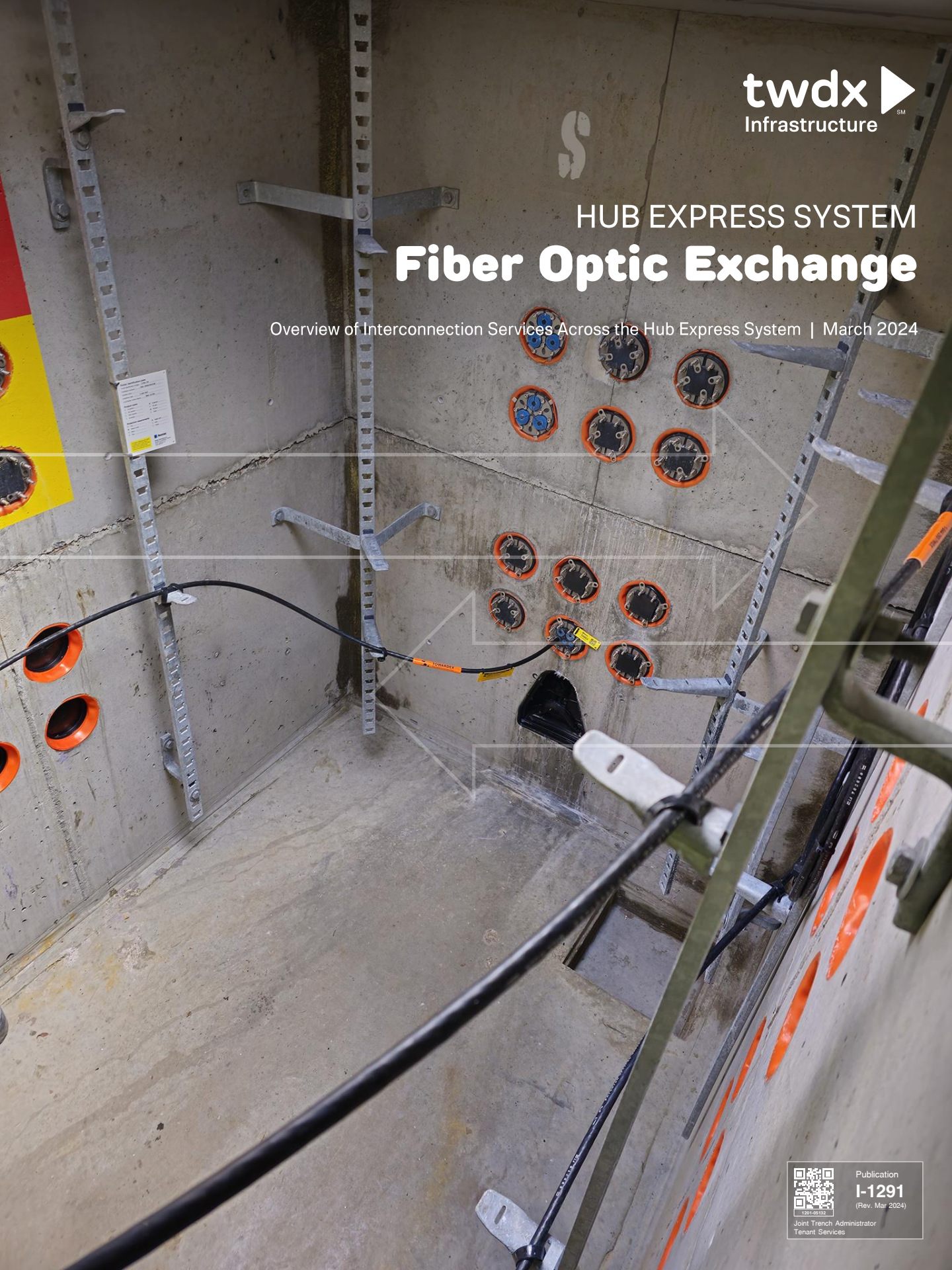


HUB EXPRESS SYSTEM Fiber Optic Exchange

Overview of Interconnection Services Across the Hub Express System | March 2024





HUB EXPRESS SYSTEM

Fiber Optic Exchange

Overview of Interconnection Services Across the Hub Express System

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01

About Fiber Optic Exchange

The Fiber Optic Exchange is a service in the Hub Express System to turbocharge your network interconnections in our underground utilities with convenience and scale.

UNDERSTANDING OUTSIDE PLANT INTERCONNECTIONS

Internet networks and telecom carriers routinely interconnect their networks together out in the streets. The added security and scale offered by leveraging their own dark fiber networks to interconnect provide a unique value proposition that couldn't otherwise be provided by carrier hotels and internet exchange points. However, interconnections occurring out in the streets (known as "**outside plant interconnections**") are often cumbersome and capital-intensive for networks to deploy and scale.

