

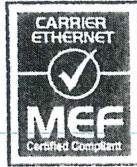
# Attachment C



## Ethernet Network Service Technical Description

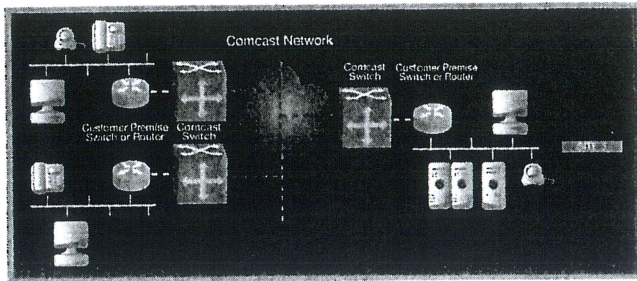
### 1.1 Service Description

Ethernet Network Service (ENS) enables customers to connect physically distributed locations across a Metropolitan Area Network (MAN) as if they are on the same Local Area Network (LAN). ENS is a reliable, more flexible, scalable, and cost-effective alternative to traditional hub and spoke network topologies using Frame Relay, TDM private lines or IP VPNs. The service provides VLAN transparency enabling customers to implement their own VLANs without any coordination with Comcast.



ENS offers three Classes of Service (CoS): Basic, Priority, and Premium. CoS options enable customers to select the CoS that best meets their applications' performance requirements. The service is offered with 10Mbps, 100Mbps or 1Gbps Ethernet User-to-Network Interfaces (UNI) and is available in increments from 1Mbps to 1Gbps.

Comcast's Ethernet Network Service is Certified MEF Compliant.



### Section 1. Technical Specifications

**1.1 Ethernet User-to-Network Interface.** The service provides bidirectional, simplex transmission of Ethernet frames using a standard IEEE 802.3 Ethernet User-to-Network Interface (UNI). Figure 1 lists the available UNI physical interfaces, their associated Committed Information Rate (CIR) bandwidth increments and the Committed Burst Sizes (CBS).

UNI Speed	UNI Physical Interface	CIR Increments	CBS (bytes)
10Mbps	10BaseT	1Mbps	25,000
100Mbps	100BaseT	10Mbps	250,000
1Gbps	1000BaseT or 1000BaseSX	100Mbps	2,500,000
		1000Mbps	25,000,000
10Gbps	10GBASE-SR or 10GBASE-LR		

Figure 1: Available UNI interface types and CBS values for different CIR Increments

**1.2 Maximum number of UNIs.** The service supports up to 100 UNIs. Additional UNIs are considered on an Individual Case Basis (ICB).

**1.3 Class of Service Option.** The service offers three CoS options. The CoS options allow for differentiated service performance levels for different types of network traffic. It is used to prioritize customer mission-critical traffic from lesser priority traffic in the network. Customers must specify a CIR for each CoS to indicate how much bandwidth should be assigned to each CoS. Figure 2 provides the service performance objectives for each CoS for distances within 250 network miles.

Performance Objective ( $\leq 250$ miles)	Class of Service (CoS)		
	Premium	Priority	Basic
Latency (one way)	< 12ms	< 23ms	< 45ms
Jitter (one way)	< 2ms	< 23ms	< 45ms
Packet Loss (one way)	< 0.001%	< 0.01%	< 1%
Availability	> 99.99%	> 99.99%	> 99.99%

Figure 2: CoS Performance Objectives

**1.4 CoS Identification and Marking.** Customers must mark all packets using 802.1p CoS values as specified in Figure 3 to ensure the service will provide the intended CoS performance objectives specified in Figure 2.

CoS	802.1p
Premium	5
Priority	2-3
Basic	0-1

Figure 3: CoS Marking

**1.5 Traffic Management.** Comcast's network traffic-policing policies restrict traffic flows to the subscribed CIR for each service class. If the customer-transmitted bandwidth rate for any CoS exceeds the subscription rate (CIR) and burst size (CBS), Comcast will discard this traffic. For packets marked with a non-conformant CoS marking, the service will transmit them using the Basic service class without altering the customer's CoS markings.

**1.6 MAC Addresses.** Comcast supports up to 250 MAC addresses per UNI and up to 2500 MAC addresses per ENS Domain.

**1.7 Maximum Frame Size.** The service supports a Maximum Transmission Unit (MTU) packet size of 1600 bytes to support untagged or 802.1Q tagged packet sizes. Jumbo Frame sizes can be supported on an Individual Case Basis (ICB).

**1.8 VLAN Tag Preservation.** The service supports IEEE 802.1Q VLAN-tagged customer packets. All customer VLAN IDs and priority code points (IEEE 802.1p) for CoS are transmitted and received unaltered by the service. Untagged packets are mapped to the native VLAN specified by customer. Customers may configure their own VLANs on their customer owned Customer Premise Equipment (CPE) without coordination with Comcast. Comcast may reserve one VLAN for network management purposes.

**1.9 Ethernet Service Frame Disposition.** Different types of Ethernet frames are processed differently by the service. Frames may pass unconditionally through the network or may be limited as in the case of broadcast, unknown unicast and multicast frames to ensure acceptable service performance. Refer to Figure 4 for Comcast's service frame disposition for each service frame type.

Service Frame Type	Service Frame Delivery
Unicast	All frames delivered unconditionally
Multicast	Frames delivered conditionally
Broadcast	Frames delivered conditionally

Figure 4: Service Frame Delivery Disposition

**1.10 Layer 2 Control Protocol (L2CP) Processing.** The service will discard, tunnel across the Comcast network, or peer (process) L2CP service frames at each UNI. Refer to Figure 5 for Comcast's L2CP disposition. For L2CPs with multiple disposition possibilities, the customer must specify to Comcast which disposition should be taken. The default disposition is to discard these L2CP service frames.

