Bell Communications Research

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LINE AND NUMBER ASSIGNMENT OVERVIEW NETWORK ADMINISTRATION DMS 100/200® SWITCHING SYSTEMS

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1. GENERAL

1.01 This practice provides the network administrator with an overview of the line and number considerations for the DMS 100/200 Switching Systems, with references to more detailed information where applicable. Controlled assignment is necessary to ensure that equipment utilization is in accordance with design specifications and meets service criteria. The technical and administrative restrictions which affect line and number assignment are described herein. Loading plans and load balance plans are also described since they are the basis for the assignment process.

1.02 When this practice is reissued, the reason(s) for reissue will be given in this paragraph.

NETWORK ADMINISTRATION RESPONSIBILITIES

1.03 Network Administration is responsible for ensuring that the Loop Assignment Center (LAC) has adequate line equipment to meet service demands at all times, and for providing adequate telephone numbers to the Business Service Center (BSC) and the Residence

Service Center (RSC). Only single lines should be provided on the list to the BSC. Requests for more than one telephone number should be handled by telephone. In a manual environment, lines available for assignment are provided by means of lists. Mechanized selection systems provide direct selections based upon controls input by the network administrator. Line equipment for complex classes of service (e.g. Integrated Business Network (IBN), and Multi-Line Hunt (MLH)) are provided under stringent controls and must be made directly by the network administrator. In a mechanized environment, Network Administration is responsible for controlling the assignment process (i.e. establishing and updating the operating parameters of the system) instead of physically making the assignments.

1.04 Network Administration is also responsible for preparing and implementing a detailed loading plan. These responsibilities exist at both the wire center and traffic unit levels. Network Administration must control the relative load in multi-entity wire centers. For example, it may be desirable to maintain a constant load in an electromechanical office while directing new growth to a DMS office. Also, Network Administration must assure that the rules of spread and balance are adhered to within the individual traffic units.

2. PLANNING LOAD BALANCE

2.01 There are two levels of load balance planning in a multi-entity wire center - the wire center level (loading plan) and the traffic unit level (load balance plan). The loading plan is necessary to ensure adequate loading of all traffic units within a multi-entity wire center. The load balance plan is necessary to load each unit within a traffic unit according to the anticipated usage of each class of service in the office. For more detailed instructions on preparing loading plans see Practice 780-200-018.

2.02 Inherent in the design of an office is an assumed loading configuration at the peak of the engineering interval. The loading plan is a logical plan for spreading customers between switches within a multi-entity wire center in the central office. It is implemented to ensure a close adherence to original design objectives.

2.03 A load balance plan is necessary for a new, growth, or replacement office and must be maintained on an ongoing basis throughout the office's life. Its purpose is to provide guidelines for achieving objective loading across all loading divisions and load units. The ultimate goal is maximum utilization of available equipment while providing an objective grade of service to all customers.

2.04 After the plans are finalized, the network administrator should monitor the actual assignment implementation. With a mechanized assignment system, adjustments to the operating parameters of the system are usually necessary in order to adhere to the plan. After cutover, the assumed loading plan input values should be replaced with actual data. This data is derived from actual line counts and subscriber line usage studies. With this data it will be possible to determine whether any adjustments should be made to the original load balance plan.

2.05 Adherence to the loading plan should be reviewed by the network administrator on a monthly (or as needed) basis. Actual growth should be compared with forecasted growth. The loading plan should also be reviewed in conjunction with the annual capacity review for possible changes. Discrepancies between the loading plan and actual loading must be reviewed and reconciled with traffic engineering and commercial forecasting on an ongoing basis. In extreme cases, adjustments may be necessary to meet the needs of particular classes of service and custom calling features.

3. LOAD BALANCE

3.01 Load balance is the set of procedures which allow a network administrator to take advantage of the total capacity available in an office while still meeting objective service levels. An effective loading plan is the key to

achieving good load balance. Once the plan is developed, loading procedures must be developed for the daily assignment job.