The Challenges

Manhole congestion and the availability of network-specific facilities at each point of interconnection present the greatest challenges in deploying interconnections using public utilities. For example, while one network operator may have its fiber optic splice enclosure located in a particular manhole, its connecting party may be located in a different manhole. To remedy this, both parties will need to seek rights to obtain a conduit to tie the two manholes together (or, worse, construct a new conduit) and then mobilize labor and materials to install a new fiber optic cable to connect their networks together. It's capital-intensive and time-consuming, especially when networks are trying to tie only a few pairs of fibers together to provide service to their customers.

The Solution

The Fiber Optic Exchange (**FOEX**) is a manhole-to-manhole transport service across the Hub Express System and adjoining utilities that are also participating. The FOEX architecture is composed of high-count "ribbonized" fiber optic cables (typically 1728-count fibers) that are connecting every single manhole across its deployed footprint. Member networks participating in FOEX are provided with 144-strand home-run cables for them to use to pick up dark fiber capacity between manholes.

By using FOEX, members can achieve continuity across different manholes without having to construct or install new fiber optic cables, vastly saving time and capital costs in deploying outside plant interconnections.



KEY TERMINOLOGY

HEX:

Hub Express System, the underground conduit system in Boston where FOEX service is offered.

FOEX Backbone Cable:

The primary *transmission* fiber optic cables installed by FOEX which crosses every manhole it is providing service to.

Member Trunk:

A 144F home-run cable provided to each participating FOEX member. Members use their Member Trunk cables to request dark fiber and "cross connect" between themselves and other connecting parties located across different manholes.

Ribbon Cross Connect:

A 12-strand ribbon splice of fibers between one Member Trunk to another Member Trunk across the FOEX Backbone Cable.

Ordering Party:

A party that submits an order for a Ribbon Cross Connect from their network to their other connecting party.

Non-Ordering Party:

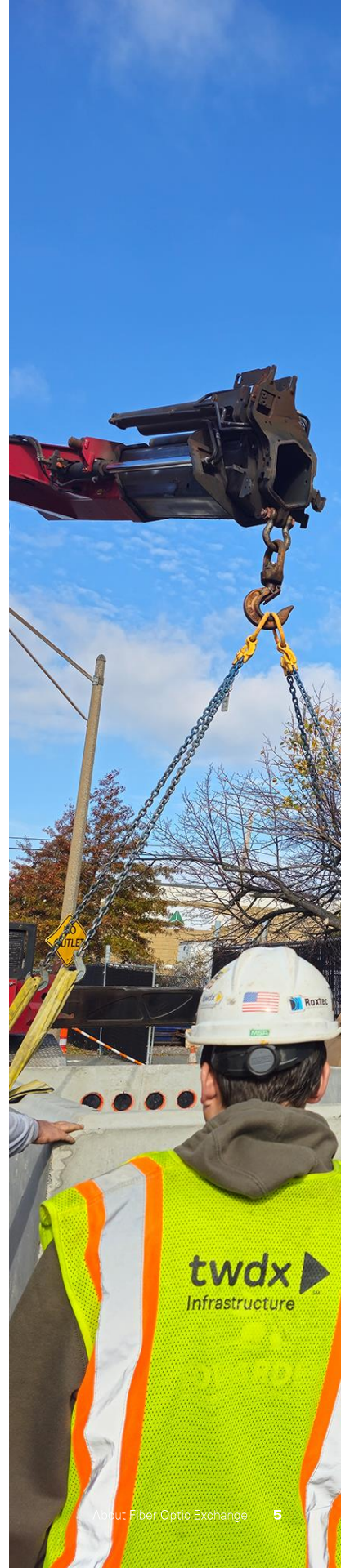
The other connecting party at the opposite receiving-end who receives a Ribbon Cross Connect that was ordered by the Ordering Party.

CFA/LOA:

Carrier Facility Assignment / Letter of Authorization—a written document issued by the Non-Ordering Party of a network interconnection, authorizing the Ordering Party to request connection to the designated facility location and assignment.

CPOP:

Customer Point of Pick Up—a specific location (such as a manhole) where Member Trunk cable is delivered for the participating member to pick up and bring into their fiber optic splice enclosure.



UNDERSTANDING MEMBER TRUNK

Each FOEX member is provided with a Member Trunk cable, which is used to request dark fiber to different manholes spanning across the FOEX system footprint. A Member Trunk cable is a micro-144F ribbon fiber optic cable, consisting of 12 ribbons. Each ribbon contains 12 strands of single mode fiber.

