T-1

- DEVELOPED IN EARLY 60'S BY BELL LABS FOR USE BY AT&T FOR USE IN INTER-OFFICE TRUNKING.

- DRIVEN BY THE NEED TO REDUCE THE AMOUNT OF OUTSIDE PLANT CABLE AND IMPROVE TRANSMISSION QUALITY.

- CURRENTLY USED BY OPERATING TELEPHONE COMPANIES AND INTER-EXCHANGE CARRIERS TO CARRY TRAFFIC BETWEEN OFFICES AND TO BRING DIGITAL SERVICE TO CUSTOMERS.

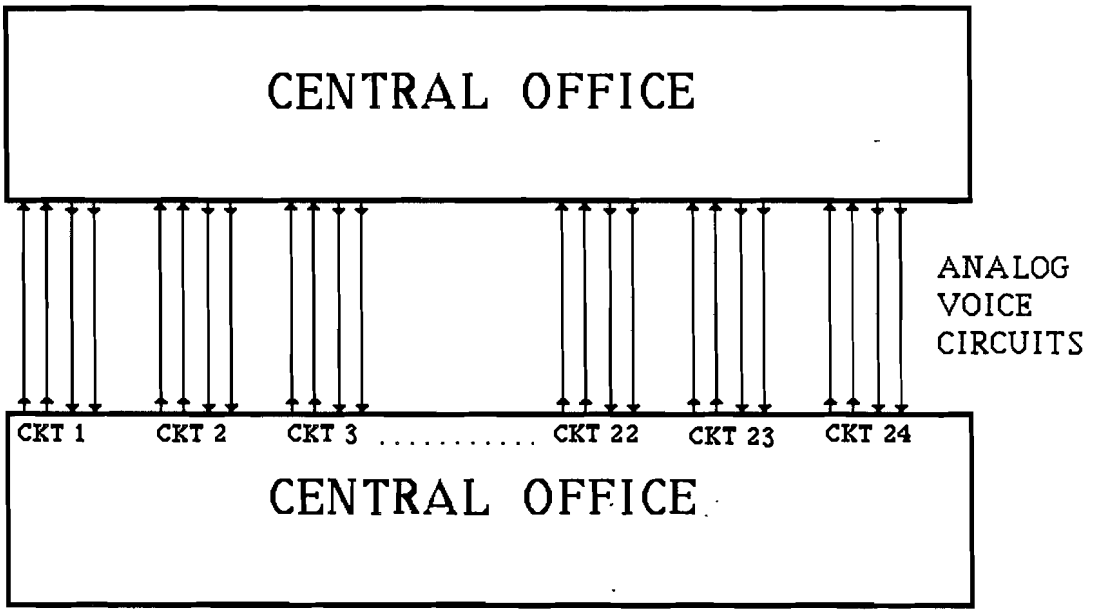
ADVANTAGES:
- IMPROVED VOICE TRANSMISSION
- ABILITY TO TRANSMIT DATA AND VIDEO AT HIGH SPEEDS AND IMPROVED QUALITY
- REDUCED LINE COSTS
- FLEXIBILITY
- NETWORKING

DISADVANTAGES:
- INITIAL EQUIPMENT COSTS
- A SERVICE OUTAGE WILL AFFECT 24 CIRCUITS
- MAINTNEANCE/SERVICE MAY REQUIRE DOWNTIME

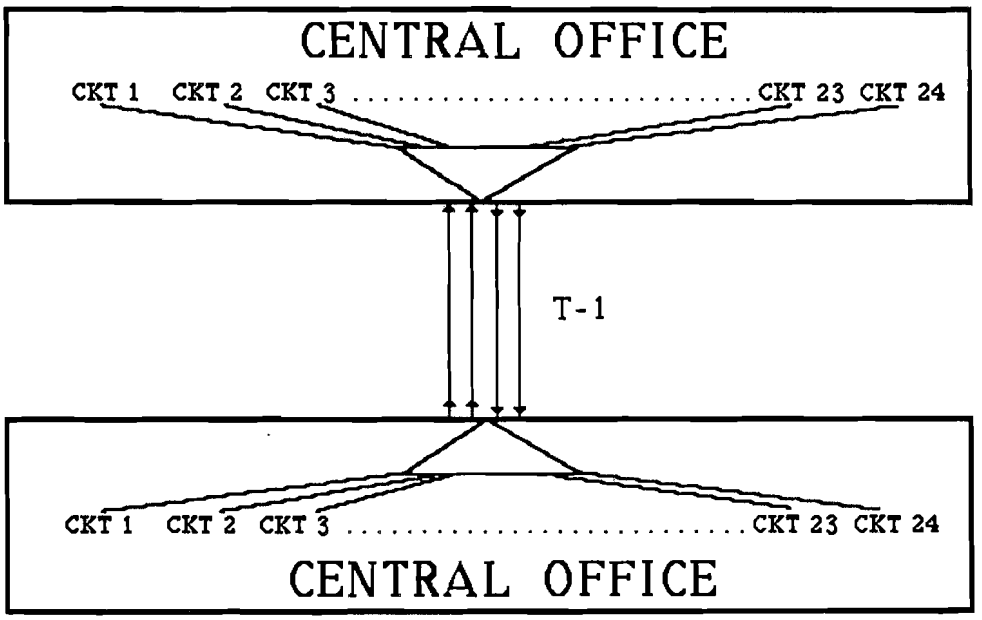
T-1 TRANSMISSION FACILITIES:
- TWISTED PAIR (COPPER)
- MICROWAVE RADIO
- FIBER OPTICS
- COAX
- SATELLITE

INTER-OFFICE ANALOG VOICE CIRCUITS VS. T-1

ANALOG INTER-OFFICE CIRCUITS REQUIRE 4 WIRES, ONE PAIR FOR TRANSMIT AND ONE PAIR FOR RECEIVE FOR EACH CIRCUIT.



T-1 SPANS REQUIRE 4 WIRES, ONE PAIR FOR TRANSMIT, AND ONE PAIR FOR RECEIVE FOR 24 VOICE/DATA CIRCUITS.

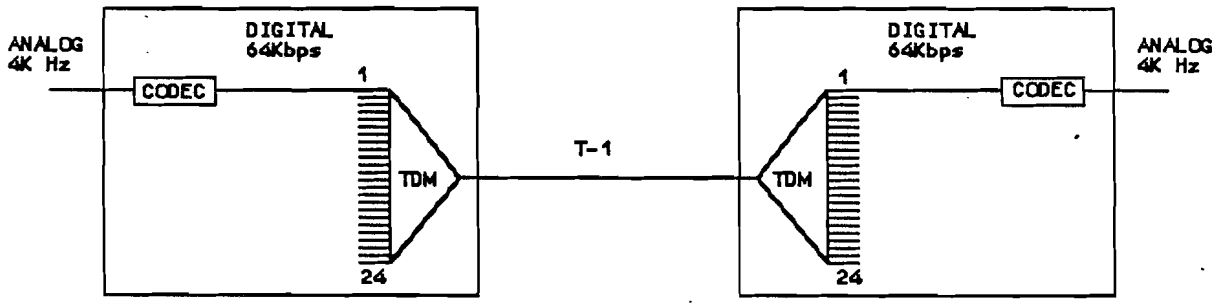


T-1

TWO-WAY DIGITAL TELECOMMUNICATIONS CIRCUIT AT 1.544Mbps

24 VOICE AND/OR DATA CHANNELS EACH AT 64Kbps

TRANSMITTED OVER 2 PAIRS OF WIRES, RADIO LINKS, OR FIBER

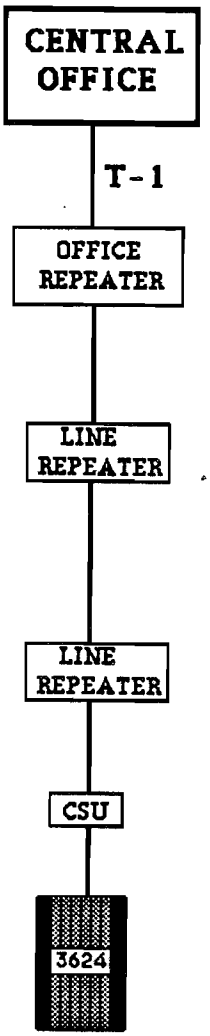


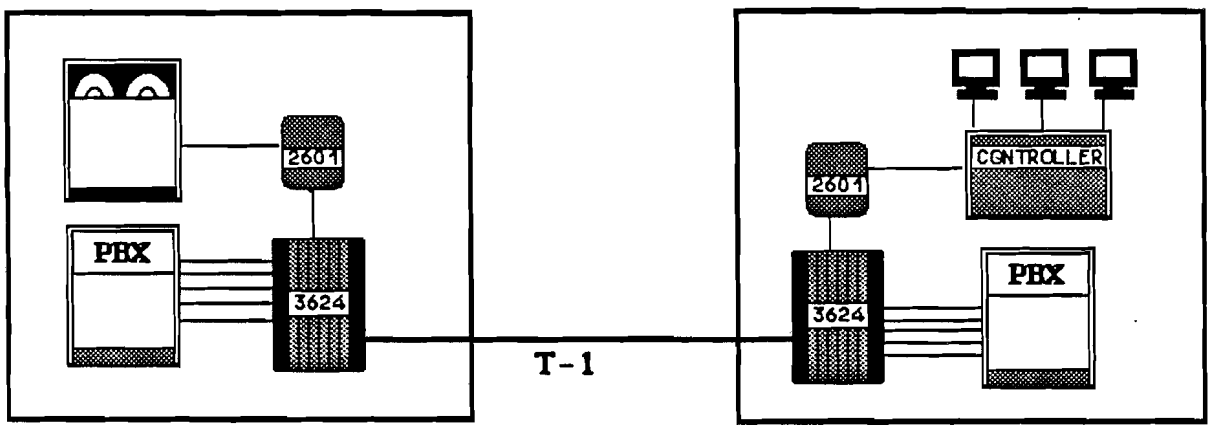
T-1 = 1.544 Mbps	
64,000 bps	VOICE CHANNEL
x 24	CHANNELS
1,536,000 bps	
+ 8,000 bps	CONTROL
1,544,000 bps	T-1

