



MEF Standard

MEF 151

Cross-Connection Service Attributes

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1 List of Contributing Members

The following members of the MEF participated in the development of this document and have requested to be included in this list.

- Amartus
- Bell Canada
- Colt
- Nokia

2 Abstract

Service Providers often deliver services to locations where cross-connections between the Service Provider and Subscriber, or between two Operators, are managed by a third party such as a data center provider or multi-tenant building owner. This organization is known as the Cross-Connection Provider within this Standard. The ability to describe and request these cross-connections is required. The scope of the cross-connections described within this document is limited to Ethernet, what is commonly referred to as “Layer 0” through OSI Layer 2.

3 Terminology and Abbreviations

This section defines the terms used in this document. In many cases, the normative definitions to terms are found in other documents. In these cases, the third column is used to provide the reference that is controlling, in other MEF or external documents.

Terms defined in MEF 61.1.1 [7], MEF 63 [8] and MEF 130 [9] are included in this document by reference and are not repeated in the table below.

Term	Definition	Reference
Cross-Connection Provider	The organization responsible for providing the Cross-Connection.	This document
External Interface	The Socket on a patch panel.	This document
Identifier String	A string consisting of at least one but not more than 53 UTF-8 characters in the range of 32–126 (0x20 to 0x7e), inclusive.	This document
Physical Layer entity	The portion of the Ethernet Physical Layer between and including the Medium Dependent Interface (MDI) and the media independent interface specific to the data rate (e.g., MII, GMII, XGMII). It contains the functions that transmit, receive, and manage the encoded signals that are impressed on and recovered from the physical medium.	Adapted from IEEE 802.3 [1]
Type-0 Cross-Connection	A service that uses or emulates a cable, optical or electrical, as a means to connect two External Interfaces together	This document
Type-1 Cross-Connection	A service connecting two External Interfaces together at the PCS layer	This document
Type-2 Cross-Connection	A service which connects two External Interfaces together at the MAC layer	This document

Table 1 – Terminology

Abbreviation	Definition	Reference
MAC	Media Access Control	IEEE 802.3 [1]
OSI	Open Systems Interconnection	ISO 7498 [5]
PCS	Physical Coding Sublayer	IEEE 802.3 [1]
PHY	Physical Layer entity	IEEE 802.3 [1]
PMA	Physical Medium Attachment	IEEE 802.3 [1]
PMD	Physical Medium Dependent	IEEE 802.3 [1]

Table 2 – Abbreviations

4 Compliance Levels

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**NOT RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in BCP 14 (RFC 2119 [3], RFC 8174 [4]) when, and only when, they appear in all capitals, as shown here. All key words must be in bold text.

Items that are **REQUIRED** (contain the words **MUST** or **MUST NOT**) are labeled as [**Rx**] for required. Items that are **RECOMMENDED** (contain the words **SHOULD** or **SHOULD NOT**) are labeled as [**Dx**] for desirable. Items that are **OPTIONAL** (contain the words **MAY** or **OPTIONAL**) are labeled as [**Ox**] for optional.

5 Introduction

Service Providers often deliver services to locations where cross-connections between the Service Provider and Subscriber, or between two Operators, are managed by a third party such as a data center provider or multi-tenant building owner (Cross-Connection Provider). The ability to describe and request these cross-connections is required. The scope of the cross-connections described within this document is limited to Ethernet, what is commonly referred to as “Layer 0” through OSI Layer 2. Three cross-connection types are defined in Sections 5.1, 5.2, and 5.3, and can be described informally as follows:

- Type-0
 - A service which uses or emulates an optical or electrical cable to connect two External Interfaces at what is commonly referred to as “Layer 0”
 - Does not terminate the IEEE 802.3 Physical Layer entity (PHY)
- Type-1
 - A service which connects two External Interfaces at OSI Layer 1
 - Makes the cross-connection at the IEEE 802.3 Physical Coding Sublayer (PCS) layer
- Type-2
 - A service which connects two External Interfaces together at OSI Layer 2
 - Terminates the PHY, makes the cross-connection at the IEEE 802.3 Media Access Control (MAC) layer, and then sources another PHY

The locations of the three types of cross-connections in relation to a generalized depiction of the IEEE 802.3 architectural model are shown in Figure 1.

