ANNEX A (INFORMATIVE) CABLING DESIGN CONSIDERATIONS

This annex is informative only and is not part of this Standard.

A.1 Application cabling lengths

The maximum supportable lengths in this annex are application and media dependent.

See table 5 in ANSI/TIA-568.0-D for balanced twisted-pair applications and table 6 in ANSI/TIA-568.0-D for optical fiber applications.

A.1.1 T-1, E-1, T-3 and E-3 circuit lengths

Table 3 provides the maximum circuit lengths for T-1, T-3, E-1, and E-3 circuits with no adjustments for intermediate connections or outlets between the circuit demarcation point and the end equipment. These calculations assume that there is no customer DSX panel between the access provider demarcation point (which may be a DSX) and the end equipment. The access provider DSX panel is not counted in determining maximum circuit lengths.

Table 3: Maximum circuit lengths with no DSX panel

Circuit type	Category 3	Category 5e, 6 & 6A	734 Type Coaxial	735 Type Coaxial
T-1	159 m (520 ft)	193 m (632 ft)	-	-
CEPT-1 (E-1)	116 m (380 ft)	146 m (477 ft)	332 m (1088 ft)	148 m (487 ft)
T-3	-	-	146 m (480 ft)	75 m (246 ft)
CEPT-3 (E-3)	-	-	160 m (524 ft)	82 m (268 ft)

NOTE: The lengths shown in table 3 are for the specific applications used in data centers and may be different from the lengths supported for various applications in ANSI/TIA-568.0-D.

Repeaters can be used to extend circuits beyond the lengths specified above.

These circuit lengths should be adjusted for insertion loss losses caused by a DSX panel between the access provider demarcation point (which may be a DSX panel) and the end equipment. Table 4 provides the reduction caused by DSX panels in maximum circuit lengths for T-1, T-3, E-1, and E-3 circuits over the recognized media type.

Table 4: Reduction in circuit lengths for DSX panel

Circuit type	Category 3	Category 5e, 6 & 6A	734 Type Coaxial	735 Type Coaxial
T-1	11 m (37 ft)	14 m (45 ft)	-	-
CEPT-1 (E-1)	10 m (32 ft)	12 m (40 ft)	64 m (209 ft)	28 m (93 ft)
T-3	-	-	13 m (44 ft)	7 m (23 ft)
CEPT-3 (E-3)	-	-	15 m (50 ft)	8 m (26 ft)

Maximum circuit lengths should be adjusted for insertion loss losses caused by intermediate connections and outlets. Table 5 provides the reduction in maximum circuit lengths for T-1, T-3, E-1, and E-3 circuits over the recognized media type.

Table 5: Reduction in circuit lengths per connection or outlet

Circuit type	Category 3	Category 5e, 6, & 6A	734 Type Coaxial	735 Type Coaxial
T-1	4.0 m (13.0 ft)	1.9 m (6.4 ft)	-	-
CEPT-1 (E-1)	3.9 m (12.8 ft)	2.0 m (6.4 ft)	4.4 m (14.5 ft)	2.0 m (6.5 ft)
T-3	-	-	0.9 m (3.1 ft)	0.5 m (1.6 ft)
CEPT-3 (E-3)	-	-	1.1 m (3.5 ft)	0.5 m (1.8 ft)

In the typical data center, there are a total of three connections in the backbone cabling, three connections in the horizontal cabling and no DSX panels between the access provider demarcation point and the end equipment.

Backbone cabling:

- one connection in the entrance room;
- two connections in the main cross-connect;
- no intermediate cross-connect.

Horizontal cabling:

- two connections in the horizontal cross-connect;
- an outlet connection at the equipment distribution area.

This “typical” configuration corresponds to the typical data center with an entrance room, main distribution area (MDA), one or more horizontal distribution areas (HDAs), and no zone distribution areas (ZDAs). Maximum circuit lengths for a typical data center configuration with six connections are shown in table 6. These maximum circuit lengths include backbone cabling, horizontal cabling, and all patch cords or jumpers between the access provider demarcation point and the end equipment.

