ICE GLOBAL NETWORK & COLOCATION

Technical Specifications

September 2024

Version 4.3

1 Scope

1.1 About This Document

The information contained in this document can be used as a technical reference guide for customers to facilitate connectivity and access to the ICE and NYSE markets, as well as access to services from other global and third-party services available via the ICE Global Network. The document also provides information on customer colocation and low latency network connectivity options at our U.S. Liquidity Center (USLC) in Mahwah, New Jersey.

The following services are outlined in this document:

Colocation Services

- Kilowatt and Cabinet
- Partial Cabinet Solutions
- Power Not Used (PNU)
- Hosting Services
- Timing Services
- Meet Me Room (MMR) Services

High Availability and Colocation Network Services

- Liquidity Center Network (LCN)
- IP Liquidity Center (SLC)
- Liquidity Center Cross Connect (LCX)
- HA Direct Connect (SDC)
- HA Limited-Service Port (LSP)
- HA Virtual Control Circuit (VCC) – (MPLS based L2VPN)
- ICE Global Network Optic Access
- ICE Global Network VPN Access – IP based VPN

Low Latency Connectivity Services

- ICE Global Network Low Latency Network (LLN)
- National Market Systems (NMS) Network

Application Services

- Core Application Services (NYSE Markets & NMS)
- Non-Core Application Services (such as Integrated Feeds)
- Content Service Provider (CSPs, including ICE Markets)

"Quick Connect Sheet" provides further information for customers connecting directly to the ICE Global Network at the USLC or High Availability Access Centers. Customers connecting via a third-party (e.g. an extranet provider, Application Service Provider (ASP), Metro Ethernet provider, or other) will also find some of this information applicable. However, customers that have chosen a third-party for connectivity into the ICE Global Network must consult with their third-party provider for interface specific information.

1.2 Document Scope

This document specifies how customers can connect to the ICE Global Network in order to gain access to receive or provide services. It also specifies connectivity options available to customers when connecting to the ICE and NYSE Group markets as well as between each other within the USLC. It provides information associated with the first three layers of the standard OSI networking model (Physical, Data Link, and Network).

ICE Global Network provides access to the individual ICE and NYSE Group markets including, but not limited to:

- ICE Futures
- ICE Endex
- ICE Clear
- New York Stock Exchange - Common Access Point (CAP)
- NYSE
- NYSE Arca Equities
- NYSE Arca Options
- NYSE American Equities
- NYSE American Options
- NYSE Bonds
- NYSE Chicago
- NYSE National
- National Market Systems (NMS)

ICE Global Network also provides access to the National Market Systems (NMS – OPRA & CTA) hosted in the USLC as well as to over 150 leading Equities, Options, Futures, Fixed Income and FX venues and trading services. This document is not meant to be a complete guide to the ICE Global Network or colocation services. It does NOT specify the application-level requirements for each of the services provided by ICE and DMA source via ICE Global Network, i.e., it does not cover supporting services such as Domain Name Systems (DNS) resolution, authentication mechanisms, APIs, and other message-based requirements. Customers will need to contact each market center/application provider directly to ensure receipt of specific documentation on message formats, authentication schemes, and any other information required to successfully connect to or receive information from individual markets.

Additionally, during provisioning, customers will receive service specific network information. This information will cover IP peering information and service addressing assignments (unicast and multicast addresses, TCP/UDP port assignments, etc.) for the relevant services ordered.

For additional information, refer to the following documents:

- US Liquidity Center Operating Policies & Procedures
- ICE Global Network Acceptable Use Policy
- NYSE Common Access Point (CAP) Agreement (for Trading on the NYSE markets)
- NYSE Technologies Connectivity Master Network Access Services
- NYSE Technologies Connectivity Master Services Agreement
- General Terms & Conditions and other documents that can be found at: https://www.ice.com/fixed-income-data-services/access-and-delivery/global-network/documents

1.3 Contact Information

For more information on the ICE Global Network and the services available, please visit https://www.ice.com/data-services/global-network or contact support via one of the numbers below:

For commercial or product questions:

Contact	Telephone	Email
ICE Global Network & Colocation Sales	**US:** +1 770 661 0010, Option 3 **Europe:** +44 207 429 4610 **APAC:** +61 3 9249 2093	iceglobalnetwork-info@ice.com

Technical or operations related questions

Contact	Telephone	Email
Customer Engineering & Provisioning	**US:** +1 212 894 5488 **Europe**: +44 207 429 4530	clientprovisioning@ice.com
Network Operations	**US:** +1 770 661 0010 **Europe:** +44 203 808 6638 **APAC:** +61 3 8593 5999 Option 1	clientnetworks@ice.com
USLC Datacenter Operations	**US:** 1-770-661-0010 Option 2 - Sub-Option 2	DC-Support-MAH@ice.com

1.4 Copyright Information

NOTE: If you have printed or downloaded a copy of this document, make certain to check our website https://www.theice.com/data-services/global-network for an updated copy as policies might change from time to time.

1.5 Version Information

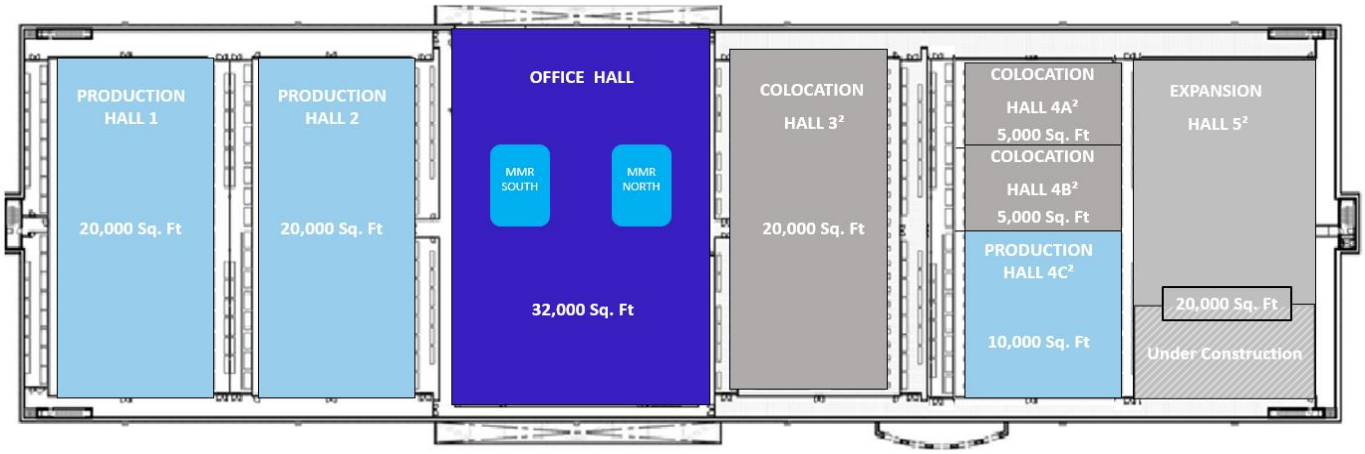
Version	Date	Comment
1.0	28 February 2016	Reinstated versioning and added new service information for Wireless and Low Latency Network
2.0	14 September 2016	Updates to section 6.2.2 LCN for greater detail on CCG vs XDP flows
2.1	8 December 2017	Updated Customer Engineering, network operations contact details and LCN diagrams
2.2	8 November 2018	Updated IGN Sales Phone Number
2.3	16 July 2019	Updates to sections 6.3.2 and 6.3.4 for greater detail on HA 40Gb SR4 availability
2.4	8 August 2019	Removed reference to Basildon in section 6.4 and corrected bandwidth units in section 7.1
3.0	21 October 2019	Branding Update
3.1	29 October 2019	Updated rate limit policy for 10G LX Ports
3.2	14 April 2020	Updated LCN Latency section
3.3	30 April 2020	Added 100G High Availability Interface Specifications
3.4	1 May 2020	Clarification of NMS Latencies over LCN
3.5	30 July 2020	Added Partial Cabinet Receptacle Specifications
3.6	3 Dec 2020	Updated LCN Policer Latencies
3.7	23 Feb 2021	Added NMS Network, Updated Cabinet Power Specifications and Mahwah Hall Layout
3.8	12 March 2021	Added Hall 4A cabinet size and electrical information to section 4.1
3.9	20 May 2021	Updates to section 4.1 for greater detail on customer provided cabinets
4.0	10 August 2021	Updated NMS section
4.1	1 March 2022	Added Homerun Connectivity Section 6.7.2
4.2	1 July 2024	Removed NMS over LCN and clarified NMS access policy. Removed HA 40G SDC bundle, ICE Global Network Optic Connect, Optic LLN between Carteret and Secaucus, VCC Section 6.4, and Wireless Sections 7.3 and 7.4. Added Hall 5.
4.3	5 September 2024	Updated requirements regarding customer-provided cabinets and PDUs

2 Contents

3 US Liquidity Center (USLC) – Mahwah

Since 2010, the USLC site houses the NYSE markets serving the global equities and derivatives trading communities.

The USLC is a state of the art, Tier 4 guided data center. Special consideration was taken during its construction to ensure that the building and supporting infrastructure such as electrical, cooling, and communications entry points are diversified and fault tolerant to meet or exceed 99.995% data availability for the systems within. USLC's colocated customers have the opportunity to take advantage of resilient infrastructure that provides direct access to NYSE trading services such as market data and content service provider data, as well as the ability to gain access to ICE and other markets, all from a single facility.



(Figure 1) – USLC Layout

USLC Location: 1700 McArthur Boulevard, Mahwah, NJ, 07430

3.1 Engineering Specifications

- 398 000 sq. ft. building situated on 28-acre site 34 miles from Wall Street, New York
- Tier 4 guided design of all critical infrastructure (2N or N+2)
- Data center white space scalable to 20,000 square ft. at 150 watts per square ft.
- Redundant fiber diversely routed to site
- 28 MW of total site electrical power
- 48 hours of emergency generator fuel storage and cooling tower water (at full load)
- Double action pre-action sprinkler fire suppression
- Armed security staff and state of the art surveillance systems
- Monitoring and Evaluation (M&E) on ground floor and data halls on mezzanine floor

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1. MMRs are on the 1st Floor of the USLC.
2. Production and Colocation Halls are on the 2nd Floor of the USLC.

4 Colocation Services

4.1 Kilowatts and Cabinets

Colocation cabinets come in standard sizes of 4kW, 8kW, and 12kW with variable power configurations available up to 15kW. A standard 4kW cabinet can scale up to 5kW of power, and a standard 8kW cabinet can scale up to 11kW of power. Customers requiring 12kW or more may purchase an upgrade kit, making the cabinet scalable to 15kW. Partial cabinets are also available in 1-2kW power configurations for customers with lower space/power requirements.

Customers requesting to use their own cabinets must submit a specification sheet for review and approval by the ICE Data Center management team. The color of customer supplied cabinets must comply with the ICE cabinet color standard where the customer cabinets will be installed.

4.1.1 Power Specification

Hall 3

Colocation Hall 3 cabinets configured as 4kW, 8kW, and up to 15kW of power use branch circuits from Remote Power Panels (RPP). One RPP provides 'A' feed power while the other provides 'B' feed power. In the event of a failure to either the 'A' or 'B' feed, the other feed is engineered to provide full power to the cabinet.

4kW cabinets

Each cabinet has two branch circuits, one from each of the RPPs. Each branch circuit is a single phase, 208VAC 30Amp feed which can support a maximum of 5kW of power. Both branch circuits are monitored to ensure each carry half of the 4kW load with an alarm in place for notifying the Data Center Operations (DCO) personnel should both branch circuits' total power exceed 4kW.

8kW cabinets

Each cabinet has four branch circuits, two from each of the RPPs. Each branch circuit is a single phase, 208VAC 30Amp feed which can support a maximum of 11kW of power. The four branch circuits are monitored to ensure each carry half of the 8kW load with an alarm in place for notifying the DCO personnel should the total power exceed 8kW.

12kW-15kW cabinets

Each cabinet has four branch circuits, two from each of the RPPs. Each branch circuit is a three phase, 208VAC 40Amp feed which can support a maximum of 15kW of power. The four branch circuits are monitored to ensure each carry half of the 15kW load with an alarm in place for notifying DCO should the total power exceed 15kW.

Hall 4 (covers Hall 4A and Hall 4B) and Hall 5

Colocation Hall 4 and Hall 5 cabinets configured as 4kW, 8kW, and up to 15kW of power use branch circuits from Overhead Busways. One overhead busway provides 'A' feed power while the other provides 'B' feed power. In the event of a failure to either the 'A' or 'B' feed, the other feed is engineered to provide full power to the cabinet.

4kW, 8kW, and 12-15kW cabinets

Each cabinet has two branch circuits, one from each of the busways. Each branch circuit is a 3 phase, 230/400VAC 30Amp feed which can support a maximum of 15kW of power. Both branch circuits are monitored to ensure each

carry half of the allocated load with an alarm in place for notifying the DCO personnel should both branch circuits' total power exceed the allocated cabinet kW.

4.1.2 Technical Specification

Hall 3

Power Strip

Two vertical power strips are provisioned in each cabinet. Strips are installed on the right side of the cabinet. Each strip is fused with the following standard configuration:

- **4kW and 8kW Cabinets Outlet Size (single phase – single strip):**
  - 30Amp (18x IEC C13, 6x IEC C19) 208 VAC receptacles
  - 30Amp (8x NEMA 5-20R) 120 VAC receptacles
  - Optional: 30Amp (24x IEC C13, 6x IEC C19) 208 VAC receptacles
  - ICE does not provided customers with 3 phase (L21-30) PDUs

- **12kW-15kW Cabinets Outlet Size (three phase – single strip):**
  - 40Amp (30x IEC C13, 6x IEC C19) 208 VAC receptacles
  - Optional Strip for 5-20R outlets
  - ICE does not provide customers with three-phase PDUs
    Customer supplied PDU's must be approved in advance by DCE and Facilities Engineering Teams

Standard Cabinet

- Manufacturer: Rittal Corporation
- Part: 9963619, Modified Custom TS8
- Color: Black
- Size: 45 Rack Unit (RU)
- Dimensions (Depth × Height × Width): 47.42 in. × 84.64 in. × 31.38 in.

Hall 4 and Hall 5

Power Strip

Two vertical 400VAC class power strips are provisioned in each cabinet. Strips are on one side of the cabinet. Each strip is fused with the following standard configuration:

- **4kW, 8kW, and 12kW-15kW Cabinets Outlet Size (three phase – single strip):**
  - 30Amp (24x locking IEC C13, 6x locking IEC C19) 230 VAC receptacles
  - L22-30P input power plug
  - Customer supplied power strips must be 400VAC class with an L22-30P plug, and approved in advance by DCE

Hall 4 Standard[1] Cabinet

- Manufacturer: Chatsworth Products Inc (CPI)
- Part: MIS-TS1520039
- Color: Black
- Size: 52 Rack Unit (RU)
- Dimensions (Depth × Height × Width): 46.63 in. × 96.94 in. × 27.53 in.

