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Manhole Meets:
Cross connects in the built environment

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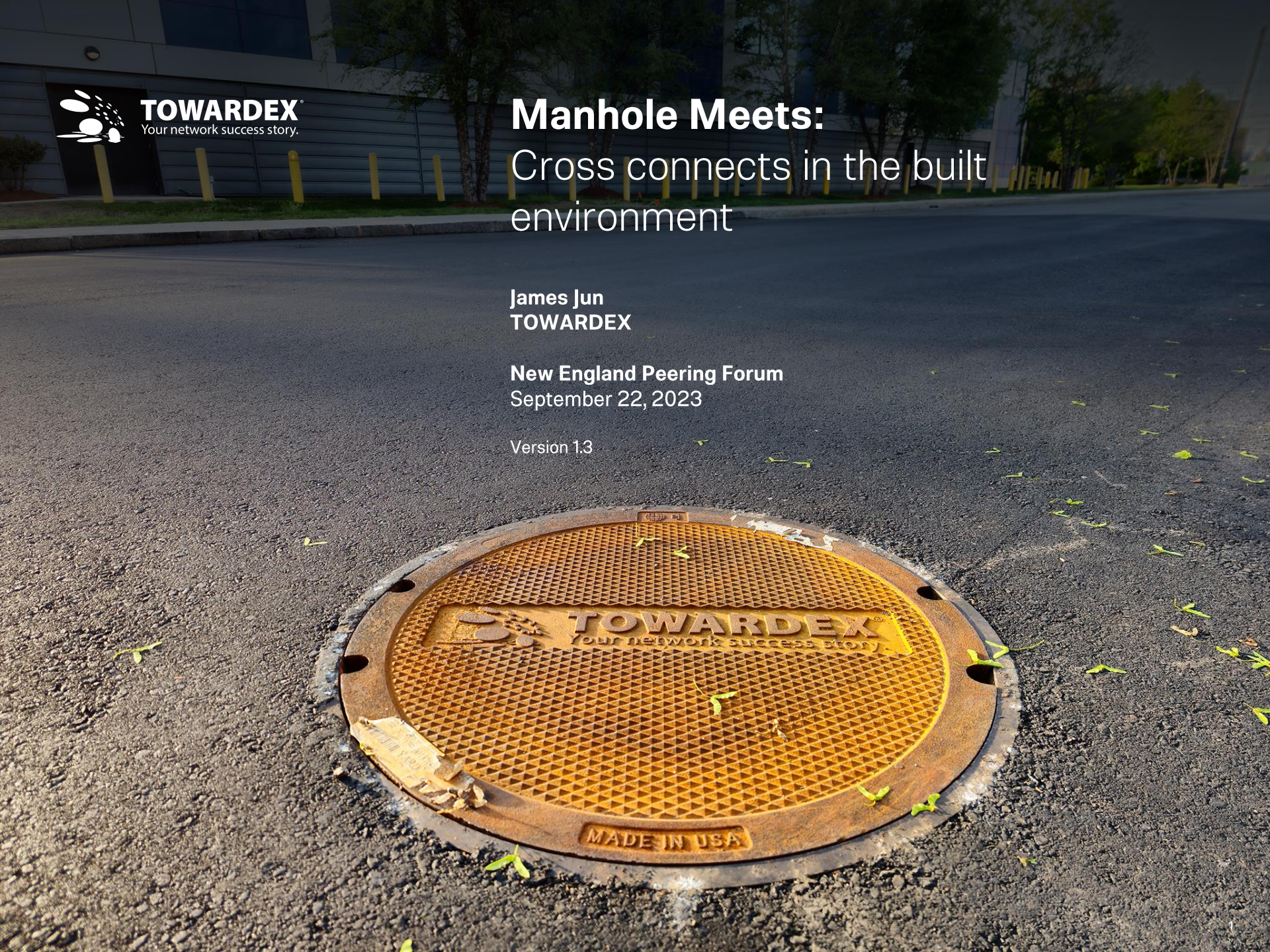

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Data centers and IXPs aren't the only place to connect networks.

A worker repairing a telegraph line circa 1863.
Credit: Library of Congress, via Associated Press

This thing called *telecommunications* has been around for a while, way older than the Internet or any so-called "longest-operating" data centers.

Today, local exchange carriers (LECs) routinely interconnect between each other out in the streets, via aerial poles and manholes.

Making connections out in the streets is not new—it has been going on since the days of telegraph.

Why meet out in streets?

Not everyone can work in data centers:

- **Hyper volume and scale:** Too many cross connects between same parties. Time to take the middleman (and costs) out of the equation.

- **Not so carrier-neutral data centers:** Some data centers start getting greedy and decide to compete with their customers, and then start kicking out said customers through rapacious conduct. What does the kick+banned customer do in the face of such destruction, simply go out of business? *Never.*

- **High-end engineering control:** Some optical spans require carefully calibrated fiber characteristics and have little tolerance for insertion losses and back reflection (think: Raman spans running very hot). Data center cross connects add reflections & insertion losses. Clearly, ILA huts work much better for long-haul transmission than data centers.

- **Too many layers:** In multi-tenanted facilities (e.g. carrier hotel with several colo operators), you go through many spans of cross connect plants owned by different parties. This results in costly troubleshooting involving multiple parties when a fiber span is broken. Not to mention the attenuation from all that insertion loss!

How do manhole meets work?

A private hand-hole owned by TWDX IP (AS27552)
Credit: TOWARDEX

Simple. You have your splice case (fiber optic enclosure), and your partner also has their splice case somewhere nearby.

Run a jumper cable in between, agree to a splice plan, and each side splices fibers respectively on their end of the cable.

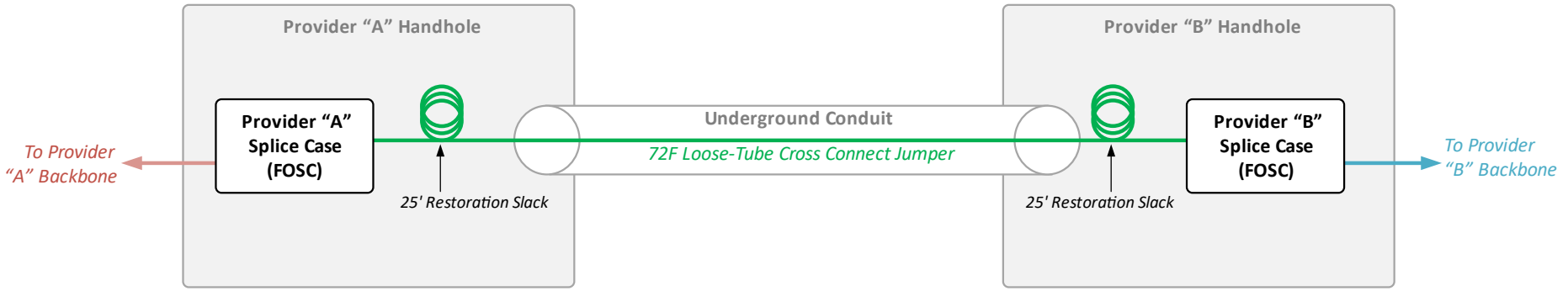
Instead of using patch panels, you *fusion splice* the cross connect fibers in a splice case. This results in vastly superior optical performance providing a very clean fiber span, but comes at the expense of reduced flexibility and requiring more planning.