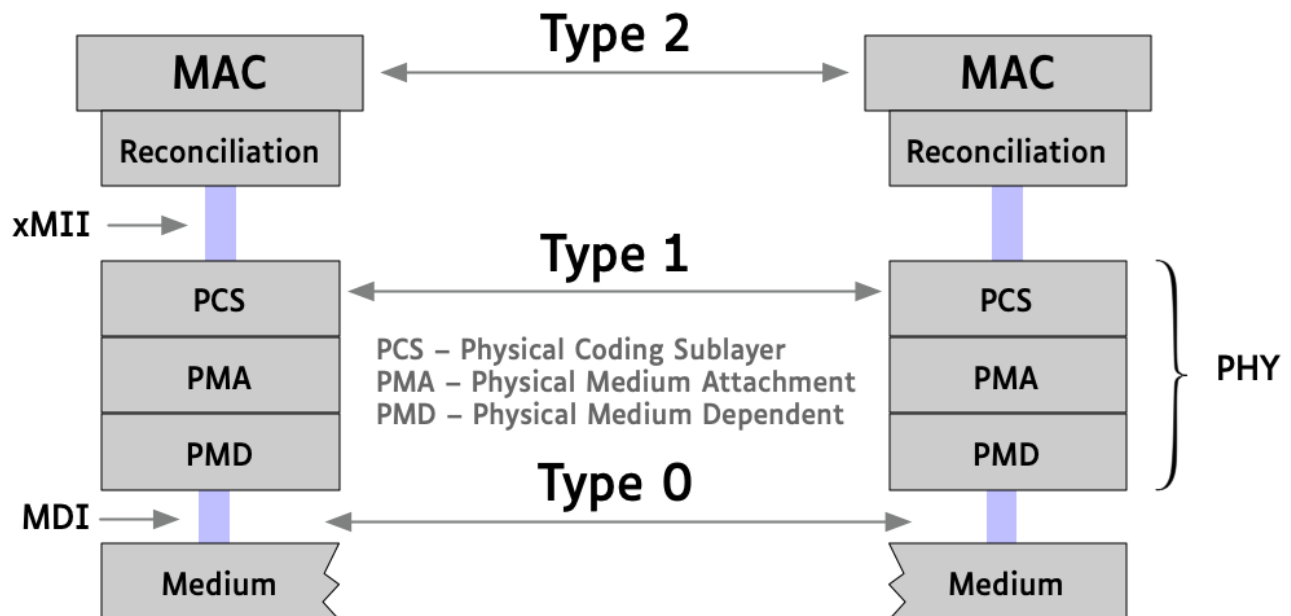


Figure 1 – Architectural Locations of Cross-Connection Types

This document defines Common (Section 6), Type-0 (Section 7), Type-1 (Section 8), and Type-2 (Section 9) Cross-Connection Service Attributes. These Service Attributes allow the cross-connection to be described, identifying both ends of the cross-connection. The Cross-Connection Service terminates with a connector that is a Socket (as defined in MEF 61.1.1 [7]) on a patch panel. The parties using the cross-connection are responsible for providing cables each with an appropriate Plug (as defined in MEF 61.1.1 [7]) for the cross-connection’s Sockets.

This document does not define cross-connections at the VLAN layer. Such cross-connections can be described using existing MEF Standards. For example, a VLAN layer cross-connection between two ENNIs can be described as an E-Transit service in MEF 51.1 [6].

5.1 Type-0 Cross-Connection

A Type-0 Cross-Connection is defined as a point-to-point service that uses or emulates a cable, optical or electrical, as a means to connect two External Interfaces together. A Type-0 Cross-Connection does not terminate the IEEE 802.3 PHY, an example of which is shown in Figure 2.