DS-	T-	bps	CHANNELS	T-1's
DS 0	---	64 K	1	---
DS 1	T-1	1.544 M	24	1
DS 2	T-2	6.312 M	96	4
DS 3	T-3	44.746 M	672	28
DS 4	T-4	274.176 M	4032	168

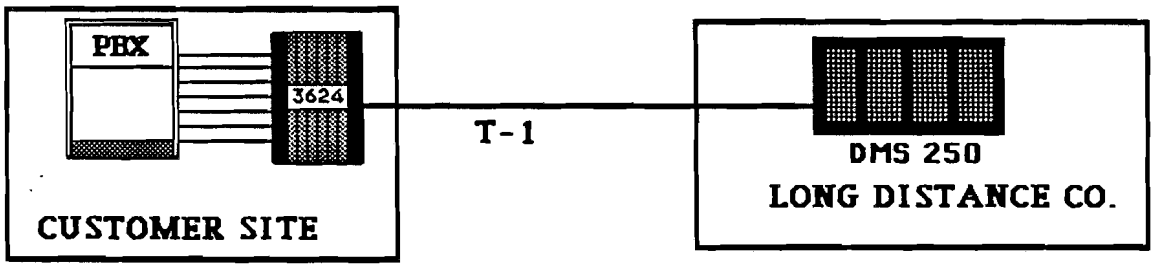
Fiber

T-1 SPAN

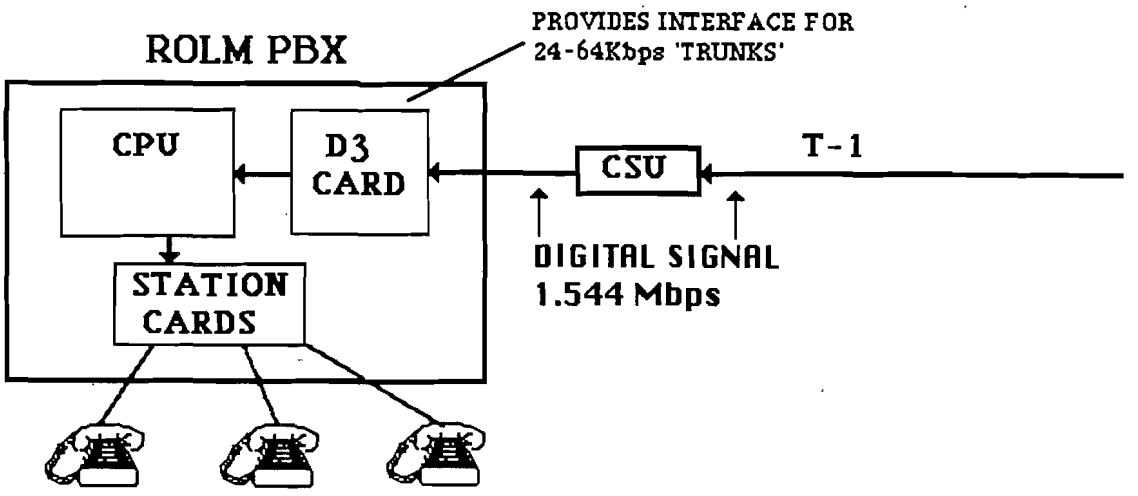

CENTRAL OFFICE
T-1
OFFICE REPEATER
LINE REPEATER
LINE REPEATER
CSU
3624



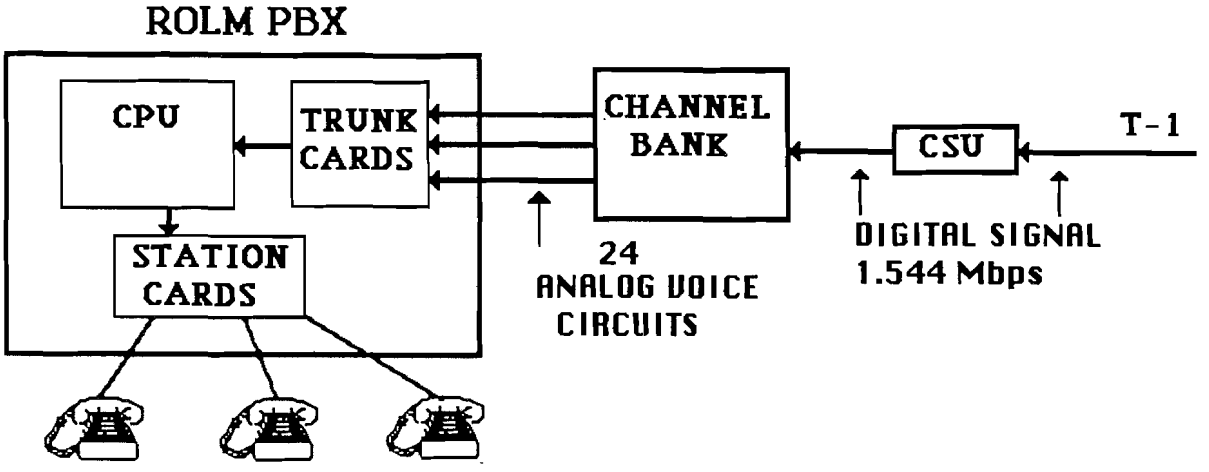
POINT TO POINT T-1 FOR VOICE & DATA



T-1 FOR LONG DISTANCE SERVICE

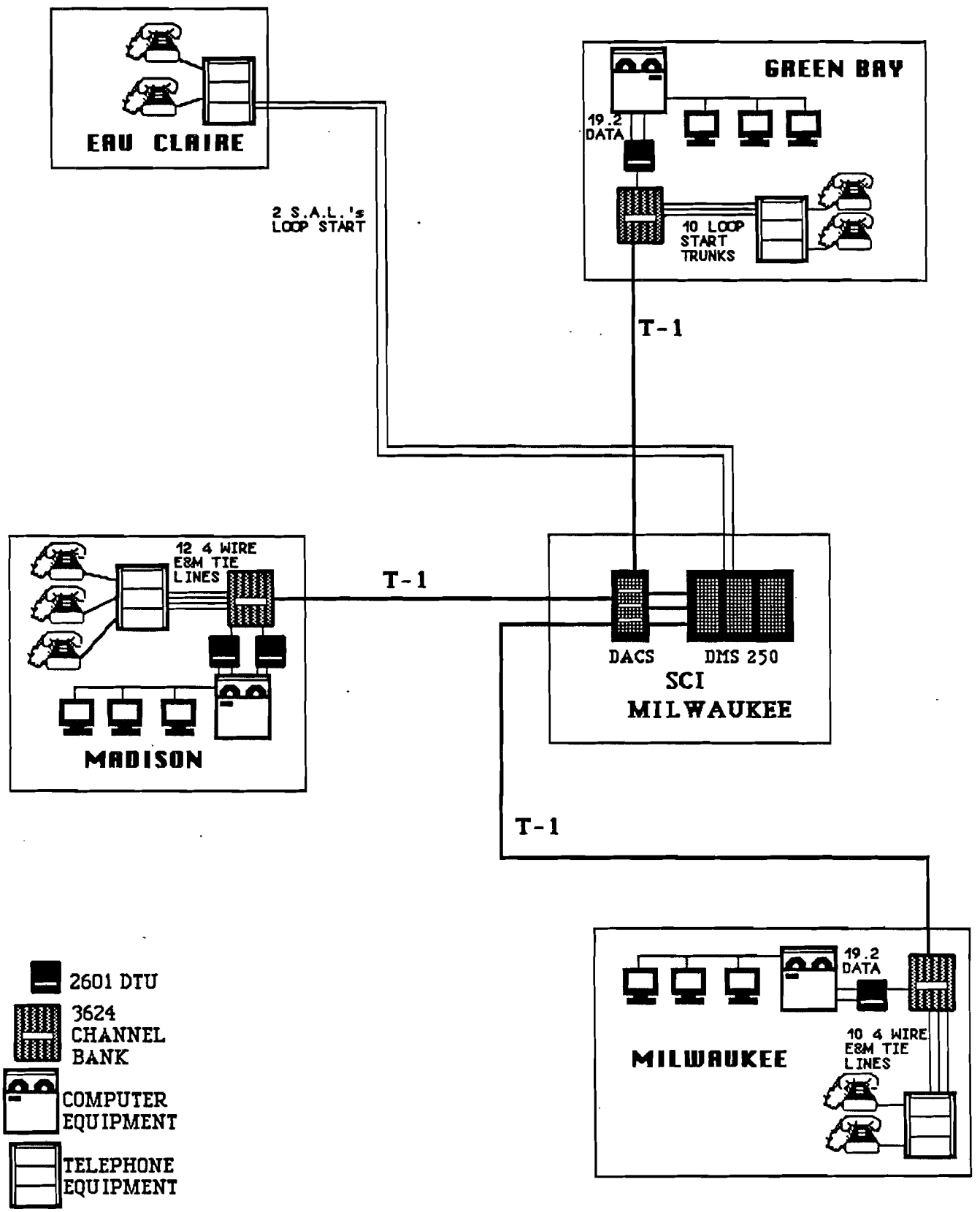


T-1 DIRECT CONNECTION TO PBX



T-1 CONNECTION TO PBX VIA CHANNEL BANK

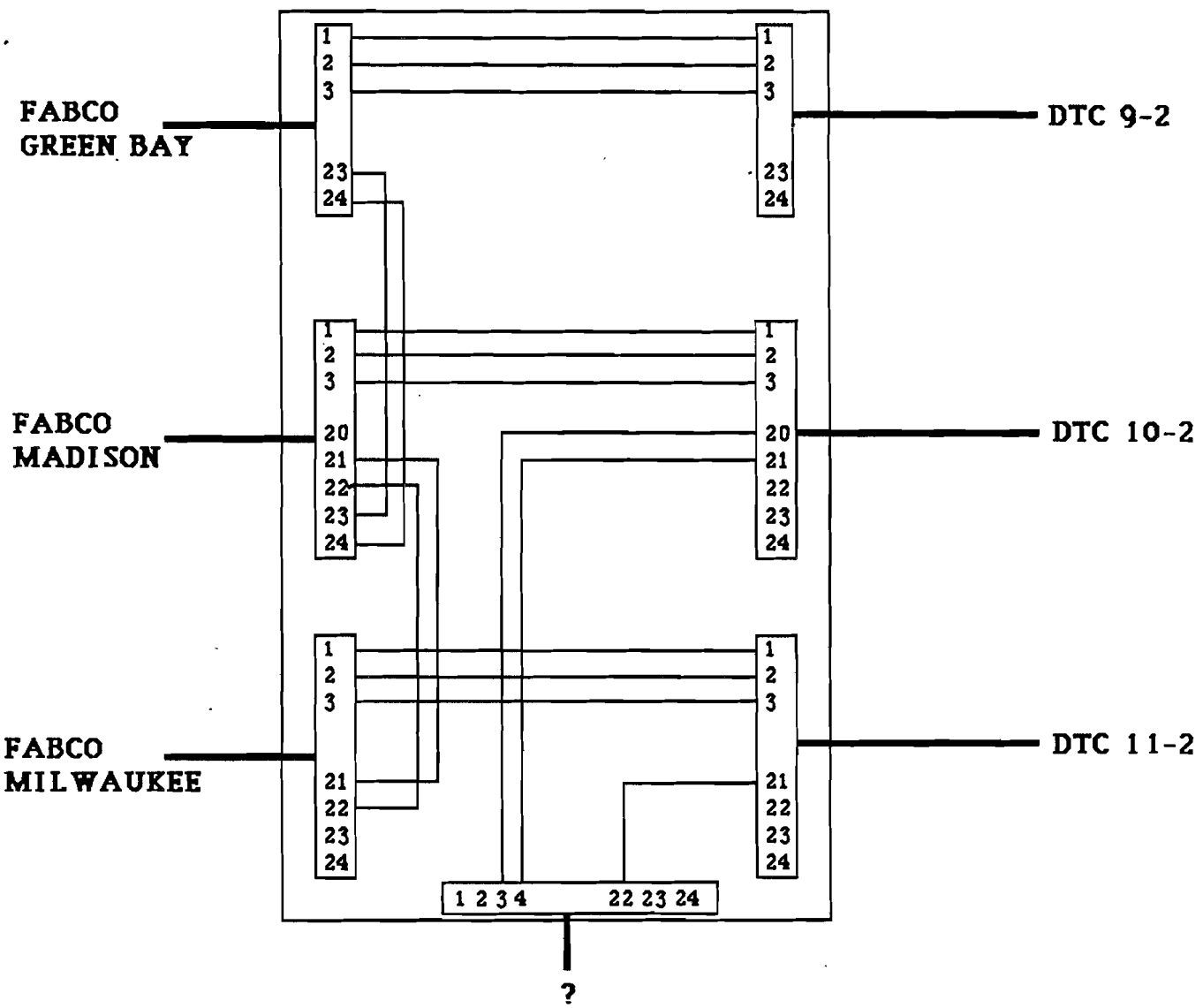
FABCO NETWORK



DACS

DIGITAL ACCESS & CROSS-CONNECT SYSTEM

A DACS IS A DEVICE USED TO CONNECT INDIVIDUAL DS0 CHANNELS ON A T-1 SPAN TO ANOTHER DS0 ON A DIFFERENT T-1, ON A CIRCUIT BY CIRCUIT BASIS. A DACS CAN BE USED FOR CONNECTING DATA CIRCUITS TO ONE ANOTHER, BYPASSING THE SWITCHED NETWORK, AND TO ENABLE BETTER UTILIZATION OF SWITCHING EQUIPMENT AND T-1 BANDWIDTH.



MADSION:
12 4-WIRE E & M TIE LINES FOR
4 19.2 DATA CIRCUITS

MILWAUKEE:
10 4-WIRE E & M TIE LINES
2 19.2 DATA CIRCUITS