FOEX members interconnect their networks together by ordering dark fiber (also known as "cross connect") from one Member Trunk to another Member Trunk. A Ribbon Cross Connect is then implemented across the FOEX Backbone Cable. The minimum amount of fiber that a member can request is 12 strands—each "cross connect" across the FOEX system is a ribbon consisting of 12 fibers. **FOEX does not provide any cross connects with less than 12 strands.**

Member Trunk cables can be delivered by TWDX Infrastructure to any valid "Meet-Me" vaults across the HEX conduit system and the first "zero" manhole of any participating adjoining utilities. The specific location at which a Member Trunk cable is delivered is called **CPOP** (Customer Point of Pick Up). TWDX Infrastructure will leave a coil of 100' of slack at the CPOP for customer's own fiber crews to come in and pick up. Customers may request up to 200' of slack coil if required for splicing and attachment into their fiber enclosure.

Member Trunk Cable ID

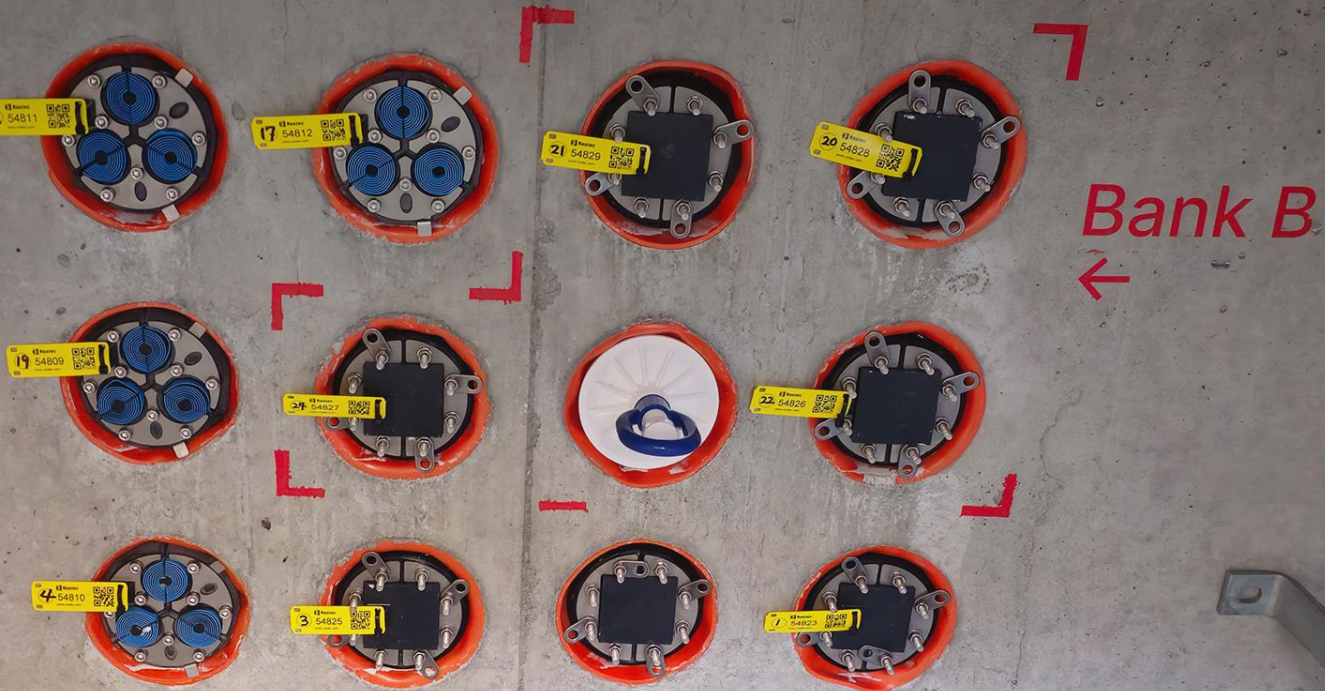
Each Member Trunk is provided with a cable ID that will be used by FOEX members to identify connecting facilities when issuing CFA/LOA. The format of Member Trunk cable ID is as follows:

LXE-000001

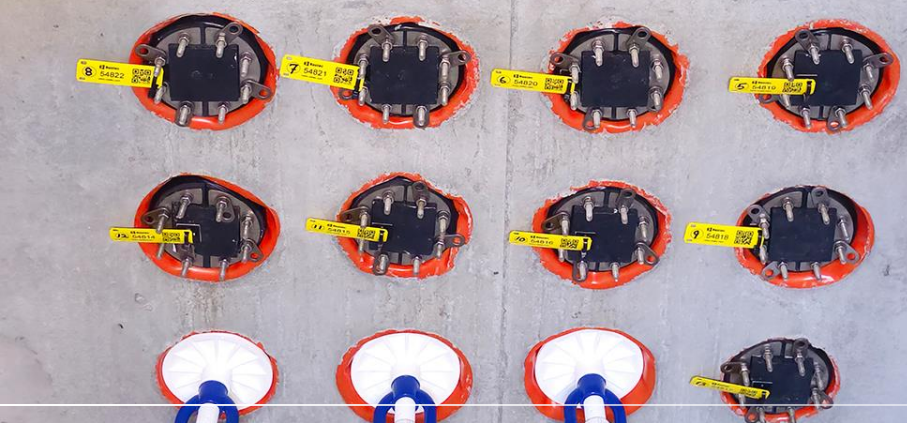


A 6 digit serial number uniquely identifying a Member Trunk cable

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02

Ribbon Cross Connect

ORDERING RIBBON CROSS CONNECT

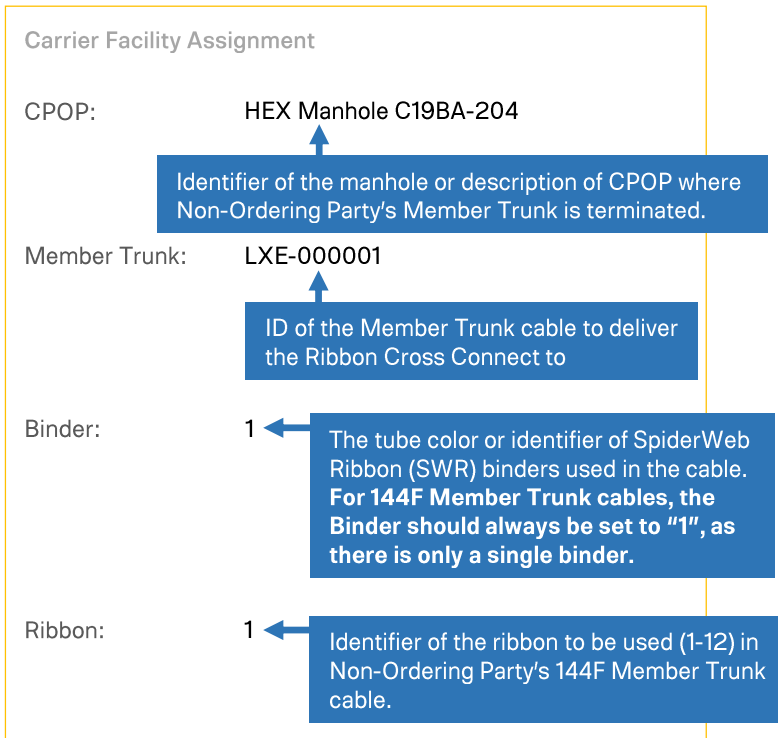
⚠ Important!

Ribbon Cross Connect can only be ordered for "Inter-Party" connections, where Non-Ordering Party and Ordering Party must be different companies. "Intra-Party" connections are not provided. To install point-to-point dark fiber capacity for intra-party use, members are advised to license a conduit from TWDX Infrastructure and install their own backbone fiber optic cable for such purposes.

To order a Ribbon Cross Connect, the Non-Ordering Party of the interconnection must first issue a CFA/LOA authorizing the Ordering Party to connect.

Formatting the CFA

The CFA/LOA must provide designated physical facility using the following format:



RIBBON CROSS CONNECT INSTALLATION

Once the order has been validated and CFA/LOA is furnished by the Non-Ordering Party, TWDX Infrastructure will mobilize and deploy fiber splicing crews across the FOEX Backbone Cable to establish continuity for the Ribbon Cross Connect. Generally, installation lead time is within 17 business days, though many requests have been processed (historically) in as little as 2-5 business days. Lead times are only reasonable commercial effort estimates, and specific deadlines cannot be contractually guaranteed.

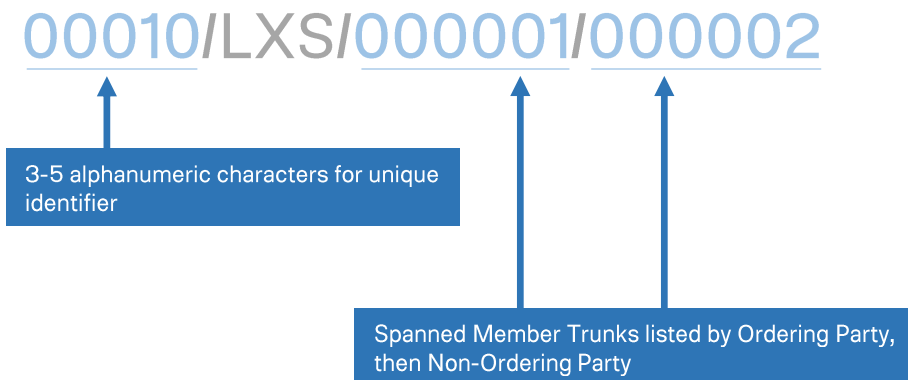
Factors Affecting Lead Times

Several factors can extend or shorten lead times, such as:

- **Permitting and traffic management (police details, crew and traffic protection, etc.)**
If the splicing location is within an area where TWDX Infrastructure maintains an approved traffic control plan with the local authorities, then a permit can be issued fairly quickly by simply renewing the one already on file (often in as little as the same day, or a few business days). If the work location requires a new traffic control plan to be submitted or is subject to any community-specific impact reviews (such as a special variance hearing, etc.), permitting delays may occur and extend out the lead time.
- **Availability of labor and materials**
During times of inclement weather (e.g., Nor'easter), lead times may be extended, as line crews are often busy dealing with outages (downed lines, damaged poles/cables, etc.) for various customers across our network.