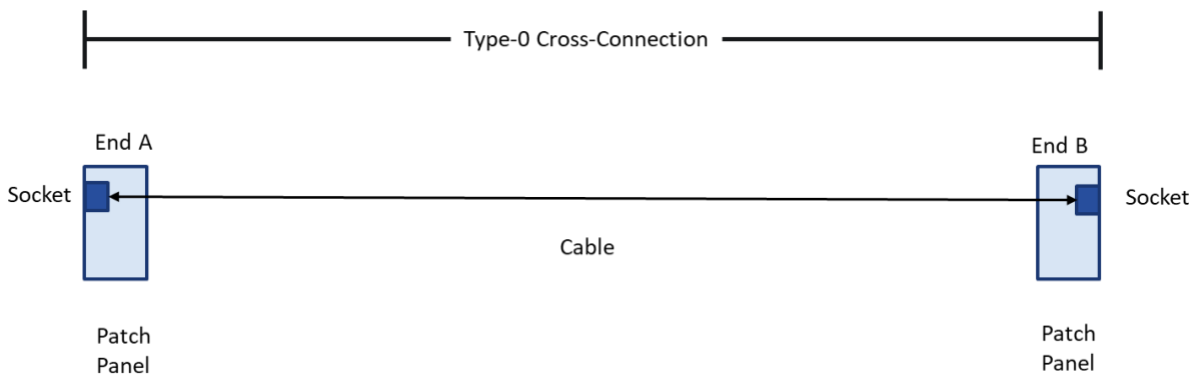


Figure 2 – Type-0 Cross-Connection Example

Figure 2 shows an example of a Type-0 Cross-Connection that provides connectivity between two patch panel Sockets (which could be in a data center) using a cable of some type. The patch panel may be located in a co-location cage, external to the co-location cage, or intermediate “Meet Me” room. The Service Attributes and their values are defined in sections 6 and 7 and are agreed to by all parties involved in the cross-connection.

Other examples of a Type-0 Cross-Connection include when one or more intermediate patch panels are used instead of just a single cable or where a photonic device is used to connect the two patch panel Sockets together. These examples of Type-0 Cross-Connections are not described in detail within this document.

5.2 Type-1 Cross-Connection

A Type-1 Cross-Connection is defined as a point-to-point service connecting two External Interfaces together at the PCS layer.

An example of a Type-1 Cross-Connection is shown in Figure 3.

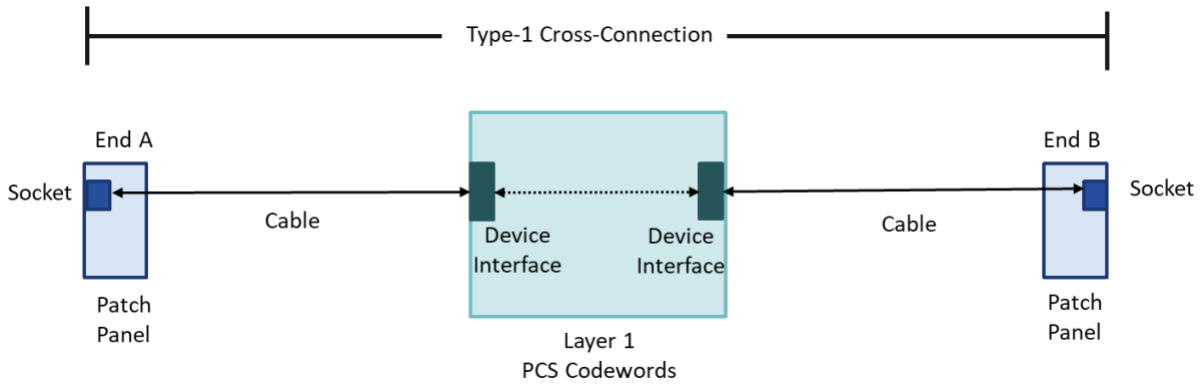


Figure 3 – Type-1 Cross-Connection Example

Figure 3 shows an example of a Type-1 Cross-Connection that provides connectivity between two patch panel Sockets (which could be in a data center). The patch panel may be located in a co-location cage, external to the co-location cage, or intermediate “Meet Me” room. Since the connection is made at the PCS layer, this Cross-Connection is transparent to most or all Layer 2 Control Protocols such as Link Aggregation (defined in IEEE 802.1AX-2020™). A Layer 1 device that makes connections using PCS codewords is a necessary component of a Type-1 Cross-Connection, its interfaces are described by the Cross-Connection Device Interface Service Attribute (Section 8.1). The Service Attributes and their values in Sections 6 and 8 are agreed to by all parties involved in the cross-connection.