3.02 Special attention should be given to uniform distribution of the following services:

- Customers with high call volume services such as 800 Service, OUTWATS, and data ports.
- PBX and multiline hunt lines in order to spread them across all frames by customer group.
- Customers with special features such as call waiting, remote call forwarding, or conferencing capabilities which might extend their holding times.
- Coin classes of service.

3.03 When the usage measurements indicate problems, corrective action should be taken. This action should be limited to transferring the load out of "hot spot" units into underloaded units. "Warm spots" should be unloaded through attrition (disconnects). The amount of load transferred should be sufficient to reduce loading to under the desired threshold.

3.04 The network administrator should attempt to transfer (considering the class of service spread), the highest usage lines and/or trunks, thereby minimizing the number of moves. In the case of lines, the choice should be made on the basis of class of service until individual line usage measurements are made available.

4. MAIN DISTRIBUTING FRAME CONSIDERATIONS

4.01 In the past, line assignments have been made on a completely random basis. Random assignment of lines is unsatisfactory because it increases jumper lengths and congests Main Distributing Frame (MDF) levels, shelves, or troughs. A mechanized line assignment system (i.e. COSMOS) will help reduce this congestion.

4.02 The objective of preferential assignment is to reduce the number of long jumpers to the extent possible while still achieving good load balance. This is accomplished by segregating the MDF into assignment zones. These zones are the preferred areas for assignment of selected cable pairs and line equipment. For preferential assignment to be successful, sufficient line equipment for each class of service must be available for assignment within each zone.

Note: The concept of zones in making short jumper assignments is used for all types of frames. Zones are established using some type of natural boundary on conventional frames. For example, the zones on the DMS modular DMF are the two half verticals on either side of a vertical wire trough. Regardless of the type of frame, any cross connection that lies wholly within one zone is a short jumper.

4.03 It is recommended that a frame congestion and control review committee be established with members from the loop assignment center, network maintenance /c.o. operations, and network administration. The function of this committee would be to monitor frame activity to ensure good load balance and the short jumper concept are maintained.

5. NETWORK MODULE

5.01 The DMS 100/200 switching network is a solid state, four-wire, four stage, digital network. The Network Module (NM) is the main component of the network (see Figure 1). Speech paths are established and maintained through it for the duration of the call.

5.02 The NM is designed for reliability through duplication. Each NM is broken down into Plane 0 and Plane 1. Duplication is on a channel basis. Both planes are active and work in a load sharing mode. If an error condition is detected in an active channel, the call is switched to the same channel in the other plane without interrupting the call.

5.03 Each NM has two sides; Receive (side A) and Transmit (side B). Side A receives

inputs from the Peripheral Modules (PM) and passes switched outputs to side B of another (or the same) NM. Side B of another (or the same) NM transmits switched outputs to the PMs.

6. LINE EQUIPMENT

GENERAL

6.01 A DMS 100 local central office has a capacity of 1500 to 100,000 subscriber lines. A DMS 200 toll central office has a capacity of 400 to 60,000 trunks of various types. A DMS 100/200 combination local and toll central office has a capacity within the ranges of a DMS 100 office plus a DMS 200 office. The specific mix in a DMS 100/200 office is determined by the traffic and equipment engineers.

PERIPHERAL MODULES

6.02 Lines and trunks interface with the network module (NM) via Peripheral Modules (PM). Currently there are two "families" of PMs - the old peripherals and the new peripherals. The main difference between the two families of peripherals is that the new PMs use a smaller type of line card (LC). Both types of PMs can interface with the same NM and coexist in the same office.

A. Old Peripherals

6.03 Subscriber lines interface with the network module via a type of PM called a line module (LM) and can accommodate up to 640 2-wire subscriber lines. The LM is connected to the NM via two, three, or four 4-wire duplicated speech links, each of which carries 30 2-way speech channels and 2 message channels. The number of speech links used is a traffic dependent function. The LM concentrates 640 lines onto 60, 90, or 120 speech links.

