EDX Markets xNET Connectivity Specification

v1.0

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1 Introduction

The EDX xNET provides connectivity to EDX operated markets services colocated with EDX. This document provides an overview of the xNET and details the connection specifications and necessary details for users to connect to the EDX xNET.

1.1 Purpose

There are multiple methods for users to connect to the EDX xNET. The purpose of this document is to provide information and details on these methods to our users so they can evaluate and connect via the method that meets the level of availability and performance they require. It details the locations and network architecture of the xNET as well as various connectivity options and specifications.

2 General Overview

2.1 xNET overview

The EDX xNET is a distributed, secure, and scalable IP network. xNET connectivity is available at each of the EDX xNET POP facilities detailed in the Facilities section of this document, and also via approved extranet and connectivity providers. The xNET enables IP connectivity to EDX facilities and services from the specified Access Points locations. To provide fair and deterministic access at prescribed locations, user connections are latency equalized to the PoP as specified in the Facilities section of this document.

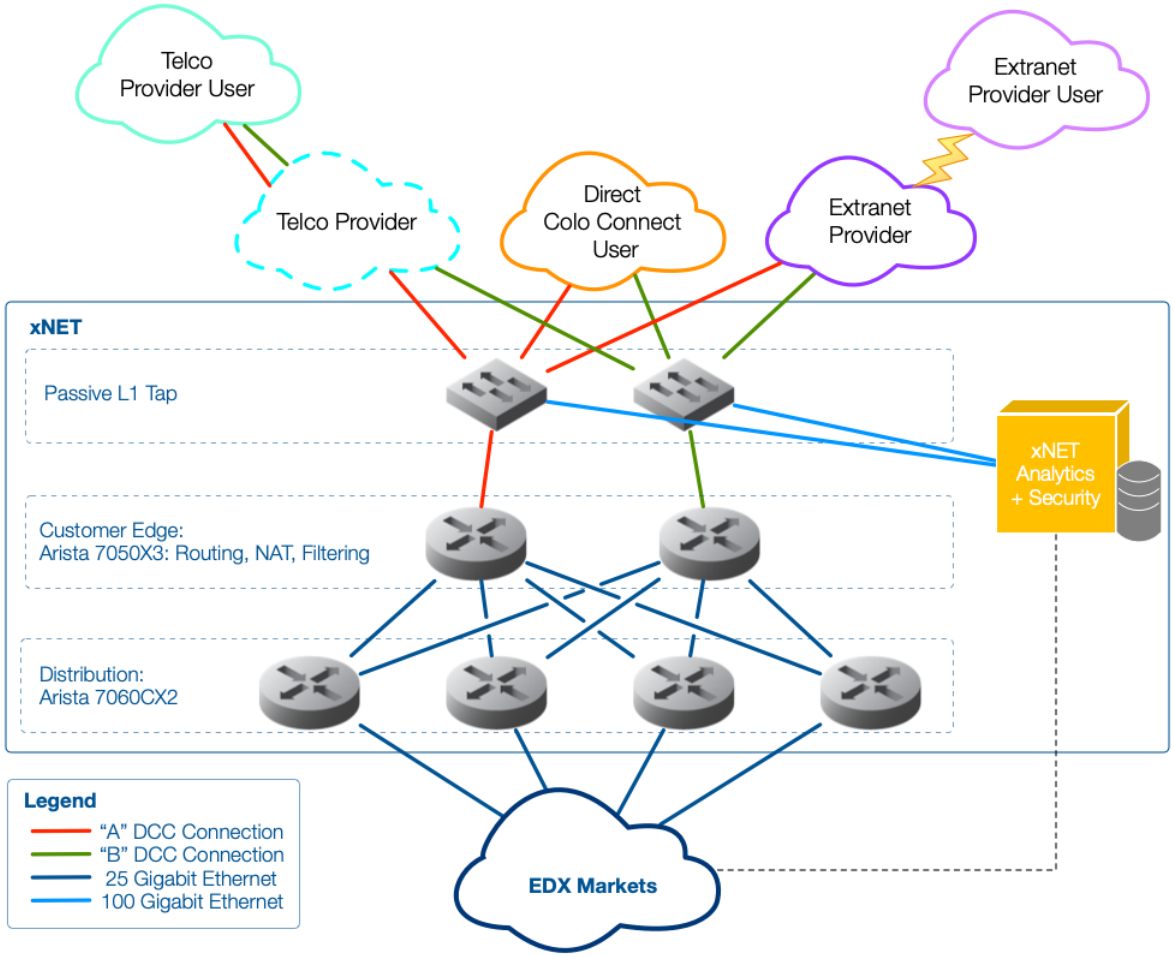
2.2 xNET High Level Architecture

The xNET is comprised of:

- Point to point fiber connectivity
- Latency equalization systems
- Passive L1 taps
- Ethernet switching and IP routing devices
- Security devices

The internal connectivity of the xNET is 25G cut-through Ethernet from customer edge (CE) to each market. This enables a low latency and deterministic network. The xNET provides discrete A/B connectivity for each user cross connect to ensure reliable operation and redundant data connectivity and delivery. The xNET supports IP unicas, multicast, and other ancillary IP services. The xNET architecture is detailed in Figure 1.

Figure 1.



2.3 xNET Technologies

2.3.1 Switching and routing

The xNET is built on Arista 7000 Series data center switching. A leaf-spine architecture provides the basis for all traffic that transits the xNET. Arista 7050X3 customer edge (CE) leaf switches provide low latency cut-through switching and IP routing, security, and address translation services on a flexible 10/25/100G platform. The xNet spine is based on a mesh of Arista 7060CX2-32 devices that enable a low latency, scalable, and dense IP routing fabric. The CE leaf is redundantly connected to the spine via QSFP100 100G-SR4 interfaces configured as 4 X 25G interfaces. The spine connects to the exchange production leaf via QSFP100 100G-SR4 interfaces configured as 4 X 25G interfaces. The interfaces are broken out to support 25G cut-through forwarding from the CE leaf to EDX facilities. Cut-through forwarding provides low-latency and deterministic forwarding for all packet sizes, minimizing the impact of serialization delay and queuing. This provide a deterministic and fair baseline of network performance for all participants.

The BGP protocol is used for unicast route distribution and control. BGP is a proven, scalable, and resilient protocol that ensures all services are available and can select the optimal path in any link, device, or location failure scenario. BGP is also used for route distribution to users and other providers and markets, providing a routing control and policy enforcement point at the ingress and egress of the xNET.

The PIM protocol is used for centralized and redundant multicast distribution on the xNET. Multicast is programmatically configured per interface on the ingress and egress of the xNET to ensure multicast data is forwarded based on user entitlement and not external protocol state.

2.3.2 Passive L1 Taps

The xNET leverages passive L1 taps for telemetry and insight at the CE. Every transaction that transits the xNET network is replicated, aggregated and precision time stamped for analysis and surveillance. The time stamp appended to each packet is accurate to nanoseconds and is derived from a NIST traceable clock. This provides the basis for state of the art analysis, data mining, and real time operational insight into both the exchange network and user application performance.

2.3.3 Security

The xNET is secured at all ingress and egress points. Access lists (ACL's) are provisioned at all cross connects to filter traffic per user. Network address translation is also leveraged for further obfuscation and security. An active intrusion detection system watches all xNET traffic for signs of malicious behavior, and triggers intervention for known exploits or attacks.

3 Facilities

3.1 xNET Access Points

The xNET Access Points are hosted in the following colocation data centers:

Facility	Address
Equinix NY4	755 Secaucus Rd Secaucus NJ 07094
Equinix CH1	350 East Cermak Road, 6th Floor Chicago IL 60616

3.2 Services Mapping

The Table below summarizes the services available at each xNET Access Point or POP.

Access point	EDX Crypto
NY4	Primary Facility
CH1	Secondary Facility

Note: To ensure fair and equal access user connections in the NY4 location are latency equalized from the termination at the user demarc to the termination at the xNET POP demarc. All other connections to xNET POP's are not latency equalized.

4 Connectivity Methods

EDX users have a choice in how they connect to the EDX Exchange. Users may choose any of the following access methods:

- Direct Colocation Connection (DCC)
- Telco Provider
- Extranet Provider

Details on these connectivity methods are provided in the sections of the document below.