5.3 Type-2 Cross-Connection

A Type-2 Cross-Connection is defined as a point-to-point service which connects two External Interfaces together at the MAC layer. It terminates the PHY, makes the cross-connection at the MAC layer, and then sources another PHY. Figure 4 shows an example of a Type-2 Cross-Connection.

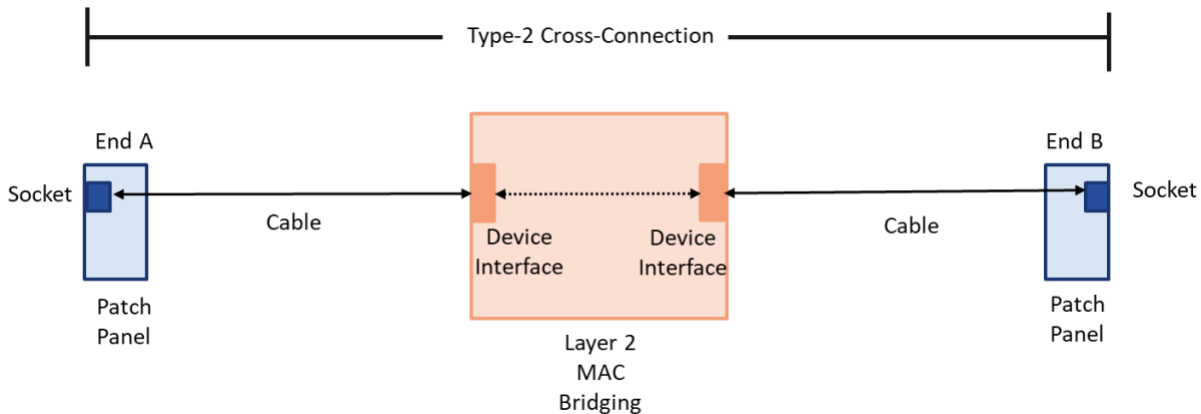


Figure 4 – Type-2 Cross-Connection Example

Figure 4 shows an example of a Type-2 Cross-Connection that includes a Layer 2 MAC Bridging Device (which could be located in a Data Center). The patch panel may be located in a co-location cage, external to the co-location cage, or intermediate “Meet Me” room. In most cases Layer 2 Control Protocols are identified and discarded. The Type-2 Cross-Connection includes the two

External Interfaces on the MAC Bridging device. The Service Attributes and their values in Sections 6 and 9 are agreed to by all parties involved in the cross-connection.

5.4 Example of Combinations of Cross-Connection Types

Different Cross-Connection Types can be combined to connect two EIs together. In this example, a Type-1 Cross-Connection is combined with two Type-0 Cross-Connections to provide a connection between the two co-location cages.