6.04 The LM is split up into four shelves of five Line Drawers (LD) per shelf. Each drawer can hold up to 32 Line Cards (LC); the type and number is dependent on class-of-service requirements. In addition, one slot is reserved for test purposes, leaving 639 assignble slots.

6.05 Two LMs are bolted together next to each other to form a Line Module Equipment (LME) frame. Looking at the LME from the front, the left LM is 0 and the right LM is 1. The 20 Line Drawers in each LM are numbered 0 (bottom left) to 19 (top right), and the Line Cards in each drawer are numbered 0-31. Since each draw holds 32 LCs, each of the 1280 lines in a LME can be identified as follows:

LME FRAME	LME BAY	LD	LC
#	0/1	00	00 (Test Card)
#	0/1	00	01-31
#	0/1	01-19	00-31

6.06 The Remote Line Module (RLM) is a double bay frame of standard DMS size which interfaces 1280 lines (640 per module) at a remote location. Each RLM comes with a controller (a mini Central Processing Unit (CPU)), one Frame Supervisory Panel (FSP) and 20 LDs. Basically a RLM is similar to the LME in the host office except that it is located at a remote location.

6.07 The capacity of the RLM is reduced with the selection of certain options or configurations, and in such a case would be reduced to interfacing 608 lines per RLM (or 1216 per frame).

6.08 The "old family" of PMs uses two types of Line Cards - Type-A (NT2X17AB) and Type-B (NT2X18AC and NT2X18AD).

6.09 Type-A Line Cards provide the following features:

- Single-party bridged ringing
- Two-party divided ringing
- Four-party fully selective ringing
- Dial-Pulse (DP) or DTMF operation
- Frequency-selective ringing
- Compatible with loop extenders, repeaters, and analog concentrators

- Temporary DP Coin Service e.g., shortage of B cards, special events.

6.10 Type-B Line Cards provide the following features:

- Single-party bridged ringing
- Dial pulse operation
- Compatible with loop extenders, repeaters, and analog concentrators
- Ground start or loop start operation
- Toll diversion
- Hotel/Motel services.

Type-B Line Cards (NT2X18AC only) also provide additional subscriber line features as follows:

- Two-party divided ringing
- Four-party fully-selective ringing (traffic limited)
- Multi-party coded ringing
- Frequency-selective ringing
- Coin dial-tone-first
- Coin semi-post-pay.

Type-B Line Cards (NT2X18AD) also provide additional subscriber line features as follows:

(a) Two-party AC/DC superimposed ringing

(b) Multi-party AC/DC superimposed and frequency ringing (bridged or divided)

(c) Coin dial-tone-first with or without +48 V on tip (loop start)

(d) Coin semi-post-pay (loop start)

(e) Compatible with single-slot or multi-slot coin stations

(f) Coin-first operation with or without +48 V on tip (ground start)

(g) Compatible with key-telephone systems (1A2 or equivalent)

(h) Compatible with Foreign-Exchange (FX) lines

(i) Compatible with bridge lifters

(j) Compatible with Telephone Answering Service (TAS) and recordings.

B. New Peripherals

6.11 There are six* new PMs (some may not yet be available) which interact to connect subscriber lines to the NM. They are the:

- Line Concentrating Module (LCM) - Replaces the LM. Interfaces with the NM via the Line Group Controller.
- Line Group Controller (LGC) - Provides the interface between the NM and the LCM. Also between the NM and the new remotes.
- Line Trunk Controller (LTC) - Serves same purpose as LGC but interfaces with trunks as well as lines.
- Remote Line Concentrating Module (RLCM) - Replaces RLM.
- Remote Switching Center (RSC) - Provides local switching capability at a remote location for up to 5760 lines.
- Outside Plant Module (OPM) - Similar in function to a RLCM, but housed in environmentally controlled cabinet for roadside placement.

While the network administrator should be familiar with all of these PMs, only the LGC, LCM, and RLCM will be covered here.

6.12 The LGC serves as the interface between the LCM, the RLCM, and the NM. The LGC is connected to the NM via 3 to 16 DS-30 links. The LGC is connected to the LCM via two to six DS-30A links and to the RLCM via two to six DS-1 links.

