ASSISTED (INTER-MTSO)

Fig. 4 — Networking Routing (Sheet 2 of 2)

3.1.2 Call Sequence

The sequence within the System 100 primary system is determined by which one of the following call configurations is initiated:

- Mobile-completed calls
- Mobile-originated calls
- Handoff (Intra-Cell, Inter-Cell Intra-MTSO)
- Handoff (Inter-Cell Inter-MTSO)
- Disconnect.

3.1.2.1 Mobile-Completed Calls

Mobile-completed call sequence and each associated channel path configuration includes six major steps [Fig. 5 (a) through (f)]. A call sequence summary of the primary system elements for mobile-completed calls is given in Table A.

1. **Paging [Fig. 5(a)]:** From the calling party's network interface point, the call is routed by standard wire-line network routing procedures to the home MTSO (also known as the Control Point MTSO) of the mobile unit. The MTSO collects the digits, converts them to the MIN (Mobile Identification Number), performs standard checks on the DN (Directory Number), and checks busy/idle status of mobile unit. The MTSO then sends audible ringing to the calling party, and instructs the paging cell sites to page the mobile unit over the forward setup channels (sometimes called paging channels).
2. **Cell Site Selection [Fig. 5(b)]:** The mobile unit, after recognizing its page and using parameters derived from an overhead word message, scans the setup channels used for access in the CGSA and selects the strongest signal. The selected channel will probably be associated with a nearby cell site (usually the nearest cell site).
3. **Page Response [Fig. 5(c)]:** The mobile unit replies to the cell site it selected over the reverse setup channel (sometimes called access channel). The selected cell site then reports the page response to the MTSO over its dedicated cell site data link. If the cell site is equipped with directional antenna, the cell site will perform a directional locate; then, send information to the MTSO regarding which antenna face the call is to be serviced along with page response.
4. **Channel Designation [Fig. 5(d)]:** The MTSO selects an idle voice channel (and associated cell site trunk) to the cell site that handled the page response and informs the cell site of its choice over the appropriate data link. The serving cell site, in turn, informs the mobile of its channel designation over the forward setup channel. The mobile tunes to the channel designated and detects the SAT (Supervisory Audio Tone) that is continuously transmitted from the cell site. The mobile unit, acting as a transponder, then transmits the same SAT over the designated voice channel to the cell site. The cell site interprets the returned SAT as successful voice channel communication.

5. **Alerting [Fig. 5(e)]:** On recognizing the returned SAT, the serving cell site transmits an alert order data message over the voice channel to the mobile unit which, in turn, signals the customer that they have an incoming call. When the mobile unit receives the alert order, it transmits ST (Signaling Tone) to the serving cell site. The cell site interprets the ST as successful alerting.

6. **Talking [Fig. 5(f)]:** When the customer answers, the cell site recognizes removal of ST by the mobile unit and sends an answer message to the MTSO over the cell site data link. The MTSO removes the audible ringing circuit and establishes the talking connection so that conversation can begin.

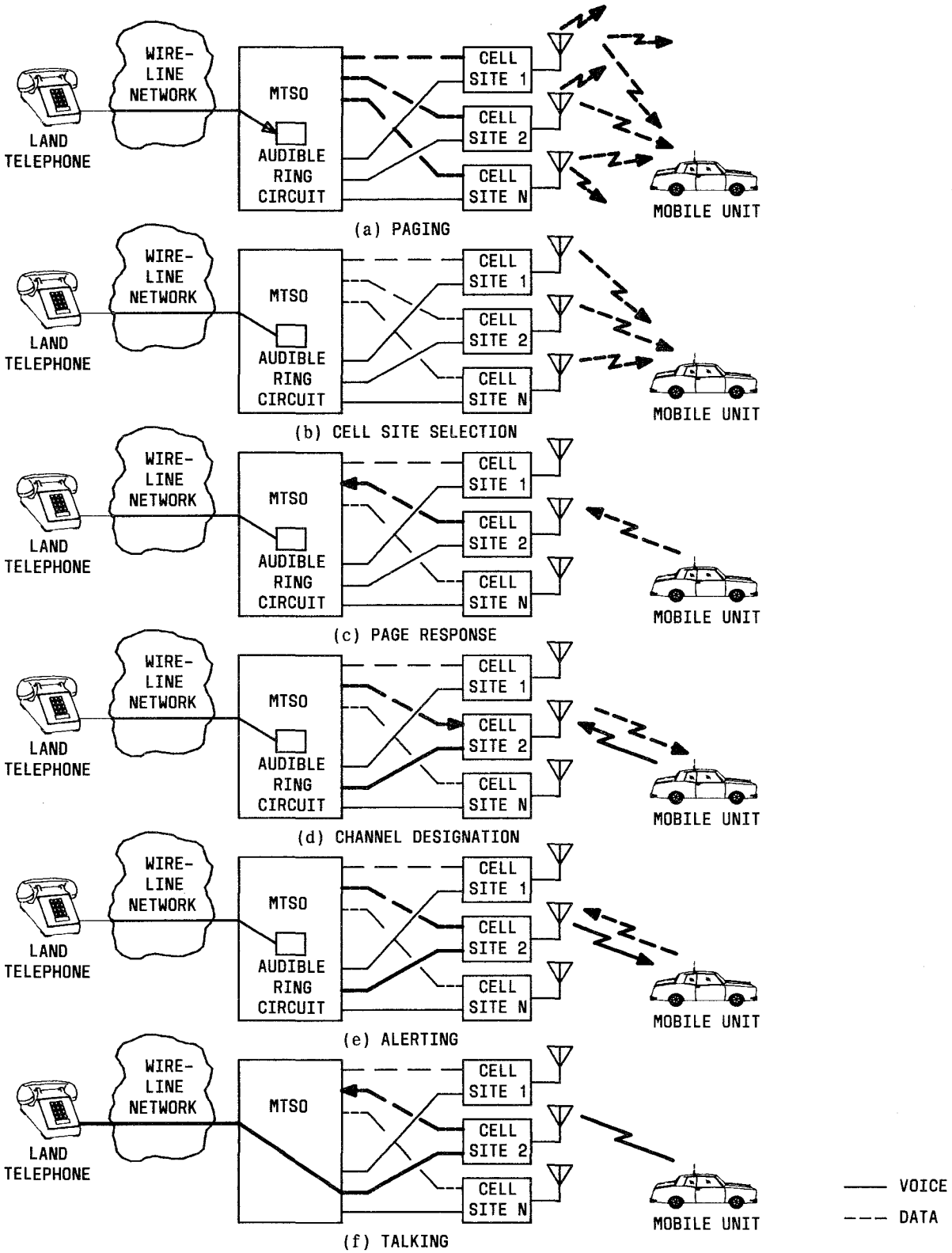


Fig. 5 — Mobile-Completed Call Sequence

TABLE A

CALL SEQUENCE FOR MOBILE-COMPLETED CALLS

SEQUENCE	MTSO	CELL SITE	MOBILE UNIT
1	—	Transmits setup channel data on forward setup channel.	—
2	—	—	Scans and locks-on forward setup channel.
3	Receives incoming call and performs translations and checks.	—	—
4	Provides audible ring to calling party.	—	—
5	Sends paging message to paging cell sites.		—
6	—	Reformats paging message.	—
7	—	Sends paging message to mobile unit via forward setup channel.	—
8	—	—	Detects page.
9	—	—	Scans and locks-on reverse setup channel.
10	—	—	Seizes setup channel.
11	—	—	Acquires synch.
12	—	—	Sends service request.
13	—	Reformats service request.	—
14	—	Performs directional location.*	—
15	—	Sends service request and priority list to MTSO.	—
16	Selects voice channel.	—	—
17	Sends channel designation message to cell site.	—	—
18	—	Reformats channel designation message.	—

* Applies to directional cell site antenna only.

TABLE A (Contd)

CALL SEQUENCE FOR MOBILE-COMPLETED CALLS

SEQUENCE	MTSO	CELL SITE	MOBILE UNIT
19	—	Sends channel designation message to mobile unit via forward setup channel.	—
20	—	—	Tunes to voice channel.
21	—	—	Transmits SAT.
22	—	Detects SAT.	—
23	—	Sends alert order.	—
24	—	Sends alert order to mobile unit via blank-and-burst on voice channel.	—
25	—	—	Alerts user.
26	—	—	Sends 10-kHz ST.
27	—	Detects 10-kHz ST.	—
28	—	—	User answers.
29	—	—	Stops sending 10-kHz ST.
30	—	Detects absence of 10-kHz ST.	—
31	—	Sends answer message to MTSO.	—
32	Receives answer message.	—	—
33	Removes audible ring and completes connection.	—	—

3.1.2.2 Mobile-Originated Calls

Mobile-originated call sequence and each channel path configuration includes six major steps [Fig. 6 (a) through (f)]. A call sequence summary of the primary system elements for mobile-originated calls is given in Table B.

1. **Preorigination [Fig. 6(a)]:** Using preorigination dialing procedures, the customer enters the dialed digits into the mobile unit memory, and depresses the SEND key to initiate the call.
2. **Cell Site Selection [Fig. 6(b)]:** The mobile unit seizes a reverse setup channel, usually of the nearest cell site, a process similar to that described previously for the mobile-completed call.
3. **Origination [Fig. 6(c)]:** The stored digits, along with the MIN and serial number (if requested) are transmitted over the reverse setup channel selected by the mobile. The selected cell site associated with this setup channel receives this information and relays it to the MTSO over its cell site data link. If the cell site is equipped with directional antenna, the cell site action is similar to that described previously for Page Response during the mobile-completed call.
4. **Channel Designations [Fig. 6(d)]:** The MTSO determines routing and charging information at this time by analyzing the dialed digits. If the MIN, serial number, or dialed digits are invalid, the call is terminated by the MTSO. As with the mobile-completed call, the MTSO now designates a voice channel and establishes voice communication with the mobile through the cell site.
5. **Digit Outpulsing [Fig. 6(e)]:** When the cell site detects the returned SAT, it transmits a voice channel confirmation message to the MTSO. The MTSO then completes the call through the wire-line network using standard digit outpulsing techniques.
6. **Talking [Fig. 6(f)]:** When outpulsing is completed, the MTSO establishes a talking connection. Communication between customers can now begin when the called party answers.

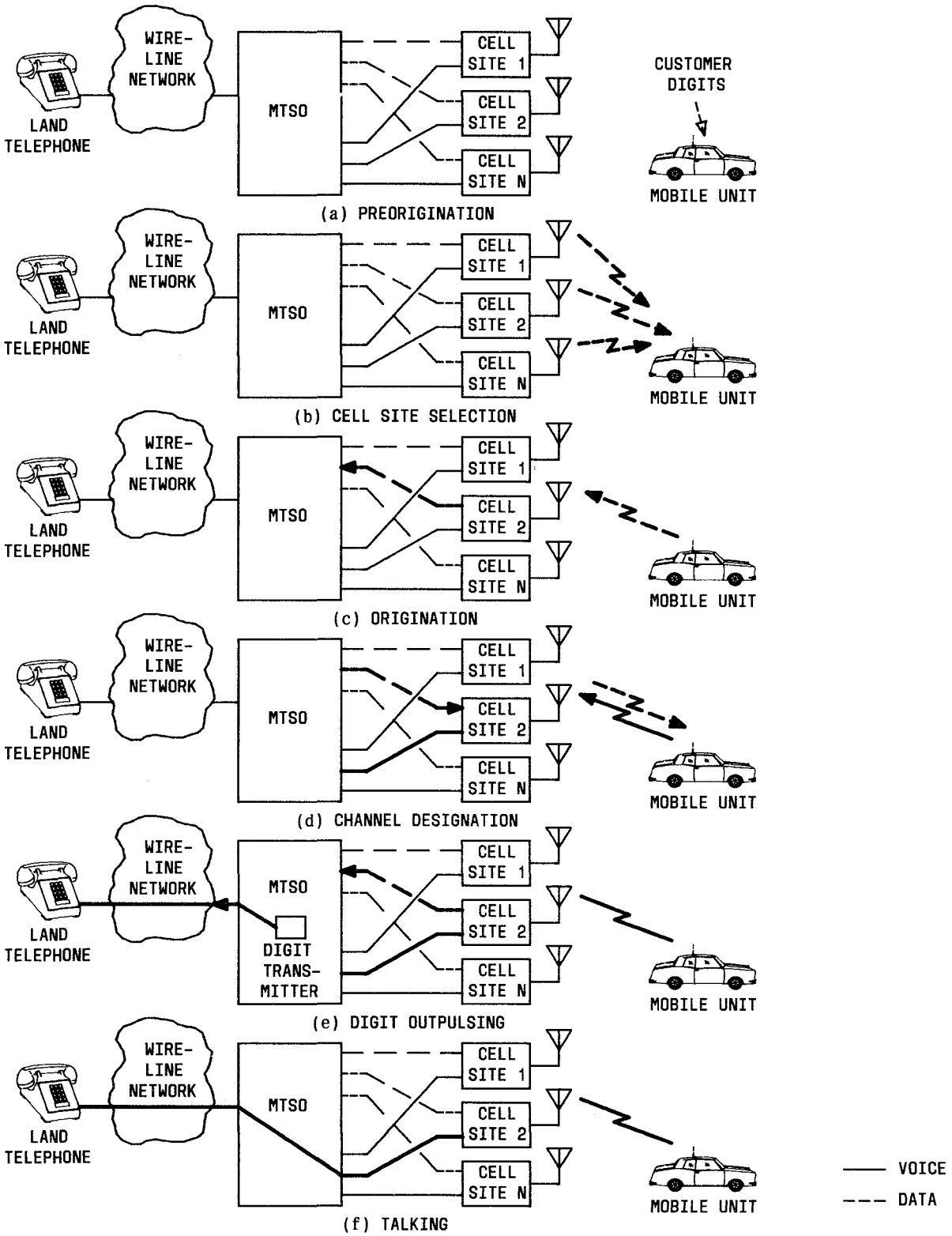


Fig. 6 — Mobile-Originated Call Sequence

TABLE B

CALL SEQUENCE FOR MOBILE-ORIGINATED CALLS

SEQUENCE	MTSO	CELL SITE	MOBILE UNIT
1	—	Transmits setup channel data on forward setup channel.	—
2	—	—	Scans and locks-on forward setup channel.
3	—	—	User initiates call.
4	—	—	Scans and locks-on reverse setup channel.
5	—	—	Seizes setup channel.
6	—	—	Acquires synch.
7	—	—	Sends service request.
8	—	Reformats service request.	—
9	—	Performs directional location.*	—
10	—	Sends service request and priority list to MTSO.	—
11	Selects voice channel.	—	—
12	Sends channel designation message to cell site.	—	—
13	—	Reformats channel designation message.	—
14	—	Sends channel designation message to mobile unit via forward setup channel.	—
15	—	—	Tunes to voice channel.
16	—	—	Transmits SAT.
17	—	Detects SAT.	—
18	—	Sends voice channel comfirmation message to MTSO.	—
19	Detects off-hook.	—	—
20	Completes call through network.	—	—

* Applies to directional cell site antenna only.

3.1.2.3 Handoff (Intra-Cell, Inter-Cell Intra-MTSO)

Handoff call sequence and each channel path configuration includes three major steps [Fig. 7 (a) through (c)].

1. **New Channel Preparation [Fig. 7(a)]:** The serving cell site, working with its Group 1 and Group 2 Neighbor lists, combines locating information from surrounding cell sites with its own and assembles a handoff list of cell site/antenna faces on which to service the call. The handoff list is then transmitted to the MTSO by the serving cell site. The MTSO analyzes the data and decides that a handoff to a new voice channel is to be attempted. The MTSO selects an idle voice channel (and an associated cell site trunk) based on the priority in the handoff list. It then sends a message to the cell site associated with the new voice channel. That cell site (for an inter-cell or intra-cell handoff) turns on the selected voice channel and transmits SAT.
2. **Mobile Handoff Command [Fig. 7(b)]:** The MTSO sends a message to the serving cell site containing the new voice channel identity. The serving cell site, in turn, transmits this information to the mobile unit over the forward voice channel by a blank-and-burst data message.
3. **Channel/Path Reconfiguration [Fig. 7(c)]:** The mobile unit transmits a brief burst of ST, turns off its transmitter, tunes to the new voice channel, and transmits the received SAT. The original serving cell site, on recognizing the ST burst, sends a handoff confirmation message to the MTSO. The MTSO reconfigures its switching network, connecting the other party with the appropriate cell site trunk to the new voice channel. The cell site with the new channel (even for an intra-cell handoff) upon recognizing the returned SAT over the new channel, sends a voice channel confirmation message to the MTSO. The MTSO interprets this message as a successful handoff.

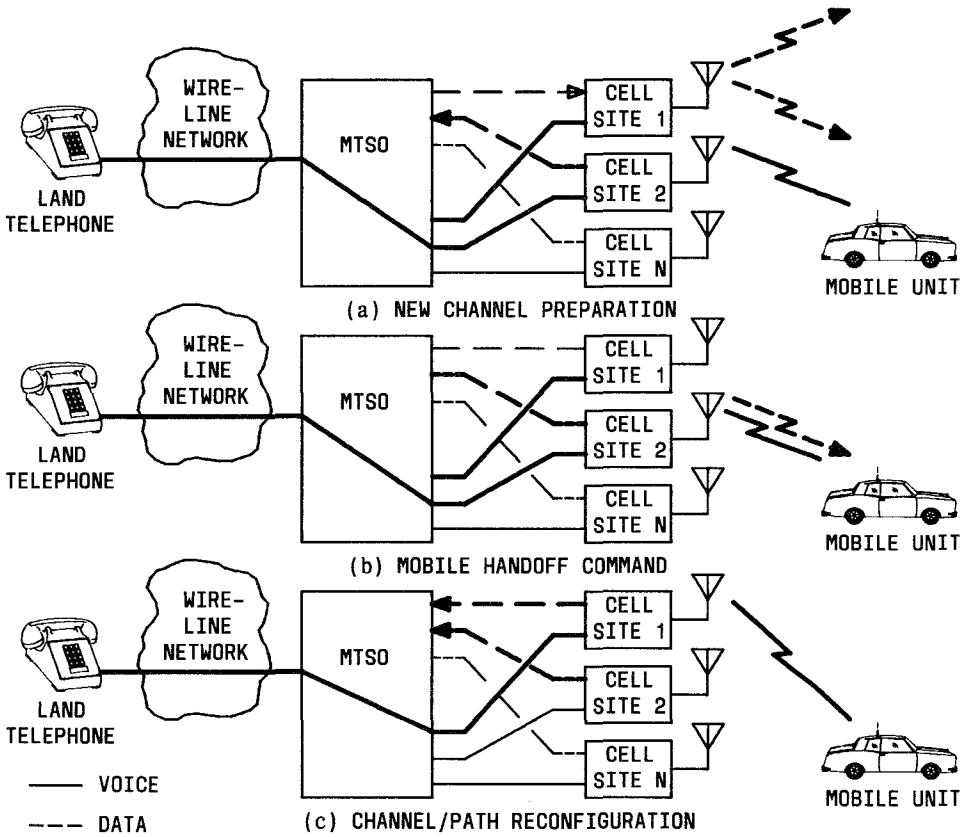


Fig. 7 — Intra-Cell, Inter-Cell Intra-MTSO Handoff Sequence

3.1.2.4 Handoff (Inter-Cell Inter-MTSO)

The inter-MTSO handoff is required for the Cellular Networking feature (1AE9.03). The capability of the inter-MTSO handoff allows uninterrupted service to mobile units crossing CGSA boundaries of two or more networked systems (abutting systems). It involves handing off a call from a cell and cell site trunk in a networked MTSO over an inter-MTSO trunk between two MTSOs.

3.1.2.5 Disconnect

The call sequence and each channel path configuration for mobile-initiated [Fig. 8(a) through (c)] and system-initiated [Fig. 9(a) through (c)] disconnect includes three major steps each.

a. The mobile-initiated disconnect actions occurring when the mobile party goes on-hook are:

   1. **Release [Fig. 8(a)]:** The mobile unit transmits ST and turns off its transmitter. The ST is received by the cell site, which times the ST and determines that a release has occurred.

   2. **Cell Site Transmitter Shutdown [Fig. 8(b)]:** In response to the release message the cell site will shutdown its own transmitter associated with the call. It then sends a release message to the MTSO over the cell site data link.

   3. **Idle [Fig. 8(c)]:** As the final action in the call, the MTSO idles all switching office resources with the call and sends any necessary disconnect signals through the wire-line network. All equipment used on this call may now be used on subsequent calls.

b. The system-initiated disconnect actions occurring when the land party goes on-hook are:

   1. **Release [Fig. 9(a)]:** The MTSO receives a disconnect message from the wire-line network. The MTSO sends a release order message to the serving cell site. The cell site transmits this order to the mobile unit over the voice channel. The mobile confirms receipt of the message by invoking the same release sequence as with a mobile-initiated disconnect.

   2. **Cell Site Transmitter Shutdown [Fig. 9(b)]:** The response of the cell site to the mobile units ST is the same as the mobile-initiated disconnect.

   3. **Idle [Fig. 9(c)]:** In response to the release message from the cell site the MTSO idles all switching office resources associated with the call.

3.1.3 Dynamic Power Control

The dynamic power control is a feature available with the 1AE8A generic, and is used by a cell site to adjust RF signal power levels during active calls. There are directed and autonomous dynamic power controls. Directed is where the cell site directs the mobile units served by that cell site to adjust voice transmitting power levels. Autonomous is where the cell site adjusts its own voice transmitting power levels.

In both types of control, the power levels are adjusted while a call is in progress. These adjustments are in response to changing voice signal strengths at the mobile unit and cell site. When received signal levels are inadequate, transmitter levels are increased. Conversely, when received signals are more than adequate, transmitter levels are reduced.

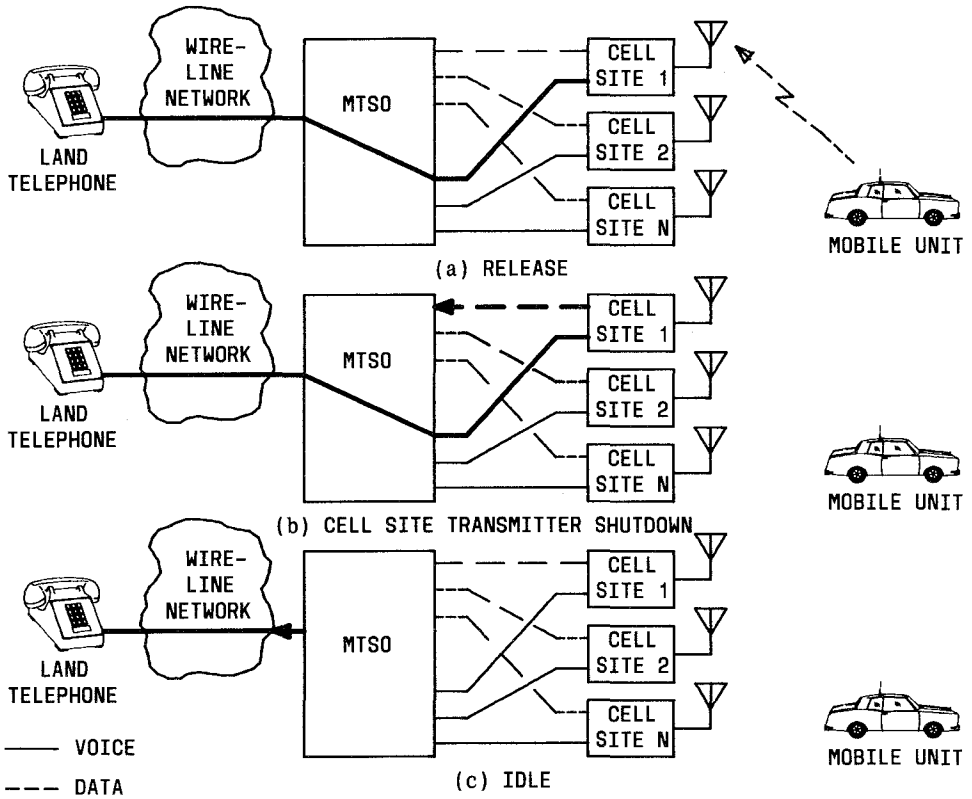


Fig. 8 — Disconnect Sequence (Mobile Initiated)

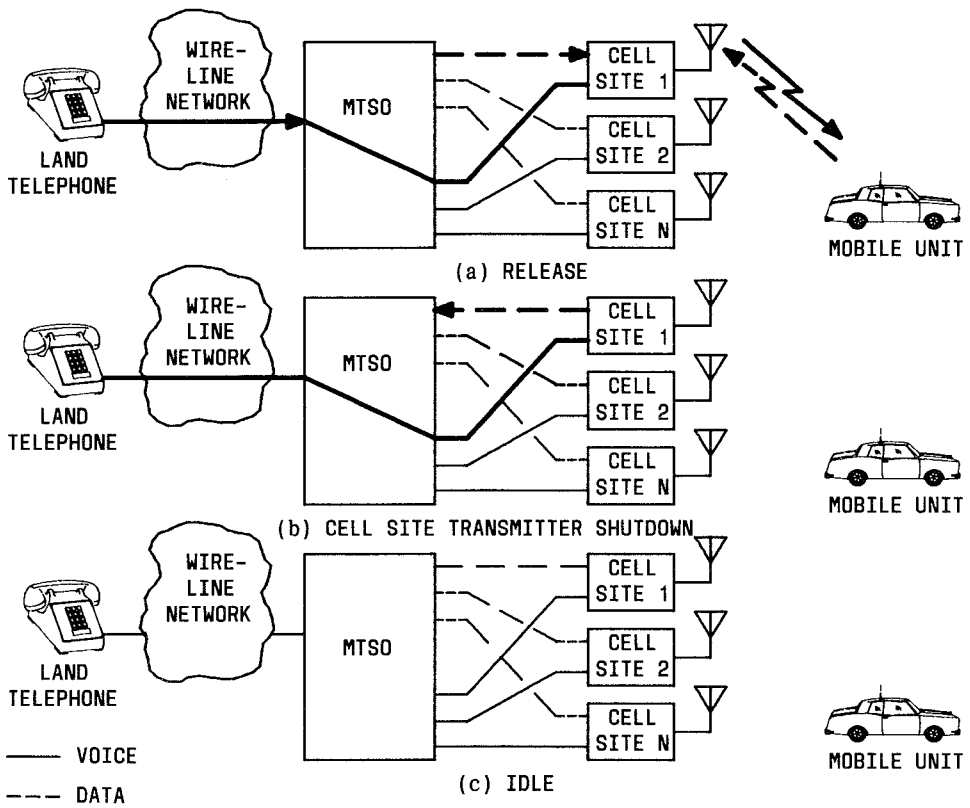


Fig. 9 — Disconnect Sequence (System Initiated)

3.2 MTSO Control

The controlling element for call processing in the primary system is the MTSO. The MTSO exercises control by providing:

- Switched interconnection with the land telephone network and mobile subscribers
- Switched connections between mobile subscribers served by the MTSO
- Administration of the radio voice channel usage
- Coordination of voice channel handoff
- Recording of the charge information
- Custom service to mobile users.

The MTSO has a set of informative recorded announcements and tones which are used to provide indications about call failures to the originating party. For example, traffic-busy conditions are indicated by a reorder tone. Tones given to mobile users may come from either the MTSO tone sources or the mobile unit itself. The MTSO controls the application of the tones. For failures encountered before a mobile has successfully tuned to a voice channel, the MTSO sends a data message (containing tone) through the cell site to the

mobile unit. If the failure occurs after successful voice channel assignment, the MTSO connects the cell site trunk to the appropriate tone source or announcement.

The MTSO records all charge-related data for the System 100 on its AMA (Automatic Message Accounting) tape. In contrast to conventional wire-line switching offices, the MTSO records a billing entry for all calls to and from a mobile. An entry is made on all calls that successfully tune to a radio voice channel.

For mobile-originated calls, the data that is recorded includes the conventional called and calling numbers, answer time, and disconnect time. This data is also recorded at the network interface point that the MTSO connected to on a particular origination. This portion of the record deals with the message unit and toll charges associated with the wire-line network. Also recorded in the AMA entry is the radio voice channel seizure and release times and the initial cell-site identification. These items pertain to the usage of the System 100 radio facilities.

For mobile-terminated calls, the office in which the call originated creates a billing record covering the usage of the land telephone network. The MTSO records the radio usage data (the voice channel seizure and release times, initial cell site, and mobile identification number).

3.3 System Coordination

The techniques used by the System 100 to coordinate call processing are:

- Signaling and supervision
- Locating and handoff
- Paging and access
- Channel set assignment
- Scanning by mobile unit
- Seizure collision avoidance.

3.3.1 Signaling and Supervision

3.3.1.1 Radio Link

Signaling may take place on both the setup and voice channels. On the setup channel, signaling is completely digital (at a rate of 10 kb/s). On the voice channel, supervisory tones and burst-type digital messages are transmitted.

Setup Channel: On the setup channels, each message word contains not only message information but also parity bits for error detection and correction. Each word is repeated five times because of the potential for errors produced by the radio environment. At the receiving end, each word is read in a 2-stage process: first, each bit is determined by a 3-

out-of-5 majority voting selection scheme; second, decoding takes place to determine the received message. Words are coded so that the logic unit can detect and correct bit errors. On the setup channel, there are synchronizing and control bits, 1-word page messages, 2-word messages, overhead messages, and order messages.

The signals transmitted over the forward setup channel (cell site to mobile unit) include: page, initial voice channel designation, order, and overhead messages. The overhead message contains information pertaining to the system identity (area call sign), setup channels to be scanned, etc. The signals transmitted over the reverse setup channel (mobile unit to cell site) include: page response, origination messages, and order confirmation messages (messages to indicate that the order is received and executed).

Voice Channel: Mobile telephone supervision includes the task of ensuring that adequate RF signal strength is maintained during a call. The System 100 uses a combination of a discontinuous blank-and-burst type, digital, wideband, data stream at 10 kb/s for signaling and a continuous out-of-band modulation for supervisory purposes. These are known respectively as ST and SAT. Both tones are transmitted over voice channels.

1. **Signaling Tone:** The ST is a 10-kHz signal transmitted in the mobile-to-cell site direction. It is sent when the user is:
   - Receiving a call (alerted)
   - Being handed off (cell site-to-cell site)
   - Disconnecting
   - Flashing for mid-call services.
2. **Supervisory Audio Tone (Not Audible to Mobile User):** Three SATs are used at frequencies of 5970, 6000, and 6030 Hz. Only one of these is used by any given cell site. A cell site will continuously transmit its SAT by voice radio to a mobile unit involved in a call. Upon receiving the SAT, the correct mobile unit will transmit the same SAT back over the voice channel. The serving cell site will react only to its own SAT being returned and will consider other SATs as interference. Cell sites with identical channel set assignments will use different SATs. The SAT is also used to distinguish a given mobile unit from other mobile units using the same channel set served at other cell sites, which may, on rare occasions, capture the channel. For more information regarding multiple SATs, see AT&T Practice 231-290-627.

The signals transmitted over the forward voice channel are command and handoff messages. The reverse voice channel is used to send order confirmation messages and dialed digits for custom features.

3.3.1.2 Land-Line Link

Cell Site Data Link: Signaling over the land facilities between the cell site and the MTSO is less prone to error than the radio link. Here, the BX.25 message protocol is used and messages are sent only once at a 9.6-kb/s rate. To increase reliability, the MTSO will retry a message if a response to a command is not received. The cell-site logic serves as a data buffer between the MTSO and the mobile unit, because of the differing data rates and formats between the land and radio links. For more information, refer to Section 7 on the cell site data link and the input/output system.

Cell Site Voice Trunk: No signaling or supervision takes place over the cell site voice trunks. They are used exclusively for voice communication.

3.3.1.3 Inter-MTSO Link

In 1AE9.03 and later, direct data and voice connections are required between MTSOs in a cellular network.

Inter-MTSO Data Link: Data connections consists of two 9.6-kb/s data links; one active and the other in the standby mode. For each System 100, the inter-MTSO (inter-system) data links are terminated on the IOP (Input/Output Processor) ports of the APS (Attached Processor System) and are under the control of the APS software.

Inter-MTSO Voice Trunk: The inter-MTSO voice trunks use SD-1A236-05 trunk circuits to provide 2-way, 4-wire facility, E&M, with MF signaling. Most signaling is done over the inter-MTSO data link rather than over the inter-MTSO trunk. Glare protection is not required. For more information on inter-MTSO trunk and data link, see AT&T Practice 231-290-619.

3.3.2 Locating and Handoff

Locating and handoff functions serve to keep the signal strength from a mobile unit at an adequate level during a call. While a call is in progress, the system samples signal levels being received at the cell site serving the call. If the signal becomes inadequate, the MTSO decides which voice channel the call should be switched to. When a new channel is found, a digital command is sent over the voice channel to the mobile for it to change frequencies. The mobile will then tune to a new voice channel. The new voice channel may be from the original cell site, or from a new cell site. While the mobile unit is changing channels, the MTSO switches the other party to the trunk associated with the new channel.

An inter-MTSO handoff is done after the location process determines that a new cell has an adequately strong signal from the mobile. It involves handing off a call from a cell and cell site trunk in one MTSO to a cell and cell site trunk in a networked MTSO over an inter-MTSO trunk between MTSOs.

3.3.3 Paging and Access

Paging is the process of determining if a mobile unit is available to receive a given incoming call. The MTSO sends paging messages, which contain the MINs of mobile units receiving calls, to all paging cell sites. These paging cell sites will then transmit the paging messages throughout the CGSA. All active mobile units scan the forward setup (also called paging) channel and respond if their own MIN is received. If an attempt is incorrect or incomplete, the MTSO sends a reorder or intercept message to the caller.

Access is the process by which a mobile unit makes a request for service. Access functions performed by a mobile unit involve:

a. Informing the system of the mobile presence in response to a page

b. Supplying the system with the mobile's identification number and dialed digits for a mobile call origination

c. Waiting for a proper channel designation.

3.3.4 Channel Set Assignment

The System 100 control plan divides the allocated frequency bands as: 835.020 to 844.980 MHz for mobile to cell site, and 880.020 to 889.980 MHz for cell site to mobile. Each frequency band is divided into 30-kHz channels having an FM (Frequency Modulation) peak deviation of 12 kHz to minimize adjacent channel interference. The 30-kHz channels are combined, one from each direction, into 333 duplex channels. These duplex channels are assigned channel numbers and grouped into 21-channel sets. One duplex channel from each set is designated as a setup channel with the remainder used as voice channels (Table C). The setup channels are identical in frequency nationwide for signaling and control functions.

Setup channels are called forward or reverse depending on direction of transmission. A setup channel is used in the forward direction by the cell site to transmit information to the mobile units. The reverse direction of a setup channel is used by mobile units to transmit information to cell sites.

3.3.5 Scanning by Mobile Unit

When a mobile unit is turned on, it scans the setup channels and tunes to the strongest one. It then synchronizes with the data stream being sent by the system. The mobile unit will rescan periodically to ensure that it is using the strongest setup channel.

Scanning is performed by an active mobile unit, automatically, or it can be triggered by any of the following events:

a. The user turns the mobile unit on

b. The system sends a rescan order

c. The logic in the mobile unit loses lock or synchronization.

3.3.6 Seizure Collision Avoidance

Seizure is the successful attempt of a mobile unit to access a setup channel. Since all mobile units compete for the same setup channels, the system must prevent a simultaneous seizure collision by two or more mobile units.

TABLE C

SYSTEM 100 DUPLEX CHANNEL SET ASSIGNMENTS

CHAN SET NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
SETUP CHANNEL	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354
VOICE CHANNEL NUMBERS	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375
	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396
	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417
	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438
	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459
	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480
	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501
	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522
	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543
	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564
	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585
	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606
	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627
	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648
	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666			

To prevent a seizure collision, System 100 uses busy-idle bits. These bits are interspersed within the data streams of both the forward and reverse setup channels. When a mobile unit is ready to transmit, it will check the busy-idle bit. If it is idle, the mobile unit transmits a data signal and looks for an idle-to-busy transition. This indicates that the system has responded.

3.4 Cellular Configurations

Normally, a CGSA will grow gradually from a low traffic start-up to its mature phase. Some systems, in their mature phase, may be serving hundreds of thousands of mobile users in a large, dense CGSA. During its evolution, the cell size, cell site, setup channels, etc., are configured differently because of the particular needs in each stage. However, during transition, changes to the existing equipment, channel assignment, cell sites, etc., are kept at a minimum to ensure a smooth growth pattern.

3.4.1 Co-Channel Cell Layout

Careful determination of co-channel cell location, that is, those cells that should use the same channel set, is made to reduce radio interference.

The CGSA is sectionalized into hexagonal shapes to start the co-channel layout. One cell is chosen as a reference and labeled A. Chains of hexagons are drawn from the reference cell, one from each side, and terminate in a co-channel cell. These co-channel cells are also labeled A (Fig. 10). This describes a 7-cell reuse pattern.

To continue the cellular layout, another cell close to the reference is chosen, and labeled, such as B. The six chains emanating from this cell also terminate in B co-channel cells (Fig. 10). This procedure is repeated until a sufficient number of cells have been labeled.

The cells form natural clusters around the reference cell and around each of its co-channel cells. The exact shape of the cluster is not unique; all that is required is that it contain exactly one cell with each label.

The number of cells per cluster determines how many channel sets must be formed out of the total allocated spectrum. The ratio of D (the distance between the centers of the nearest neighboring co-channel cells) to R (the cell radius) is called the co-channel reuse ratio (D/R) (Fig. 11). The number of cells per cluster is governed by co-channel interference considerations. As the number of cells per cluster increases, the relative separation distance between co-channel cells will increase.