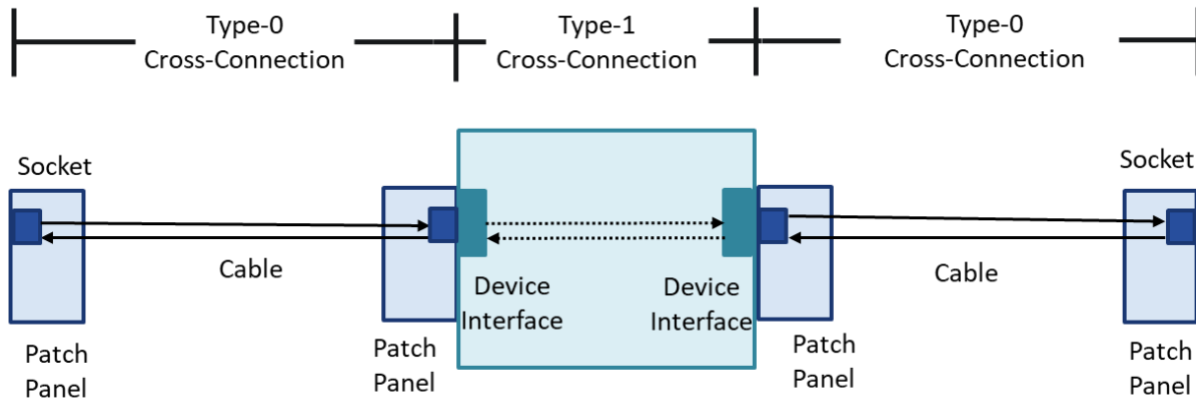


Figure 5 – Type-0 and Type-1 Cross-Connections Example

6 Common Cross-Connection Service Attribute Definitions and Requirements

The Service Attributes defined within this section apply to the three types of Cross-Connection services defined in section 5.

6.1 Identifier String

The Identifier String is used for various identifiers within this standard.

- [R1] An Identifier String **MUST** be a string consisting of at least one but not more than 53 UTF-8 characters in the range of 32–126 (0x20 to 0x7e), inclusive.

6.2 Cross-Connection Service Identifier

The Cross-Connection Service Identifier uniquely identifies the Cross-Connection Service.

- [R2] The Cross-Connection Service Identifier **MUST** be an Identifier String.
- [R3] Each Cross-Connection Service Identifier **MUST** be unique among all of the Cross-Connection Provider's Cross-Connection services.

6.3 Cross-Connection External Interface Identifier Service Attribute

The Cross-Connection External Interface Identifier Service Attribute uniquely identifies the External Interface at one end of the Cross-Connection.

- [R4] The Cross-Connection External Interface Identifier **MUST** be an Identifier String.
- [R5] Each Cross-Connection External Interface Identifier **MUST** be unique within a given Cross-Connection.

6.4 Cross-Connection External Interface Type Service Attribute

The Cross-Connection External Interface Type Service Attribute describes the cable and connector to be used at a given External Interface in the Cross-Connection. It is derived from the Data Cable Service Attribute defined in MEF 130 [9].

The Cross-Connection External Interface Type Service Attribute is defined as a 3-tuple containing *<CrossConnectionExternalInterfaceIdentifier, CableType, ExternalInterface>*.

- The *CrossConnectionExternalInterfaceIdentifier* parameter value is as specified in section 6.3.
- The value of *CableType* parameters is one of the following:
 - *Cat5 Ethernet*
 - *Cat5e Ethernet*

- *Cat6 Ethernet*
 - *Cat6e Ethernet*
 - *Single Mode Fiber*
 - *Multi-mode Fiber 50-micron core*
 - *Multi-mode Fiber 62.5-micron core*
- The value of *ExternalInterface* parameter indicates the Connector Type per Table A1-5 of MEF 61.1.1 [7] Section A1-1.3.1.

The following requirement applies to the Cross-Connection External Interface Type Service Attribute.

- [R6]** *ExternalInterface* parameter of the Cross-Connection External Interface Type Service Attribute **MUST** be used to describe the external-facing Socket at the patch panel.

Note: While the Service Attributes defined in this section are derived from MEF 130 [9], they do not include all the attributes and parameters defined in that document.

7 Type-0 Cross-Connection Requirements

This section specifies the requirements for a Type-0 Cross-Connection in addition to the Common Service Attributes (section 6).

- [R7] A Type-0 Cross-Connection **MUST** transport the signal received at the ingress External Interface transparently (i.e., bit identical) to the egress External Interface.

The following requirement applies to the Type-0 Cross-Connection.

- [R8] For a Type-0 Cross-Connection the values of the *CableType* parameters of the Cross-Connection External Interface Type Service Attribute **MUST** be the same at each Cross-Connection External Interface of the Cross-Connection.
- [O1] For a Type-0 Cross-Connection the values of the *ExternalInterface* parameters of the External Interface Type Service Attribute **MAY** be different at each Cross-Connection External Interface of the Cross-Connection.

8 Type-1 Cross-Connection Requirements

This section defines the Service Attributes of a Type-1 Cross-Connection, in addition to the Common Service attributes (section 6). These Service Attributes are derived from those specified in MEF 130 [9] section 7.11, MEF 63 [8] section 8.1.2, and MEF 61.1.1 [7].