6.13 The LCM is half the size (with the same capacity-640 lines) as the LM. Each LCM

* There are additional PMs dedicated to trunks which are not covered here.

is divided into two shelves with five Line Drawers (LD) per shelf. Each drawer can hold up to 64 of the new smaller Line Cards (LC). It is possible to accommodate multi-slot cards and to assign any mix of line cards (and service) to the same drawer.

6.14 Two LCMs are bolted together one on top of the other to form a Line Concentrating Equipment (LCE) frame. Looking at the LCE from the front, the bottom LMC is 0 and the upper LCM is 1 (See Figure 2). The ten drawers in each LCM are numbered 00 (bottom left) to 19 (top right). (Each drawer is broken up into two sections of 32 LCs per section.)

6.15 The Remote Line Concentrating Module (RLCM) is connected to the LGC in the host office by from two to six DS-1 links. The RLCM can interface up to 640 subscriber lines. Basically the RLCM is similar to the LCM in the host office except that it is located at a remote location.

6.16 The "new family" of PMs uses a new smaller series of line cards — Type-A (NT6X17AA), Type-B (NT6X18AA and NT6X18AB), Type-C (NT6XZ1AA), Type-D (NT6X71AA), and Type-E (TN6X19AA, NT6X20AA, and NT6X23AA).

6.17 Type-A Line Cards provide the following features:

- Single-party bridged ringing
- PBX loop start
- Superimposed ringing
- Frequency Selective ringing (bridged ringers).

6.18 Type-B Line Cards provide all of the features of a Type-A card plus:

- Two-party divided ringing
- Multiparty coded ringing
- PBX ground start
- Hotel/Motel
- Coin-prepay and semi-post pay
- PBX toll diversion
- Frequency Selective ringing (divided ringers without +48V interface).

Type-B Line Cards (NT6X18AB) provides all of the above features and is used where coin pad disabling is required. The NT6X23AA Power Converter Card is associated with the NT6X18AB card and is required to supply +48V power for coin stations requiring +48V such as Mechanized Calling Card Service (MCS). It occupies two positions, 00 and 16.

6.19 Type-C Line Cards provide Integrated Business Network (IBN) service.

6.20 Type-D Line Cards provide data service to lines equipped with DMS-100 data units using time compression multiplexing (TCM) transmission. The NT6X71AA cards occupy two card positions (vertically) so the drawer capacity is cut in half.

6.21 Type-E Line Cards provide message waiting features.

C. Responsibilities

6.22 The provisioning of B-Type Line Cards is complicated by a number of factors such as:

- Ground start requirements are difficult to determine precisely from the General Planning Forecast (GPF).
- The B-Type Line Card is more expensive than the A-Type Line Card.
- Overprovisioning of B-Type cards could create a buildup of A-Type services on B-Type cards which would have to be cleared periodically by line transfers.
- The overall objective of the traffic engineer and network administrator is to avoid limiting the machine on B-Types at the same time minimizing the quantity of A-Type Services on B-Type cards.

6.23 In order to meet the objective, the network administrator should:

- Develop a forecast of B-Type requirements on a year-by-year basis.
- Track B-card usage monthly and notify the equipmemt engineering group of potential shortages.
- Keep the number of B-cards assigned to A-Type services to a minimum.
- Provide network maintenance with a forecast of E-CUTS for re-claiming B-cards.

7. ASSIGNMENT CONSIDERATIONS

7.01 In switching systems such as DMS 100/200 switches, a quantity of telephone numbers and line equipment are excluded from the total available to customers. These items are separated into several categories which are defined subsequently.

A. Telephone Numbers

7.02 There are no restrictions inherent in the DMS 100/200 switch that restricts the assignment of telephone numbers. However, there are other considerations as described in this BR and in Practices 780-103-010 and 780-200-014.

