

HDD and Bundled Microduct : Cross-Border Project

WHITE PAPER

A Scalable Approach to Underground Fiber Deployment
Combining trenchless construction with scalable fiber pathways

Nogales, Arizona–Nogales, Sonora Cross-Border Installation





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Executive Summary

Fiber network owners must solve two related infrastructure problems: how to lay an underground pathway with minimal disruption, and how to ensure that the pathway can support years of network growth. Horizontal directional drilling (HDD) addresses the first problem by creating a controlled underground bore without the need for continuous open-cut trenching. Bundled microduct addresses the second by providing multiple protected pathways for current and future fiber cables within a single installed assembly.

Used together, HDD and bundled microduct form a complete deployment strategy. HDD can reduce surface disturbance and restoration exposure at roads, developed corridors, waterways, rail crossings, border crossings, and other constrained locations. Bundled microduct can multiply the usefulness of the installed route by providing several independent pathways that can be placed into service over time.

One universal size or duct count does not define the most appropriate bundle. Four-way and seven-way bundles are common choices in the United States, with 7-way 18/14mm systems particularly familiar in many U.S. deployments. In other regions, including parts of Asia, and other international markets, smaller microduct sizes such as 14/10 mm may be preferred because of local cable designs, pathway constraints, density goals, or established construction practices. The correct configuration should be selected around the intended cable, installation distance, expansion plan, and route conditions.

This paper explains the benefits, planning considerations, and combined lifecycle value of HDD and bundled microduct. It also presents an initial case study from a July 2026 installation between Nogales, Arizona, USA, and Nogales, Sonora, Mexico,, where Knet participated with an outside-plant contractor partner in an approximately 450-foot HDD crossing and subsequent installation of a Knet 7-way 18/14mm bundled microduct system.



HDD creates the route.

Bundled microduct creates scalable fiber capacity.

1. The Need for a Combined Deployment Strategy

Rapid fiber expansion is increasing pressure on rights-of-way, roads, utility corridors, and developed areas. Network planners are often asked to build new capacity while limiting traffic impacts, surface restoration, environmental disturbance, and repeated construction.

A project that solves only the immediate fiber requirement may become expensive to revisit when capacity needs change.

The strongest underground designs therefore address both construction efficiency and pathway scalability from the beginning. HDD can help avoid a continuous trench, while bundled microduct can reserve several independent cable pathways during the same construction effort. The combination supports a build-once, expand-as-needed approach.

2. Horizontal Directional Drilling

2.1 What HDD Is

Horizontal directional drilling is a steerable trenchless construction method used to install pipe, conduit, or cable along a planned underground path. A typical operation includes a pilot bore, enlargement of the bore when required, and pullback of the product or protective pathway. The work is performed from limited entry and exit areas rather than through a continuous surface trench.

HDD is not automatically the best method for every route. Its success depends on appropriate design, competent contractors, reliable utility locating, geotechnical understanding, drilling-fluid management, equipment selection, and realistic pullback planning. The method should be evaluated against open trenching and other trenchless options based on site-specific conditions.

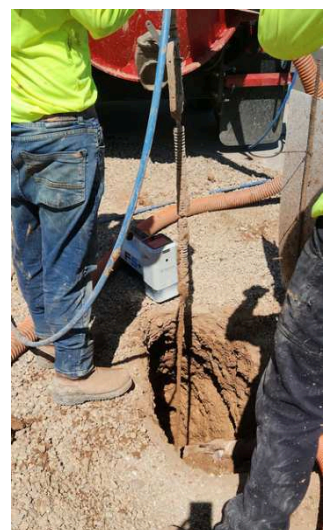


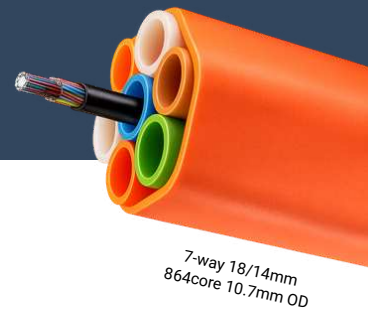
2.2 Why HDD Is Used

- Reduced continuous surface excavation compared with open-cut construction.
- Ability to cross roads, railways, waterways, landscaped areas, and developed corridors.
- Potential reduction in pavement cuts, traffic disruption, and restoration work.
- A controlled route that can avoid or pass beneath surface obstacles.
- Applicability to short utility crossings as well as longer, more complex installations.
- Ability to install multiple bundled-microduct assemblies through a single properly designed bore, greatly increasing the number of independently usable fiber pathways created during one HDD operation.

2.3 Growing Market Familiarity

HDD has become a familiar construction option across much of the United States, particularly for utility and telecommunications crossings. Internationally, adoption is uneven. Several Asian countries have mature trenchless sectors and experienced contractors, while other areas are still developing owner awareness, equipment availability, design practices, and trained crews. This variation creates an opportunity to transfer proven planning and installation practices from established markets without assuming that one market model fits every country.