- [R9] A Type-1 Cross-Connection **MUST** terminate the incoming signal (received from the ingress External Interface) below the PCS layer, pass the PCS codewords transparently (i.e., bit identical), and source another PHY below the PCS layer to the egress External Interface.

8.1 Cross-Connection Device Interface Service Attribute

The Cross-Connection Device Interface Service Attribute describes the physical interface for one Cross-Connection External Interface of Type-1 and Type-2 Cross-Connections. The value of the Service Attribute is a 4-tuple $\langle \text{CrossConnectionExternalInterfaceIdentifier}, p, c, o \rangle$ adapted from MEF 63 [8] section 8.1.2, where:

- The *CrossConnectionExternalInterfaceIdentifier* parameter value is as specified in section 6.3
- *p* is the Client Protocol, and
- *c* is the Coding Function, (as extended in the following paragraph) and
- *o* is the Interface Function (as extended in the following paragraph).

The values of *c* and *o* are modified by this Standard to include the electrical 10 Mbps, 100 Mbps, and 1000 Mbps physical layer (*pl*) values described in MEF 61.1.1 [7] Table A1-4 as well as the three Connector Types (*ct*) specified in MEF 61.1.1 [7] Table A1-5.

The following requirement applies to the Type-1 Cross-Connection.

- [R10] The value of *p* **MUST** be *Ethernet* at each External Interface involved in a Type-1 Cross-Connection.
- [R11] The value of *c* **MUST** be the same at each External Interface involved in a Type-1 Cross-Connection.
- [R12] The value of *o* **MUST** be specified for each External Interface involved in a Type-1 Cross-Connection.
- [O2] The value of *o* **MAY** be different at each External Interface involved in a Type-1 Cross-Connection.
- [O3] For Type-1 Cross-Connections the value of the *CableType* parameter of the Cross-Connection External Interface Type Service Attribute **MAY** be different at each Cross-Connection External Interface.

- [O4] For Type-1 Cross-Connections, the value of the *ExternalInterface* parameters of the Cross-Connection External Interface Type Service Attribute **MAY** be different at each Cross-Connection External Interface.

9 Type-2 Cross-Connection Requirements

This section specifies the requirements for a Type-2 Cross-Connection in addition to the Common Service attributes (section 6).

- [R13] A Type-2 Cross-Connection **MUST** terminate the Ethernet PHY and perform MAC Bridging (i.e., support a MAC Relay Entity) as defined in IEEE 802.1Q [1].
- [R14] For a Type-2 Cross-Connection, the Cross-Connection Device Interface Identifier Service Attribute **MUST** be as described in section 8.1 and requirements [R10], [R11], [R12], [O2], [O3], and [O4] apply to a Type-2 Cross-Connection.

10 References

- [1] IEEE Std 802.1Q™-2022, *IEEE Standard for Local and metropolitan area networks — Bridges and Bridged Networks*, 2022
- [2] IEEE Std 802.3™-2022, *IEEE Standard for Ethernet*, 2022
- [3] IETF RFC 2119, *Key words for use in RFCs to Indicate Requirement Levels*, by Scott Bradner, March 1997
- [4] IETF RFC 8174, *Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words*, by B Leiba, May 2017, Copyright © 2017 IETF Trust and the persons identified as the document authors. All rights reserved.
- [5] ISO 7498, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model --- Part 1*, November 1994
- [6] MEF 51.1, *Operator Ethernet Service Definition*, December 2018
- [7] MEF 61.1.1, *Amendment to MEF 61.1: UNI Access Link Trunks, IP Addresses, and Mean Time to Repair Performance Metric*, July 2022
- [8] MEF 63, *Subscriber Layer 1 Service Attributes*, August 2018
- [9] MEF 130, *Device Physical and Environmental Service Attributes*, February 2023

Appendix A Cross-Connection Examples (Informative)

This appendix describes the mapping of Service Attributes to the Cross-Connection configurations. The Cross-Connection is provided by a Cross-Connection Provider (third party) that is neither the Subscriber nor the Service Provider.

A.1 Type-0 Cross-Connection

An example of a Type-0 Cross-Connection is shown in Figure 6.