GREEN BAY
10 LOOP START CIRCUITS
2 19.2 DATA CIRCUITS

NETWORK NEEDS:
-ABILITY TO CALL OTHER LOCATIONS AS EASILY AND INEXPENSIVELY AS POSSIBLE, DIRECTLY TO THE DESIRED EXTENSION IF POSSIBLE.
-TAKE ADVANTAGE OF WATS TYPE PRICING FOR LONG DISTANCE CALLS.
-DIGITAL TRANSMISSION FACILITIES FOR DATA CIRCUITS.

DIALING PLAN:
FOR ALL OUTBOUND LONG DISTANCE CALLS THE USER SELECTS AN OUTBOUND L.D. LINE. FOR OFF-NET (NOT TO ANOTHER FABCO LOCATION ON THE NETWORK) THE USER DIALS 1+ THE LONG DISTANCE NUMBER. FOR ON-NET CALLS THE USER DIALS 4 +LXX, WHERE THE LXX IS THE EXTENSION NUMBER. THE 'L' ALSO IS THE LOCATION NUMBER (1-MILWAUKEE, 2-MADISON, 3-EAU CLAIRE, 6-GREEN BAY). ALL CALLS TO GREEN BAY AND EAU CLAIRE ARE DIALED 300 OR 600 BECAUSE THE KEY SYSTEMS AT THESE LOCATIONS CANNOT PROCESS CALLS DIRECTLY TO EXTENSIONS, AND THE CALLS ARE PROCESSED THRU THE ATTENDANT.

SCHNEIDER NATIONAL / SCHNEIDER COMMUNICATIONS

SCHNEIDER NATIONAL:

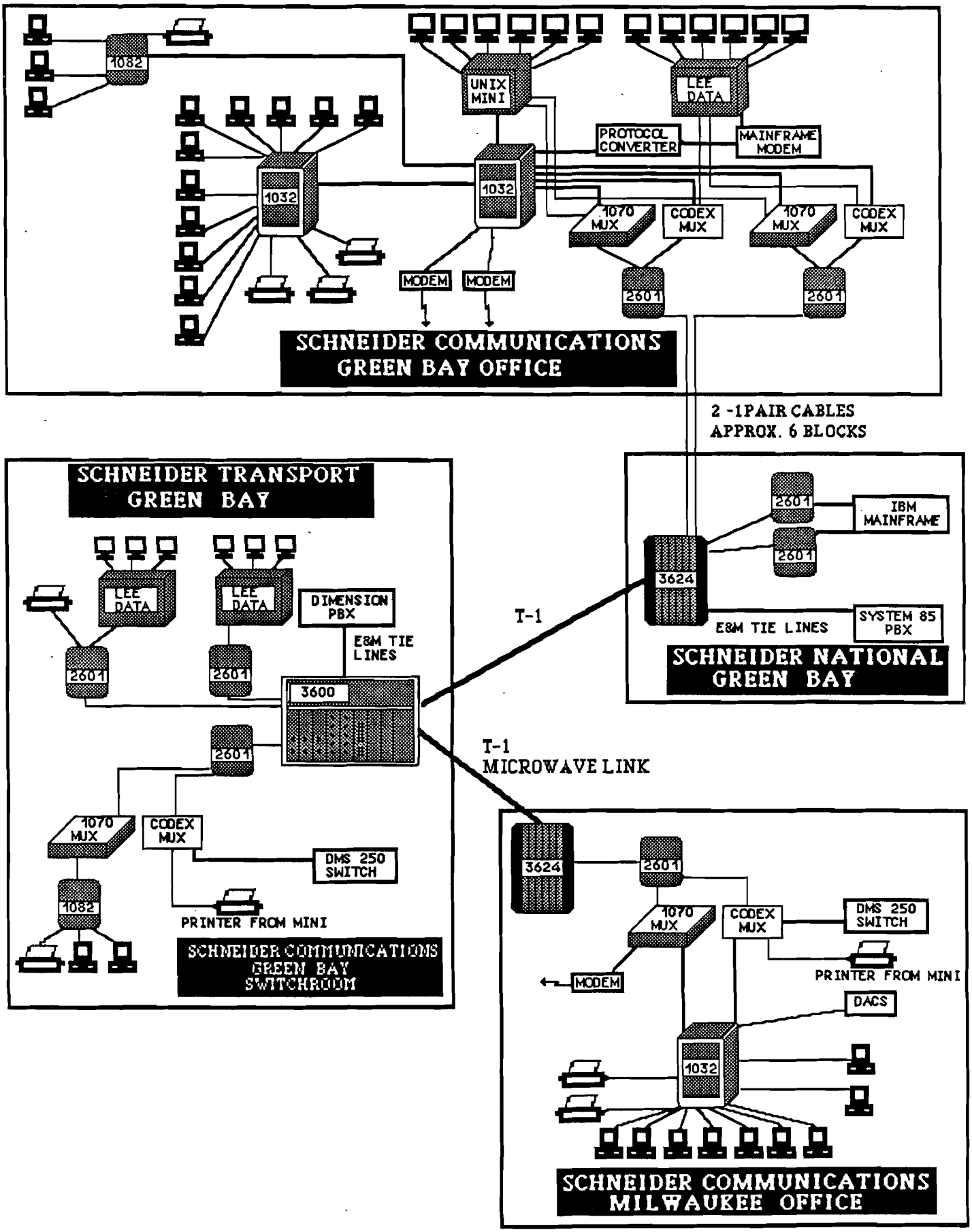
2 - 19.2 DATA CIRCUITS MAINFRAME TO REMOTE CONTROLLERS
1 - 4800 BAUD DATA CIRCUIT FOR REMOTE PRINTER