Ingress MAC Address	Layer 2 Control Protocol	L2CP Frame Disposition
01-80-C2-00-00-00	STP, RSTP, MSTP	Tunnel (All UNIs)
01-80-C2-00-00-01	PAUSE	Discard (All UNIs)
01-80-C2-00-00-02	LACP, LAMP	Peer or Discard (disposition specified per UNI)
01-80-C2-00-00-02	Link OAM	Peer or Discard (disposition specified per UNI)
01-80-C2-00-00-03	802.1X	Discard (All UNIs)
01-80-C2-00-00-07	E-LMI	Discard (All UNIs)
01-80-C2-00-00-0E	LLDP	Discard (All UNIs)
01-80-C2-00-00-20 through 01-80-C2-00-00-2F	GARP, MRP	Tunnel (All UNIs)

**Figure 5: L2CP Frame Disposition**

**1.11 Online Reporting.** Comcast provides the customer with password-protected access to online reports containing historical network traffic information. Reports may vary based on the customer solution.

## Section 2. Monitoring, Technical Support and Maintenance

**2.1 Network Monitoring.** Comcast monitors all Comcast Services purchased by a customer on a 24x7x365 basis.

**2.2 Technical Support.** Comcast provides customers a toll-free trouble reporting telephone number to the customer Business Services Network Operations Center (BNOC) that operates on a 24x7x365 basis. Comcast provides technical support for service-related inquiries. Technical support will not offer consulting or advice relating to CPE not provided by Comcast.

**2.3 Escalation.** Reported troubles are escalated within the Comcast BNOC to meet the standard restoration interval described in the Service Level Objectives. Troubles are escalated within the Comcast BNOC as follows: Supervisor at the end of the standard interval plus one hour; to the Manager at the end of the standard interval plus two hours, and to the Director at the end of the standard interval plus four hours.

**2.4 Maintenance.** Comcast's standard maintenance window is Sunday to Saturday from 12:00am to 6:00am local time. Scheduled maintenance is performed during the maintenance window and will be coordinated between Comcast and the customer. Comcast provides a minimum of forty-eight (48) hour notice for non-service impacting scheduled maintenance. Comcast provides a minimum of seven (7) days notice for service impacting planned maintenance. Emergency maintenance is performed as needed.

## Section 3. Service Level Objectives

Comcast provides Service Level Objectives for the service, including network availability, mean time to respond, and mean time to restore. The service objectives are measured monthly from the Comcast point of demarcation.

**3.1 Availability.** Availability is a measurement of the percentage of total time that the service is operational when measured over a 30 day period. Service is considered "inoperative" when either of the following occurs: (i) there is a total loss of signal for the service, (ii) output signal presented to the customer by Comcast does not conform to the technical specifications in Section 1.

**3.2 Mean Time to Respond.** Mean Time to Respond is the average time required for the BNOC to begin troubleshooting a reported fault. The Mean Time to Respond objective is fifteen (15) minutes upon receipt of a fault notification or from the time a trouble ticket is opened with the BNOC.

**3.3 Mean Time to Restore.** Mean Time to Restore is the average time required to restore service to an operational condition as defined by the technical specifications in Section 1 of this document. The Mean Time to Restore objective is four (4) hours for electronic equipment failure or six (6) hours for fiber optic facilities failure from the time a trouble ticket is opened with the BNOC.

## Section 4. Customer Responsibilities

Comcast provides CPE for provisioning its services and the delivery of the UNI. Comcast will retain ownership and management responsibility for this CPE. As a result, the CPE must only be used for delivering Comcast services. Customers are required to shape their egress traffic to the contracted CIR.

**Customers have the following responsibilities related to the installation, support, and maintenance of the Service.**

**4.1** Provide an operating environment with temperatures not below fifty-five (55) or above eighty-five (85) degrees Fahrenheit. Humidity shall not exceed ninety (90) percent at eighty-five (85) degrees Fahrenheit.

**4.2** Provide secure space sufficient for access to one (1) standard, freestanding, equipment cabinet at each of the customer facilities, no further than fifty feet from the customer router or switch interface.

**4.3** Provide outside cable entry conduit(s), entry cable ground point, and internal building conduit to allow Comcast the ability to rod/rope a fiber optic cable to the point of demarcation.

**4.4** Locate and mark all private underground utilities (Water, Electric, etc.) along path of new underground placement not covered by utility companies.

**4.5** Provide a pull rope in any existing duct that Comcast is to use and ensure existing duct is serviceable for Comcast use.

**4.6** Obtain 'right-of-way' entry easement for Comcast facilities and equipment from property owners at each customer location.

**4.7** The customer is responsible for coring of the building's outside wall and internal walls. Upon request, Comcast can perform this activity on an 'as needed' basis for an additional one-time fee.

**4.8** Provide UPS AC power equipment, circuit sizing to be determined, if applicable.

**4.9** Emergency local generator backup service, if applicable.

**4.10** Provide access to the buildings and point of demarcation at each customer location to allow Comcast and its approved Contractors to install fiber for service installation. Provide access to each location for regular (8am - 5pm) and emergency (24 hour) service and maintenance of Comcast's equipment and facilities.

**4.11** Provide, install and maintain a device that is capable of routing network traffic between the Service and the customer's Local Area Network (LAN).

**4.12** Customer must provide a point of contact (POC) for installation, service activation and any maintenance activities.