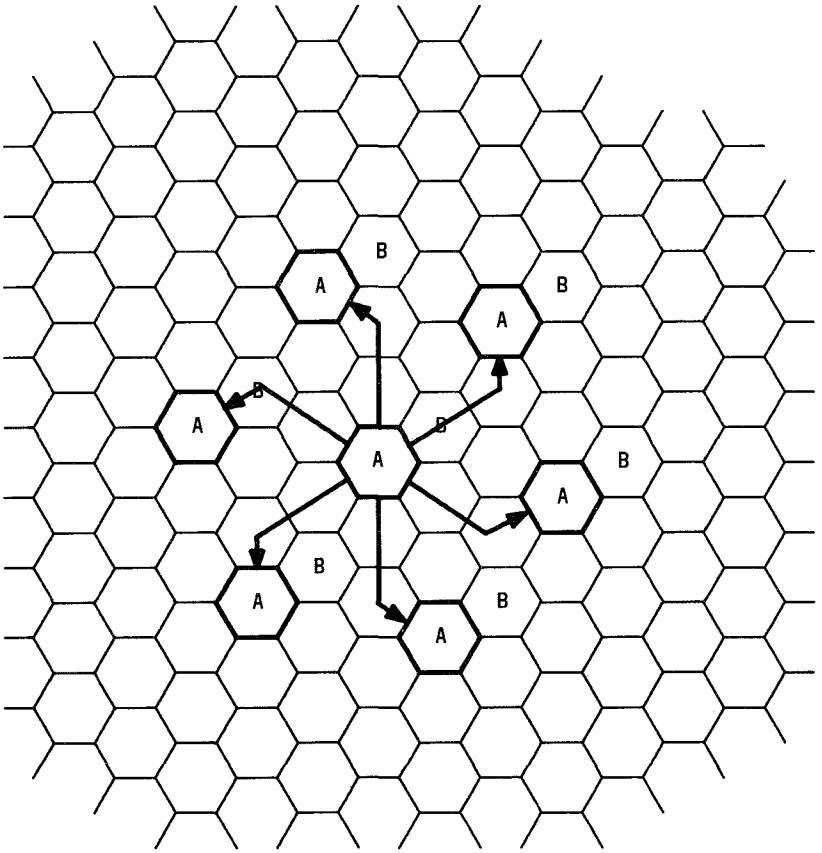
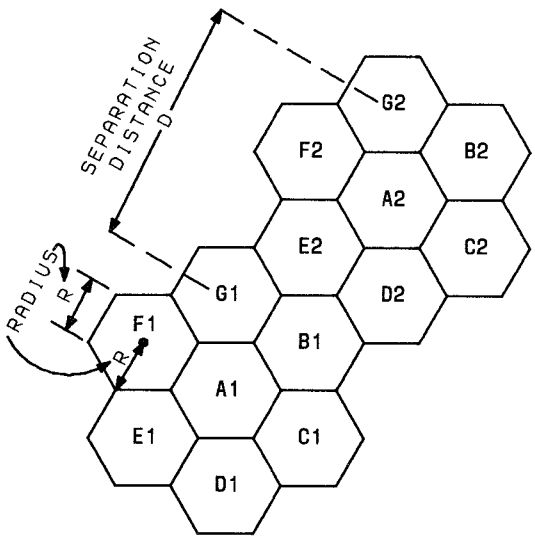


Fig. 10 — Determination of Co-Channel Cells With 7 Cell Reuse Patterns



NOTE:
1. Seven-cell repeat pattern; D/R = 4.6 (seven channel sets: A-G) each channel set is used twice (subscript 1,2) for example channel set a is used in cells A1 & A2. This pattern is used in a growth configuration

Fig. 11 — Co-Channel Reuse Ratio (D/R)

3.4.2 Start-Up

When a System 100 is first planned and installed in a new service area, the system design goal is to have a start-up configuration to serve the CGSA at minimum initial cost. This implies using a minimum number of cell sites (i.e., using the largest size cell which still can provide adequate coverage) in most cases. In most metropolitan areas, a typical CGSA will range from 600- to 3000-square miles. For a start-up cell, the typical cell radius may range from 8 to 10 miles. With these wide range of areas, practically all initial configurations will have fewer than 20 cells, with most having fewer than 10.

In a start-up configuration, omnidirectional antennas and centrally located cell sites are used for each cell (Fig. 12). The cell radius is determined by the terrain and environment of the particular CGSA of interest. The system design prefers to use start-up cells of uniform size in one CGSA. The total number of cells required must be sufficient to cover the entire CGSA. At this stage, paging and access functions share the same channels; hand-off, signaling functions, etc., operate in the manner as described before. In the start-up configuration, the D/R is typically about six in order to reduce co-channel interference. The channel sets will be reused in a 12-cell pattern (Fig. 13), instead of the 7-cell reuse pattern which is typically used for growth configurations. Using omnidirectional antennas for the start-up configuration increases trunking efficiency and reduces initial cost, but usage of this type of antenna exhibits slightly poorer interference rejection. In a start-up configuration, interference problems are not serious because channels are not reused extensively.

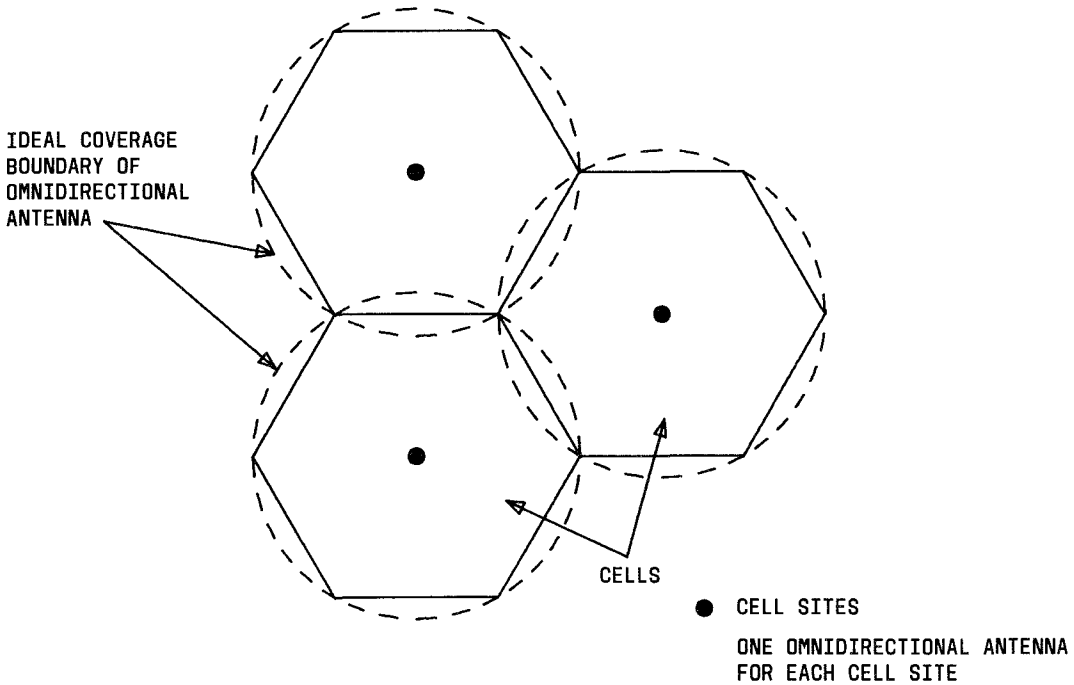


Fig. 12 — Cells Served by Omnidirectional Antennas

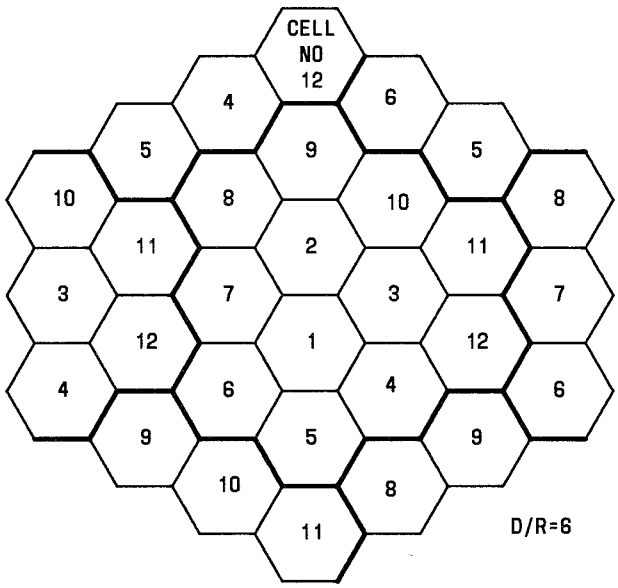


Fig. 13 — Cell Reuse Pattern for Start-Up Configuration

3.4.3 Growth

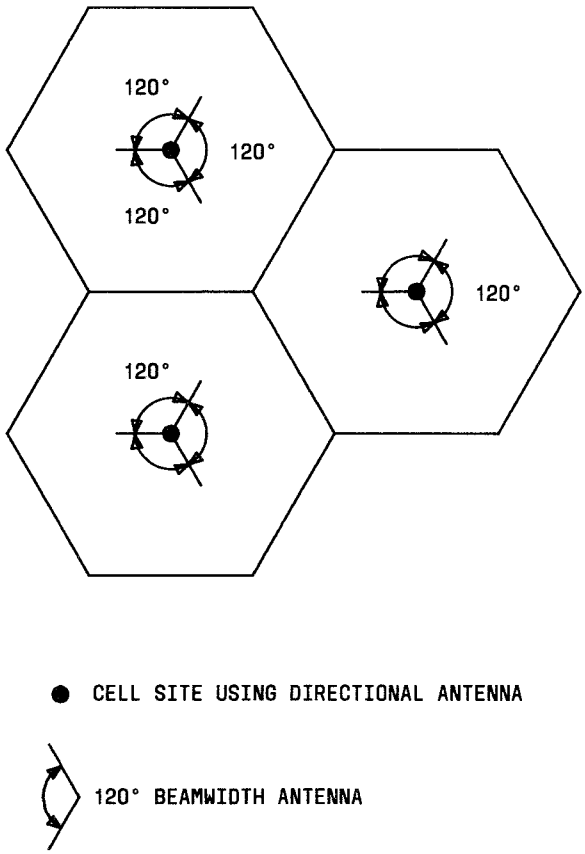
A growth configuration is a pattern developed by using growth schemes after the capacity offered by the start-up configuration is saturated. The beginning of this phase is indicated by heavy traffic demand and increased blocking probability when there are no additional channels available in the start-up configuration. The demand for growth can be met by the cell attachment technique when the demand is to serve new geographical areas outside the existing CGSA; or by the cell-splitting technique when the demand is to serve more telephone traffic within the existing service area. Cell splitting can be accomplished at each affected cell site by replacing the omnidirectional antenna with three 120-degree directional antennas (when high co-channel interference makes them necessary) and by reducing the cell size. By using the directional antennas, the complete coverage of each cell is provided by three different antennas at the centrally located cell site (Fig. 14). The use of directional antennas creates cells whose idealized boundary forms a regular hexagon as in the omnidirectional case. At each cell site, three channel sets can be assigned and each directional antenna will use its own assigned channel set to serve traffic in its respective sector.

When the first cell split is required, the transition from start-up to growth configurations begins. The growth plan requires that, in addition to the use of directional antennas, the cell radius be reduced by half (Fig. 15). However, existing cells do not change radius until all possible growth sites are in place. The detail of locating new cell sites in the cell-splitting process is illustrated in Fig. 16. New cell sites are added midway between two existing cell sites. The original site will remain a site for a new cell. For all subsequent cell splits, the cell radius is reduced to one-half of the previous cell radius.

Using directional antennas in this arrangement reduces co-channel interference. Therefore, the channel reuse ratio is reduced from 6 for a start-up configuration to a 4.6 for a growth configuration, and 7-cell reuse pattern is allowed. This configuration of fewer cells permits more frequency reuse and increases the spectral efficiency of the system.

In a realistic growth pattern, traffic demand may be heavy only in a few cells in part of the CGSA. In these instances, it would not be necessary to initiate a cell-split procedure throughout the whole CGSA, because it would add many unnecessary cell sites and equipment. Cell splitting may initially involve only the few cells that encounter the heaviest traffic in the CGSA. After such a cell split, the resulting pattern contains larger cells overlaid by a grid of smaller cells (Fig. 17). In this configuration, forward setup channels will remain at the original omnidirectional sites; but access functions will be equipped at all new and old cell sites. The total coverage of paging channels remains the same, covering the whole CGSA; but there will be more access channels, one to each cell site. As cell split advances, all channels will eventually be used in smaller cells; and larger cells will cease to exist as servers of traffic.

Using cells as small as 1 mile in radius, the CGSA will be capable of serving in the order of 50,000 CCS (Hundred Call Seconds) per busy-hour. Using current estimates for average customer calling characteristics, this implies a limiting capacity of several hundred thousand users in a CGSA with the existing spectrum allocation. At this point in growth, the system will be capable of using several hundred cell sites. The majority of these sites would form a grid defining cells with a radius of approximately 1 mile.



● CELL SITE USING DIRECTIONAL ANTENNA

120° BEAMWIDTH ANTENNA

Fig. 14 — Cell Served by Directional Antennas

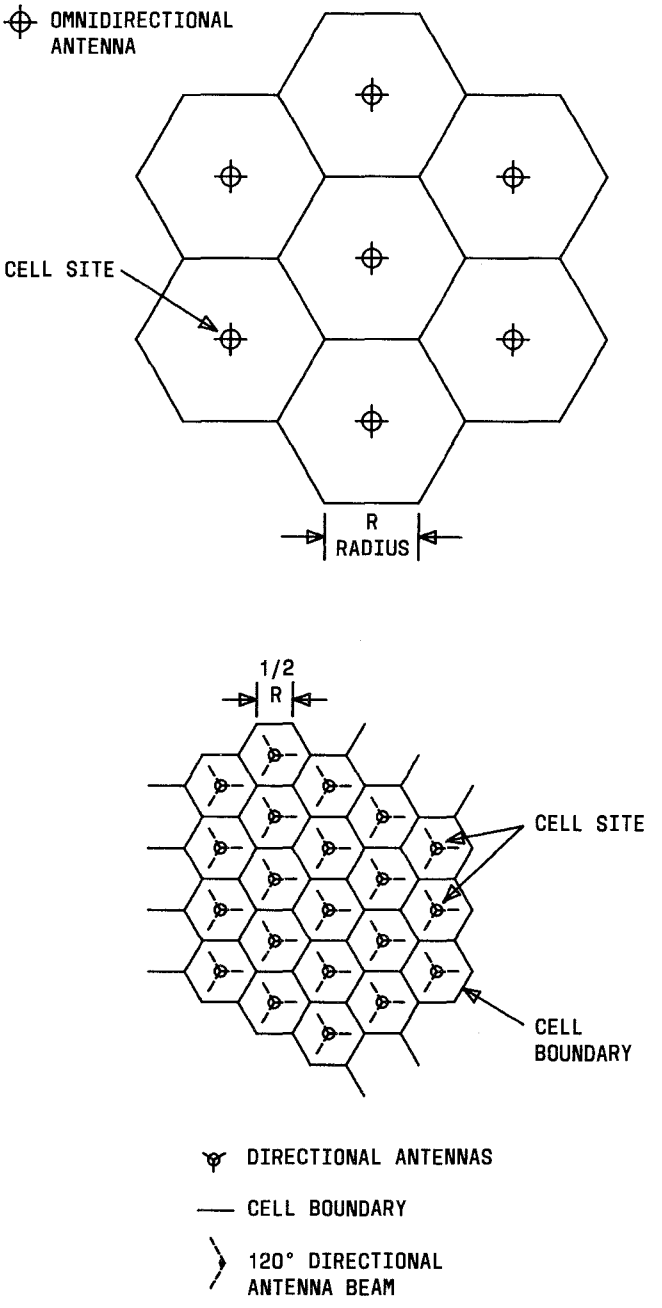


Fig. 15 — Cell Split (Start-Up to Growth Configurations)

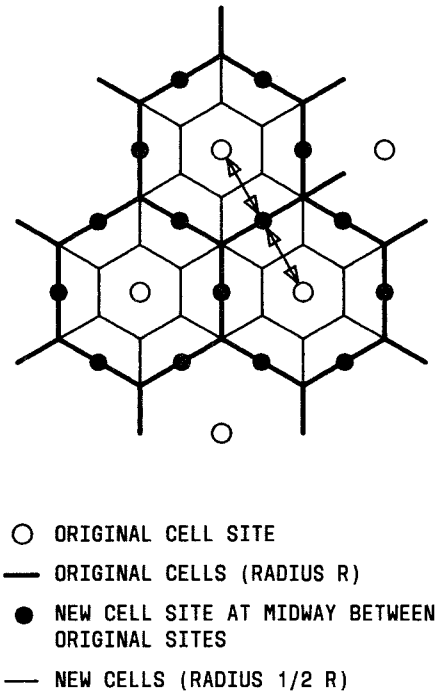


Fig. 16 — Location of Cell Sites in Cell-Splitting Process

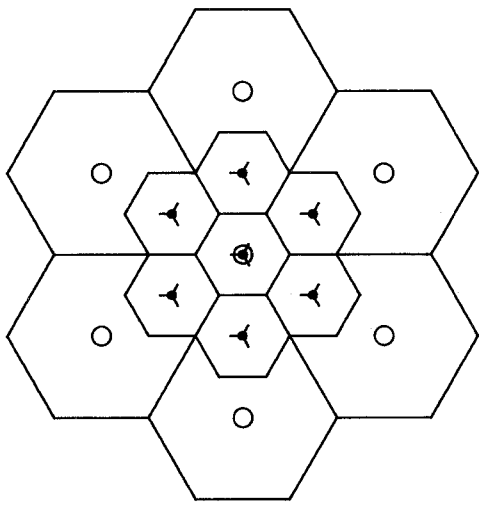


Fig. 17 — Cell Site Antenna Arrangement After Cell Splitting

3.5 Network Integration

3.5.1 Numbering Plan

Each mobile unit is assigned a standard 10-digit DN of the form NPA-NXX-XXXX and is registered in its home CGSA. The NIPs, with which the MTSO interconnects, reserve blocks of line numbers associated with the 3-digit NIP code in the DNs. Where there is more than one NPA (Numbering Plan Area) in the CGSA, different NIP codes may be assigned in each NPA. In this way, the system can page and identify each home mobile unit by using only the last seven digits of its DN.

3.5.2 Dialing Arrangements

The System 100 dialing arrangements for calls to and from the mobile units are described in the following paragraphs.

3.5.2.1 Calls to a Mobile Unit

When a mobile unit is in its home CGSA, a call to the mobile unit is placed by dialing its number using the local dialing conventions. The call will then be routed through local or toll network to the NIP where that number is assigned. The NIP then transmits the telephone number of the called mobile unit to the control point MTSO (the first MTSO to receive the incoming call).

When the called mobile unit **is not** located in its home CGSA, the mobile unit is called a roamer. Beginning with Cellular Networking (1AE9.03), a roamer can be a Network Roamer or a Non-Network Roamer. (A Non-Network Roamer is sometimes called a "foreign" roamer). To complete a call to a roamer, there are several different possibilities. These include:

- Calling the home directory number (cellular network paging and termination in a networked MTSO).
- Calling the temporary local directory number via single-stage dialing in a specific networked MTSO.
- Calling the roamer access number plus the home directory number via 2-stage dialing in a specific networked MTSO.

In the second or third case, the mobile customer must inform all potential callers of the special roamer access number or temporary local directory number at the location where the mobile customer intends to stay.

A land-line user equipped with touch-tone dialing may directly dial the roamer access number or temporary local directory number assigned at the foreign CGSA. If the land-line user dials the roamer access number, then upon receipt of a second dial tone, the land-line user dials the 10-digit directory number of the roamer.

A land-line user, equipped with a rotary dial or a coin phone, may dial the standard directory number assigned at the foreign CGSA. The attendant will assist the land-line user by requesting the 10-digit number of the mobile unit and completing the call. If the roamer access number is required, the MTSO will expect to see the roamer access number pulses via MF rather than touch-tone dialing tones.

3.5.2.2 Calls From a Mobile Unit

Mobile call originations can be made from:

- The home MTSO (by a Home Mobile)
- An MTSO that is directly networked to the subscriber's home MTSO (by a Non-Network Roamer)
- An MTSO that is not directly networked to the subscriber's home MTSO (by a Non-Network Roamer).

A call from a mobile unit is dialed exactly as in land-line service. If the called number has the same NPA as the mobile unit, the NPA code is not dialed. The mobile unit, in a sense, carries its NPA wherever it goes. For example, the user of a Chicago-based mobile unit never has to dial area code 312, no matter where the call is originated. On the other hand, area code 212 must be dialed to complete calls to New York City even when the mobile unit is in that city. The necessity of any additional digits to be added with the call from a mobile unit is determined by the MTSO pretranslation software. Any additional digits are automatically added by the pretranslation software. The translations at an MTSO can also be arranged so that the user must send a 1 or 0 prefix with the dialed telephone number. This dialing procedure is consistent with AT&T long range planning to permit interchangeable NPA and central office codes.

When a call is placed from a mobile unit, the call may be routed into the nationwide telephone network by one of several means at the option of the serving company. It may be routed via:

a. The NIP which is nearest to the called number.

b. The NIP which is assigned the mobile unit standard DN.

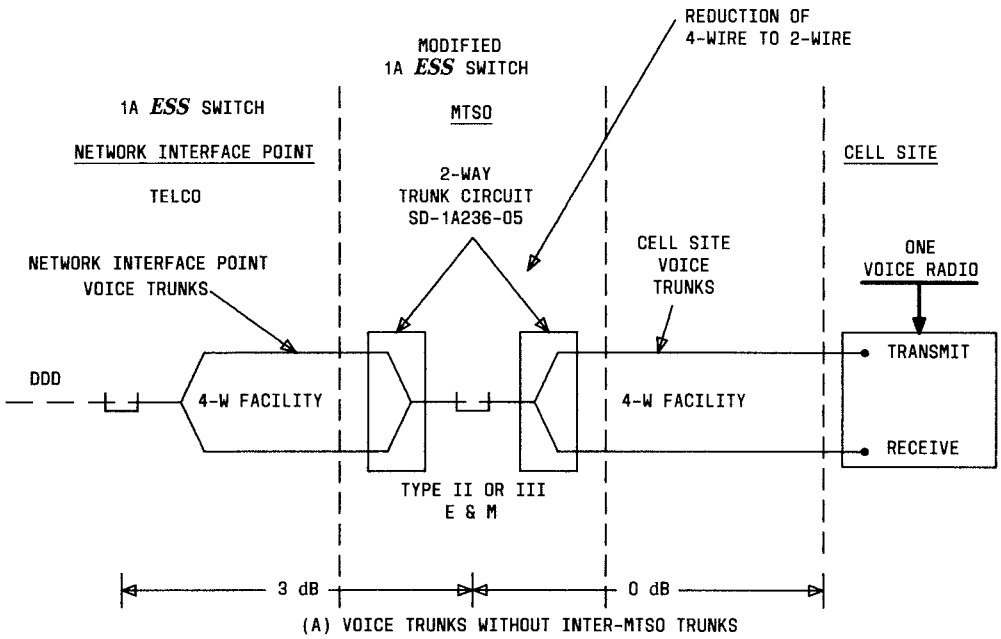
3.5.3 Network Interface Point, Inter-MTSO, and Cell Site Voice Trunks

The land-line voice path, connecting a mobile unit to the DDD network, includes network interface point voice trunks and cell site voice trunks. If two or more MTSOs are involved, inter-MTSO trunks are required. Since System 100 gains access to the existing DDD network at the class 5 level in the switching hierarchy, the voice trunks between an NIP and mobile unit meet the transmission requirements for a local loop and 500-type telephone set.

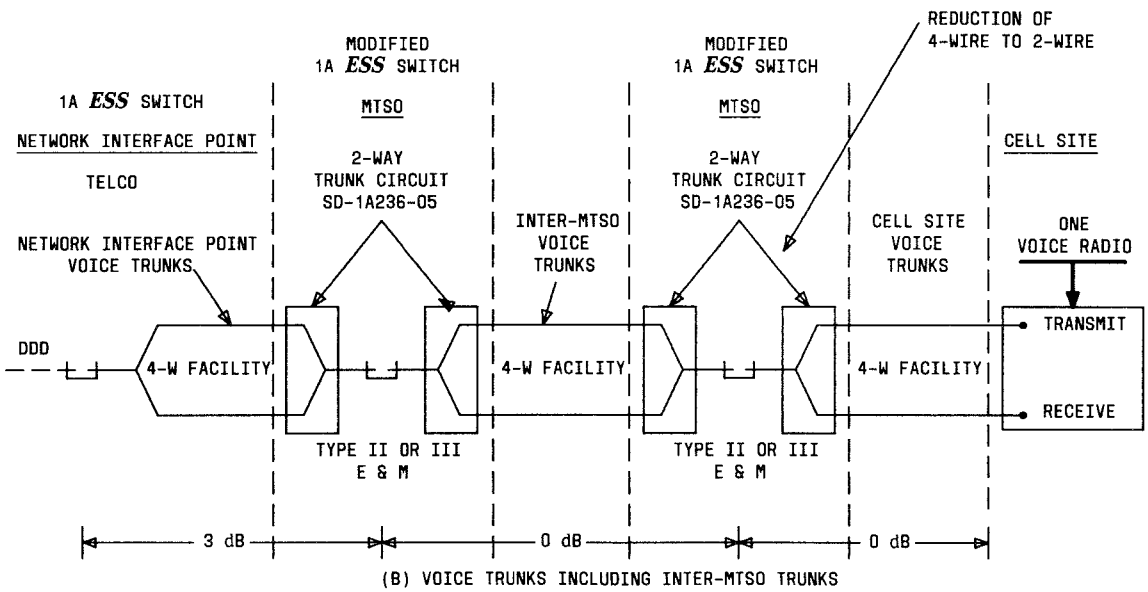
Four-wire transmission facilities are used for network interface point, inter-MTSO and cell site voice trunks. The voice trunks are reduced down to a 2-wire facility at the MTSO appearance. The cell site and inter-MTSO voice trunk operates at a transmission loss of 0 dB and the network interface point trunk operates at no greater than 3-dB loss. Noise and attenuation distortion requirements applicable for PBX tie trunks as given in AT&T Practice 851-300-100 are similar for System 100 voice trunks.

Inward and outward calls are transmitted over 2-way voice trunks. The network interface point voice trunks use MF signaling and returned answer supervision. The cell site and inter-MTSO voice trunks are similar to network interface point voice trunks but are only used for voice communication. Most signaling between the MTSO and cell sites take place over dedicated full duplex data links. Most signaling between two or more MTSOs take place over inter-MTSO (inter-system) data links.

All voice trunks from a cell site, inter-MTSO, and/or network interface point terminate in the MTSO switching network 2-way trunk circuit (SD-1A236-05). Each cell site voice trunk is dedicated (directly connected) to one particular voice radio at a cell site (Fig. 18). Loop-around trunk circuits are used for mobile-to-mobile calls within the same CGSA. All voice trunks have entries on the trunk group supplementary record (ESS 1216 form) that are useful when analyzing trouble. For maintenance information on System 100 voice trunks, refer to Section 11 of this practice.



(A) VOICE TRUNKS WITHOUT INTER-MTSO TRUNKS



(B) VOICE TRUNKS INCLUDING INTER-MTSO TRUNKS

Fig. 18 — System 100 Voice Trunks

4. SYSTEM FEATURES

Note: Please contact your AT&T Account Executive if you have questions regarding feature licensing information.

4.1 Cellular Networking

CN (Cellular Networking) is a feature that permits an AUTOPLEX System 100 MTSO (Mobile Telephone Switching Office) to be interconnected (networked) with other AUTOPLEX System 100 MTSOs and AUTOPLEX System 10 MTSOs for the purpose of providing Abutting System Service. CN provides improved continuity of roamer service across the boundaries of two or more CGSAs (Cellular Geographical Service Areas).

The Abutting System Service allows the following specific network capabilities:

- Inter-MTSO handoff which involves a handoff via an inter-MTSO trunk between two MTSOs.
- Inter-MTSO handback which involves a handoff that removes an inter-MTSO trunk from the call path.
- Per-directory number paging in multiple abutting MTSOs.
- Full support of immediate call forwarding, conditional call forwarding, don't answer, and conditional call forwarding busy line features in abutting MTSOs. This includes remote activation of these features from any networked MTSO.
- Full fraud prevention for inter-MTSO terminations to roamers in abutting MTSOs. This includes positive matching of the directory number/serial number pair as stored by the home MTSO.
- Positive serial number check (not associated with directory number) for roamer originations in abutting MTSOs.
- Improved Roamer II fraud prevention which involves permitting a serial number to be entered directly against a TLDN (Temporary Local Directory Number).
- Compatibility with AUTOPLEX System 10 (includes multiple digital cellular switches).

A System 100 may be networked with up to 15 other System 100s in different CGSAs. If the network includes a System 10, each digital cellular switch counts as one of the 15 possible switches in the network. It is also possible for a System 100 to network with another System 100 or System 10 that is networked with other MTSOs without being part of the other MTSO's network. This is the concept of overlapping networks.

The CN feature is available with 1AE9.03 with corresponding Attached Processor System and Cell Site Generics. For additional information regarding the CN feature, refer to AT&T Practices 231-290-619 and 231-252-000.

4.2 Speed Calling

Note: Speed calling is not supported by 1AE9.03 generic.

SC (Speed Calling) allows mobile users to have an abbreviated code assigned to frequently called numbers. This permits the dialing of selected numbers using fewer digits than normally required.

The 1-digit SC feature allows mobile customers to place calls from a list, of up to eight frequently called numbers, by dialing a 1-digit SC code. The SC code range is 2 through 9.

An SC list is kept in the MTSO memory for each customer having this feature. To make or change an entry on an SC list from a mobile unit, the user dials a special change SC list access code (74), an SC code (2 through 9), and the new number (7 or 11 digits) to be placed on the list. The SC list is also changeable from the MTSO via recent change.

4.3 Roamer I

Roamer I service is available beginning with the 1AE7 generic program. A mobile unit located in a foreign CGSA is called a roamer. The roamer feature provides the capability to process calls to or from roaming mobile units. A land-line customer with touch-tone dialing must dial a special roamer access number. Upon receipt of a second dial tone, the 10-digit DN of the roamer is then dialed. A land-line customer equipped with rotary dial or a coin phone user must be processed through an attendant to complete the call. For more information on Roamer I, refer to AT&T Practice 231-290-615.

Roamer I service is available with 1AE9.03 generic program for either Network or Non-Network Roamers located in a foreign CGSA if the MTSOs involved have an agreement in force to exchange mobile serial numbers and billing data.

4.4 Roamer II

Roamer II service is available beginning with the 1AE8A generic program. Roamer I service is provided with Roamer II service. With Roamer II the roamer has the option of requesting a DN from the host system in which mobile unit is roaming. This DN, referred to as a TLDN, is assigned for a specified period of time to the roamer. A land-line customer can then reach the roamer directly by dialing only the TLDN. A mobile unit that has been assigned a TLDN may also receive custom calling services; such as, call forwarding, 3-way calling, call waiting, and priority calling. For more information regarding Roamer II, refer to AT&T Practice 231-290-616.

Roamer II service is available with 1AE9.03 generic program for either Network or Non-Network Roamers located in a foreign CGSA.

4.4.1 Call Delivery

Call delivery is a service that may be requested with Roamer II service. This service allows the roamers home CGSA to forward calls to the TLDN at the host system. Call delivery can be provided only if the roamer has call forwarding in the home system.

4.5 Call Waiting

Call waiting service is available beginning with the 1AE8A generic program. This service allows a mobile user to detect an incoming call when a call is already in progress. The mobile user can then answer the new call, alternately converse with either party while the other party is held, and at any time disconnect one of the parties and continue talking to the remaining party. For more information on call waiting service, refer to AT&T Practice 231-290-610.

4.6 Call Forwarding

Call forwarding service is available beginning with the 1AE8A generic program. The mobile user may request either immediate or conditional call forwarding. Immediate call forwarding redirects an incoming call immediately, and attempts to signal the mobile unit by a short alert. Conditional call forwarding redirects an incoming call if the mobile unit is busy, does not respond to paging, or does not answer within a specified time (about 15 seconds).

A mobile user may activate call forwarding at any time by dialing an access code and the desired number from the mobile unit. The access code depends on whether the forwarding should be immediate or conditional. Another access code is available that will disable the call forwarding service. For more information on immediate and/or conditional call forwarding service, refer to AT&T Practices 231-290-607 and 231-290-608, respectively.

4.6.1 Priority Calling

Priority calling is available with call forwarding. This service allows the mobile unit to be alerted even though call forwarding is active. An additional DN is assigned to the mobile unit which provides cut-through when incoming calls are forwarded for the mobile's regular assigned DN.

4.7 Three-Way Calling

Three-way calling service is available with the 1AE8A generic program. This service allows a mobile user, during a call, to dial and consult with a third party while the second party is held, and then either drop the third party and return to the second, or include both in a 3-way call. If a 3-way call is set up, the user may at any time drop the third party and continue with the second or end the call by releasing. The mobile user cannot drop out of a

3-way call and leave the other parties connected. For more information on 3-way calling service, refer to AT&T Practice 231-290-609.

4.8 Roamer Serial Number Registration

The RSNR (Roamer Serial Number Registration) custom feature is available beginning with 1AE7A.09 generic program. This feature uses the FSN (Fraudulent Serial Number) list as a list of allowed roamer serial numbers instead of using the FSN as a list of known fraudulent roamers. The set card required for the RSNR is FF008 and is set to 1 for an MTSO with this feature.

4.9 Roamer Serial Number Announcement

The Roamer Serial Number Announcement custom feature is available beginning with 1AE7A.10 generic program. This feature allows a cellular service provider to provide an announcement instead of an intercept tone to a roamer who has been denied access to the system. Pseudo route index 4FPRI141 is required for this feature.

4.10 Message Service

The MS (Message Service) custom feature is available beginning with 1AE8A.02 generic program. This feature allows a mobile subscriber to have calls conditionally forwarded to a message storage system where the calling party can leave messages for the subscriber. The set card required for MS is FF010 and is set to 1 for this feature. For additional information, see AT&T Practice 231-290-622.

4.11 Limited Service Area

The LSA (Limited Service Area) feature is available beginning with 1AE8.05 generic program. This feature allows the service provider to provide a reduced rate to a customer for calls placed within a defined local service area. The local service area is only a part of the CGSA to which the system normally provides service. When the customer uses cell sites outside the defined local service area, a higher rate is charged for the calls. The set card required for LSA is FF012 and is set to 1 for this feature. For additional information, see AT&T Practice 231-290-624.

4.12 Project Accounting Service

The PAS (Project Accounting Service) custom feature is available beginning with 1AE8A.05 generic program. This feature allows a mobile subscriber to add an identifying account number to an AMA (Automatic Message Accounting) record for a mobile originating or a mobile terminating call. The account number appears on the mobile subscriber's telephone bill. The set card required for PAS is FF013 and is set to 1 for this MTSO feature.

For additional information, see AT&T Practice 231-290-623.

4.13 Expanded Roamer Serial Number List

The ERSNL (Expanded Roamer Serial Number List) custom feature is available beginning with 1AE8A.06 generic program. The ERSNL is sometimes called the " Enlarged Fraudulent Serial Number List." The ERSNL can have up to 512,000 serial number entries. The MTSO has the option of specifying a valid (positive list) or a fraudulent (negative list) of subscriber unit serial numbers. An MTSO may have ERSNL or RSNL (Roamer Serial Number List), but not both. For additional information, see AT&T Practices 231-290-619 and 231-252-000.

4.14 Mobile Unit Intercept Tone

The MUIT (Mobile Unit Intercept Tone) custom feature is provided on a per MTSO basis and is available beginning with 1AE8A.05 generic program. This custom feature allows users to determine whether or not they will be charged for mobile call originations. The set card required for the MUIT is FF020 and is set to 1 for an MTSO with this feature.

When a mobile call origination cannot be completed and a voice channel has not been assigned, the MTSO sends an MUIT command to the mobile unit over the setup channel. The mobile unit generates a two-frequency tone to the user, and no AMA record is made.

When a mobile call origination cannot be completed and a voice channel assignment has been made, the MTSO sends a reorder tone to the mobile unit over the voice channel. In this case an AMA record entry is made. An exception to this is when a voice channel assignment is not received within 5 seconds of a service request. The mobile unit would then time out and generate its own reorder tone with no AMA record made.

There are no recent change implementation procedures for the MUIT custom feature.

4.15 Roamer Access to Business Office

The RABO (Roamer Access to Business Office) custom feature provided on a per MTSO basis and is available beginning with 1AE8.05 generic program. This feature allows a cellular service provider to route calls from unregistered roamers directly to the cellular provider's business office. The set card required for RABO is FF019 and is set to 1 for this MTSO feature.

4.16 Direct Connection to Interexchange Carriers

The Direct Connection to Interexchange Carriers feature permits a mobile customer to originate a call that uses the services of ICs (interLATA carriers) and INCs (international carriers). There are two CI (Carrier Interconnect) arrangements: the R2CI (Release 2 CI) and R3CI (Release 3 CI). The R2CI is via class 5 zone offices and R3CI is via direct connect.

The R2CI is a custom feature, is provided on a per MTSO basis, and is available beginning with 1AE8A generic program. The R3CI is a custom feature that is available beginning with 1AE9 generic program. For additional information, see AT&T Practice 231-290-628.

4.17 Look Ahead Trunk Hunt

The LATH (Look Ahead Trunk Hunt) custom feature is provided on a per MTSO basis and is available beginning with 1AE8A.08 generic program. This custom feature determines the availability of an outgoing trunk or tone/announcement service circuit before a mobile originated call is brought up to a voice channel. If an idle resource is not found, the call is intercepted on a setup channel. The set card required for the LATH is FF030 and is set to 1 for this MTSO feature.

4.18 Routing Service for Emergency Calls

The RSEC (Routing Service for Emergency Calls) custom feature is provided on a per MTSO basis and is available beginning with 1AE8A.08 generic program. This custom feature routes 911 calls from a mobile to the PSAP (Public Service Access Point) that is nearest to the current location of the mobile. When the 911 is dialed, the call is routed to a DN based on the cell site number and the logical antenna face that is serving the call. The set card required for the RSEC is FF029 and is set to 1 for this MTSO feature. For additional information, see AT&T Practice 231-290-629.

