Level(3)

Ethernet Service Standards

February 2013

Introduction

Congratulations on the purchase of your new Ethernet-access enabled service with Level 3 Communications! By selecting Ethernet to access your service, you have ensured the best price/performance and the maximum flexibility in reconfiguration and upgrading your service in the future. Unlike legacy TDM access standards (such as DS1, DS3, etc.) that ensure consistent configuration throughout the length of a circuit, the current Ethernet standards do not guarantee this. As a result, it is crucial that your equipment is properly configured to ensure the performance of your service meets your expectations.

Please review the guidelines outlined in this document before connecting your new service and call us if you have any questions.

Ethernet Performance Factors

Several variables impact actual throughput in a network during data transfer and testing. These variables are bandwidth of the circuit, roundtrip latency from sending host to receiving host, the TCP window size, and packet loss during the data transfer.

Packet Loss

Packet loss is the loss of any frame or packet in the data flow and has a direct negative impact to Ethernet throughput, particularly TCP based application throughput. The loss of a single packet in a TCP flow will result in the retransmission of data and impact the TCP window negotiation process

Latency

Latency is the measure of time it takes a packet to transit the network due to fiber propagation and electronics in the path and can affect TCP throughput due to the nature of the protocol handshakes.

Frame Size (MTU)

Generally, throughput efficiency improves with packet size, as long as configured Maximum Transmission Unit, and Maximum Received Unit support the larger packets. Throughput efficiency is negatively impacted with small packet sizes.

TCP Windowing

Transmission Control Protocol (TCP) relies on a handshake dialogue, positive confirmation of data sent and received, and a retransmission capability to recover lost data. TCP is most efficient when the protocol can negotiate a congestion window size and maintain that state for the duration of the data transfer session. Packet loss during the negotiation process will cause retransmission of data, will disrupt the negotiation process, and will impact the ability to reach full throughput.

Ethernet Configuration Guidelines

The following provides basic interface connectivity standards, cabling, etc. Customer Edge (CE) device configuration guidance is provided for those Ethernet service speeds most commonly associated with customer performance issues.

Interface Connectivity

The following are the network interface connection options available for Ethernet access.

Interface	Handoff	Fiber Mode	Bandwidth Usage Limit
10/100 Base T	Copper	N/A	100 Mbps
100 Base FX	Fiber	Multi-mode	100 Mbps
1000 Base SX	Fiber	Multi-mode	1 Gbps

Interface	Handoff	Fiber Mode	Bandwidth Usage Limit
1000 Base LX/LH	Fiber	Single-mode	1 Gbps
1000 Base ZX	Fiber	Single-mode	1 Gbps

Level 3 will typically install an Ethernet RJ-45 patch panel or fiber patch panel at the customer premise as the demarcation point for the service.

Copper Cabling Requirements

The copper cabling used from Level 3 PE to patch panel and patch panel to CE interface must be UTP Category 5e or better cabling. The terminating ends should be built to the TIA/EIA-568-B standards. TIA/EIA-568-C specifies the maximum horizontal cable run length is 90 meters, with a total cable length of 100 meters, including patch cords. The maximum patch cord length should be 5 meters. Termination of the cable ends will be RJ-45 using 568A termination.

Fiber Optic Cabling Requirements

The fiber optic cabling should adhere to the TIA/EIA-568-C.3 standards. 50 micron Multi-mode cable should be restricted to an overall length of 550 meters. Duplex connectors on fiber patch cords should be used to avoid transmit/receive cross-over.

Customer Provided Equipment (CPE) Interface Configuration

Please verify that your router is rated at the maximum speed of the service you purchased. Even so-called home routers support only a few hundred Mbps maximum speed despite supporting the GigE (1000Mbps) specification for its interfaces.