3. Bundled Microduct

3.1 What Bundled Microduct Is

Bundled microduct is a factory-assembled group of small-diameter ducts designed to create multiple independent pathways for fiber optic microcables. The individual ducts may be arranged within an outer sheath or otherwise held in a controlled bundle, depending on the product design. Each microduct can be assigned to a separate cable, customer, network function, phase, or future expansion requirement.

3.2 The Core Benefits

- Multiple fiber pathways installed in a single coordinated operation.
- Unused ducts reserved for future cable placement.
- Separation of customers, carriers, services, or redundant network functions.
- Ability to add capacity without performing another major civil construction project.
- Support for phased capital deployment: install the pathway now and add fiber as demand develops.
- Potential for cable replacement or technology upgrades without disturbing other occupied ducts.
- Efficient use of space inside a larger protective pathway or in direct-buried applications designed for the selected product.

3.3 Configuration Is Application-Specific

Bundled microduct should be discussed as a product family rather than as a single configuration. Four-way and seven-way systems are both popular. A 7-way 18/14mm configuration offers seven individual ducts with approximately 18 mm outside diameter and 14 mm inside diameter per microduct, subject to the specific product standard and tolerance. In other markets, bundled 14/10 mm systems may be more common because they increase pathway density and align with smaller microcable designs.

Configuration example	Potential planning value
4-way bundle	Moderate pathway count; compact assembly; useful where expansion needs are defined but not extremely high.
7-way 18/14mm	Popular U.S. configuration; balance of pathway count and larger internal duct diameter; suited to a broad range of microcables.
Bundles using 14/10mm	Higher pathway density and smaller cable compatibility; common in many international network designs.
Higher-count bundles	Maximum pathway density for municipal, carrier-neutral, campus, and high-growth routes; requires careful cable and installation planning.



4. Why HDD and Bundled Microduct Work Better Together

HDD and bundled microduct solve different parts of the same infrastructure challenge. HDD enables reaching the destination with minimal surface disturbance. Bundled microduct ensures that the route provides multiple optimized cable pathways for current and future utilization.

HDD Contribution	Bundled Microduct Contribution
Creates a controlled underground route	Creates multiple controlled fiber pathways
Reduces continuous trenching	Reduces the likelihood of future repeat construction
Crosses difficult surface obstacles	Reserves capacity through the difficult crossing
Improves initial construction access	Improves long-term network flexibility
Requires planning of bore geometry and pullback	Requires planning of cable fit, duct count, and expansion needs

The combined value is most visible at locations that are expensive or difficult to revisit. A road, railway, border, waterway, or urban crossing may justify installing additional pathway capacity beyond what the first fiber cable requires. By installing a suitable bundle during the initial project, the owner can preserve options for future growth without repeating the most disruptive portion of the civil work.

4.1 Multiple Bundles Through a Single Bore

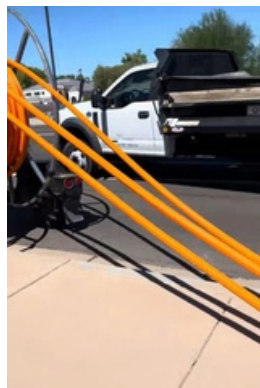
A further advantage of HDD is that one properly sized and engineered bore can accommodate more than one bundled-microduct assembly. This allows the civil construction effort to create substantially more pathway capacity than a single bundle alone, without requiring a separate bore for each assembly.

The installation shown below demonstrates three 7-way 18/14mm bundled-microduct assemblies being back-pulled through one bore. Together, the three bundles provide 21 independent microduct pathways through the same underground crossing. This approach can be especially valuable where future capacity, carrier separation, redundancy, or customer segmentation is expected.

The number and size of bundles that can be installed in one bore must be confirmed during design. Bore diameter, bundle geometry, bend radius, pulling tension, friction, soil conditions, drilling-fluid management, and product handling all affect feasibility and installation limits.



Three 7-way 18/14mm bundled-microduct reels are staged for installation.



The three bundled-microduct assemblies are aligned for simultaneous pullback.



Three bundles approach the bore entry point as one coordinated installation.



The bundled assemblies enter the bore together, creating 21 independent pathways.

One bore. Three 7-way bundles. Twenty-one independent microduct pathways.



Microduct splice closures are designed to simplify fiber deployment and maintenance while providing long-term reliability. Compared to direct burial splicing, closures keep connections protected, organized, and easily accessible for future use.



5. Lifecycle and Business Benefits

5.1 Build Once, Expand as Needed

A bundled system allows the owner to separate civil construction from the timing of fiber demand. The underground route and pathways can be installed during the initial project, while fiber cables are added to individual microducts over time. This can reduce the risk of either underbuilding the route or installing all projected fiber capacity before it is needed.