4.19 Electronic Industries Association Roamer Dialing

The TDRD (10-Digit Roamer Dialing) custom feature, also known as the EIA (Electronic Industries Association) Standard Dialing Plan, is provided on a per MTSO basis and is available beginning with 1AE8.08 generic program. The current roamer dialing procedure enables subscriber units to dial 7 digits. This custom feature would change the dialing procedure to require a roamer to dial 10 digits (NPA-NXX-XXXX). Set card required for TDRD is FF028 and is set to 1 for this MTSO feature.

4.20 Dynamic Channel Allocation

The Dynamic Channel Allocation custom feature is provided on a per MTSO basis and is available beginning with 1AE9.05 generic program. The DCA (Dynamic Channel Allocation) increases the effective use of the spectrum by allowing radio channels that interfere with one another to be equipped at multiple cell sites. The availability of such a channel at one cell is conditional with it not being in use at an interfering cell. For additional information, see AT&T Practice 231-290-630.

4.21 Plant Measurement End-of-Month Summary

The PMES (Plant Measurement End-of Month Summary) optional feature is provided on a per MTSO basis and is available beginning with 1AE9.04 generic program. The current PM (Plant Measurement) 02 end-of-month report is generated on the 23rd day of each month. This feature will change the end-of-month summary generation date to the first day of each month. Set card required for PMES is FF033 and is set to 1 for this MTSO feature.

4.22 Expanded Roamer Service List

The ERSL (Expanded Roamer Service List) optional feature is provided on a per MTSO basis and is available beginning with 1AE9.03 generic program. The current RSL (Roamer Service List) can have up to 300 NPA or NPA-NXX entries. This optional feature will permit the MTSO to increase the list from 300 to 2,000 NPA or NPA-NXX entries. Set card required for ERSL is FF032 and is set to 1 for this MTSO feature.

5. MOBILE UNIT

The mobile unit (Fig. 19) consists of a control unit, a transceiver, and the mobile antenna.

5.1 Control Unit

The control unit provides the mobile subscriber interface to the System 100. A typical control unit is illustrated by Fig. 20. Table D identifies the controls and indicators used by the subscriber. The control unit provides the required physical interface between user and the telephone network. The control unit includes a handset to provide the acoustical interface, a pushbutton keypad to enter commands into the telephone network, and audio and visual indicators to provide customer alerting.

A 32-digit dialing capability is available with the 1AE8A generic program. This capability allows the mobile unit user to enter and send up to 32 digits for the 10XXX dialing with carrier interconnect for international calls. It also allows 10XXX of international DDD numbers as destinations for call forwarding.

5.2 Transceiver

The typical transceiver unit shown in Fig. 21 contains the duplex radio receiving and transmitting circuits and the logic circuitry within one assembly housing. See Table E for a description of the transceiver controls and connections. This unit is normally mounted within the trunk or luggage compartment of sedan or station wagon-type vehicles, behind or under the seat of pickups and trucks, and wherever convenient and adequately protected in vans. The logic circuitry within the transceiver unit provides control for all mobile unit call processing functions and is actively functioning even during the on-hook state as long as power is applied to the unit.

5.3 Antenna (Mobile)

The mobile unit transceiver employs one antenna. The antenna is vertically polarized and can be mounted on the roof or rear deck of the vehicle (Fig. 19). The antenna serves as the receiver and/or transmitting antenna.

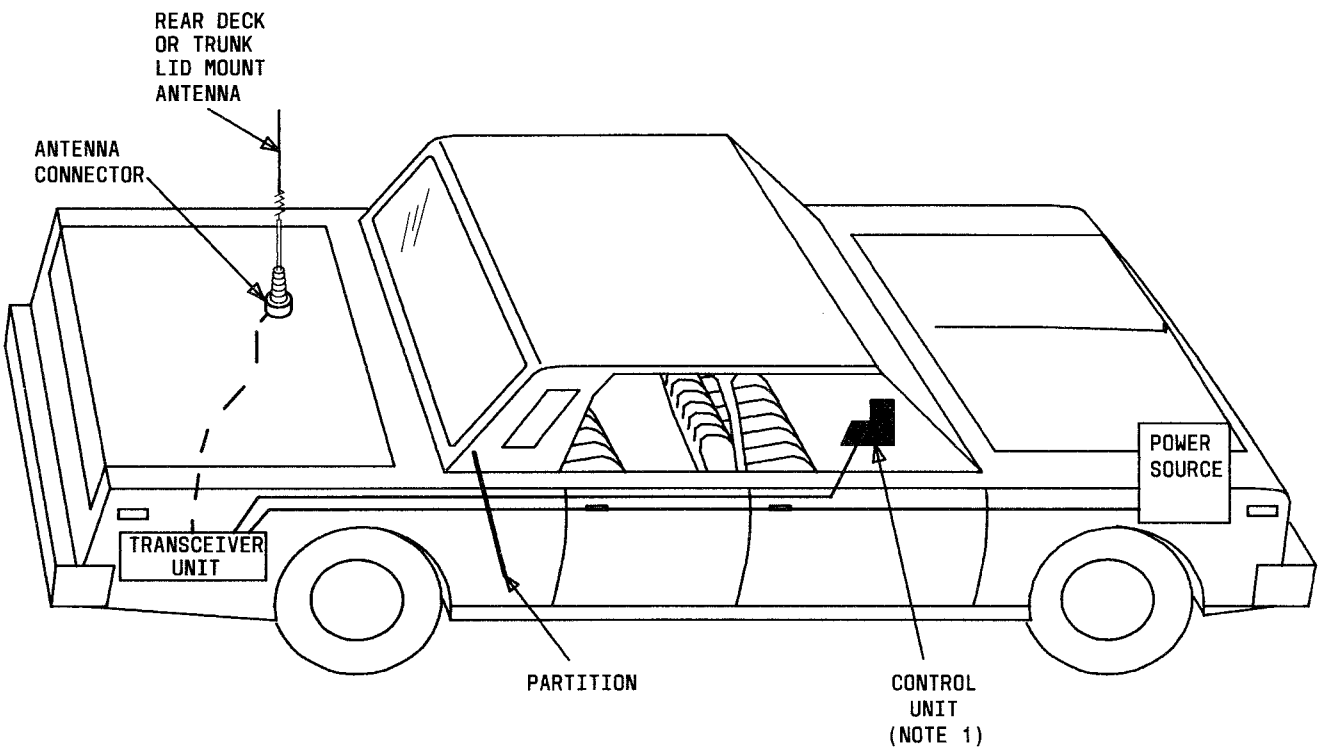
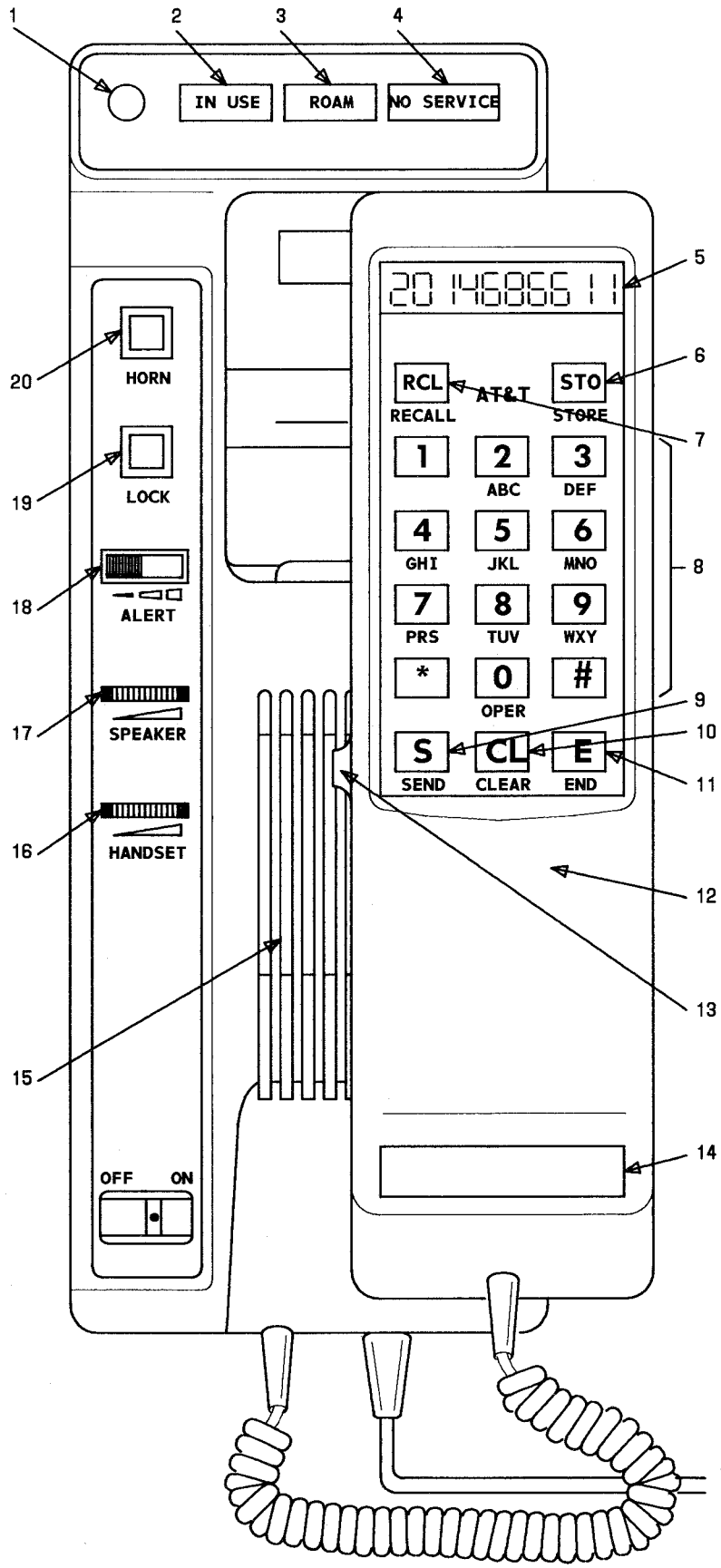


Fig. 19 — Typical Mobile Unit Equipment Placements and Connections



1 - POWER ON INDICATOR
2 - IN USE INDICATOR
3 - ROAM INDICATOR
4 - NO SERVICE INDICATOR
5 - DIALED NUMBER DISPLAY
6 - STORE KEY
7 - RECALL KEY
8 - KEYPAD
9 - SEND KEY
10 - CLEAR KEY
11 - END KEY
12 - HANDSET
13 - LATCH
14 - MOBILE UNIT DN
15 - SPEAKER
16 - HANDSET VOLUME CONTROL
17 - SPEAKER VOLUME CONTROL
18 - ALERT (RINGER) VOLUME CONTROL
19 - LOCK KEY
20 - HORN KEY

NOTE:
1. See Table D for function of controls and indicators

Fig. 20 — Typical Control Unit

TABLE D

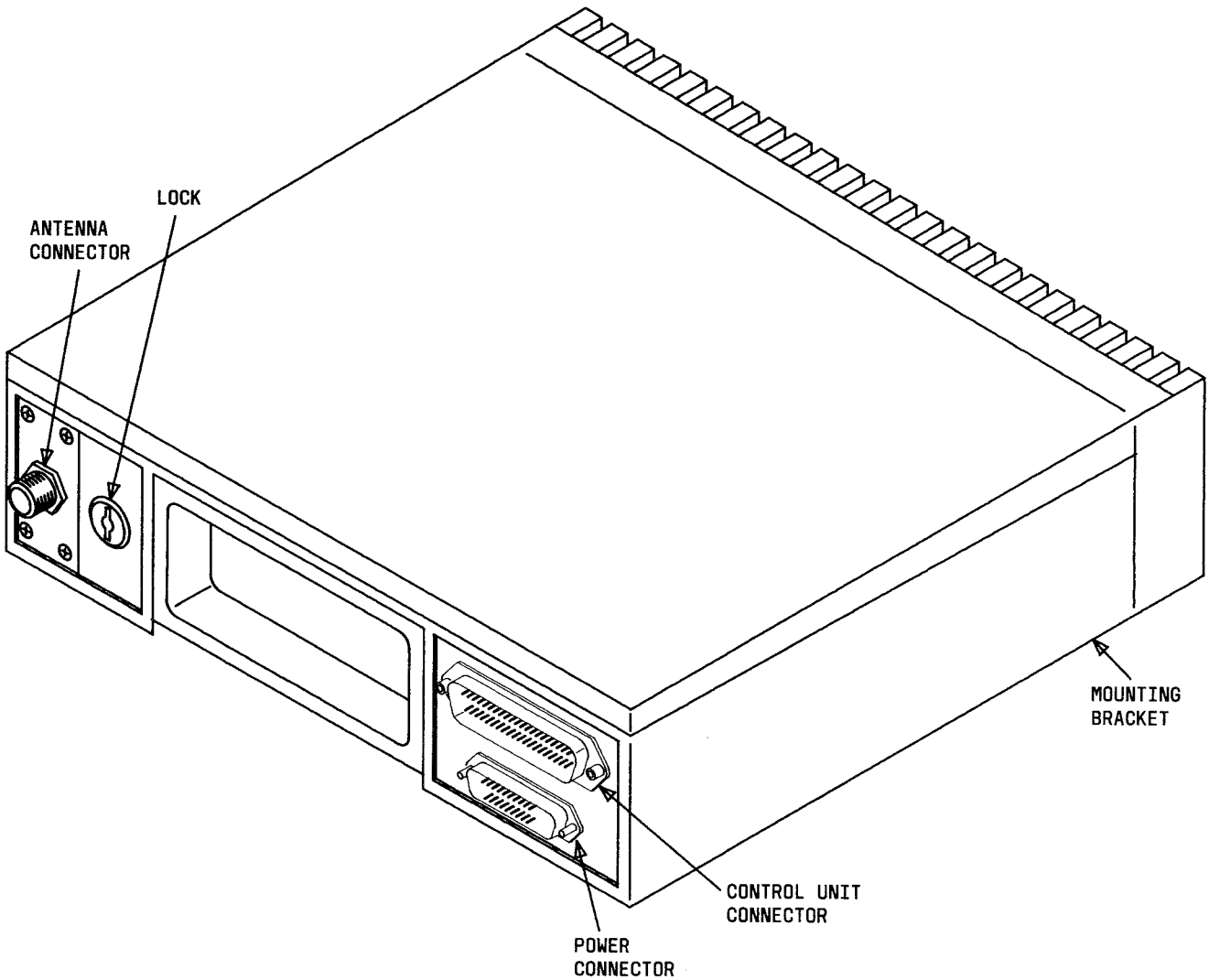
TYPICAL CONTROL UNIT CONTROLS AND INDICATORS

NAME	TYPE	FUNCTION
Power On Indicator	Lamp (green)	When lighted, control unit is on.
In Use Indicator	Lamp (green)	Is lighted for duration of call.
Roam Indicator	Lamp (amber)	When lighted, the mobile unit is within radio transmission range of a foreign CGSA.
No Service Indicator	Lamp (amber)	When lighted, the mobile unit is out of radio transmission range of an CGSA and cannot place or receive calls.
Dialed Number Display	Ten digit (LED)	Displays 10-digits of dialed telephone number. More than 10-digits may be entered.
Store (Sto) Key	Pushbutton	When pressed, allows up to ten telephone numbers to be stored in memory for future use.
Recall (Rcl) Key	Pushbutton	When pressed, allows each of ten possible telephone numbers, stored in memory, to be recalled to dialed number display for review or dialing.
Keypad	Pushbutton	Used to enter telephone numbers into control unit before initiating call. Keypad is lighted when control unit is on.
Send (S) Key	Pushbutton	When pressed, initiates radio transmission procedures for telephone number in dialed number display. Also may be used to answer calls without lifting handset (listen only) and switchhook flashing.
Clear (CL) Key	Pushbutton	When pressed, clears dialed number display.
End (E) Key	Pushbutton	When pressed, places mobile unit in an on-hook state. This key may be used in place of returning handset to handset cradle.
Handset	—	Can remain in cradle during call placement and receiving procedures. Must be removed from cradle to speak from mobile unit.
Latch	Thumb Latch	Secures handset to its cradle.
Mobile Unit DN	—	The specific 10-digit DN of that mobile unit.
Speaker	—	Gives audible confirmation of keystrokes, allows user to listen to recorded announcements, confirms called party has answered (without picking up handset until they have answered), etc.

TABLE D (Contd)

TYPICAL CONTROL UNIT CONTROLS AND INDICATORS

NAME	TYPE	FUNCTION
Handset Volume Control	Thumbwheel	Adjusts volume of receive audio from handset earpiece.
Speaker Volume	Thumbwheel	Adjusts volume of receive audio from external speaker.
Alert (Ringer) Volume Control	—	Adjusts volume of alerting signal (ringing on incoming call).
Lock Key	Pushbutton	Pressing this key for 1/2 second places the mobile unit in a locked state. This state prevents calls from being placed from the mobile unit and can be removed by entering a unique 3-digit code.
Horn Key	Pushbutton	Pressing this key causes horn to be activated during an incoming call.



NOTE:
1. See Table E for function of controls and connectors

Fig. 21 — Typical Transceiver

TABLE E

TYPICAL TRANSCEIVER UNIT CONTROLS AND CONNECTORS

NAME	TYPE	FUNCTION
Antenna Connector	Coaxial	Provides input/output port for mobile unit antenna.
Lock	Key Lock	Inhibits unauthorized entry into transceiver unit.
Mounting Bracket	—	Mounts and secures transceiver unit in place. (Usually a metal tray underneath the transceiver unit).
Control Unit Connector	Multiple Pin (Male)	Accepts female connector of main cable from control unit.
Power Connector	Multiple Pin (Male)	Accepts female connector of power cable from mobile units power source.

6. CELL SITE

The cell site provides the link between mobile units and the MTSO. It converts the radio signals into the proper signal form for transmission over the radio link and/or the land-line link. Figure 22 illustrates the internal functions of a fully redundant, fully automated testing capability cell site. A comprehensive description of the cell site, identified as MOD (Model) 1 is available in AT&T Practice 401-200-100. A second cell site version identified as MOD 2 is also available, in a basic configuration with optional equipment for future growth. A description of the cell site is available in AT&T Practice 401-200-102. For the purpose of the document, the text will depict the MOD 1 cell site.

The cell site uses analog and digital circuitry which employs a small number of functional components, many of which are controlled by microcomputer-based controllers. Internal control of the cell site resides in a CSC (Cell Site Controller). More information on the CSC is given under Cell Site Data Link in Section 7.

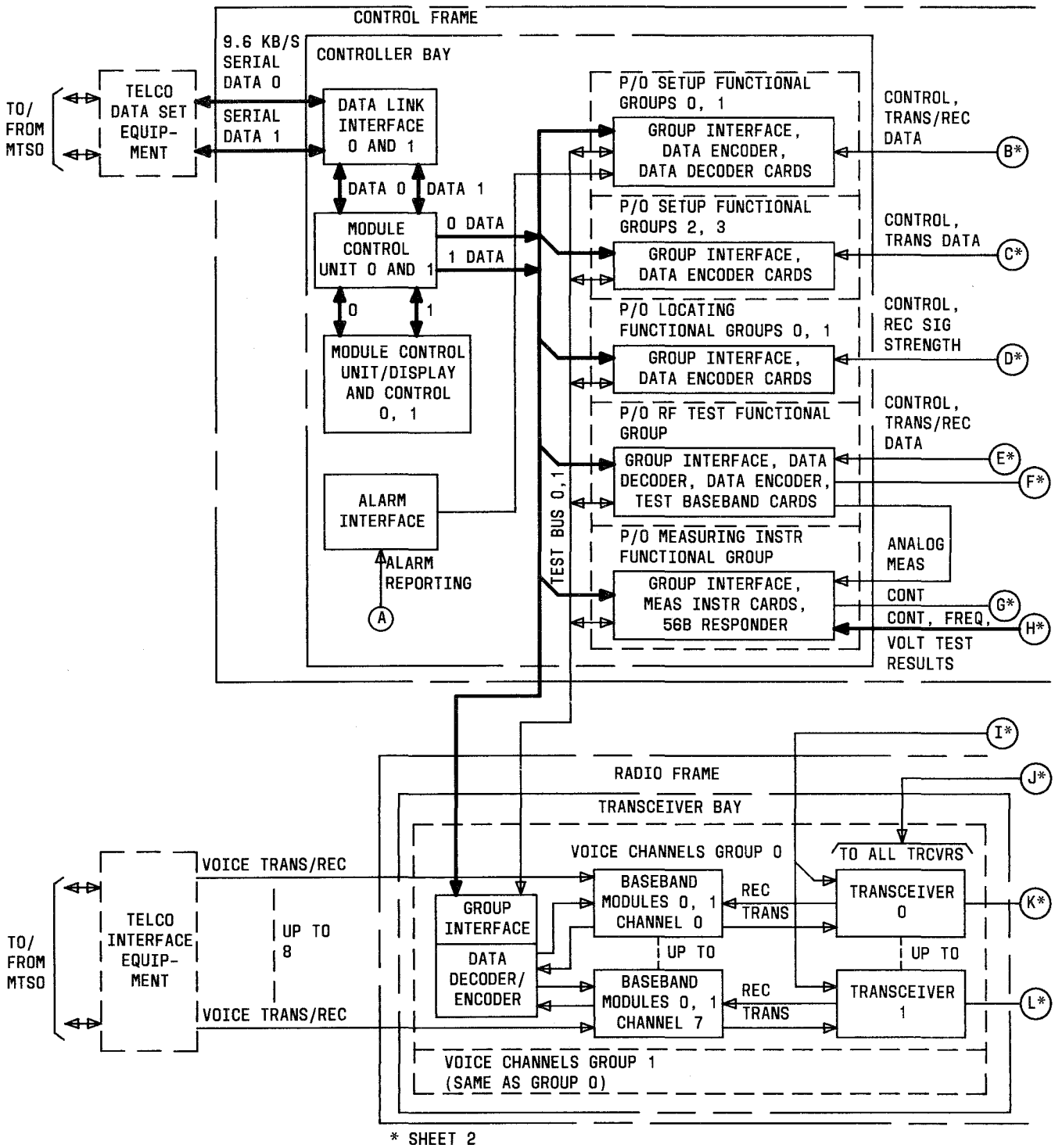


Fig. 22 — Cell Site Functional Block Diagram (Sheet 1 of 2)

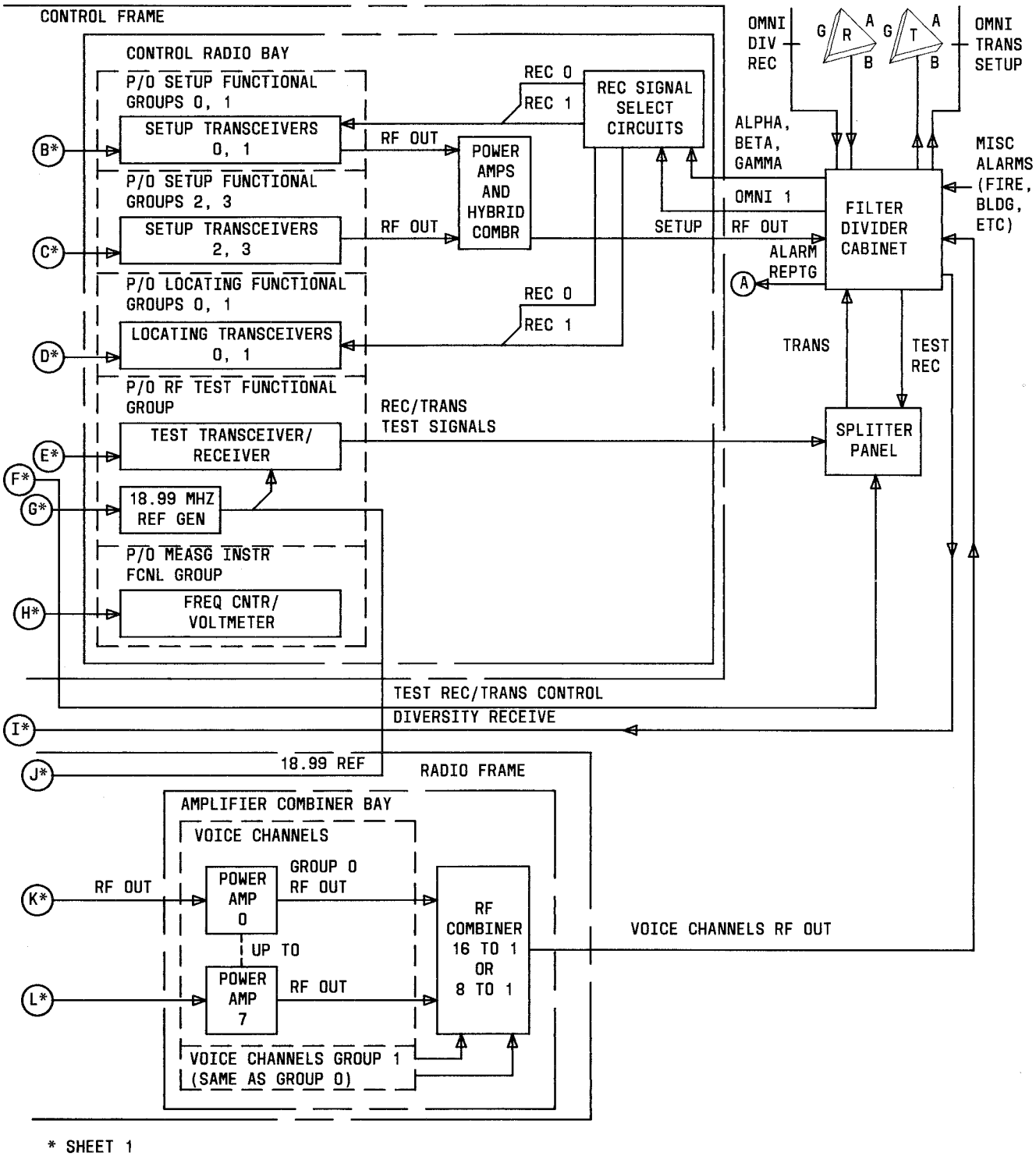


Fig. 22 — Cell Site Functional Block Diagram (Sheet 2 of 2)

6.1 Equipment

Cell sites are equipped with setup radio groups 0 and 1 which have both transmitters and receivers. Some cell sites, in addition to having groups 0 and 1, will also be equipped with setup radio groups 2 and/or 3 which have transmitters only. Setup radio groups 2 and 3 are used to transmit the paging messages throughout the CGSA. The cell sites equipped with groups 2 and/or 3 are called paging cell sites. Setup radio group 0 is not normally active and serves as an on-line spare for the other three groups.

All cell sites are equipped with locating radios 0 and 1 which have receivers only. Locating radios (or receivers) are used to make signal strength measurements on the voice channels. The results are used to determine if a mobile unit should be assigned to a particular voice channel for a call. One of the two radios is normally active and the other serves as an on-line spare but both radios may be active at any given time.

At the inception of the System 100 in any locality, the cell sites will use transmitter and receiver antennas whose patterns are omnidirectional in the horizontal plane. The phrase omnidirectional cell site refers to a site equipped with omnidirectional voice-channel antennas. Most of the first cell sites will be equipped for the paging and access functions. They will have high-power transmission capabilities to cover large areas for paging and access (8- or 10-mile radius for example). As the system grows by the cell splitting process, the original cell sites will retain the paging function transmission radius and have a reduction in transmission radius for the access function. The paging cell sites will have, for example, an 8-mile radius for paging and a 2-mile radius for access. New cell site locations will normally be equipped for the access function only.

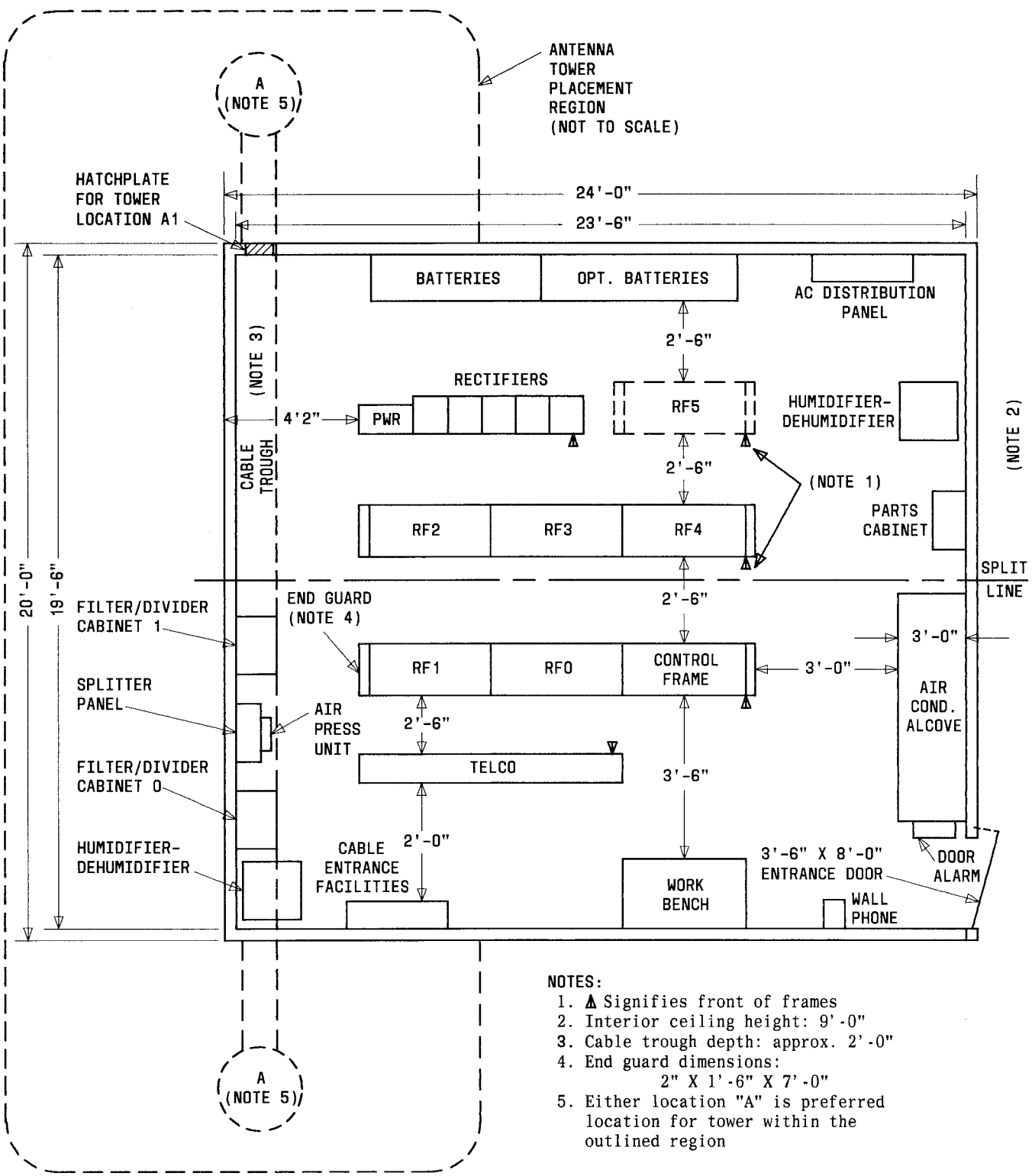
In mature systems, cell sites will have three faces; that is, each voice channel in a cell site will be transmitted and received over one of three 120-degree sector directional antennas, rather than over an omnidirectional antenna. These directional antennas will be oriented, so that extensions of the edges of the antenna's front lobes form the sides of the hexagonal cells.

Omnidirectional transmit antennas are used for all cell site setup channels, and either omnidirectional and/or directional antennas are used for cell site voice channels.

In comparison with an omnidirectional transmitting antenna, a directional antenna can deliver the same signal level in the region that it serves while causing substantially less interference within co-channel cells. Similarly, a directional receiving antenna substantially attenuates interference received from mobile units at bearings not spanned by the front lobe.

A typical physical layout of cell site equipment is shown in Fig. 23. Cell site equipment may be housed in an existing facility having sufficient space or in a dedicated building (site constructed). A spare parts cabinet and workbench are provided to support maintenance tasks. The cell site equipment is divided into three major equipment areas:

- Control and radio
- Antenna (cell)
- Power and environmental.



NOTES:
1. ⚠ Signifies front of frames
2. Interior ceiling height: 9'-0"
3. Cable trough depth: approx. 2'-0"
4. End guard dimensions:
   2" X 1'-6" X 7'-0"
5. Either location "A" is preferred location for tower within the outlined region

Fig. 23 — Typical Cell Site Equipment Configuration

6.1.1 Control and Radio Equipment

The control frame and radio frame are each made up of two standard 1A ESS switch type bays measuring 7 feet high, 26 inches wide, and 18 inches deep. See Fig. 24 for the arrangement of panels in the control frame. See Fig. 25 for the arrangement of panels in the radio frame.

6.1.1.1 Control Frame

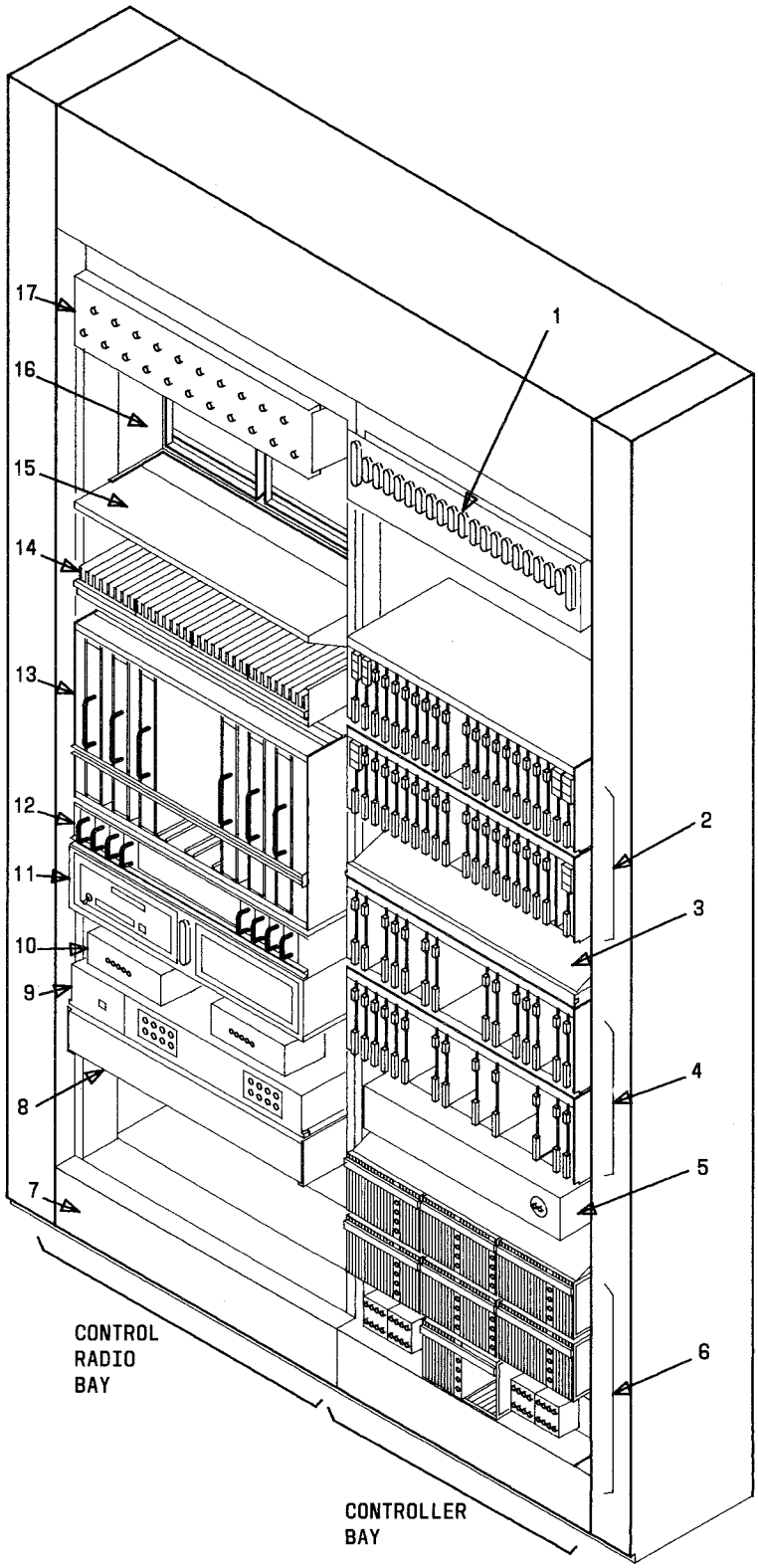
The control frame consists of the controller bay and the control radio bay. The controller bay contains the CSC, the logic unit, and the dc-to-dc converter units for both bays. The control radio bay may contain up to four setup radios, two locating radios, eight RF switches for directional (alpha, beta, gamma) or omni receive antenna selection, and test interface circuits. The outputs from the transmitters of the four setup transceivers are hybrid-combined to feed a single antenna.

6.1.1.2 Radio Frame

The radio frame consists of the transceiver bay and the amplifier-combiner bay. One radio frame can accommodate up to 16 radio voice radios. As many as six radio frames can be installed at a cell site, so that a single cell site can accommodate up to 96 voice radios (also called voice channels). Both bays are of a modular design, and the quantity of equipment is dependent on the number of voice radios to be implemented. The transceiver bay contains the plug-in voice radios, associated control units, and voice data interface equipment. The equipment per frame is divided into two functional groups (0 and 1) of eight voice radios (0-7) per group. The amplifier-combiner bay contains a ceramic combiner (RF multiplexer) and the power amplifiers for the transmitters. A dual 8-channel or a 16-channel combiner is available. The output from each combiner is fed to a separate transmitting antenna.