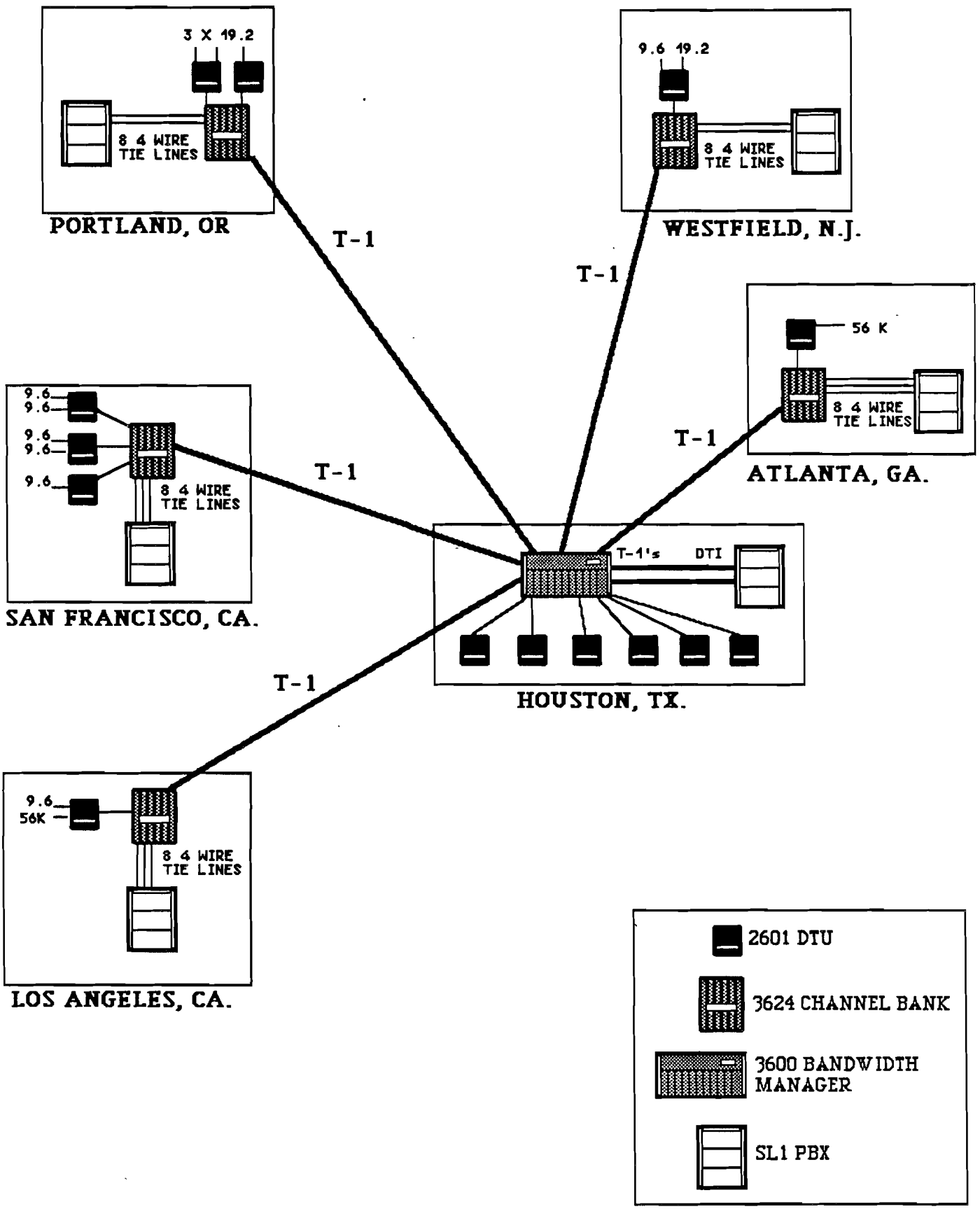
E & M TIE LINES BETWEEN SYSTEM 85 AND DIMENSION 2000

SCHNEIDER COMMUNICATIONS:

9.6 DATA LINE FROM GREEN BAY OFFICE TO GREEN BAY SWITCHROOM
9.6 DATA LINE FROM GREEN BAY OFFICE TO MILWAUKEE SWITCHROOM

REMOTE ACCESS TO MAINFRAME AND UNIX MINI COMPUTER
FILE TRANSFER AND PRINTER SHARING BETWEEN LOCATIONS
ACCESS TO DMS AND DACS MAINTENANCE PORTS


1082
UNIX MINI
LEE DATA
PROTOCOL CONVERTER
MAINFRAME MODEM
1032
1032
1070 MUX
CODEX MUX
1070 MUX
CODEX MUX
MODEM
MODEM
2601
2601
SCHNEIDER COMMUNICATIONS GREEN BAY OFFICE
2 -1PAIR CABLES APPROX. 6 BLOCKS
SCHNEIDER TRANSPORT GREEN BAY
LEE DATA
LEE DATA
DIMENSION PBX
E&M TIE LINES
2601
2601
3600
2601
1070 MUX
CODEX MUX
DMS 250 SWITCH
1082
PRINTER FROM MINI
SCHNEIDER COMMUNICATIONS GREEN BAY SWITCHROOM
T-1
T-1 MICROWAVE LINK
2601
IBM MAINFRAME
2601
3624
E&M TIE LINES
SYSTEM 85 PBX
SCHNEIDER NATIONAL GREEN BAY
3624
2601
1070 MUX
CODEX MUX
DMS 250 SWITCH
MODEM
PRINTER FROM MINI
DACS
1032
SCHNEIDER COMMUNICATIONS MILWAUKEE OFFICE


3 X 19.2
8 4 WIRE TIE LINES
PORTLAND, OR
T-1
9.6 19.2
8 4 WIRE TIE LINES
WESTFIELD, N.J.
T-1
56 K
8 4 WIRE TIE LINES
ATLANTA, GA.
T-1
9.6
9.6
9.6
9.6
9.6
8 4 WIRE TIE LINES
SAN FRANCISCO, CA.
T-1
T-1's
DTI
HOUSTON, TX.
T-1
9.6
56K
8 4 WIRE TIE LINES
LOS ANGELES, CA.
2601 DTU
3624 CHANNEL BANK
3600 BANDWIDTH MANAGER
SL1 PBX

3624
INTELLIGENT T-1 CHANNEL BANK

COMPACT SIZE: 17" x 12" x 4" 15lbs.
LOW POWER COMSUMPTION
NO SPECIAL ENVIORMENTAL LIMITATIONS
FULLY CONNECTORIZED

INTEGRATED VOICE/DATA MULTIPLEXER
VOICE: FXS LOOP START/GROUND START
PRIVATE LINE AUTOMATIC RING DOWN
E & M TYPE I 2/4 WIRE