Hall 5 Standard[1] Cabinet

- Manufacturer: Chatsworth Products Inc (CPI)
- Part: MIS-TSZ1534386
- Color: Black
- Size: 52 Rack Unit (RU)
- Dimensions (Depth × Height × Width): 50.93in. × 96.86 in. × 27.53 in

Customer-Provided Cabinets and PDUs

Customer-Supplied Cabinets

- Customers requesting to supply their own cabinets must submit a specification sheet for review and written approval by the ICE Data Center management team.
- The color of customer supplied cabinets must comply with the ICE cabinet color standard, which is black.
- Customer is responsible for arranging white-glove delivery service, which includes unloading the cabinets at the loading dock and transporting cabinets to their cage.
- ICE is not responsible for any damages or defects to the customer-supplied cabinets.
- ICE will install the cabinets within the cage, including grounding, bonding and leveling the cabinets.
- Once notified this is complete, customer will have up to 14 calendar days to complete its inspection and request any modifications.

Customer-Supplied PDUs

- Customers requesting to supply their own PDUs must submit a specification sheet for review and written approval by the ICE Data Center management team.
- ICE is not responsible for any damages or defects to the customer-supplied PDUs.
- ICE will install and energize the PDUs.
- Once notified this is complete, customer will have up to 14 calendar days to complete its inspection and request any modifications.

Customer-Requested Replacement of ICE PDUs for Customer-Supplied PDUs

- Customers requesting to replace ICE-supplied PDUs with customer-supplied PDUs must submit a specification sheet for review and written approval by the ICE Data Center management team.
- Customer must submit a change request (SSR) to initiate replacement work, and sign a waiver of liability form to be provided by ICE. ICE is not responsible for any damages or defects to the customer-supplied PDUs.

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[1] Note that a 42.69” deep cabinet may be required in certain locations in Hall 4, and Hall 5 at the discretion of NYSET.

- ICE will coordinate the timing of the PDU replacement with the customer, and complete necessary electrical work. Customer is responsible to arrange onsite support to remove power cords from existing PDUs and install into new PDUs, or coordinate with data center personnel to support this effort.
- ICE will install and energize the PDUs.
- Once notified this is complete, customer will have up to 14 calendar days to complete its inspection and request any modifications.

Common Cabinet Specifications

Server Enclosure Specification

- 2 Server Enclosure Specification
- Hinge and lock points are internal and not accessible from outside cabinet with doors closed. Mounting of server fans can be installed without need for cutouts
- 3 Server Enclosure Specification
- Enclosure widths equal to or greater than 28 in. (700mm) allow for 19 in., 21 in., and 23 in, rack mounting of components and/or allow for the offsetting of 19 in. rails, left or right, to allow for additional cable management and air plenum space.

Material Specifications

Roll formed carbon steel and closed frame members provide a welded, vertical and horizontal structure of symmetrical profile. All metal components are primed, baked, powder coated, and baked again to assure maximum appearance and corrosion resistance. RAL 7035 and Sand Texture Black are available as standard colors. Optional color choices are available upon request.

- Sidewalls: 16 gauge cold rolled carbon steel
- Front and Rear Door: 14 gauge cold rolled steel
- Frame: 16 gauge cold rolled carbon steel with unlimited mounting options provided by installation holes spaced at 0.98 in. (25mm) intervals

Frame

- Enclosure frame are a 16 fold design, with 0.98 in. (25mm) repetitive hole pattern (round and slotted holes) to allow installation of various components
- Rack mounted equipment are installed on four independent vertical mounting rails
- All metal surfaces are free of burrs, and welded joints are ground free of weld splatter
- The frame is fully welded and provides minimum 3000lb static load capacity
- The frame meets Seismic Zone 3, standard, and can be upgraded to Seismic Zone 4

Doors

- Sheet cold rolled steel, 14 gauge, with horizontal and vertical door stiffeners to provide additional rigidity and mounting surfaces
- Front door is provided with a foamed in place perimeter gasket
- Fully perorated front and split rear doors with 64% air flow
- Reversible hinges, rated for 66 lbs. per hinge, are design with a minimum of three quick release hinges and captive hinge pins
- Minimum of two-point latching/locking for security

Roof Panels

- Fully perforated with four 4 in. diameter cable entry points
- Grommets are provided to seal unused cable entry holes
- Gasket
- Mating surfaces are sealed with closed cell foam-in-place (FIP) polyurethane gasket
- Bonding
- All components of the cabinet must have a grounding stud to have common ground potential with the use of grounding straps
- Hardware to be provided to for enclosure connection to facility grounding components
- Component Mounting Rails (19 in.)
- Front and rear mounting rails are depth adjustable multi-fold "Z" shaped, compliant with EIA-310-D standards
- Vertical mounting rails are constructed of 2.5 mm/12-gauge steel with equipment mounting holes using 9.5 mm^2
- Total static load capacity (regardless of location in the cabinet) of 2000 lbs.; equivalent to 47.6 lbs. per RU. Weight is measured using equal weight loading on all four rails
- Mounting rail depth can be adjusted as desired as along as the maximum useable depth is no less than 2 in. of the overall enclosure depth (i.e. 38 in. in 40 in. deep frame)
- Designed with floating attachment points in top and bottom of frame only, preventing the interference of interstitial cable management space from the vertical rails to the sidewalls
- Individual RU space is identified by a line at the top and the bottom of each RU and sequentially numbered. RUs have three holes, with the middle hole used as placement for designated space number, and measure 1.75 in. (44.45 mm) high. RU space marking is ink jet applied, not adhesive backed. The rear side of all mounting rails mirror the same RU space markings

Additional sets of mounting holes, which replicate the hole pattern of the frame, are available for the installation of various accessories such as vertical or horizontal cable management, and power strips.

Enclosure widths equal to or greater than 29 in. (700 mm) shall allow for 19 in., 21 in., and 23 in. rack mounting of components and/or allow for the offsetting of 19 in. rails, left or right, to allow for additional cable management and air plenum space.

Baying

- Baying of cabinets is to be accomplished
  - Without disturbing any cables or rack mounted equipment
  - With the use of simple tools
  - After access into the cabinet, so as not to compromise cabinet level security
- Baying of cabinets is not allowed for the purpose of increasing the width of the row

4.2 Partial Cabinet Solutions

Partial cabinet solutions provide a packaged solution for colocation customers who require limited space and power.

A standard bundle is offered which includes the following base items:

- 8Us of rack space
- 1 x IP SLC connection (dedicated)
- 1 x LCN LX connection (dedicated)
- 2 x NMS Network connections (dedicated)
- 2 x LCX cross connect

- Time service

Selected items above are also customizable to a limited extent via choices of:

- 10G and 40G IP SLC connectivity
- 10G and 40G LCN connectivity
- 10G and 40G NMS connectivity
- 1kW or 2kW of total power
- NTP or PTP timing services protocol

Two vertical power strips are provisioned in each partial cabinet. Strips are on each side in the back of the cabinet with 20 amp (10 x IEC C13) 208V receptacles

4.3 Power Not Used (PNU)

Power Not Used (PNU) offers the colocation customer an option to pay a reduced rate for the option to reserve cabinets and kilowatts that the customer anticipates will be required in the future. PNU availability is dependent upon overall available power and cabinets in the USLC.

4.4 Hosting Services

The Hosting Services allow approved third-party service providers (called Hosting Users) to occupy space in the USLC and provide services directly to USLC customers.

Hosting Users are able to offer hosting services to customers and can be categorized as any of the following exchange participants:

- Member
- Non-Member
- Sponsored Participant (SP)

4.5 Timing Services

Customers within the Colocation Halls have the following options for receiving time and synchronization services based on their precision requirements.

- Network Timing Protocol (NTP) services across the LCN
- Direct Precision Timing Protocol (PTP) service over Ethernet
- Direct Global Positioning System (GPS) feed

4.5.1 Network Timing Protocol Service

Customers can receive NTP services from a Stratum 1 time source via their LCN connections. NTP peering IP addresses will be provided during the provisioning process. For more information on LCN connection specifications, refer to *Liquidity Center Network Service* section later in this document.

4.5.2 Precision Time Protocol Service

Colocation customers looking for precise synchronization accuracy will be provisioned with PTP IEEE1588 compliant feed. PTP services can be received by directly connecting to USLC PTP environment via direct Ethernet 1G MMF fiber cross-connection, which will give them the ability to achieve sub 1µs precision using a NIC with an IEEE1588-compliant hardware clock.

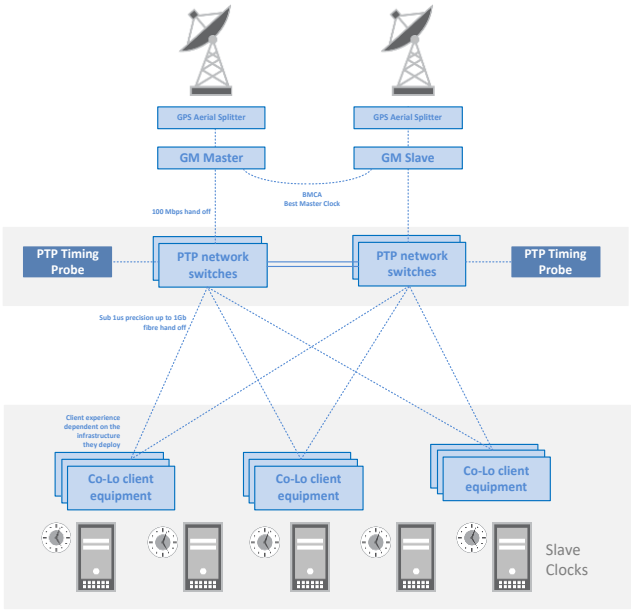
PTP Distribution

The USLC PTP service relies on a local clock that is synchronized through the GPS constellation. The clock on the USLC uses rubidium holdovers and is verified by the National Institute of Standards and Technology (NIST) through their synchronization services.

The synchronization method is distributed over standard Ethernet connections to the colocation customers in accordance with the IEEE1588 protocol. The PTP service provided at the USLC is specifically set up to support only multicast functionality of IEE1588.

Each of the USLC Colocation Halls is furnished with a group of PTP boundary switches, providing the direct point of connectivity between the PTP Distribution Network and the directly connected customers. Each of the directly connected customers should have two physical connections to the facility for redundancy. Customers connecting to ICE's PTP environment should support BGP4 protocol for exchange of source routes and PIM SM in case of implementing multicast-only and hybrid PTP profiles.

RFC1918 private ranges will be assigned to the customers; alternatively, customers may use their globally registered IP addresses. BGP Autonomous System (AS) addresses will be assigned from the private space identified by American Registry for Internet Number (ARIN).



(Figure 2) – PTP Distribution Network

4.5.3 Global Positioning System

Customers may receive time services via a direct feed from Global Positioning System (GPS) antennas. GPS time, the designated atomic time scale, relies on atomic clocks in both GPS ground control stations and satellites. GPS systems

broadcast on at least two carrier frequencies, L1, and L2 (with newer satellites also broadcasting L5). ICE supports signals on L1 at 1575.42 MHz, and L2 at 1227.6 MHz.

The USLC is equipped with three separate antennas and GPS receivers. Customers are recommended to subscribe to all three feeds in order to form a quorum and spot an errant source.

GPS services will be delivered to a customer's cabinet via an ICE LMR400 cable with N-type connector. ICE is not responsible for any issues related to connector alteration.

Customers will be provided with precise time offset information as well as the estimated delay associated with the cable length between the GPS antenna and their cabinet as part of the GPS services installation and calibration process.

4.5.4 Time Service Comparison Table

Media Options:	Accuracy	Delivery Method
NTP	A few milliseconds	Delivered over LCN network
PTP	Sub microsecond to sub 10 microseconds	Delivered over a dedicated PTP network
GPS	Sub microsecond	Direct connection within USLC

5 High Availability

5.1 Overview

Supporting the NYSE exchanges in providing high availability and quality to the production systems operated is the High Availability (HA) network. High Availability is a secure, resilient and redundant multi-exchange, multi-asset class and multi-participant global network. By connecting to High Availability, a customer has the possibility to connect to a broad range of services, including the ICE and NYSE exchanges, third party markets, alternative trading systems, clearing and settlement services, market data vendors, content service providers, and other core securities industry participants.

The High Availability network backbone is comprised of two diverse, logical networks that connect over 20 Access and Data Centers in North America and Europe to all ICE and NYSE markets and Data Centers. This provides customers in the financial services industry with distinct geographical locations to which they can meet the High Availability edge routers.

In addition, ICE Global Network low latency products (IGN Wireless and IGN Low Latency Network) augment the ICE Global Network product portfolio by adding options focused on speed over redundancy.

5.2 High Availability Highlights

- High Availability is a front-end network interface for approved customers to connect to ICE and NYSE markets as well as third-party content. ICE Global Network supports industry-standard network protocols for the transport of financial market applications and data. It provides reliable and redundant transport mechanisms for data traffic and acts solely as a transport network, exclusively supporting the IP protocol suite for connecting to each of the markets.
- High Availability allows customers to consolidate disparate WAN connections into consolidated connections and to maintain high-availability network access to market systems.
- Customers connect to High Availability by connecting directly via an Ethernet port at one or more of the High Availability Access Centers, or by connecting via a third-party (extranet) provider. Customers who access High Availability through a third-party service or extranet provider must confirm interface specifications with their specific provider.
- High Availability provides a carrier-grade infrastructure supporting industry-standard protocols widely accepted and utilized in Internet connectivity, while maintaining the security, operational integrity, and high standards of availability of ICE and NYSE trading.

High Availability provides some security functions at the network layer but in addition, each market accessed and the systems and services that it supports will have their own set of security requirements that may include/require end systems to perform authentication and access control.

This document only outlines information regarding the network interface to which customers will connect and not the detail of the application services offered over High Availability. Customers must work with the IGN Sales or Provisioning teams to learn more about service-specific details.

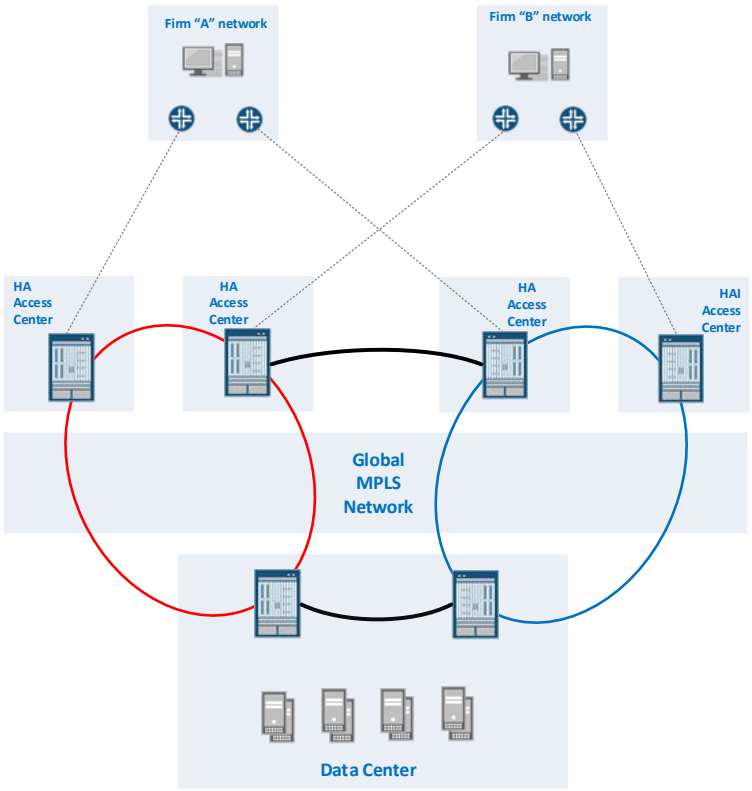
5.3 Connectivity Options

High Availability supports the following connectivity methods:

- **High Availability IP Direct Connect (SDC):** Direct access for customers. Customers order their own Ethernet local loop and configure the equipment directly connected to High Availability.
- **Application Service Providers (ASP):** Provides a form of value-added software service to customers and aggregates them to the ICE Global Network backbone for access to ICE and NYSE applications.
- **Extranet Service Providers (ESP):** Aggregates customers with Layer 3 routing to the ICE Global Network backbone for access to ICE and NYSE applications.