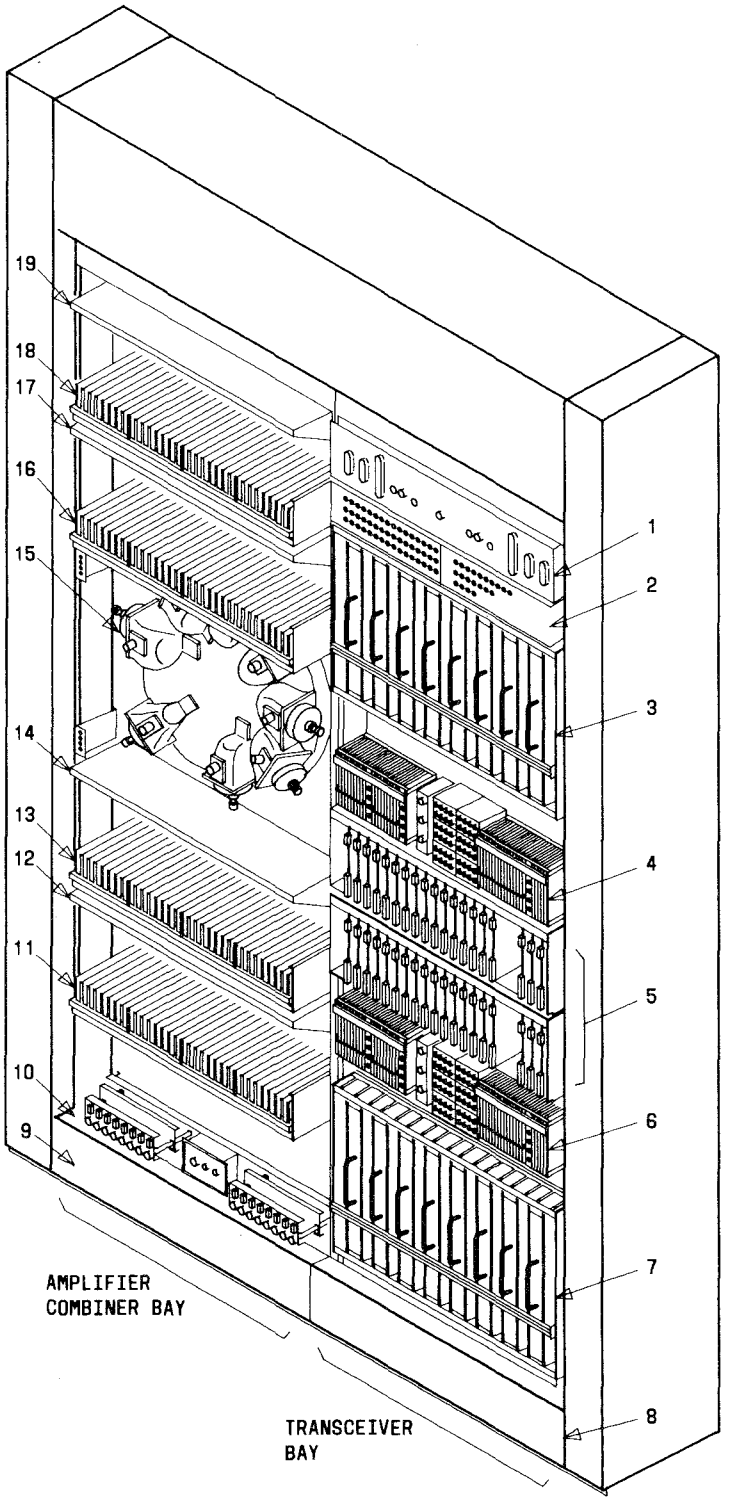
6.1.2 Antenna (Cell)

Cell site antenna equipment consists of filter-divider cabinets, a splitter panel, an air-pressurization system, antennas and masts with platforms. One filter-divider cabinet is required for an omnidirectional system of up to 64 voice radios, and 2 cabinets are required for an omnidirectional system of more than 64 voice radios and for all directional systems. There is one voice transmit antenna assigned to each radio frame which can contain up to 16 voice radios.



1 – Controller Bay-Logic Interconnection Panel
2 – Controller Bay-Module Control Unit
3 – Controller Bay-Logic Fuse Panel
4 – Controller Bay-Logic Unit
5 – Controller Bay-Responder Panel
6 – Controller Bay-Converter Panel
7 – Control Radio Bay-Power Filter Panel
8 – Control Radio Bay-RF Test Unit
9 – Control Radio Bay-RF Fuse Panel
10 – Control Radio Bay-Reference Frequency Generator Panel
11 – Control Radio Bay-Monitor Panel
12 – Control Radio Bay-Receiver Switch Divider Panel
13 – Control Radio Bay-Transceiver Panel
14 – Control Radio Bay-Amplifier Mounting Panel
15 – Control Radio Bay-Amplifier Fan Panel
16 – Control Radio Bay-Setup Combiner Panel
17 – Control Radio Bay-RF Interconnection Panel

Fig. 24 — Control Frame



1 – Transceiver Bay – Transceiver Interconnection Panel
2 – Transceiver Bay – Transceiver Jack Panel
3 – Transceiver Bay – Transceiver Panel Group 0
4 – Transceiver Bay – Transceiver Power Distribution Panel Group 0
5 – Transceiver Bay – RF Control Panel Group 0 and 1
6 – Transceiver Bay – Transceiver Power Distribution Panel Group 1
7 – Transceiver Bay – Transceiver Panel Group 1
8 – Transceiver Bay – Transceiver Power Filter Panel
9 – Amplifier Combiner Bay – Amplifier Power Filter Panel
10 – Amplifier Combiner Bay – Amplifier Fuse Panel
11 – Amplifier Combiner Bay – Amplifier Mounting Group 1, Panel 0
12 – Amplifier Combiner Bay – Amplifier Fan Panel 0, Group 1
13 – Amplifier Combiner Bay – Amplifier Mounting Panel 1, Group 1
14 – Amplifier Combiner Bay – Amplifier Fan Panel 1, Group 1
15 – Amplifier Combiner Bay – RF Multiplexer Panel 16 or Dual 8 Channel
16 – Amplifier Combiner Bay – Amplifier Mounting Panel 1, Group 0
17 – Amplifier Combiner Bay – Amplifier Fan Panel 1, Group 0
18 – Amplifier Combiner Bay – Amplifier Mounting Panel 0, Group 0
19 – Amplifier Combiner Bay – Amplifier Fan Panel 0, Group 0

Fig. 25 — Radio Frame

Diversity reception is used on all channels at the cell site (diversity reception is not used at the mobile unit). RF (Radio Frequency) distribution to and from the cell site antenna(s) is provided by separate receive and transmit circuits within the filter divider cabinet(s). Transmit circuits within the filter divider cabinet contain transmit band filters and directional couplers for coupling a portion of the RF applied to the antenna back to the cell site for testing. Receive circuits contain receive band filters, preamplifiers, power dividers, and directional couplers for injecting test signals. The splitter panel contains circuits for distributing and selecting RF paths during a test. The air pressurization system includes equipment that keeps the RF cables pressurized and dry.

6.1.2.1 Antenna Mast/Platform

Two typical antenna masts with platforms are shown in Fig. 26. The mast is normally 150-feet high for omnidirectional cell sites and 100-feet high for directional cell sites. Other lengths, from 40 to 130 feet, are also available. An existing structure such as a microwave or downtown central office building may be used in place of the mast. A triangular platform is located at the top of the mast. The three faces (sides), clockwise, are called alpha, beta, and gamma. Each face is approximately 10-feet long.

The antenna mast and platform are designed to minimize physical deflection. The two major sources of deflections are the wind and uneven solar heating of the steel mast. In general, the antenna hardware is designed to maintain system specifications under extreme temperature changes and winds up to 100 miles per hour.

The RF transmission line to the antennas uses semi-rigid air-filled coaxial cables to keep the RF losses low. The cables are routed inside the mast through a suspended conduit cluster. The conduit allows for cable system growth and ease of replacement if required. The interior mounting provides protection to the cables and significantly improves the visual appearance.

6.1.2.2 Omnidirectional Configuration

A maximum equipped omnidirectional cell site antenna (Fig. 26) includes:

- Six omni voice transmit antennas
- One omni setup transmit antenna
- Two omni receive antennas.

The omni transmitting and receiving antennas are end-supported and electrically center-fed to minimize antenna pattern squint-angle change over the frequency band. They are approximately 13 feet in length, including the mounting, and are placed in a 2-1/2 inch diameter fiberglass housing.

Omni voice transmit (6 maximum T0-T5) antennas are mounted above the platform. The omni setup antenna is also mounted above the platform on one of its far corners. There is one omni setup antenna for every cell site. The omni receive antennas (two per cell site) are mounted below the platform. These two receive antennas feed all cell site voice radios, setup radios, and locate radios.

6.1.2.3 Directional Configuration

A maximum equipped directional cell site antenna (Fig. 26) includes:

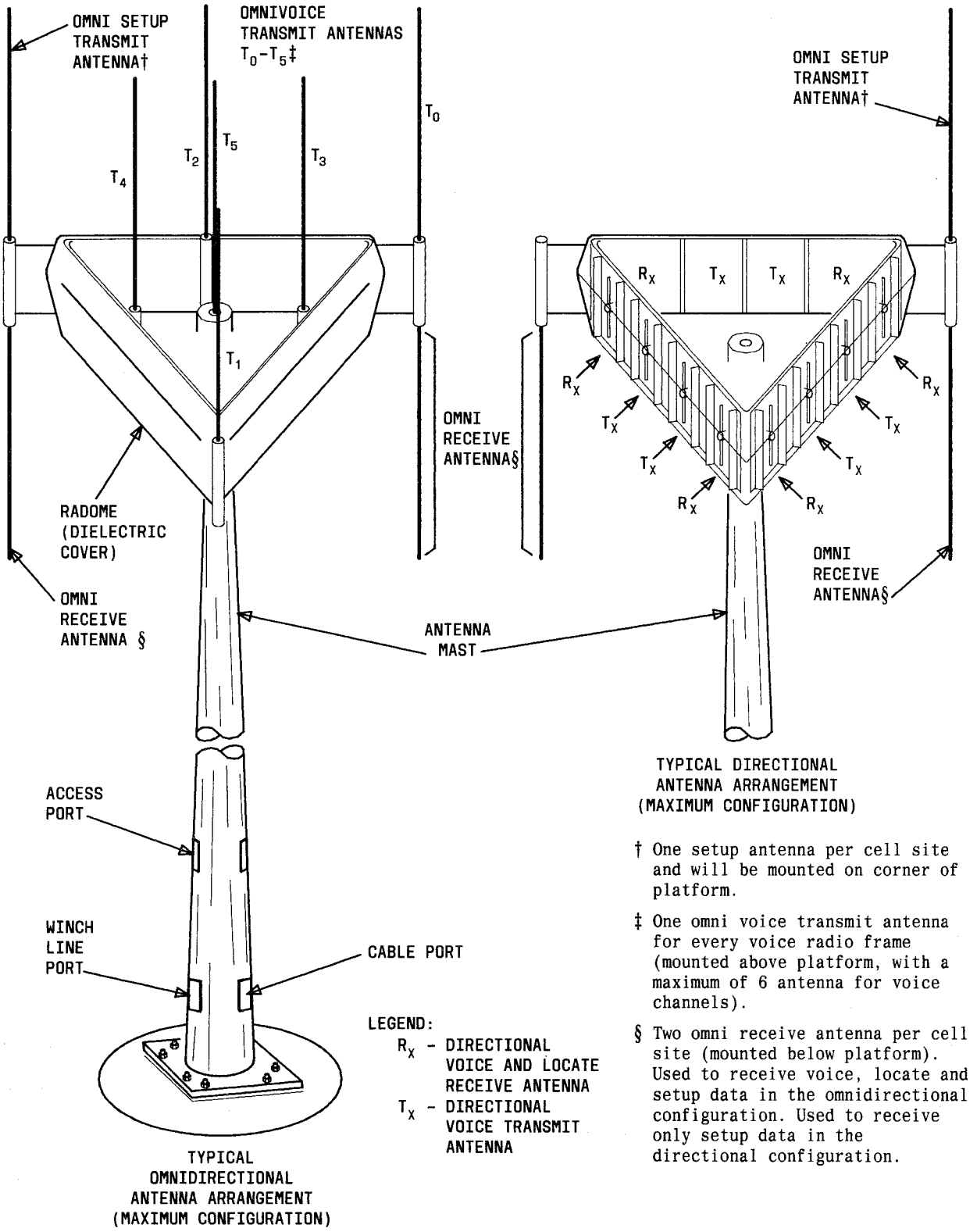
- Six directional voice transmit antennas
- Six directional voice and locate receive antennas
- One omni setup transmit antenna
- Two omni receive antennas.

Directional voice transmit (Tx) and directional voice/locate receive (Rx) antennas are mounted behind a contoured radome on the faces of the platform. The azimuth alignment of the directional antenna faces are the same for every cell site in the CGSA. There are two directional receive antennas (for diversity) and one or two directional transmit antennas per face. The directional receive antennas feed locate and voice radios. The omni setup and two omni receive antennas are mounted above and below the platform like the omnidirectional configuration. In the directional configuration, the omni receive antennas only feed the setup radios.

6.1.3 Power and Environmental Equipment

All cell site operating dc voltages required by the control and radio equipment are generated by dc-to-dc converters from a +24 V dc supply provided by either a 150B power plant or a 1150A battery plant. The 1150A battery plant has limited capacity and is primarily used in existing building facilities which cannot support the floor weight load requirements of a 150B power plant. The dc-to-dc converters, located on the control frame, supply all dc voltages required by the control frame and radio frame, with the exception of +24 V dc supplied by the power plant. Commercial ac power input to the cell site is 208/120 volts, 3-phase, 4-wire, 60 Hz. Emergency power is provided by an auxiliary generator in case of commercial ac power outage.

Cell site environmental equipment consists of an air-conditioning/heating system and air humidifying/dehumidifying equipment. Air filtration is provided by the use of a standard air-conditioning/heating filter element. Ambient temperature within the cell site is maintained in the range of +50 to +85 degrees Fahrenheit. Relative humidity is maintained in a range of 20 to 55 percent.



† One setup antenna per cell site and will be mounted on corner of platform.

‡ One omni voice transmit antenna for every voice radio frame (mounted above platform, with a maximum of 6 antenna for voice channels).

§ Two omni receive antenna per cell site (mounted below platform). Used to receive voice, locate and setup data in the omnidirectional configuration. Used to receive only setup data in the directional configuration.

Fig. 26 — Cell Site Antenna Configurations

7. MOBILE TELEPHONE SWITCHING OFFICE

The central coordinating element for the System 100 is the MTSO. It provides mobile customers with services that are similar to those available for land telephones. Basic mobile service includes direct dialed mobile-to-mobile, mobile-to-land, and land-to-mobile calling. A MTSO serves a large geographic coverage area and all mobile calls are switched through it. Generally, a coverage area contains many local offices over which the land subscribers are distributed.

The MTSO is a modified 1A ESS switch. The modifications include:

- Expanded IOP (input/output processors)
- No LLN (line link networks)
- Additional lamp keys on the control and display panels of the maintenance control center
- Additional software packages to control and/or process mobile telephone calls.

The MTSO equipment interconnections are illustrated in Fig. 27.

The MTSO connects to one or more network interface points over standard voice trunk transmission facilities. Directory numbers for mobile telephones are assigned from within the local exchanges that are served by those network interface points. This arrangement is similar to that used with a PBX, and makes use of existing capabilities in local ESS switches. The functions performed by the MTSO include:

- Interfacing the System 100 to the public switched telephone network
- All System 100 switching functions
- Overseeing system operations including maintenance, call processing, and initialization
- Data collection, input/output functions, and maintenance personnel
- Maintenance of the System 100 software data base
- Responsibility for the overall integrity of the system.

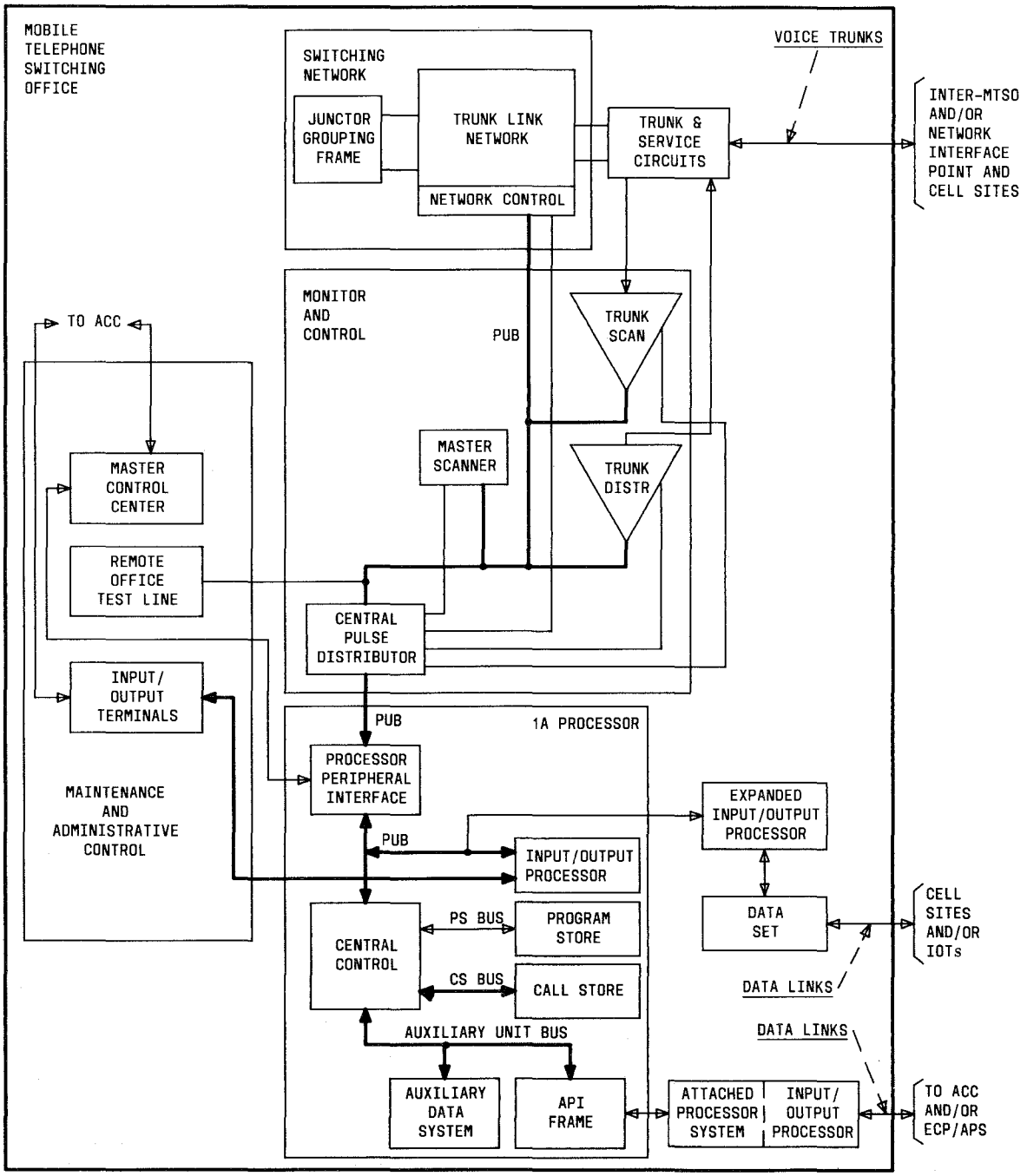


Fig. 27 — MTSO Equipment Interconnections Block Diagram

In addition to controlling the switching equipment needed to interconnect with the land telephone network, the central processor of the MTSO controls many of the actions of the cell sites and, through the cell sites, controls many of the actions of the mobile units. While both the cell site and the mobile unit possess a certain amount of autonomy, the system is presently designed with the view toward centralized decision making and call processing by the MTSO. This design is for purposes of reliability, maintainability, and economy. The MTSO is linked with each cell site by a group of voice trunks, one trunk for each radio channel installed in the cell site, and two dedicated cell site data links. The cell site logic circuits serve to: (1) buffer and format the data signals between the MTSO and the mobile units, and (2) control the land-based radios.

The hardware in the MTSO is mounted in frames. The frames used in an MTSO are either single-, double-, or triple-bay frames. Most bays are 2 feet 2 inches wide except for some single bay frames where a bay is 3 feet 3 inches wide. All frames are 7 feet tall. Most 1A processor frames are 18 inches deep, while the rest of the system frames are 12 inches deep.

7.1 Basic System Techniques

Some basic system techniques used in the System 100 are:

- Stored program control
- Functional concentration
- Time-shared control
- Optional feature loading
- Modular design
- Plug-in equipment units
- Duplication
- Automatic fault location and system reconfiguration.

Stored Program Control: The functions performed by the system stored program control are specified by programs consisting of appropriate combinations of precisely defined instructions. Examples of such program instructions are:

1. Observe the state of a specified group of trunks
2. Add two specified quantities
3. Observe the sign of a specified quantity
4. Decide accordingly which of two alternatives to execute.

The program instructions, suitably encoded, are stored in memory units from which they are transmitted to the control unit for interpretation and execution. Thus, the operation of the system can be altered considerably by program changes without circuit modifications.

Functional Concentration: The system equipment is concentrated in a small number of highly efficient units, each specialized in some broad system function: such as, control, input, output, memory, etc. The result is a simple overall System 100 equipment organization.

Time-Shared Control: A single control unit directs the operation of all other system units in accordance with program instructions. Using electronic devices, the control unit can operate at speeds much faster than the rate at which events associated with a single call occurs. Consequently, the control equipment is time-shared for all the calls accommodated by the system. Time-shared control is accomplished by subdividing the task required to process a call into small segments and by interweaving the segments with those associated with other calls. In addition, certain operations can be performed concurrently on behalf of a number of calls.

Modular Design: System units are provided in modular blocks for economy and convenience in office growth.

Plug-In Equipment Units: A major portion of the system units are plug-in units. Faulty units can be replaced quickly and conveniently.

Duplication: To insure uninterrupted customer service, equipment whose failure would affect a large number of customers is duplicated. For example, the equipment contains duplicated CCs (Central Controls). Both units operate side by side on the same input information, but only one unit is given an active status. If a malfunction occurs in the active unit, the duplicate unit is switched to active status with no loss in customer service. Also, the equipment contains two spare PSs (Program Stores) used to replace an active PS should a malfunction occur.

Automatic Fault Location: System 100 automatically performs a large portion of its own checking for system troubles. Within the 1A processor, this check is accomplished by comparing the outputs of duplicate units. In the peripheral community, this checking is performed by scanning of maintenance points. When a trouble is detected, system tests should indicate which unit is at fault, and fault recovery programs should remove it from active status. Further testing aids the maintenance personnel in determining exactly what caused the malfunction.

7.2 1A Processor

The 1A processor includes the following:

- Duplicated CC
- PS and CS
- ADS (Auxiliary Data System)
- 1A memory spectrum

- Dedicated IOP frame
- PPI (Processor Peripheral Interface) frame
- API (Attached Processor Interface) frame.

7.2.1 Central Control

There are two CCs (CC0 and CC1) provided in each 1A processor system. The CC performs the information processing tasks that enable the 1A processor to operate and maintain the System 100. The CC reads, decodes, and executes the control program with a basic machine cycle of 700 nanoseconds. Frequently, there is data associated with an instruction. This data, which is stored in the CS, is read and processed by the CC as directed by the instruction. An instruction which includes a memory access requires 1400 nanoseconds. Normally, the duplicated CCs operate in step; that is, both CCs perform the same operation at the same time. However, one CC is designated active while the other is designated standby. Matching circuits are provided in each CC to insure that they execute the same instructions, transmit and receive the same data, and make the same decisions. If either CC should fail, the system automatically removes the failing unit from service and continues operation in a nonmatching mode.

To perform this information processing, the CC must communicate with the other units in the System 100. The four primary buses that enable this communication are:

- PS bus
- CS bus
- AUB (Auxiliary Unit Bus)
- PUB (Peripheral Unit Bus).

The PS and CS buses provide the communications path to the CC for all PSs and CSs, respectively. The AUB provides the communications path to the CC for both the APS and ADS. The PUB provides the communications paths for the IOPs, PPI, and the switching network (Fig. 27).

When either data or instructions are transferred from the CC to units of the 1A processor, the units are enabled via the coded enable method. With coded enable, a sync pulse followed by an address is sent to every unit on a bus. Only the unit whose internal address matches the one sent over the bus will process the information. When the processing is complete, an ASW (all-seems-well) signal is sent by the addressed unit to indicate the successful completion of the operation.

Data or instruction transfers between the CC and the switching system are performed via the PUB. Units of the switching network are enabled by the CPD (Central Pulse Distributor) enabling. The CPD unit within the switching network provides this enabling. Upon receiving an order from CC, the CPD pulses the enable line associated with the desired unit. The CC then places data on the PUB and only the unit receiving the CPD enable pulse is able to accept and act on this data. When the unit receives an enable pulse from the CPD, it returns a verify signal to the CC. The verify signal is used by the CC to determine if the correct unit was enabled.

7.2.2 Call Store/Program Store

The physical CS and PS memory units are equipped in pure communities of 64K semiconductor or 256K semiconductor stores. Both of these stores have MOS (Metal Oxide Semiconductor) RAM (Random Access Memory). Each store unit periodically does its own refresh operation.

Call Store: The CS is a read-write memory. DCS and UCS are identical physically, but are used in the processor differently. Since the DCSs handle transient call processing information, they are fully duplicated. UCSs are used to store PS fault recognition programs, translation information, and portions of the parameter information. A backup copy of the UCS information is kept on disk memory in the APS.

If a DCS is faulty, it is removed from service; and its duplicate operates in a simplex mode. If a UCS is faulty, it is removed from service and will be replaced by a CS from the DCSs. This would leave the replacement duplicate CS operating in a simplex mode.

Program Store: The PS is a read-write memory. PSs are used to store the generic program (also called the resident program), a portion of parameters, and utility programs. The utility programs are typically kept in the APS and are loaded into a PS when needed.

All information stored in a physical PS is kept on disk memory in the APS (also called backup). This eliminates the need for duplicate PS memory units as with the DCS. However, in order to maintain continuous reliable operation, two additional PS memory units (called rover stores) are provided to replace any faulty PS. If a faulty PS is detected, it is removed from service and replaced by a rover store. The same information stored in the faulty PS is read into the rover store replacement from backup.

During normal operation, the two rover stores keep duplicate copies of on-line PSs that store base level and other critical program instructions. In the event one of these on-line PS units is faulty, a replacement rover store does not need to be loaded from backup.

7.2.2.1 256K Call Store/Program Store Semiconductor Memory Unit

The 256K CS/PS memory units are mounted in two bay frames. The frame has a combination of CS and PS memory units. One 256K CS/PS memory unit equals one CS or one PS. Each unit includes a power section and 12 circuit packs on which memory, logic, power control, and bus interface functions are located. Each 256K CS/PS memory unit has a storage capacity of 262,144 (decimal) 26-bit words (24 data bits and 2 parity bits). For more information on the 256K CS/PS memory unit, refer to AT&T Practices 254-201-014 and 254-201-015.

7.2.3 Auxiliary Data System

The ADS (Auxiliary Data System) is a versatile, medium speed, data handling system. ADS utilizes magnetic tape for data storage and retrieval functions. The ADS is used for:

- SR (System Reinitialization)
- AMA (Automatic Message Accounting) or CAMA (Centralized Automatic Message Accounting)
- Program updates
- System memory dumps
- General data handling.

Two communities make up the ADS. Each community includes two DUSs (Data Unit Selectors) and from 2 to 16 pairs of DUC (Data Unit Controllers) and DUs (Data Units) (each pair is made up of one DUC and one DU). The purpose of the DUS is to interface the DUC and DU pairs to the central control over the auxiliary unit bus.

The DUS is located in the API frame. The DU may be either a tape transport or data link. When the DU is a tape transport, the associated DUC is a TUC (Tape Unit Controller). The TUC and tape transport are both physically located in a tape unit frame J5A002A. When the DU is a data link, the associated DUC is a DLC (Data Link Controller). For more information on the ADS, refer to AT&T Practices 254-201-000 and 254-201-001.

7.2.4 Processor Peripheral Interface Frame

The primary functions of the PPI (Processor Peripheral Interface) frame are to interface the CC with the peripheral community and the C&D (Control and Display) panel of the MCC (Maintenance Control Center) with the rest of the system. The PPI provides these interfaces via the PUB. The PPI also provides the logic required to control and monitor the lamps, keys, and displays of the C&D.

The remaining functions of the PPI are to provide the logic required for testing the CC access to the PUB, and monitoring for the 1A processor power frame. Testing of the CC access to the PUB is provided by loop-around circuitry within the PPI frame. Maintenance programs run by the CC send test messages out over the PUB. The loop-around circuitry traps these messages and sends them back to the CC over the PUB. The maintenance programs then compare the original message with the one received from the loop-around circuits to determine if a fault exists on the PUB.

Power switches, located at each frame of the 1A processor, contain lamps and switches that permit maintenance personnel to observe power status and to make requests for a change in power status. Circuitry within the PPI monitors these switches and reports any requests to CC. This circuitry also monitors the power switch to determine if any power failures have occurred. Monitored conditions within the power switch are:

- Request to place equipment out-of-service
- Request power off
- Request power on
- Power fault.

This circuitry also provides the CC with the ability to control the power switch. This control allows the CC to light the appropriate lamps on the power switch and to initiate a test of the power monitor circuit on the associated frame.

7.2.5 Input/Output Processor Frame

The purpose of the IOP (Input Output Processor) frame is to provide an interface between the 1A processor CC and the following:

- IOTs (Input Output Terminals) which are provided as part of the 1A processor using systems
- DSs (Data Sets) as required to interface with distant cell site locations
- Computer-supported maintenance, monitoring, and management-related systems.

An IOP frame may be fully or partially equipped. A fully equipped IOP frame contains two IOP bus units, one filter unit, and two IOPs. A fully equipped IOP contains one IOP logic unit and a 1A or 3B IOP growth unit. A fully equipped IOP frame containing 1A IOP growth units is illustrated by Fig. 28. A fully equipped IOP frame containing 3B IOP growth units is illustrated by Fig. 29. It is possible for a fully equipped IOP frame to contain 1A and 3B IOP growth units. The IOPs may also be provided with no growth units.

7.2.5.1 IOP Frame Equipped With 1A IOP Growth Units

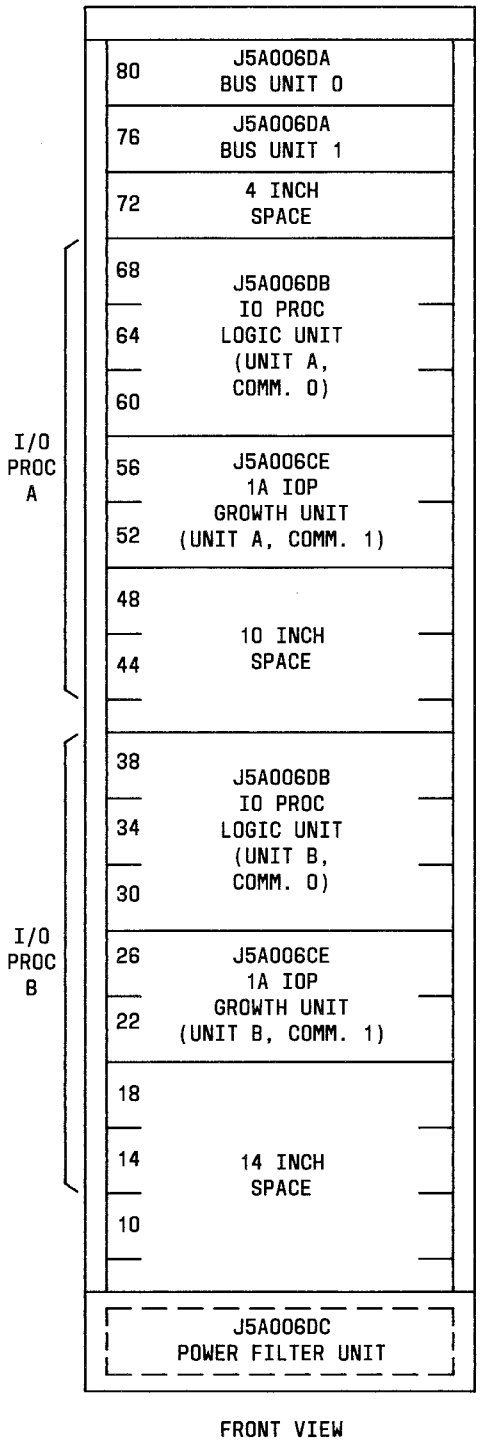
This type of IOP frame may consist of one or two IOPs, designated A or B. The fully equipped IOP consists of one IOP logic unit and one 1A IOP growth unit, each of which may be equipped with one microprocessor community (Fig. 30). A microprocessor community consists of one IOMP (Input Output Microprocessor), 0 or 1, and up to 8 LIUs (Line Interface Units), numbered 0 through 7. A fully equipped microprocessor community can accommodate between 8 and 24 IOTs or DSs on eight separate IO channels. The number of IOTs or DSs which may be accommodated by a microprocessor community is dependent on LIU equipage. A microprocessor may be equipped with any combination of three available LIUs. Each particular type of LIU is equipped with either 1, 2, or 3 IO ports. Fully equipped, the IOP can accommodate up to 48 IOTs or DSs on 16 channels. A fully equipped IOP frame can accommodate up to 96 IOTs or DSs on 32 IO channels.

The IOP input/output channels may be run at data rates of 0.11, 1.2, 1.8, 2.4, 4.8, or 9.6 kb/s, half or full duplex. The data rate of an IO channel is determined by data stored in the 1A processor memory. The maximum data rate of an IO channel is dependent on the data rates of other IO channels in the same community. A community may have a total data rate of 19.2 kb/s. The channels of a microprocessor community do not have to operate at the same data rate. Any of the eight channels of a microprocessor community can operate at any applicable data rate autonomous to the data rate of any other channel in the community, as long as the combined data rate of the community does not exceed 19.2 kb/s.

7.2.5.2 IOP Frame Equipped With 3B IOP Growth Units

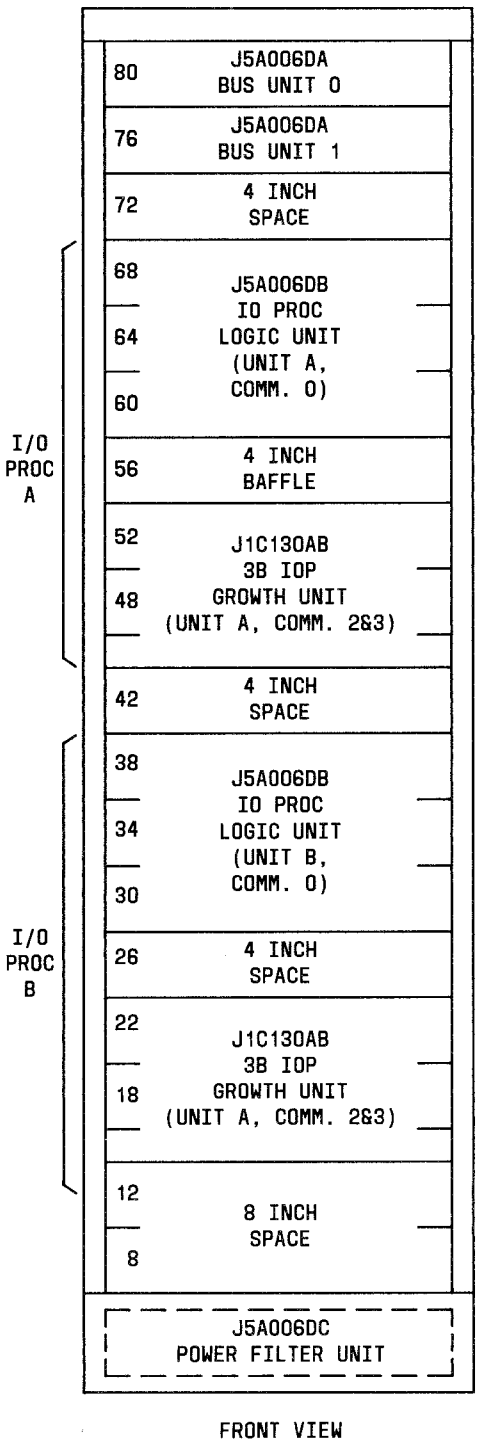
This IOP frame may consist of one or two IOPs, designated A or B. The fully equipped IOP consists of one IOP logic unit and one 3B IOP growth unit. The IOP logic unit includes the IOMP 0 in the frame. The 3B IOP growth unit consists of one fanout board and one or two PC (Peripheral Controller) communities (Fig. 31). The fanout board is IOMP 1 in the frame. Each PC community may be equipped with up to four PCs. A fully equipped PC community can accommodate up to four IO devices on four separate IO channels. Therefore, a fully equipped 3B IOP growth unit can accommodate eight IO devices on eight separate channels. This fully equipped IOP can accommodate between 16 and 32 IO devices on 16 separate IO channels. The number of IOTs or DSs which may be accommodated by the microprocessor community in the logic unit is dependent on LIU equipage. A fully equipped IOP frame can accommodate up to 64 IO devices on 32 separate IO channels.

A peripheral controller IO channel can transmit or receive data at rates of 9.6 or 56 kb/s. The data rates of an IO channel are determined by data stored in CC. The data rate of a peripheral controller IO channel is independent of the data rate of any other peripheral controller IO channel. The maximum data rate of a PC community is 224 kb/s, half or full duplex.



NOTES:
1. J5A006DB (SD-5A052-02), and J5A006CE (SD-5A049-01) Units Are arranged for use with asynchronous or isochronous terminal devices.
2. The 1A IØP growth unit (J5A006CE) or 3B IØP growth Unit (J1C130AB) may be job engineered into any frame.

Fig. 28 — IOP Frame Layout (Equipped With IOP Growth Units)



NOTES:
1. J1C130AB (SD-4C049-01) Unit is arranged for synchronous high speed terminal devices.
2. The 1A IØP growth unit (J5A006CE) or 3B IØP growth Unit (J1C130AB) may be job engineered into any frame.