DATA: ASYCH/SYNCH
DTE/DCE
SPEEDS TO 64 Kbps
RS232
X.21
V.35
1 PAIR INTERFACE TO 3624

SOFTWARE CONFIGURATION, MONITORING, & CONTROL

ALARM REPORTING - LOCAL AND REMOTE

INTERNAL DIAGNOSTICS

3630
PRIMARY RATE MULTIPLEXER

ALL OF THE FEATURES OF THE 3624

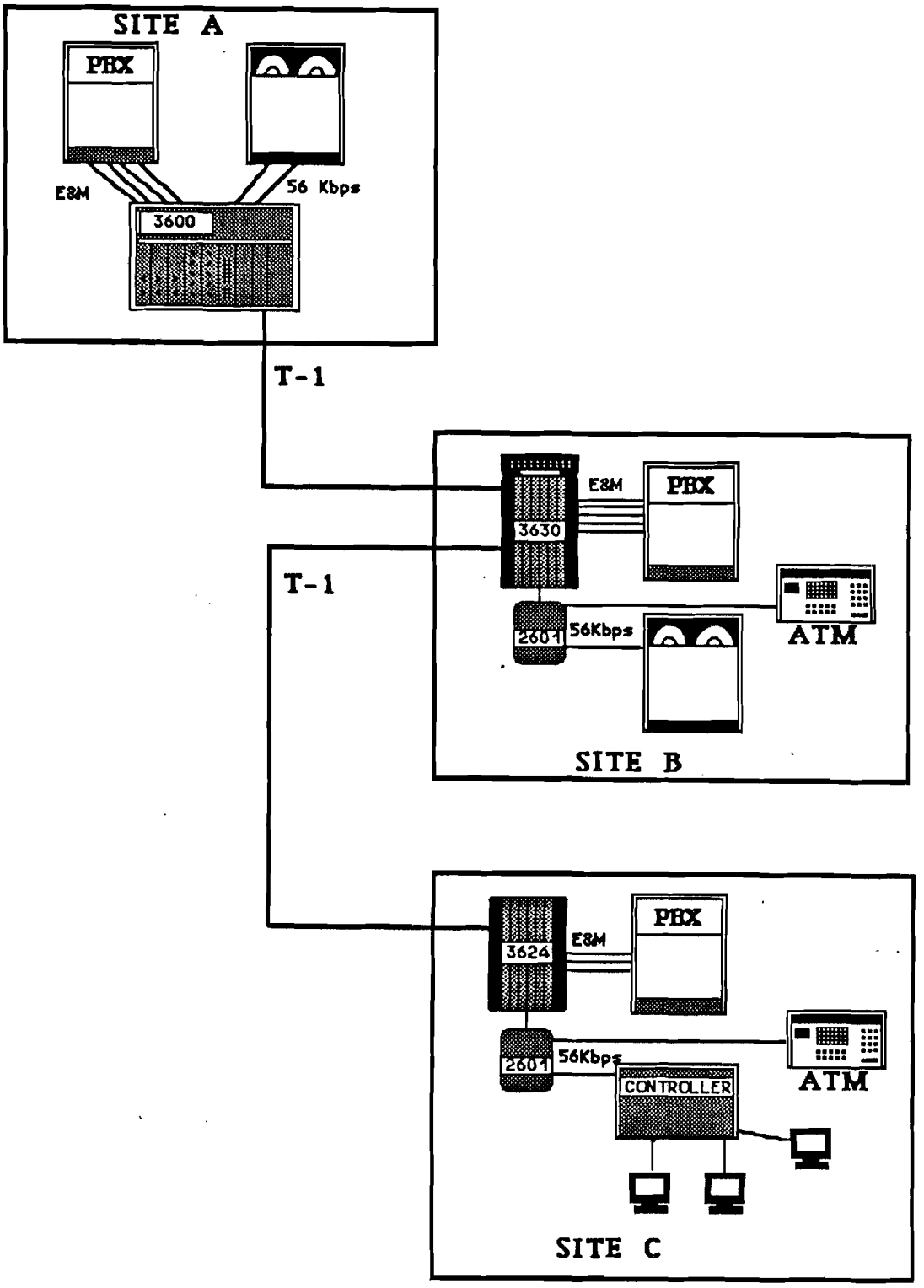
SUPPORTS 2 T-1 SPANS

DROP & INSERT CAPABILITY

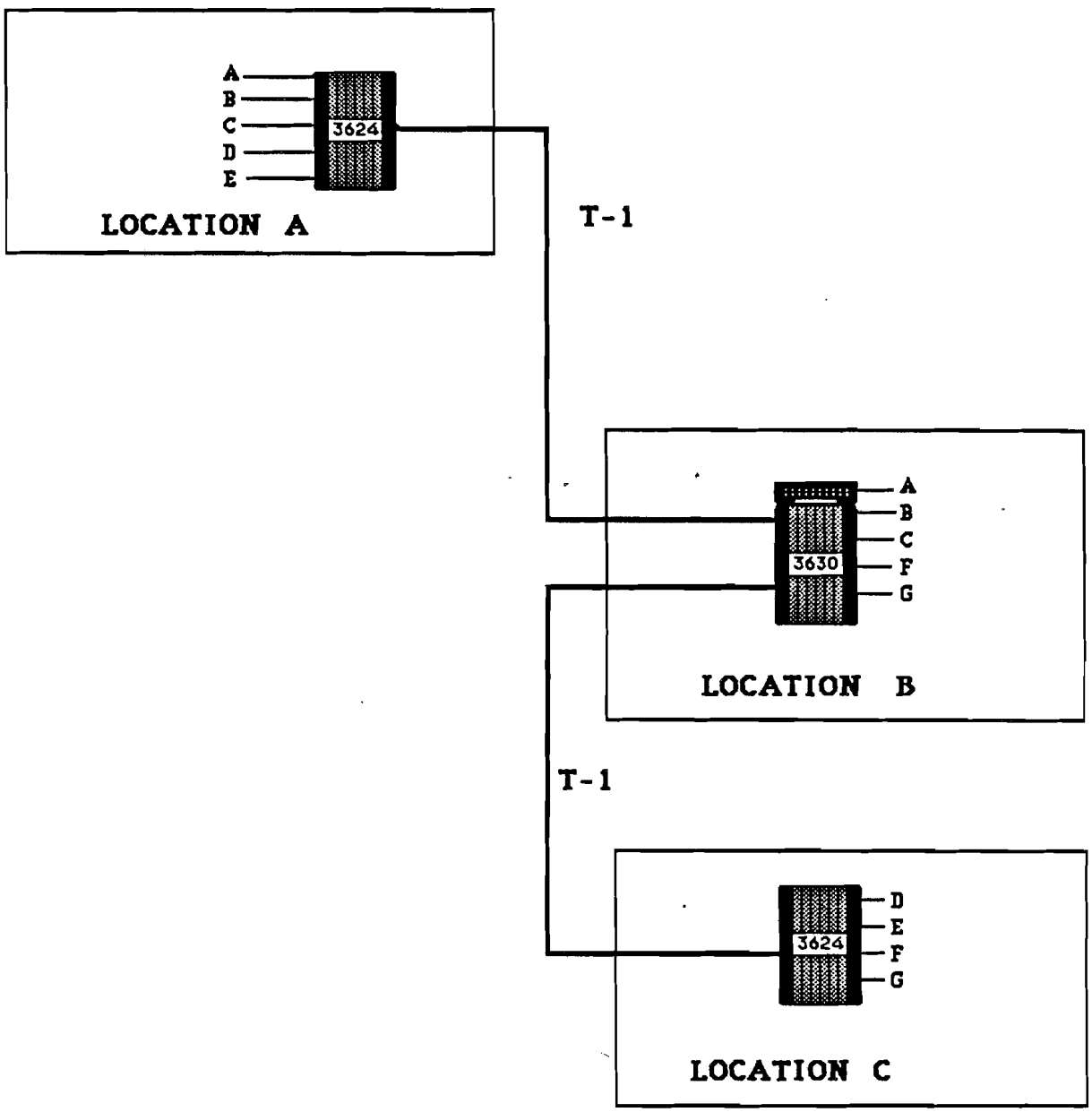
SUPPORTS 32 VOICE AND/OR DATA CHANNELS

SUPPORTS FXO CHANNELS (FOR OPX APPLICATIONS)