High Availability is designed to meet the unique needs of members of the financial services industry with various product offerings covering redundancy, high capacity, and ultra-low latency access to markets. For cost-effectiveness, scalability, and operational efficiency, the traffic of multiple customers is aggregated onto the High Availability fiber-optic backbone and delivered to relevant Access and Data Centers. For customers requiring optimum latency over redundancy, low latency connectivity methods, used in conjunction with High Availability SDC, will provide a complete solution.

Customers are able to run multiple business services over a single physical connection to High Availability. Direct connectivity into the High Availability network is currently available from the US (New York, New Jersey, and Chicago) and Europe (Paris, London, Amsterdam, Frankfurt, and Bergamo). This architecture allows customers to implement redundant paths to at least two Access or Data Centers, one on each logical network from their own sites. Figure 1 shows two logical networks providing diverse access for customers connecting to High Availability locations.



(Figure 3) – High Availability Logical Overview

5.4 High Availability Concepts

To meet the unique requirements of its domestic and international customers and vendors, High Availability provides a high capacity, high-availability, secure, and easy to use IP-based conduit into and out of the individual datacenters and markets. By using the industry-standard TCP/IP suite of protocols, High Availability enables customers to implement interactive and computer-to-computer connections to the services offered with less preparation and development time, and with a greater assurance of compatibility and interoperability. To the greatest extent practicable, High Availability seeks to empower existing and new customers to:

- Gain access to market services quickly and easily
- Have a range of choices for access and performance, vendor, technology, and cost
- Access multiple services over a single physical connection to High Availability
- Add additional connections designed specifically for low latency
- Utilize widely available and accepted industry-standard applications, protocols, and structured data formats, to reduce complexity, leverage the customers' resources, and minimize the need for development or customization while still addressing their particular service requirements
- Minimize the amount of systems development required, and adopt generic solutions consistent with the above
- Increase customers' control over their interface to services
- Simplified process for requesting service changes

5.5 High Availability US Access and Data Centers

High Availability Access and Data Centers are the entrance points for customers to connect to the HA network. These Access and Data Centers are securely fenced-in cages that are hosted in large telecommunications facilities. Each cage contains HA backbone equipment and customer access equipment. See below for a list of HA US Access and Data Centers.

High Availability Access and Data Centers				
Address	**Ring**	**City**	**State**	**Zip**
32 Avenue of the Americas	Blue	New York	NY	10013
111 8th Ave	Blue/Red	New York	NY	10011
111 N Canal St	Red	Chicago	IL	60661
165 Halsey St	Red	Newark	NJ	07102
300 Boulevard E	Blue/Red	Weehawken	NJ	07086
350 E Cermak Rd*	Blue/Red	Chicago	IL	60616
800 Secaucus Road	Blue/Red	Secaucus	NJ	07094
755 Secaucus Road	Blue/Red	Secaucus	NJ	07094
1400 Federal Blvd	Red	Carteret	NJ	07008
1700 MacArthur Blvd*	Blue/Red	Mahwah	NJ	07430

* Data Centers

5.6 Protocols Supported

High Availability acts as a transport mechanism for multiple IP-based markets, and as such, is agnostic to the transport layer protocol employed; however, High Availability is configured to only allow transmission of IP-based transport protocols required by its own market systems and those of business partners. By adopting the use of the industry-standard IP protocols,

the intention is to reduce complexity, leverage customers' resources, and reduce the need for development or customization. ICE Global Network will continue to support future industry standards as they change.

5.7 Physical connectivity options

From a physical connectivity perspective, the following connection standards are supported by High Availability:

Media Options	Ethernet Standards
Single-mode fiber in HA Access Centers	1000BASE-LX
	10GBASE-LR
	40GBASE-LR4
	100GBASE-LR4[1]
Multimode fiber in USLC	1000BASE-SX
	10GBASE-SR
	40GBASE-SR4

5.8 Security Goals

The security architecture and security mechanisms of High Availability ensure the operational integrity of ICE operated systems and networks against threats arising via external internetworking connections. High Availability does not specifically protect customers' networks but does enforce traffic filtering and routing policies on the High Availability network at those points where it connects to customers.

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[1] 100GBASE-LR4 only available in specific locations

6 Network Connectivity Services: Detailed Specifications

6.1 Overview

ICE Global Network provides multiple connectivity options to support customers' individual requirements. Within the USLC, customers can connect to LCN, High Availability SLC, or the NMS Network. LCN is the low latency local network within the USLC, for Mahwah NYSE hosted markets and services as well as NYSE DR services, and High Availability SLC provides access to the same NYSE services (Production/DR/test/certification), as well as the full portfolio of ICE Futures applications, NMS and third-party services. The NMS Network offers the lowest latency access to the OPRA, CTA and CQ data feeds within the USLC.

Outside of the USLC, for WAN connectivity, customers can select from High Availability (SDC and LSP), IGN LLN, IGN Optic and IGN Wireless. High Availability SDC and LSP products provide the ability to access all content available on the ICE Global Network via a single, consolidated connection. IGN Optic provides connectivity from the customer Colocation Halls to resources outside the Data Center, and the Wireless and Low Latency Network services allow for low latency connectivity between Mahwah and select access centers.

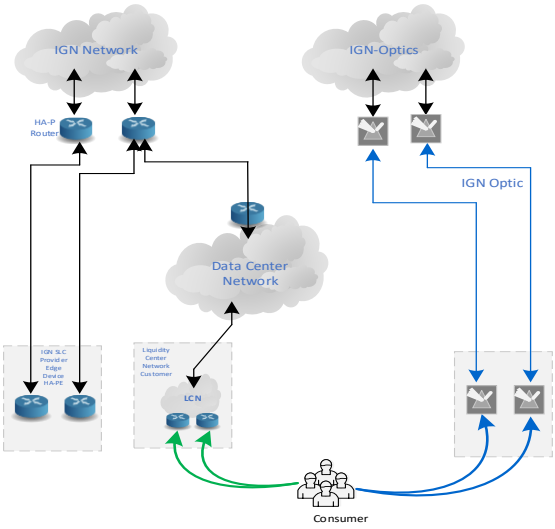
This section outlines the detailed physical and logical interface requirements for each of the different products along with routing considerations.

6.2 Liquidity Center Network (LCN) Services

The Liquidity Center Network (LCN) is only available to customers colocated within the USLC. The LCN allows for the fastest and most direct path to the NYSE Group trading systems and provides the lowest latency profile for delivery of proprietary NYSE Group market data. In addition to speed, the low latency LCN network offers the benefit of a highly redundant local network.

LCN is available in two bandwidth options:

- 10G LX ultra-low latency
- 40G ultra-low latency



(Figure 4) – NYSE / Liquidity Center Networks

IMPORTANT: The following restrictions and cautions apply to customer usage of the LCN network:

Customers with both LCN and High Availability SLC connections are not recommended to use the LCN as a fail-over or redundant path for SLC or vice versa.

Customers utilizing a combination of 10G LX and 40G LCN connections should be mindful of the following considerations:

Common policies (single or multiple routers):

- LCN will entitle both A and B feeds on both 10G LX and 40G connections for PIM customers - customer will be responsible to subscribe to the proper feed(s) that fits their port speed
- Must announce unique IP prefixes into each environment (except during migration)
- Must use BGP "AS Path" manipulation to influence route selection over preferred path for unicast
- Must use route policy to influence NYSE IP prefixes over preferred path for unicast services
- Must use route policy to influence NYSE IP multicast source prefixes (RPF) over preferred path

Single router:

- May consume all multicast services over either connection, only if entitlements are identical on both connections
- May only use a single path to access NYSE services - either via 10G LX or 40G LCN and for unicast services only

Multiple routers:

- May consume all multicast and/or unicast services over both connections according to their provisioned entitlements

Customers with multiple (active) 10G LX or 40G LCN connections:

- Will have their connections terminated on separate network leaf switches, as available
- Must provide unique IP prefixes over each connection for unicast services only
- Must use route policy to influence NYSE IP prefixes over preferred path for unicast services only
- Must use route policy to influence NYSE IP multicast source prefixes over preferred path

6.2.1 LCN Physical Connectivity

LCN 10G LX physical connections will be terminated on a patch panel in the customer's colocation cabinet with an LC through connector. LCN 40G physical connections will be through an MTP terminated 12 core OM3 Multimode fiber trunk cable presented in the customer's colocation cabinet. Each trunk cable should be connected to a 10G or 40GBASE-SR4 (QSFP) transceiver.

Standard Fiber Connection Requirements		
Speed	**10G**	**40G**
Connector	LC Connector	MTP Connector - 12 Core OM3
Fiber	Multimode	Multimode Fiber
Wavelength	850 nm	4 x 850 nm - 40GBASE-SR4 QSFP Transceiver

Additional LCN Connectivity Options

Customers deploying network switches which support 40 Gigabit Ethernet (*IEEE P802.3ba*) by combining four sequential SFP+ interfaces into a logical 40 Gigabit Ethernet port, will need to use a breakout or fan/out harness. The resulting interface must be fully compliant with the IEEE 40 Gigabit Ethernet standard. The fan/out harness is a cable adaptor with one end having a pinned MTP connector and the opposite end breaking out to four MM-50M LC connectors.

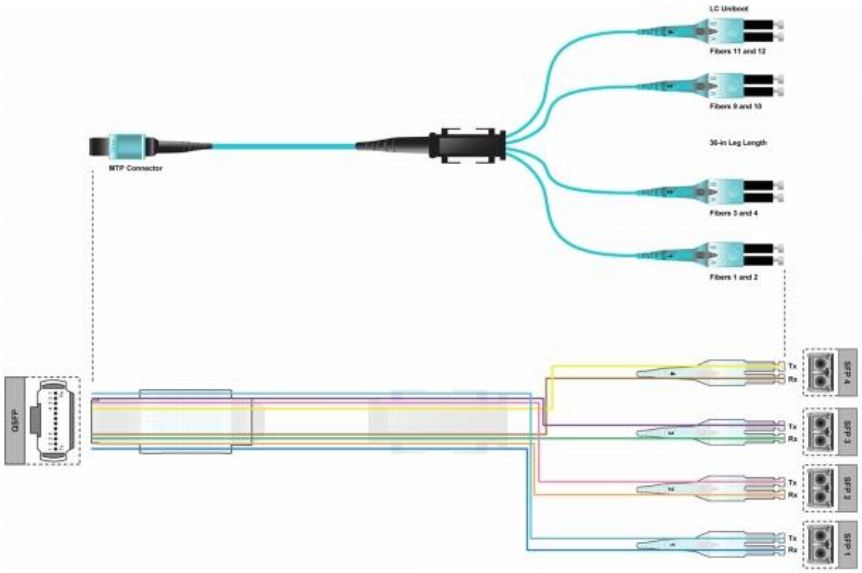


Figure 5 - Example - Fan Out Cable

Along with the fan/out harness, an MTP coupler will be needed. The MTP coupler is the means by which the trunk cable and the fan/out harness are connected together. Please see figure below.

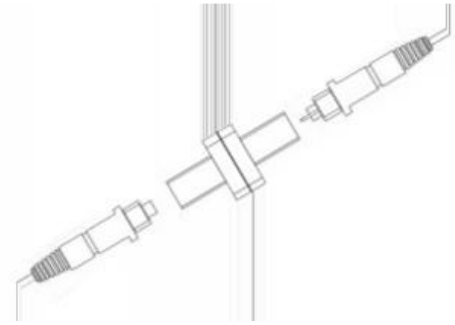


Figure 6 - MTP M/M Coupler

Optional Fiber Connection (Agile Port - Fanout)		
Type	**Fan-Out LC**	**40G - MTP**
Connector	4 x LC Connector	MTP Connector - 12 Core OM3
Fiber	Multimode Fiber	Multimode Fiber
Wavelength	850 nm	850 nm - 40GBASE-SR4 QSFP Transceiver

6.2.2 LCN address space

Customers' IP address space

Each customer's IP addressable entity (logical or physical) that accesses market services requires its own IP address. Given this IP address, LCN is able to route outbound to the customer's device via the access method contracted by that customer (i.e. the address must be reachable). Every IP address that can be assigned to a device must be either a globally-unique, registered IP address or a private IP address from a range of RFC1918 IPs assigned by ICE.

If a customer's device uses a private address from a range not assigned by IGN, the customer might choose to implement Network Address Translation (NAT) to present a globally registered IP address. However, NAT may limit the customer's ability to take advantage of redundant connections seamlessly and could interfere with the functionality of the applications that rely on knowing the true IP address of the end device. Customers must work with ICE Customer Engineering during their provisioning process to resolve any related issues.

LCN implements anti-spoofing packet filtering on edge router ports, which will discard inbound IP datagrams with unexpected source addresses. Customers may wish to implement packet filtering in their router(s) or firewall to limit access to LCN from within their enterprise.

Network Address Translation / Proxy

The LCN network does not use NAT or proxy services. Each customer connection is filtered to receive the authorized set of routes and services.

6.2.3 LCN networking configuration

Customer-owned layer 3 device and LCN switches will exchange IP routes using BGP. The BGP addresses for peering are available from the ICE Customer Engineering Team as part of the customer installation package.

BGP Hold Timers

Customers should set their BGP settings to peer with LCN as follows:

hold time value: 20 seconds
keep alive interval: 6 seconds

BGP Autonomous System information

The Autonomous System numbers for USLC is as follows:

US – USLC ASN: #64552

BGP Community Strings

The following information is provided to the customer for the purposes of traffic engineering within their own network(s). In the community name, "dh" stands for "data hall", "sw" stands for "switch". LCN overrides any community values advertised by customer's network(s).

community dh1-sw1 = 64552:0	**community dh2-sw1 = 64552:2**
community dh1-sw2 = 64552:1	**community dh2-sw2 = 64552:3**

BGP unicast routes advertised

LCN will advertise IPv4 routes for all public unicast services in the USLC. Colocation customers should accept those routes that are required for the products they purchase. Route information for each product will be provided during the provisioning process.