B. Utilization Plans

7.03 After the capacity is defined for a DMS traffic unit, the network administrator should develop a directory number utilization plan. The following guidelines are provided for the preparation of this plan:

- Determine any reserved number requirements, i.e., IBN.
- Determine the main station equivalent of the limiting item.
- Determine the number of directory numbers to be assigned per NXX at exhaust date.
- Prepare projections of assignable directory numbers by NXX for at least four future intervals.

7.04 Before finalization, the utilization plan should be reviewed with traffic engineering, network maintenance, LAC, and marketing. After the plan is mutually agreed upon, the network administrator should supervise the actual assignment implementation. The number assignment list (in offices not equipped with mechanized line assignment) is prepared as follows:

- Refer to the appropriate interval on the directory number utilization plan and the last line count to determine the NXX(s) to be used for preparing the number assignment list.
- Select the required number of assignments from the number book for the appropriate NXX(s) and note this in the records.

C. Aging

7.05 Directory numbers are considered available for assignment when certain aging requirements have been met or when intercept studies have been made to determine candidates for accelerated reassignment. The guidelines for number aging are found in Practice 780-200-014, Determination of Line and Number Requirements.

7.06 Quite often, a well known and frequently called number is considered unassignable for an indeterminate period, and is not reassigned without a study. It is desirable that arrangements be made locally for customer services to advise network administration when a disconnected number might require special handling, e.g., numbers that have served a taxi company, a large store, a public service, etc. or numbers listed incorrectly in the directory.

7.07 Blocks of numbers should be reserved for directory number utilization plans and area transfers. Numbers should also be reserved in order to efficiently serve series completion, and IBN customers. The marketing group should be helpful in determining how much series completion and IBN numbers need to be planned for.

7.08 The Multi-Line hunting feature offers an excellent opportunity to conserve number assignments and reservations. Unless a customer's functions are identified by individual

directory numbers, a 7-digit number is not required for each line of a Multi-Line Hunt Group (MLHG). This feature becomes especially important whenever panel or step-by-step machines are replaced with a DMS for it may permit the release of 7-digit numbers for other assignments since only the pilot line is assigned a directory (or telephone) number. Marketing should obtain the customers' concurrence before releasing directory numbers for this reason.

7.09 A NXX code should not be dedicated to an IBN customer unless the customer requires or is expected to reach the administration maximum code fill within the life of the existing code universe. Otherwise, the IBN customer should share a code with other IBN/Plain Old Telephone Service (POTS) customers. When opening a new NXX code, it is recommended that POTS customers first be assigned numbers in the 0000, 1000, 8000, and 9000 groups, thereby reserving the remaining thousand groups for IBN extension numbers. Centrex extensions are normally not assigned in these thousand groups because it is recommended that the 0, 1, 8, and 9 digits be used for accessing the IBN attendant, special services, a Common Control Switching Arrangement (CCSA), and local exchange network, respectively.

7.10 The impact of area transfers on number reservation is less involved. When an area transfer is scheduled or anticipated, the network administrator should ensure that a sufficient quantity of directory numbers are available to accommodate the transfer.

D. Series Completion

7.11 Series completion, which hunts over directory numbers, is available for POTS customers with less than ten lines. This arrangement is available for PBX customers with five or less lines and not having special features such as stop-hunt or random make busy.

7.12 It is recommended that series completion should be used when initial translations are prepared. However, it is not recommended that a PBX customer with series completion be converted to MLH because a sixth line is added after initial assignments have been made. The assignment of a make-busy key to a line in the group would require conversion of the series completion group to a MLHG.

E. Line Hunting

7.13 The DMS switch offers the following line hunting arrangements.

- Directory Number Hunting (DNH)
- Multi-Line Hunting (MLH)
- Distributed Line Hunting (DLH)
- Bridged Night Numbers (BNN).

The maximum number of lines in a hunt group is 256. The maximum number of hunt groups is 8192.

7.14 The DMS 100/200 switch offers two types of hunting within a hunting group, regular and circular.

- Regular (or Sequential) Hunt is an arrangement in which hunting begins with the Start Hunt Terminal Number and continues sequentially through the last terminal number in the group.
- Circular Hunting is a form of station hunting in which the switching equipment hunts over all stations in a DN hunt group regardless of the starting point. The call is completed to the first idle line in the group.