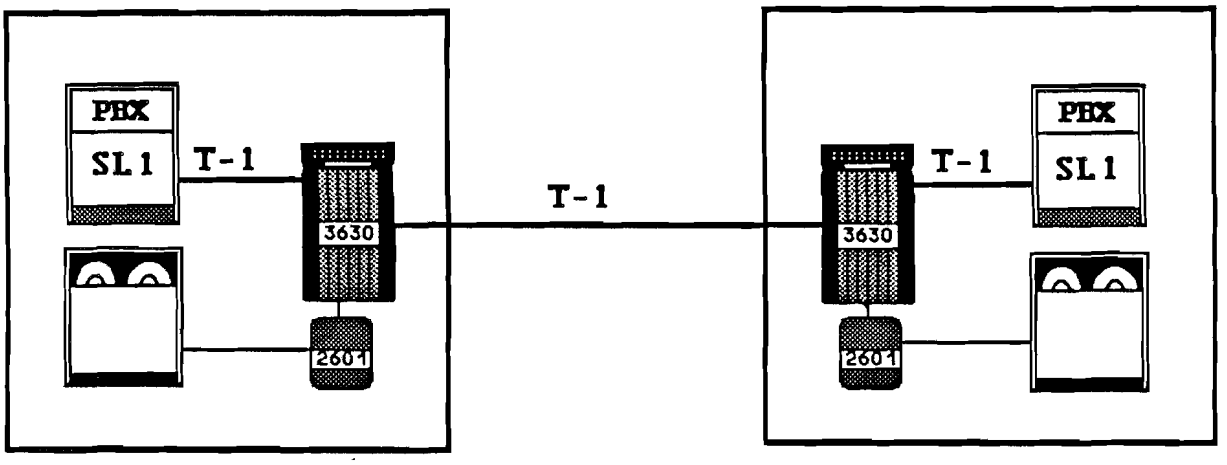
PROTECTION SWITCHING


SITE A
PBX
E&M
56 Kbps
3600
T-1
E&M
PBX
3630
T-1
2601
56Kbps
ATM
SITE B
PBX
E&M
3624
2601
56Kbps
CONTROLLER
ATM
SITE C

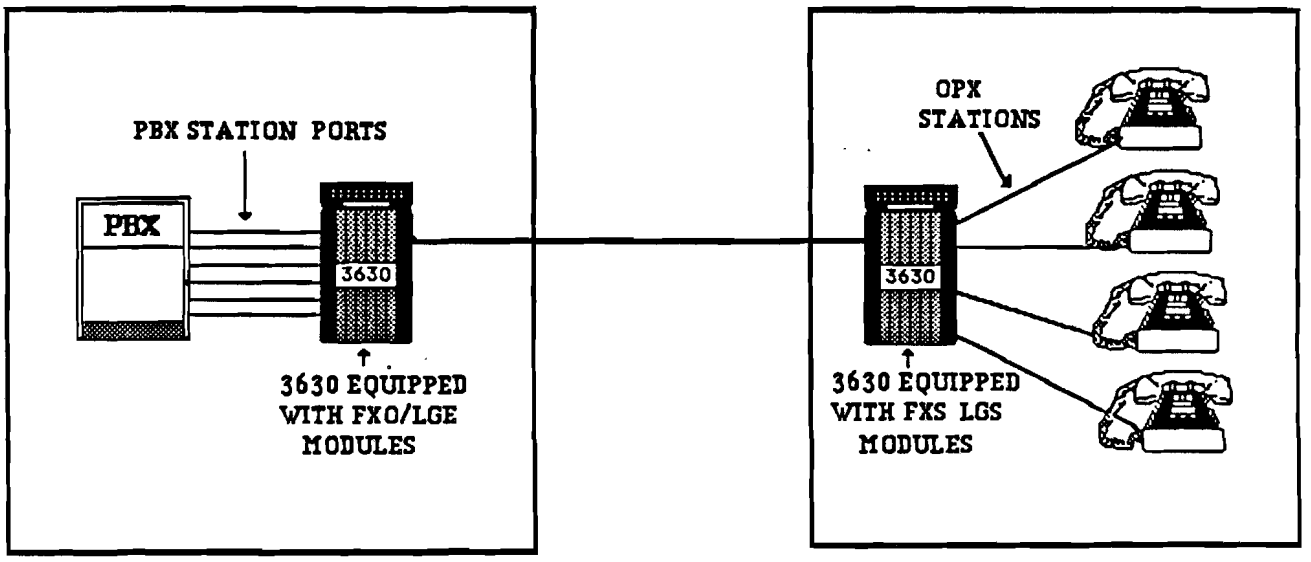
DROP, INSERT & BYPASS



DROP & INSERT WITH T-1 INTERFACE TO PBX



OFF PREMISE EXTENSION APPLICATION



3600
BANDWIDTH MANAGER

INTEGRATED VOICE AND DATA MULTIPLEXER

ACCEPTS BOTH T-1 AND CEPT PRIMARY RATES

VOICE COMPRESSION

SUBRATE DATA MULTIPLEXING

SUPER RATE DATA

MULTI-DROP DATA BRIDGING

FLEXIBLE NETWORK CLOCKING

DIRECT CONNECT DATA INTERFACE CARDS

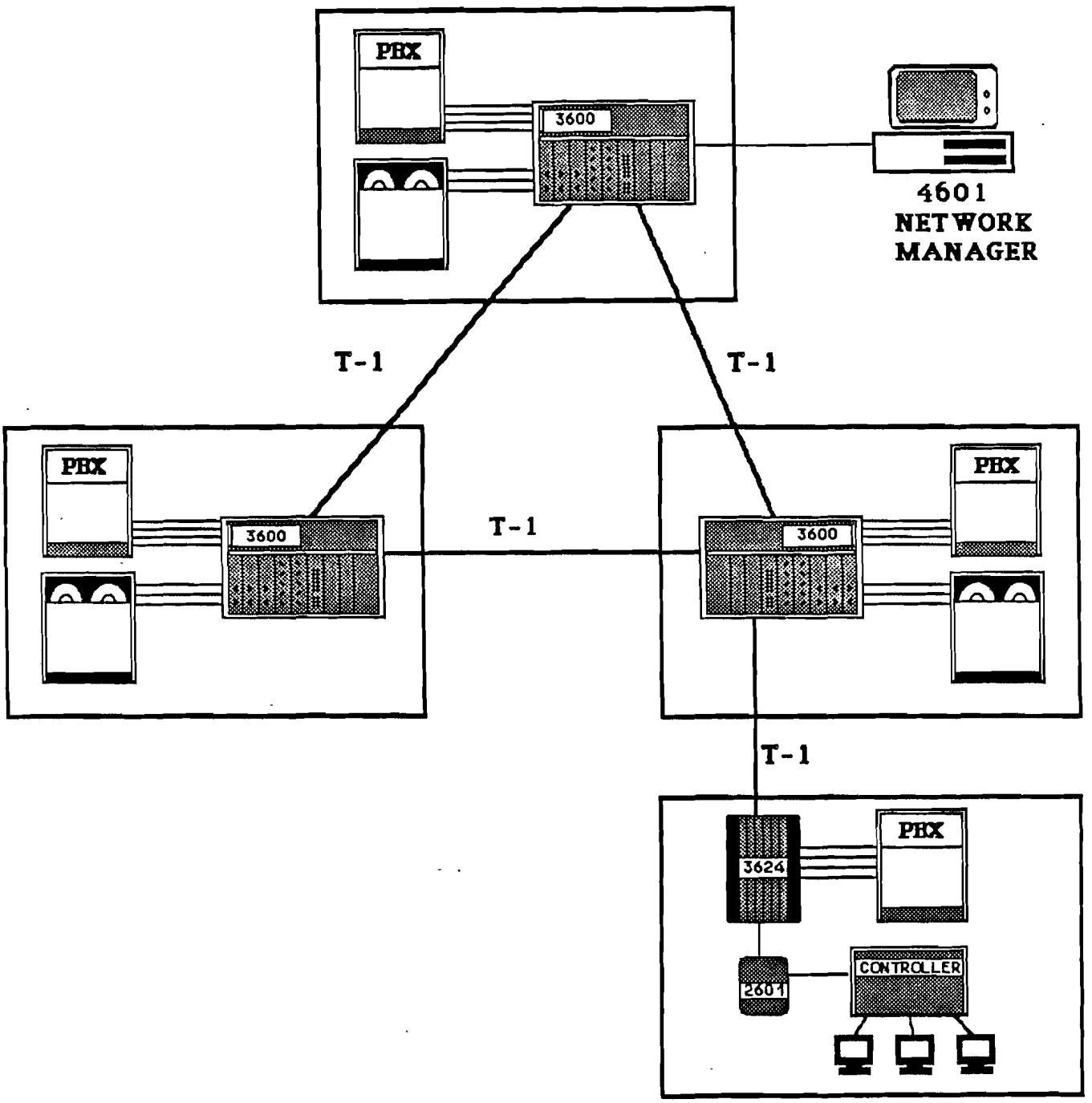
ADVANCED REDUNDANCY FEATURES

FLEXIBLE CROSS CONNECTIONS (DACS)

VOICE INTERFACES
- FXS LOOP/GROUND START
- E & M TYPE I, II, III 2 & 4 WIRE
- FXO LOOP/GROUND START

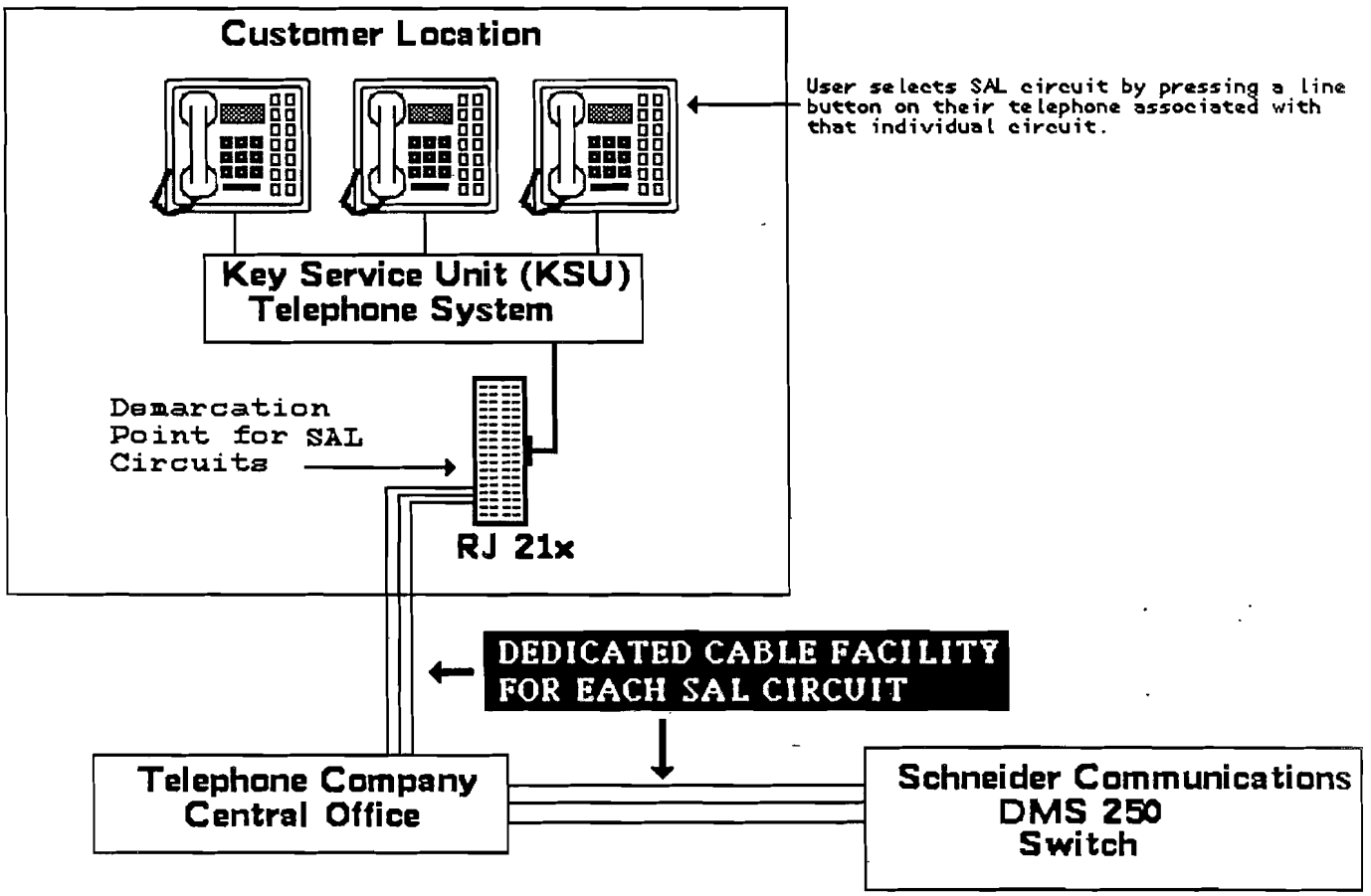
DATA INTERFACES (BOTH DIRECT CONNECT & DTU)
- RS232
- X.21
- V.35