Types of Manhole Meets today.

Inter-Manhole Meets:

Each network constructs its own private manhole and installs a conduit in between.

Gets expensive and difficult (or sometimes impossible) to obtain permission from local authorities due to street congestion.



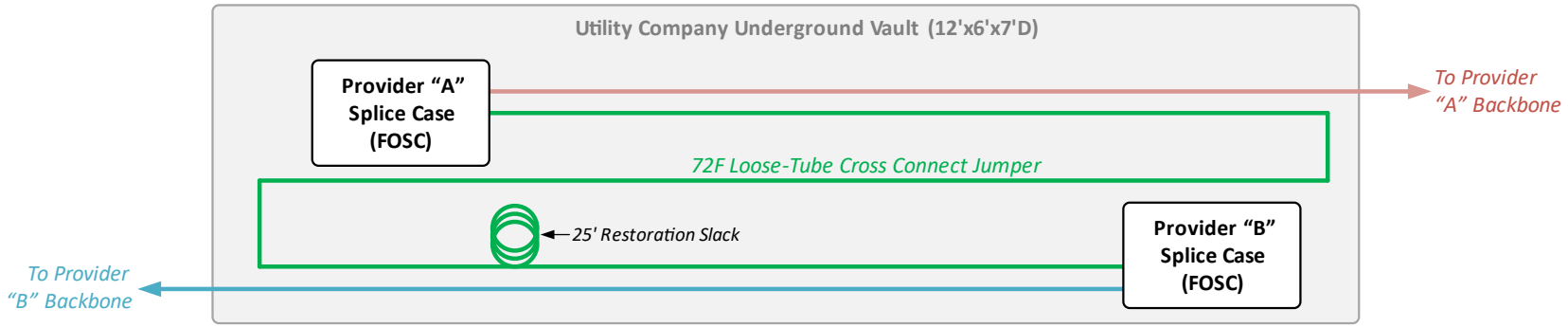
Types of Manhole Meets today.

Intra-Manhole Meets:

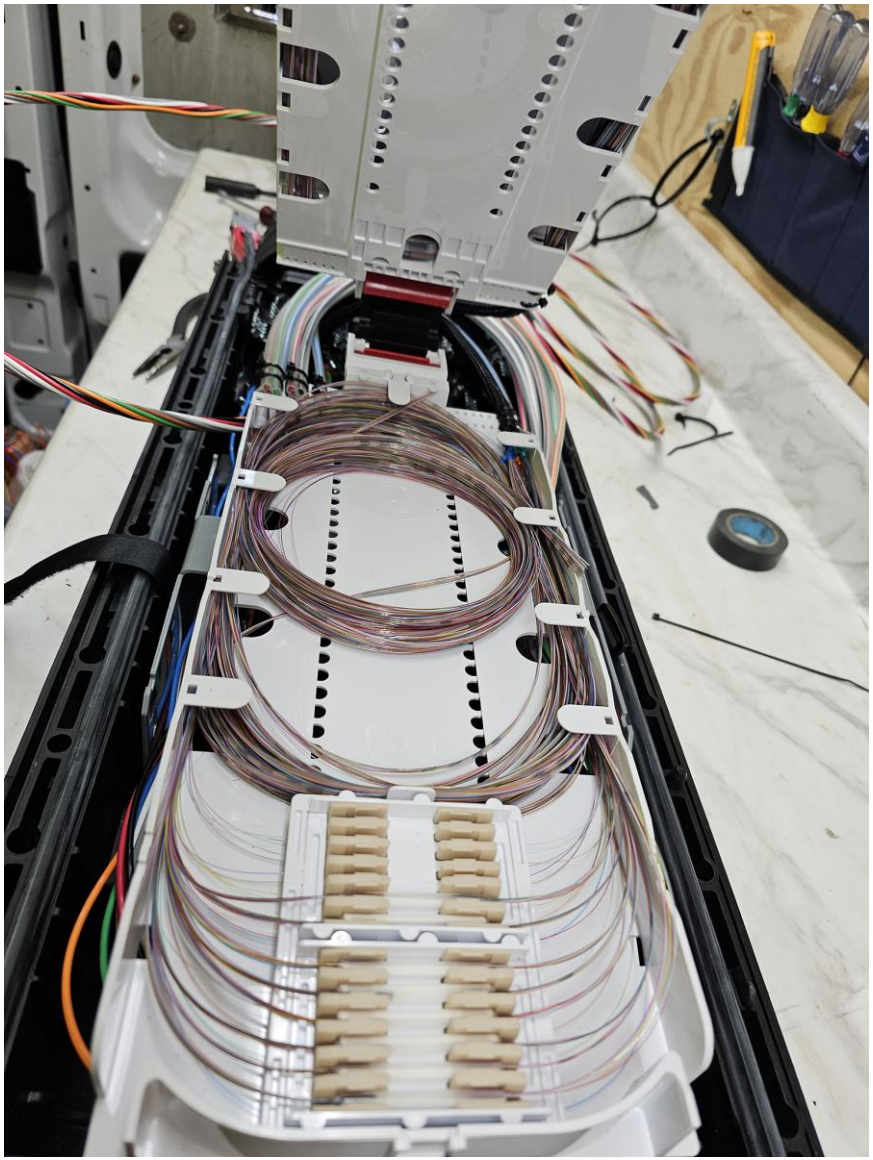
Each network is a member of a big utility system and manholes are huge basements (10′x5′ — 12′x6′ TYP). **Very easy and little cost** when both networks are lucky to be allowed to do this.

Horrendously expensive and difficult to implement if the utility does not allow it, or otherwise if new physical infrastructure has to get built. UG vault constructions are for monopoly utilities specializing in transmission lines, not your everyday ISPs.

NB: LECs will also 'intra-manhole meet' in a small handhole. Works fine for limited applications, but bend radius is a real issue (forget high-count fibers), and won't scale for multiple parties.



An example of manhole meet:



Can we “democratize” and scale this up?

Clearly, manhole meets are for LECs and savvy operators who possess the wherewithal and know-how to implement. It can get very expensive and barrier to entry is high.

This is why data centers are the easiest place and your best friend for connecting networks, because they allow anyone (well, almost anyone), to “cross connect” for a simple fee.

But there is a risk to relying solely on data centers for interconnection:

Data centers in US are not subject to common carrier regulations, whereas utility owners and LECs are dutifully held to them by law. Colo agreements are essentially “at-will” licenses—when a data center decides that it’s competing with its own customers, it can refuse to renew a customer’s colo license as vengeful act, kicking them out of the building. **A network provider whose colo is terminated could find themselves in an economic catastrophe with little to no legal recourse**, disrupting critical services.

There has got to be a better way of doing manhole interconnections, at scale.