## Section 5. Definitions

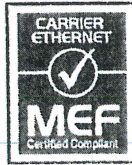
**5.1 Latency.** Latency, also known as Frame Delay, is defined as the maximum delay measured for a portion of successfully delivered service frames over a time interval.

**5.2 Jitter.** Jitter, also known as Frame Delay Variation, is defined as the short-term variations measured for a portion of successfully delivered service frames over a time interval.

**5.3 Packet Loss.** Packet Loss, also known as Frame Loss, is the difference between the number of service frames transmitted at the ingress UNI and the total number of service frames received at the egress UNI.

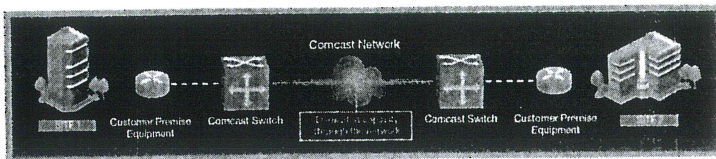
1.3 Description

Comcast's Ethernet Private Line (EPL) Service is a reliable, more scalable, higher bandwidth alternative to traditional TDM Private Lines. EPL service enables customers to connect their Customer Premises Equipment (CPE) using a lower cost Ethernet interface. EPL service enables customers to use any VLANs or Ethernet control protocol across the service without coordination with Comcast.



EPL service provides one Ethernet Virtual Connection (EVC) between two customer locations. EPL offers three Classes of Service (CoS) including: Basic, Priority, and Premium. CoS options enable customers to select the CoS that best meets their applications' performance requirements. EPL service is offered with 10Mbps, 100Mbps or 1Gbps Ethernet User-to-Network Interfaces (UNI) and is available in speed increments from 1Mbps to 1Gbps.

Comcast's Ethernet Private Line Service is Certified MEF Compliant.



Section 1. Technical Specifications

**1.1 Ethernet User-to-Network Interface.** The service provides bidirectional, full duplex transmission of Ethernet frames using a standard IEEE 802.3 Ethernet interface (UNI). Figure 1 lists the available UNI physical interfaces, their associated Committed Information Rate (CIR) bandwidth increments and the Committed Burst Sizes (CBS).

Line Speed	UNI Physical Interface	CIR Increments	CBS (bytes)
10Mbps	10BaseT	1Mbps	25,000
100Mbps	100BaseT	10Mbps	250,000
1Gbps	1000BaseT or 1000BaseSX	100Mbps	2,500,000
		1000Mbps	25,000,000
10Gbps	10GBASE-SR or 10GBASE-LR		

Figure 1: Available UNI interface types and CBS values for different CIR Increments

**1.2 Class of Service Option.** The service offers three different classes of service. The CoS options allow for differentiated service performance levels for different types of network traffic. It is used to prioritize customer mission-critical traffic from lesser priority traffic in the network. The customer must specify a CIR for each CoS to indicate how much bandwidth should be assigned to each CoS. Figure 2 lists the service performance objectives for each CoS for distances within 250 network miles.

Performance Objective (≤ 250 miles)	Class of Service (CoS)		
	Premium	Priority	Basic
Latency (one way)	< 12ms	< 23ms	< 45ms
Jitter (one way)	< 2ms	< 23ms	< 45ms
Loss (one way)	< 0.001%	< 0.01%	< 1%
Availability	> 99.99%	> 99.99%	> 99.99%

Figure 2: CoS Performance Objectives

**1.3 CoS Identification and Marking.** Customer must mark all packets using 802.1p CoS values as specified in Figure 3 to ensure the service will provide the intended CoS performance objectives specified in Figure 2.

CoS	802.1p
Premium	5
Priority	2-3
Basic	0-1

Figure 3: CoS Marking

**1.4 Traffic Management.** Comcast's network traffic-policing policies restrict traffic flows to the subscribed CIR for each service class. If the customer-transmitted bandwidth rate for any CoS exceeds the subscription rate (CIR) and burst size (CBS), Comcast will discard the non-conformant packets. For packets marked with a non-conformant CoS marking, the service will transmit them using the Basic service class without altering the customer's CoS markings.

**1.5 Maximum Frame Size.** The service supports a Maximum Transmission Unit (MTU) packet size of 1600 bytes to support untagged or 802.1Q tagged packet sizes. Jumbo Frame sizes can be supported on an Individual Case Basis (ICB).

**1.6 VLAN Tag Preservation.** The service supports IEEE 802.1Q VLAN-tagged customer packets. All customer VLAN IDs and priority code points (IEEE 802.1p) for CoS are transmitted and received unaltered by the service. Untagged packets are mapped to the native VLAN specified by customer. Customers may configure their own VLANs on their customer owned CPE without coordination with Comcast. Comcast may reserve one VLAN for network management purposes.

**1.7 Ethernet Service Frame Disposition.** The service delivers all service frames associated with the EVC unconditionally across the network as specified in Figure 4.

Service Frame Type	Service Frame Delivery
Unicast	All Frames delivered unconditionally
Multicast	All Frames delivered unconditionally
Broadcast	All Frames delivered unconditionally

Figure 4: Service Frame Delivery Disposition

**1.8 Layer 2 Control Protocol (L2CP) Processing.** Certain L2CP frames are discarded at the UNI, tunneled across the Comcast network or peered at (processed by) the UNI. Refer to Figure 5 for Comcast's L2CP disposition. For L2CPs with multiple disposition possibilities, the customer must specify to Comcast which disposition should be taken. The default disposition is to discard these L2CP service frames.