Table 6: Maximum circuit lengths for the typical data center configuration

Circuit type	Category 3	Category 5e, 6, & 6A	734 Type Coaxial	735 Type Coaxial
T-1	135 m (442 ft)	184 m (603 ft)	-	-
CEPT-1 (E-1)	92 m (303 ft)	134 m (439 ft)	305 m (1001 ft)	137 m (448 ft)
T-3	-	-	141 m (462 ft)	72 m (236 ft)
CEPT-3 (E-3)	-	-	153 m (503 ft)	78 m (257 ft)

With maximum horizontal cable lengths, maximum patch cord lengths, no customer DSX, no intermediate distribution area (IDA), and no ZDA, the maximum backbone cable lengths for T-1, E-1, T-3, or E-3 circuits are shown in table 7. This “typical” configuration assumes that the entrance room, MDA, and HDAs are separate rather than combined, and that there is no IDA. The maximum backbone cabling length is the sum of the length of cabling from the entrance room to the MDA and from the MDA to the HDA.

Table 7: Maximum backbone length for the typical data center configuration

Circuit type	Category 3	Category 5e, 6, & 6A	734 Type Coaxial	735 Type Coaxial
T-1	<1 m (<3 ft)	46 m (150 ft)	-	-
CEPT-1 (E-1)	<1 m (<3 ft)	<1 m (<3 ft)	190 m (624 ft)	29 m (95 ft)
T-3	-	-	26 m (85 ft)	0 m (0 ft)
CEPT-3 (E-3)	-	-	38 m (126 ft)	0 m (0 ft)

These calculations assume the following maximum patch cord lengths in the “typical” data center:

- 10 m (32.8 ft) for balanced twisted-pair and fiber in the entrance room, MDA, and HDA;
- 5 m (16.4 ft) for 734-type coaxial cable in the entrance room, MDA, and HDA;
- 2.5 m (8.2 ft) for 735-type coaxial cable in the entrance room, MDA, and HDA.

Due to the very short lengths permitted by category 3 balanced twisted-pair cabling and 735 type coaxial cable for T-1, T-3, E-1, and E-3 circuits, category 3 balanced twisted-pair and 735-type coaxial cables are not recommended for supporting these types of circuits.

Backbone cabling lengths can be increased by:

- limiting the locations where T-1, E-1, T-3, and E-3 circuits are provisioned (for example only in the MDA or horizontal cabling originating from the MDA);
- provisioning circuits from multiplexers or other circuit provisioning equipment located in the MDA, IDA, or HDA;
- provisioning circuits using horizontal cabling from the MDA, reducing the number of connections from six to two, and reducing the number of patch cords.

A.1.2 Baluns E-3 and T-3 circuits

Baluns permit E-3 and T-3 circuits to use twisted-pair cabling instead of 75-ohm coaxial cabling.

Lengths for E-3 and T-3 circuits over twisted-pair cabling depends on a number of factors, including the electrical characteristics of the baluns, which are beyond the scope of this Standard. However, lengths for E-3 and T-3 circuits over twisted-pair cabling using baluns will be considerably shorter than the lengths for these circuits over 734 type coaxial cabling.

Taking into account only the insertion loss of the cabling and two twisted-pair connections, the maximum lengths for E-3 and T-3 circuits with baluns over twisted-pair cabling is:

Table 8: Maximum circuit lengths over baluns NOT including insertion loss of baluns

Circuit type	Category 5e Cable & Panels	Category 6 Cable & Panels	Category 6A Cable & Panels
T-3	60.0 m (196.8 ft)	67.8 m (222.5 ft)	69.3 m (227.4 ft)
CEPT-3 (E-3)	66.2 m (217.2 ft)	74.5 m (244.2 ft)	75.9 m (249.1 ft)

These calculations assume that the baluns are attached directly to the access provider DSX panel, that there is no customer DSX panel, and that there are two twisted-pair connections. The lengths above need to be reduced by the following lengths for each decibel of insertion loss for the pair of baluns:

Table 9: Reduction in maximum circuit length for each 1 dB insertion loss for a pair of baluns

Circuit type	Category 5e Cable & Panels	Category 6 Cable & Panels	Category 6A Cable & Panels
T-3	10.2 m (33.4 ft)	11.1 m (36.6 ft)	11.4 m (37.4 ft)
CEPT-3 (E-3)	11.7 m (38.3 ft)	12.8 m (41.9 ft)	13.0 m (42.7 ft)

If the circuit is to pass through more than two connections, the circuit lengths will need to be reduced as described in table 10.