Ribbon Cross Connect ID

Upon completion, a Ribbon Cross Connect ID identifying the 12-fibers pathway will be provided to the Ordering Party, using the following format:



DISCONNECTS

A Disconnect Order may be submitted by the Ordering Party to request disconnection of a Ribbon Cross Connect. When submitting a Disconnect Order, the customer will need to provide a valid Ribbon Cross Connect ID identifying the pathway to be removed.

Upon receiving a valid Disconnect Order, TWDX Infrastructure will dispatch fiber crews to remove the splice facing each Member Trunk connection spanned by the Ribbon Cross Connect.

At work completion, the Ordering Party will have 72 hours to undo the disconnection for any reason (e.g., disconnect order was submitted in error and caused a human-error outage, etc.). After 72 hours have passed, the customer will need to submit a new Disconnect Order to re-attempt disconnection. There is no refund for any Disconnect Orders that have been undone and reversed at the request of the Ordering Party.

⚠ Important!

It is the Ordering Party's duty and responsibility to positively identify for traffic impacts and verify the validity of the Disconnect Order.

We're under no obligation to check for running traffic on any fibers covered by a valid Disconnect Order.

Neither TWDX Infrastructure nor TOWARDEX will be liable for any network traffic interruption or loss caused by an erroneous Disconnect Order submitted by the Ordering Party, or by Ordering Party's breach of duty to correctly identify for traffic and live transmissions on any network facilities it controls.





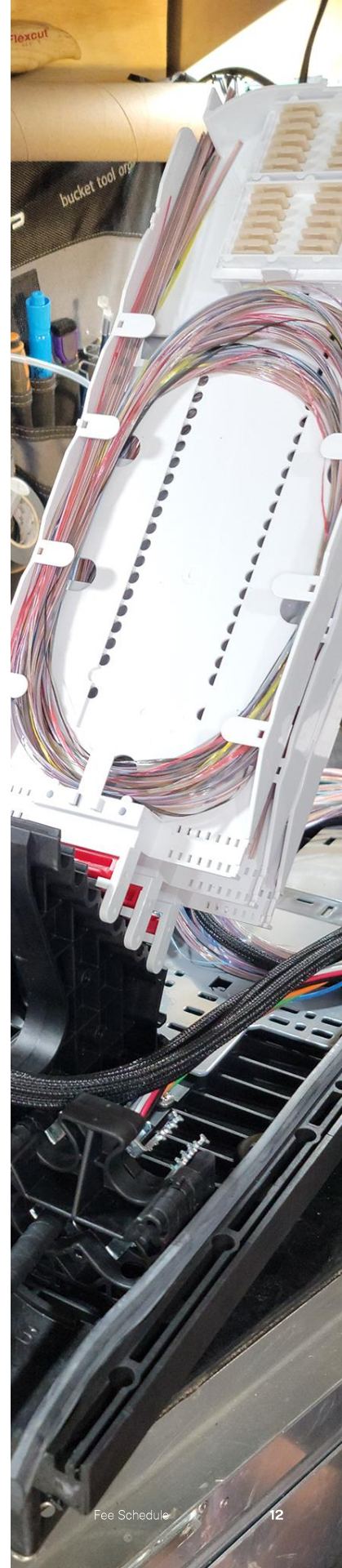
03

Fee Schedule

FOEX members pay an annual membership fee and one-time fees for each work activity. Aside from the annual membership fee, there is **no recurring cross connect fee** on any fibers provisioned across FOEX.

FIBER OPTIC EXCHANGE RATE CARD

Initial Setup and Membership Dues		
Initial setup to install your first 144F Member Trunk connection. Also includes 1 st year membership.	\$10,000 one time	
Annual Membership Fee 1 st year is free. Applies to second year and onward.	\$8,000 per year	
Ribbon Cross Connect Installations and Disconnects		
Install one (1) 12-strands Ribbon Cross Connect	\$2,100 one time	One time fee is charged to the Ordering Party for "truck roll" activity (install and disconnect) occurring on each Ribbon Cross Connect. If you're ordering or disconnecting more than one ribbon, multiply the one time fee by the total number of Ribbon Cross Connects you're adding or removing.
Disconnect one (1) 12-strands Ribbon Cross Connect		
Additional Capacity		
Additional 144F Member Trunk connection	\$10,000 one time	





04

Frequently Asked Questions

Question:

Does the Zayo/Joint Trench Partners (JTP) system participate in the FOEX program? I have my network's splice case located in a Zayo manhole on Inner Belt Road. Can you deliver Member Trunk there, or do I have to extend my network into HEX and license duct space and manhole occupancy in the HEX system?