Destination MAC Address	Layer 2 Control Protocol	L2CP Frame Disposition
01-80-C2-00-00-00	STP, RSTP, MSTP	Tunnel (All UNIs)
01-80-C2-00-00-01	PAUSE	Discard (All UNIs)
01-80-C2-00-00-02	LACP, LAMP	Peer or Discard (disposition specified per UNI)
01-80-C2-00-00-02	Link OAM	Peer or Discard (disposition specified per UNI)
01-80-C2-00-00-03	802.1X	Tunnel (All UNIs)
01-80-C2-00-00-07	E-LMI	Tunnel (All UNIs)
01-80-C2-00-00-0E	LLDP	Tunnel (All UNIs)
01-80-C2-00-00-20 through 01-80-C2-00-00-2F	GARP, MRP	Tunnel (All UNIs)

Figure 5: L2CP Frame Disposition

## 2. Monitoring, Technical Support and Maintenance

**2.1 Work Monitoring.** Comcast monitors all Comcast Services purchased by the customer on a 24x7x365 basis.

**2.2 Technical Support.** Comcast provides customers a toll-free trouble reporting telephone number to the customer Business Services Network Operations Center (BNOC) that operates on a 24x7x365 basis. Comcast provides technical support for service-related inquiries. Technical support will not offer consulting or advice on issues relating to CPE not provided by Comcast.

**2.3 Escalation.** Reported troubles are escalated within the Comcast BNOC to meet the standard restoration interval described in the Service Level Objectives. Troubles are escalated within the Comcast BNOC as follows: Supervisor at the end of the standard interval plus one hour; to the Manager at the end of the standard interval plus two hours, and to the Director at the end of the standard interval plus four hours.

**2.4 Maintenance.** Comcast's standard maintenance window is Sunday to Saturday from 12:00am to 6:00am local time. Scheduled maintenance is performed during the maintenance window and will be coordinated between Comcast and the customer. Comcast provides a minimum of forty-eight (48) hour notice for non-service impacting scheduled maintenance. Comcast provides a minimum of seven (7) days notice for service impacting planned maintenance. Emergency maintenance is performed as needed.

### Section 3. Service Level Objectives

Comcast provides Service Level Objectives for the service, including network availability, mean time to respond, and mean time to restore. The service objectives are measured monthly from the Comcast point of demarcation.

**3.1 Availability.** Availability is a measurement of the percentage of total time that the service is operational when measured over a 30 day period. Service is considered "inoperative" when either of the following occurs: (i) there is a total signal for the service, (ii) output signal presented to the customer by the service does not conform to the technical specifications in Section 1.

**3.2 Mean Time to Respond.** Mean Time to Respond is the average time required for the BNOC to begin troubleshooting a reported fault. The Mean Time to Respond objective is fifteen (15) minutes upon receipt of a fault notification or from the time a trouble ticket is opened with the BNOC.

**3.3 Mean Time to Restore.** Mean Time to Restore is the average time required to restore service to an operational condition as defined by the technical specifications in Section 1 of this document. The Mean Time to Restore objective is four (4) hours for electronic equipment failure or six (6) hours for fiber optic facilities failure from the time a trouble ticket is opened with the BNOC.

### Section 4. Customer Responsibilities

Comcast provides CPE for provisioning its services and the delivery of the UNI. Comcast will retain ownership and management responsibility for this CPE. As a result, the CPE must only be used for delivering Comcast services. Customers are required to shape their egress traffic to the contracted CIR.

**Customers have the following responsibilities related to the installation, support, and maintenance of the Service.**

**4.1** Provide an operating environment with temperatures not below fifty-five (55) or above eighty-five (85) degrees Fahrenheit. Humidity shall not exceed ninety (90) percent at eighty-five (85) degrees Fahrenheit.

**4.2** Provide secure space sufficient for access to one (1) standard, freestanding, equipment cabinet at each of the customer facilities, no further than fifty feet from the customer router or switch interface.

**4.3** Provide outside cable entry conduit(s), entry cable ground point, and internal conduit to allow Comcast the ability to rod/rope a fiber optic cable to the demarcation.

Identify and mark all private underground utilities (Water, Electric, etc.) along the path of new underground placement not covered by utility companies.

**4.5** Provide a pull rope in any existing duct that Comcast is to use and ensure existing duct is serviceable for Comcast use.

**4.6** Obtain 'right-of-way' entry easement for Comcast facilities and equipment from property owners at each customer location.

**4.7** The customer is responsible for coring of the building's outside wall and internal walls. Upon request, Comcast can perform this activity on an 'as needed' basis for an additional one-time fee.

**4.8** Provide UPS AC power equipment, circuit sizing to be determined, if applicable.

**4.9** Emergency local generator backup service, if applicable.

**4.10** Provide access to the buildings and point of demarcation at each customer location to allow Comcast and its approved Contractors to install fiber for service installation. Provide access to each location for regular (8am - 5pm) and emergency (24 hour) service and maintenance of Comcast's equipment and facilities.

**4.11** Provide, install and maintain a device that is capable of routing network traffic between the Service and the customer's Local Area Network (LAN).

**4.12** Customer must provide a point of contact (POC) for installation, service activation and any maintenance activities.

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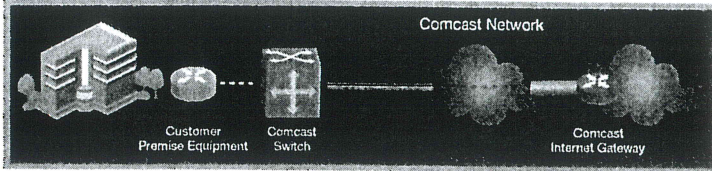
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**5.2 Jitter.** Jitter, also known as Frame Delay Variation, is defined as the short-term variations measured for a portion of successfully delivered service frames over a time interval.