Table 10: Reduction in maximum circuit length for each additional twisted-pair connection (after the 1st two)

Circuit type	Category 5e Cable & Panel	Category 6 Cable & Panel	Category 6A Cable & Panel
T-3	1.9 m (6.3 ft)	1.1 m (3.5 ft)	1.1 m (3.5 ft)
CEPT-3 (E-3)	1.9 m (6.3 ft)	1.1 m (3.5 ft)	1.1 m (3.5 ft)

A.1.3 TIA-232 and TIA-561 console connections

The recommended maximum lengths for TIA-232-F and TIA-561/562 console connections up to 20 kb/s are:

- 23.2 m (76.2 ft) over category 3 balanced twisted-pair cable;
- 27.4 m (89.8 ft) over category 5e or higher balanced twisted-pair cable.

The recommended maximum lengths for TIA-232-F and TIA-561/562 console connections up to 64 kb/s are:

- 8.1 m (26.5 ft) over category 3 balanced twisted-pair cable;

- 9.5 m (31.2 ft) over category 5e or higher balanced twisted-pair cable.

A.2 Cross-connections

In the entrance room, MDA, IDA, and HDA, jumper and patch cord lengths used for cross-connection to backbone cabling should not exceed 20 m (66 ft).

The only exception to these length restrictions should be in the case of 75-ohm coaxial cables, for DS-3 patching, the maximum length should be 5 m (16.4 ft) for type 734 coaxial and 2.5 m (8.2 ft) for type 735 coaxial in the entrance room, main cross-connect, intermediate cross-connect, and horizontal cross-connects.

A.3 Separation of functions in the main distribution area

The MDA should have separate racks for balanced twisted-pair, coaxial cable, and optical fiber distribution unless the data center is small and the main cross-connect can fit in one or two racks. Separate patching bays for balanced twisted-pair cables, coaxial cables, and optical fiber cables simplify management and serves to minimize the size of each type of patching bay. Arrange patching bays and equipment in close proximity to minimize patch cord lengths.

A.3.1 Twisted-pair main cross-connect

The twisted-pair main cross-connect (MC) supports twisted-pair cable for a wide range of applications including low speed circuits, T-1, E-1, consoles, out-of-band management, KVM, and LANs.

Consider installing category 6A twisted-pair cabling for all balanced twisted-pair cabling from the MC to the intermediate cross-connects (ICs) and HCs, as this will provide maximum flexibility for supporting a wide variety of applications. Cabling from the E-1/T-1 demarcation area in the entrance room should be 4-pair category 5e or higher.

The type of terminations in the MC (IDC connecting hardware or patch panels) depends on the desired density and where the conversion from 1- and 2-pair access provider cabling to 4-pair computer room structured cabling occurs:

- if the conversion from 1- and 2-pair access provider cabling occurs in the entrance room, then balanced twisted-pair cable terminations in the MC are typically on patch panels. This is the recommended configuration;
- if the conversion from 1- and 2-pair access provider cabling occurs in the MC, then balanced twisted-pair cable terminations in the MC should be on IDC connecting hardware.

A.3.2 Coaxial main cross-connect

The coaxial MC supports coaxial cable for T-3 and E-3 cabling (two coaxial cables per circuit). For smaller data centers and shorter cable runs, 735-type coaxial cable may be considered. All other coaxial cabling should be 734-type coaxial cable.

Termination of coaxial cables should be on patch panels with 75-ohm BNC connectors. The BNC connectors should be female-BNC on both the front and back of the patch panels.

A.3.3 Optical fiber main cross-connect

The fiber MC supports optical fiber cable for local area networks, storage area networks, metropolitan area networks, computer channels, and SONET circuits.

Termination of fiber cables should be on optical fiber patch panels.

A.4 Separation of functions in the horizontal distribution area

HDAs should have separate cabinets or racks for balanced twisted-pair, coaxial cable, and optical fiber distribution unless the horizontal cross-connect is small and only requires one or two racks. Separate patching bays for balanced twisted-pair cables, coaxial cables, and optical fiber cables simplify management and minimize the size of each type of patching bay. Arrange patching bays and equipment in close proximity to minimize patch cord lengths.

The use of a single type of cable simplifies management and improves flexibility to support new applications. Consider installing only one type of balanced twisted-pair cable and only one type of optical fiber cable for horizontal cabling (for example all category 6 or all category 6A, and all OM4 cable or all OM3 cable).

A.5 Cabling to end equipment

Equipment cord lengths from the ZDA to floor standing systems in which patch panels cannot be installed should be limited to a maximum of 22 m (72 ft), equipment cord lengths from the ZDA to systems install in cabinets in which patch panels can be installed should be limited to a maximum of 10 m (33 ft).

If individual equipment outlets are located on the same equipment rack or cabinet as the equipment served in lieu of a ZDA, equipment cord lengths should be limited to 5 m (16 ft).