Fig. 29 — IOP Frame Layout (Equipped With 3B IOP Growth Units)

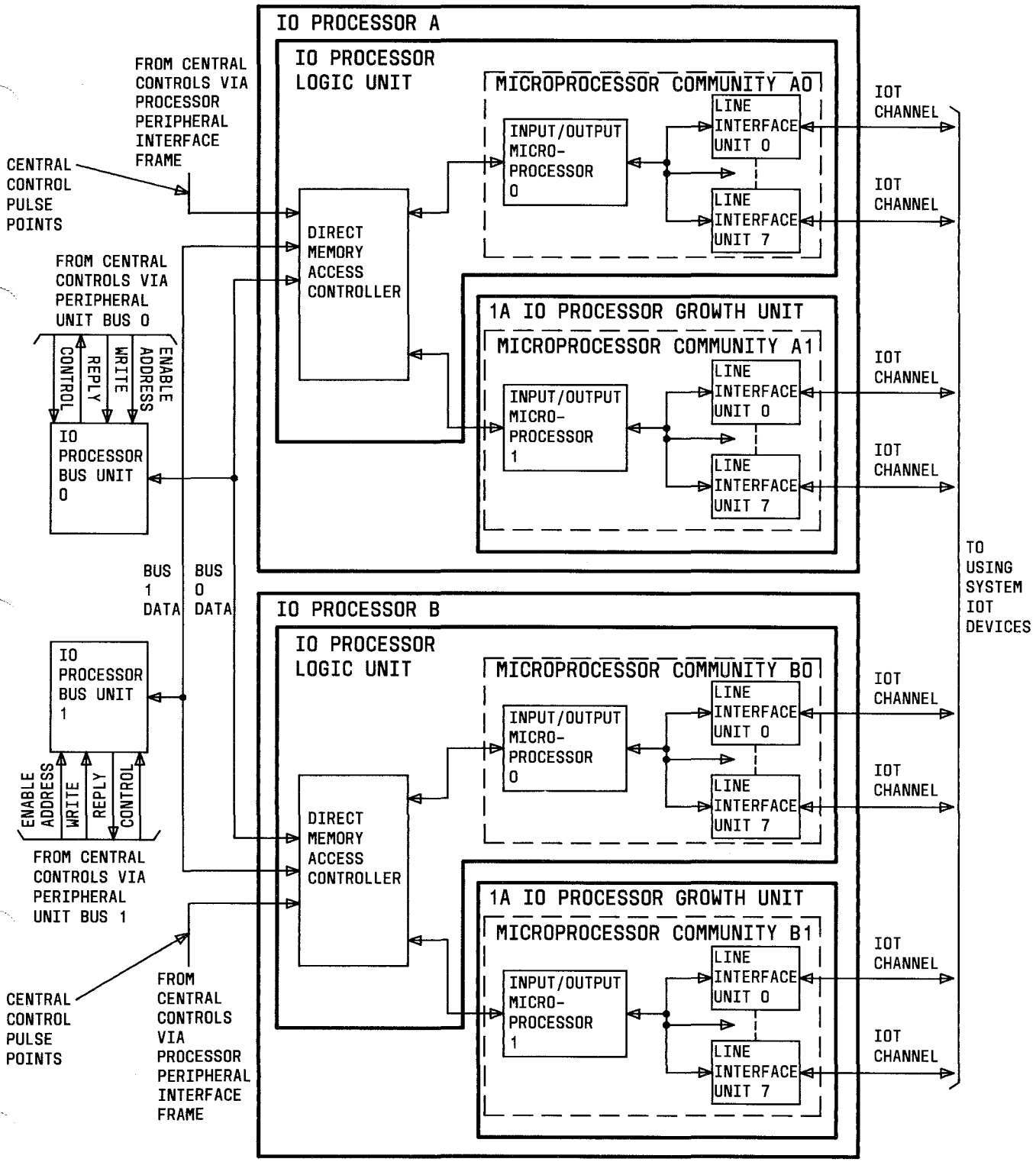
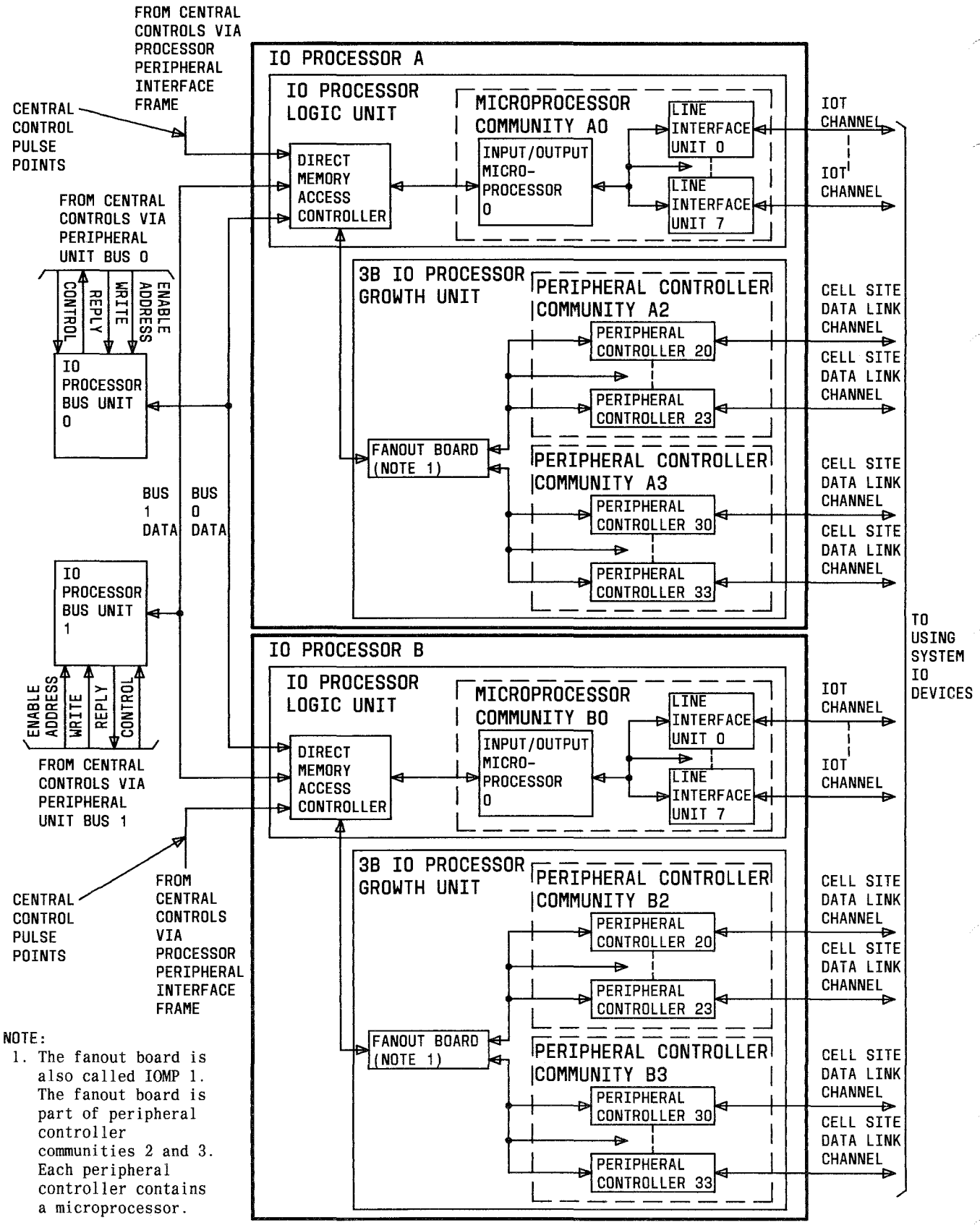


Fig. 30 — IOP Frame Block Diagram (Equipped With 1A IOP Growth Units)



NOTE:
1. The fanout board is also called IOMP 1. The fanout board is part of peripheral controller communities 2 and 3. Each peripheral controller contains a microprocessor.

Fig. 31 — IOP Frame Block Diagram (Equipped with 3B IOP Growth Units)

7.2.6 Attached Processor Interface Frame

The purpose of the API (Attached Processor Interface) frame is to interface the 1A processor central control with the ADS and APS over the auxiliary unit bus. The API frame includes components from the ADS (data unit selector) and APS (API unit). The API frame is physically part of the 1A processor and is used in pairs.

Each API frame is a single-bay frame, 7 feet high and 3 feet 3 inches wide. The equipage of an API frame for an MTSO is one data unit selector J5A004AZ-1, and one API unit J5A012AA-1 (the API frame is designed to hold up to three API units). For more information on the API frame, refer to AT&T Practices 254-201-002 and 254-201-003.

7.3 Attached Processor System

The APS (Attached Processor System) is a self-maintaining disk storage system. It is used by the 1A processor as backup for the PS and portions of CS. The maximum storage capacity of the APS is 160 or 340 megabytes of memory.

The APS hardware includes an AT&T 3B20D2 computer and a duplicated API unit. The AT&T 3B20D2 computer is mounted in a 7-foot high, 2-foot 2-inch wide by 24- and 18-inch deep frame. The API unit transfers data between the 1A processor and the AT&T 3B20D2 computer over the AUB. Each API unit is mounted in separate API frames of the 1A processor. For more information on the general system application of the APS, refer to AT&T Practice 231-301-005.

7.3.1 Attached Processor System Data Link

Beginning with 1AE9.03 Generic Program, a pair of 4-wire 9.6 kbaud dedicated data links are required between each abutting MTSO in the Cellular Network. Each of the two links connects AT&T 3B20 computer to another 3B20 computer (MTSO to MTSO).

If line conditioning is required, an 829A data auxiliary set is required for each APS data link. For more information on the APS data link application, refer to AT&T Practice 231-290-619.

7.3.2 Attached Processor System Input/Output Processor

An APS IOP (Attached Processor System Input/Output Processor) growth unit will be required when the spare slots are exhausted in the existing IOP. There are normally seven spare slots in the existing APS IOP.

7.4 Input/Output System

The IO system (Fig. 32) provides wire-line paths for signaling and supervision between the MTSO, cell sites, and IOT devices. The transmission path from the CCs goes through an IOP frame and then to IOTs and/or cell sites. When the transmission path is more than 200-cable feet long, a data set is normally used.

Each IOP frame is stamped with an IOP number at the bottom of the frame. Each physical IOP unit within the frame is stamped with an IOP number on its power switch. The IOP processor generic program identifies the individual components of an IOP frame with terminology previously used in the old IO frame. The term IOUS (Input/Output Unit Selector) refers to the DMAC (Direct Memory Access Controller) in the IOP frame. The term IOMP (Input/Output Microprocessor) refers to fanout boards and/or microprocessors in the IOP frame. The term IOUC (Input/Output Unit Controller) refers to LIUs (Line Interface Units) and PCs (Peripheral Controllers).

The maximum number of IOP frames in an MTSO is 32 (0 through 31). The maximum number of IOPs is 64 (0 through 63). As with all 1A ESS switches, the MTSO may be equipped with up to four IOP frames (0 through 3) that interface the 1A processor to various IOT applications. An MTSO has additional IOP frames (starting with IOP frame 4 and up through a maximum of IOP frame 31) for cell site data link application. These additional frames are called expanded IOP frames and, they interface the 1A processor to the cell sites. If needed, IOP frames 1 through 3 may also be used for cell site data link application; however, IOP frame 0 is always dedicated for IOT applications.

For IOP polling purposes the IOP frames are divided into eight groups (0 through 7) with four IOP frames per group. Each group may be equipped with up to eight IOUSs. The IOP applications, frame grouping, and unit member numbering for a maximum office configuration is illustrated in Fig. 33.

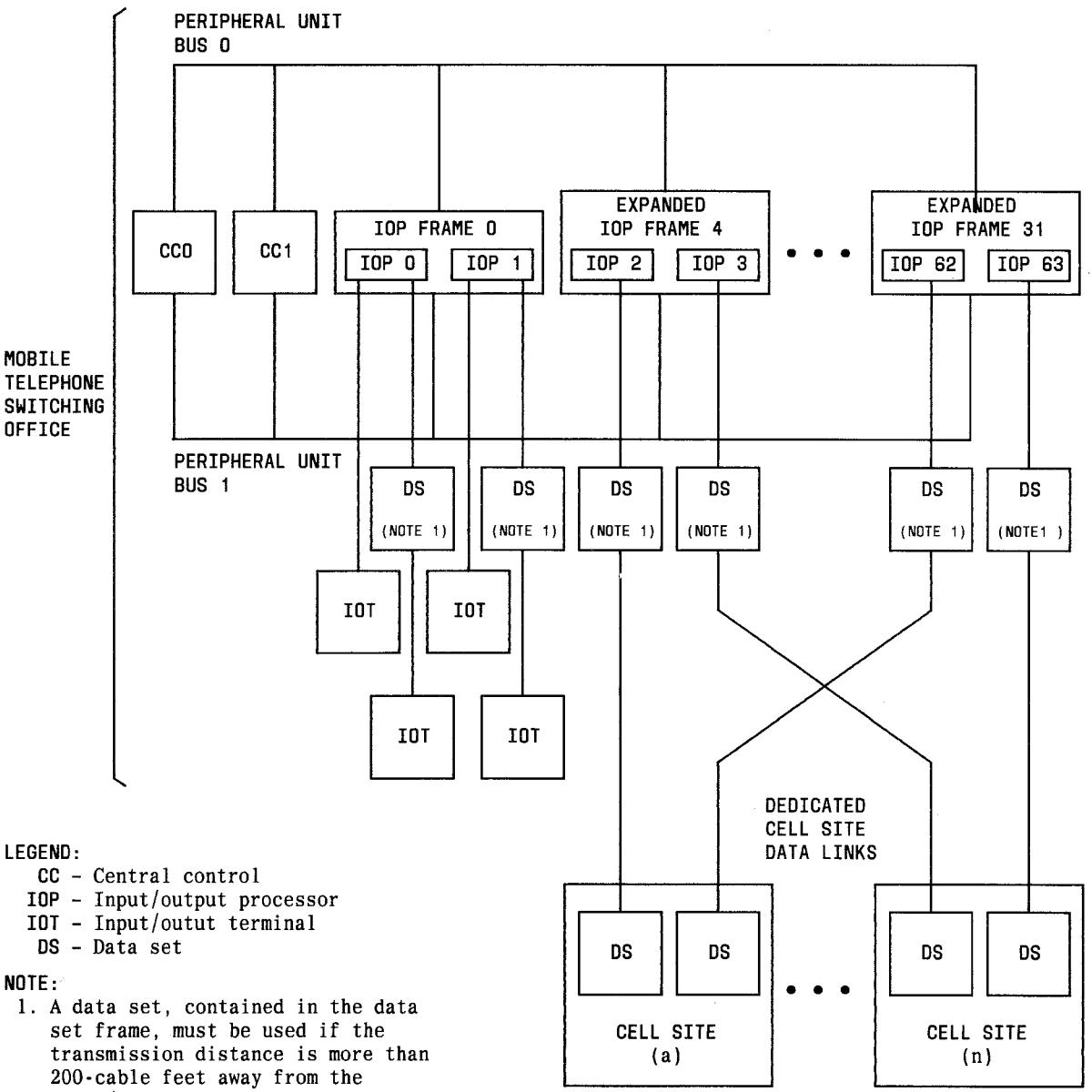
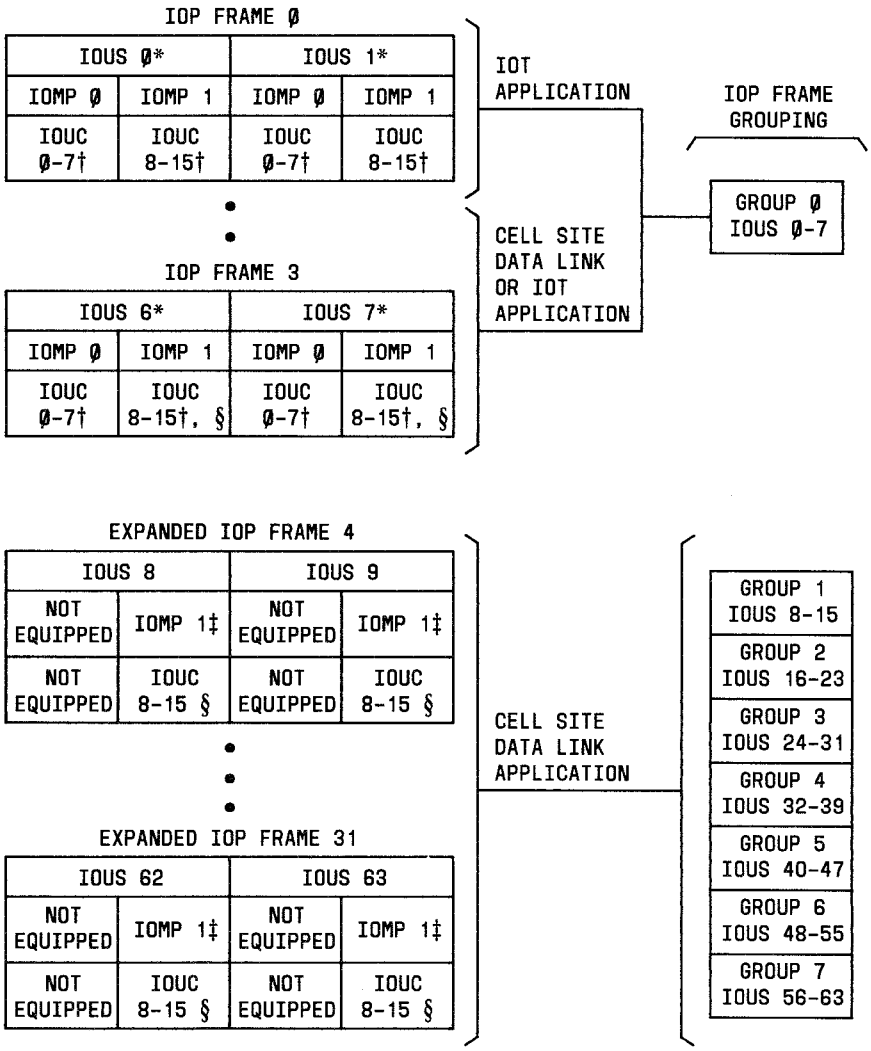


Fig. 32 — Simplified Input/Output System



* IOUS 0 and 1 are dedicated to the 1A processor. Portions of group 0 may be used for cell site data link application.

† The IOUC for IOT application is a FG27 circuit pack.

‡ The IOMP 1 for cell site data link application is a fanout board.

§ The IOUC for cell site data link application is a TN82 circuit pack.

Fig. 33 — IOP Frame Grouping by Application for a Maximum Equipped MTSO

7.5 Cell Site Data Link

The cell site data link is a dedicated wire-line supervision and signaling path, for transmitting data messages between an MTSO and a cell site. Both data links (0 and 1), to a cell site, operate in a full duplex mode. One cell site data link is used for call processing messages. The other is used for maintenance and administrative messages. If one link is out-of-service, the two message streams are sent over the remaining link. For reliability, data link 0 connects to one expanded IOP frame while data link 1 connects to a separate expanded IOP frame (Fig. 33).

The cell site data link is divided into three basic sections. These are the 1A IOP hardware at the MTSO, a portion of the CSC with the DLI (Data Link Interface) hardware at the cell site, and the transmission facilities connecting both ends (Fig. 34). The CSC was discussed previously under CELL SITE in Section 6.

The 1A IOP hardware at the MTSO, for one data link, includes a DMAC, a fanout board, and a PC. The PC is the lowest level in the IOP hardware hierarchy. Each PC is a TN82 circuit pack that contains a microprocessor controlling one IOP channel or cell site data link. Directly above the PC, in the hierarchy, is the fanout board. There can be a maximum of eight PCs attached to each fanout board. The failure of a fanout board also means the loss of all the attached PCs. The DMAC controls the fanout board. The failure of a DMAC means the loss of the attached fanout board.

The portion of a CSC that is considered to be part of a cell site data link is located on circuit pack TN272 of each MCU. It is helpful to think of the data link in this manner, since the data link diagnostics test this part of the MCU when requested to diagnose the cell site end of the data link. The DLI hardware at a cell site includes circuit pack TN161 for one data link. The transmission facilities, connecting a cell site to the MTSO, include the dedicated lines and a data set.

Each MCU of the CSC contains a control switch that allows maintenance personnel, at a cell site location, to manually request frame functions. Each request is acknowledged by a lamp on the MCU. The maintenance terminal at the MTSO prints the configuration message and diagnostic data resulting from a maintenance request. These requests are:

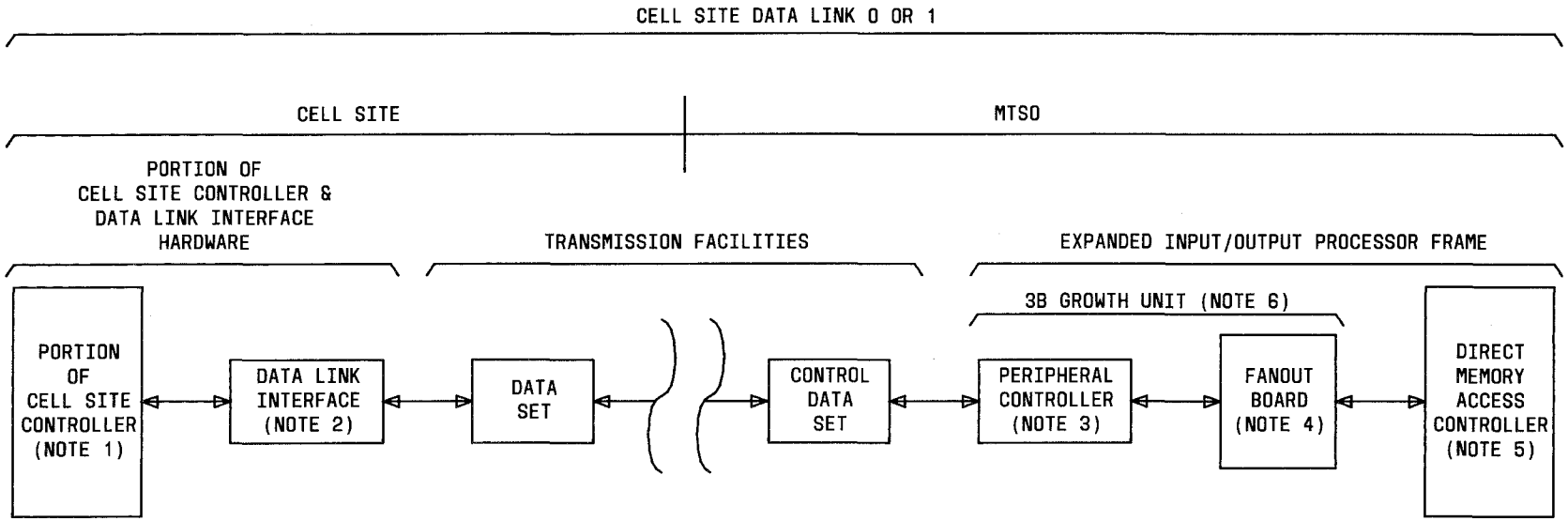
- ROS (Request Out-of-Service)
- Conditional remove
- Conditional restore.

In the event of a data link failure, communication can continue between the MTSO and cell site by reconfiguring the appropriate IOP. Anytime something happens in one data link section, it will affect the other two sections. For example, if the IOP is not operational, then the link will not support message traffic even though the other two sections may be operational.

The cell site data link hardware components are referred to by different names for terminal IO messages. These are: IOUS for DMAC, IOMP 1 for fanout board, IOUC for PC, and MCU for CSC.

> **Note:** Although two IOMPs are controlled by each IOUS (per IOP), the cell site data links are only attached to IOMP 1 through the PCs. The PCs are designed to handle the high speed cell site data links. The IOMP 0, with its attached LIUs, is used for terminal channels and similar low speed data links. The LIU is referred to as an IOUC for terminal IO messages.

For maintenance information on the cell site data link, refer to Section 11 of this practice.



NOTES:

1. One of the many CPs making up a cell site controller is the TN272. Both data links connect to this CP and this connection is considered part of the data link.
2. The data link interface is a TN161.
3. The peripheral controller is also called an input/output unit controller (IOUC). An IOUC is a TN82.
4. The fanout board is also called input/output microprocessor 1 (IOMP 1). An IOMP 1 is a UN60.
5. The direct memory access controller is also called an input/output unit selector (IOUS). An IOUS includes a number of different circuit boards.
6. The 3B growth unit also includes a power monitor board which is a TN71.

Fig. 34 — Cell Site Data Link - Block Diagram

7.6 Maintenance and Administrative Control

The maintenance and administrative control consists of equipment used by maintenance personnel in maintaining an ESS switch. Maintenance and administrative control also contains the hardware that allows the MTSO to relieve incoming traffic congestion caused by outside switching centers. The following equipment is included in the maintenance and administrative control:

- Maintenance Control Center
- Trunk and line test panel
- Manual trunk test position
- Terminals
- ROTL (Remote Office Test Line).

7.6.1 Maintenance Control Center

The MCC serves as the primary interface between the MTSO and the maintenance personnel. The MCC consists of a 1A processor C&D (Control and Display) frame, a maintenance terminal including a cathode-ray type display terminal, and a TLTP (Trunk and Line Test Panel). The MCC equipment is a functional group and does not define a physical location. For example, an ADS tape unit may be located next to the C&D frame. The tape unit is not functionally part of the MCC but is located next to the C&D for the convenience of maintenance personnel.

7.6.1.1 Control and Display Panels

The C&D panels serve as a direct communications link between maintenance personnel and the system. The controls enable manual recovery of the system by direct control of system operation and configuration when automatic recovery fails. The indicators and displays provide system status and performance information. As a functional unit, the C&D panels are connected to System 100 through the PPI frame. The PPI contains the C&D logic for the lamps, keys, and displays.

The C&D includes the following panel.

- 1A processor display and override panel
- 1A processor A-level program request and system display panel
- 1A ESS switch system status panel.

The 1A processor display and request panels are common to all ESS switch applications of the 1A processor; however, the 1A ESS switch system status panel has additional capabilities that are unique to System 100.

The lamp/keys associated with the additional display and request functions include:

- CELL SITE
- PROGRAM CONTROL OFF-NORM
- AUTOPLEX CONTROLS IN EFFECT
- TTY MESSAGE INHIBITED.

The proper MCC lamp/key lights when:

1. Hardware fails in one or more cell sites or cell site data links, which may or may not affect call processing
2. A program control function is active
3. One or more cell sites are traffic overloaded
4. Cell site messages have been inhibited by the MTSO.

The PROGRAM CONTROL OFF-NORM and TTY MESSAGE INHIBITED lamp/keys presently exist in the 1A ESS switch system status panel. The CELL SITE and AUTOPLEX CONTROLS IN EFFECT lamp/keys are new to the 1A ESS system switch status panel. All of these lamp/keys include manual request functions to give additional information of equipment status and performance. When any of these lamp/keys is in a lighted condition, it may be depressed (request made) to produce a terminal output message containing the reason the lamp is on.

The CELL SITE lamp/key display functions include primary and secondary lighted conditions. The primary condition, which is indicated when the lamp/key is lighted red, means that a problem is inhibiting call processing at one or more cell sites. The secondary condition, which is indicated when the lamp/key is lighted amber, means that a problem has caused a degraded call processing condition at one or more cell sites. Manual removal of equipment will not cause these lamp/keys to be lighted.

The PROGRAM CONTROL OFF-NORM lamp/key is an indicator of active abnormal program controls or a normal program control that is not functional in the MTSO and/or one or more cell sites. The lamp/key is lighted red for either of these conditions and extinguishes when the condition passes. These program controls will inhibit:

- Interrupts
- Functional tests
- Routine diagnostics
- Processor forced active
- Monitor
- Pump-up
- Audits.

The AUTOPLEX CONTROLS IN EFFECT lamp/key is lighted amber when an overload control is active. These are:

1. MTSO call limiting control
2. Maintenance personnel manually invoke forward setup channel control
3. One or more cell sites invoke overload control.

When this lamp/key is depressed, a terminal output message is printed giving the status of all three overload controls. The lamp will extinguish when the overload condition passes.

The TTY MESSAGE INHIBITED lamp/key is lighted red when cell site messages have been suppressed in the MTSO. This condition will also cause the PROGRAM CONTROL OFF-NORM lamp/key to be lighted.

7.6.1.2 Trunk and Line Test Panel

The TLTP (Trunk and Line Test Panel) provides the system with a facility to manually remove from service and to test trunks and service circuits for System 100. The TLTP is also used to perform a number of miscellaneous transmission tests.

7.6.2 Automatic Message Accounting

The AMA (Automatic Message Accounting) feature is included with all MTSOs. Its function is to automatically record billing data on calls. Software programs accumulate, format, and transfer the billing data from call store to magnetic tape of the ADS. This tape is manually removed on a periodic basis and shipped to an RAO (Revenue Accounting Office) for processing. For more information on the AMA feature, refer to AT&T Practice 231-290-620 or 231-290-618 (CN AMA).

7.6.3 Manual Trunk Test Position

The MTTP (Manual Trunk Test Position) is used to test System 100 2-wire trunks. Between two MTTP is an AMT (Auxiliary Manual Test) frame. The AMT frame mounts transmission test sets as well as a terminal. The terminal can be optionally a send/receive channel. This configuration enables quick and convenient trunk transmission testing, level measurements, and maintenance state control at the MTTP. The MTTP and AMT can be located up to 1500 cable feet from the switching office.

7.6.4 Input/Output Terminals

The IOTs (Input/Output Terminals) provide maintenance personnel with the capability to communicate with System 100. Communication between the maintenance personnel and the CC is over transmission paths. These paths are called IOCs (Input/Output Channels). An IOC consists of an IOU (Input/Output Unit), an IOUC, and from one to three IOTs. Several CS memory areas serve as storage for terminal messages. Some of the channels are specifically used for a medium-speed (1200 baud) transmission rate which requires the use of a DATASPEED® 40 terminal as an IOT. Other channels require a slow-speed (110 baud) transmission rate which requires the use of a Model 43 terminal as an IOT. A few of the channels can be used for either slow- or medium-speed transmission rates. Table F shows the different IOCs and their rates. For more information on the different IOC types, refer to AT&T Practice 966-120-100.

7.6.5 Remote Office Test Line

The ROTL (Remote Office Test Line) is a feature with hardware in the MTSO and software contained in the generic program base. This feature provides the capability of performing trunk transmission tests. The interface between the local maintenance terminal and the ROTL is provided by hardware called the PCI (Program Controlled Interrogator). The PCI allows for locally initiated automatic trunk transmission tests using ROTL. The testing location is typically the MTSO or ACC. These tests are initiated via the maintenance channel, TLTP panel, or the MTTP frame.

TABLE F

INPUT/OUTPUT CHANNEL (IOCs) for MTSO

CHANNEL FUNCTION	MNEMONIC	CHANNEL SPEED	TERMINAL TYPE
Local maintenance	LOC	Medium	DATASPEED 40
Remote maintenance	REM	Medium	DATASPEED 40
Recent change service order	RCS	Slow or Medium	DATASPEED 40 or Model 43 KSR
Administrative dial service	TR1	Medium	DATASPEED 40
Supplementary dial service	TR2	Medium	DATASPEED 40
Supplementary remote maintenance	SRM	Medium	DATASPEED 40
ACC maintenance	AC1	Medium	DATASPEED 40
Supplementary ACC maintenance	AC2	Medium	DATASPEED 40
Beltline maintenance	BLT	Slow	
Calling line identification	CLT	Slow or Medium	DATASPEED 40 or Model 43 KSR
Plant service center	PSC	Slow or Medium	DATASPEED 40 or Model 43 KSR
Network management	NMG	Slow or Medium	DATASPEED 40 or Model 43 KSR
First trunk maintenance	ST1	Slow	Model 43 KSR
Second trunk maintenance	ST2	Slow	Model 43 KSR
Third trunk maintenance	ST3	Slow	Model 43 KSR
Fourth trunk maintenance	ST4	Slow	Model 43 KSR

7.7 Monitor and Control

In order for the 1A processor to perform the call processing and maintenance testing functions required to operate an MTSO, the 1A processor must communicate with the switching network. It is the job of the peripheral monitor and control units to provide the 2-way communication link required by the 1A processor. These units consist of:

- Scanners
- SDs (Signal Distributors)
- CPDs (Central Pulse Distributors).

7.7.1 Scanners

Scanners are current sensing devices which furnish input information to the CC (Central Control). Scanners are used to monitor customer trunks for on-hook and off-hook conditions. Scanners also monitor other circuits at discrete time intervals as directed by the system. The scanners are provided in 512- or 1024-point modules which are physically located on network and trunk frames. Master scanners are provided for diagnostic and miscellaneous scanning functions.

Each point in the system to be scanned is connected to a current-sensing device called a ferrod sensor. The ferrod consists of a ferrite rod enclosed by a pair of control windings. A single-turn interrogate winding and a single-turn readout winding are threaded through two holes in the center of the ferrod. The control windings are connected in series with the circuit to be sensed or supervised. A scanner can select and interrogate any group of 16 ferrods specified by information received from the CC. Each of the 16 ferrods interrogated will cause a pulse or no pulse output referred to as a 1 or 0 readout, respectively. Whether the readout is a logic 1 or 0 depends on the state of the scanned circuit. For example, if a customer trunk is being observed, the on-hook (open) condition results in a 1; the off-hook (closed) condition is a 0. In response to signals from the CC, a scanner produces a 16-bit output word that is transmitted to the CC for interpretation.

The following types of scanners are used in the MTSO:

- Universal trunk scanners
- Miniaturized universal trunk scanners
- Master scanners
- Combined miscellaneous trunk (master) scanners.

The scanners differ mainly in function and types of ferrods used; however, the control and operation of all scanners are essentially the same. The total number of scan points required in a 2-wire MTSO is about one and one-half times the number of office trunks.

The master scanner supplements the trunk and junctor scanners to collect additional information at many points in an MTSO. The master scanner also supplies the scan point for miscellaneous trunk frame circuits. This scanner consists of 1024-point ferrod sensor matrix and duplicated control matrix.

7.7.2 Signal Distributors

The SDs are used to select and control equipment within the MTSO for which operation at electronic speeds is not required. The SDs provide the CC with a means for selecting and operating magnetic latching relays in trunk and service circuits, junctor circuits, and certain control circuits. Thus, SDs are the buffers between microsecond CC requests and the millisecond relay response.

An SSD (Supplementary Signal Distributor) unit located on a miscellaneous trunk frame is available for use when the SD point arrangement of the junctor and universal trunk frames is insufficient. This SSD unit provides a complete SD for circuits located on miscellaneous trunk frames.

7.7.3 Central Pulse Distributors

The CPDs (Central Pulse Distributors) are used to provide CC with access to many points within the system requiring action signals.

Upon receiving an order from the CC, a CPD selects and pulses one of the outputs specified by the address from the CC. Outputs from the CPD may be either unipolar (pulses of only one polarity) or bipolar (pulses of either polarity). Unipolar pulses are mainly used to enable peripheral units (scanners, SDs, network frame controllers). The verification pulse that results is returned to the CPD, decoded, and then sent to the CC. Bipolar pulses, sent to peripheral and other units, can be used to change the state of flip-flops or to operate a logic circuit. Circuits receiving a bipolar output pulse do not return a verify pulse to the CPD.

7.8 Switching Network

The MTSO switching network (Fig. 35) includes the following:

- TLNs (Trunk Link Networks)
- Junctors
- Trunks
- Associated network control equipment
- Junctor grouping frames.

7.8.1 General

The MTSO switching network is used to establish metallic paths for voice transmission and signaling. The network connects trunks to trunks, and trunks to various service circuits. The service circuits consist of tones, signal transmitters, signal receivers, ringing circuits, and maintenance circuits. The network consists of a number of trunk switching circuits, and junctor switching circuits interconnected through the JGF (Junctor Grouping Frame). The number of TLNs used is determined by the volume of traffic assigned to the office. Each

path shown in Fig. 35 represents two wires, tip and ring. When a MTSO is ordered as a new office, it will consist of a 1A processor and a remreed switching network. The remreed switch is the basic switching element of the TLN.

7.8.2 Trunk Link Network

The remreed TLN frame provides four stages of switching through the switching network, and consists of TSCs (Trunk Switch Circuits) and JSCs (Junctor Switch Circuits). Trunks and service circuits are terminated on the TSC.

Trunk-to-junctor ratios of 1:1 or 1.5:1 (Table G) may be arranged by providing a 1024 TLN. A 1:1 trunk-to-junctor ratio is provided with a 2048 TLN. A 1:1 trunk-to-junctor ratio (2048 TLN) represents eight TSCs and eight JSCs. Only one trunk-to-junctor ratio can be used in a single MTSO. The selection of a specific ratio is traffic dependent and may be changed to meet the needs of office growth. The 1024 TLN (1.5:1 trunk-to-junctor ratio) represents six TSCs and four JSCs. The remreed 1024 TLN occupies one 2-bay frame with a total width of 6 feet 6 inches. The remreed TLN is used for 1:1 and 1.5:1 trunk concentration ratios. The four separate TSCs and JSCs on the 1024 remreed TLN share the PUB receivers and the diagnostic bus connections for each bay.

The remreed TLNs are only available equipped with a full complement of JSCs. The TSCs may be provided on a fractional network basis with remreed hardware.

7.8.3 Junctor Grouping Frame

Interconnection between a TLN and other TLNs is provided by the JGF. The JGF is shown in Fig. 36. The junctor pattern for a particular office depends on its size and type of traffic.