5 Direct Colocation Connectivity (DCC)

Equipment colocation users at the NY4 or CH1 sites should contact Equinix (equinix.com). EDX will assist in generating the LOA's required for provisioning cross connects to the xNET POP demarc as part of the connection process.

5.1 Physical Connectivity

All user DCC network connections must be single mode optical fiber. The xNET supports 10G, 25G, 40G, and 100G Ethernet interface types. 40G may only be provisioned as a 4 X 10G Ethernet port-channel. 100G may be provisioned as a 4 X 25G Ethernet port-channel or a 1 X 100G Ethernet interface. The connection termination will be dictated by the choice of Ethernet interface selected.

5.2 Ethernet Interface and Media Types Supported

The table below lists the interface types supported for DCC's at all xNET PoP locations. 1G or lower bandwidth connections to the xNET are available via the approved extranet providers.

Interface Type	Supported Range	Media Type	Wavelength	Core Size	Termination
10G Standard	2KM	10G-LR	1310	G.652	Duplex LC
10G Extended	40KM	10G-ER	1550	G.652	Duplex LC
25G Standard*	2KM	25G-LR	1310	G.652	Duplex LC
25G Extended*	40KM	25G-ER	1310	G.652	Duplex LC
40G LAG (4X10G)*	2KM	40GBASE-PLR4 or 4x10G LR	1310	G.652	4 X Duplex LC
40G Standard*	10KM	40GBASE-LR4	1310	G.652	Duplex LC
100G LAG (4X25G)*	2KM	100G-PSM4 or 4 X 25G-LR	1310	G.652	4 X Duplex LC
100G Standard*	10KM	100G-LR4	1295.56 1300.05 1304.58 1309.14	G.652	Duplex LC

*Currently all xNET interfaces that access EDX are configured as 10G interfaces. Extranet providers will be provisioned for higher bandwidth only when aggregating participants for these markets.

5.3 Logical Connectivity

The DCC interface is an Ethernet connection configured as an IP point to point connection. The section below enumerates the protocols and configurations that are supported on a DCC interface.

5.3.1 Protocol Support

5.3.1.1 IPv4

The Internet Protocol Version 4 (IPv4) is used as the network layer for all unicast and multicast packets forwarded on the xNET.

5.3.1.2 ICMP

The Internet Control Message Protocol (ICMP) is used to determine reachability for any DCC connected endpoint or service. This may be used during initial provisioning and connectivity validation as well as for troubleshooting and path tracing.

5.3.1.3 TCP

The Transmission Control Protocol (TCP) is supported as the basis for all unicast, reliable, and connection oriented IP communications on the xNET. Services such as MEMO order entry, market data retransmission, and drop copy are all TCP based. By default, destination ports are filtered and only specific ports are permitted at the DCC interface based on the services the user has requested.

5.3.1.4 UDP

The User Data Protocol (UDP) is supported for low latency, loss-tolerant multicast IP communications on the xNET. The MEMOIR market data feeds are UDP based. By default UDP is only permitted outbound on a DCC interface.

5.3.1.5 BGP

The Border Gateway Protocol (BGP) is implemented as the recommended external gateway protocol for exchanging route and path information with the xNET. It provides a robust set of policy, redundancy, and security features for all users when connecting to the xNET and EDX services. More details regarding BGP configurations are provided in the sections below.

5.3.1.6 Static Routing

In lieu of a user connection supporting BGP as the route exchange protocol, static routing can be provisioned for IP reachability. This is not recommended and is handled on a case by case basis.

5.3.1.7 PIM

Protocol Independent Multicast (PIM) is used as the multicast routing protocol on the xNET and DCC user connections. PIM provides dynamic failover and RPF resolution for multicast sources. Although a PIM neighbor and RP will be defined for each DCC connection, multicast data flows are automatically provisioned based on entitlement by EDX and external PIM/IGMP joins are filtered. This configuration allows users to receive and forward multicast data received on the DCC interfaces while ensuring A/B path and data diversity.

5.3.2 Logical Redundancy

DCC connections are provisioned in A/B pairs. Each A/B connection pair terminates at different network devices at the xNET. A/B path diversity for multicast data distribution is required and maintained regardless of user interface configuration or preference. It is recommended that users advertise their source networks on both interfaces for maximum redundancy.