A.6 Fiber design consideration

High termination density can be achieved using multi-fiber increments and the use of MPO connectors. If cable lengths can be accurately pre-calculated, pre-terminated multi-fiber cable assemblies can reduce installation time. In these cases, the effects of additional connections should be considered to ensure overall fiber system performance. High data-rate end equipment may accommodate multi-fiber connectors directly (e.g., 40/100G Ethernet with multimode optical fiber).

A.7 Balanced twisted-pair design consideration

The patch panels should provide adequate space for labeling of each patch panel with its identifier as well as labeling each port as per ANSI/TIA-606-C requirements.

ANNEX B (INFORMATIVE) ACCESS PROVIDER INFORMATION

This annex is informative only and is not part of this Standard.

B.1 Access provider coordination

B.1.1 General

Data center designers should coordinate with local access providers to determine the access providers' requirements and to ensure that the data center requirements are provided to the access providers.

B.1.2 Information to provide to access providers

Access providers will typically require the following information for planning entrance rooms for a data center:

- address of the building;
- general information concerning other uses of the building, including other tenants;
- plans of telecommunications entrance conduits from the property line to the entrance room, including location of maintenance holes, hand holes, and pull boxes;
- assignment of conduits and innerducts (or soft-sided subducts) to the access provider;
- floor plans for the entrance facilities;
- assigned location of the access providers protectors, racks, and cabinets;
- routing of cables within entrance room (under access floor, overhead cable ladders, other);
- expected quantity and type of circuits to be provisioned by the access provider;
- date that the access provider will be able to install entrance cables and equipment in the entrance room;
- requested location and interface for demarcation of each type of circuit to be provided by the access provider;
- requested service date; and
- name, telephone number, and email address of primary customer contact and local site contact.

B.1.3 Information that the access providers should provide

The access provider should provide the following information:

- conduit requirements, including:
    - size and quantity
    - innerduct (or soft-sided subduct) size and quantity (if owner installed)
    - bend limitations
    - pull string placement
    - minimum burial depth
    - locate wire or locate ball placement
    - stub up location and specifications
- bonding requirements;
- backboard sizing;
- final grading and landscape impact;

- handhole or maintenance hole location;
- space and mounting requirements for protectors on balanced twisted-pair cables;
- quantity and dimensions of access provider racks and cabinets;
- power requirements for equipment, including receptacle types;
- service clearances; and
- installation and service schedule.

B.2 Access provider demarcation in the entrance room

B.2.1 Organization

The entrance room will have up to four separate areas for access provider demarcation:

- demarcation for low-speed balanced twisted-pair circuits, including DS-0, ISDN BRI, and telephone lines;
- demarcation for high-speed DS-1 (T-1 or fractional T-1, ISDN PRI) or CEPT-1 (E-1) balanced twisted-pair circuits;
- demarcation for circuits delivered on coaxial cable including DS-3 (T-3) and CEPT-3 (E-3); and
- demarcation for optical fiber circuits (for example, SONET OC-x, SDH STM-x, Fast Ethernet, Gigabit Ethernet, 10 Gigabit Ethernet, 40 Gigabit Ethernet, and 100 Gigabit Ethernet).

Ideally, all access providers provide demarcation for their circuits in the same location rather than in their own racks. This simplifies cross-connects and management of circuits. The centralized location for demarcation to all access providers is often called meet-me areas or meet-me racks. There should be separate meet-me or demarcation areas or racks for each type of circuit; low speed, E-1/T-1, E-3/T-3, and optical fiber. Cabling from the computer room to the entrance room should terminate in the demarcation areas.

If an access provider prefers to demarcate their services in their racks, the customer can install tie-cables from that access provider's demarcation point to the desired meet-me/demarcation area.

B.2.2 Demarcation of low-speed circuits

Access providers should be asked to provide demarcation of low-speed circuits on IDC connecting hardware. While service providers may prefer a specific type of IDC connecting hardware (e.g., 66 block), they may be willing to hand off circuits on another type of IDC connecting hardware upon request.