VLANs

Customer interfaces to the LCN network will NOT be configured for 802.1Q VLANs, and VLAN tagging set by the customer may be ignored or tagged packets discarded. All traffic between the customer and the LCN will share a single, non-tagged interface.

6.2.4 LCN multicast

The primary method of multicast distribution within the Data Centers is via PIM-SM (Protocol Independent Multicast-Sparse Mode). Using this protocol, customers will be able to subscribe to the multicast feeds of their choice and have the option of taking multiple connections that can be used for resiliency with dynamic recovery or separation of redundant multicast feeds, over the LCN network. Colocation customers should consider deploying network equipment which supports both PIM-SM and BGP.

For customers who do not require dynamic recovery between their LCN links, multicast services can be statically provisioned over the LCN connections in a configuration that the customer requests, with the restriction that dynamic (PIM-SM) and static (IGMP) multicast configurations cannot be mixed on the same interface.

It is recommended that customers interested in receiving multicast services also consider ensuring that their network devices and servers support IGMPv2.

For many products, ICE Global Network distributes multicast in a dual-stream configuration, providing a duplicated 'A' stream and 'B' stream for redundancy. For more information, please consult the product specification for NYSE multicast data of interest. This can be found at https://www.nyse.com/market-data/real-time.

Multicast source routes

Routes for all public multicast sources in the USLC will be sent to LCN multicast customers via BGP. Customers are responsible for configuring their equipment appropriately if they wish to balance or separate 'A' and 'B' multicast traffic when multiple LCN links are used.

PIM-SM rendezvous points

Colocation customers using PIM-SM to dynamically receive multicast products from LCN should configure their CPE to point to the LCN PIM Rendezvous Point (RP). LCN provides high availability RPs using Anycast mechanisms. Customers must statically configure the RP mapping.

IP addresses related to NYSE Core multicast services (sources, groups, RPs) can be downloaded here:
https://www.nyse.com/publicdocs/nyse/data/IP_Addresses.xlsx

6.2.5 LCN rate limiting

Colocation customers' LCN 10G LX and 40G interfaces will be configured with fixed ingress and egress aggregate rate limiters. LCN ports will be policed at 10% of their port speed. All ingress and egress (control and data) traffic on each customer 10G LX port will be limited to 1G and each customer 40G port will be limited to 4G without any regard to its origin, destination, protocol or priority. Any ingress or egress traffic surpassing the bandwidth thresholds will be unconditionally discarded.

6.3 High Availability Services

The use of logical interfaces and virtual LANs (VLANs) is fundamental to the method by which High Availability delivers access to multiple content sources simultaneously through a single network interface. For all NYSE markets, for example, an individual VLAN is used to support all the unicast IP services associated with test and production. This is separate to the NYSE multicast VLAN and additional VLANS that exist for the ICE Markets access as well as other third-party content. This concept allows High Availability to maintain a logical separation between key services and significantly improves High Availability's ability to provision new services, scale the environment, and at the same time, allows the customers to maintain that logical separation should they wish to do so.

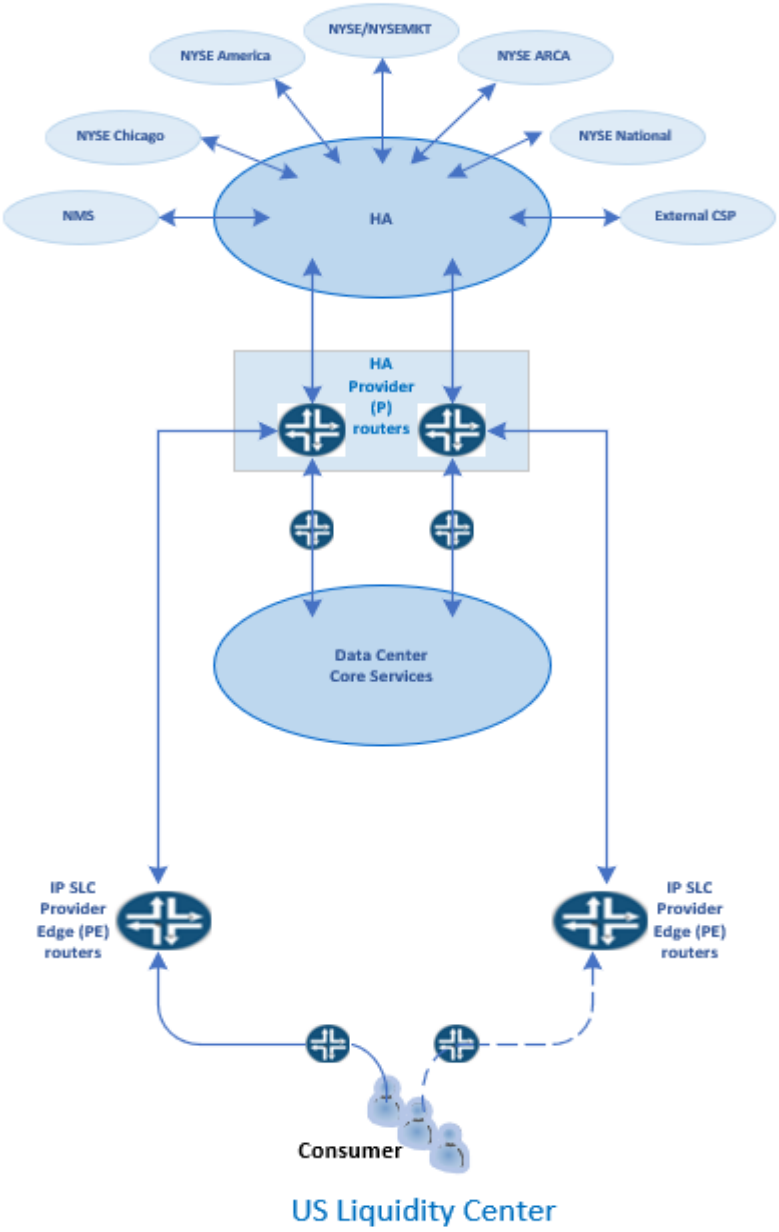
At the network layer, High Availability requires the logical interfaces to be defined separately on a customer's Ethernet interface in order to receive the services available from each of the individual services. These logical interfaces must be capable of supporting the 802.1Q protocol, which allows for processing IP packets tagged with the 802.1Q information and interpreting the logical separation associated with the individual virtual LANs, or VLANs. Using this architecture, HA delivers each set of unicast services on a separate VLAN to the customer's edge router. Customers are not required to transport the traffic via VLANs within their own networking environments.

High Availability services are available both inside the USLC and on the WAN, with different options for connectivity based on a customer's key drivers; be that remote location accessibility, speed, or resiliency required.

This section outlines key interface information for the various High Availability services:

6.3.1 High Availability Liquidity Center (SLC) services

High Availability Liquidity Center (SLC) services offer access to a global MPLS network that connects customers to ICE and NYSE Markets and Services as well as third-party financial industry content service providers. All SLC services are available to colocation customers in the USLC.



(Figure 7) – USLC

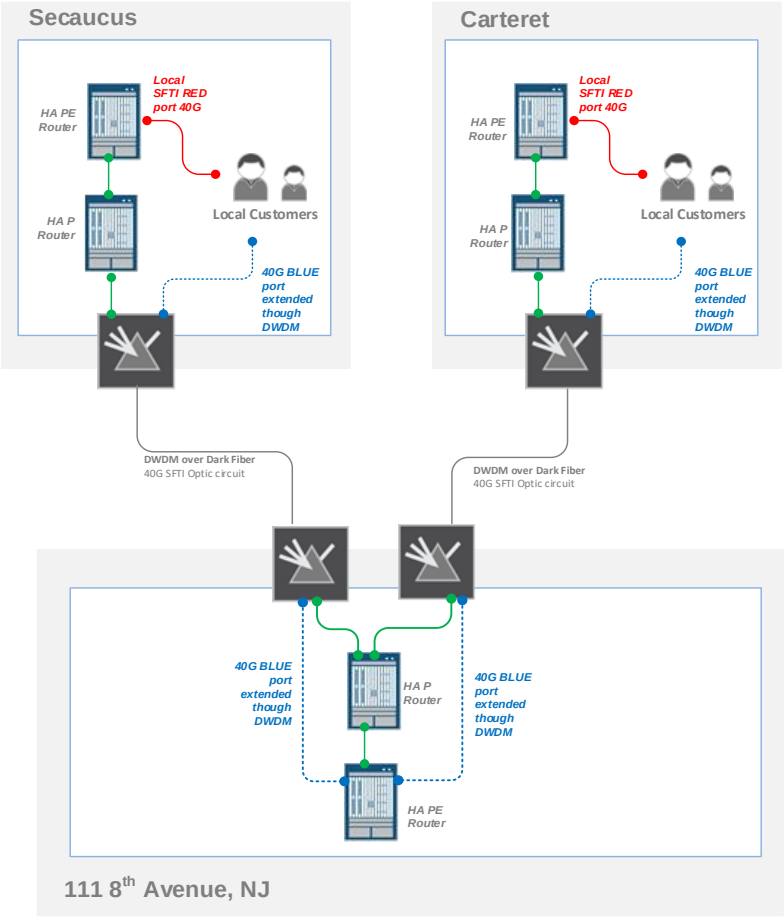
6.3.2 High Availability Physical Connectivity (Mahwah)

Physical connections for SLC customers require that customers connect their equipment within the USLC via 1G, 10G or 40G Ethernet connections. Customers' connections to SLC must be configured for 802.1q trunking to support VLAN tagging.

Standard Fiber Connection Requirements			
Speed	**1G**	**10G**	**40G**
Connector	LC Connector	LC Connector	MTP Connector - 12 Core OM3
Fiber	Multimode	Multimode	Multimode
Wavelength	850 nm	850 nm	4 x 850 nm - 40GASE-SR4 QSFP Transceiver

6.3.3 High Availability Direct Connect (SDC) Ethernet (WAN)

High Availability Direct Connection (SDC) enables firms to use their own Ethernet connectivity to connect with ICE Global Network at geographically diverse and vendor-neutral Access Centers outside of Mahwah.



(Figure 8) – IGN HA SDC

6.3.4 High Availability Physical Connectivity (SDC)

High Availability supports various circuit types, including: 1G, 10G, 40G and 100G Ethernet. 1G & 10G connections are available in all locations, while 40G and 100G are available in most IGN access centers. The SDC Ethernet handoff to the customer will be the following specification for all locations:

1G	Single-mode
Ethernet Standard	1000Base-LX
Source Wavelength	1310nm
Receiver Sensitivity	-20dBm
Distance	10km limit using 9/125µm
Connector	LC

10G	Single-mode
Ethernet Standard	10GBase-LR
Source Wavelength	1310nm
Receiver Sensitivity[1]	-15dBm
Distance[2]	10km[3] limit using 9/125µm fiber
Connector	LC

40G	Single-mode
Ethernet Standard	40GBASE-LR4
Source Wavelength Per Lane	Lane 0– 1264.5 nm through 1277.5 nm Lane 1– 1284.5 nm through 1297.5 nm Lane 2– 1304.5 nm through 1317.5 nm Lane 3– 1324.5 nm through 1337.5 nm
Receiver Sensitivity Per Lane[1]	–13.7 dBm
Distance[2]	10km[3] limit using 9/125µm fiber
Connector	LC

100G	Single-mode
Ethernet Standard	100GBASE-LR4
Source Wavelength Per Lane	Lane 0–1294.53 through 1296.59 nm Lane 1–1299.02 through 1301.09 nm Lane 2–1303.54 through 1305.63 nm Lane 3–1308.09 through 1310.19 nm
Receiver Sensitivity Per Lane[1]	–10.6 dBm
Distance[2]	10km[3] limit using 9/125µm fiber
Connector	LC

6.3.5 Limited-Service Port (LSP)

LSP enables firms to use their Ethernet connectivity to connect with a limited-service High Availability port. It provides customers with a way to access a single NYSE Non-Core, ICE or third-party service via a directly connected 1G HA port. This port comes with a choice of one of the following Non-Core services: CSP or VCC. To add further entitlements onto an LSP, customers will be required to upgrade to a full HA SDC port. NOTE: LSPs are not available within the USLC.

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[1] Customer power received at interface must be equal to or greater than this value.
[2] Power level at handoff is the limiting parameter, not distance.
[3] Fiber distance not to exceed 10km even if the fiber budget can be attained due to residual dispersion distortion.

6.3.6 High Availability Address Space (SLC, SDC and LSP)

Customer IP Address Space

ICE Global Network customers are encouraged to use the registered IP address range(s) for connectivity. If the registered IP addresses are not available, ICE will assign the IP addresses from a predefined private IP range. Customers may choose to implement Network Address Translation (NAT) to present a globally registered IP address to High Availability; however, NAT may limit customers' ability to take advantage of redundant connections seamlessly and could interfere with the functionality of the applications that rely on knowing the true IP address of the end device.

Network Address Translation / Proxy

High Availability does not use NAT or proxy services. Each customer connection is filtered to receive the authorized set of routes and services.

NOTE that the exception to this is ICE Global Network wireless services with detail outlined in a different document.

Networking BGP Peering

Customers' will exchange IP routes with High Availability using BGP. The BGP addresses for peering will be allocated by the Customer Engineering Team as part of the customer installation process.

IMPORTANT: BGP peering addresses must be allocated by ICE Global Network. Customer-provided Ips cannot be accommodated.

BGP Hold Timers

Customers should set their BGP settings to peer with HA as follows:

hold time value: 20 seconds
keep alive interval: 6 seconds

BGP Autonomous System Information

The Autonomous System number for HA is as follows:

US – HA ASN: #26585

BGP Unicast Routes Advertised

HA will advertise IPv4 routes for all public unicast services in the USLC. Colocation customers should accept those routes that are required for the products they purchase. Route information for each product will be provided during the provisioning process.

Multicast

The primary method of multicast distribution within the USLC is via PIM-SM (Protocol Independent Multicast-Sparse Mode). Using this protocol, customers can subscribe to the multicast feeds of their choice and have the option of taking multiple connections that can be used for resiliency with dynamic recovery or separation of redundant multicast feeds, over the HA network. Colocation customers should consider deploying network equipment which supports both PIM-SM and BGP.

For customers that do not require dynamic recovery between their HA links, the option exists to be statically provisioned for multicast services with the following restrictions: dynamic (PIM-SM) and static (IGMP) multicast configurations may not be mixed on the same interface.

For NYSE's products, ICE Global Network distributes multicast in a dual-stream configuration, providing a duplicated 'A' stream and 'B' stream for redundancy. For more information, please consult the product specification for the multicast data of interest. This can be found at https://www.nyse.com/market-data/real-time.

Multicast Source Routes

Routes for all services multicast sources will be sent to High Availability multicast customers via BGP. Customers are responsible to configure their equipment appropriately if they wish to balance or separate 'A' and 'B' multicast traffic when multiple High Availability links are used.