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Introducing the Hub Express System

Installation of a Hub Express System manhole.
Credit: TWDX Infrastructure

Open-Access Infrastructure as an Ecosystem

A HEX interconnector on Third Ave
Credit: TWDX Infrastructure

Hub Express System (HEX) is Boston's first "open-access" underground utility for data centers and internet networks, located in the Inner Belt area.

HEX duct bank consists of 12—4" to 24—4" ducts, further subdivided into subducts using MaxCell Edge. Design capacity is ~135 subducts for cable occupancies.

HEX UG vaults are huge. They're typically 7'x5' to 12'x6'.

Now, let's see what we can do with this large "Dig Once" conduit system!

Commonly used services across HEX

A HEX manhole being installed in 2023.
Credit: TWDX Infrastructure

Regulated utility attachments for LECs:
Providing conduit and manhole licenses to LECs in compliance with federal and state laws[1] and including 1996 Telecommunications Act. Conduit license fee is **$1.54/ft/year** for a cable sized up to 1.05″ OD.

Hosted Fiber Network for non-LECs:
A turn-key solution which provides a *private dark fiber* network with an entire cable dedicated to the customer, and optional add-ons for splice cases.

Because this is a managed dark fiber service, the customer does not need to be a LEC and does not perform any installation works (nor has any physical access) in the duct system.

1. 47 USC § 224, MGL c.166 § 25A and 220 CMR 45.00

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Scaling Up Manhole Meets Across HEX

Duct terminators in a HEX underground vault.
Credit: TWDX Infrastructure

The Challenges

Inspecting a fiber cable installation across HEX.
Credit: TWDX Infrastructure

Not every network is going to be commonly present in the same manhole as you. Reasons include:

- Different route plans
- Manhole congestion—limited space in vault for everyone to place their splice case
- Unique service requirements (no plans to ring-cut existing cable in a particular MH)

Previously, when the network you're trying to get to is located in a different manhole, you'd have to acquire rights (license) to a conduit leading to their manhole, and install a new cable to meet up.

This is costly and complicated, limiting the utility of manhole meets. *Can we do better?*

The Solution: Fiber Optic Exchange (FoEX)

A fiber optic cable being installed across HEX.
Credit: TWDX Infrastructure

FoEX is a manhole-to-manhole transport service, seamlessly allowing members to request dark fiber to connect networks located across different manholes, without having to license a new conduit and/or construct a new cable by themselves to establish continuity.

The FoEX architecture is a 1728F cross connect trunk cable spanning the length of HEX (and adjoining utilities), with splice case installed in every underground vault it crosses.

FoEX allows member networks to be spread out over various manholes and still be able to "cross connect" easily, allowing manhole interconnections to rapidly scale up in volume.

Inter-Manhole Meets as a service

Interconnection conduits arriving in a HEX manhole.
Credit: TWDX Infrastructure

Each FoEX member gets a 144F ribbon cable connecting their network onto the nearest FoEX splice case.

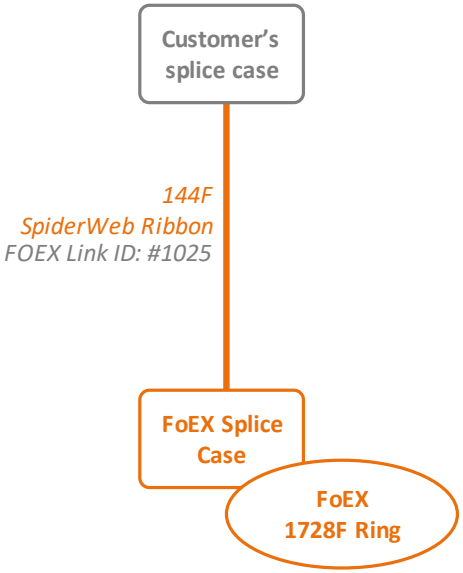
Minimum cross connects that can be requested from one member to another **6 connections**, where we will splice one ribbon (12 strands) for each request.

There is no monthly recurring fee to use FoEX fibers: Instead, FoEX members pay an annual membership fee to cover plant maintenance, and non-recurring charges during each work activity.

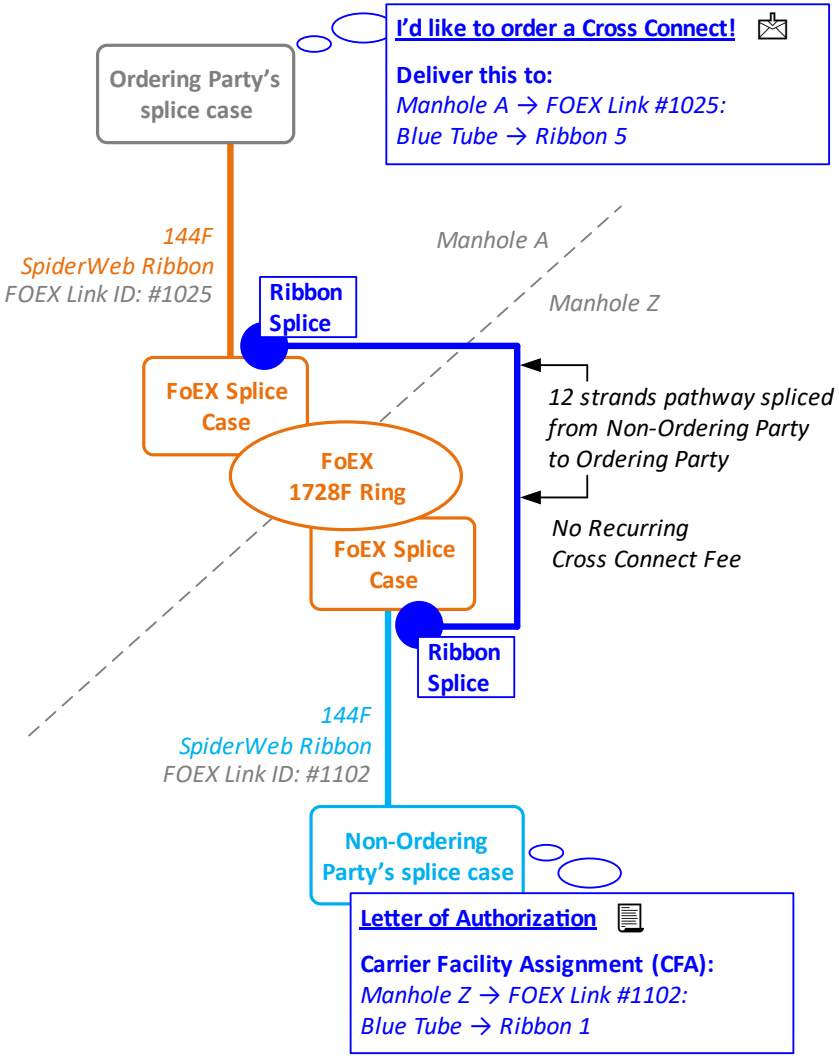
FoEX fibers are only for "inter-party" cross connects—"intra-party" connections are not provided. Each CFA/LOA must be issued by a member who is different from the ordering party.

