



TDS Wholesale Carrier Ethernet Services

TDS E-Transit Service Offerings

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1. General

This document provides the specifications of TDS Telecom's (TDS) Wholesale Carrier Ethernet Transit (E-Transit) service offerings. E-Transit standards are currently in progress within the Metro Ethernet Forum (MEF). The current offerings from TDS are based on the principles of "MEF 33 – Ethernet Access Service Definitions" and consist of a standardized Layer 2 service across the TDS CEN and are dedicated to a single Carrier Ethernet Operator. It is the intention of TDS to be MEF compliant from end-to-end once an E-Transit industry standard is published.

1.1. Carrier Ethernet Stakeholders

The MEF defines three principle stakeholders of E-Access Services:

- **Operator** – The organization responsible for a particular CEN in a multi-network Carrier Ethernet Service implementation
- **Service Provider** – The organization from which the Subscriber purchases the Carrier Ethernet service and owner of the service from end-to-end
- **Subscriber** – The end user purchasing the Carrier Ethernet service

1.2. Additional Terminology

The following terms defined and described here are used throughout this document:

- **All-to-One Bundling** – The association of all internal services (C-Tags) at an UNI
- **Bundling** – The association of select, multiple internal services (C-Tags) at an UNI
- **Carrier Ethernet Network (CEN)** – The entire Service Provider or Operator network used to transport Ethernet services
- **Customer Edge equipment (CE)** - The equipment at the Subscriber location that connects to the TDS CPE
- **Ethernet Virtual Connection (EVC)** – The logical association of the entire service connection between two or more external interfaces (both UNIs)
- **External Network-to-Network Interface (ENNI)** – The physical demarcation point between TDS and another Operator
- **Operator Virtual Connection (OVC)** – The logical association of a specific part of the service connection between two or more external interfaces (ENNI or UNI) within an Operator CEN, one of which MUST be an ENNI (generally represented by red and blue dashed lines)
- **OVC End-Point** – The association of a specific OVC with a specific external interface (UNI or ENNI)
- **User-to-Network Interface (UNI)** – The physical demarcation point at a Subscriber location between the TDS CPE and the Service Provider (or Subscriber's) CE

Figure 1 (below) shows the relationship between other Operators and TDS. TDS and the bordering Operators will work together to establish a pair of ENNIs to exchange Ethernet frames between CENs. The Service Provider owns the relationship with the Subscriber and maintains the EVC for end-to-end connectivity. The Service Provider orders an OVC from TDS for the portion of the EVC that traverses the TDS network. In this example, the Service Provider could be Operator 1, Operator 2 or a third party.

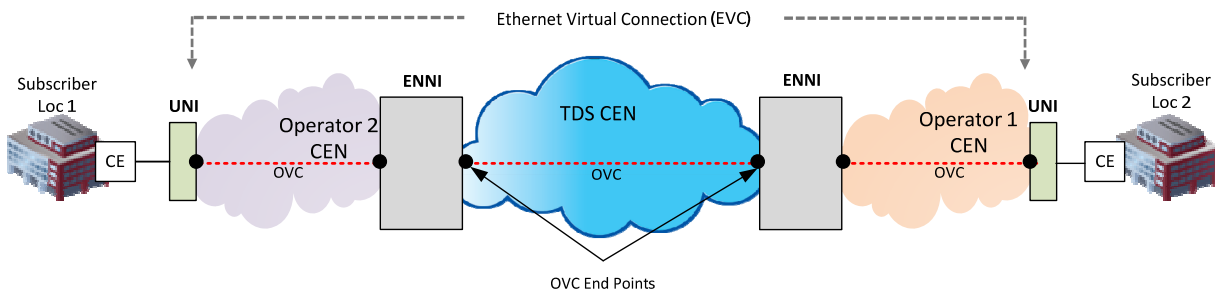


Figure 1: Subscriber/Service Provider/Operator Relationship

2. Carrier Ethernet E-Transit Services

Because E-Transit is not yet a published MEF standard service, TDS provides their E-Transit service based on the standards and service attributes established by the MEF for E-Access. Conformance to MEF principles is highly recommended.

2.1. TDS E-Transit Service

The TDS E-Transit service offering is based on the MEF Technical Specification “MEF 33 - Ethernet Access Service Definitions” and defined below.