Please ensure that you have configured the following interface options (if available) on your router for the ethernet port connected to Level 3:

For 10/100Mbps Interfaces, set :

- Interface speed – 100Mbps, no auto-negotiation
- Interface duplex – Full-Duplex, no auto-negotiation
- Interface flow-control – Disabled
- Interface keep-alive – Disabled
- Multi-Virtual Circuit Support – configure VLAN tagging of customer traffic
- Traffic Shaping – Configure traffic shaping using an egress rate shaping policy on CPE router (see Traffic Shaping).

For 1 Gigabit Interfaces, set:

- Interface speed – 1000Mbps, no auto-negotiation
- Interface duplex – Full-Duplex, no auto-negotiation
- Interface flow-control – Disabled
- Interface keep-alive – Disabled
- Multi-Virtual Circuit Support – Configure VLAN tagging of customer traffic
- Traffic Shaping – Configure traffic shaping using an egress rate shaping policy on CPE router (see Traffic Shaping).

Traffic Shaping

Customer should enable Traffic Shaping on the Customer Provided Equipment (CPE) switch or router to ensure maximum throughput efficiency.

- Traffic shaping is required in order to ensure that packets are not dropped when entering the network as traffic policing is applied on the Level 3 Communications network
- If shaping is not enabled by customer, Level 3 (or one of our 3rd party access vendors) will randomly drop traffic if the customer signal exceeds the Committed Information Rate (CIR) that is contracted for the connection
- Most enterprise-class routers on the market should support traffic shaping
- Our Ethernet services can scale from 3 Mbps to 1 Gbps as long as the customer can shape their traffic; if the customer is not able to shape their traffic, they should purchase service in the 10/100/1000 Mbps speed tiers to achieve maximum use of the bandwidth; failure to comply with this recommendation will result in reduced throughput and performance.
- Example Traffic Shaping Configuration Parameters
  - Purchased Service = 50Mb/s CDR
  - Customer Router = Cisco 2900
  - Configure Port Level Traffic Shaper to 50Mb/s

Resulting Example Configuration:

```
! Match any traffic with class-map:

class-map match-all class-cpe-wan-out

match any

!
! Parent policy-map matches class-map traffic and applies shaper

policy-map policy-cpe-wan-out

class class-cpe-wan-out

  shape average 50000000

!

! Apply policy-map outbound on Level3-facing interface:

interface GigabitEthernet0/2

service-policy output policy-cpe-wan-out
```

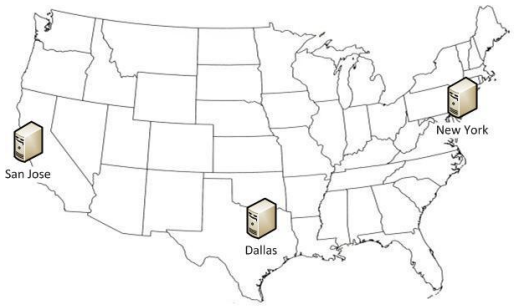
Please Note:

If you configure your device according to these specifications and are still encountering performance problems with your circuit, please speak to a service activation specialist and be sure to mention that you read and applied the guidelines in this document to speed the troubleshooting process.

Validating Performance

There are many methods and tools available in the industry for testing Internet service speed, unfortunately many of these methods introduce variables such as 3rd party networks, server performance, and other software-based characteristics that are difficult to predict and rely upon.

For convenience, Level 3 has provided several test points on the network to which customers can test to validate the throughput of their Internet service. These servers provide geographic diversity and will minimize the influence of external variables.



San Jose: http://linespeedtest.sanjose1.level3.net/

Dallas: http://linespeedtest.dallas1.level3.net/

New York: http://linespeedtest.newyork1.level3.net/

A successful test should result in throughput at ~95% of the purchased service capacity, with protocol and application overhead accounting for the remaining 5%. For example, if the service capacity purchased is 100Mb/s we would expect a clean service to result in ~95Mb/s throughput. If the service ordered were 50Mb/s, we would look for a test result of ~47Mb/s.

We encourage our customers to connect to one of the test points upon activation of their service to ensure it is operating as expected. If at some point during normal course of operation the throughput of the service is in question, the test points should again be leveraged to assist in the isolation of the trouble.