**5.3 Packet Loss.** Packet Loss, also known as Frame Loss, is the difference between the number of service frames transmitted at the ingress UNI and the total number of service frames received at the egress UNI.

Service Description

Comcast's Ethernet Dedicated Internet (EDI) Service provides a reliable, simpler, more flexible, and higher bandwidth options than T1 or SONET-based dedicated Internet access services. The service is offered with a 10Mbps, 100Mbps or 1Gbps Ethernet User-to-Network Interface (UNI) in speed increments from 1Mbps to 1Gbps subject to available capacity. The service provides an Ethernet Virtual Connection (EVC) from the customer premises location to a Comcast Internet Point of Presence (POP) router.



Section 1. Technical Specifications

**1.1 Ethernet User-to-Network Interface.** The service provides bidirectional, full duplex transmission of Ethernet frames using a standard IEEE 802.3 Ethernet interface (UNI). Figure 1 lists the available UNI physical interfaces, their associated Committed Information Rate (CIR) bandwidth increments and the Committed Burst Sizes (CBS).

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10Mbps	10BaseT	1Mbps	25,000
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10Gbps	10GBASE-SR or 10GBASE-LR	1000Mbps	25,000,000

Figure 1: Available UNI interface types and CBS values for different CIR Increments

**1.2 Traffic Management.** Comcast's network traffic-policing policies restrict traffic flows to the subscribed, Committed Information Rate (CIR). If the customer-transmitted bandwidth rate exceeds the subscription rate (CIR) and burst size (CBS), Comcast will discard the non-conformant packets. The customer's router must shape their traffic to their contracted CIR.

**1.3 Maximum Frame Size.** The service supports a maximum transmission unit (MTU) frame size of 1518 bytes including Layer 2 Ethernet header and FCS.

**1.4 Layer 2 Control Protocol (L2CP) Processing.** All L2CP frames are discarded at the UNI.

**1.5 IP Address Allocation.** IP address space is a finite resource that is an essential requirement for all Internet access services. Comcast assigns eight (8) routable IP addresses to each customer circuit. Customers can obtain additional IP addresses if required.

**1.6 Domain Name Service.** Comcast provides primary and secondary Domain Name Service (DNS). DNS is the basic network service that translates host and domain names into corresponding IP addresses, and vice-versa.

**1.7 Border Gateway Protocol (BGP) Routing.** Comcast supports BGP-4 routing as an optional service feature. BGP-4 allows customers to efficiently multi-home across multiple ISP networks. The service requires an Autonomous System Number (ASN) be assigned to a customer by the American Registry for Internet Numbers (ARIN). Customers should also be proficient in BGP routing protocol to provision and maintain the service on their router. Section 5 "Comcast BGP Policy" provides further details. Comcast supports private peering if the customer is multi-homed to Comcast's network only.

**1.8 Online Reporting.** Comcast provides the customer with a password-protected web portal to access online reports containing their historical network traffic information. Reports may vary based on the customer's service.

Section 2. Monitoring, Technical Support and Maintenance

**2.1 Network Monitoring.** Comcast monitors all Comcast Services purchased by a customer on a 24x7x365 basis.

**2.2 Technical Support.** Comcast provides customers a toll-free trouble reporting telephone number to the customer Business Services Network Operations Center (BNOC) that operates on a 24x7x365 basis. Comcast provides technical support for service-related inquiries. Technical support will not offer consulting or advice on issues relating Customer Premise Equipment (CPE) not provided by Comcast.

**2.3 Escalation.** Reported troubles are escalated within the Comcast BNOC to meet the standard restoration interval described in the Service Level Objectives. Troubles are escalated within the BNOC as follows: Supervisor at the end of the standard interval plus one (1) hour; to the Manager at the end of the standard interval plus two (2) hours, and to the Director at the end of the standard interval plus four (4) hours.

**2.4 Maintenance.** Comcast's standard maintenance window is Sunday to Saturday from 12:00am to 6:00am local time. Scheduled maintenance is performed during the maintenance window and will be coordinated between Comcast and customer. Comcast provides a minimum of forty-eight (48) hour notice for non-service impacting scheduled maintenance. Comcast provides a minimum of seven (7) days notice for service impacting planned maintenance. Emergency maintenance is performed as needed.

Section 3. Service Level Objectives

Comcast provides Service Level Objectives for the service, including network availability, mean time to respond, and mean time to restore. The service objectives are measured monthly from the Comcast point of demarcation.

**3.1 Availability.** Availability is a measurement of the percentage of total time that the service is operational when measured over a 30 day period. Service is considered "inoperative" when either of the following occurs: (i) there is a total loss of signal for the service, (ii) output signal presented to the customer by Comcast does not conform to the technical specifications in Section 1.

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**3.3 Mean Time to Restore.** Mean Time to Restore is the average time required to restore service to an operational condition as defined by the technical specifications in Section 1 of this document. The Mean Time to Restore objective is four (4) hours for electronic equipment failure or six (6) hours for fiber optic facilities failure from the time a trouble ticket is opened with the BNOC.

## 4. Customer Responsibilities

Comcast provides CPE for provisioning its services and the delivery of the UNI. Comcast will retain ownership and management responsibility for this CPE. As a result, the CPE must only be used for delivering Comcast services. Customers are required to shape their egress traffic to the contracted CIR.

**Customers have the following responsibilities related to the installation, support, and maintenance of the Service.**

**4.1** Provide an operating environment with temperatures not below fifty-five (55) or above eighty-five (85) degrees Fahrenheit. Humidity shall not exceed ninety (90) percent at eighty-five (85) degrees Fahrenheit.