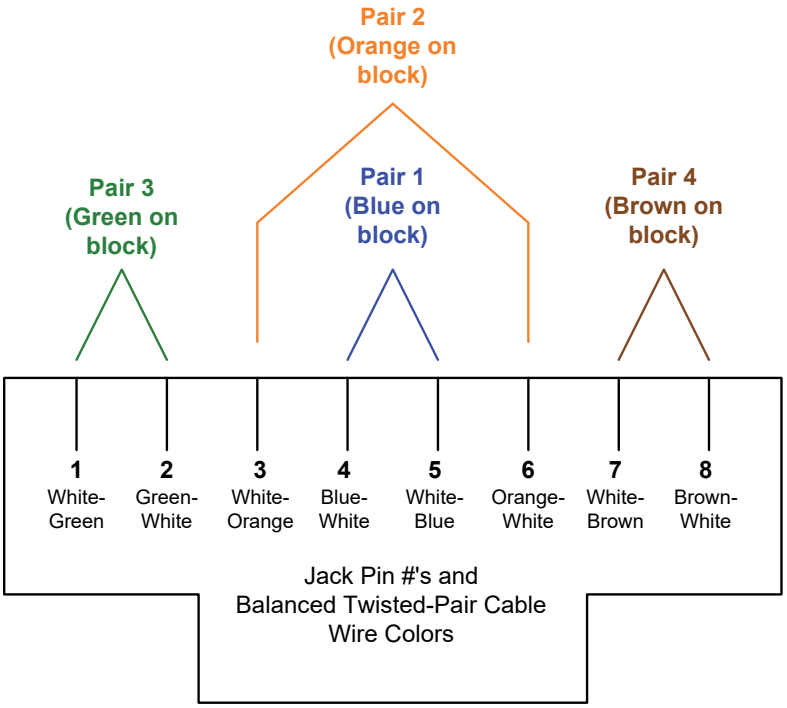
Cabling from the low-speed circuit demarcation area to the MDA should be terminated on IDC connecting hardware near the access provider IDC connecting hardware.

Circuits from access providers are terminated either in one or two pairs on the access provider IDC connecting hardware. Different circuits have different termination sequences, as illustrated in Figure 15 and Figure 16.

Each 4-pair cable should be terminated in an eight-position modular jack at the EDA. The 100 ohm balanced twisted-pair equipment outlet/connector should meet the modular interface requirements specified in IEC 60603-7. In addition, the telecommunications outlet/connector for 100 ohm balanced twisted-pair cable should meet the requirements of ANSI/TIA-568.2-D and the terminal marking and mounting requirements specified in ANSI/TIA-570-C.

Pin/pair assignments should be as shown in Figure 15 or, optionally, per Figure 16 if necessary to accommodate certain 8-pin cabling systems. The colors shown are associated with the horizontal

distribution cable. These illustrations depict the front view of the equipment outlet and provide the list of the pair position for various circuit types.



(View from Front of Jack or Back of Plug)

1) **Phone Lines**:1-pair cross-connect to Pair 1**(Blue**)

2) **ISDN BRI U-Interface (U.S.)**: 1-pair cross-connect to Pair 1 (**Blue)**

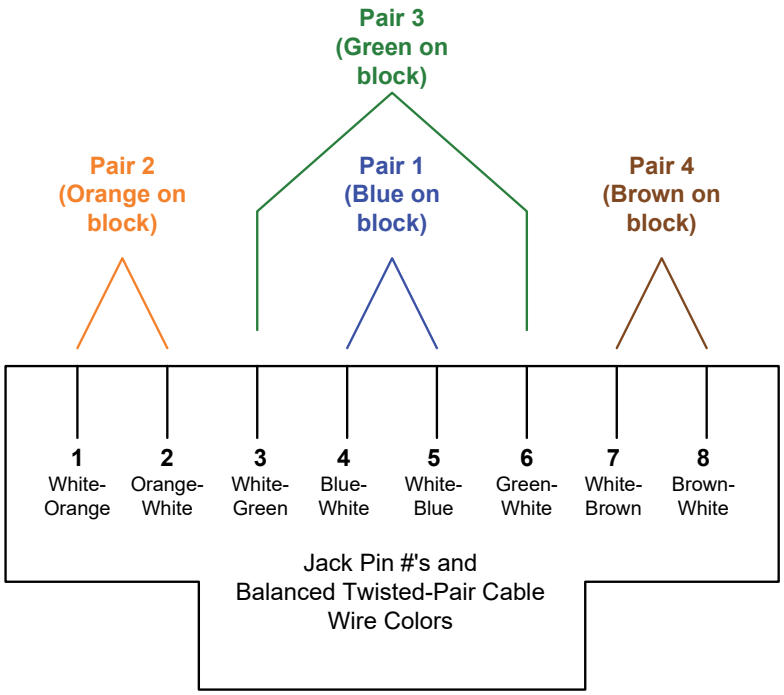
3) **ISDN BRI S/T-Intf (Intl)**: 2-pair cross-connect to Pairs 1 & 2 (**Blue** & **Orange**)