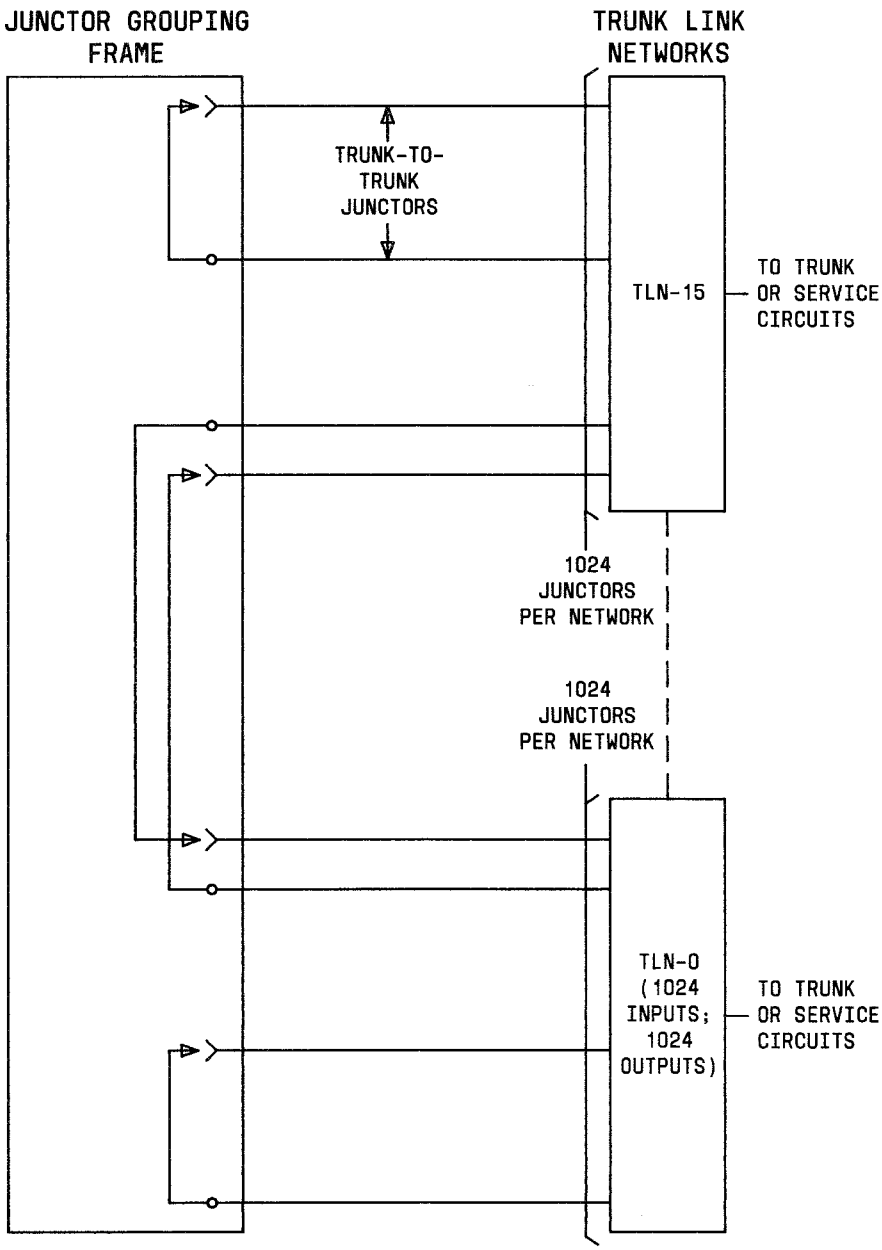


Fig. 35 — MTSO Switching Network

TABLE G

TRUNK LINE NETWORK SIZES

RATIO OF TRUNK TERMINALS TO JUNCTORS	MAX NO. OF TSCs PER TLN	MAX NO. OF TERMINALS PER TLN	MAX NO. OF JUNCTORS PER TLN	MAX NO. OF TLNs PER OFFICE	MAX NO. OF TRUNKS PER OFFICE
1 to 1	4	1024	4	16	16,384
1.5 to 1	6	1024	4	16	24,567
1 to 1	8	2048	8	16	32,768

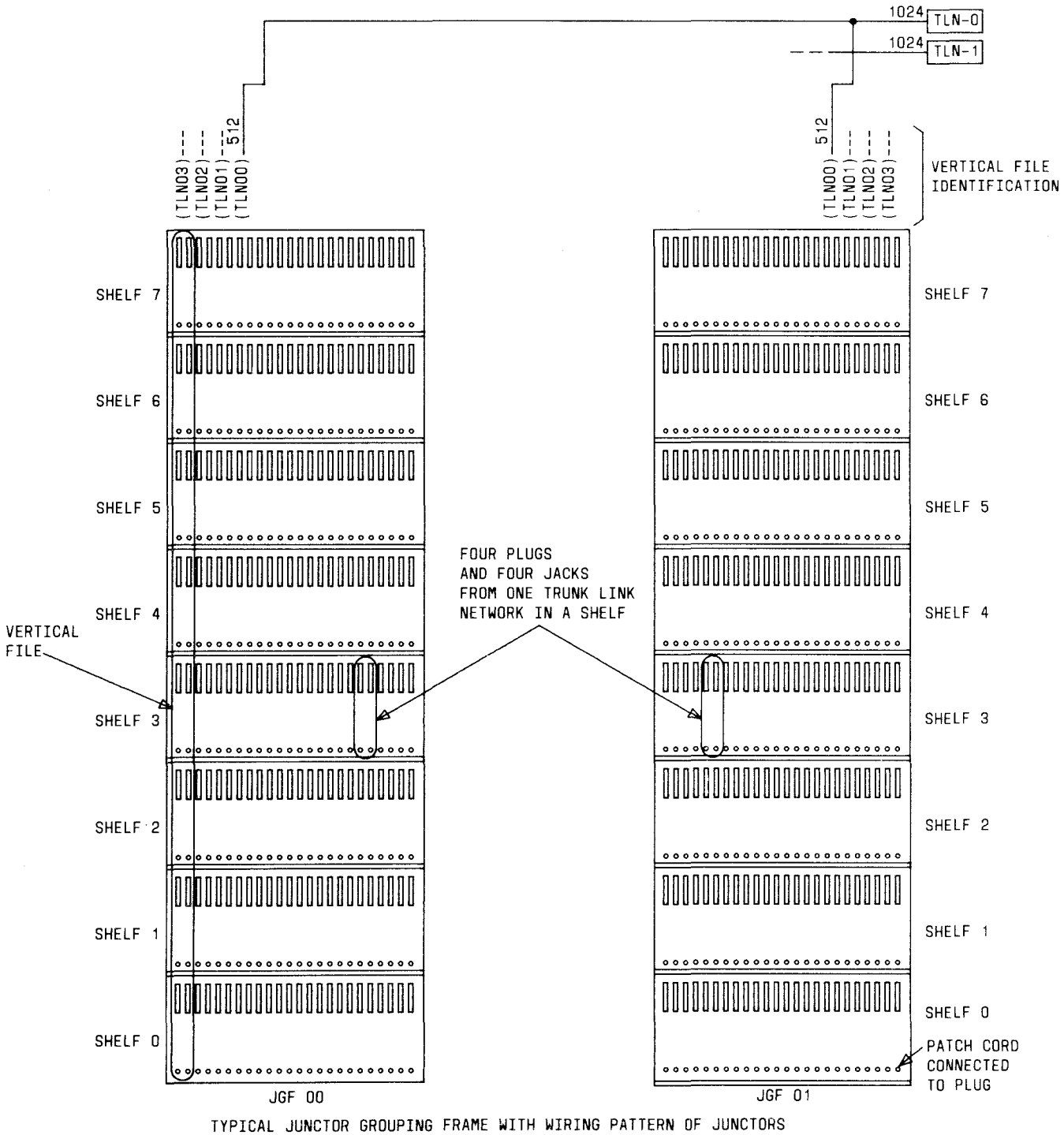


Fig. 36 — JGF Layout - 12 Vertical File

7.9 Distribution Frames

In addition to the units and frames already mentioned, other frames are used which perform noncontrol functions. These frames are primarily distribution frames and are used to interconnect two groups of leads in a unique pattern according to the office assignment. The interconnecting pattern can be easily rearranged when assignments are changed. The additional noncontrol frames are:

- MDF (Main Distributing Frame) and Protector Frame
- TDF (Trunk Distributing Frame)
- IDF (Intermediate Distributing Frame).

7.9.1 Main Distributing Frame and Protector Frame

All outside cables from cell sites and NIPs (Network Interface Points) are terminated at the protector frame on protectors that prevent damage to office equipment from lightning and power crosses on selected special circuits when required. Cables from the protectors are connected to alternate columns of terminal blocks at the main distributing frame and are distributed vertically. The horizontal side of the MDF contains the TLN frame appearances for all incoming and all outgoing trunks.

7.9.2 Trunk Distributing Frame

The TDF interconnects all incoming and outgoing trunks and service circuits and the TLN appearances. The TLN appearances are connected to alternate columns of terminal blocks and the trunk circuits and service circuits are connected to the remaining columns.

7.9.3 Intermediate Distributing Frame

The IDF (Intermediate Distributing Frame) interconnects the main distributing frame and incoming and outgoing trunk circuits. In appearance, the intermediate distributing frame is the same as the trunk distributing frame. Cable pairs from the main distributing frame are connected to alternate columns of terminal blocks while cable pairs from the trunk circuits are connected to the remaining columns.

7.9.4 Power Distribution Frame and Power Plant Frame

Area bus centers and power distribution fuse boards are located near the MTSO equipment and serve as distribution points for the various voltages.

The power distribution system for the MTSO follows standard plant practices. The normal ac power source for the entire office is commercial ac. If commercial ac is lost, engine-driven alternators supply reserve ac power to replace commercial ac. Primary dc

power is normally supplied by battery plant rectifiers that convert commercial/reserve ac to primary dc power. When commercial/reserve ac is disrupted, reserve batteries take over for the rectifiers and supply primary dc power to the MTSO. The dc voltages other than primary dc required by the office are provided by dc-to-dc converters that convert primary dc to the various dc voltages. Some critical office loads require uninterrupted (protected) ac power which is supplied by a dc-to-ac inverter when commercial ac is lost. Other ac loads that are essential to the office, but can tolerate short interruption of ac power without degrading service, are supplied commercial/reserve (essential) ac power. Those loads that are not essential to the office are supplied from only commercial ac power.

The normal primary sources for the entire system is 208 volts, 240 volts, or 480 volts, 60-Hz, 3-phase commercial ac power. If commercial ac power is lost, the gas-turbine or diesel alternator reserve power system supplies reserve 480 volts, 60-Hz, 3-phase primary ac power. Emergency 208/120 volts ac power can also be provided by the 504B power plant which supplies single or 3-phase ac voltage from the 48-volt office battery during a commercial power failure. Primary dc power for the system is +24 volts and -48 volts supplied by the 111A power plants or 326A and 326B power plants. Negative or positive 130 volts is supplied by the 610B or 660C converter plants and delivered to fuse panels on a miscellaneous frame in the switchroom for distribution to the loads.

7.9.5 Power Conversion and Distribution Frame

The PCDF (Power Conversion and Distribution Frame) is a 3-bay frame and provides dc power for the 1A processor frames in the 1A processor complex. The PCDF also provides a status and alarm interface between the plant power distribution facilities, power converters in the PCDF, and the 1A processor. The PCDF receives -48 volts power from the plant power distribution system. The outputs of the PCDF are -48 volts and +24 volts for distribution to the 1A processor.

7.10 Trunk and Service Circuits

Trunk circuits in the MTSO are used mainly to provide transmission and supervision (telephone on-hook or off-hook). All other functions of conventional trunks, such as pulsing, charging, timing, etc., are delegated either directly to the program control or to the service circuits which, in turn, are under program control. Service circuits include tone circuits, ringing circuits, circuits for transmitting and receiving information, and other similar circuits. Service circuits are connected through the network to trunks as required. These circuits perform functions which can be handled more economically by providing a few special circuits than by providing additional equipment in each trunk to accommodate the same function.

7.10.1 Miscellaneous Trunk Frame

The MT (Miscellanous Trunk) frame is a single-bay frame, 2 feet 2 inches wide. The frame has 36 two-inch mounting plate spaces used for mounting trunk and service circuits. The MT frame mounts the trunk and service circuits which do not fit the universal pattern required for mounting on the UT (Universal Trunk)/MUT (Miniaturized Universal Trunk)

frame. Circuits on the MT frame are cabled via unit terminal strips to their associated master scanner, signal distributor, and distributing frame terminations.

The MT frame does not contain a scanner or signal distributor. The MT frame is also used to mount other equipment, such as, an SSD, and a terminal.

7.10.2 Combined Miscellaneous Trunk Frame

The CMT (Combined Miscellaneous Trunk) frame is a double-bay frame (3 feet 3 inches wide) that provides housing for the control circuits and up to 256 circuit board mounted miscellaneous trunk circuits.

The CMT frame can be provided with up to two SSDs and a master scanner. Each SSD supplies 960 points capable of operating either full-size or miniature magnetic latching relays. The master scanner supplies 1024 scan points.

The plug-in miscellaneous trunks are plugged into the TIC (Trunk Interconnections Circuit). The TIC is designed for a specific group or type of miscellaneous trunk and is mounted in the CMT frame. Each TIC houses circuit boards containing miniaturized ferrods for scanner functions and circuit boards containing triacs (solid-state switches) for signal distributor functions. A CMT frame can provide housing for 16 TICs. Each TIC can provide housing for 16 miscellaneous trunk circuits, plug-in triac matrix circuit boards, and plug-in scanner matrix circuit boards.

The miscellaneous trunks are organized into nine groups of trunk circuits. Each group requires a TIC that accepts only trunk circuits from that particular group. A TIC can accept any trunk circuit in the group it is designed for, but cannot accept trunk circuits from any other group.

7.10.3 Miniaturized Universal Trunk Frame

The MUT (Miniaturized Universal Trunk) frame consists of a pair of 2-foot 2-inch bays arranged in a home-mate configuration that provides plug-in housing for 256 circuit board mounted universal trunk units. Each trunk unit may contain one or two trunk circuits. The MUT frame also provides power, filters, and fusing for the trunk units. Contained in the MUT frame are two 1024-point triac signal distributors, a 1024-point scanner, and peripheral bus units.

The scanner in the MUT supervises only trunk and service circuits mounted in the MUT frame. The home frame has controller 0 for 1024-point scanner and the mate frame has controller 1 for the 1024-point scanner. The associated matrix is split in half with 512 points on the home frame and 512 points on the mate frame.

There is a pair of SD controllers in the home frame and another pair in the mate frame. Therefore, both the home and mate frames have a 1024-point SD.

7.11 Ringing and Tone Frame

The ringing and tone frame is available with three different capacities: 0.5 amp, 1.5 amp, and 6 amp. These frames are the 806H, 812A, and 808A ringing and tone frames, respectively. There are two versions of each frame: the ac-dc ringing and tone power plant and the superimposed ringing and tone power plant. These ac-dc ringing and tone power plant versions provide the following tones:

- Audible ringing tone
- Touch-tone dialing
- High tone
- Busy verification tone
- Simulated audible ringing tone
- Preempt tone
- Precedence audible ringing tone.

Similar frames of 0.5-amp capacity on two bays, 1.5-amp capacity ac-dc on four bays, and 6-amp capacity superimposed on five bays are available.

7.12 13A Announcement System

The 13A announcement system is a completely electronic announcement system that uses the 29A magnetic bubble memory to store digitized speech. The 13A announcement system is a multichannel system capable of having between one and eight channels. Each channel can supply one prepared announcement. Circuitry for an announcement message is located on circuit packs called message modules. There are three types of message modules: a 12-second FML (Fixed Message Length), a 3- to 12-second VML (Variable Message Length), and a 3- to 24-second VML. Each message module can provide an announcement of up to 500-trunk circuits simultaneously. The message modules uses the 29A bubble memory packages to store the prepared announcements. During the recording of an announcement, the analog speech is converted to an equivalent digital signal. Adaptive delta modulation is used to make the conversion by using encoding and decoding circuitry. Once the conversion is made, the digitized speech is stored.

Recording an announcement into the 13A announcement system is accomplished by the use of a handset or cassette tape recorder. Once a message is recorded, the stored information will remain stored even if power is removed from a module.

8. EQUIPMENT CHARACTERISTICS

In order to provide reliable, continuous service all common system units are duplicated. This duplication minimizes the possibility of an interruption of service to customers.

8.1 MTSO Duplication

Both the interconnecting leads and the buses are duplicated to ensure continuous service. The CC is able to communicate over either one of these buses or interconnections. Duplicated units in the MTSO may communicate with the CC over either bus or interconnecting lead. Duplicated units are designated as standby and active. The active bus is defined as the bus the active CC uses for receiving and sending information. An active store block is one which is transmitting information on an active bus. Similar definitions apply to other duplicated units. The redundancy of equipment provides a way for the system to easily switch out a nonoperating unit and switch to a unit which will operate properly.

The following units are duplicated in the MTSO (Fig. 37):

- Central controls
- Program stores
- Call stores
- Central pulse distributors
- Data unit selectors
- Attached processor system
- Switching controllers
- Signal distributor controllers
- Scanner controllers
- Ringing and tone plants.

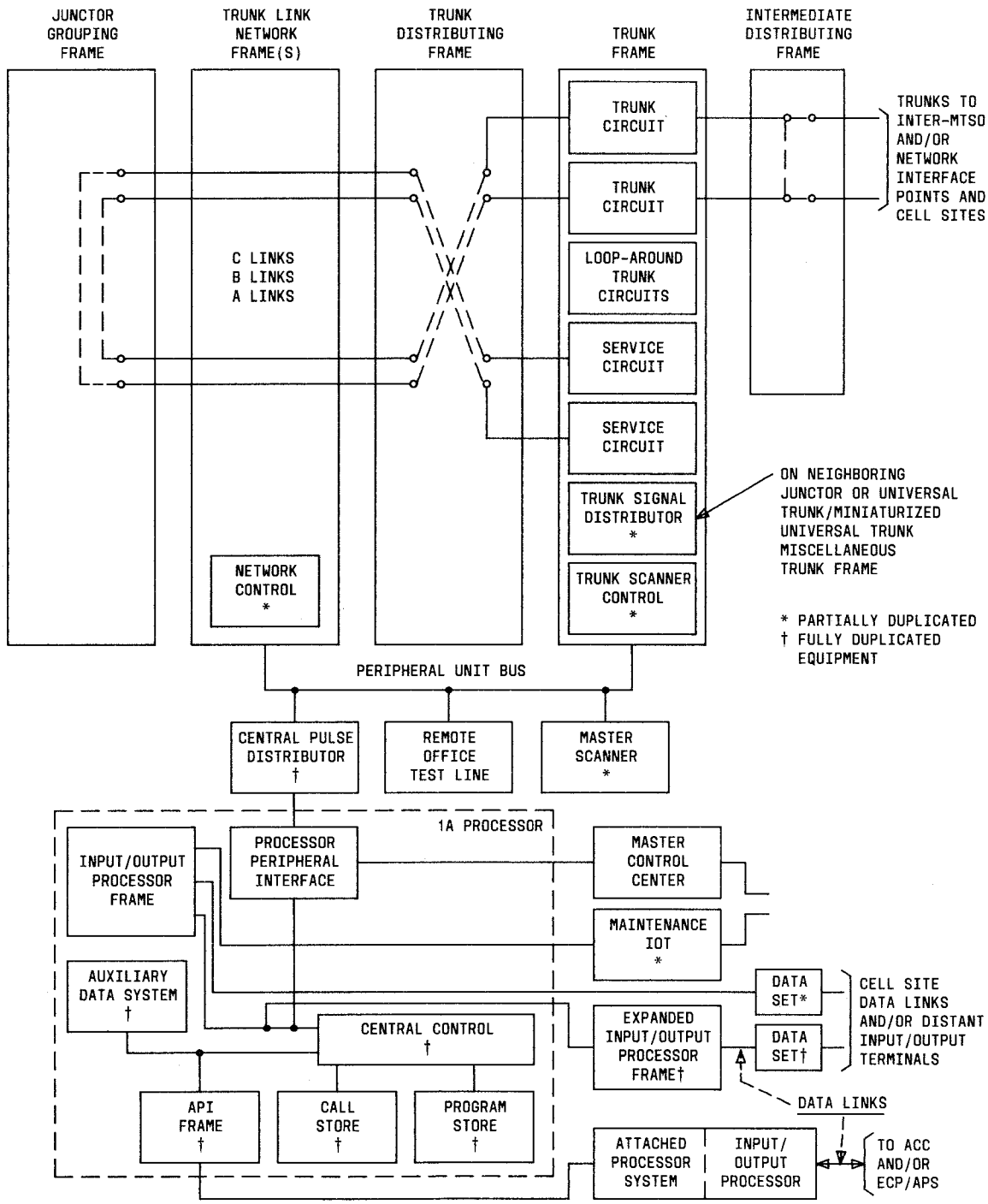


Fig. 37 — MTSO Duplicated Equipment Block Diagram

8.2 Cell Site Duplication

The cell site and data link equipment that is duplicated is listed in Table H. Also listed is equipment that is not duplicated or simplex.

8.3 Equipment Elements

Most System 100 functions are performed by the following types of apparatus:

- Remreed switches for network switching
- Ferrod sensors for scanning
- Magnetic latching wire-spring relays
- Semiconductor devices.

8.3.1 Remreed Switches

The remreed switch is the basic switching device used in TLNs and is similar to the ferreed switch in many respects. Only one type of the basic switch is used to accommodate both the network tip and ring conductor paths and the no test vertical path functions. Grid apparatus units are packaged in two connectorized configurations: the 10A junctor grid unit and the 11A trunk grid unit. The 11A trunk grid unit contains two stages of 8-by-8 switches connected in a 64-by-64 configuration. The 10A junctor grid unit contains the same 64-by-64 configuration and, in addition, is arranged with test access switches to each output terminal.

The remreed switch is arranged with two windings so that part of each winding is both above and below the shunt plate. Sealed contact operation (close) occurs only by current pulses in both windings simultaneously (coincidence). A single current pulse through either winding causes switch contact release. The remreed sealed contact differs from the ferreed sealed contact in that the remanent magnet material is located in the reeds inside the sealed contact. The remreed switch also does not require continuous current to maintain an operated or released state. Remreed switches are not operated or released while current is applied to the contacts.

TABLE H

CELL SITE AND DATA LINK EQUIPMENT QUANTITIES

UNIT OR FRAME	QUANTITY	COMMENTS
Cell Site Data Link	2	Each Data Link Includes One PC, FO BOARD, DMAC, DLI, DS at Each End, and Portions of a CSC
Cell Site Controller	2	Also Called MCU and/or Cell Processor
Cell Site Voice Trunk	96 Max	
Setup Radio Group	4 Max	0-3
Locating Radio	2	0,1
Voice Radio Group	12 Max	8 Radios Max Per Group
Test Generator Group	1	Simplex
Measurement Inst	1	Simplex
Cell Alarms	32 Max	
RF Switch	1	Simplex
SAT OSC	96 Max	One Per Voice Channel
REF GEN	2	
Receive Antenna	2	For OMNI Only Cell Site
Receive Antenna	8 Max	For Directional Cell Site
Transmit Antenna	7 Max	One or Two Per Radio Frame
Radio Frame	6 Max	0-5
Control Frame	1	Simplex

8.3.2 Ferrod Sensor

The ferrod sensor used in scanners provides magnetic coupling between the interrogate and readout windings by current applied to the control winding. This current, or the absence of current, is established by the state of the circuit to be sensed. An example is sensing of an on-hook or off-hook condition of a trunk. The on-hook condition causes a binary 1 output, and the off-hook condition causes a binary 0 output.

Four types of ferrods are used in the System 100 and vary only in sensitivity. The more sensitive types are used to sense distantly located conditions.

8.3.3 Magnetic Latching Relays

Magnetic latching wire-spring relays appear similar to conventional wire-spring relays. The main characteristic of magnetic latching relays is the remanent core material which retains enough residual magnetism to hold these relays operated after the operating current is disconnected. Actual operation is accomplished by a negative pulse and released by a positive pulse. No current is required to maintain an operate or release state.

The magnetic latching relays are operated and released by the SDs and provide the final closing of a metallic path in the associated circuit. The relay generates a pulse when the path is closed. This pulse is detected by the signal distributor controller and serves as verification of the closure. The same type of verification occurs when the relay is released.

8.3.4 Semiconductor Devices

Semiconductor devices mounted on plug-in circuit packs are used for most of the logic and controls. Semiconductor devices make possible the operating speed and reliability required by the system. The circuit pack provides the rapid replacement of defective circuitry and restoration of the unit to service.

9. MTSO SOFTWARE

The software that controls the System 100 is stored in the MTSO and is comprised of a generic program and data structures. The data structures consist of parameter and translation data.

9.1 Generic Program

The MTSO generic program is a general purpose switching system control program that is installed in every MTSO as opposed to each office having an individually tailored program. The primary reason for this is that all of the support effort required to maintain the program, implement new features, etc., would become completely unmanageable if it were to be required on a per-office basis.

The MTSO generic program includes:

a. Base
    1. Core
    2. Base Features

b. Optional Feature Packages.

The core is part of the base program that is always required. The core includes routines to provide normal telephone service. It also includes essential maintenance and administrative functions.

Base features are incorporated with the core as part of the base program. These features are developed as FPs (Feature Packages). They are normally provided within the generic program as a relocatable FP.

Optional FPs are features that must be individually selected by each cellular provider. These FPs are not included in the base program. Selected combinations of FPs are offered as optional feature groups.

Most optional FPs are separately loadable; that is, if they are not requested, program store memory is not allocated for them.

9.2 Parameter Data

The parameter data is the engineered part of the data structure which defines, for each MTSO, the services offered to customers. It also contains the information about what equipment exists in the MTSO and what call store memory allocations have been made.

The only time that it is necessary to make any changes to the parameter data is when a hardware or software modification of the MTSO occurs. The hardware modifications are typically growth situations where equipment frames are being added. The software modifications are usually the result of a reissue of the generic program made to improve some segment of the code, incorporate new capabilities into the program, and to correct program errors which have been detected. The type of System 100 information contained in parameters is five fundamental types:

- Equipment items
- Software (usually traffic dependent)
- Certain MS and CPD assignments
- Office options
- Translations-parameters compatibility.

The IOP member number translator (IOMTRANS) data in the System 100 for the first eight IOPs will not be changed and will be stored in parameters. The IOMTRANS data for the additional IOPs will be stored in translations.

9.3 Translation Data

The translation data contains the specific details about each trunk, service circuit, and their equipment units in the MTSO. For the mobile unit, the information includes the services to which the customer subscribes and the type of mobile equipment used by the customer. The trunk and service circuit translation data includes which trunks are associated in each trunk group, etc. The translation data also contains the data which is used to translate office codes and to determine routing and charging information as to the disposition of irregular calls, such as partially dialed numbers.

The translation data is subject to continuing changes, since new customers are being added daily and old customers are changing vehicles or changing the services to which they subscribe. The trunk translations are similarly being changed to keep efficient trunk group sizes, modify routing, and to change charging information when telephone rates change.

In order to affect these changes, the generic program provides the ability to input the required modifications to the translation data. Since this is a continuing process, it becomes the responsibility of the cellular provider to manage the translation data.

10. SYSTEM 100 SOFTWARE ORGANIZATION

The software for the System 100 is structured to:

- Accommodate a large number of calls
- Provide sufficient flexibility for MTSO, cell site, and traffic growth
- Add service features
- Provide automatic detection and diagnoses of trouble conditions and to restore memory to cell site(s) in trouble
- Provide trunk/data link switching for calls, as mobile units move throughout the CGSA
- Provide improved continuity of roamer service across the boundaries of two or more CGSAs by using abutting system service.

The System 100 software organization is illustrated in Fig. 38. The software packages include:

- 1A ESS switch generic base at the MTSO
- MTSO subsystems unique to System 100
- Data link control and message switching
- APS generic
- Cell site generic.

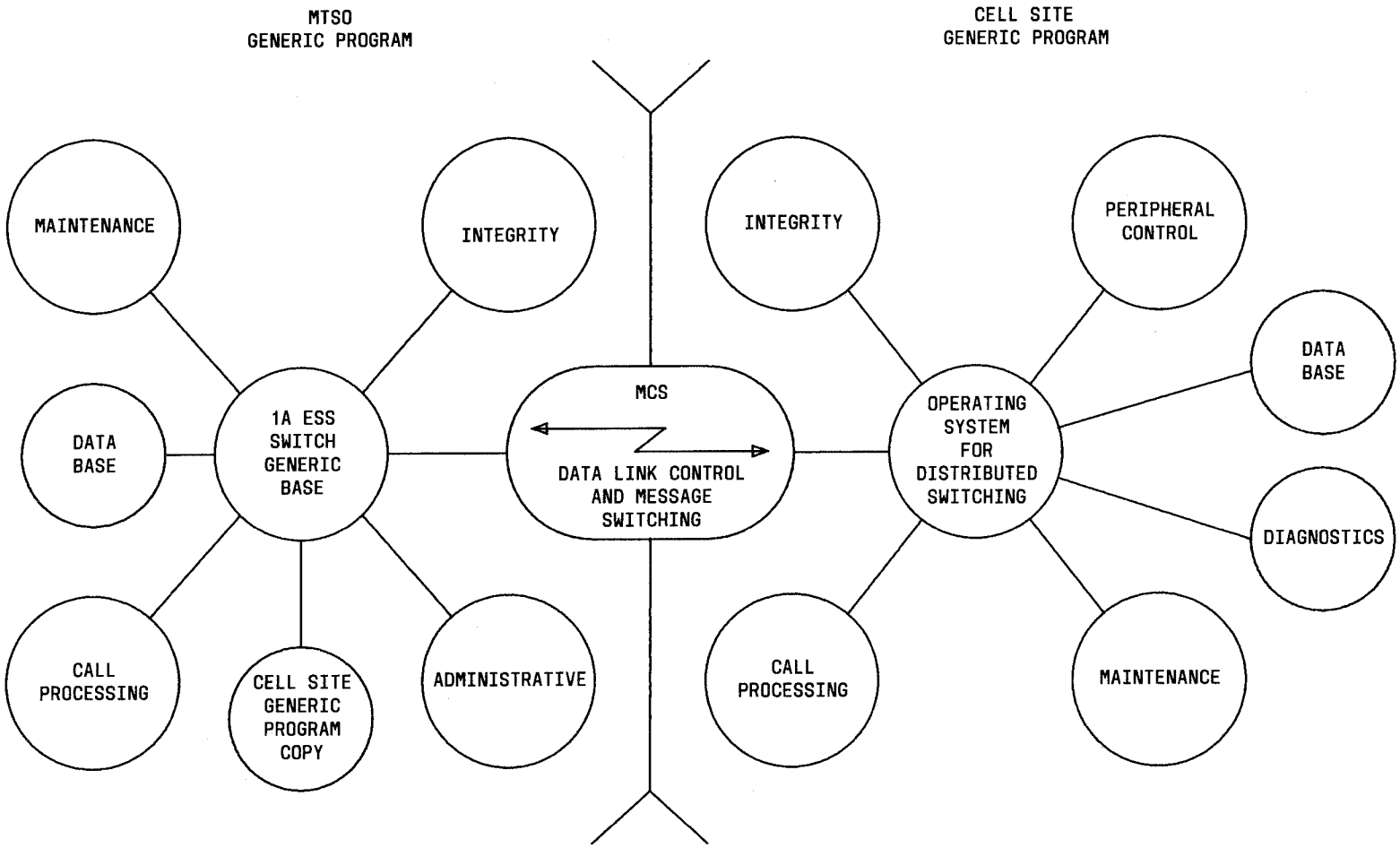


Fig. 38 — System 100 Software Organization

10.1 1A ESS Switch Generic Base at the MTSO

The MTSO uses the core of a 1A ESS switch (1AE7, 1AE8A. or 1AE9.03) generic base with System 100 subsystems added in the same manner as base features are. Optional feature packages are not included.

The core of the 1A ESS switch base program can be divided into a number of major functions. These functions are associated with programs designed to perform a particular system operation. The general categories of nonmaintenance programs include:

a. Input/output programs which specialize in collecting a particular type of input information to be processed (for example, call origination) or in transmitting to peripheral equipment such information that has resulted from processing.

b. Call processing programs which specialize in the processing of information associated with a particular type of call or phase of a call.

c. Service routine programs which specialize in processing functions not exclusively related to one type of call or a phase of a call. These routines are called upon, when needed, by the various call processing programs and are referred to as clients of the service routine program. As an example: any program can request a translation service routine to determine the mobile identification number corresponding to a given directory number.

d. An ECMP (Executive Control Main Program) which schedules the tasks of the input/output and call processing programs.

The organization of the base is also related with the organization of the information stored in the temporary memory of the duplicated CS (Call Store). In general, each program functions with one or more duplicated CS areas. The contents of these areas are modified to reflect the occurrence of events or the results of processing. Information recorded by one program may later be used by the same program and/or by others.

Each duplicated CS area consists of one or more words. The size and layout of the area varies from case to case. A duplicated CS word may be used completely to store some item of information or may be divided into parts of one or more bits. Each word or part of a word has a precisely defined assignment. A whole word may be used, for example, to store the identity of the TLN terminal connected to the customer MF receiver used for a particular incoming call. Groups of four bits may be used to store the various digits dialed by an originating customer. A single bit may be used to indicate whether a test has passed or failed.

The organization of the 1A ESS switch generic program is strongly influenced by the fact that the system must operate in real time; that is, the MTSO must respond promptly to actions that occur at times not under the control of the system. A single time-shared high-speed CC (Central Control) must keep up with the flow of information from subscribers and from other MTSOs or zone offices. Consequently, the establishment of a hierarchy of priorities is necessary. Some system functions are of a nondeferrable nature and must be performed under tightly controlled schedules. Other functions are of a deferrable nature and occasionally can be delayed without significant adverse effects. For example, monitoring originations is a deferrable type function; and when postponed for a number of milliseconds, there is no noticeable effect on service. Detecting incoming MF signals is a nondeferrable

type function; and if postponed for even 5 milliseconds, signals may be missed, thus mutilating digits.

The CC scans each trunk and junctor scanner every 100 milliseconds. Should the MTSO traffic become heavy, scans related to deferrable type functions are moved out.

Nondeferrable type operation is carried out on schedule by a clock interrupt or a maintenance interrupt. Program execution is immediately interrupted and a transfer made to another program associated with the source of the interrupt signal. When the interrupt program has completed its functions, the program that was interrupted resumes operation as though no interrupt had occurred.

10.2 MTSO Subsystems Unique to System 100

10.2.1 Attached Processor System Generic

A copy of the APS (Attached Processor System) generic program is maintained in the MTSO with the 1A ESS switch generic base.

10.2.2 Cell Site Generic Copy

A copy of a cell site generic program is maintained in the MTSO with the 1A ESS switch generic base. This copy is sometimes referred to as the MTSO copy (Fig. 38). For more information on each subsystem in a cell site generic program, refer to Cell Site Generic in Section 10.

10.2.3 Multi-Cell Generic

The MTSO has the capability to simultaneously support many cell sites operating with different versions of the cell site generic (called multi-cell generic). The multi-cell generic helps maintenance personnel to coordinate changes which involve hardware and software components that are dependent on one another. A cell site operating with hardware changes and a cell site operating without similar changes can be supported at the same time by a common MTSO. This is also true for software changes that are to be made. The multi-cell generic is useful as a backup for cell site updates and generic retrofits because old versions are immediately available from the 3B file of APS.

When any version of the cell site generic is read into PS (Program Store) it becomes the resident version. This same version is automatically loaded into the 1A and 3B files of APS. The 3B file always maintains every additional cell site generic version, including the current resident version in PS and 1A file of APS.

After a request for download, all or part of the resident cell site generic version is loaded into a cell RAM. If the resident version is not for the particular cell site, the required version is first paged from the 3B file to replace the resident version in PS and 1A file before download. The paged version now becomes the current resident cell site generic in PS. The 3B file of APS still maintains a copy of the replaced version.

10.2.4 Call Processing

The System 100 call processing uses finite state support software design language. This is maintained by the STCR (State Table Controller) program. A feature selector is used to determine the type of call or feature involved with the dialed digits in a call.

For each type of call or feature there is a coordinator which controls feature processing. As additional features are added to the System 100, new feature coordinators can be added. The feature coordinators operate functional coordinators which control the functions making up calls or features.

The functions for standard calls are setting up the call, supervising the talking state, and disconnecting the call. Where the functions performed are the same, functional coordinators can be used by more than one feature coordinator.

Mobile unit originated calls are passed from an origination message hopper unloader to the MORINT (Mobile Originated Call Interface). The MORINT sends the call to the MORG (Mobile Originated Call Processor). The MORG analyzes the dialed digits and brings the mobile unit up to a voice channel. It then calls the feature selector which determines the feature coordinator to be used.

Calls on incoming trunks to the MTSO are processed by the standard 1A ESS switch call processing programs in the generic base. Software is provided in the ICAL (Incoming Call Digit Analysis) program that separates calls to mobile units from other calls. The ICAL then calls an interface routine which calls the mobile terminated call coordinator.

10.2.5 Overload Control

The MTSO overload control software is included in the call processing subsystem. The System 100 overload control system identifies overload conditions and initiates appropriate control strategies. Standard 1A ESS switch mechanisms are used for hardware and software register overflows in the MTSO. For real-time overloads the strategies are to delay and/or eliminate work.

10.2.6 MTSO Maintenance

The System 100 maintenance subsystem interface to the 1A ESS switch generic base MAC (Maintenance Control) subsystem of the MTSO is kept to a minimum. The System 100 maintenance packages execute under control of the subsystems to which they interface. However, if a maintenance function requires execute times greater than 3 milliseconds, a generic base MACP (Maintenance Control Program) 1A processor job or ECMP base level subsystem is used. One example is a base level request to download a cell site.

The System 100 maintenance software packages, at the MTSO, include the DLMS (Data Link Maintenance Subsystem), speech path maintenance subsystems, and the terminal maintenance subsystem.

The DLMS routines coordinate maintenance of the cell site data links based on data link status information. This status information is obtained from the PFLR (Processor F-Level Recovery) subsystem and/or LEAR (Link Error Analysis and Recovery) subsystem. The PFLR is part of the 1A generic base, at the MTSO, and it keeps status information on IOP components of the data links. The LEAR is a software subsystem at the cell site, and it also maintains data link status information. The LEAR responds to errors which occur on the data link and reports to the DLMS. The LEAR's status is sometimes referred to as the data link status.