**4.2** Provide secure space sufficient for access to one (1) standard, freestanding, equipment cabinet at each of the customer facilities, no further than fifty feet from the customer router or switch interface.

**4.3** Provide outside cable entry conduit(s), entry cable ground point, and internal building conduit to allow Comcast the ability to rod/rope a fiber optic cable to the point of demarcation.

**4.4** Locate and mark all private underground utilities (Water, Electric, etc.) along path of new underground placement not covered by utility companies.

**4.5** Provide a pull rope in any existing duct that Comcast is to use and ensure existing duct is serviceable for Comcast use.

**4.6** Obtain 'right-of-way' entry easement for Comcast facilities and equipment from property owners at each customer location.

**4.7** The customer is responsible for coring of the building's outside wall and internal walls. Upon request, Comcast can perform this activity on an 'as needed' basis for an additional one-time fee.

Provide UPS AC power equipment, circuit sizing to be determined, if applicable.

Emergency local generator backup service, if applicable.

**4.10** Provide access to the buildings and point of demarcation at each customer location to allow Comcast and its approved Contractors to install fiber for service installation. Provide access to each location for regular (8am - 5pm) and emergency (24 hour) service and maintenance of Comcast's equipment and facilities.

**4.11** Provide, install and maintain a device that is capable of routing network traffic between the Service and the customer's Local Area Network (LAN).

**4.12** Customer must provide a point of contact (POC) for installation, service activation and any maintenance activities.

## Section 5. Comcast BGP Policy

The following provides the routing requirements to interconnect with the Comcast network. Additional details of Comcast's BGP inbound/outbound network policy and traffic engineering is available upon request.

**5.1** Customers must be multi-homed to run BGP, either:

- a. multi-homed within Comcast's network
- b. multi-homed with Comcast and another service provider

**5.2** Customers must use an Autonomous System (AS) number assigned by a regional registrar American Registry for Internet Numbers (ARIN), Réseaux IP Européens (RIPE), or Asia Pacific Network Information Centre (APNIC) etc. that is registered to their organization.

- a. All customer route announcements must be registered with a regional registrar. A route object must exist for each route prefix in one of the well known global routing registries such as RADB.
- b. The customer ASN needs to be verifiable in WHOIS database.
- c. Comcast will only accept private peering when the customer is multi-homed to Comcast only.
- d. Comcast will support a 4-byte ASN starting 01/01/2010 in accordance with ARIN policy.
- e. Comcast will assign a private ASN in the range of 64512-65534 for private peering and not accept any customer provided private ASN.
- f. Comcast will strip off the private ASN when advertising to peers.

**5.3** Customers must use a router that supports BGPv4.

- a. Comcast will not run BGP4 with customers connected on a link with less than 2Mbps bandwidth.
- b. Customers are responsible to ensure their peering routers have adequate CPE processing power and memory space if a full Internet table is requested.
- c. Comcast will employ all best-known practices to establish, maintain, and troubleshoot BGP4 sessions with all BGP4 compliant router vendors. However, Comcast makes no warranty that it can establish and maintain a BGP4 session with any CPE due to vendor interoperability.

**5.4** Customers can specify one of the following received-prefixes options:

- a. Default-route only
- b. Comcast customer routes
- c. Comcast customer routes + default-route
- d. Full routes
- e. Full routes + default-route

**5.5** Customer must be capable of configuring their BGP session with Comcast. This includes all setup of neighbor statements and all sanity checks on customer CPE.

**5.6** Comcast requests the use of an MD5 authentication key for all EBGP sessions. The customer should specify the MD5 password.

**5.7** Customers must prevent redistribution from their Interior Routing Protocol (IGP) into BGP. Customers should also apply restrictive filters on outbound announcements so that only the customer's intended outbound prefixes are announced to Comcast.

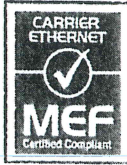
**5.8** Comcast will assign a /30 IP address for the interfaces that connect to Comcast's network. This will be assigned from a Comcast address block publicly registered with ARIN and already advertised as part of a larger aggregate to the Internet.

**5.9** Comcast will announce any portable or non-portable net block so long as this space is larger than /24, and the space is assigned to the customer via WHOIS or RWHOIS databases. If the net block does not belong to the customer and the net block is not already being announced from the customer's AS then Comcast will need to have an LOA (Letter of Agreement) from the true owner of the block stating that they are aware of, and are accepting of the fact that our customer wants to make the announcement through Comcast.

**5.10** Comcast does not alter any of its BGP4 configurations, including route-maps, filter-policies, and communities, for any individual customer, but rather will dynamically alter BGP policy dependent on the customers' employment of predefined Comcast BGP communities. This ensures the Comcast network is built and maintained in a strategic, organized, and efficient fashion and reduces mean-time-to-repair for BGP related trouble.

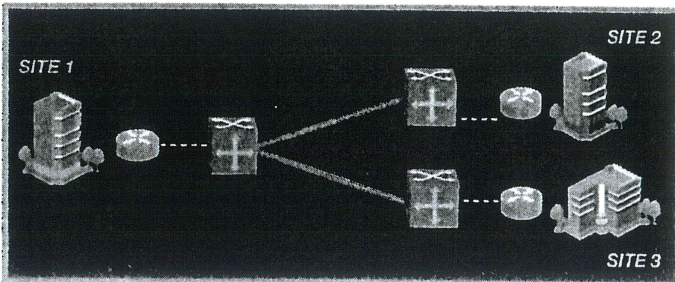
Service Description

Comcast's Ethernet Virtual Private Line (EVPL) Service is a scalable, more flexible, higher bandwidth and cost effective alternative to traditional TDM Private Lines, Frame Relay or ATM Layer 2 VPNs and IP VPNs. EVPL service provides an Ethernet Virtual Connection (EVC) between two customer locations similar to Ethernet Private Line service but supports the added flexibility to multiplex multiple services (EVCs) on a single UNI at a customer's hub or aggregation site.