FoEX Cross Connect Ordering Process

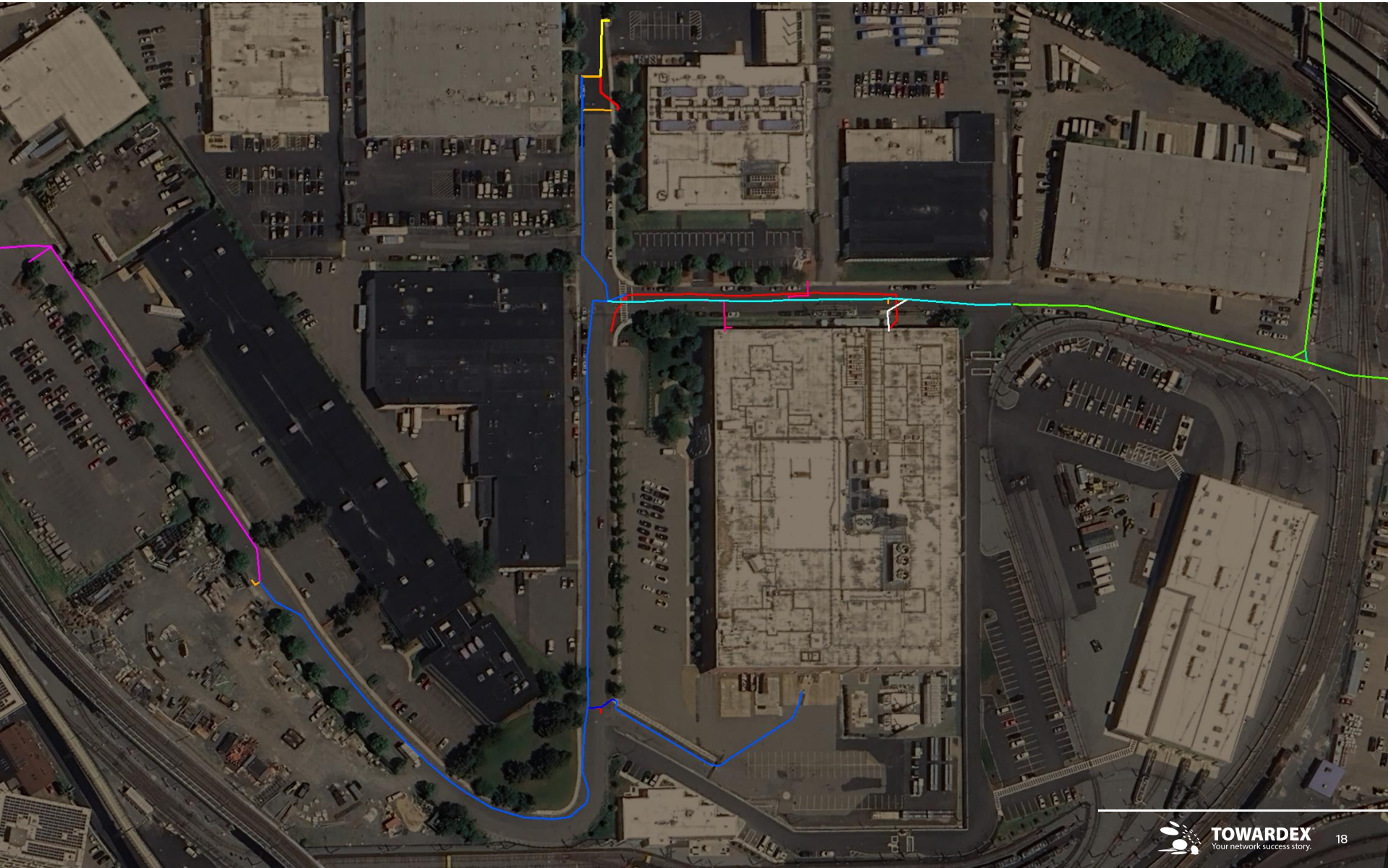
1. Customer orders a FoEX Member Connection
Each member connection is a 144F ribbon cable.



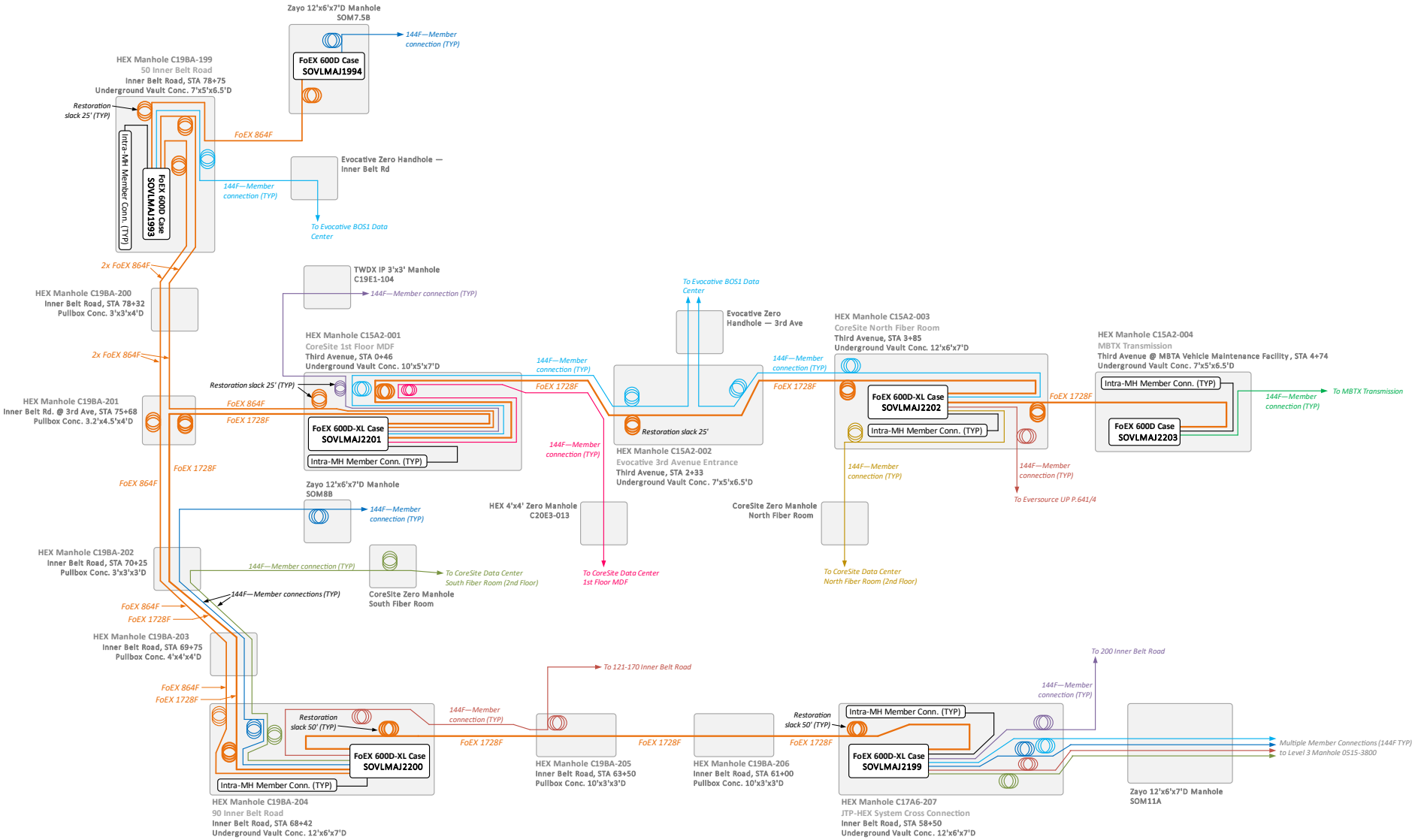
2. Non-Ordering Party Issues CFA/LOA to Ordering Party
Each cross connect in FoEX is minimum of 6 connections (12 strands ribbon splice).