PIM-SM Rendezvous Points

Colocation customers using PIM-SM to dynamically receive multicast products from High Availability should configure their side to point to the High Availability PIM Rendezvous Point (RP) for the specific multicast products ordered. High Availability provides high availability RPs using Anycast mechanisms. Customers must statically configure the RP mapping.

IP addresses related to NYSE Core multicast services (sources, groups, RPs) can be downloaded here:
https://www.nyse.com/publicdocs/nyse/data/IP_Addresses.xlsx

For customers who choose to receive NMS services over High Availability connections, the multicast RP, group(s) and source(s) information will be provided during the provisioning process or can be found on the OPRA Plan website (www.opraplan.com/document-library), or the CTA website (https://www.ctaplan.com/tech-specs).

The RP information used for NMS services will be independent of that used to provide NYSE Core and Non-Core multicast services in the USLC. The route to the USLC, including NMS, ICE and relevant third-party service RPs' will be announced to the customers via BGP.

Rate Limiting

High Availability interfaces are configured with ingress (from the customer into High Availability services) rate limits on a per-product basis. Each product has a base rate limit, which may be customized on a case-by-case basis.

Rate limits are added, but not shared. For example, if a customer purchases two products, each with a 50M rate limit, the customer may send 50M for each product simultaneously, for a total of 100M. The customer may not, however, send more than 50M of traffic for either product. The BGP, PIM-SM and other protocol traffic will be restricted to levels appropriate for the protocol. HA will silently discard inappropriate network control traffic at the HA edge. Traffic destined for the IP ranges of the ICE and NYSE Markets and Services and to third-party financial industry content service providers that have been provisioned will be allowed; other IP traffic will be silently discarded.

Connection Monitoring

Each customer's HA connection has the ability to be monitored on-demand, non-intrusively, via a tap on the connection. This connectivity model does not impact latency or line performance.

6.4 ICE Global Network Optic Access

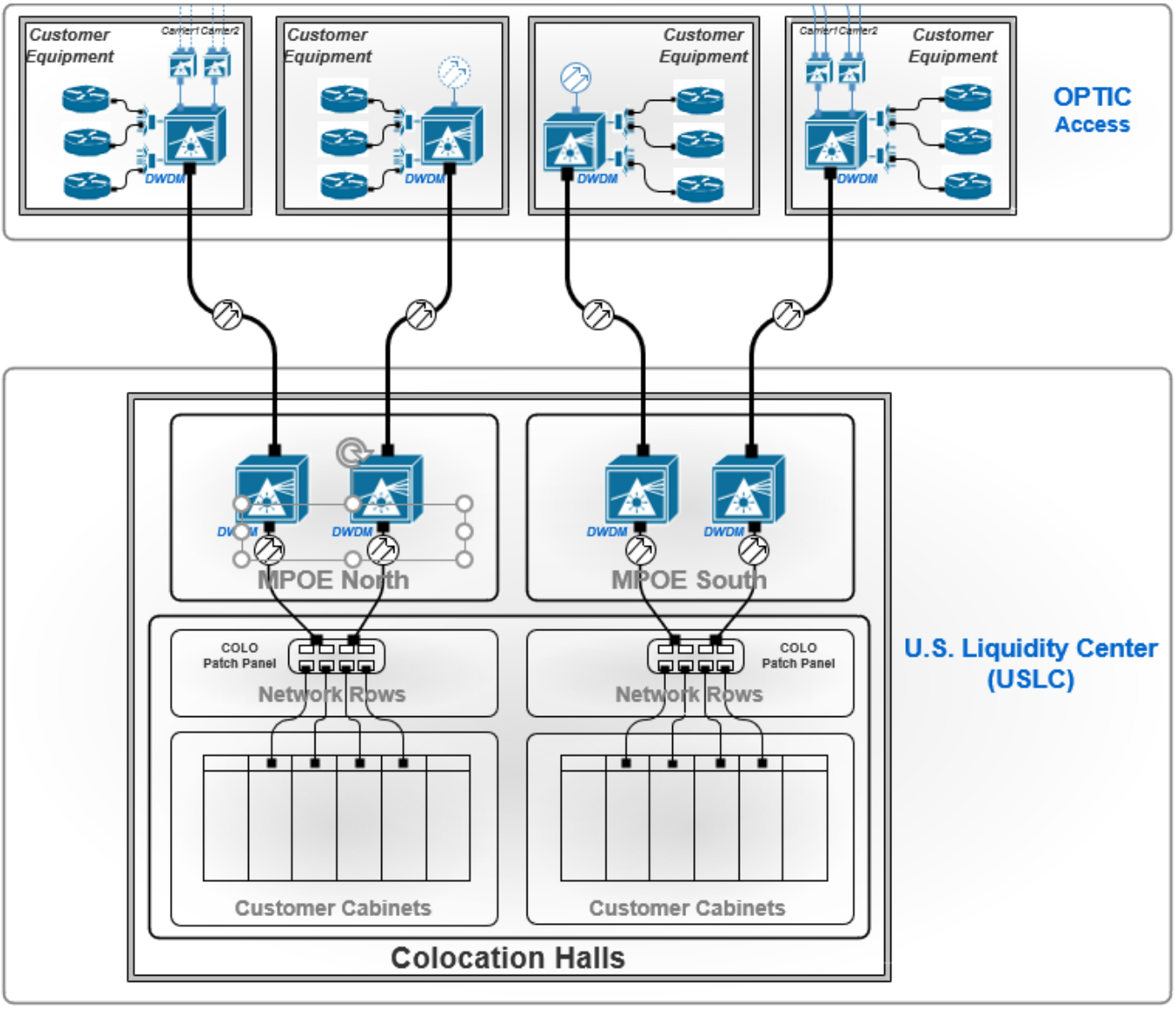
ICE Global Network Optic Access is a Layer 1 fiber-optic based, private circuit option for customers who require a direct circuit from the USLC to any of the locations listed below. At each of these locations, termination must be on equipment belonging to the customer or a third-party telecommunications carrier.

Each Optic Access circuit is provided to the customer with an Ethernet handoff, at a speed of either 1G, 10G or 40G, and is transported over ICE Global Network's dark fiber-based optical systems using Ethernet over DWDM technology. Optic Access is a non-redundant, point-to-point connectivity solution and redundancy is achieved by customers using a second optical circuit to a diverse location chosen from any of the destinations listed below.

As depicted in the table below, Optic Access is available in five different destinations. Each route between the USLC and any remote destination uses a dedicated pair of optical fibers that penetrates the USLC building through one of the three entry points available.

IGN Optic Access Destinations	City	State
32 Avenue of the Americas	New York	NY
111 8th Ave *	New York	NY
165 Halsey St *	Newark	NJ
800 Secaucus Rd *	Secaucus	NJ
1400 Federal Blvd *	Carteret	NJ

* Access Centers offering 40G IGN Optic



(Figure 8) – IGN Optic

6.4.1 IGN Optic Access Physical Connectivity

USLC Physical Specification

Within the USLC, ICE will provide a pair of 850 nm Multimode LC fibers into the customer's colocation cabinet for each IGN Optic Access circuit purchased. The fiber pair will be terminated on a patch panel in the customer's colocation cabinet, with an LC connector. Customers are responsible for providing a patch cable from the patch panel to their equipment.

Access Center Physical Specification

Within the Access Centers, customers have two options for terminating their IGN Optic Access circuit. The circuit can be extended to the customers' equipment within the access center or the circuit can be extended to a third-party provider circuit. ICE will provide an Ethernet handoff as outlined below.

6.4.2 IGN Optic Access Logical Connectivity

IGN Optic Access provides a lighted circuit over DWDM connectivity to customers. The service provides full end-to-end transparency. The service will transport customer MAC address information and VLAN information across the circuit but will not directly interact with the customer's Ethernet CPE.

6.4.3 Optical Interfaces

1G	Multimode	Single-mode
Ethernet Standard	1000Base-SX	1000Base-LX
Source Wavelength	850nm	1310nm
Receiver Sensitivity	-17dBm	-20 dBm
Distance	500m limit using 50/125 µm fiber	10km limit using 9/125 µm

10G	Multimode	Single-mode
Ethernet Standard	10Gase-SR	10Gase-LR
Source Wavelength	850nm	1310nm
Receiver Sensitivity[1]	-12dBm	-15dBm
Distance[2]	300m limit using 50/125 µm, OM3 fiber (2000MHz-km)	10km (3) limit using 9/125 µm fiber

40G	Multimode	Single-mode
Ethernet Standard	Not available	40GBASE-LR4
Source Wavelength		Lane 0– 1264.5 nm through 1277.5 nm Lane 1– 1284.5 nm through 1297.5 nm Lane 2– 1304.5 nm through 1317.5 nm Lane 3– 1324.5 nm through 1337.5 nm
Receiver Sensitivity[1]		-15dBm
Distance[2]		10km[3] limit using 9/125 µm fiber

6.4.4 Monitoring

ICE provides end-to-end monitoring of the IGN Optic Access circuits. This includes performance monitoring, troubleshooting, and fault management on a per channel and overall system basis. This does not include the capability of capturing and analyzing customer application data.

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[1] Customer power received at interface must be equal to or greater than this value.
[2] Power level at handoff is the limiting parameter, not distance.
[3] Fiber distance not to exceed 10km even if the fiber budget can be attained due to residual dispersion distortion.

6.5 Liquidity Center Cross Connect (LCX)

Liquidity Center Cross Connect (LCX) is a Layer 1, physical connectivity option which provides point to point connections delivered over Single-mode (SMF) or Multimode (MMF) fiber between two USLC customers' cabinets, or between the USLC customer cabinet and the Meet Me Rooms (MMR). LCX are terminated on ICE provided patch panels.

LCX permits two cabinets, owned by the same customer or two different customers, to connect their network environments together via a Multi/Single-mode fiber handoffs, as well as from a customer to a telecom carrier in either of the MMRs. LCX is sold in units of 1, 6, 12, 18, and 24 pairs of fiber.

LCX is limited to these deployments:

- Interconnections among a customer's non-adjacent cabinets
- Interconnections between cabinets belonging to two different customers Connections between a customer and a vendor, except when vendor is providing trade execution or matching. In this scenario a vendor must become a CSP of either LCN CSP or High Availability to provide these services[1]
- Connections between a Sponsored Participant and a Sponsor whose cabinets are not contiguous
- Connections between customers' cabinets and cabinets in the MMRs

6.5.1 LCX Physical Connectivity

Within the USLC, customers have two options for LCX connections: OM3 Multimode and Single-mode fiber. All LCX connections are terminated with standard LC Connector. These fiber trunks will extend from a fiber patch panel in the cabinet assigned to the customer to a patch panel within the network raw in the Colocation Hall. Cross connects can be provided from this point to any of the approved endpoints as specified above. It is important to note that LCX connections from the Colocation Halls to the MMRs utilize SMF only.

1G	Multimode	Single-mode
Ethernet Standard	1000Base-SX	1000Base-LX
Source Wavelength	850nm	1310nm
Distance	500m limit using 50/125 µm OM3 Fiber	10km using 9/125 µm fiber

10G	Multimode	Single-mode
Ethernet Standard	10GBase-SR	10GBase-LR
Source Wavelength	850nm	1310nm
Distance	300m limit using 50/125µm, OM3 fiber	10km using 9/125 µm fiber

40G	Multimode	Single-mode
Ethernet Standard	40GBASE-SR4	40GBASE-LR4
Source Wavelength	4 media x 850nm	4 media x 1310nm
Distance	300m limit	10km using 9/125 µm fiber

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[1] This restriction is required so that all exchanges and ATS are operating in a similar fashion.

6.5.2 Homerun Connectivity

Within the USLC, customers have homerun connectivity options to connect between their non-contiguous cabinets. Colocation customers will be provided a handoff of several pairs of 850nm OM3/OM4 MMF (Multimode Fiber) and 1310nm SMF (Single-mode Fiber) via structured cabling trunks, terminated in new/existing fiber patch panels (FPP) with standard LC or MPO cassette. Homerun LCX is sold in packs of 6, 12, 18, and 24 pairs of fiber.

1G	Multimode	Single-mode
Ethernet Standard	1000Base-SX	1000Base-LX
Source Wavelength	850nm	1310nm
Distance	500m limit using 50/125 µm OM3/OM4 Fiber	10km using 9/125 µm fiber

10G	Multimode	Single-mode
Ethernet Standard	10GBase-SR	10GBase-LR
Source Wavelength	850nm	1310nm
Distance	300m limit using 50/125µm, OM3/OM4 fiber	10km using 9/125 µm fiber

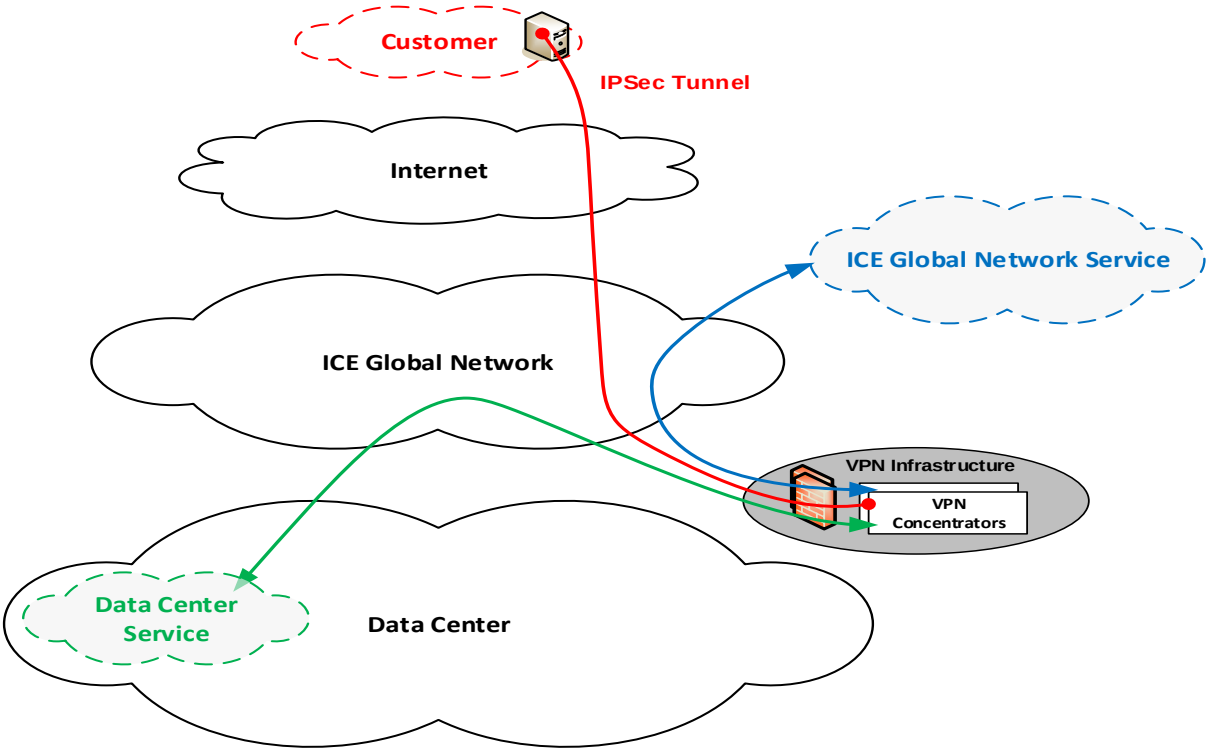
40G	Multimode	Single-mode
Ethernet Standard	40GBASE-SR4	40GBASE-LR4
Source Wavelength	4 media x 850nm	4 media x 1310nm
Distance	300m limit	10km using 9/125 µm fiber

6.5.3 Administration of the LCX

ICE provides the connection and maintains the physical state of the connection but does not administer or provide for any traffic flow that occurs over the LCX connection.