EVPL offers three Classes of Service (CoS) including: Basic, Priority, and Premium. CoS options enable customers to select the CoS that best meets their applications' performance requirements. The service is offered with 10Mbps, 100Mbps or 1Gbps Ethernet User-to-Network Interfaces (UNI) and is available in speed increments from 1Mbps to 1Gbps.

Comcast's Ethernet Network Service is Certified MEF Compliant.



Section 1: Technical Specifications

**1.1 Ethernet User-to-Network Interface.** The service provides bidirectional, simplex transmission of Ethernet frames using a standard IEEE 802.3 interface (UNI). Figure 1 lists the available UNI physical interfaces, their associated Committed Information Rate (CIR) bandwidth increments and the Committed Burst Sizes (CBS).

UNI Speed	UNI Physical Interface	CIR Increments	CBS (bytes)
10Mbps	10BaseT	1Mbps	25,000
100Mbps	100BaseT	10Mbps	250,000
1Gbps	1000BaseT or 1000BaseSX	100Mbps	2,500,000
		1000Mbps	25,000,000
10Gbps	10GBASE-SR or 10GBASE-LR		

Figure 1: Available UNI interface types and CBS values for different CIR Increments

**1.2 Service Multiplexing.** The service enables customers to multiplex multiple services (EVCs) on a given UNI. A typical application for EVPL is to upgrade a hub and spoke topology where several remote (spoke) sites need to connect to a regional or central (hub) site. The hub site can have all remote site EVCs multiplexed on a single UNI eliminating the need for multiple ports on the customer's router or Ethernet switch. Note that when service multiplexing is used, the sum of CIR bandwidth for all EVCs multiplexed at the UNI and cannot exceed the UNI port speed.

**1.3 Class of Service Option.** The service offers three different classes of service. The CoS options allow for differentiated service performance levels for different types of network traffic. It is used to prioritize customer mission-critical traffic from lesser priority traffic in the network. The customer must specify a CIR for each CoS to indicate how much bandwidth should be assigned to each CoS. Figure 2 lists the service performance objectives for each CoS for distances within 250 network miles.

Performance Objective ( $\leq 250$ miles)	Class of Service (CoS)		
	Premium	Priority	Basic
Latency (one way)	< 12ms	< 23ms	< 45ms
Jitter (one way)	< 2ms	< 23ms	< 45ms
Packet Loss (one way)	< 0.001%	< 0.01%	< 1%
Availability	> 99.99%	> 99.99%	> 99.99%

Figure 2: CoS Performance Objectives

**1.4 CoS Identification and Marking.** The customer must mark all packets using 802.1p CoS values as specified in Figure 3 to ensure the service will provide the intended CoS performance objectives specified in Figure 2.

CoS	802.1p
Premium	5
Priority	2-3
Basic	0-1

Figure 3: CoS Marking

**1.5 Traffic Management.** Comcast's network traffic-policing policies restrict traffic flows to the intended CIR for each service class. If the customer-transmitted bandwidth rate for any CoS exceeds the subscription rate (CIR) and burst size (CBS), Comcast will discard the non-conformant packets. For packets marked with a non-conformant CoS marking, the service will transmit them using the Basic service class without altering the customer's CoS markings.

**1.6 Maximum Frame Size.** The service supports a Maximum Transmission Unit (MTU) frame size of 1600 bytes to support untagged or 802.1Q tagged frame sizes. Jumbo Frame sizes can be supported on an Individual Case Basis (ICB).

**1.7 VLAN Tag Preservation.** The service supports IEEE 802.1Q VLAN-tagged customer frames. All customer VLAN IDs and priority code points (IEEE 802.1p) for CoS conforming to the C-VLAN/EVC map are transmitted and received unaltered by the service. If a native VLAN is specified by the customer in the C-VLAN/EVC map, untagged frames are mapped to the native VLAN and transmitted over the corresponding EVC. Customers must coordinate their C-VLAN add/move/delete/changes with Comcast. Comcast may reserve one VLAN for network management purposes.

**1.8 Standard number of EVCs per UNI:** up to 20. Additional EVCs are available, charges may apply.

**1.9 Standard number of VLAN IDs per EVC:** up to 20. Additional VLAN IDs are available, charges may apply.

**1.10 Ethernet Service Frame Disposition.** All Frames are delivered conditionally through the network based on which EVCs they are sent to as specified in the VLAN ID to EVC map provided by the customer. Refer to Figure 4 for Comcast's service frame disposition for each service frame type.

Service Frame Type	Service Frame Delivery
Unicast	Frames delivered conditionally
Multicast	Frames delivered conditionally
Broadcast	Frames delivered conditionally

Figure 4: Service Frame Delivery Disposition

**Layer 2 Control Protocol (L2CP) Processing.** Certain L2CP frames are discarded at the UNI, tunneled across the Comcast network or peered at (as specified by) the UNI. Refer to Figure 5 for Comcast's L2CP disposition. For L2CPs with multiple disposition possibilities, the customer must specify to Comcast which disposition should be taken. The default disposition is to discard these L2CP service frames.