FoEX Availability at Inner Belt



FoEX Inter-Manhole Transport Architecture



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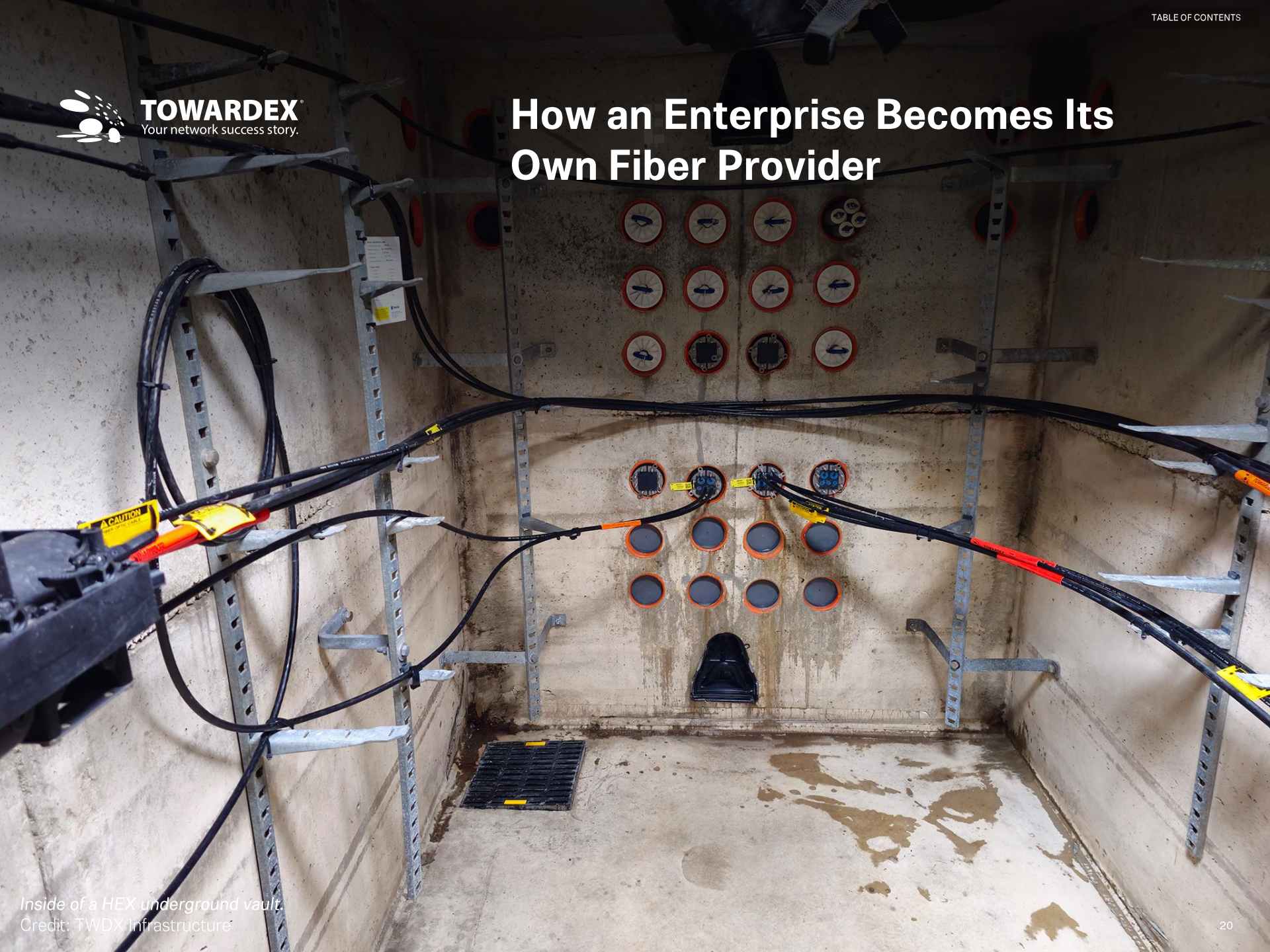
How an Enterprise Becomes Its Own Fiber Provider



Inside of a HEX underground vault.
Credit: TWDX Infrastructure

How a CDN utilizes HEX to scale their Boston network.

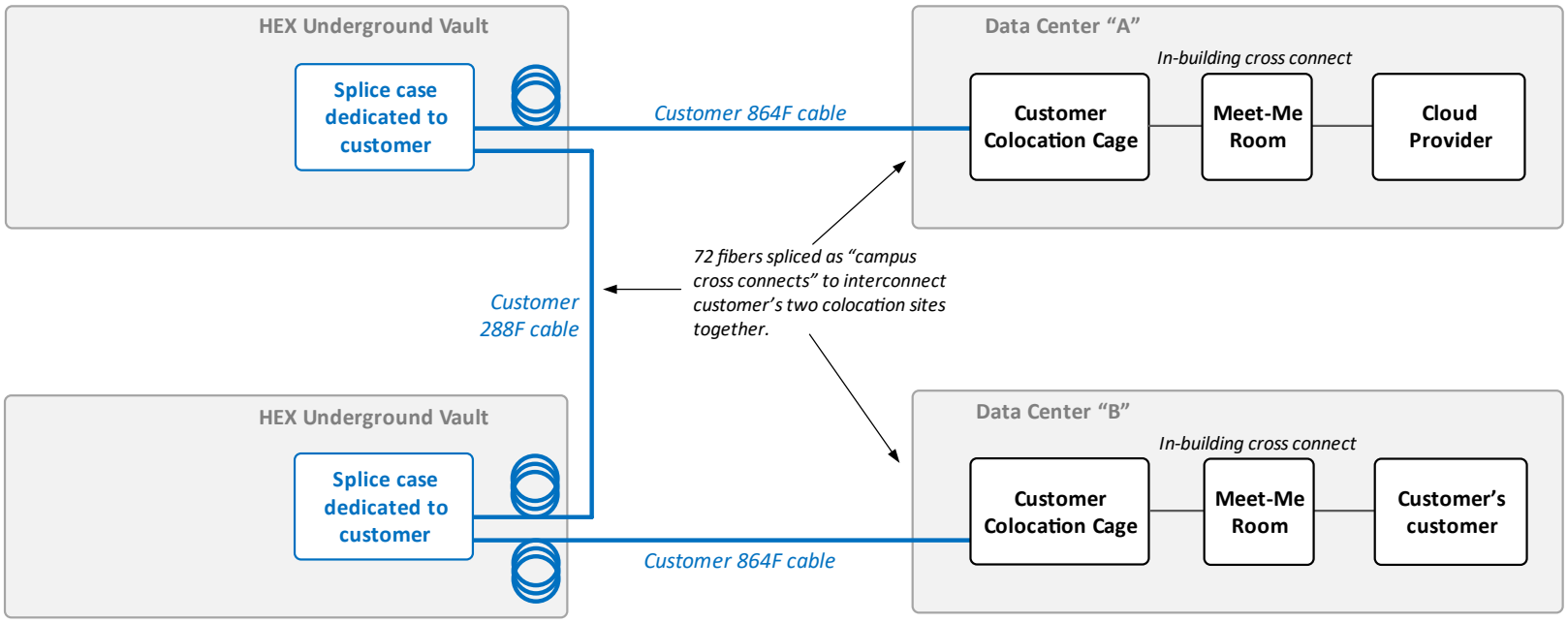
A HEX underground vault being installed.
Credit: TWDX Infrastructure