6.6 ICE Global Network VPN Access – IP based VPN

ICE Global Network VPN Access is an IPsec based LAN-to-LAN connection via Internet providing a secure, encrypted transport across the Internet for all unicast sessions. Customers can securely connect to IGN unicast services using their own IPsec devices and Internet connections, and variable bandwidth options are available, from 1M to 20M. VPN can be used for access to ICE, NYSE Core and selected third-party content unicast services.



(Figure 9) – ICE Global Network VPN Access

6.6.1 Connectivity (LAN to LAN)

Customers will use their own IPsec enabled devices and Internet connections to access the IGN VPN. The VPN tunnel encryption method will be agreed upon during the provisioning process. Customers will be able to access IGN VPN services using ICE Global Network assigned RFC1918 IP addresses.

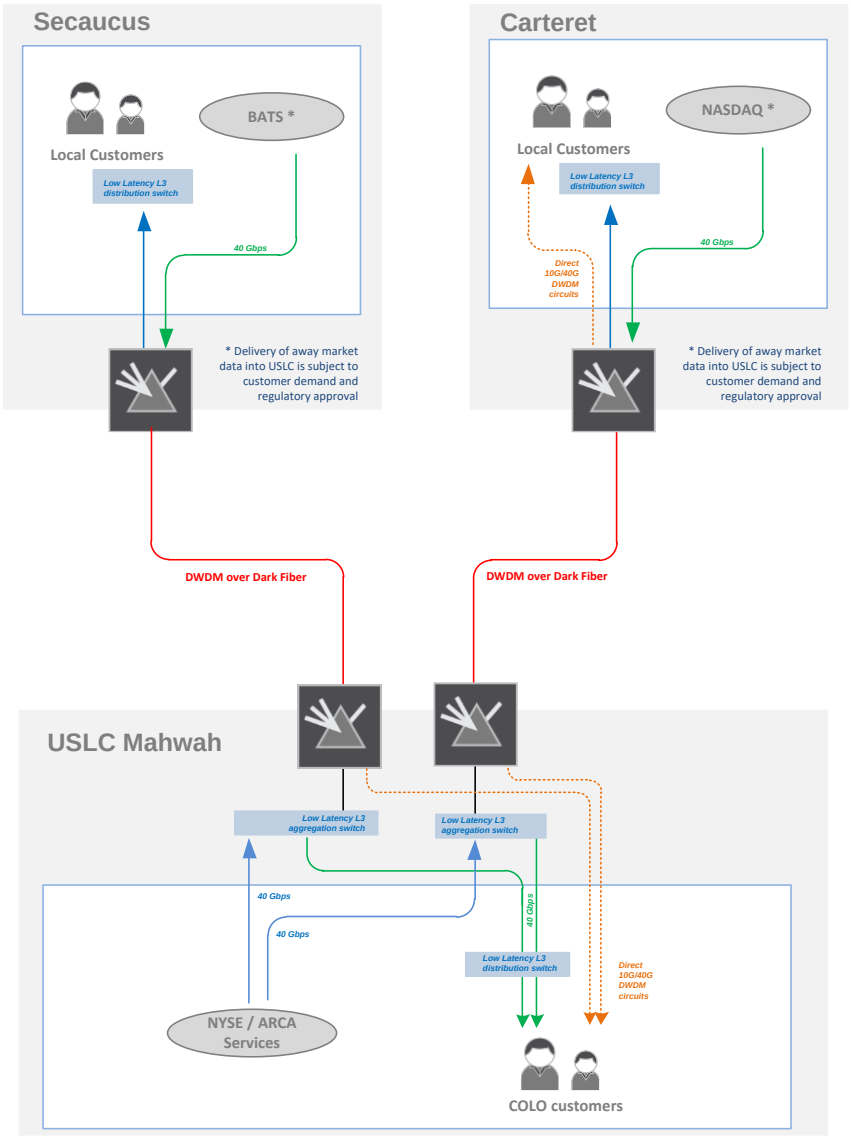
6.6.2 ICE Global Network VPN: Network Considerations

- Customers must have an IPsec enabled device and Internet connection at their end
- An IPsec enabled device could be either a router capable of IPsec or a firewall with VPN capability and customers are responsible for configuring and supporting their IPsec enabled device
- Connectivity is via IPsec tunnels only, direct Internet connectivity is not supported
- Customer must ensure that any Internet facing firewall has its security policy amended to allow the following protocols:
    - IKE – UDP port 500 (Internet Key Exchange)
    - IPsec over NAT-T – UDP port 4500
    - ESP – Protocol 50 (IPSec)
- It is important that the IPsec device has a static public IP address assigned to the interface which creates the VPN tunnel
- Customers need to NAT their host LAN IP addresses to the ICE Global Network assigned private IP range

7 Low Latency Services

7.1 Optic Low Latency Network (Optic LLN)

Optic LLN is a low latency connectivity option which uses optimized network technology and the fastest available fiber routes between the USLC and key US trading locations in Secaucus and Carteret



(Figure 10) – IGN Optic LLN

7.1.1 Optic LLN Highlights

- Ports in Secaucus and Carteret are available at either 10G or 40G speeds
- Raw bandwidth (circuits) are available on both routes (10G or 40G)

- Optic LLN utilizes the fastest commercially available fiber links between Mahwah and Secaucus, as well as Mahwah and Carteret
- Optic LLN uses the fastest carrier grade optical switching hardware available along the entire path
- A customer with a traditional HA port can add an Optic LLN port to decrease end-to-end latency, however it should be noted that Optic LLN only offers a subset of the services available over the global ICE Global Network wide area network.

IMPORTANT: Optic LLN is a single path, point-to-point network solution only. Unlike High Availability options, it does not offer resilience along the route, and customers must ensure resiliency via an alternative ICE Global Network product or provider. In addition, Optic LLN is designed to provide access to USLC NMS services and NYSE production services, including proprietary market data and order entry. However, please note that NYSE Group testing, certification, and DR services, along with ICE and other third-party content, cannot be accessed via Optic LLN.

7.1.2 Optic LLN Physical Connectivity

Customers are connected via 10G or 40G Ethernet cabling to the customer edge switch. The following table lists the standards used for both DWDM direct circuit services and IP services:

10G	Single-mode (Mahwah)	Single-mode (Secaucus / Carteret)
Ethernet Standard	10GBase-LR	10GBase-LR
Source Wavelength	1310nm	1310nm

40G	Single-mode (Mahwah)	Single-mode (Secaucus / Carteret)
Ethernet Standard	40GBASE-LR4	40GBASE-LR4
Source Wavelength	Lane 0– 1264.5 nm through 1277.5 nm Lane 1– 1284.5 nm through 1297.5 nm Lane 2– 1304.5 nm through 1317.5 nm Lane 3– 1324.5 nm through 1337.5 nm	Lane 0– 1264.5 nm through 1277.5 nm Lane 1– 1284.5 nm through 1297.5 nm Lane 2– 1304.5 nm through 1317.5 nm Lane 3– 1324.5 nm through 1337.5 nm
Receiver Sensitivity	-15dBm	-15dBm

7.1.3 Optic LLN Address Space

Customers' IP Address Space

Each customer's IP addressable entity (logical or physical) that accesses market services requires its own IP address. Given this IP address, Optic LLN is able to route outbound to the customer's device via the access method contracted by that customer (i.e. the address must be reachable). Every IP address that can be assigned to a device is either a globally unique, registered IP address or a private IP address from a range of RFC1918 IPs assigned by ICE/NYSE.

Similar to other ICE Global Network services, customers can use their own public ASN or use a private one provided by ICE.

Network Address Translation / Proxy

The Optic LLN network does not use NAT or proxy services. Each customer connection is filtered to receive the authorized set of routes and services.

7.1.4 Optic LLN Networking Configuration

Only BGPv4 is allowed between the Optic LLN network and customers (pim and igmp). No static routing or IGMP is allowed.

VLANs

IMPORTANT: Customer interfaces to the Optic LLN network will NOT be configured for 802.1Q VLANs and VLAN tagging set by the customer may be ignored or tagged packets discarded. All traffic between the customer and the Optic LLN edge will share a single, non-tagged interface.

7.1.5 Failure Considerations

- As Optic LLN is a non-redundant, point-to-point service, customers must pay attention to all failover scenarios.
- For those connected to both High Availability and Optic LLN, the routing must be carefully configured in order to avoid routing issues.

IMPORTANT: Unicast and Multicast services offered on Optic LLN are also available on High Availability, therefore, customers must adjust their BGP metrics accordingly to ensure they correctly define primary and secondary paths.

As an example, a customer can configure better metrics for NYSE ARCA unicast prefixes received over Optic LLN while still also accepting the same prefixes from the High Availability connection. The same approach can be applied to multicast routing. Generally, customers are advised to prefer the route toward the NYSE RPs and the multicast source range via Optic LLN.

The key point is to make sure that both paths are available at any given time.

7.2 NMS Network

The NMS Network in the USLC is used by the Securities Industry Automation Corporation ("SIAC") on behalf of the Consolidated Tape Association (CTA) and the Options Price Reporting Authority (OPRA) to distribute CTA/CQ and OPRA Multicast Feeds (collectively, the "NMS Feeds"). Customers can access these NMS Feeds via the NMS Network.

Utilizing low-latency equipment and optimized network topology, the NMS Network enables direct access to the NMS Feeds in the USLC without using the High Availability Network, although connecting indirectly to the NMS Feeds via High Availability continues to be an option.

The NMS Network offers ports to access either or both of the NMS Feeds via an independent infrastructure. These ports can accommodate both participant input and subscriber output. Supported connectivity options are 10G or 40G Ethernet customer access ports.

Participants sending data to CTA and OPRA ("NMS Participants") use separate input-enabled leaf switches. Ports on these input-enabled leaf switches allow NMS Participants to receive multicast services and to connect to both input and retransmission unicast services. These input-enabled leaf switches are only available to NMS Participants, or Service Providers acting on behalf of NMS Participants and for the sole use of such NMS Participants.

7.2.1 Latency

The NMS Network uses low-latency network switches and optimized topology to minimize latency.

7.2.2 NMS Network Physical Connectivity

The NMS Network supports native 10G and 40G Ethernet Access ports. Physical network connections to the NMS Network ports are provided over structured fiber infrastructure and dependent on access method: Multimode (MMF) using an MTP/MPO connection for colocation connections.

NMS Network 10G physical connections are terminated on a patch panel in the customer's colocation cabinet with an LC through connector. NMS Network 40G physical connections are through an MTP terminated 12 core OM3 Multimode fiber

trunk cable presented in the customer's colocation cabinet. Each trunk cable should be connected to a 10G/40GBASE-SR4 (QSFP) transceiver.

Standard Fiber Connection Requirements		
Speed	**10G**	**40G**
Connector	LC Connector	MTP Connector - 12 Core OM3
Fiber	Multimode Fiber	Multimode Fiber
Wavelength	850 nm	4 x 850 nm - 40GBASE-SR4 QSFP Transceiver

NMS Network Connectivity Options

Customers deploying network switches which support 40G Ethernet (*IEEE P802.3ba*) by combining four sequential SFP+ interfaces into a logical 40G Ethernet port, need to use a breakout or fan out harness. The resulting interface must be fully compliant with the IEEE 40 Gigabit Ethernet standard. The fan out harness is a cable adaptor with one end having a pinned MTP connector and the opposite end breaking out to four MM-50M LC connectors.

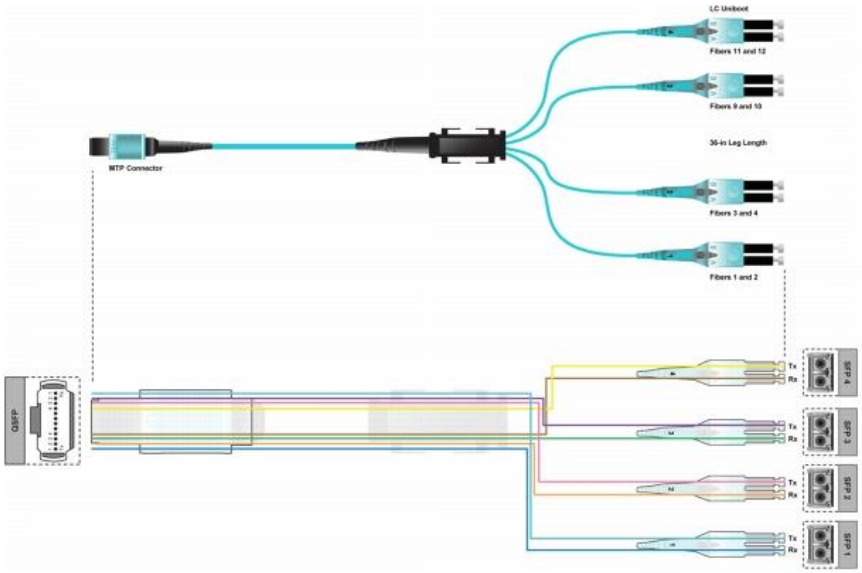


Figure 11 - Example - Fan Out Cable

Along with the fan out harness, an MTP coupler is needed. The MTP coupler is the means by which the trunk cable and the fan out harness are connected together. Please see figure below.

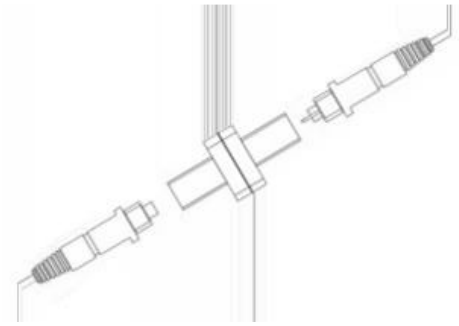


Figure 12 - MTP M/M Coupler

Optional Fiber Connection (Agile Port - Fan out)		
Type	**Fan-Out LC**	**40G - MTP**
Connector	4 x LC Connector	MTP Connector - 12 Core OM3
Fiber	Multimode Fiber	Multimode Fiber
Wavelength	850 nm	850 nm - 10G/40GBASE-SR4 QSFP Transceiver

8 Content Service Providers (CSPs)

A Content Service Provider (CSP) is a third-party provider of services to the financial industry, including but not limited to order routing, order matching, market data, trade clearing, and settlement. A list of CSPs available on ICE Global Network can be obtained from your account representative. CSPs have the following attributes:

Mandatory:

- Connect to a minimum of two ICE Global Network devices over diverse paths for resiliency.
- Advertise publicly registered IP addresses.
- Accept publicly registered IP address from ICE Global Network customers.