2.1.1. E-Transit Ethernet Private Line (Transit EPL)

A Transit EPL service is an ENNI port-based, point-to-point OVC that associates exactly one ENNI with exactly one other ENNI across the TDS CEN. A Transit EPL is a true EPL from end-to-end; therefore no tags are exchanged between Operators. This means the “S-VLAN ID Preservation” attribute has a value of ‘NO’, the “Service Multiplexing” attribute has a value of ‘NO’, the “Bundling” attribute also has a value of ‘NO’ and, therefore, the “All to One Bundling” attribute has a value of ‘YES’. This combination of attributes means all service frames sent from one ENNI is mapped to a single OVC to the other ENNI. There is no need to coordinate a detailed OVC end-point map.

Figure 2 (below) shows an example of a single E-Transit service. The delivery of this service requires a dedicated ENNI handoff on each side, represented by ENNIs A and B.

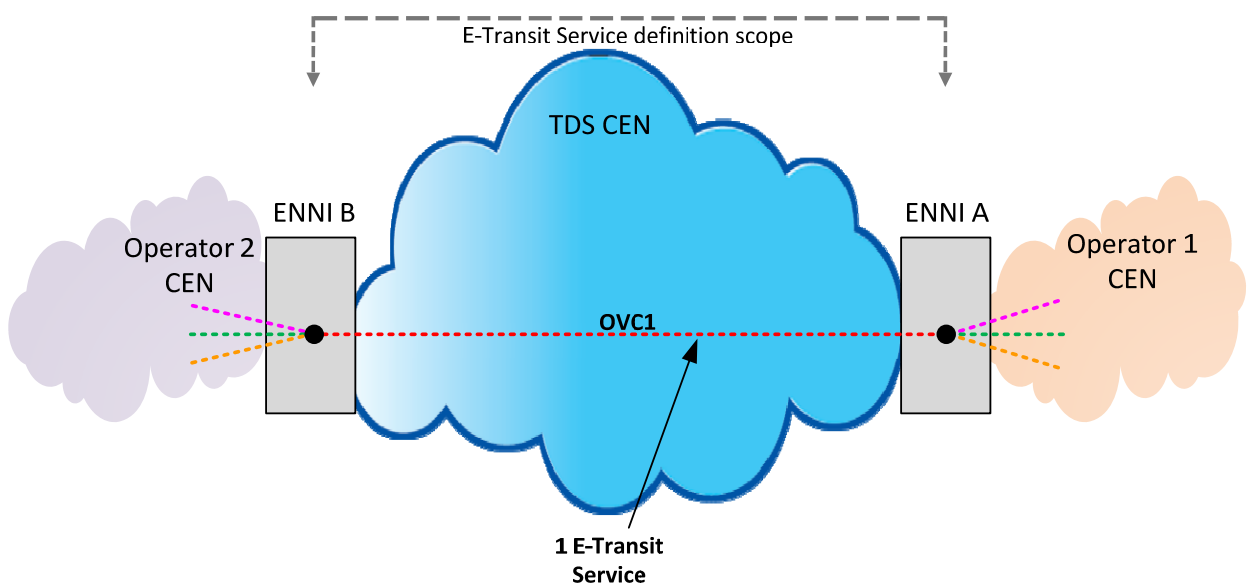


Figure 2: Single Transit EPL

Figure 3 (below) shows an example of one Carrier (Operator 1) ordering an E-Transit service to Operators 2 and 3. The delivery of each E-Transit service requires a dedicated ENNI handoff, represented as ENNIs A, B, C and D. Operator 1 would connect to Operator 2 through the TDS CEN using ENNI A and B. Operator 1 would connect to Operator 3 through the TDS CEN using ENNI C and D.