Yes, the Zayo system is a participating adjoining utility in FOEX.

TWDX Infrastructure can deliver Member Trunk connections to the first Zayo manhole ("zero manhole") where HEX duct system interconnects with Zayo. TWDX Infrastructure will not install Member Trunks beyond the first "zero" Zayo manhole where HEX ducts physically arrive. It is the customer's responsibility to extend its Member Trunk connection further within the Zayo/JTP system, if its splice case is not located in the first "zero" manhole.

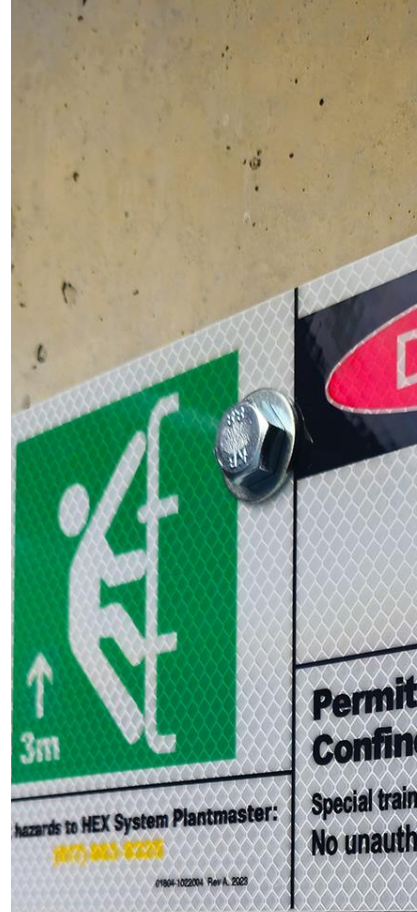
You must have legal authority and permission to occupy conduits and manholes in the JTP system before requesting any Member Trunk connection be delivered there. TWDX Infrastructure will contact Zayo to review & approve each request prior to delivering any Member Trunks into Zayo manholes. We will refuse your order if Zayo informs us that you're not permitted to occupy or work in their manhole.

Question:

Do I have to use FOEX to interconnect with other networks across the HEX system? Can I just license a new conduit from you and run my own cable to the other party?

You're not required to use FOEX to create interconnections between any tenants of the HEX system. FOEX is a value-add membership program offered to members of the Hub Express System for convenience purposes, and participation in FOEX is entirely optional and not mandatory. You and your other connecting party are more than welcome to obtain a license for a new conduit from TWDX Infrastructure and install your own cable to meet up at your own cost and expense, subject to the terms of your license agreement and HEX system's *Licensee Operating Rules and Regulations*.

For information about conduit licensing and *Licensee Operating Rules and Regulations*, visit the TWDX Infrastructure web site at infrastructure.twdx.net.



Question:

What is the pitch of the ribbon that is provided in the 144F Member Trunk cable? My fiber splicer wants to confirm this to ensure that alignment is precise when splicing onto our network.

The pitch of the ribbon in 144F Member Trunk connections is 250 μm . The manufacturer cutsheet for the Member Trunk cable will be provided upon request.