First Challenge:
The customer wants "campus cross connects" between their colo cages spread across two data centers in Inner Belt.

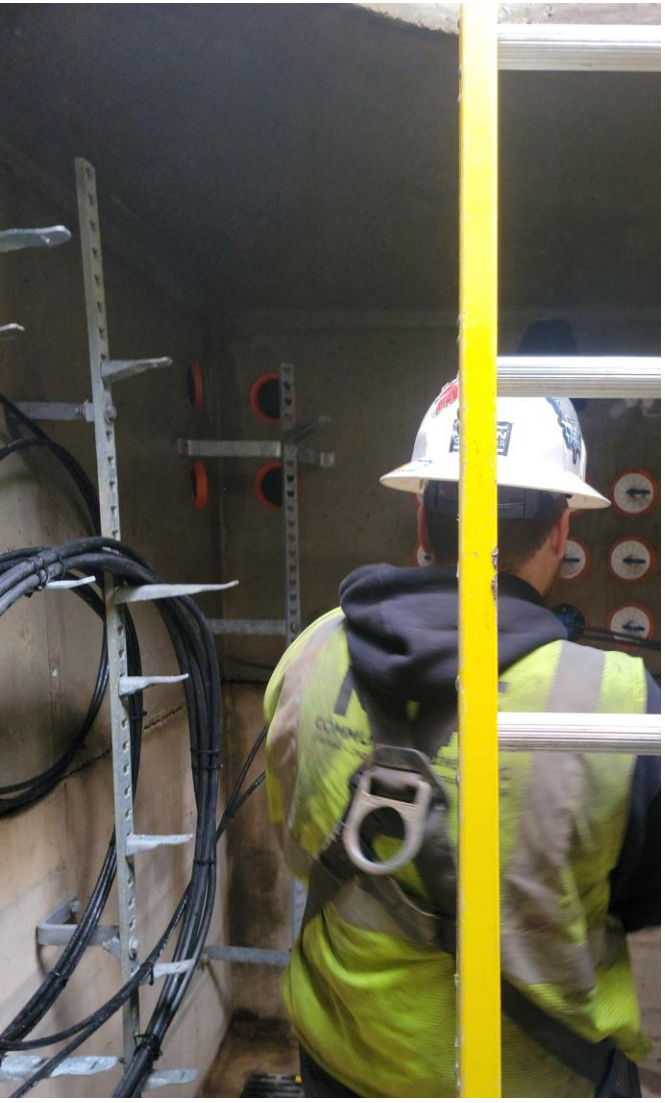
Solution:
Rather than purchasing two pairs of retail dark fiber and using DWDM, for similar price, the customer uses **Hosted Fiber Network** on HEX and allocates 72 fibers to tie their two colo sites together.

Campus Cross Connects Made Cost Effective:

Forget dark fiber, just take the whole cable.



Intra-manhole cross connection



A worker prepping to receive a cable.
Credit: TWDX Infrastructure

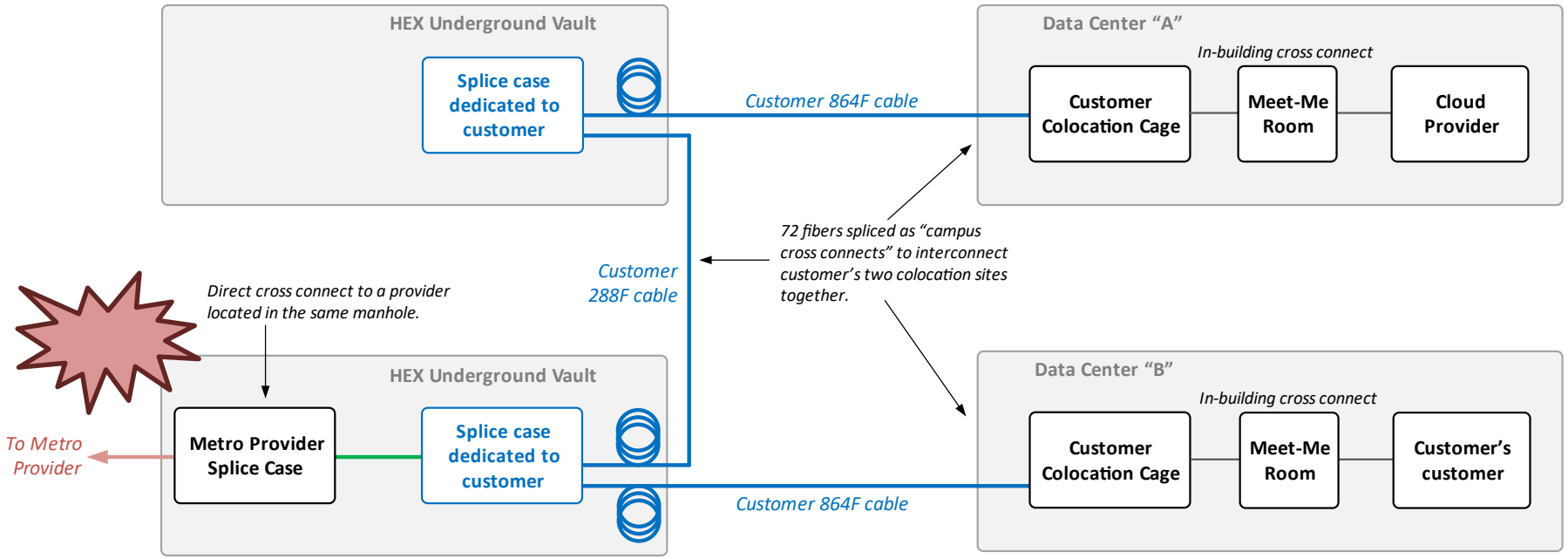
Now, the customer wants to connect to a metro fiber provider located in the same HEX manhole as one of customer's **Hosted Fiber Network** splice cases.