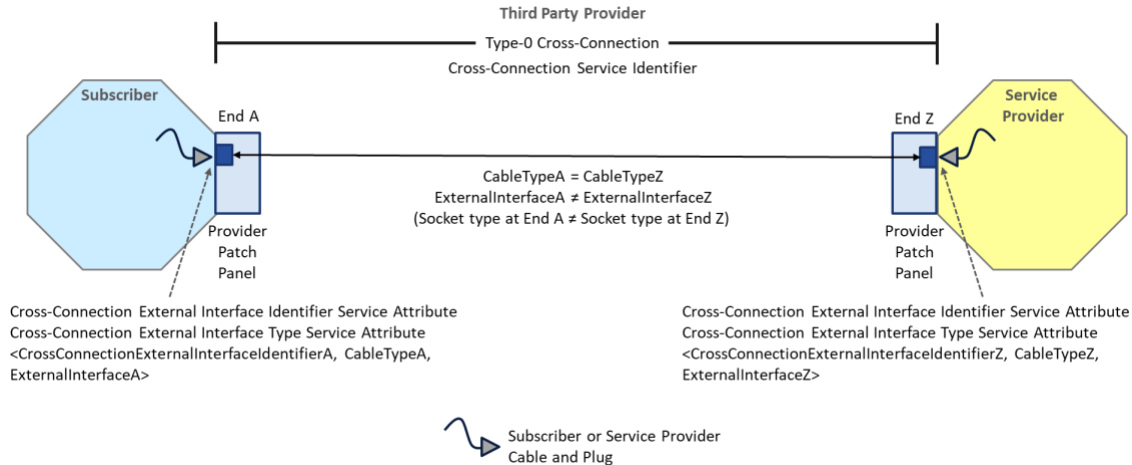


Figure 6 – Example of Type-0 Cross-Connection with Service Attributes

The Type-0 Cross-Connection example shows the Service Attributes at each end of the Cross-Connection. This example also shows the cable and Plug that is inserted into the Socket in the patch panel. In Figure 6, Figure 7, and Figure 8 where an "=" sign is used, such as for "CableTypeA = CableTypeZ", it means the values of those two parameters must be the same. Where a "≠" sign is used, such as for "Socket type at End A ≠ Socket type at End Z", it means the values of those two parameters may be different.

A.2 Type-1 Cross-Connection

An example of a Type-1 Cross-Connection is shown in Figure 7.