Optional:

- Provide unicast services, with bandwidth policed at the ingress into ICE Global Network.
- Provide multicast services, with bandwidth policed at the ingress into ICE Global Network.
- Accept privately-registered IP addresses for customers that do not have public address space.

Limitations:

- Limit unicast services by bandwidth, i.e. customer may subscribe to the service, but it might not have enough bandwidth for it to work correctly.
- Limit multicast services by filters, i.e. once the filter is open, customer can get the service and the only bandwidth limitations are due to capacity or the customer port, ICE Global Network backbone, or CSP ingress interface into ICE Global Network.

9 Application Services

9.1 High Availability Virtual Local Area Network (VLAN)

ICE Global Network provides a wide range of services to the financial industry, some of which include order routing, order matching, market data, trade clearing and settlement.

A list of Application Services available on ICE Global Network can be obtained from your account representative. All applications services have the following attributes:

- Connect to a minimum of two ICE Global Network devices over diverse paths for resiliency
- Provide unicast services, with bandwidth policed at the ingress into ICE Global Network
- Provide multicast services, with bandwidth policed at the ingress into ICE Global Network
- Advertise publicly registered IP addresses
- Accept publicly registered IP address from ICE Global Network customers
- Accept privately registered IP addresses for customers that do not have public address space
- Limit unicast services by bandwidth, i.e. customer may subscribe to the service, but it might not have enough bandwidth for it to work correctly.
- Limit multicast services by filters, i.e. once the filter is open, customer can get the service and the only bandwidth limitations are due to capacity or the customer port, ICE Global Network backbone, or CSP ingress interface into ICE Global Network.
- Customer connects to HA VLAN using standard interface configuration

10 Carrier Meet-Me-Room Services

Telecommunication providers, including both fiber and wireless (Telcos), have access to two Meet-Me-Rooms (MMR) located on the north and south ends of the first floor of the USLC. The MMRs provide a space for installing equipment and terminating fiber optic cables. Telcos are welcome to use multiplexing equipment in the MMRs to provide their customers with a single connection between the MMR and the equipment outside of the MMR. This will allow for a direct and private connection to several other organizations residing within the two MMRs. Utilizing the MMRs for storing and/or installing additional equipment is strongly discouraged.

10.1 Engineering Considerations

The two MMRs are fed by three Point of Entry (POE) rooms; entering at the east, north, and northwest sides of the building. Each POE connects to a dedicated zero-manhole at the property line of the USLC. An ICE-owned conduit system connects each POE to its associated zero-manhole.

The north and northwest zero-manholes have a limited amount of outwardly facing 4 inch conduits which extend beyond the property line. Telcos that contract for services in Mahwah can request access to one conduit in each of these zero-manholes. The east zero-manhole is different in that the outwardly-facing conduit system is fully built out and ICE will assign carriers to inner-ducts. Each Telco will be fully responsible for extending their fiber optic cable into the USLC facility. This includes, but is not limited to, building to ICE's zero-manholes by intercepting existing 4 inch conduits if required, pulling of fiber, any necessary civil works, and the associated legal agreements with third parties.

Distance Between Zero-manhole - MMR		
Zero-manhole	**MMR**	**Length (FT)**
East[1]	South	1260
North	South	985
Northwest	South	1150
East	North	1075
North	North	600
Northwest	North	1495

10.2 MMR Layout

There are two facility rooms located at the north and south sides of the USLC that are dedicated for carriers to land their communications equipment. Rack space in these facilities is separated into two basic components: "Carrier Frames" and "Distribution Frames." It is from these locations that carriers may extend their network equipment and connect to colocated customers' equipment in the Colocation Halls. To extend these connections, each carrier frame will have a dedicated fiber patch panel with 96 strands of 10 µm Single-mode fiber (SMF) and 48 strands of OM3 50 µm Multimode fiber (MMF) with LC connections pulled into the Main Distribution Frame (MDF); from this point, fiber cross connects are made to fiber trunks that extend out to network cabinets in the Colocation Halls.

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1. Distance for the East Zero-manhole to the MMRs includes the distance from the Utility pole to the zero-manhole.

10.2.1 Power Specifications

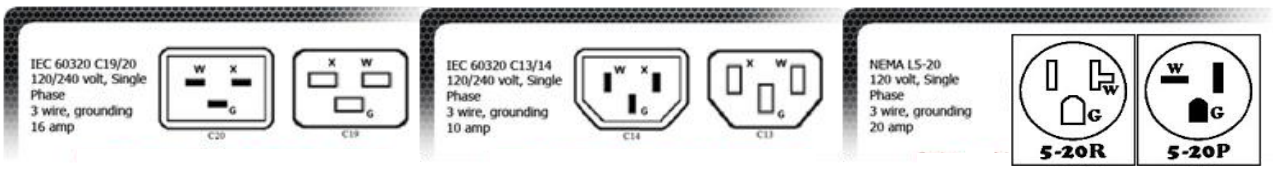
Branch circuits from Power Distribution Units (PDU) provide the Telco's cabinet with either 4 or 8 kilowatts of power. One PDU provides 'A' feed power while the other provides 'B' feed power. Each cabinet has two branch circuits, one from each of the PDUs. Each branch circuit is a single phase, 208VAC feed fused at 30 amps generating 6.24 kilowatts of power. Both branch circuits are monitored (each should carry half of the kilowatt load) with an alarm in place for notifying the facilities should the two branch circuits total power exceed the contracted kilowatts.

10.2.2 Technical Specification

10.2.2.1.1 Power Strip

Two vertical power strips are provisioned with a 4kW order and four strips are provisioned with an 8kW order. A 4kW cabinet has its power strips installed on one side of the cabinet. An 8kW cabinet has its power strips installed two on each side of the cabinet. Each power strip plugs into a L14-30 outlet installed above the cabinet. Additional power strip outlet configurations and power outlets are available; customers are responsible for providing the appropriate cables. Each strip is fused with the following standard configuration:

- Outlet Size: 30 A, 208 VAC (18 x IEC C-13 + 6 x IEC C19) single phase – single strip
- Outlet Size: 30 A, 120 VAC (6 NEMA 5-20R) single phase – single strip
- Local Meter



(Figure 14) – Standard Power Cable Connectors

Cabinet

- Manufacturer: Rittal Corporation
- Size: 52 RU
- Dimensions (Depth × Height × Width): 41.33 in. × 96.4 in. × 27.55 in.
- 19 in. mountable rails

Appendix A. ICE Global Network Connectivity Options Summary

Available Network Connectivity Options	
High Availability Direct Connection (SDC)	High Availability Direct Connection (SDC) enables firms to use their own Ethernet connectivity to connect with ICE Global Network at geographically diverse and vendor-neutral HA Access Centers outside of the USLC.
IP Liquidity Center	An IP-based Wide Area Network (WAN) service designed to connect USLC colocated customers to local and remote ICE, NYSE and NMS market systems, and third party CSPs.
Liquidity Center Network (LCN)	A Local Area Network (LAN) within the USLC that provides local connectivity to NYSE markets.
Liquidity Center Cross Connects (LCX)	A Layer 1 network providing connections exclusively between non-contiguous intra-customer racks and connections between two separate customers in the Colocation Halls, as well as connections to the Telcos in the Meet-Me-Rooms.
Low Latency Network (LLN)	Point to point fiber services between USLC in Mahwah and Carteret & Secaucus access centers. Access to all NYSE and NMS services.
National Market System (NMS) Network	Access in the USLC to the National Market Systems market data feeds comprised of CTA/CQ and OPRA.
Optic Access	A point to point Ethernet service to connect customers' colocation environments in the USLC to ICE Global Network access centers using Dense Wave Division Multiplexing (DWDM) technology.
Virtual Control Circuit (VCC)	A transparent Layer 2 network that offers customers with network ports a point-to-point circuit on the network.
Virtual Private Network (VPN)	ICE Global Network access point via virtual private network over the Internet, secure VPN tunnel. Supports unicast services up to 20Mbps.
Wireless	Ultra-low latency routes engineered specifically for capital markets. Provides select market data feeds and raw bandwidth services.

Appendix B. Technical Terms and Acronyms

Acronym/Term	Description
802.1Q	An IEEE standard for exchanging VLAN information between Ethernet switches by using tags in the TOS field of the IP header.
Access	(1) Communications connectivity, as in direct access customer. (2) The ability to work with a specific subset of the data managed by ICE Global Network, as in access control and authorization.
Access Center	An Infrastructure location where customers connect to ICE Global Network services and can rent Rack Unit (RU) space to host network kit in support of their ICE Global Network connection.
AS	Autonomous System: A set of networked devices owned and operated by the same entity. More formally, a distinct network recognized as operated by a single organization and assigned a unique identifier known as an AS number.
BGP	Border Gateway Protocol: A protocol for exchanging route information between Layer 3 network devices, defined in RFC 1771. This protocol is most often used to connect networks to the Internet.
BGP Peer	Two routers that maintain a TCP connection via BGP for the purpose of exchanging BGP route table information. For more information, see RFC 1771.
CAP	Common Access Point (Common Access Point Network for NYSE markets located in the USLC): Provides access to NYSE production systems and services. Both Production and Test options are available
Core Market Data	Market data offered over the ICE Global Network which includes some of the market data generated by NYSE's USLC hosted exchanges
CSP	Content Service Provider: A third-party provider of services to the financial industry
CSP Network	Content Service Provider Network: An access point for third-parties to provide services to USLC colocation customers.
Customer	Any person or entity that has contracted for NYSE Technologies Connectivity services.
DCE	Data Center Engineering Team
DCO	Data Center Operations Team
DNS	Domain Name Services: A network protocol to maintain a distributed database able to link IP addresses to alphanumeric names and respond to customer queries with this association and other related information.
DWDM	Dense Wave Division Multiplexing: A technology that expands useful bandwidth on fiber optic cable by transmitting data via different light wavelengths simultaneously.
Data Hall	An independent room in the data center intended as an operating environment for IT equipment.
Ethernet	A standard for Layer 2 network connectivity as defined by the IEEE standard 802.3

Acronym/Term	Description
Extranet	A non-public network intended to give system or network access to a set of outside entities that have individual intranets.
Extranet Provider	Any external vendor that connects to ICE Global Network for the purpose of redistributing ICE Global Network services to remote customers, often with additional access methods or protocols for the convenience of the end customer(s).
G	Abbreviation for "Gbps" – short for Gigabits per second and used to indicate data transfer speed
HA Access Center	A physical facility, usually a third-party access center, where ICE hosts HA equipment and where customers may gain direct network access to IGN.
ICE	Intercontinental Exchange Group, Inc., parent of NYSET, NYSE Group and its affiliates, which also operates the ICE Futures Exchanges
Internet	The public collection of networks commonly known as the Internet, originally conceived and implemented by the Department of Defense and public universities as the ARPANet.
IPSec VPN	A standard for Virtual Private Networks that uses the network cryptographic protocols for protecting IP traffic to provide an encrypted, secure tunnel for IP data traffic across a non-secure public extranet or the Internet.
LCN	Liquidity Center Network, used by colocation customers to connect to financial services housed within the USLC.
Liquidity Center	A trading environment that houses NYSE matching engines and/or colocation customers. Customers who colocate at a Liquidity Center can connect to ICE Global Network services and house their financial servers in the Colocation Halls.
LAN	Local Area Network: A network of machines generally limited to a local area, such as one or more floors of a building, or nearby buildings.
LSP	Limited-Service Port: An HA port that allows access to a single NYSE Non-Core service.
M	Abbreviation for "Mbps" – short for Megabits per second and used to indicate data transfer speed
MAN	Metropolitan Area Network: A collection of LANs that would otherwise be a Wide Area Network (WAN), but which is local to a single metropolitan area.
NIC	Network Interface Controller, also known as a network card. A hardware component for servers that facilitates network connections
NOC	Network Operations Center
NMS	National Market Systems: Consolidated equity (CTA/CQ) and options (OPRA) market data for the US financial markets to the financial industry.
NYSE	New York Stock Exchange
NYSET	NYSE Technologies Connectivity, Inc., an operating entity of the USLC and the ICE Global Network

Acronym/Term	Description
OCx	Optical Carrier level x: The Synchronous Optical Network (SONET) includes a set of signal rate multiples for transmitting digital signals on optical fiber. The base rate (OC-1) is 51.84 Mb.
Packet Filtering	A technology that inspects packets as they enter a piece of networking equipment, such as a router, and take action on the packet (such as to discard, forward, or log it) based on a preconfigured rule set.
PIM	Protocol Independent Multicast: The protocol used by ICE Global Network to route multicast packets.
Production Network	A network supported by NYSE which directly supports the trading functionality and/or core business of one of internal NYSE's business owners.
Public Extranet Provider	See Extranet Provider.
Services	Applications provided for customer's consumption by the Production Networks connected to ICE Global Network.
SLC	High Availability Liquidity Center connection
SONET	Synchronous Optical Network: A standard for optical telecommunications transport formulated by the Exchange Carriers Standards Association (ECSA) for the American National Standards Institute (ANSI). SONET bandwidth is divided into OCx levels
TCP	Transport Control Protocol: A connection oriented IP Transport layer protocol.
UDP	User Datagram Protocol: A connectionless IP transport layer protocol. Primarily used by ICE Global Network to transport IP multicast data.
VLAN	Virtual Local Area Network: A networking standard that allows network devices, sometimes even those that span multiple Layer 2 switches, to appear as if they all reside upon a traditional shared media Ethernet segment.
WAN	Wide Area Network: A network connectivity model using protocols to support distances greater than a MAN or LAN.

Appendix C. Quick Connect Sheet – High Availability

The following is the list of information that High Availability Direct Connection customers need to consider when configuring their routers.

1. Upon receiving approval to connect to ICE Global Network, customers will be provided with provisioning information pertinent to the services to which they have been requested to be entitled. This list will be supported by a Customer Technical Interchange (CTI) Meeting and will be provided by a Customer Engineering representative. Detail will include:

    - The VLAN IDs associated with each set of services to which the customer is entitled.
    - The IP addresses of servers for each service network to which the customer will route unicast datagram's (all of which will be globally registered IP addresses), including all relevant UDP and TCP port assignments.
    - Summary IP ranges of FSNs advertised to the customer via BGP-4 over each service VLAN.
    - List of BGP communities associated with BGP routes announced to the customer for each service. This gives customers the ability to customize routing to FSNs within their networks according to their needs.
    - Multicast group addresses associated with the services to which the customer is entitled. This will include the UDP destination port assignments as applicable.
    - IP addresses of FSN subnets where multicast sources are located.
    - HA US registered AS number **(26585).**
    - The private IP addresses for use on the connection between customer's router and the HA edge router; this will include separate addresses for each of the logical interfaces (each logical interface is required for each VLAN and each will require its own set of unique addresses)
    - BGP passwords (MD5) will be supported but are not required and will be administered by Customer Engineering

2. Customers will be required to provide Customer Engineering with the following network-related information for configuring the HA edge router port:

    - Summary IP addresses of subnets within customer's network which will be advertised by customer's routers into HA network via BGP.
    - Customers' host IP addresses to which unicast IP services will be routed. If customers cannot provide globally registered addresses, ICE will provide private address ranges for use by the requesting customer only.
    - Customers will provide Customer Engineering with a registered AS number or ICE will provide the customer with a private number to use for exchanging BGP information with HA ONLY. This is not to be confused with the HA AS number.