STATISTICS

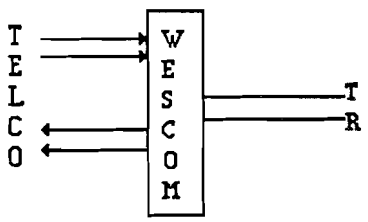

PBX
3600
4601
NETWORK
MANAGER
T-1
T-1
PBX
3600
T-1
3600
PBX
T-1
3624
PBX
2601
CONTROLLER

Special Access Lines (SALs)

KEY TELEPHONE SYSTEM

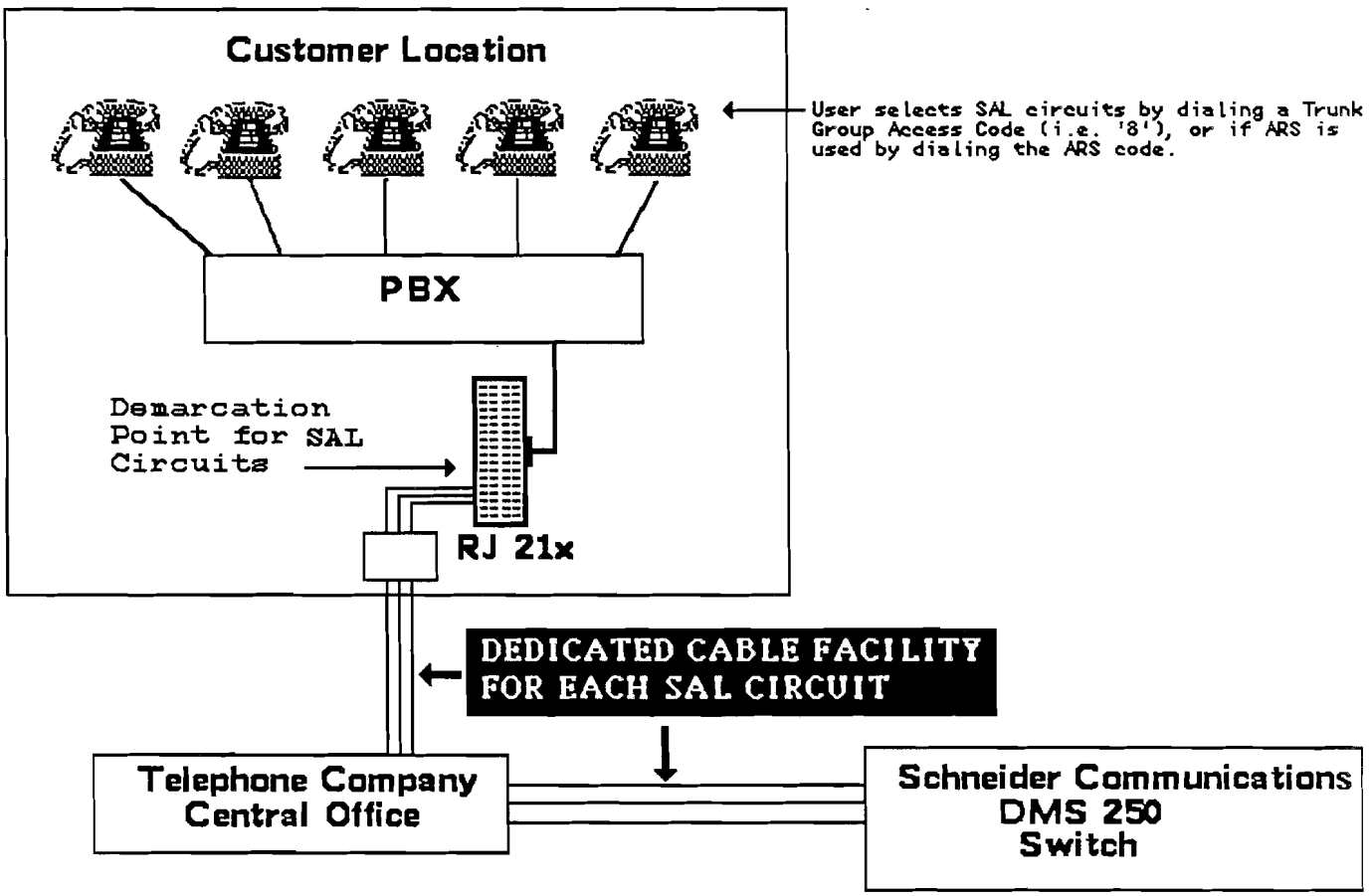


LOOP START

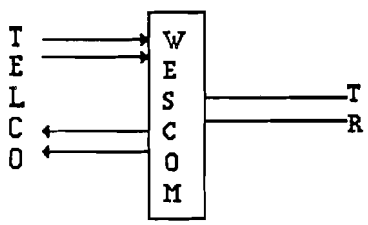


Special Access Lines (SALs)

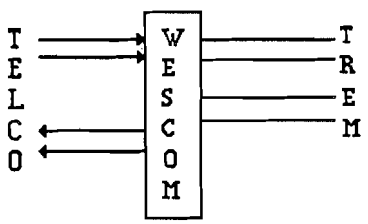
PBX Telephone System



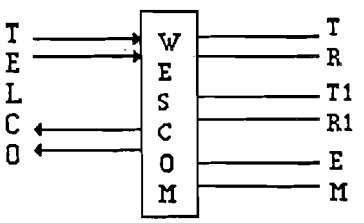
LOOP/GROUND START



2-WIRE E & M

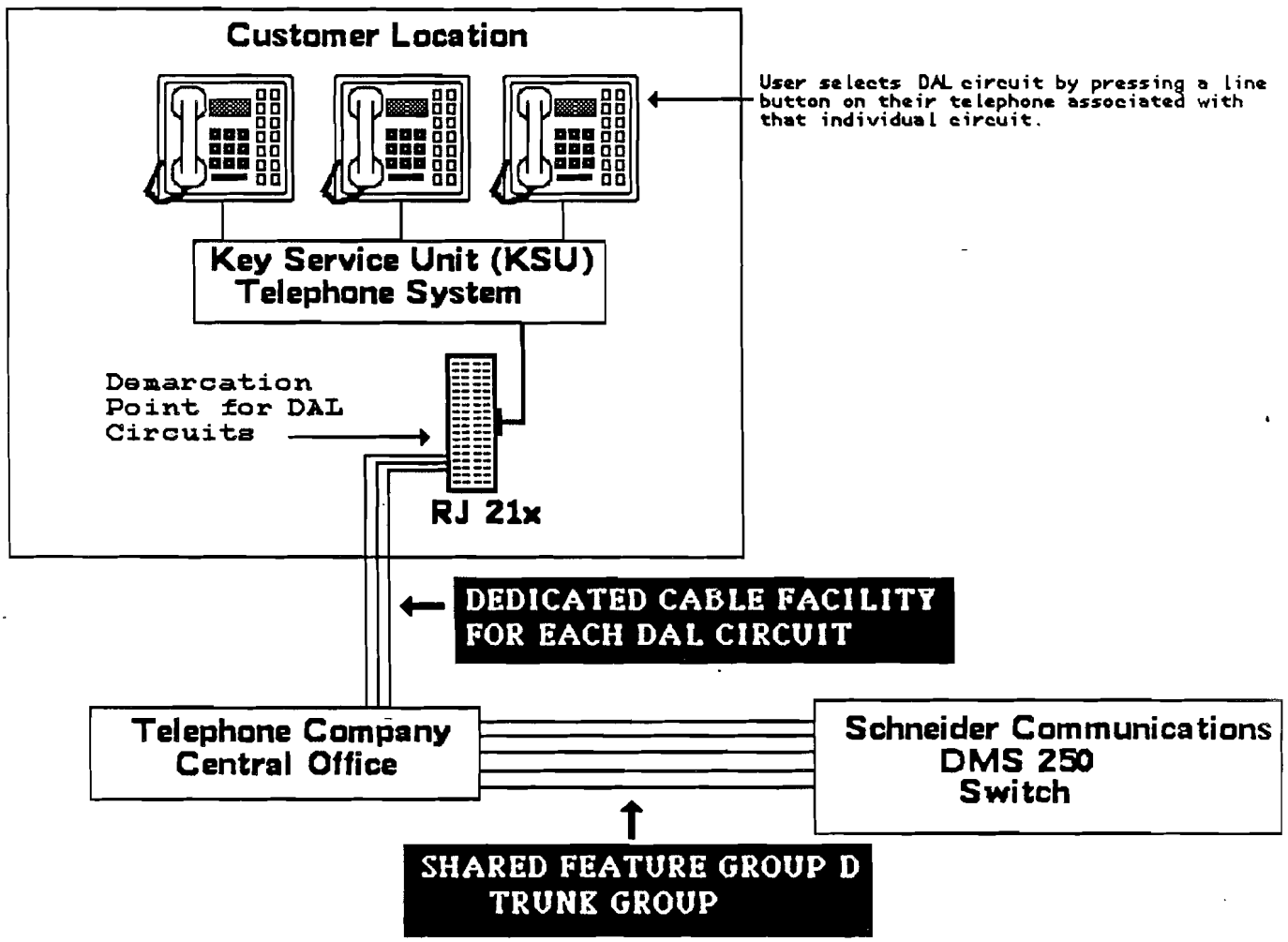


4-WIRE E & M



Dedicated Access Lines (DALS)