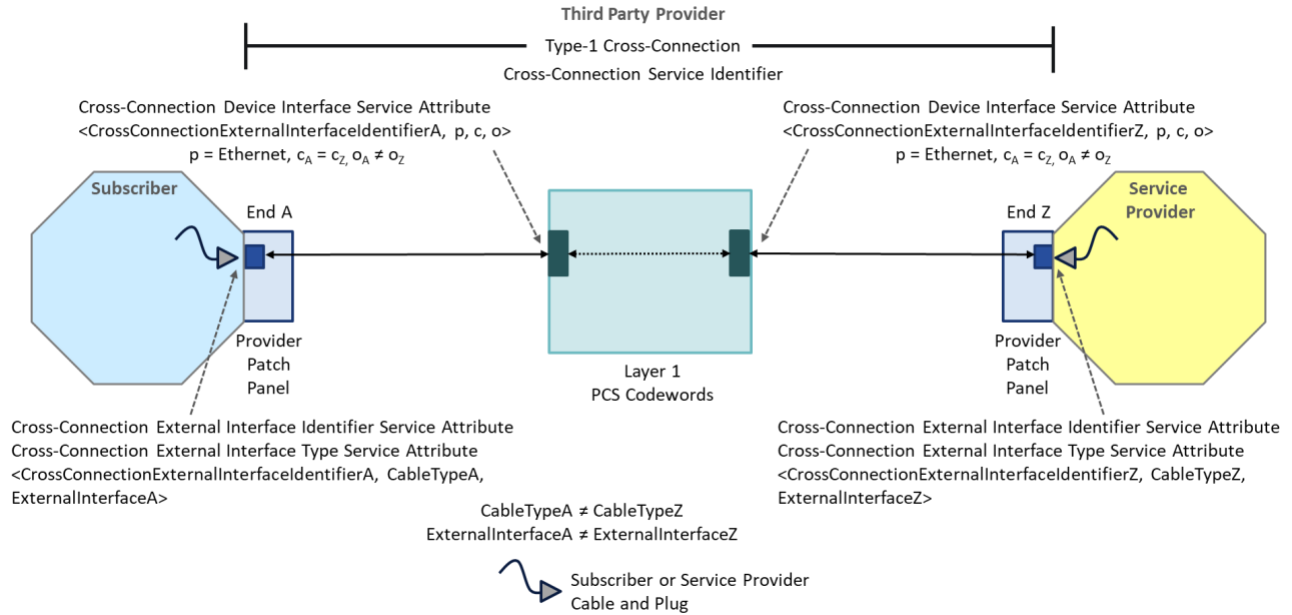


Figure 7 – Example of Type-1 Cross-Connection with Service Attributes

The Type-1 Cross-Connection example shows the Service Attributes at each end of the Cross-Connection. This example also shows the cable and Plug that is inserted into the Socket in the patch panel.

A.3 Type-2 Cross-Connection

An example of a Type-2 Cross-Connection is shown in Figure 8.

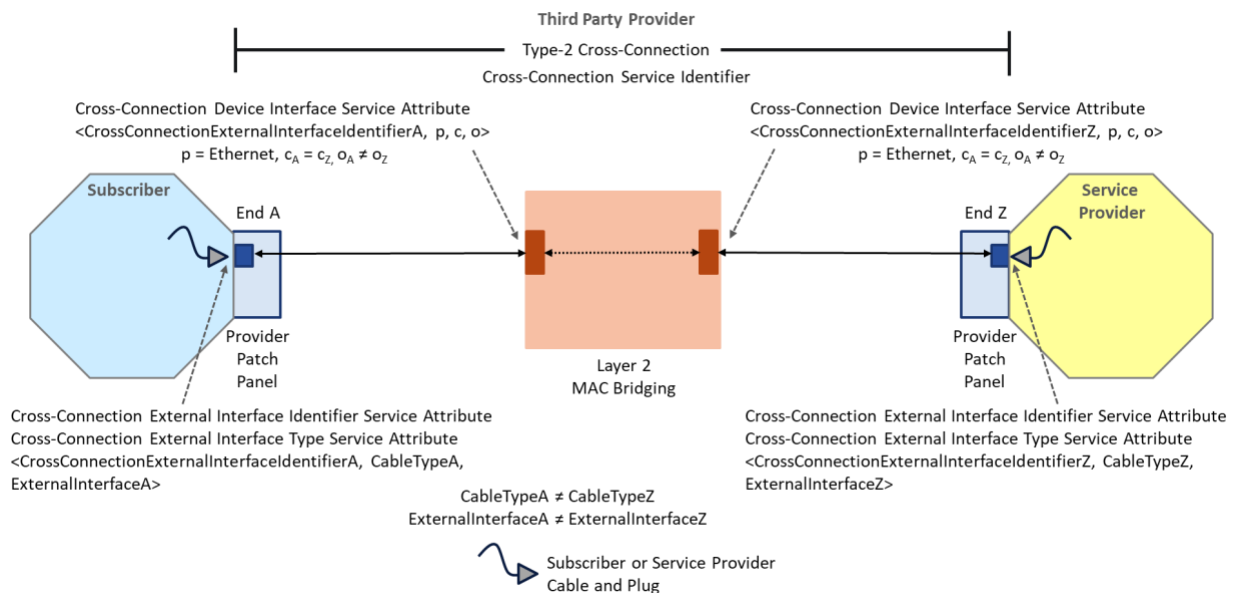


Figure 8 – Example of Type-2 Cross-Connection with Service Attributes

The Type-2 Cross-Connection example shows the Service Attributes at each end of the Cross-Connection. This example also shows the cable and Plug that is inserted into the Socket in the patch panel.

Appendix B Acknowledgements (Informative)

The following contributors participated in the development of this document and have requested to be included in this list.

- Mike **BENCHECK**
- David **MARTIN**
- Fahim **SABIR**
- Larry **SAMBERG**
- Jason **WOLFE**