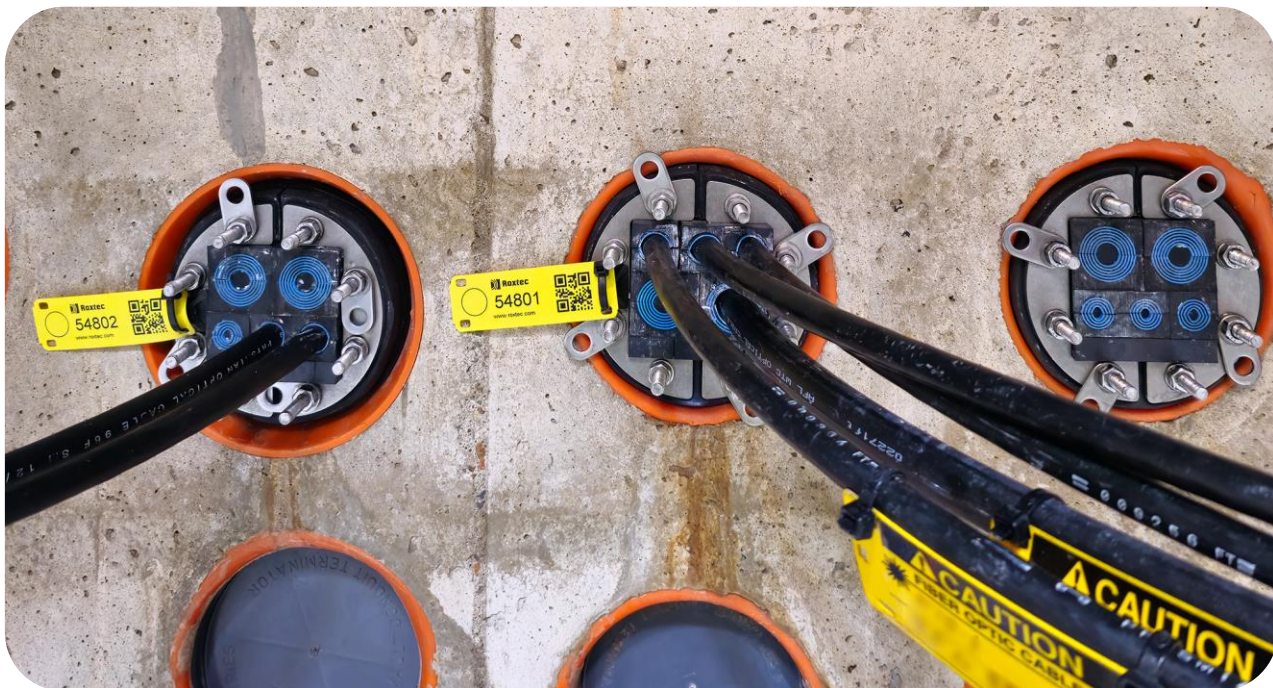
Question:

No recurring cross connect fee is great, but does the annual membership fee increase with the scope and volume of Ribbon Cross Connects and Member Trunks I use? Also, who owns the FOEX Backbone Cable?

No. Everyone pays the same annual membership fee at the same price, regardless of how many Ribbon Cross Connects or Member Trunk connections they have.

The FOEX Backbone Cable is owned by TOWARDEX. Although TOWARDEX owns the Hub Express System, pursuant to federal law under 47 USC § 224(g), TOWARDEX cannot simply take a conduit for free for its own uses at the expense of other ratepayers (licensees) using the facility. Therefore, TOWARDEX imputes to its costs of providing the FOEX Backbone Cable at the same attachment rates as any other company would otherwise be liable for, when licensing a conduit across the HEX system.

The annual membership fee paid by each FOEX participant helps us fund the costs of installing, upgrading, and expanding the FOEX Backbone Cable and also pays for its ongoing expenses, including conduit attachment rates, supplier contracts, taxes and fees, indemnification, and so forth.



Question:

Can you lower the \$2,100 one-time fee for Ribbon Cross Connect installation and disconnect requests?

No. Each installation and disconnect activity requires TWDX Infrastructure to pull permits, mobilize and deploy its work forces, request police detail, and implement traffic controls for both the safety of our crews and the traveling public. There is a significant cost to each "truck roll" activity occurring in public ways.

However, it is worth noting that each Ribbon Cross Connect provides you 6 pairs of dark fiber connections (12 strands). Therefore, the one-time fee to cover our truck roll activity is commensurate with market rates in the industry for cross connect installation and disconnect charges.

As each Ribbon Cross Connect provides you 6 connections, we recommend members to plan ahead accordingly in their network deployment plans.

Question:

Can I get discounts on one-time fee if I order multiple Ribbon Cross Connects at once?

No. One-time fee for disconnect and installation activities is charged for each Ribbon Cross Connect.



Question:

I only want 1 connection to my other connecting party. Can you provide a single-pair dark fiber instead of a Ribbon Cross Connect? Why must everything be in ribbons and at minimum of 12 strands?

Due to the volume of interconnections and the limited space in manholes and splice enclosures, high-density ribbon-based fiber optic cables (also known as "micro" cables) are used to build and operate the FOEX Backbone Cable.

Fiber optic enclosures have limited space—there is a limitation to the number of butt splices that can be held in trays in the enclosure. In order to meet the capacity to hold and splice the volume of fibers required for the FOEX Backbone Cable, we need to "compress" the number of butt splices required, by consolidating 12 fibers into each butt splice. Therefore, we require the use of ribbon fiber optic cables that are designed for high-density network deployments. Since each butt splice is 12 strands, that is the minimum quantity that will be provided across the FOEX Backbone Cable.

Question:

Can you deliver the Member Trunk connection into a building that has a lateral conduit into HEX system?

We do not deliver FOEX connections to private properties. However, if the property owner owns the "zero" manhole where HEX conduits arrive and allows splicing inside the zero manhole, then we can deliver your Member Trunk to that manhole.