KEY TELEPHONE SYSTEM



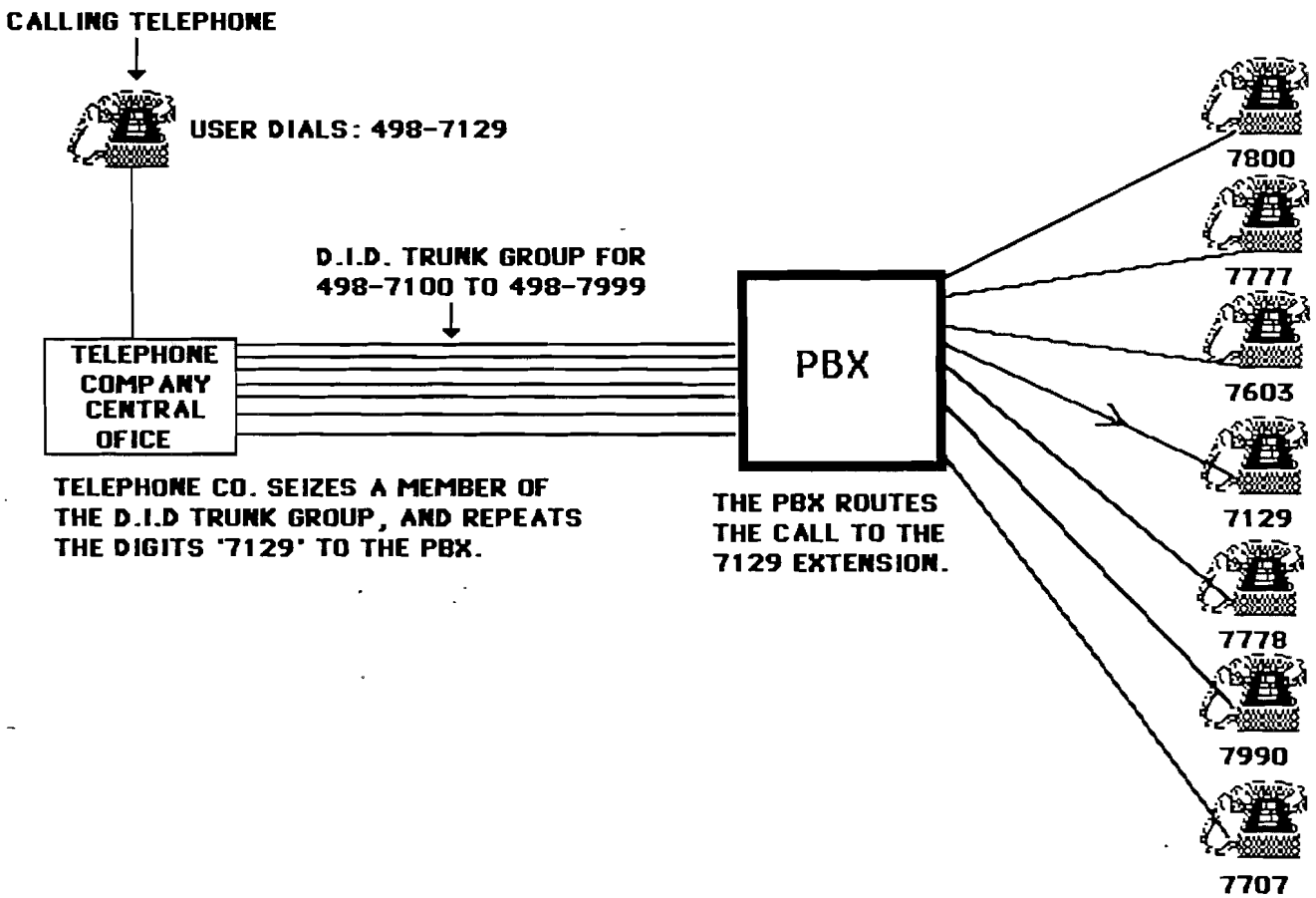
DIRECT INWARD DIAL (D.I.D.)

A D.I.D. (Direct Inward Dial) trunk is a member of a trunk group that is dedicated to a particular customer location. The trunk group is identified by the digits in the dialed telephone number. Blocks of numbers are reserved by the customer for their use. A customer can usually reserve numbers in blocks of tens, but they are usually reserved in blocks of 100 to allow for growth and flexibility.

Once the telephone company recognizes the call as belonging to a particular D.I.D. customer, it looks at the trunk group assigned to that customer for an available circuit. If no D.I.D. circuits are available to the customer's PBX, the telephone company will return a busy signal to the calling party. If a trunk is available, the telephone company will send a 'wink' (1/4 second reversal of loop current) to the PBX. When the PBX is ready to receive digits from the telephone company, it will return a 'wink'. The telephone company will then send the predetermined number of digits to the PBX. The number of digits sent will either be the last three or four digits of the dialed number. Once the PBX receives the digits, it may delete or add digits to accommodate it's dialing plan, it then routes the call to the appropriate station. If the desired station is available, it will ring the phone at that station. If the station is busy and no special calling features (call forwarding or call coverage) are active the calling party will receive a busy signal which is generated by the PBX, not from the telephone company. If special calling features are activated, the PBX will handle the call following the protocol set up by the feature that is active (i.e. a call forwarding setup will forward the call to the designated station). Once the call is answered by a station, the PBX reverses loop current a second time and leaves it reversed until the call is disconnected. This provides answer supervision to the telephone company. The length of time for the calling party to hear a 'ringback' signal will be somewhat longer on a D.I.D circuit than on a standard telephone circuit. This is due to the additional routing that must take place, and due to the fact that the ringback is provided by the PBX, rather than the telephone company.

D.I.D. circuits provide the advantages of each user having their 'own' telephone number for incoming calls. This reduces the amount of time an attendant must spend answering and routing calls. They also provide a dedicated trunk group for incoming calls which is usually highly utilized.

D.I.D. CIRCUITS



A.R.S. Automatic Route Selection
L.C.R. Least Cost Routing

A.R.S. and L.C.R. are terms that commonly refer to a PBX feature that automatically chooses the most economical route for a call, based on the time of day and available circuits.

PBX's often terminate calls in various ways, local calls over local trunks, long distance calls over local trunks using either the primary interexchange carrier, an alternate carrier using a 10XXX code, WATS circuits to AT&T or other carriers, or FX lines. Many PBX's use several or all of the above methods to terminate calls. Training users to dial the appropriate access code for the most economical choice at various times of the day, would be difficult if not impossible.

The modern PBX's have powerful Central Processing Units (CPU) built into them to control all of the functions and features that they provide. A PBX is really a powerful computer designed to process and handle telecommunications functions. By using the power of the CPU it is possible to have the PBX route all calls over the most economical route at various times of the day and have all routing transparent to the user.

The PBX routes the calls according to tables that are programmed into a routing database. The tables consist of area codes and office codes (exchange codes) and a listing of possible routing choices. If necessary, the PBX can also modify the dialed digits to accommodate any special dialing pattern that may be necessary for any given route choice (trunk group).

When the user dials a telephone number, the digits are stored in the PBX's memory, and then compared to the routing tables. If the dialed number is seven digits, it is first determined if the call is local or long distance. If the exchange dialed is a local call, the PBX routes the call over the local exchange lines. If the call is long distance, the PBX will search the routing tables for a match. Once the match is found it will attempt to locate an available circuit in the first choice trunk group. If no circuits are available in that group, it will continue through the other choices available for that particular routing entry.

If the dialed number includes an area code, the PBX first searches through the routing tables for a match of the area code dialed and then if there are various routing choices within that area code, it will search for an office code match. Some PBX's do 3 digit screening which routes the call by the area code dialed and doesn't take into account any of

the other digits dialed. If the PBX does 6 digit screening it first finds the appropriate area code entry and then searches for a match in the office code entries. If 6 digit screening is used there is often an entry for office codes that don't find a match. This prevents blocked calls due to new office codes that are added within area codes. Once the PBX locates the appropriate routing table, it will attempt to process the call starting with the first choice route and continuing on until the call is completed or blocked due to the unavailability of circuits.

Some PBX's also offer a feature that permits users to 'queue' their call. Queueing is a feature that holds the called number in the PBX's memory until the call can be placed over one of the available routing choices. This feature is usually activated by dialing a feature code or depressing a feature button when a 'fast busy' is returned to the user to indicate that all circuits are busy. When the call can be completed, the PBX rings the users phone with a distinctive ring, to indicate that a trunk is available. The PBX will temporarily keep the trunk available for the call, waiting for the user to pick up their phone. If the user does not pick up their phone (within a programmed amount of time) the trunk will be released to be used by another call and the user's call will be dropped from the queue.

PBX's also have the ability to permit certain users to have access to more trunk groups than others. The users Class of Service (COS) that is programmed into the PBX indicates what features and types of trunks the user has access to. Therefore, someone with an enhanced COS may have more routing choices available to them than other users and have fewer blocked or queued calls. The COS can limit phones to intercom only, local calls or limited long distance, as well as permitting or restricting access to queueing and other features.

Mark Hare