7.15 Directory number hunting is usually limited to 15 lines, each having its own directory number. It is accessed by dialing any DN in the group and will hunt either sequentially or circularly depending upon the option chosen. Multi-line hunting is usually limited to 16-30 lines with a DN assigned to the first line only. Hunting is always done sequentially. Distributed line hunting has only a pilot DN. Hunting always starts at the line immediately following the line that was selected on the previous call. Hunting is done using the circular option so that calls are distributed equally throughout the group. Large hunt groups are

usually assigned to DLH.

7.16 Each hunt group is assigned an arbitrary 3-digit group number ranging from 001 through 999. Lines associated within a group are identified by a 3-digit terminal number, 000-999 are the valid entries.

7.17 Bridged right number hunt groups are used by customers who need to receive all of their incoming service, via their listed telephone number (TN), require only one TN assignment. However, if the customer needs to use any of the trunks to dial selected stations (via night service connections at the PBX switchboard), additional DN assignments are necessary. When DNs are required, they do not need to be assigned in consecutive numbering sequence even though they may be associated with consecutively numbered terminals.

F. Integrated Business Network (IBN)

7.18 IBN integrates voice and data services to form a total business communications system. Up to 4065 IBN customer groups can be assigned to any one DMS 100 switch.

G. Line Equipment

7.19 Any class of service can be assigned any DMS line equipment location equipped with the proper line card. There are other administrative restrictions and requirements that limit the availability of line equipment. These restrictions and requirements are covered in this part and in Practice 780-200-014.

H. Administrative Restrictions

7.20 Some of the administrative restrictions for the DMS switch unusable lines are:

- Reservations and Assignments over 30 days
- Plant test lines.
- Defective line equipment
- Other local administrative requirements.

I. Ground Start Lines

7.21 Most customer lines are loop-start lines that generate an origination by closing the path between the tip and ring at the station set (forming a loop). Scanning is done at the central office by applying a voltage between the tip and ring and sensing the loop current flow produced by the customer line origination.

7.22 Ground Start lines (e.g., coin-first coin phones and PBX-CO trunks) generate an origination by grounding the ring conductor at the station set. Scanning is done at the central office by applying a voltage with respect to ground on the ring conductor and sensing the current flow in the ring conductor produced by the customer line origination. Since certain PBX's interpret a ground on the tip conductor to mean something else (disconnect, etc.), the tip conductor at the Central Office is disconnected during scanning on Ground Start Lines. The tip conductor is disconnected under software control in the DMS 100/200 switch therefore, any line equipment number may be assigned as Ground Start.