Solution:
The customer allocates 12 strands of fibers on their custom dark fiber network for this metro provider.

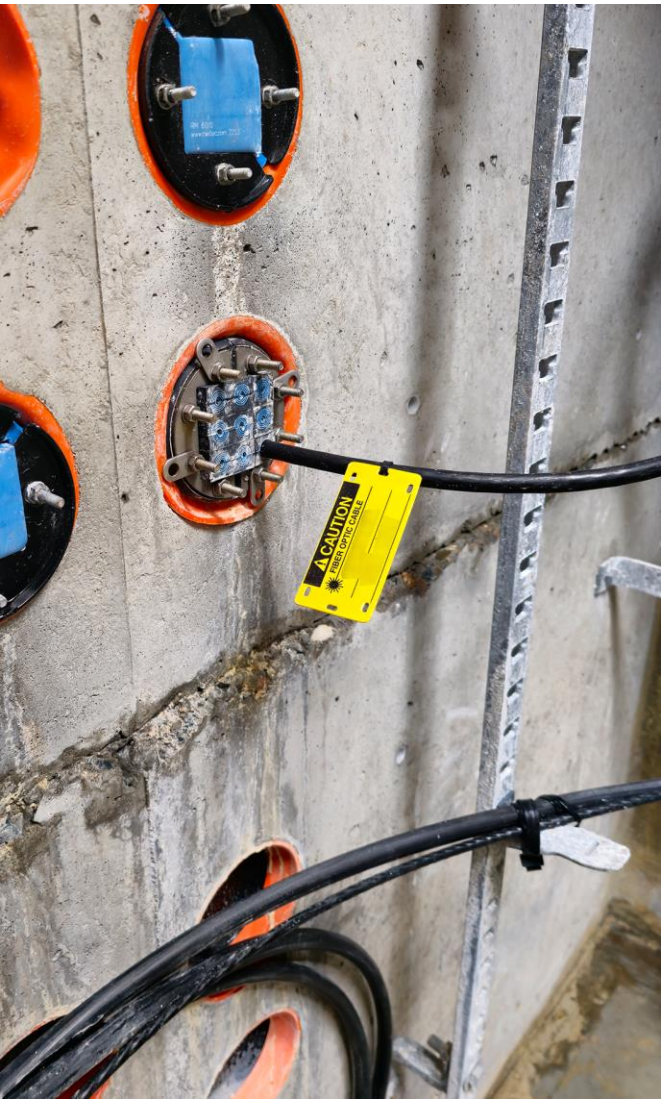
HEX workers run an intra-manhole cable for the metro provider's crews to pick up, and splices 12 strands in customer's splice case.

Intra-Manhole Cross Connects Added:

Customer purchases carrier connectivity from the street.



Inter-manhole cross connection



A tenant connection arriving in a HEX manhole.
Credit: TWDX Infrastructure

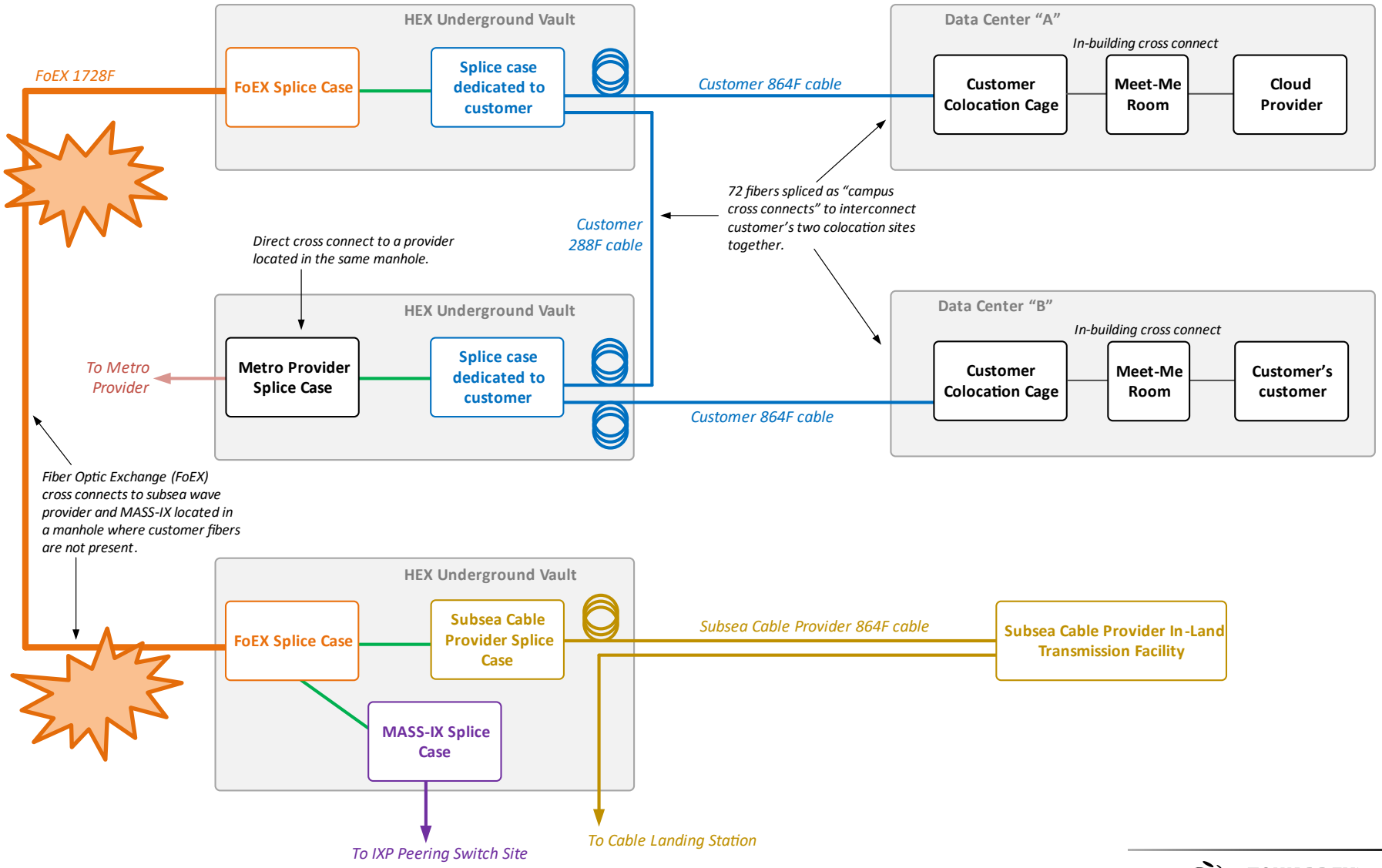
Now, the customer wants to connect to IX to add peering, and a subsea cable provider to purchase lit capacity to London using the HEX duct system.

These providers however are not in the same manholes as customer's dedicated splice cases.

Solution:
Customer becomes a Fiber Optic Exchange (FoEX) member and requests 24 fibers for *inter-manhole transport service*, without requiring anyone to physically run a new cable.

Inter-Manhole Cross Connects Added:

Customer becomes its own fiber provider.