The speech path maintenance subsystem for the System 100 includes changes in existing 1A ESS switch programming.

The terminal maintenance subsystem also includes changes in the existing 1A ESS programs along with additional new programs. These new programs are responsible for processing IO messages and dial-up terminal channel.

The MTSO maintenance subsystem does not provide verification of functions performed in a cell site. Error checking for valid messages and protocol checks are included in each message sent to a cell site. The cell site returns an acknowledgment to any action requested by the MTSO.

10.2.7 MTSO Integrity

The MTSO integrity subsystem software is functionally divided into three areas:

- System initialization
- System integrity monitor
- Audits.

10.2.8 System Initialization

The initialization software at the MTSO uses the standard 1A ESS switch recovery phases. There are four phases of initialization numbered 1, 4, 5, and 6.

Phase 1 executes demand audits in a correcting mode and runs 1 to 2 seconds in duration. Phase 4 executes hardware and software initialization but saves all stable calls (transient calls are lost). Phase 5 executes the equivalent of a phase 4 but in certain states will pump main memory from disk storage. Phases 4 and 5 run approximately 25 seconds in duration. Phase 6 executes a total system initialization and all calls are dropped. This phase runs approximately 32 seconds in duration.

The requests to clear transient and/or stable calls are automatically sent by the MTSO to the cell sites after phase 4, 5, or 6 has run. The MTSO will download generic data to the cell site(s) after a phase 6 has run and the MTSO is cycling on base level. The download operation can be manually allowed or inhibited at the MCC by the DIRECT DATA INSERT-9 lamp/key. When this key is depressed the MTSO is allowed to download to the cell sites.

Initialization of the cell site data link hardware is performed when the IOP hardware is initialized. This is accomplished by interfacing with the PFLR subsystem.

Initialization of a cell site by manual means is provided through an office terminal channel. A key on the MCC control and display panels provides the ability to request download to all cells. The terminal input message formats used for manual cell site initialization are:

- INIT:CELL a:TC! (transient clear)
- INIT:CELL a:SC! (stable clear)
- INIT:CELL a:BOOT! (download).

The TC message results in a transient clear at a specified cell site. The SC message results in a total initialization and dropping of all calls at a cell site. The BOOT message results in downloading of program text and total initialization of a cell site. The SC and/or BOOT messages can be used when the cell site is in an unknown state.

10.2.9 System Integrity Monitor

The MTSO integrity monitor observes the overall sanity of the cell sites. It makes use of several key system indicators to determine the condition of the overall system. These include data link trouble, cell site phases, and critical cell site alarms.

This integrity monitor also maintains a record of the indicators mentioned in the previous paragraph. When thresholds are exceeded, an automatic recovery action will be initiated. Recovery actions include demand audits and levels of system initialization. The integrity monitor also provides an escalation strategy for these recovery actions.

10.2.10 Audits

Operational audits at the MTSO make use of the maintenance control program 1A ESS switch audit schedules for audits (MACA). The audit input SA-AUDIT message and the output SA01, SA02, and SA03 messages follow the 1A ESS switch standard. The operational audits added to the 1A ESS switch for the System 100 include call processing, maintenance, and message communication.

The call processing audits will verify the mobile call register, mobile origination call register, outstanding page list, page message area, and mobile busy/idle bits.

The maintenance audits for cell site voice trunks will verify the cell site trunk status word, test resource word, and the common call and maintenance data sent over the trunks. The cell site data links are audited to verify the channel status block, IOMP activity mask table, and the IOUC activity mask word. The terminal software package is audited to verify the channel to cell site and cell site to channel table. The initialization and download operations are audited to verify the cell site initialization register and cell site download control table.

The message communication audit will verify the mobile message registers for the busy and idle lists.

10.2.11 Administrative

The System 100 administrative software performs two functions: (1) collection of measurement data which includes hourly traffic measurements (on a cell site basis), radio signal strength, trunk group occupancy, and voice channel selection activity event recording (handoff data), and (2) overhead word administration.

10.2.12 Hourly Traffic Measurements

In addition to the standard 1A traffic measurements, at the MTSO, traffic measurements pertaining to mobile telephone service are kept at the cell sites. Once per hour they are collected by the MTSO and output on the traffic terminal.

10.2.13 Radio Signal Strength

Periodically the radio signal strength data is collected and formatted at the cell sites. These measurements are for a specified set of voice and control channels. The terminal input program for the network administration channel, at the MTSO, recognizes requests for signal strength measurements. For each request a function coordinator will be used to send a message to the cell site to activate the measurements. The function coordinator notifies the cell site to terminate the measurements when a specified time is over. The measurements, in the form of histograms, are output by the cell site on the appropriate output channel.

10.2.14 Trunk Group Occupancy and Voice Channel Selection Recording

The cell site trunk group occupancy is measured by a 10-second scan. This measurement produces a terminal message containing the number of trunks that are customer busy and maintenance busy for any trunk group selected for the measurement. For any one measurement time period there is a maximum of nine trunk groups measured.

Voice channel selection activity event recording is used to closely monitor activity in any given cell site. As an event occurs, the call processing program determines if this measurement of the event has been turned on. If so, it prints the required data on the traffic channel along with the time.

10.2.15 Overhead Word Administration

Every cell site broadcasts overhead words over each forward setup channel (sometimes called forward control channel) to the mobile units. This data provides system identification and operating parameters to the mobile unit(s). The overhead words are broadcast once every second. Several optional words are sent with the overhead words if system parameters warrant.

10.2.16 MTSO Data Base

The data base at the MTSO is composed of translation data. The additional translation data for System 100 maintenance are:

- Cell site translation block
- Dial-up telephone number for a specific cell site
- Translate IOUC to cell site member and cell site data link interface number
- Translate cell site member number and cell site data link to IOUC
- Translate voice radio to trunk.

10.3 Data Link Control and Message Switching

The MCS (Message Communication Subsystem) software, also called the message switch, sends and receives cell site data link messages between the MTSO and cell sites. The MTSO has MCS (MCS-M) software and each cell site has MCS (MCS-C) software. Both MCSs will report any data link trouble they detect while doing their job. The MCS-M reports data link trouble to the DLMS. The MCS-C reports data link trouble to the LEAR. The MCS also performs queuing and buffering of data link messages. The queuing is done on a priority basis. The MCS administers the cell site data links in a load sharing configuration. Cell site data link messages are classified as operational and maintenance. Operational or call processing related messages are classified as high priority. Maintenance messages are given low priority.

High-priority messages are sent over link 0 and low priority over link 1. However, both priority messages may be sent over a single link. If only one link is in service, the MCS insures that low-priority messages are not lost or delayed too long from being transmitted under high load conditions. The MCS also allows a link to be removed and restored under manual control without losing messages by a " soft switch" function.

All maintenance data link messages sent to the MTSO from cell sites are unloaded at the MTSO into a maintenance hopper. The messages are then dispensed to a specific data link message handler. Maintenance messages are also sent to and received from cell sites that are in a growth state (call processing not active). However, at least one data link between the MTSO and a growth cell site must be in-service. No call processing messages are sent from the MTSO to a growth cell site.

Maintenance messages are transmitted over the data link in specific message classifications:

- Client requested message
- Nonrecovery configuration message
- Recovery message
- Terminal messages.

10.4 Cell Site Generic Subsystems

The cell site generic is a combination of subsystems. These subsystems are illustrated by Fig. 38. Most of the cell site generic is in RAM of the CSC. A copy of everything in RAM is maintained in the MTSO. Portions or all of the MTSO's copy is downloaded to the cell site RAM for initialization or recovery. For more information on the MTSO copy, refer to MTSO Subsystems Unique to System 100 in Section 10. Download and Recovery is located in Section 11.

10.4.1 Operating System for Distributed Switching

Cell site software operates under control of the OS/DS (Operating System for Distributed Switching). The OS/DS is provided by a modified 5ESS™ switch interface module. This operating system schedules terminal and system processes for execution, provides timing, and provides the communication interface between processes within a cell site.

Terminal processes are software created upon request and destroyed upon completion. System processes are software created upon cell site initialization and remain permanent. Each process consists of a program, PCB (Process Control Block), and a stack area.

As an operating system the OS/DS provides System 100 with memory management (PCBs, stacks), process communication, priority execution of processes and timing functions. The software components of an OS/DS message include:

- Receiving process identifier
- Sending process identifier
- OS message type
- Priority of OS message
- Length of text region
- The message of the text region itself.

The OS/DS transmits messages to a specified process on a first-in, first-out basis. However, a process priority may be specified in any order by use of a primitive command. All OS/DS processes are provided with a default priority. A process may execute at a higher priority if specified in the message which activates the process. Timing functions are also provided in the OS/DS by the use of a primitive command.

10.4.2 Cell Site Call Processing

The call processing software at the cell site includes four functions:

- Call sequencing
- Locating
- Overhead word administration
- Data collection.

Call sequencing is performed by the CCP (Call Control Process). There is a CCP for each voice radio in each cell site.

Location measurements and analysis of a call is done by call processing at the cell site. For higher order location measurements, OS messages are sent to the appropriate neighboring cells. After the neighbor cells have measured the signal strength of a call, they return the results to the requesting cell.

An overhead word message is sent out periodically on each forward setup channel. This message contains both system and cell site information that the mobile unit uses for the call processing. The administration of the overhead word includes the updating and transmission of the message.

The data collection function performed by cell site software is an exact extension of the MTSO administrative software.

10.4.3 Cell Site Maintenance

Most maintenance software at a cell site executes under control of OS/DS. The maintenance software is written in the C language with the exception of some system integrity and recovery software which is in 8086 assembly language. The C language makes

use of a stack area for saving registers and variables when control is passed from one function to the next. Maintenance software assures the integrity of the stack area which maintains the integrity of the cell site.

Cell site maintenance software employs the use of three software stack areas:

- OS/DS
- System
- Recovery.

These stack areas correspond to the level of execution of processes in the OS/DS. The OS/DS stack area is used during the execution of a process in the operating system. The system stack area is used during the execution of a program on operational interrupt level. The recovery stack area is used during recovery processing of resets and interrupts. Each reset or interrupt will initialize the recovery stack area to the top. The recovery software is responsible for initializing the OS/DS stack area and the system stack area as a result of a recovery action.

The reset and interrupt recovery software makes use of a hardware reset error counter to provide an escalation strategy if a reset or interrupt recovery fails to complete normally. When a reset or interrupt recovery completes, the reset counter will be zeroed. If the recovery action fails to complete, the counter will be incremented under hardware control. The recovery software can modify the recovery action based on the value of the reset counter.

Another software component of the System 100 cell site maintenance subsystem is the MRA (Maintenance Request Administrator). The MRA makes hardware configuration changes and respective EST (Equipment Status Table) changes. The MRA administers all maintenance requests received either from manual or automatic maintenance software.

10.4.4 Cell Site Integrity

The cell site integrity subsystem is functionally divided into the areas of:

- Initialization
- Integrity monitor
- Overload control
- Audits.

10.4.5 Initialization

Cell site initialization is performed under control of cell site integrity software. Several types of initialization are defined by the integrity subsystem:

- Single structure initialization via demand audits in an initialization mode

- Single process purge
- Transient clear
- Stable clear-total initialization of cell site hardware and software
- Download and stable clear of a cell site.

Each initialization can be triggered by internal cell site recovery actions.

The integrity software will initialize the cell site when unwinding from resets and interrupts. This includes using stacks and aborting any active OS/DS process. A single process purge, transient clear or stable clear is used by cell integrity after a reset or interrupt recovery when control cannot be returned to point of interrupt.

10.4.6 Integrity Monitor

The integrity monitor software assures that cell site programs are not cycling in invalid loops. The cell site integrity monitor subsystem is an extension of the MTSO integrity monitor software, mentioned in previous paragraphs.

10.4.7 Overload Control

The cell site overload control software is included in the cell site integrity subsystem. The overload control insures a minimum acceptable rate of service for low priority processes during peak traffic loads. The overload control runs periodically to detect overload state transitions and to apply control over call processing work.

10.4.8 Audits

The cell site audits perform two basic functions: (1) the detection of invalid conditions, and (2) initialization of software structures or hardware. Invalid conditions would include data inconsistency and lost resources.

Specific audits are provided for each functional software structure at a cell site. For example, there are audits for: call registers, OS/DS process control block memory, etc. This allows system integrity to associate a failing audit and the structure that is in error.

Cell site audits that detect errors initialize the structure or hardware and send a message to the MTSO indicating the error. These audit messages sent to the MTSO will result in a terminal output message. The printout may be inhibited or allowed by the INH or ALW AUDPRINT input terminal message.

The OS/DS audits verify the process control block, timer control block, stack control block, and message control block.

Call control process audits for cell site call processing verify its task control register and counters used to determine voice channel availability. Common control is audited to verify the 200-ms and 3-second timing lists, the POB (Peripheral Order Buffer) queues, and POB free list. Peripheral control is audited to verify scan control tables, reverse messages, setup radio, location radio, and voice radio. Overhead word administration is audited to verify its task control register.

The maintenance audits verify the MRA EST, routine maintenance scheduler run status and terminal process counter, setup radio logical to physical translation, and MRA terminal process counter.

The message communication audit verifies the large and small buffer pool index tables. Also audited is the large and small message buffers.

10.4.9 Cell Site Peripheral Control

The peripheral control software provides a structured software interface for cell site peripheral communication. The peripheral control subsystem executes these functions:

- Low signal level processing
- Input/output request service
- Message routing
- Sequencing peripheral units through a series of steps.

10.4.10 Cell Site Diagnostics

Hardware in the cell site is diagnosed totally by the diagnostic subsystem resident in each cell site. Diagnostic execution can be initiated from:

- Terminal message requests
- Requested as part of an IOUS IOUC restore request from the MTSO
- Routine requests from cell site subsystems
- Fault recovery requests from a cell site
- All forms of diagnostic requests result in an OS/DS message sent to the MRA subsystem. The MRA then makes a request to the diagnostic supervisor to run the diagnostic. All outputs generated from the diagnostic are sent to the data link communication process. After the diagnostic is completed or stopped, the diagnostic supervisor returns control to the MRA. The MRA is responsible for post-diagnostic configuration.

Each cell site diagnostic consists of a list of phases and contains at least a phase 1. All other phases are optional and can be numbered nonsequentially.

Each phase of a diagnostic has an abort routine. This abort routine is responsible for cleaning up conditions set up at the beginning and restored at the end of a phase.

A diagnostic exists for each configurable element at a cell site. Each of these diagnostics is organized into phases that test individual replaceable circuit boards. These diagnostics can be executed either by manual request or automatic software routines and will diagnose the cell site:

- Data link interface
- Cell site controller
- Setup radio
- Voice radio
- Locating radio
- Alarm interface
- Common radio equipment
- Measuring instruments
- Test generator
- Reference frequency generator.

Interactive manual diagnostics of cell site hardware are also available. These diagnostics provide:

- Phase looping
- Segment looping (J loop)
- Pause at specified segment
- Step specified number of segments
- Synchronization.

The interactive diagnostic capabilities are executed by the diagnostic supervisor. All of these diagnostics are acknowledged by an output terminal message upon completion. The interactive diagnostic mode inhibits failing diagnostic printout data other than the first failure unless the RAW parameter is used.

10.4.11 Cell Site Data Base

The data base software at a cell site is composed of translation data. Four types of cell site translation data are:

- Hardware equipage data (rf generator, measuring instruments, frequencies, SATs, etc.)
- Location data (neighbor lists, thresholds, etc.)
- Status data (digital color code, transmitting levels for setup radios, signal strength indicators, etc.)
- AUTOPLEX System miscellaneous information (data common to all cells).

The master copy of this translation data resides in the MTSO. During cell site initialization the translation data is sent to the cell site by the MTSO. When the master

copy is modified, the corresponding cell site data is updated. The data base in the cell site is write-protected. Only initialization and recent change update programs are able to write to the protected memory.

11. MAINTENANCE

11.1 Maintenance Philosophy

System 100 obtains a high degree of system reliability through automated and manual ESS switch-type maintenance. The maintenance philosophy follows standard 1A ESS switch practices for the MTSO and new additional maintenance considerations for the mobile units, cell sites, cell site data links, and cell site voice trunks.

Routine and trouble-clearing maintenance can be automatic (software program) and/or manually performed. Routine maintenance is defined as those activities performed at regular intervals and designed to identify, as soon as possible, potential failure conditions and/or equipment failures. The goal of routine maintenance is to consistently maintain normal system operation. Manual routines/tests are defined by the equipment test list. Trouble clearing is defined by those maintenance activities designed to locate and correct/replace faulty equipment.

The System 100 maintenance philosophy is governed by the fact that a substantial portion of the common control hardware shared by all users is located remotely from the switching office. When it is necessary for manual on-site maintenance, personnel are dispatched from the System 100 maintenance work center.

Maintenance provisions for System 100 include:

- Remote (secure) dialup for cell site maintenance.
- Maintenance circuits and programs that provide for the detection and diagnosis of failures automatically or by manual requests.
- A System 100 overload control system that provides the means to detect, control, and alleviate various system traffic overload conditions.
- An MCC that provides a centralized control point for communicating, controlling, testing, and recording requirements of the system.
- An office alarm system that provides for both system-detected and locally-detected failures.

The maintenance plan for System 100 is supported by:

- Reliable circuits using long-life components and liberal margins between component ratings and actual operating conditions.
- Rapidly replaceable circuits by the use of plug-in units.
- Duplication of equipment throughout the system except where a failure would affect only a small number of subscribers.

- High-speed facilities to switch duplicated equipment in or out of service and to combine system units in various configurations.
- Various types of redundancy (parity bits, one-out-of-N codes, etc.) in the information transmitted between units in order to detect errors.

System 100 maintenance tasks (automatic/manual) include:

- Recent changes
- Initialization of cell site(s) or cell site equipment
- Acceptance
- Audits
- Updating of programs
- Battery plant inspection testing radio frequency and power supply
- Functional tests
- Clearing failing diagnostics
- Clearing alarm condition
- Reconfiguration of cell site(s)/data link(s)
- Recovery.

11.1.1 MTSO Coordinated Maintenance

The MTSO coordinates a number of hardware and software facilities that provide maintenance personnel with primary system information and control capabilities in the areas of:

- Surveillance
- Reconfiguration
- Integrity
- Diagnostics
- Traffic overload
- Recovery
- Testing.

Routine and corrective maintenance may be controlled/monitored from an optional ACC. The ACC maintains the primary system by interfacing the MTSO via the AMAS software package at the ACC. See Section 2 of this practice on the ACC.

11.1.1.1 MTSO Overload Control

The primary objective of overload control is to maintain efficient call processing and stability, provide minimum, graceful service degradation, and maximize throughput.

The overload control system at the MTSO consists of monitors that detect traffic overload conditions and controls that regulate the calls admitted during an overload. An overload condition exists when the call handling capacity of System 100 is exceeded for a sustained period of time.

The MTSO overload control feature will:

- Use existing 1A ESS switch overload control program parameters to limit the rate at which new originations and incoming calls are processed
- Give call originations priority over incoming calls
- Defer nonessential tasks during MTSO minor real-time overload
- Limit mobile originations from a cell site during MTSO major real-time overload
- Allow manual invoking of overload controls on the forward setup channels
- Maintain status of CELL OVERLOAD lamp/key on the system status panel in the MCC
- Provide terminal IO messages of lamp/key status and individual cell site overload status.

The terminal messages are provided for reporting MTSO and cell site overload status information, and to manually invoke forward setup channel overload controls. The CELL OVERLOAD status lamp/key will be lighted when MTSO call limiting control, manual invoked forward setup channel control, and/or one or more cell sites invoking overload control is active.

11.1.2 Cell Site Maintenance

Since a remote cell site is an operational extension of the MTSO switching periphery, it requires the same high-quality maintenance considerations as if it were in the switching office. The cell sites contain, as much as possible, automatic stand alone maintenance functions which are independent of MTSO control.

Cell site maintenance involves both routine and corrective maintenance activities. Cell site trouble clearing is based upon software diagnostic tests run from the MTSO. Interpretation of diagnostic test results is described in the AUTOPLEX System 100 Trouble Locating Manual (AUTOPLEX-TLM).

The cell sites autonomously perform certain error-detection, correction, and quarantine functions. Error checking for valid messages and BX.25 protocol checks are used for each message sent to a cell site from the MTSO. The cell site returns to the MTSO an acknowledgment of any action requested.

Manual maintenance performed at cell site locations can be confirmed by maintenance personnel, while still at the cell site, via portable dial up at each cell site.

11.1.2.1 Cell Site Overload Control

The cell site overload control feature will:

- Respond to MTSO real-time overload by invoking a fixed mobile origination call limit
- Respond to manual requests of overload controls of the forward setup channels
- Defer nonessential work during cell site real-time overload
- Prevent excessive call processing handling of external location requests by limiting location messages
- Periodically update overload status recorded by the MTSO.

11.1.3 Cell Site Data Link Maintenance

The MTSO controls maintenance of the cell site data link (Fig. 28) via the DLMS software. The DLMS is interfaced with the standard 1A ESS switch IOP software for actions taken on the data links. If an IOP is taken OOS, the DLMS will take the associated data link OOS. And, if the data link is to be taken OOS, the DLMS will request the IOP to be removed from service which, in turn, will take the data link OOS.

11.1.3.1 Data Link Diagnostics

The data link diagnostics consist of two parts: (1) the PC tests which are part of the IOP diagnostics and, (2) the data link tests. The PC diagnostics test the TN 82 circuit pack which is located at the MTSO. The data link diagnostic will test the TN 161 circuit pack located at the cell site. The data link diagnostic test also includes testing the transmission facilities connecting the cell site and MTSO (Fig. 28).

Requesting a conditional restore of the data link first causes the IOP diagnostic tests to be run. If the IOP diagnostic passed, the data link diagnostic tests are run. If either the IOP or data link diagnostic fails, the data link will be left OOS.

Requesting a diagnostic causes only the specified IOUC or data link tests to be run, depending on the diagnostic that was requested.

If the IOP diagnostic fails, a " trouble analysis" bit is set in the System 100 channel status tables so that fault recovery and routine exercise programs do not attempt to place the unit back into service. Manual action by maintenance personnel is required to restore the unit to service.

A failing data link diagnostic does not cause any trouble analysis bit to get set in the channel status table. This allows the fault recovery programs to attempt a restoral of the

data link to service in the event of a duplex failure. The reasons for this maintenance philosophy are:

a. The data link diagnostic includes a data transmission test of the facilities. It is quite possible for a facility problem to be of a transient nature. For example, there could be a momentary loss of carrier signal.

b. There is no well defined dividing line between the CSC and the DLI in the cell. For example, the CSC contains programmable controllers which are used to implement the BX.25 message protocol. These controllers are needed to perform any data transmission tests. If an attempt was made to make a dividing line, the data link diagnostic would be less than complete.

11.1.3.2 Data Link State Administration

There is status information about the various parts of the cell site data link kept in several places. First, the PC has its own hardware status register in which it maintains various information about its operational status. This register is referred to as the CSR (Channel Status Register). The 1A PFLR programs have status information for each part of the IOP hardware in the cell site data link. This status information kept by the PFLR is referred to as the IOUS status, IOMP status, and IOUC status. The PFLR status has only two states, in-service or OOS, which is a direct reflection of the state of the data link hardware. The PFLR also keeps other maintenance information about each unit. The MCS-M keeps status information about the current operational state of the PC in order to determine if the PC can accept more work. The internal DLMS data link states are:

- Unequipped
- Active
- Restore
- Remove
- Disconnect
- Out-of-service.

The unequipped state means that the physical hardware does not exist or is in a growth state. The active state means that the link is in service and can be used by MCS-M for sending and receiving data link messages. The restore state means that the link is in the process of being restored to service by software. This is a transient state and requires the MCS-M to hold up message traffic destined for the link so that message sequencing can be maintained during the process of returning message traffic, that has previously been rerouted to the mate link, back to the specified link. This state is only valid if the mate link is in the active state. The remove state means that the link is in the process of being removed from service. This is also a transient state which requires the MCS-M to hold up message traffic destined for the link so that message sequencing can be maintained during the process of taking the link OOS and rerouting its traffic to the mate link. Again, this is only a valid state when the mate link is marked active. The disconnect state means that the link has been restored but communication with the cell has not been established as defined by the link protocol. A data link in this state requires the MCS-M to reroute all message traffic to the mate link. The OOS state means the data link is not available for operational use. This state also requires the MCS-M to reroute messages to the mate link.

The LEAR subsystem, at the cell site, also maintains the data link status. The LEAR has a similar set of states as DLMS. The MCS-C, at the cell site, takes the same actions based on the LEAR status as the MCS-M does based on the DLMS status when sending data link messages.

11.1.3.3 Data Link Removals

Removing a cell site data link from service, either manually or by automatic software routine, will remove equipment from service in the MTSO IOP hardware and the CSC with DLI hardware at the cell site. There are three types of data link removals.

Conditional (Soft) Removal: This is the removing of an active link from service without losing messages, duplicating messages, or receiving messages out of sequence. A conditional removal will be denied when the removal of a data link results in a duplex data link failure. This type of failure removes the entire cell site from service.

Unconditional (Hard) Removal: This is the removing of an active link from service without regard to the loss of message traffic on the data link or the disruption of cell site diagnostic activities on the data link.

Conditional Removal: This is an attempt to remove an already OOS data link. This type of removal request is made in order to delay MACP from sending any requests down an OOS data link. The OOS data link may have a diagnostic or exercise program executing at the cell site and an interruption would cause a failure. The conditional removal request, in this case, delays MACP and allows time for the programs to be aborted instead of failing. The MTSO will print the abort output message.

Any manual request or software routine diagnostic to remove a data link from service will be treated as a soft removal by the system. Either of these two types of requests will be honored only if it will not cause the cell site to be removed from service.

11.1.3.4 Data Link Restorals

A cell site data link is restored to service in a three phase sequence.

1. **Hardware Initialization Phase:** The first phase causes the PC to be initialized by the PFLR subsystem and the cell site data link hardware used by the LEAR subsystem.
2. **The BX.25 Protocol Initialization Phase:** The second phase is performed by the PC and hardware at the cell site end of the data link. After the BX.25 message protocol is used and the PC has established communication with the cell site, the PC sends a service request to the cell site to indicate a successful protocol initialization.
3. **Software Initialization Phase:** The last phase is triggered by the successful completion of phase 2. The MCS-M then calls on DLMS to begin initializing the operational software associated with the cell site data link and transfer message traffic to the data link.

11.1.4 Cell Site Voice Trunk Maintenance

The System 100 voice transmission facilities (speech path) include equipment located both at the MTSO and at the cell site. It is necessary to coordinate maintenance activities that are initiated and carried out at both locations. Software programs at the MTSO maintain overall control of the maintenance of the voice facilities.

Existing 1A ESS switch trunk maintenance procedures are used for the cell site voice trunks. These maintenance procedures will detect faults and sectionalize each fault to one of three portions of the overall speech path:

1. The land facility,

2. The baseband module, or

3. The radio transceiver equipment.

Cell site trunks and/or voice radios are tested by diagnostics for operation and verification of the entire voice facility integrity. These diagnostics are executed automatically, as a result of error analysis, or manually from the terminal or the trunk test panel. The diagnostic phases for cell site trunks are:

- PH 1: Baseband module
- PH 2: Transceiver
- PH 3: RF power amplifier
- PH 4: Receive antenna
- PH 5: Transmit antenna
- PH 6: Voice channel functional test
- PH 7: MTSO trunk circuit relay test
- PH 8: Continuity test (for land facility voice channels only)
- PH 9: Continuity test (for land facility and baseband module of voice channel)
- PH 10: Continuity test (end-to-end which includes voice channel, baseband module, and transceiver).

Diagnostic phases 1 through 6 are controlled by software in the cell site while phases 7 through 10 are controlled by MTSO software.

Voice radio diagnostics may be requested manually by maintenance personnel at the MTSO and may be used to isolate faults in the complete voice path. The cell site controlled portion of these diagnostics are also requested by automatic error analysis at the cell site when errors are detected during cell site call processing.

Comprehensive transmission tests are available, using the MTSO PCI and ROTL. For voice trunk operational tests from the MTSO to the cell site and network interface point, refer to AT&T TOP 231-050-007 (Manual Trunk Test Position) and AT&T TOP 231-050-009 (Trunk and Line Test Panel). For maintenance of the 2-way trunk circuit in the MTSO, refer to AT&T TOP 231-251-000.

11.1.4.1 Voice Trunk State Administration

Overall coordination of the states (both maintenance and traffic) of cell site voice trunks is maintained in the MTSO. This state administration agrees with the existing 1A ESS switch maintenance procedures.

Standard TML (Trunk Maintenance List) processing procedures are used to diagnose the trunk facilities whenever call processing failures in the MTSO indicate a specific trunk. There are additional procedures, however, for cell site error analysis that request cell site radio equipment be diagnosed and/or removed from service. The cell site can request control of a specific trunk. When this request is received, the MTSO places the trunk in a maintenance state as soon as it goes traffic idle. In some cases, it will be necessary for the trunk to be forced idle if it does not go idle within an acceptable time interval.

When radio equipment diagnostics fail at the cell site, a message is sent to the MTSO, requesting that the trunk be removed from service. These requests are of two types: (1) A normal or conditional removal request results when a routine diagnostic fails. The trunk is removed (locked out) only if OOS limits are not exceeded, and (2) When PEAR (Peripheral Error Analysis and Recovery) has determined that a trunk is faulty, a request is made to unconditionally remove the trunk, independent of OOS limits.

11.1.4.2 Routine Diagnostics

The voice radio portion of the voice path diagnostic, executed at the cell site, runs approximately every 24 hours. In the routine mode, the voice radio diagnostic is not linked with the end-to-end diagnostic, which is scheduled at the MTSO.

11.1.5 Network Interface Point Trunk Maintenance

The MTSO is responsible for the maintenance of the trunks connecting to the class 5 NIPs (Network Interface Points). Standard manual and automatic trunk diagnostic procedures are used, with the NIP providing all required test lines. The CAROT (Centralized Automatic Reporting On Trunks), however, is not available for transmission testing of these trunks. Automatic transmission testing is implemented in the MTSO.

11.1.6 Inter-MTSO Data Link Maintenance

Procedures helpful for inter-MTSO data link maintenance are listed as follows. These procedures are performed at the APS.

- Isolate inter-MTSO data link failure (control or tributary End)
- Clear diagnostic failure in inter-MTSO data link
- Remove inter-MTSO data link from service
- Restore inter-MTSO data link to service
- Test control or tributary data set in modem test mode.

For more information on inter-MTSO data link maintenance, refer to AT&T Practice 231-252-000.

11.1.7 Inter-MTSO Trunk Maintenance

Since call address information is normally passed over the inter-MTSO data links, voice transmission maintenance depends more heavily on automatic trunk testing involving responders, and the scheduled trunk diagnostics. In addition, manual testing of inter-MTSO trunks may be performed the same as any interoffice trunk using the MTT (Manual Trunk Test) position. The following items must be considered.

- The trunks have an EML (Estimated Measured Loss) of 0 dBm.
- The trunks may be equipped with 20kHz demodulators if Private Voice and Data is being offered.
- Glare protection is not required.

11.2 Fault Recognition Program

Fault detection, notification, and verification in the System 100 are complex due to the nature of radio systems and specifically to the remote cell sites (i.e., the radio hardware is remote). In order to maintain such a complex system many stimuli are used in identifying the following faults.

- Call failures
- Alarms
- FT (Functional Test) failures
- Diagnostic aborts
- Error counts (at a cell site)
- Software error reports
- Hardware generated error reports.

Fig. 39 illustrates how the MTSO coordinates system maintenance by using cell site trouble stimuli is a feedback control loop.

When a malfunction is detected, call processing is momentarily interrupted by the CC interrupt sequencer which transfers the program control to an appropriate fault recognition program. The occurrence of a malfunction is detected mainly by means of circuits that perform matching, parity checking, or by scan points which monitor circuit conditions. The fault recognition program performs three functions:

- Determines which system unit failed and removes the unit from service.
- Reestablishes an operational configuration of the system.
- Requests an appropriate diagnostic program initiation at some later time and returns control to the call processing programs.

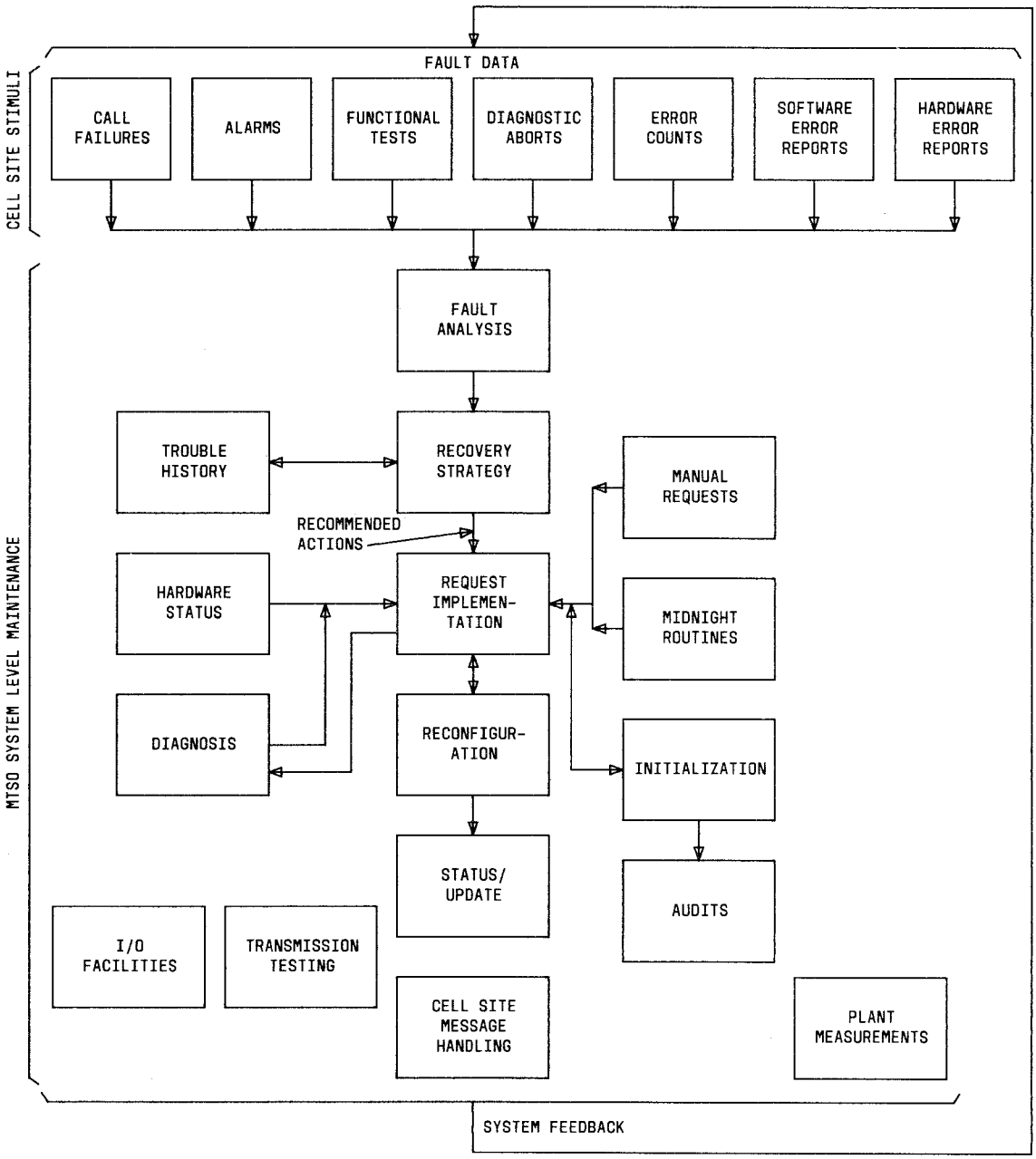


Fig. 39 — Maintenance Overview

11.3 Diagnostic Program

A diagnostic program provides a systematic sequence of tests for localizing a fault to a small number of plug-in circuit packs or other types of replaceable units. The diagnostic program operation does not interrupt normal telephone service, because the diagnostic actions are segmented and interleaved with the processing of calls. In turn, the diagnostic results are printed out on the maintenance channel. With the aid of a trouble-locating manual, these printed results are translated by maintenance personnel into the location and type of unit that requires replacement.

Loop-around facilities are provided on both the cell site data links and cell site trunks. The diagnostic routines make extensive use of the looped facilities to perform both voice and data transmission quality tests. Many of the cell site hardware components contain self-testing circuits. The diagnostics use the self-testing circuits primarily to aid in segmentation of the circuits and fault identification. Fixed voltage and frequency sources for meters and A through D converters are examples of the self-testing circuits in a cell site. The diagnostics periodically verify the operation of these circuits to ensure that these circuits will not incorrectly indicate a failed unit.

11.4 Exercise Program

The exercise program is a low-priority scheduled routine which includes trunk-to-trunk test calls, noise tests, and network map verifications.

11.5 Audit Program

The audit program is a form of exercise program which provides continuous checks for errors in stored data, and reinitializing data found in error. Audits detect software and hardware conditions that would otherwise go undetected. They are not intended to detect faults. They detect stable hardware and software conditions that are invalid.

The MTSO uses the standard 1A ESS switch MACA (Maintenance Control Program for Audits) with additional audits for System 100. Each cell site has audits for its own various functional software subsystems. Refer to System 100 software organization part of this practice for a description of the particular audits of the MTSO and cell site.

Demand audits may be requested of a cell site via input terminal messages. The demand audit allows for all, single, or a set of audits. All requests for audits are acknowledged by an output terminal message to the MTSO when the audit is completed. The terminal output messages contain the number of errors detected by the demand audit. All audits requested in the demand mode inhibits the normal audit output if an error is detected. The PROGRAM OFF NORMAL lamp on the MTSO MCC is updated for each request, and should be lighted during the time an audit is inhibited.

Routine audits in each cell site are automatically executed every few minutes by the cell sites integrity subsystem. These routine audits are also executed during peak traffic periods.