8. REFERENCES

A. Bellcore Practices

BR 241-220-100 DMS 100/200 Translations Users Manual

B. Northern Telecom Practices

NTP 297-1001-103
Peripheral Modules

NTP 297-1001-120
Equipment Labeling, Numbering and Referencing

NTP 297-1001-155
Peripheral, Trunk Group and Line Assignment Guide

NTP 297-2101-101
Line Module Description

NTP 297-2101-102
Remote Line Module Description

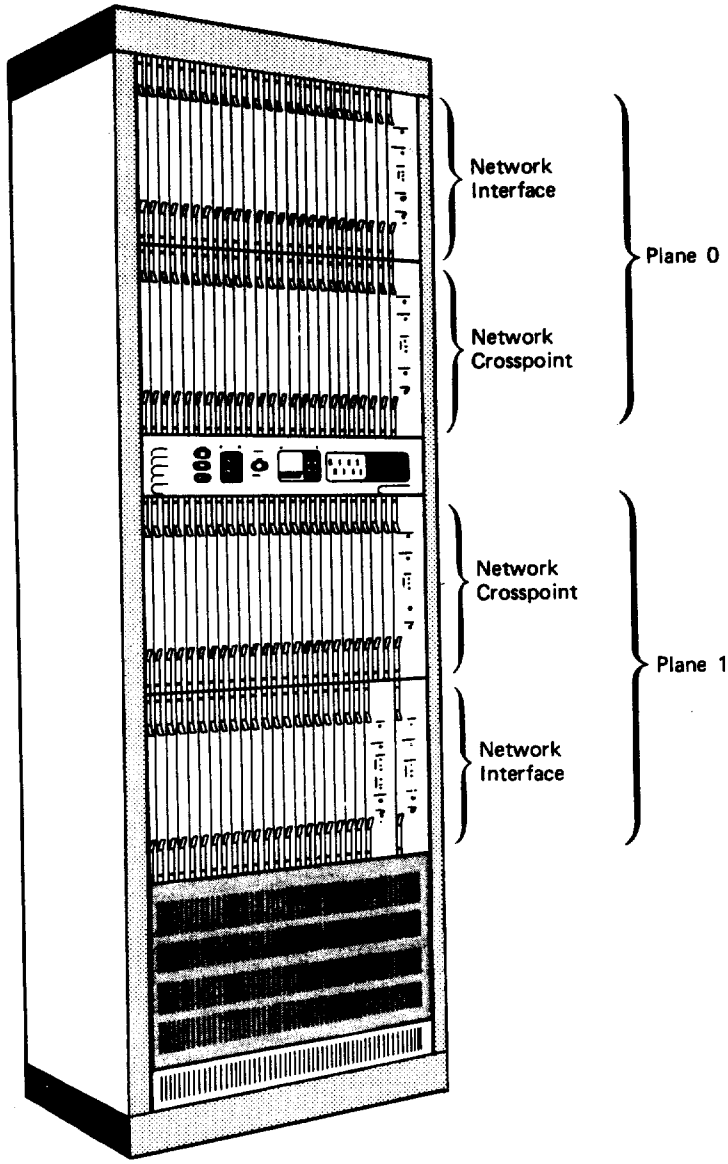

Figure 1. Network Module

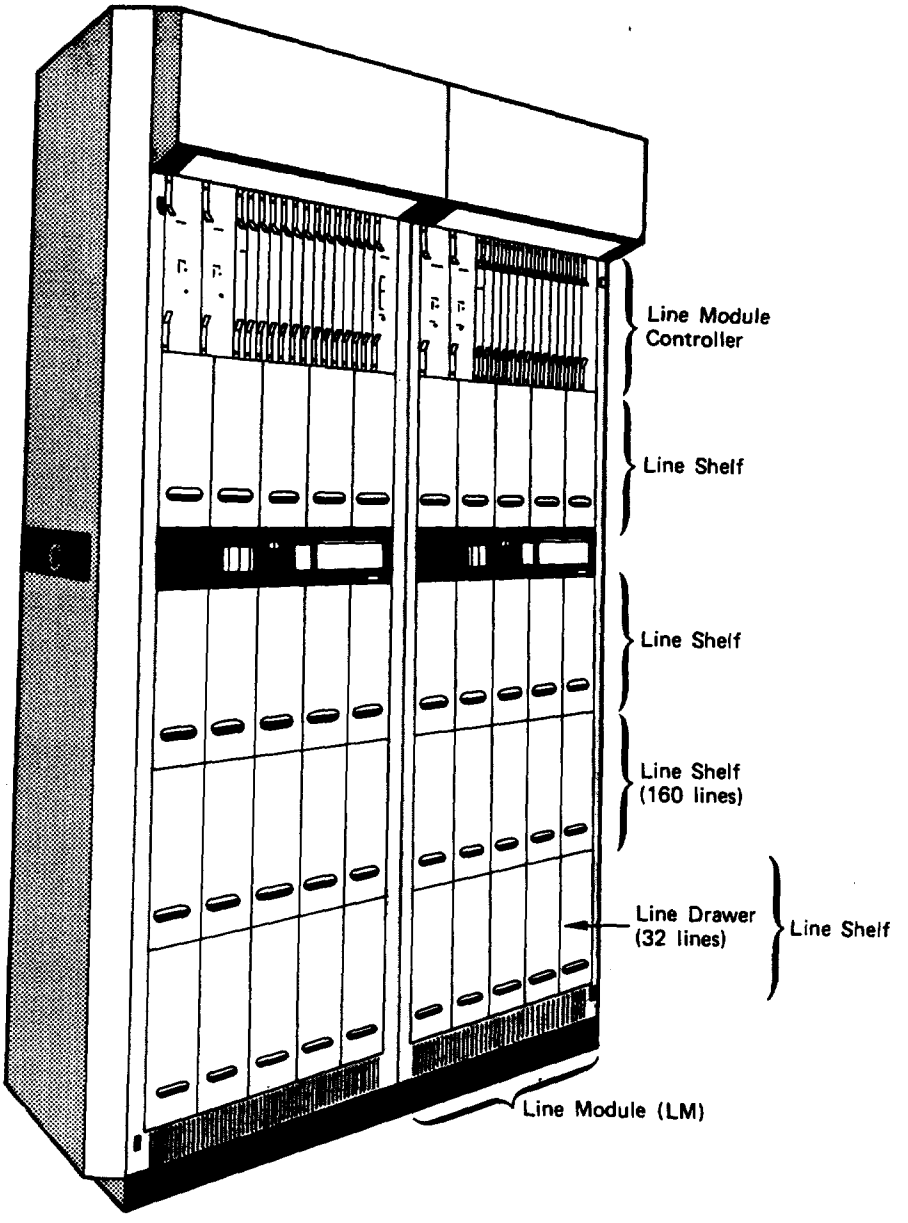

Figure 2. Line Module Equipment (LME) Frame

CC = CONTROL COMPLEX
PC = POWER CONVERTER

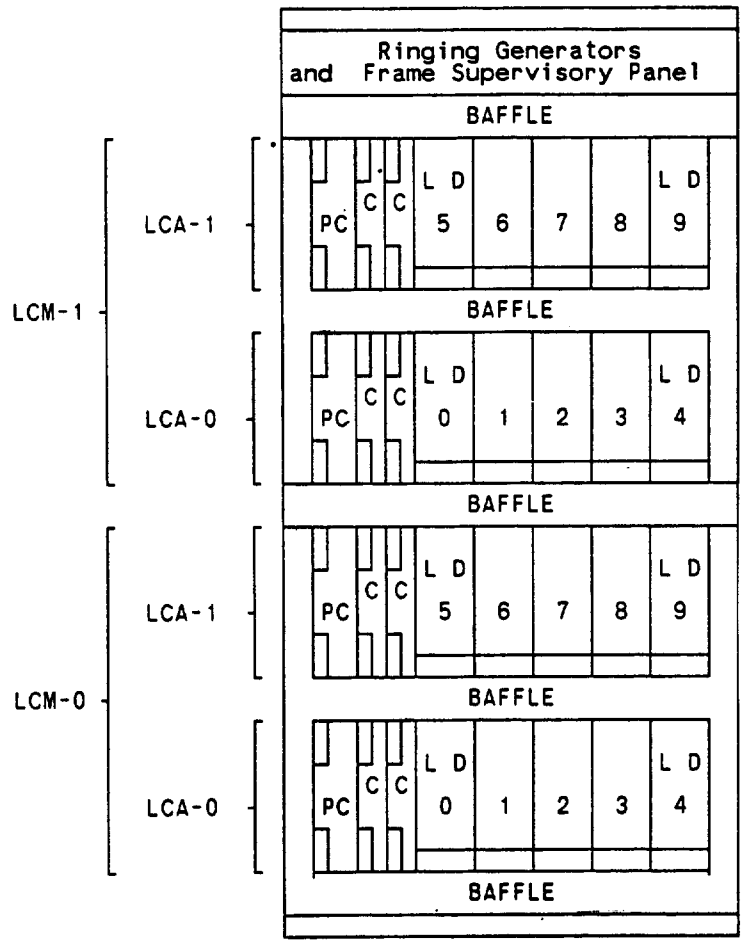

Figure 3. Line Concentrating Equipment (LCE) Frame