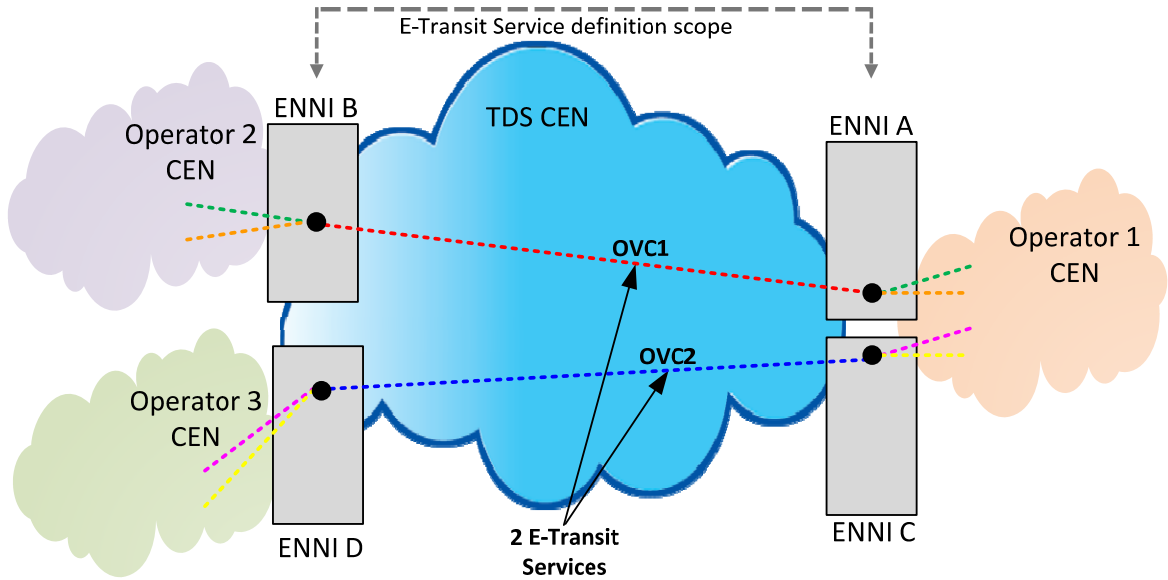


Figure 3: Multiple Transit EPLs

3. Carrier Ethernet E-Access Attributes

3.1. OVC Service Attribute Values

In addition to the service descriptions above, TDS will default to the values shown below for the following OVC Service Attributes:

- OVC MTU Size: 1526 – 9000 Bytes
- CE-VLAN ID Preservation: Yes
- CE-VLAN CoS ID Preservation: Yes
- Ability to provide Service Level Specification (SLS) metrics
- Unicast Service Frame Delivery: Deliver Unconditionally
- Multicast Service Frame Delivery: Deliver Unconditionally
- Broadcast Service Frame Delivery: Deliver Unconditionally
- Layer 2 Control Protocol Tunneling:
 - CDP
 - STP
 - UTP
 - PVST
 - DTP
 - LLDP
 - ULD
 - All others are discarded

3.2. ENNI Service Attributes

Table 1 shows the Physical Mediums supported by the ENNI devices deployed by TDS.

| IEEE Designation | Description |
|------------------|--------------------|
| 1000BASE-SX | MMF; up to 550m |
| 1000BASE-LX | SMF; up to 5,000m |
| 1000BASE-EX | SMF; up to 40,000m |
| 1000BASE-ZX | SMF; up to 70,000m |
| | |
| 10GBASE-SR | MMF; up to 300m |
| 10GBASE-LR | SMF; up to 10,000m |
| 10GBASE-ER | SMF; up to 40,000m |
| 10GBASE-ZR | SMF; up to 80,000m |

Table 1: ENNI Physical Layer Values

TDS deploys the following ENNI Devices:

- Accedian MetroNID-GTS for a 1G ENNI
- Accedian MetroNODE-LTS for a 10G ENNI

Those devices support ENNI Services Attributes with the following values:

- Physical Layer: see Table 1(above)
- Number of Links: 1 or 2
- Protection Mechanism: Link Aggregation or None
- ENNI Maximum Transmission Unit Size: 1526 – 9000 Bytes
- Support for Bandwidth Profiles

3.3. Oversubscription

The Service Provider reserves the right to oversubscribe the 1G or 10G ENNI connection as they choose. However, the responsibility of monitoring the bandwidth on that link falls to the Service Provider. TDS recommends following the MEF recommendation of keeping the sum of the CIR values for all OVCs provisioned on a given ENNI to less than 70% of the ENNI port speed because bandwidth profile algorithms do not count frame overhead (interframe GAP and preamble bits), which consume bandwidth.

4. Service Level Agreements and Management

4.1. Service Level Specifications

TDS offers Service Level Agreements in accordance to the Performance Tiers and Class of Service metrics standardized in MEF 23.1. TDS offers three tiers of SLAs: Premium, Basic and Best Effort. Table 3 (below) details the specifications against which the TDS SLAs are measured:

| TDS Wholesale Commercial Ethernet Performance Metrics | PT1 High Short Reach | PT1 High Standard | PT2 High Standard |
|--|-----------------------------|--------------------------|--------------------------|
| Premium SLA | | | |
| Maximum OVC Distance | 50 miles | 150 miles | 500 miles |
| One-way Frame Delay | 5ms | 10ms | 25ms |
| Inter Frame Delay Variation | 2ms | 3ms | 8ms |
| One-way Frame Loss Ratio | 0.01% | 0.01% | 0.01% |
| One-way Availability | 99.99% | 99.99% | 99.99% |
| Basic SLA | | | |
| Maximum OVC Distance | 50 miles | 150 miles | 500 miles |
| One-way Frame Delay | 30ms | 30ms | 30ms |
| Inter Frame Delay Variation | 10ms | 10ms | 10ms |
| One-way Frame Loss Ratio | 0.10% | 0.10% | 0.10% |
| One-way Availability | 99.90% | 99.90% | 99.90% |
| Best Effort | | | |
| Maximum OVC Distance | 50 miles | 150 miles | 500 miles |
| One-way Frame Delay | BE | BE | BE |
| Inter Frame Delay Variation | BE | BE | BE |
| One-way Frame Loss Ratio | BE | BE | BE |
| One-way Availability | BE | BE | BE |
| ADDITIONAL NOTES | | | |
| * Operators are allowed to provide more stringent values than the Maximum MEF values | | | |
| * Values are not required for both FD and MFD, but at least one must be specified | | | |
| * Values are not required for both IFDV and FDR, but at least one must be specified | | | |
| * All values apply to Green frames only | | | |
| * MEF 23.1 does not define values for multipoint OVCs | | | |

Table 2: SLA Specifications

4.2. Service Activation – Testing and Turn Up

TDS will complete an RFC-2544 service acceptance test all fiber based OVCs ordered with a Premium or Basic SLA. The acceptance test will measure and record One-way Frame Delay, Inter Frame Delay Variation and One-way Frame Loss Ratio at the time of turn up to create a birth certificate.

4.3. Service OAM Methodologies

TDS will performance monitor point-to-point OVCs ordered with a Premium SLA using the ITU-T Y.1731 standards. TDS follows the Y.1731 Maintenance End-point Group (MEG) Level recommendations from MEF, as shown in Figure 6 (below). TDS will assign MEG Level 2 to each OVC ordered by the Service Provider. The Service Provider is encouraged to use MEG Level 3 or above for the EVC as a whole.

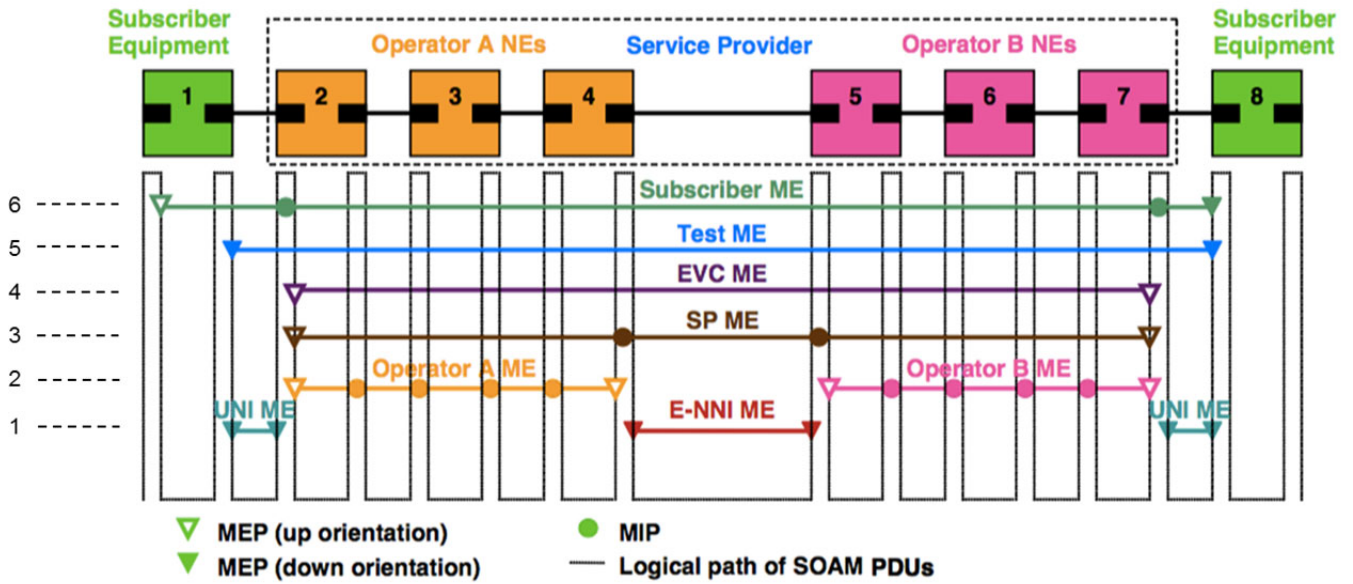


Figure 4: Y.1731 MEG Levels

5. E-Transit Network Channel and Interface Codes

The following tables provide the proper NC/NCI codes used when putting in an ASR order for any of the TDS E-Transit services presented above. TDS is committed to using valid COMMON LANGUAGE® codes where possible; however, in some instances, non-standard coding may be necessary. Code combinations are outlined below for the following order scenarios:

- A NC/NCI combination for the physical build at each ENNI
- A NC/NCI combination for the Ethernet virtual connection

5.1. ENNI Codes

| NC Codes - E-Transit EPL (Fiber Only) | | | | | | | | |
|---------------------------------------|-----------------------------------|--|-------------|---|-----------------|-----------------------|------|-----|
| SERVICE CODE | SERVICE DESCRIPTION | | OPTION CODE | OPTION DESCRIPTION | CONNECTION TYPE | SERVICE CODE MODIFIER | ENNI | EVC |
| KF | ETHERNET at 1 GBPS | | L- | LAN - None, No further options | CLCI S/S | KF, LU | X | |
| KF | ETHERNET at 1 GBPS | | LA | LAN - Network Monitoring | CLCI S/S | KF, LU | X | |
| KG | ETHERNET at 10 GBPS | | L- | LAN PHY at 10.3125 Gbps, Ethernet Frames, payload only - None, No further options | CLCI S/S | KG, LZ | X | |
| KG | ETHERNET at 10 GBPS | | LA | LAN PHY at 10.3125 Gbps, Ethernet Frames, payload only - Network Monitoring | CLCI S/S | KG, LZ | X | |
| VL | Metro Ethernet Virtual Connection | | C- | Point-to-point Operator Virtual Connection (OVC) per MEF 26 (an association of one UNI and one ENNI) - None, No further options | CLCI S/S | CU, VL | | X |

| ENNI NCI Codes - E-Transit EPL (Fiber Only) | | | | | | |
|---|------------|--|-----------|--|------------|-------------|
| NCI | CONDUCTORS | PROTOCOL DESCRIPTION | IMPEDANCE | OPTION DESCRIPTION | NCI (ENNI) | SECNCI (CO) |
| 02LNF.AA2 | 2 | Local Area/Wide Area Network (LAN/WAN) Interface | Fiber | 1310 nm, Single-mode Fiber (e.g. 100BASE-LX10, 1000BASE-LX, 10GBASE-LR and 10GBASE-LW in IEEE 802.3) w/Auto Negotiation | X | |
| 02LNF.AA3 | 2 | Local Area/Wide Area Network (LAN/WAN) Interface | Fiber | 1550 nm, Single-mode Fiber (e.g. 10GBASE-ER and 10GBASE-EW in IEEE 802.3, and 1000BASE-ZX, 10GBASE-ZR, and 10GBASE-ZW based on specific vendor implementations) w/Auto Negotiation | X | |
| 02LNF.AA4 | 2 | Local Area/Wide Area Network (LAN/WAN) Interface | Fiber | 850 nm, 50 micron multimode Fiber (e.g. specified for 10BASE-FL, 1000BASE-SX, 10GBASE-SR and 10GBASE-SW in IEEE 802.3) w/Auto Negotiation | X | |
| 02CXF.N1C | 2 | Digital Termination On A Switch/Router | Fiber | 1 Gbps Ethernet ENNI termination per MEF 26, COS Enabled. (Supports multiple classes of service via the subsequently ordered OVCs.) (Applicable for KF Service Code only) | | X |
| 02CXF.NXC | 2 | Digital Termination On A Switch/Router | Fiber | 10 Gbps Ethernet ENNI termination per MEF 26, COS Enabled. (Supports multiple classes of service via the subsequently ordered OVCs.) (Applicable for KG Service Code only) | | X |

| EVC/OVC NCI Codes - E-Transit EPL (Fiber Only) | | | | | | |
|--|------------|---|----------------|--|------------|---------------|
| NCI | CONDUCTORS | PROTOCOL DESCRIPTION | IMPEDANCE | OPTION DESCRIPTION | NCI (ENNI) | SECNCI (ENNI) |
| 02VLN.A2 | 2 | Ethernet/Operator Virtual Connection (EVC/OVC) Termination per MEF 10 and MEF 26 (Describes how the EVC/OVC being ordered interacts with the associated UNI/ENNI) | None (virtual) | PORT MAP WITH ALL TO ONE BUNDLE (This EVC/OVC accepts ALL frames ingressing the UNI/ENNI, No service multiplexing) | X | X |