3. With respect to PIM Sparse-Dense Mode, HA uses all default values where they apply (see Example L3 Switch Configuration for an example configuration). With respect to BGP Parameters, BGP Timers for each customer's direct connection to HA must NOT be set lower than following values:

    - Keep-alive interval – 6 sec
    - Time-out interval – 20 sec.

4. With respect to RIP2 parameters, recommended minimal values for RIP-2 timers are:

    - Update interval – 30 sec
    - Timeout interval – 75 sec.

Customers who configure their routers with other parameter values will risk interoperability issues. A separate logical interface will be required for each VLAN to which the customer will be connecting. On the VLANs supporting unicast services, BGP will be used for the exchange of unicast routing information between HA and customer's network. On the VLAN

dedicated for multicast service delivery, RIP2 is the protocol currently used for exchanging unicast routes associated with the multicast sources. It is assumed, (but not required), that the customer will deploy PIM Sparse-Dense mode with Auto-RP enabled and use the unicast route information learned via RIP2 for the purposes of routing multicast packets.

For customers who request it, ICE Global Network will configure static IGMP joins on the HA edge routers connected to the customer. Customers who do not implement PIM Sparse-Dense mode with Auto-RP enabled will find this useful for supporting static "always on" forwarding of multicast data across the HA demarcation to customer's edge router. Routing information about the sources of multicast data will be provided via RIP-2.

Appendix D. Sample – Layer 3 Switch Configuration

The information presented here is in no way meant to imply or represent a certification or recommendation. Customers must make their own evaluations and work with their vendor of choice regarding the solution needed to meet the interface requirements of HA. The configuration presented here was created for a typical Cisco device capable of connecting to HA with the following considerations and assumptions:

- The device was configured to connect to all the HA VLANs
- The typical example of a customer who will be receiving both unicast and multicast data
- Assumes the Layer 3 switch is connected to a HA edge router via a single 1000Base-SX connection (Port 25) and to the members internal network with a 1000Bast-T connection (Port1)

```
-------------------------Configuration file example begins below---------------------------
version 12.2
no service pad
service password-encryption
!
switch 1 provision ws-c3750g-24ts-1u
vtp mode transparent
ip subnet-zero
ip routing
no ip domain-lookup
!
ip multicast-routing distributed
!
no file verify auto
spanning-tree mode pvst
spanning-tree extend system-id
!
vlan internal allocation policy ascending
!
vlan 10-14,16-21,152,252
!
interface GigabitEthernet1/0/1
 description Member side of interface (not routing with HA)
 no switchport
 ip address 192.168.126.26 255.255.255.252
 ip accounting output-packets
 ip pim sparse-dense-mode
 ip rip advertise 5
 ip dvmrp metric 1
 ip dvmrp unicast-routing
 ip igmp query-interval 120
 load-interval 30
 keepalive 30
 speed 1000
 duplex full
!
interface GigabitEthernet1/0/2
interface GigabitEthernet1/0/3
interface GigabitEthernet1/0/4
interface GigabitEthernet1/0/5
interface GigabitEthernet1/0/6
interface GigabitEthernet1/0/7
interface GigabitEthernet1/0/8
interface GigabitEthernet1/0/9
interface GigabitEthernet1/0/10
!
interface GigabitEthernet1/0/11
!
interface GigabitEthernet1/0/12
!
interface GigabitEthernet1/0/13
```

```
!
interface GigabitEthernet1/0/14
!
interface GigabitEthernet1/0/15
!
interface GigabitEthernet1/0/16
!
interface GigabitEthernet1/0/17
!
interface GigabitEthernet1/0/18
!
interface GigabitEthernet1/0/19
!
interface GigabitEthernet1/0/20
!
interface GigabitEthernet1/0/21
!
interface GigabitEthernet1/0/22
!
interface GigabitEthernet1/0/23
!
interface GigabitEthernet1/0/24
!
interface GigabitEthernet1/0/25
 description Gigabit Ethernet WAN connection to HA
 switchport trunk encapsulation dot1q
 switchport trunk allowed vlan 10-14,16-21,152,252
 switchport mode trunk
 load-interval 30
 speed nonegotiate
 no cdp enable
!
interface GigabitEthernet1/0/26
!
interface GigabitEthernet1/0/27
!
interface GigabitEthernet1/0/28
!
interface Vlan1
 no ip address
 shutdown
!
interface Vlan10
 description VLAN connection to multicast Virtual Backbone
 ip address 10.129.6.1 255.255.255.252
 ip pim sparse-dense-mode
 ip dvmrp metric 1
 ip igmp query-interval 120
 load-interval 30
!
interface Vlan11
 description VLAN connection to Unicast Virtual backbone
 ip address 10.129.14.1 255.255.255.252
 ip pim sparse-dense-mode
 ip dvmrp metric 1
 ip igmp query-interval 120
 load-interval 30
!
router bgp 65221
 no synchronization
 bgp log-neighbor-changes
 network 198.140.52.3
 aggregate-address 10.53.0.0 255.255.224.0 as-set summary-only
 aggregate-address 204.200.184.0 255.255.248.0
 timers bgp 6 20
 redistribute connected
 redistribute static
```

```
 redistribute rip
 neighbor HA peer-group
 neighbor HA remote-as 26585
 neighbor HA distribute-list 102 out
 neighbor 10.129.6.2 peer-group HA
 neighbor 10.129.14.2 peer-group HA
no auto-summary
!
ip classless
ip http server
!
ip pim rp-address xxx.xxx.xxx.xxx Static RP Configuration option
!
ip access-list standard Multicast-Cash-Feed
 permit 233.54.12.243
 permit 233.54.12.242
 permit 233.54.12.241
 permit 233.54.12.240
  deny   any
--------------------------Configuration file example ends above----------------------------
```

Appendix E. Data Center Cabling and Installation Guidelines

These data center racking, power and cabling guidelines were developed to establish a baseline of quality and workmanship within ICE cabinets. The guidelines apply to all ICE Data Center and Access Center locations and are intended to improve communication between DCO staff, customers and their designated customer representatives (including engineers and installers). They maintain a level of expectation for data center engineering and installation services performed and while not intended to cover every situation or special condition that an engineer or installer may encounter, nor to be used instead of applicable codes and standards, they do provide a tool for use alongside relevant codes and standards, outlining minimum standards in terms of quality of work for installations. The guidelines should be read in conjunction with the US Liquidity Center Colocation Policies available at https://www.theice.com/data-services/global-network and when DCO staff are able to clarify guidelines or to provide a ruling on quality and workmanship compliance.

General

- All equipment and materials used within the USLC shall be either (a) listed by the Underwriters Laboratories, Inc. (UL) and other Nationally Recognized Testing Laboratory (NRTL) or (b) inspected and approved by the local Authority Having Jurisdiction (AHJ).
- All equipment and materials shall be manufactured and installed in accordance with applicable codes and regulations including but not limited to ANSI, ASME, FM, IEEE, NEC and NEMA standards.
- All equipment and materials will be used in accordance with the manufacturer's instructions or technical manuals.
- All equipment and materials shall be marked with the manufacturer's name, trademark or other descriptive marking by which the organization responsible for the product may be identified.
- All equipment and materials shall be marked with the voltages, current, wattage or other ratings as necessary.
- All equipment shall be free from recognizable hazards that are likely to cause death or serious physical harm.
- All installation work shall be performed in a neat and workmanlike manner.
- During and post installation work, visitors shall practice "good housekeeping" by keeping the work area clear of all obstructions – detail of items to be adhered to are outlined in the US Liquidity Center - Colocation Operating Policies document.
- Visitors to all ICE Data Center and Access Center locations shall follow and obey the directions on all signs.
- When onsite, customers shall adhere to all Intercontinental Exchange Critical Site Work Rules. Outlined below.
- Customers must report any unsafe or hazardous conditions to the DCO staff immediately.

Qualified Personnel

- All data center installation work shall be performed by qualified personnel who have the skills and knowledge related to the specific work method they are tasked with performing.
- Qualified personnel shall have received appropriate training to recognize and avoid the hazards that may be present with respect to that equipment or work method they are performing.
- Work shall be performed by a licensed or certified installer when required by local jurisdiction.
- All electrical branch circuit installation work up to the final service outlet supporting the IT cabinet shall be performed by the DCO staff.

Equipment Mounting

- All IT kit shall be installed in the colocation cabinet plumb and level true as intended and secure. All of these factors shall be immediately apparent.
- All fasteners or supports used in mounting the IT kit shall be sufficient to substantially secure the equipment in place to the colocation cabinet.

Power Cabling

- Only approved and properly maintained equipment line/power cords that have no exposed live parts, exposed ungrounded metal parts, damage, fraying or splices are to be used in installations.
- Cabinets shall be clearly labeled on the outside rear of the cabinets where three phase power circuit lines cords have been installed.
- All line cords shall be rated at or above the current capacity and voltage required to continuously power the device served.
- All line cords shall be suitable for the temperature, conditions, and location where installed.
- All line cords shall be provided with a means of strain relief so that a pull on the flexible line cord will not be transmitted directly to the wiring terminations.
- Line cords, plugs or cord caps that have different electrical ratings shall not be interchangeable with one another.
- Line cords with a ground conductor that has less current-carrying capacity than the other conductors shall not be allowed.
- Line cords that have the ground pin cut off or that have had the ground protection compromised in any way shall not be allowed.
- Adaptors designed to defeat the grounding connection are not allowed.
- Equipment line cords may not be daisy chained (i.e., to plug one power cord into another power cord).
- Equipment line cords shall only be powered from an electrical receptacle located in the same cabinet as the IT device that the line cord is supporting.
- A line cord that ends with a splitter or "Y" may not feed separate devices or other line cords.
- Insert plugs fully so that no part of the prongs are exposed when the line cord is in use.
- The length of equipment line cords within cabinets shall be sufficient to neatly train the line cord from the receptacle to the device served while minimizing line cord coils and loops within the IT cabinet.
- All equipment line cords shall be sufficiently supported using devices intended for the purpose.
- The use of extension cords in any application is strictly prohibited with colocation cabinet.

Rack Mount Power Distribution Units (PDU) [Power strips]

- A PDU shall be capable of being readily installed and wired as intended.
- The inherent design of a PDU shall ensure the electrical coordination between the Data Center Operator provided branch circuit service outlet and the PDU.
- A PDU with an external grounding stud shall be bonded to the data center cabinet ground with a conductor sized in accordance with the local electrical code.
- Each PDU shall be electrically connected to a separate and distinct permanently installed Data Center Operator provided branch circuit service outlet.
- Dual supply PDUs with two separate and distinct power circuits within the same PDU enclosure shall be prohibited unless each of the power circuits terminate in separate, fully electrically segregated partitions within the PDU.
- All PDUs shall be plugged into the Data Center Operator provided service outlet by the Data Center Operator's own personnel.
- PDUs are not to be daisy chained to one another or to separate equipment line cords.
- Electrical contact shall be reliably maintained at any point at which a connection is made between current-carrying parts.
- A PDU shall have all live parts protected against exposure to contact by persons when the PDU is assembled and installed as intended.
- PDU receptacles shall be constructed so that a standard attachment plug of the same configuration and with maximum length blades is capable of seating properly without exposure of the blades between the plane of the face of the plug and the plane of the rim of the PDU receptacle.
- A PDU with integral fuse protection shall be constructed to ensure the enclosure can confine the effects of a fuse rupture to the interior of the enclosure.
- A PDU with integral fuse protection shall be constructed to ensure that no electrically live parts are exposed to contact by persons when a fuse is being removed or replaced.
- A PDU with integral fuse protection shall be constructed to provide for a fuse in each ungrounded conductor.

Rack Mount Transfer Switches (TS)

- A TS shall be capable of being readily installed and wired as intended.
- TS line cords should be permanently affixed to and terminated within the enclosure of the TS. Where a TS is supplied with a removable line cord it shall only be approved for installation where the cabinet that it supports feeds only single phase equipment loads.
- Each TS shall be electrically connected to a separate and distinct permanently installed Data Center Operator provided branch circuit service outlet.
- All TSs shall be plugged into the Data Center Operator provided service outlet by the Data Center Operator's own personnel.
- Unless approved by the local AHJ, TSs are not to be daisy chained to one another, from a rack mount PDU receptacle or to separate equipment line cords.

- Electrical contact shall be reliably maintained at any point at which a connection is made between current-carrying parts.
- A TS shall have all live parts protected against exposure to contact by persons when the TS is assembled and installed as intended.
- TS receptacles shall be constructed so that a standard attachment plug of the same configuration and with maximum length blades is capable of seating properly without exposure of the blades between the plane of the face of the plug and the plane of the rim of the TS receptacle.
- A TS with integral fuse protection shall be constructed to ensure the enclosure can confine the effects of a fuse rupture to the interior of the enclosure.
- A TS with integral fuse protection shall be constructed to ensure that no electrically live parts are exposed to contact by persons when a fuse is being removed or replaced.
- A TS with integral fuse protection shall be constructed to provide for a fuse in each ungrounded conductor.

Critical Site Work Rules

- All vendors, contractors and service personnel are to be appropriately attired and act in a professional manner.
- Offensive, abusive or other inappropriate behavior by customers, customer representatives, vendors, contractors or service personnel will result in immediate and permanent dismissal from the site.
- Fire exits are to be kept clear.
- Smoking is not permitted in critical site spaces.
- Eating or drinking is not permitted in critical site spaces.
- Energized equipment IS NOT PERMITTED to be turned off any unless directed to do so by the DCO staff.
- Non-UPS electrical outlets are only to be used if/when as directed by ICE DCO.
- Do not place or lean anything on or against any computer equipment, UPS, PDU, air conditioner, fire system pull station, live electrical panels or similar devices as identified by ICE.
- Customers are not allowed to removed floor tiles at any time
- Use safety cones, barricades, caution tape and other safety equipment/devices to direct people away from open floor tiles or other hazardous areas.
- Do not remove floor tile stringers unless absolutely necessary.
- Do not step on cables, conduit or electrical boxes under any raised floor.
- Keep cables away from air conditioner valves, strainers, water and drain lines, fire system smoke heads, piping and other MEP equipment.
- Fire-seal all openings around conduit and cable penetrations between different fire zones.
- All vacuums used in critical spaces must have a HEPA filter on the discharge.
- No metal cutting in the computer and communication rooms. Metal cutting in other spaces must be performed in a manner that will contain the dissipation of metal filings and be approved in advance by ICE.

- The use of open flame cutting tools IS NOT permitted.
- Gunpowder discharge activated construction tools or devices ARE NOT permitted.
- At the completion of the job, remove all tools and garbage from the site and, where applicable, verify that all raised floor tile stringers and floor tiles are secure, straight and level.