11.6 Recovery

Cell site recovery is an integral part of the maintenance scheme. Recovery action may be directed by the cell site integrity subsystem, located at the cell site, or by the CLSI (Cell Site Initialization) program which is located at the MTSO. When a cell site malfunctions, cell site integrity subsystem directs the recovery action by performing low level initialization. If the CLSI program determines that the cell site cannot recover itself, then the CLSI directs the cell site to perform high level initialization.

The cell site integrity subsystem initializes hardware and/or software processes (MRA, RMS, PEAR, etc.) at appropriate recovery levels. Recovery action is divided into low and high level initialization which may involve a download operation. The initialization levels and related action by the integrity subsystem is illustrated by Table I.

History tables are used to provide a second and third try at different recovery strategies. History tables have a delaying type effect on the integrity subsystem due to the high probability of transient errors common to radio systems. Therefore, the cell integrity subsystem will delay or retard action against the transient type of errors generated by adverse weather conditions, etc.

The cell integrity subsystem receives data input from fault analysis. It also keeps a reset level counter and utilizes an escalation table which specifies the suggested actions to recover the cell site(s). The suggested error response is determined by indexing the escalation table via the reset level counter. When the reset level counter has determined a recovery attempt is necessary, the appropriate cell site initialization level is invoked.

All initialization levels may be invoked automatically. Most levels can be invoked manually. The INIT:CELL input message is the normal method to manually request a software phase level. Software phase level SPP and up may be manually requested. A last resort to manually initialize a cell site is via the CFR:CELL input message. This input message allows manual cell site hardware configuration and is not normally used. The CFR:CELL message forces specific cell site units active, which invokes a hardware level of initialization. Automatic initialization is invoked by the cell sites integrity subsystem detecting a faulty hardware or software condition.

The source types (originations) that invoke cell site initialization levels are:

- MTSO (automatic MTSO initialization phases 4, 5, or 6)
- Terminal input message
- CELL (originated by cell site recovery program)
- CLSI (originated by cell site initialization program at the MTSO)
- AUTO LINK RST (automatic data link restoral)
- MANUAL LINK RST (manual link restoral)
- INH CP/ALW CP REQ (manual inhibit or allow call processing terminal input request - either case invokes TC cell site software phase).

All cell site recovery action is indicated by terminal output messages. For any high level (CLSI directed) initialization, an MTSO report message is printed (REPT:CELL PHASE). These messages identify the software phase level and source type for initialization performed. In this case, when the cell site phase level starts and completes, the REPT:CELL PHASE START and REPT:CELL PHASE COMPL messages are printed respectively. When the cell site returns to normal operation and remains so for a specified period of time, a REPT:CELL RCOVERY SUMMARY message is printed. If the source type was CELL or CLSI for high level initialization, the PHASE START message is followed by a group of cell site postmortem messages. For low level (cell site recovery program directed) initialization, the cell site responds by having the postmortem message group printed. The REPT:CELL PHASE messages are not printed for low level initializations.

TABLE I

CELL SITE RECOVERY INITIALIZATION LEVELS

HARDWARE RESET COUNTER LEVEL	SOFTWARE PHASE LEVEL	ACTION TAKEN BY CELL SITE RECOVERY PROGRAM	CELL SITE POSTMORTEM MESSAGE GROUPS (NOTE)	CELL SITE FAULT	COMMENTS
LOW LEVEL INITIALIZATION					
0	Return to Point of Interrupt (RPI)	Maintenance interrupt or software defensive check (no calls lost).	CSC HW STACK TRACE	Hardware	Returning interrupt.
			STIMULUS STACK TRACE STACK FRAME: (1 or 2)*	Software	Return assert.
1 through 7	Single Process Purge (SPP)	A single process is initialized and repeats if necessary. An excessive amount of SPPs results in an escalation of the recovery action to the TC phase level (normally no calls lost).	STIMULUS STACK TRACE PROCESS PURGE STACK FRAME (1 or 2)* DATA DUMP of PCB (1 or 2)*	Software	Assert which causes SPP.
			CSC HW STACK TRACE PROCESS PURGE STACK FRAME (1 or 2)* DATA DUMP of PCB (1 or 2)*	Hardware	Maintenance interrupt which causes SPP (partial increments of hardware reset counter level).
			CSC HW STACK TRACE PROCESS PURGE STACK FRAME (1 or 2)* DATA DUMP of PCB (1 or 2)*	Hardware	Hardware reset which causes SPP (full increments of hardware reset counter level) This may have been stimulated by software recovery action.

TABLE I (Contd)

CELL SITE RECOVERY INITIALIZATION LEVELS

HARDWARE RESET COUNTER LEVEL	SOFTWARE PHASE LEVEL	ACTION TAKEN BY CELL SITE RECOVERY PROGRAM	CELL SITE POSTMORTEM MESSAGE GROUPS (NOTE)	CELL SITE FAULT	COMMENTS
HIGH LEVEL INITIALIZATION					
8 and 9	Transient Clear (TC)	All processes are reinitialized (stable calls remain — transient calls lost).	CSC HW STACK TRACE STACK FRAME (1 or 2)* RCOVRY SUMMARY	Hardware	Any stimulus which causes high level initialization.
10 and 11	Stable Clear (SC)	All processes are reinitialized (all calls lost).			
12 and 13	Stable Clear and Boot (SC & BT)	All processes are reinitialized. All RAM data and text (instructions) memory is downloaded from MTSO to cell site (all calls lost).			
14 and 15	Stable Clear and Boot and Ignore Errors (SC & BT & IE)	All processes are reinitialized. All RAM data and text (instructions) memory is downloaded from MTSO to cell site. Errors (i.e., hash sums) during download are ignored by cell site (all calls lost).			

Note: Each keyword in a postmortem message group is preceded by REPT or DUMP in the output message. This first message of each group is the lead message and is the only message alarmed in the terminal printout.

* This type of postmortem message consists of two separate output messages and one will always print with the message group. The other message will print depending on the error source and inhibit/allow state of cell site (via terminal input message).

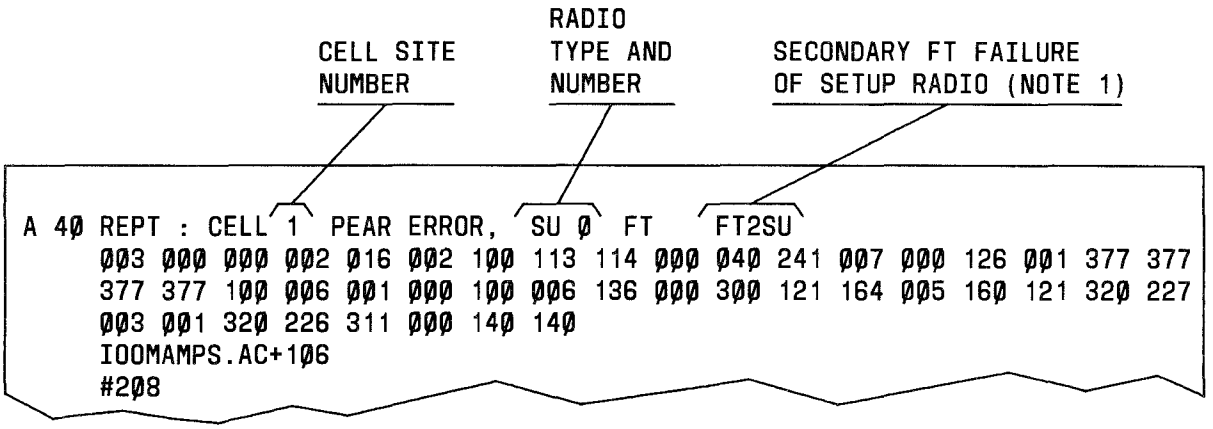
11.7 Functional Tests

Functional tests are run automatically, by internal cell site maintenance software, to determine the operating condition of on-line setup and locating radios. There are three types of FTs:

- Forward setup
- Reverse setup
- Locating.

Functional tests simulate the transmitting and receiving of messages between the cell site setup/locating radios and a mobile unit. The tests include originating and terminating simulated calls to the RF test unit in the control frame, locating the RF test unit, and establishing audio continuity. During these tests, the RF test unit is connected to the cell site antenna system through the use of directional couplers so that the majority of radio frequency equipment is included within the test loop. Failures or high error rates in the tests are considered reliable indicators of cell site equipment problems.

Functional tests are interleaved with normal call traffic every 15 minutes for setup radios and approximately every 15 minutes for locating receivers. When an FT fails, a primary or secondary REPT:CELL PEAR ERROR output message is printed at the MTCE terminal. A primary FT failure indicates a radio at fault, and a secondary FT failure indicates cell site antenna trouble (Fig. 40). The MTSO provides maintenance personnel with the capability to inhibit or allow FTs via input terminal messages. For more information and how to analyze FT failures, refer to AT&T Practice 231-200-020 and AT&T TOP 231-250-010.



NOTE:
1. FT1LC = Primary FT failure indicates location radio
   FT1SU = Primary FT failure indicates setup radio
   FT2LC = Secondary FT failure of location radio indicates receive antenna
   FT2SU = Secondary FT failure of setup radio indicates transmit antenna

Fig. 40 — Example of Secondary FT Failure Output Message

11.8 Software Changes

Changes to System 100 generic include: (1) overwrites for the MTSO standard 1A ESS switch generic, and (2) cell updates for the cell site generic. The overwrite capability is for changing the 1A ESS switch generic of the MTSO and follows standard maintenance procedures. Cell update procedures are used to retrofit or modify the cell site generic and include cell generic updates, cell program updates and possible hardware and/or firmware updates. The cell site generic specification is J-41653. Each cell site generic, issue, or program update change may require changes on both J-41653 and J-6A002B-2. Each 1A ESS switch generic, point issue, or BWM (SCANS) change may require changes on both J-41653 and J-6A002B-2.

Changes to System 100 translations include RC (Recent Change)/Verify. The RC/Verify capability is used to change or identify any translations currently in the MTSO data base and follows standard 1A ESS switch procedures. When recent change procedures modify cell site translation data, the RC/verify subroutine will automatically contact the cell site translation update subroutine at the cell site. The cell site translation update, when contacted, will request the MTSO to send that cell site translators that have been changed.

Changes to System 100 parameter data include the standard 1A ESS switch parameter overwrite and update procedures for MTSO software changes. There is no cell site software data that is specifically called parameters. The data containing the limits of a cell site are built into each cell site translations.

For more information on System 100 software changes, refer to:

- AT&T Practice 231-200-020 (Maintenance Considerations)
- AT&T Practice 231-201-008 (Cell Site Generic and Translation Updates)
- AT&T Practice 231-218-401 (System 100 RC/Verify Message Formats and Associated Implementation Procedures)
- AT&T Practice 231-411-010 (RC Mapping)
- AT&T TOP 231-250-010 (Cell Site Maintenance, Initialization, and Recovery)
- AT&T TOP 231-468-011 (System Recovery and System Operations With APS).

11.9 Download

Download is an operation of sending all or part of the cell generic (not including cell translators) from the MTSO copy to a cell site RAM (Random Access Memory) area. A download is classified as either full or partial. A full download includes the entire cell generic and is requested automatically by the cell site or manually by the INIT:CELL a:BOOT[IE]! terminal input message. A partial download includes portions of the cell generic and is only requested automatically by the cell site.

Download is included as part of several initialization phase levels and is used during a recovery attempt. The cell site integrity subsystem coordinates the recovery action for either automatic or manual source requests of initialization. The integrity subsystem resides in the CSC (Cell Site Controller) ROM (Read Only Memory). If the integrity subsystem determines a download is required, it calls one of its subroutines to request download. The routine that accomplishes this is bootstrap (sometimes called boot). Bootstrap sends the download request to a subroutine in the MTSO called pumpup. After the request from bootstrap is received, pumpup downloads part or all of the MTSO copy over both data links simultaneously and into the RAM of the duplicated CSC. If one of the data links is unavailable, pumpup is forced to download over the remaining mate link.

A partial download is requested when the integrity subsystem determines that checksums of 50 or less memory blocks in the cell generic are bad. A partial download may or may not occur at cell initialization levels SC (Stable Clear) and above. A full download is requested by a manual input message or when the integrity subsystem determines that checksums of more than 50 memory blocks are bad and/or escalates the initialization level during recovery action to the SC plus BOOT and above. Full download only occurs at levels SC plus BOOT and above. A partial download may be requested by bootstrap after a full download. Any SC phase level including a download operation will have the download occur first and then the SC initialization. During the SC, the integrity subsystem calls the cell translation initialization subroutine (which is located in cell generic). This translation routine sends a request to the MTSO for the cell translators to be sent to the RAM area.

A full download is not only used for recovery, but is also used to initialize a new cell site being added to the CGSA (Cellular Geographic Service Area) and/or generic update procedures on an operating cell site. The terminal output message REPT:CELL PHASE START is printed when initialization action is started. A REPT:CELL [FULL or PARTIAL] BOOT STARTED message is printed if and when download is part of the initialization. A successful download is indicated by a REPT:CELL [FULL or PARTIAL] BOOT FINISHED

message. After the initialization sequence is completed by the integrity subsystem a REPT:CELL PHASE COMPL is printed.

12. EQUIPMENT ADDITIONS (MTSO GROWTH)

Office growth is necessary whenever an MTSO must add equipment or equipment frames to increase call handling capacity.

In the MTSO, frames can be added to an operating system using relatively few wired connections. Parameter and translation changes instead of wired logic modifications provide most of the information required by the 1A ESS switch for an added frame.

When new equipment or equipment frames are added to an MTSO, they must be added without an interruption in existing service. Continuous service is possible, primarily due to the duplicate design of the MTSO which permits numerous operating configurations among the duplicated system units. Another aspect of the MTSO that allows growth to be accomplished in a smooth and orderly sequence is the way parameter and translation data defines the equipment. After the added equipment is wired into the system, selected parameter and translation updates can be performed to allow the system diagnostic and fault recognition programs to test the equipment. Testing occurs without interference to call processing, and call processing programs are unaware of the added equipment due to the parameter and translation updates that have not yet been accomplished.

Major objectives during MTSO growth are to minimize the possibility of interruption of or impairment to customer service, to minimize changes required in normal operating procedures of the System 100 company, and to permit allowable margins and overlap of installation effort to provide efficient job schedules and use of the work force. These objectives can best be implemented by providing a safe and well defined environment in which growth frames can be tested without interference to the operating system. The intervals where simplex operation (no duplication) of equipment is required are minimized. Installation procedures are sequenced to allow growth frames to be integrated into the system in small steps that can be easily verified. Several safe stopping points are provided in the growth procedures to allow for unforeseen difficulties that may arise. The procedures are kept simple and explicit and use computer generated data where applicable.

System evaluation tests must be performed prior to and after office growth to ensure that the MTSO is in excellent operating condition. These tests consist of testing the emergency action portion of the MCC to ensure that the system can operate without trouble in all possible configurations of the CCs, CSs, and PSs. Also, the system tests verify that power can be removed and restored to either one of the duplicate buses or equipment units without equipment troubles or adverse system action. An optional test is to execute a manual phase of reinitialization to make sure this function is operational.

Restrictions which must be considered in any office growth are imposed by, dc power requirements, frame interdependencies (point assignments), frame line-up pattern, special wire length limitations, and other similar items. The dc power problem is easily solved, but other restrictions create tasks which are different and unique. Each task raises problems which must be solved individually.

Besides the addition of growth frames, there are other changes which must be accomplished. Translation changes may be performed before the system testing interval, just prior to diagnostic testing, or after testing to complete growth and merge added equipment into service. Parameter changes may be performed just prior to testing or after testing. Junctor redistribution is required when networks are added or when junctor occupancy changes.

If there are a number of frames to be installed, they must be added to the existing machine in a particular sequence. There are also certain procedures which are followed for all frames and other procedures which are executed for only a given class of frames.

13. GLOSSARY

13.1 Terms

The following is a glossary defining some terms used in the System 100.

Abutting MTSOs. All MTSOs (1-15) in a network which exchange pages and set up calls using the CN (Cellular Networking) feature. The network to which abutting MTSOs belong may or may not physically abut.

Abutting System Service. The service provided to CN subscribers that allows for continuous mobile phone service across CGSA boundaries without interruption. this is accomplished by the networking of two or more abutting MTSOs.

Address. A combination of bits that identifies a location in a storage device or equipment unit.

Access Channel. A setup channel used by a subscriber unit to access a system to obtain service. (See reverse setup channel.)

Adjacent Channel Interference. Radio interference caused by the channels on either side of the desired channel in the frequency band.

Analog Color Code. An SAT (Supervisory Audio Tone) transmitted by a cell site on a voice channel and transmitted back by a subscriber unit for the purpose of detecting the capture of a subscriber unit by an interfering cell site and/or the capture of a cell site by an interfering subscriber unit.

Barker Sequence. A bit pattern useful for word synchronization.

Blank and Burst. A means of signaling over a voice channel, whereby the voice is blanked briefly and a burst of data is sent. The data may be sent in the land-to-mobile or mobile-to-land direction.

Bootstrap. A software subsystem, in a cell site ROM, that works hand-in-hand with the pumpup subsystem at the MTSO. The bootstrap subsystem, when required, requests a full or partial download, organizes the cell generic after being downloaded from the MTSO, and completes the download operation. (See **Download** term.)

Busy-Idle Bits. The portion of the data stream transmitted by a cell site on a forward setup channel that is used to indicate the current busy-idle status of the corresponding reverse setup channel.

BX.25 Protocol. This protocol is the AT&T adaptation of the standard format on protocol X.25 formed by the Consultive Committee on International Telegraph and Telephone. The X.25 is an international committee agreement on rules governing the format and timing of software messages to control data movements and correct errors.

Capture. Refers to the phenomenon of FM capture, whereby a signal only a little stronger than another signal dominates the weaker signal after demodulation.

Carrier-Only. Unmodulated carrier.

Cell. A geographical region within which calls are expected to be served by a particular cell site.

Cell Site. An installation containing the radio and control equipment necessary to complete the talking path to the mobile unit.

Cell Site Controller. A module control unit located at a cell site that provides basic control of the cell's internal functions. Portions of the TN-272 circuit pack (one of the many types making up the CSC) are considered to be part of the data link hardware.

Cell Site Data Link. A dedicated wire-line supervision and signaling path for transmitting data messages between an MTSO and a cell site. The components of the cell site data link include the 1A IOP hardware at the MTSO, the data link interface and portions of CSC hardware at the cell site, and the transmission facilities connecting both ends.

Cell Site Face. A specific sector covered by a directional antenna pattern at a cell site.

Cell Site Voice Trunk. Provides a voice wire-line communication path from the MTSO to the cell site. Each trunk is physically connected from the MTSO switching network to a voice radio at a cell site. (Also called speech path.)

Cell Splitting. The process whereby cells are subdivided into smaller cells by adding cell sites, in order to handle increased traffic demand or provide adequate coverage.

Channel. Refers to a pair of frequencies used for mobile communication. One is used for cell site-to-mobile transmission while the other is used for mobile-to-cell site transmission.

Channel Assignment. The process of specifying which voice channel(s) is to be used at each cell site in a CGSA, and a channel(s) so assigned.

Channel Designation. The process of instructing a subscriber unit to tune to a selected channel.

Channel Reuse. The simultaneous use of a single voice channel for multiple conversations by different cell sites in the same CGSA.

Channel Reuse Pattern. Pattern in which assignment of channels are repeated in a CGSA.

Channel Set. A group of channels which will generally be assigned collectively to a cell site.

Co-Channel Interference. Radio interference between channels of the same frequency. (As between different cell sites in a channel reuse pattern.)

Control Channel. A synonym for setup channel.

Control Point MTSO. The first MTSO to receive an incoming call from the DDD or provide an outgoing call to the PSTN (Public Switch Telephone Network), or loop-around trunk becomes the control point for the call duration. Also the control point MTSO will provide the three-port conference switch used for setting up three-way and call waiting calls. In other words, it is the MTSO through which the voice trunk from the NIP (Network Interface Point) for the original call is present. A master MTSO is a Control Point (e.g., the first MTSO in a call that involves two or more MTSOs). It should be noted that the concept of the Control Point MTSO is fixed for the entire call. The role of master and slave MTSO varies as handoff or handback or both takes place.

D/R Ratio. The ratio of the distance, D, between co-channel cell centers and the cell radius, R.

Data Link Interface. An interface, at a cell site, between the transmission facilities and the cell site controller.

Data Set. Equipment for performing the conversion of signals between data processors or terminals (usually digital) into signals suitable for transmission over data links, and for control of the connection.

Decode. To translate information into a form recognizable by the unit receiving the information.

Digital Color Code. A digital signal transmitted by a cell site over a forward setup channel and included in a seizure precursor by the subscriber unit that is used to detect the capture of the reverse setup channel by an interfering mobile unit.

Direct Distance Dialing. The completion of long distance calls by customer dialing from the originating location.

Direct Memory Access Controller. Provides supervisory and control processing interface for data exchanged between the 1A processor and the input/output microprocessor communities.

Directional Antenna. A radio antenna designed to transmit and receive a radio signal more strongly in some azimuthal directions than others.

Directory Number. A dialable number that provides a unique 10-digit address in the PSTN (Public Switched Telephone Network).

Diversity. The ability to improve the quality of the signal on a fading channel by utilizing

the outputs of several decorrelated branches of the communication path.

Download. An operation that moves full or partial cell site generic data from MTSO memory to cell site RAM using functions called pumpup and bootstrap. This is done while other system operations are being performed. Download is required to initially load programs into a cell RAM, reloading cell RAM when it is lost or mutilated, or when a cell is added to a CGSA.

Duplicated Call Store. Memory units containing transient information pertaining to call processing.

Enable Pulse. A pulse that permits a unit or circuit to become operative.

Encode. To code information into a form suitable for transmission from one unit to another.

Error. A malfunction, the symptoms of which cannot be reproduced under program control. (See **Fault** term.)

Fading (Rayleigh Fading). Fluctuations in RF signal level due to multipath propagation interference effects. (Rayleigh refers to a specific model for the resulting signal strength.)

Fanout Board. A buffer, located within an IOP frame, that serves as an interface between the direct memory access controller and PC of a 3B growth unit.

Fault. A malfunction, the symptoms of which can be reproduced under program control. (See **Error** term.)

Flash Request. A message sent on a voice channel from a subscriber unit to a cell site indicating that a user desires to invoke special processing.

File Store System. Disk memory storage system that maintains the nonresident generic program and backup information for all PSs and unduplicated CSs.

Foreign Mobile Service Area. A CGSA other than the assigned home CGSA of a subscriber unit.

Forward Blank-and-Burst. Sending blank-and-burst (see blank-and-burst definition) data from land to mobile.

Forward Setup Channel. A setup channel used from a cell site to a subscriber unit. (See **Paging Channel** term.)

Forward Voice Channel. A voice channel used from a cell site to a subscriber unit.

Functional Test. A test that determines functional operation of on-line setup and/or location radios at a cell site. Maintenance personnel can inhibit or allow a functional test via maintenance terminal input messages INH or ALW.

Group 1 Neighbor List. Those cell sites listed (not a handoff list) in a cell site that are the most likely candidates for a handoff attempt.

Group 2 Neighbor List. Those cell sites listed (not a handoff list) in a cell site that are likely candidates (but less likely than Group 1 neighbors) for a handoff attempt.

Handoff. The act of transferring a subscriber unit from one voice channel to another.

Handoff List. A priority list of available cell site antenna faces for a handoff attempt. This list is formed by the serving cell site after it checks its own locating information along with its Group 1 and, if necessary, Group 2 neighbor lists. The list is then transmitted to the MTSO.

Home Mobile Unit. A subscriber unit which operates in the mobile service area from which service is subscribed.

Home Mobile Service Area. The Mobile Service Area from which the mobile unit subscribes service.

Initialization. A system recovery phase of software, hardware, and/or download operation that takes an existing state (possibly unknown) and sets it to a desired state.

Inter-cell Handoff. A handoff between antenna faces of different cell sites.

Intra-cell Handoff. A handoff between antenna faces of the same cell site.

Interruption. Refers to audio interruption on the voice channel, such as, during handoff or when the user sends a flash request.

Land-Originated Call. See **Mobile-Terminated Call** term.

Line Interface Unit. An input/output unit controller, located within an input/output processor, that interfaces an input/output microprocessor and input/output terminal data links. The LIU (Line Interface Unit) is a circuit board that is available with 1, 2, or 3 input/output ports. This type of input/output unit controller is used in the 1A growth unit, and does not contain a microprocessor.

Locating Radio. A command tunable radio, at a cell site, used exclusively for receiving subscriber unit signals over a voice channel. The received subscriber unit signal is used by other cell site equipment to make signal strength measurements that provide subscriber unit location information.

Master and Slave MTSO. When the serving MTSO initiates the inter-MTSO handoff or handback to the abutting MTSO using the CN (Cellular Networking) feature, the two MTSOs assume a master-slave relationship for the purpose of the handoff or handback. The serving MTSO is the master and the abutting MTSO is the slave. Also, this application applies to inter-MTSO call termination. The role of the master and slave MTSO varies as handoff or handback or both takes place.

Memory Circuit. A circuit which, having been put in some state by an input signal, will remain in that state after removal of the input.

Mobile Identification Number. A 34-bit number which is a binary representation of the 10-digit MIN (Mobile Identification Number) assigned to a subscriber unit.

Mobile-Originated Call. A call originating from a subscriber unit.

Mobile-Terminated Call. A call completed to a subscriber unit (also referred to as land-originated call).

Mobile Telephone Switching Office. A modified 1A ESS switch which serves as the coordinating element for the primary system in the System 100.

Mobile Unit. The full complement of equipment interfacing a user with a cellular system.

Module Control Unit. See **Cell Site Controller** term.

Multipath. A transmission medium in which the signal travels several paths simultaneously.

Multiple Seizure. An instance of two or more subscriber units simultaneously seizing a setup channel.

No Service. The condition a subscriber unit is in when passing through a noncoverage area and therefore cannot originate or receive calls.

Nonresident Program. Portion of generic program that is maintained in APS and brought to the PS only when needed.

Number Assignment Module. A field programmable plug-in module that includes unique information for individual subscriber unit identification.

Omnidirectional Antenna. A radio antenna that transmits and receives energy equally well in all azimuthal directions.

Operational Support System. The OSS (Operational Support System) are Computer based systems that assist operation centers with their tasks; e.g., keeping track of system status, analysis of trouble reports, growth data, etc.

Paging. The process in which the MTSO, via cell sites, sends a data stream over paging channels throughout a mobile service area informing subscribers units when they are receiving calls from the network.

Paging Cell Site. A cell site that performs the paging function in addition to the access function. They can be equipped with setup radio groups 2 and 3 which have transmit capability only.

Paging Channel. A forward setup channel which is used to page subscribers units and send orders. (See **Forward Setup Channel** term.)

Parameter Information. Information contained in the call store pertaining to office equipment and certain hardware and software options.

Parity Bit. A bit attached to a word to make the total number of ones, including the parity bit, odd or even.

Parity Check. A check on the validity of a binary word by determining whether the number of ones in the word is odd or even.

Peripheral Controller. An input/output unit controller, located within an input/output

processor, that interfaces the input/output microprocessor 1 (fanout board) with a cell site data link. The PC (Peripheral Controller) is a circuit board that has 2 IO ports, with each port providing a different data transmission rate. This type of input/output unit controller is used in the 3B growth unit, and each PC contains a microprocessor in order to handle high speed synchronous data link applications.

Portable Mobile Unit. A subscriber unit which is not constrained to operate exclusively from a vehicular installation.

Primary System. The major hardware components, located within the CGSA, which include MTSOs, cell sites, subscriber units, cell site voice trunks, and the cell site data links.

Program. An organized set of instructions used to control system functions.

Program Store. A memory unit that stores the resident generic program.

Protocol. Regulations and codes controlling formatting and timing of messages.

Public Switched Telephone Network. The traffic network that provides public telephone service.

Pumpup. A software subsystem, at the MTSO, that works hand-in-hand with the bootstrap subsystem at a cell site. After a request from bootstrap, the pumpup subsystem will download cell site generic data from the MTSO PS memory to a cell site RAM (Random Access Memory). (See **Download** term.)

Queue. A waiting list of jobs that need to be done.

Radio Link. Radio transmission path between cell site and subscriber unit. The components are the setup channel and voice channel.

Read. To retrieve information from a memory device.

Real Time. Actual time occurrence of an event. A real time control system is one in which information related to a physical process is converted by the control equipment quickly enough so that the outputs obtained are useful in controlling that process.

Redundancy. The use of additional equipment and facilities to continue service when trouble occurs.

Registration. The steps by which a subscriber unit identifies itself to a cell site as being active in the system at the time the message is sent.

Release Request. A message sent from a subscriber unit to a cell site indicating that the user desires to disconnect the call.

Reorder Tone. A low tone interrupted at 120 ipm which indicates that the local switching paths to the called office or equipment serving the called customer are busy or that no toll circuit is available.

Resident Program. That portion of the generic program that is maintained continuously in the program store.

Reverse Blank-and-Burst. Sending blank-and-burst (see blank-and-burst definition) data from mobile-to-land.

Reverse Control Channel. The control channel used from a subscriber unit to a cell site.

Reverse Setup Channel. The setup channel used from a subscriber unit to a cell site. (See **Access Channel** term.)

Reverse Voice Channel. The voice channel used from a subscriber unit to a cell site.

Roamer. A subscriber unit which operates in a mobile service area other than the one from which service is subscribed.

Scan of Channels. The procedure by which a subscriber unit examines the signal strength of each forward setup channel and selects the channel with the strongest signal.

Seizure. Initialization of a cell site's reverse setup channel data receiver; also a subscriber unit's transmission of the initialization pattern.

Seizure Precursor. Pattern of bit synchronization, word synchronization, and digital color code bits sent by a subscriber unit on a reverse setup channel to prepare the cell site to receive a message.

Self-Location. The process by which idle subscriber units, by selecting the strongest setup channel, tend thereby to select a cell site serving the cell they occupy.

Serial Number. A permanently assigned equipment identification number installed in a subscriber unit at the time of manufacture and transmitted to a cell site, during call processing, for identification purposes.

Setup Channel. A channel used for the transmission of digital control information from a cell site to a subscriber unit or from a subscriber unit to a cell site. (Also called control channel.)

Signaling Tone. A 10-kilohertz tone transmitted by a mobile unit on a voice channel to confirm orders, signal flash requests, and signal release requests.

Speech Path. See **Cell Site Voice Trunk** term.

Subroutine. A sequence of programmed instructions to perform a particular function which may be common to several software programs.

Subscriber Unit. A generic name for a full compliment of equipment interfacing a subscriber with a cellular system. This equipment can be mobile or portable. A unit is considered by a serving MTSO as either a home mobile or a roamer.

Supervisory Audio Tone. One of three tones in the 6-kilohertz region that are transmitted by a cell site and returned by a subscriber unit. (See **Analog Color Code** term for SAT usage.)

System Code. A digital identification signal transmitted on a setup channel which is used to detect the capture by a cell site of a subscriber unit operating in a foreign mobile service area.

System Identification. A digital identification associated with a cellular mobile service area; each equipped area is assigned a unique number.

System Operator. The entity that makes available access to the cellular network.

Temporary Memory. A read and write memory which contains information that can be changed by the internal circuitry of the system.

Time-Shared Circuit. A common circuit whose services are used by a number of circuits during separate time intervals.

Transceiver. A transmitter-receiver paired radio capable of transmitting and receiving simultaneously.

Translation. A software operation used to obtain additional information, via translators, of a known piece of information.

Translations. Static information contained in the unduplicated CS pertaining to the individual lines or trunks. It is made up of about 75 to 150 translators, and may be used, for instance, to convert a directory number into an equipment location, to derive the class of service, etc.

Translator. A portion of the translations where information is obtained for a particular translation. A translator includes a group of software tables which contain data for the type of translation being performed.

Transmission Facilities. An element of physical telephone plant that forms a direct telecommunication path between stations and/or switching systems. Examples would be a multipair cable, a coaxial cable system, or a microwave radio system.

Trouble. A fault or error that causes a deviation from normal system operation.

Unduplicated Call Store. Memory units used to contain office data, both parameter data and translation data.

Unipolar Pulses. A pulse of one polarity only, either positive or negative.

Vehicular Mobile Unit. A subscriber unit operating from a vehicle with an exterior antenna system.

Voice Channel. A radio frequency channel on which a voice conversation occurs and on which brief digital messages may be sent from a cell site to a subscriber unit or from a subscriber unit to a cell site.

Voice Channel Selection. The process by which one of the channels assigned to a cell site face is chosen for a particular call.

Word. A set of characters associated to express system information. (The term word may be prefixed by an adjective describing the nature of the characters, such as a binary word.)

Write. To insert information into a memory device.

Network Interface Point. A class 5 switching office that provides an interface point between System 100 and PSTN.

13.2 Abbreviations and Acronyms

The following is a definition of abbreviations and acronyms used in this AT&T practice.

ACC	System 100 Control Center
ADMS	System 100 Data Management System
ADS	Auxiliary Data System
AFAC	System 100 Facility Administration Center
AIOD	Automatic Identified Outward Dialing
ALIT	Automatic Line Insulation Test
AMA	Automatic Message Accounting
AMAS	System 100 Maintenance and Administration System
AMT	Auxiliary Manual Test
AMWC	System 100 Maintenance Work Center
APEC	System 100 Planning and Engineering Center
API	Attached Processor Interface
APS	Attached Processor System
ASW	All-Seems-Well
AU	Auxiliary Unit
AUB	Auxiliary Unit Bus
CAROT	Centralized Automatic Reporting On Trunks
CB	Code Blocking
CC	Central Control
CCP	Call Control Process
CCS	Hundred Call Seconds
C&D	Control And Display
CGSA	Cellular Geographic Service Area
CI	Carrier Interconnect
CMT	Combined Miscellaneous Trunk
CPD	Central Pulse Distributor
CS	Call Store
CSC	Cell Site Controller

CSR	Channel Status Register
DCA	Dynamic Channel Allocation
DCS	Duplicated Call Store
DDD	Direct Distance Dialing
DLCS	Data Link Communication Subsystem
DLI	Data Link Interface
DLMS	Data Link Maintenance Subsystem
DMA	Direct Memory Access
DMAC	Direct Memory Access Controller
DN	Directory Number
D/R	Distance to Radius
DS	Data Set
DSCH	Dual Serial Channel
DUC	Data Unit Controller
DUS	Data Unit Selectory
ECMP	Executive Control Main Program
EIA	Electronic Industries Association
ERSL	Expanded Roamer Service List
ERSNL	Expanded Roamer Serial Number List
EST	Equipment Status Table
FM	Frequency Modulation
FML	Fixed Message Length
FP	Feature Package
FSN	Fraudulent Serial Number
FT	Functional Test
IC	Inter-LATA Carrier
ICAL	Incoming Call Digit Analysis Program
ID	Identification
IM	Interface Module
INC	International Carrier
IO	Input/Output
IOC	Input/Output Channels
IOMP	Input/Output Microprocessor
IOMTRANS	Input/Output Processor Member Number Translator
IOP	Input/Output Processor

IOT	Input/Output Terminal
IOU	Input/Output Unit
IOUC	Input/Output Unit Controller
IOUS	Input/Output Unit Selector
JGF	Junctor Grouping Frame
JSC	Junctor Switch Circuit
LATH	Look Ahead Trunk Hunt
LEAR	Data Link Error Analysis and Recovery
LIU	Line Interface Unit
LOC	Local Maintenance Channel
LSA	Limited Service Area
LTD	Local Test Desk
MACA	Maintenance Control Program for Audits
MACP	Maintenance Control Program
MCC	Maintenance Control Center
MCU	Module Control Unit
MCS	Message Communication Subsystem
MDF	Main Distributing Frame
MS	Message Service
MHD	Moving Head Disk
MIN	Mobile Identification Number (NPA-NXX-XXXX)
MOD	Model
MORG	Mobile Originated Call Processor
MORINT	Mobile Originated Call Interface
MOS	Metal Oxide Semiconductor
MRA	Maintenance Request Administrator
MT	Miscellaneous Trunk
MTCE	Maintenance
MTSO	Mobile Telephone Switching Office
MTT	Manual Trunk Test
MUIT	Mobile Unit Intercept Tone
MUT	Miniaturized Universal Trunk
NIP	Network Interface Point
NPA	Numbering Plan Area
OSS	Out-of-Service

OS/DS	Operating System for Distributed Switching
OSS	Operational Support System
PAS	Project Accounting Service
PBX	Private Branch Exchange
PC	Peripheral Controller
PCB	Process Control Block
PCI	Program Controlled Interrogator
PEAR	Peripheral Error Analysis and Recovery
PFLR	Processor F-Level Recovery
PM	Plant Measurement
PMES	Plant Measurement End-of-Month Summary
POB	Peripheral Order Bus
PPI	Processor Peripheral Interface
PS	Program Store
PUB	Peripheral Unit Bus
RABO	Roamer Access to Business Office
RAM	Random Access Memory
ROTL	Remote Office Test Line
RSEC	Routing Service for Emergency Calls
RSL	Roamer Service List
RSNL	Roamer Serial Number List
RSNR	Roamer Serial Number Registration
SAT	Supervisory Audio Tone
SC	Speed Calling
SCCS	Switching Control Center System
SD	Signal Distributor
SP	Signal Processor
SSD	Supplementary Signal Distributor
ST	Signaling Tone
STT	Supplementary Trunk Test
STCR	State Table Controller
TDF	Trunk Distributing Frame
TDRD	10-Digit Roamer Dialing
TGC	Trunk Group Control
TIC	Trunk Interconnections Circuit

TLM	Trouble Locating Manual
TLN	Trunk Link Network
TLT	Trunk and Line Test
TML	Trunk Maintenance List
TNN	Trunk Network Number
TSC	Trunk Switch Circuit
TSPS	Traffic Service Position System
TTY	Teletypewriter
TRC	Tape Unit Controller
UCS	Unduplicated Call Store
UT	Universal Trunk
VML	Variable Message Length
ZO	Zone Office

14. ISSUING ORGANIZATION

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The AT&T Documentation Management Organization