Destination MAC Address	Layer 2 Control Protocol	L2CP Frame Disposition
01-80-C2-00-00-00	STP, RSTP, MSTP	Discard (All UNIs)
01-80-C2-00-00-01	PAUSE	Discard (All UNIs)
01-80-C2-00-00-02	LACP, LAMP	Peer or Discard (disposition specified per UNI)
01-80-C2-00-00-02	Link OAM	Peer or Discard (disposition specified per UNI)
01-80-C2-00-00-03	802.1X	Discard (All UNIs)
01-80-C2-00-00-07	E-LMI	Discard (All UNIs)
01-80-C2-00-00-0E	LLDP	Discard (All UNIs)
01-80-C2-00-00-20 through 01-80-C2-00-00-2F	GARP, MRP	Tunnel (All UNIs)

Figure 5: L2CP Frame Disposition

Section 2. Monitoring, Technical Support and Maintenance

**2.1 Network Monitoring.** Comcast monitors all Comcast Services purchased by a customer on a 24x7x365 basis.

**2.2 Technical Support.** Comcast provides customers a toll-free troubleshooting telephone number to the customer Business Services Network Operations Center (BNOC) that operates on a 24x7x365 basis. Comcast provides technical support for service-related inquiries. Technical support will not offer consulting or advice on issues relating Customer Premise Equipment (CPE) not provided by Comcast.

**2.3 Escalation.** Reported troubles are escalated within the Comcast BNOC to meet the standard restoration interval described in the Service Level Objectives. Troubles are escalated within the BNOC as follows: Supervisor at the end of the standard interval plus one (1) hour; to the Manager at the end of the standard interval plus two (2) hours, and to the Director at the end of the standard interval plus four (4) hours.

**2.4 Maintenance.** Comcast's standard maintenance window is Sunday to Saturday from 12:00am to 6:00am local time. Scheduled maintenance is performed during the maintenance window and will be coordinated between Comcast and customer. Comcast provides a minimum of forty-eight (48) hour notice for non-service impacting scheduled maintenance. Comcast provides a minimum of seven (7) days notice for service impacting planned maintenance. Emergency maintenance is performed as needed.

Section 3. Service Level Objectives

Comcast provides Service Level Objectives for the service, including network availability, mean time to respond, and mean time to restore. The service objectives are measured monthly from the Comcast point of demarcation.

**3.1 Availability.** Availability is a measurement of the percentage of total time that the service is operational when measured over a 30 day period. Service is considered "inoperative" when either of the following occurs: (i) there is a total loss of signal for the service, (ii) output signal presented to the customer by Comcast does not conform to the technical specifications in Section 1.

**3.2 Mean Time to Respond.** Mean Time to Respond is the average time for the BNOC to begin troubleshooting a reported fault. The Mean Time to Respond objective is fifteen (15) minutes upon receipt of a fault notification or the time a trouble ticket is opened with the BNOC.

**3.3 Mean Time to Restore.** Mean Time to Restore is the average time required to restore service to an operational condition as defined by the technical specifications in Section 1 of this document. The Mean Time to Restore objective is four (4) hours for electronic equipment failure or six (6) hours for fiber optic facilities failure from the time a trouble ticket is opened with the BNOC.

Section 4. Customer Responsibilities

Comcast provides CPE for provisioning its services and the delivery of the UNI. Comcast will retain ownership and management responsibility for this CPE. As a result, the CPE must only be used for delivering Comcast services. Customers are required to shape their egress traffic to the contracted CIR.

**Customers have the following responsibilities related to the installation, support, and maintenance of the Service.**

**4.1** Provide an operating environment with temperatures not below fifty-five (55) or above eighty-five (85) degrees Fahrenheit. Humidity shall not exceed ninety (90) percent at eighty-five (85) degrees Fahrenheit.

**4.2** Provide secure space sufficient for access to one (1) standard, freestanding, equipment cabinet at each of the customer facilities, no further than fifty feet from the customer router or switch interface.

**4.3** Provide outside cable entry conduit(s), entry cable ground point, and internal building conduit to allow Comcast the ability to rod/rope a fiber optic cable to the point of demarcation.

**4.4** Locate and mark all private underground utilities (Water, Electric, etc.) along path of new underground placement not covered by utility companies.

**4.5** Provide a pull rope in any existing duct that Comcast is to use and ensure existing duct is serviceable for Comcast use.

**4.6** Obtain 'right-of-way' entry easement for Comcast facilities and equipment from property owners at each customer location.

**4.7** The customer is responsible for coring of the building's outside wall and internal walls. Upon request, Comcast can perform this activity on an 'as needed' basis for an additional one-time fee.

**4.8** Provide UPS AC power equipment, circuit sizing to be determined, if applicable.

**4.9** Emergency local generator backup service, if applicable.

**4.10** Provide access to the buildings and point of demarcation at each customer location to allow Comcast and its approved Contractors to install fiber for service installation. Provide access to each location for regular (8am - 5pm) and emergency (24 hour) service and maintenance of Comcast's equipment and facilities.

**4.11** Provide, install and maintain a device that is capable of routing network traffic between the Service and the customer's Local Area Network (LAN).

**4.12** Customer must provide a point of contact (POC) for installation, service activation and any maintenance activities.

Section 5. Definitions

**5.1 Latency.** Latency, also known as Frame Delay, is defined as the maximum delay measured for a portion of successfully delivered service frames over a time interval.

**5.2 Jitter.** Jitter, also known as Frame Delay Variation, is defined as the short-term variations measured for a portion of successfully delivered service frames over a time interval.

**5.3 Packet Loss.** Packet Loss, also known as Frame Loss, is the difference between the number of service frames transmitted at the ingress UNI and the total number of service frames received at the egress UNI.