5.3.3 IP Interface Configuration

Each DCC connection will be configured as an IPv4 point to point interface. No bridging or L2 forwarding is permitted and all traffic must be IP routed to and from the DCC interface. BGP peering is *required* for dynamic bi-directional route distribution and failover. A user can select static IP routing, however when static routing is enabled no dynamic distribution or failover options are available and the user must manually maintain their own routing tables.

5.3.4 IPv4 Addressing and BGP peering

EDX recommends that users provide their own registered IPv4 source addresses and BGP AS numbers for connecting to the xNET. We also recommend using /31 addressing for these

connections to preserve address utilization. In lieu of of a user providing their own registered network addresses and AS number, EDX will allocate and maintain private IP addresses and AS numbers for the user to provision connectivity. EDX multicast data streams are all within registered IPv4 multicast address ranges to guarantee uniqueness.

5.3.4.1 BGP Settings

The following settings for each BGP peering session are configured:

- timers 5 15
- send-community
- Outbound route-map for filtering and appending communities
- Inbound route-map for filtering and preferring based on communities
- AS PATH filtering

5.3.4.2 Outbound Advertisements

The following address types are advertised:

- Multicast RP's
- Multicast data sources ranges
- Order gateway ranges
- Other optional service ranges

Details on these addresses can be found in the "xNET IP Addressing" section of this document.

These are the defined BGP communities for all EDX prefixes transmitted:

- EDX transmits the routes advertised via "A" interfaces with the "36370:41" community appended
- EDX transmits the routes advertised via "B" interfaces with the "36370:42" community appended

By default EDX assumes that the participant uses both the A and B interfaces as equal cost IP paths. These communities are provided so that a policy matching this community can be implemented to prefer the A or B path for unicast traffic transmitted to the xNET.

5.3.4.3 Inbound Advertisements

xNET BGP peers only accept pre-defined user source network ranges in inbound BGP advertisements. All other prefixes will be filtered. The AS PATH information received from user BGP peers is also filtered. If a user decides to change their source networks range(s) a change request must be made. By default all permitted inbound prefixes will be installed as equal cost IP routes. This means that unicast traffic by default transmitted outbound from the xNET can take either the A or B interface path. If you want the xNET to prefer a path, these are the defined "prefer communities" for customer prefixes sent to the xNET:

- Prefer the interface with route updates having the "YOURAS:41" community appended
- Optionally, route updates with the "YOURAS:42" community appended can be used to indicate the "B" interface.
- If you choose to AS PREPEND, please do so with your peering ASN

5.3.5 Unicast Service Connectivity

EDX services are reachable at defined, registered IPv4 addresses and specified IANA private ports.

5.3.6 Security

DCC connections have a “permit only, deny all” security policy that denies any traffic that is not predefined based on entitlements or service agreements. Functions such as deep packet inspection, network address translation, and rate limiting may be implemented and EDX reserves the right to change these policies at any time. Wherever possible these changes will not be disruptive to users and their DCC configurations.

5.3.7 xNET IP Addressing

IP address information can be found in the “xNET Services IP Addressing” document maintained at the EDX User Portal, or provided on request to connect@edxmarkets.com.

6 Telco Provider Connectivity

A telco provider selected by a user may provide a private or shared circuit to xNET access points. The provided circuit will be terminated at the demarcation point in the colocation facility and a separate DCC will be requested and provisioned for connection to the xNET POP demarc. Once the circuits are terminated, the connectivity details in the Direct Colocation Connectivity (DCC) section are the same for this connection method.

7 Extranet Provider Connectivity

A EDX approved extranet provider selected by a user may provide access to the xNET via shared infrastructure. With this method the user will access the EDX xNET via their providers “third party” DCC connection at any of the listed POP’s. The user will be responsible for coordinating service and connectivity activation with their provider prior to access any EDX services via a third party extranet connection.

A list of approved extranet providers is maintained at EDX User Portal, or provided on request to connect@edxmarkets.com.

8 Connectivity Requests and xNET Information

If you would like more information on the xNET or want to start getting connected please go to edxmarkets.com to get started, or contact us at connect@edxmarkets.com.