Please note that if the zero manhole at the property belongs to the HEX system (i.e., it has 'TOWARDEX' emblem on the manhole cover, or we inform you that the manhole belongs to HEX system), then we cannot deliver the Member Trunk there. TWDX Infrastructure does not permit any splicing inside zero manholes owned by the HEX system—such activities must be performed inside designated underground vaults (such as "Meet-Me" holes).



Question:

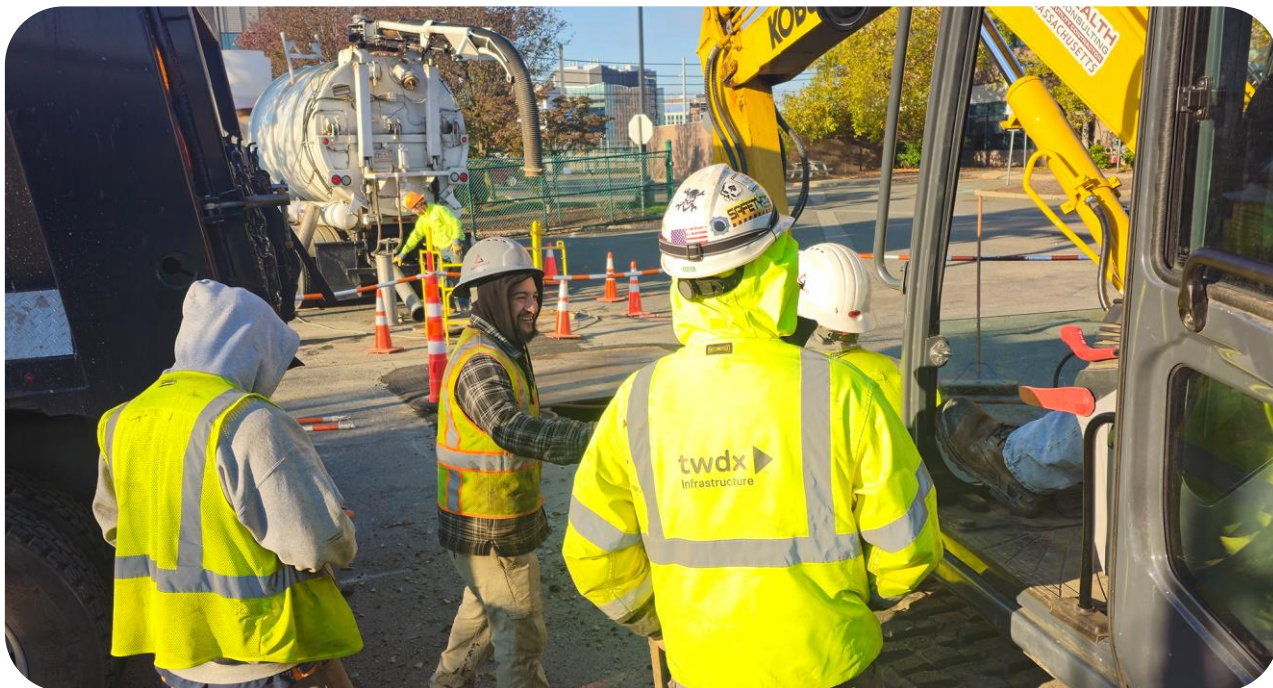
I'm currently not a tenant of the Hub Express System. Is there any way I can make use of FOEX services?

Yes. To join FOEX, you'll either need to be a public utility company or CLEC who is currently a licensee or a member of the HEX system, **or you can be "sponsored" (associate member) through an existing licensee of the HEX system.**

In the latter option, you don't need to be a CLEC to participate, but you will be interfacing solely with the provider who is sponsoring your participation, including paying for any fees set forth by your sponsoring provider. Further, as you're neither a member nor a licensee of the HEX system, you're not entitled to partake in any project activities (inspections, field meetings, provisioning, etc.) involving the HEX system, and we will not provide you with any support for your use of FOEX services. Instead, all communications, customer support, and deliverables you'll require will be provided to you by your sponsoring provider.

TWDX Infrastructure does not enforce or set any rates that a sponsoring provider may charge, and any commercial terms and agreements for your use of FOEX services will be made between you and your sponsoring provider. TWDX Infrastructure will bill your sponsoring provider for FOEX services at the same rates and pricing set forth and kept updated in this publication.

TOWARDEX offers **Turn-Key Network Infrastructure** services for non-CLECs to utilize the HEX system, including becoming sponsored to participate in FOEX. You are, however, welcome to seek the services of any other telecommunications provider who is a licensee or a member in the HEX system (including those who compete against TOWARDEX) to utilize FOEX services; we do not require you to use TOWARDEX or any particular provider to make use of sponsored access to FOEX services.



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