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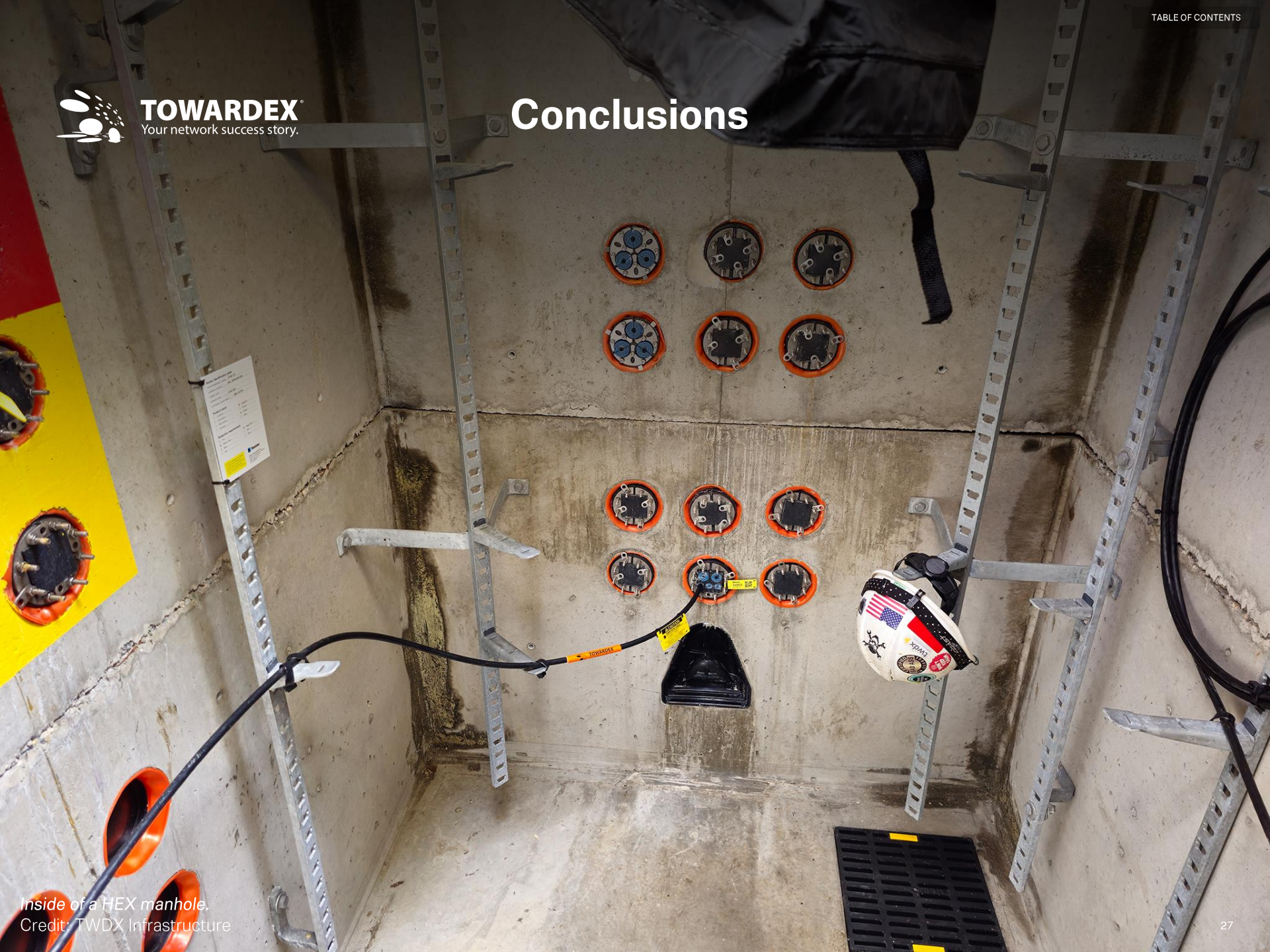
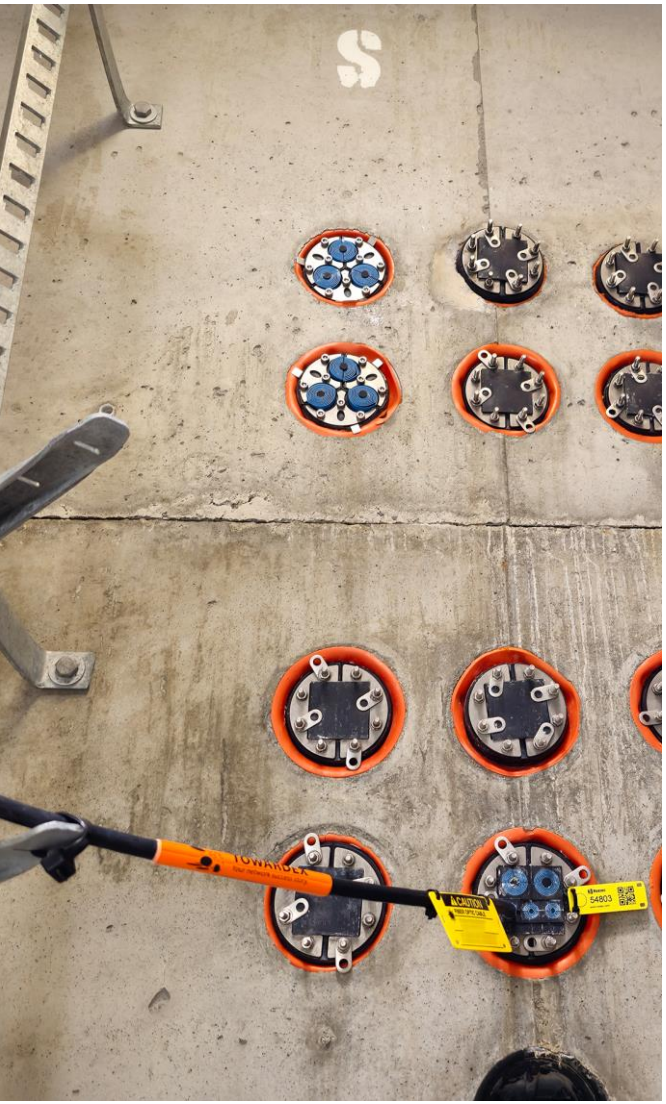
Conclusions



Inside of a HEX manhole.
Credit: TWDX Infrastructure

A community of interconnected data centers.



Forget "Meet-Me Holes."
With HEX, we turn the whole neighborhood into a "*Meet-Me Street*" of interconnected manholes and data centers.

Key Points:

- Data center cross connects offer the utmost convenience, agility and quickest deployments.
- Manhole meets require extended planning, but give you total control, security and volumetric scale in implementing mass cross connections.
- **Cross connects over a *network* of interconnected manholes**—all you can eat buffet of cross connects.
- Utilities are regulated common carriers. They can't kick you out of their manholes for simply being a competitor (as long as you're paying your bills and not violating laws, contracts/etc.).

A Hosted Fiber Network customer cable.
Credit: TOWARDEX

Q & A