4) **56k/64k Leased Line**: 2-pair cross-connect to Pairs 3 & 4 (**Green** & **Brown**)

5) **E1/T1**: 2-pair cross-connect to Pairs 1 & 3 (**Blue** & **Green**)

6) **10Base-T/100Base-T**: 2-pair cross-connect to Pairs 2 & 3 (**Orange** & **Green**)

Figure 15: Cross-connection circuits to IDC connecting hardware cabled to modular jacks in the T568A 8-pin sequence



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5) **E1/T1**: 2-pair cross-connect to Pairs 1 & 2 (**Blue** & **Orange**)

6) **10Base-T/100Base-T**: 2-pair cross-connect to Pairs 2 & 3 (**Orange** & **Green**)

Figure 16: Cross-connection circuits to IDC connecting hardware cabled to modular jacks in the T568B 8-pin sequence

The conversion from access provider 1-pair and 2-pair cabling to 4-pair cabling used by the data center structured cabling system can occur either in the low-speed circuit demarcation area or in the main distribution area (MDA).

The access provider and customer IDC connecting hardware can be mounted on a plywood backboard, frame, rack, or cabinet. Dual-sided frames should be used for mounting large numbers of IDC connecting hardware (3000+ pairs).

B.2.3 Demarcation of T-1 circuits

Access providers should be asked to hand-off T-1 circuits on RJ48X jacks (individual 8-position modular jacks with loop back), preferably on a DSX-1 patch panel mounted on a customer-owned rack installed in the DS-1 demarcation area. Patch panels from multiple access providers and the customer may occupy the same rack.

For example, in the United States and Canada, access providers typically use DSX-1 patch panels that fit 585 mm (23 in) racks. Thus, the DS-1 demarcation area should use one or more 585 mm (23 in) racks for access provider DS-1 patch panels. These same racks or adjacent 480 mm (19 in) racks can accommodate patch panels for cabling to the MDA. Outside the United States and Canada, access providers typically use DSX-1 panels that fit in 480 mm (19 in) racks.

The DSX-1 patch panels may require power for indicator lights. Thus, racks supporting access provider DSX-1 patch panels should, at minimum have one 20A 120V circuit and a multi-outlet power strip.

Allocate rack space for access provider and customer patch panels including growth. Access providers may require rack space for rectifiers to power DSX-1 patch panels.

Access providers can alternatively hand off DS-1 circuits on IDC connecting hardware. These IDC connecting hardware can be placed on the same frame, backboard, rack, or cabinet as the IDC connecting hardware for low-speed circuits.

A single 4-pair cable can accommodate one T1 transmit and receive pair. When multiple T1 signals are placed over multi-pair unshielded twisted-pair cable, the transmitted signals should be placed in one cable and the receive signals placed in a separate cable.

If the data center support staff has the test equipment and knowledge to troubleshoot T-1 circuits, the DS-1 demarcation area can use DSX-1 panels to terminate T-1 cabling to the MDA. These DSX-1 panels should have either modular jacks or IDC terminations at the rear.

The IDC connecting hardware, modular jack patch panels, or DSX-1 panels for cabling to the MDA can be on the same or separate racks, frames, or cabinets as the ones used for access provider DSX-1 patch panels. If they are separate, they should be adjacent to the racks assigned to the access providers.

The customer (data center owner) may decide to provide its own multiplexers (M13 or similar multiplexer) to demultiplex access provider T-3 circuits to individual T-1 circuits. T-1 circuits from a customer-provided multiplexer should not be terminated in the T-1 demarcation area.

B.2.4 Demarcation of E-3 & T-3 circuits

Access providers should be asked to hand-off E-3 or T-3 circuits on pairs of female BNC connectors, preferably on a DSX-3 patch panel on a customer-owned rack installed in the E-3/T-3 demarcation area. Patch panels from multiple access providers and the customer may occupy the same rack.

In the United States and Canada, access providers typically use DSX-3 patch panels that fit 585 mm (23 in) racks. Thus, the E-3/T-3 demarcation area should use one or more 585 mm (23 in) racks for access provider DSX-3 patch panels. These same racks or adjacent 480 mm (19 in) racks can accommodate patch panels for cabling to the MDA. Outside North America, access providers typically use DSX-3 panels that fit 480 mm (19 in) racks.