5.2 Reduced Exposure to Repeat Construction

The cost of returning to a constrained crossing is not limited to drilling or trenching. It may also include design, permitting, traffic control, mobilization, utility coordination, environmental controls, restoration, and schedule risk. Reserving independent microduct pathways can reduce the likelihood that these activities must be repeated simply to add another cable.

5.3 Segmentation and Commercial Flexibility

Individual microducts can be designated for separate operators, customers, network layers, public agencies, redundant routes, or future technologies. Depending on ownership and commercial strategy, spare pathways may also support leasing, capacity sharing, or phased customer connections.

5.4 Asset Protection and Operational Control

Separating cables into individual ducts can improve organization and reduce direct interaction among cables during installation or replacement. Clearly identified duct colors, route records, access points, seals, and test documentation help operations teams manage the asset over its service life.

6. Design and Installation Considerations

The benefits described in this paper depend on proper system design.

HDD geometry and bundled-microduct selection should be coordinated rather than developed independently.

Route and geotechnical conditions: soil, rock, groundwater, existing utilities, surface constraints, and required cover.

Bore profile: entry angle, exit angle, depth, bend radius, reamed diameter, and transition geometry.

Pullback loads: anticipated tensile forces, friction, buoyancy effects, product strength, and allowable installation limits.

Protective pathway strategy: direct installation or placement inside a larger conduit, based on product design and project requirements.

Bundle configuration: number of microducts, microduct outside and inside diameters, sheath construction, identification, and spare capacity.

Cable compatibility: cable outside diameter, weight, stiffness, blowing characteristics, and manufacturer-recommended fill ratios.

Access planning: handholes, vaults, termination points, slack storage, couplers, and future cable-installation equipment access.

Sealing and cleanliness: water and gas blocking, temporary caps, permanent seals, and prevention of dirt or drilling-fluid contamination.

Testing and documentation: continuity, pressure or integrity testing where applicable, mandrel verification, route records, footage markings, and as-built information.

Longer installations and more complex routes require special attention to minimum bend radius, allowable pulling tension, bore lubrication, product handling, and the conditions that will later affect cable blowing.

Contractors and product suppliers should review the intended installation procedure before construction begins.



7. Case Study: Nogales Cross-Border Installation

On July , 2026, Knet participated with an outside-plant contractor partner in an HDD installation connecting Nogales, Arizona, USA with Nogales, Sonora, Mexico. The project provides a practical example of how trenchless construction and bundled microduct can be combined at a high-value crossing.

Item	Details
Location	Nogales, Arizona ,USA to Nogales, Sonora, Mexico
Date	July , 2026
Approximate HDD length	450 feet
Construction method	Horizontal directional drilling
Installed fiber pathway	Knet 7-way 18/14mm bundled microduct
Pathways created	Seven independent microducts
Project participants	Knet and an OSP contractor partner

7.1 Installation Sequence

The contractor completed an approximately 450-foot HDD crossing across the international boundary area. A protective HDPE pathway was pulled through the completed bore. The Knet 7-way 18/14mm bundled microduct was then installed through that pathway, creating seven individual routes for fiber deployment.

7.2 Why the Project Matters

The significance of the installation is not limited to the initial crossing. The HDD operation established the underground route, while the bundled microduct converted that route into a multi-pathway fiber asset. Future cables can be assigned to available microducts based on network requirements, subject to access, permitting, and operational arrangements.

7.3 Initial Lessons

HDD and bundled microduct should be planned as one system, including pullback and subsequent cable-installation requirements.
 High-value crossings benefit from reserving multiple pathways during the initial civil construction effort. A widely used U.S. configuration such as 7-way 18/14mm can provide substantial capacity, but the underlying design principles apply to other bundle sizes and regional preferences.
 Clear coordination among the owner, drilling contractor, OSP contractor, and product supplier is essential.

HDD minimizes the disruption required to reach the destination. Bundled microduct maximizes the capacity delivered through that route.

8. Applying the Model in Developing HDD Markets

Markets that are expanding their use of HDD can benefit from adopting both the construction method and the lifecycle planning discipline that makes each bore more valuable. The goal should not be to copy U.S. product selections automatically. Instead, owners should combine proven trenchless practices with microduct configurations suited to local cable designs, contractor capabilities, space constraints, standards, and network economics.

8.1 Priorities for Market Development

Training for designers, inspectors, drill operators, and outside-plant crews.

Improved utility mapping, locating, and verification before drilling.

Geotechnical investigation scaled to project risk.

Clear specifications for drilling fluids, bore tracking, pullback limits, and product protection.

Coordination between HDD contractors and fiber-infrastructure suppliers.

Demonstration projects that document installation data and long-term performance.

Configuration selection based on regional cable sizes rather than a single global default.

In many European and Asian markets, bundled 14/10mm systems may align well with established microcable designs and pathway-density goals. In the United States, 4-way and 7-way systems, including 18/14mm and larger bundled microduct products, may be more familiar. Both approaches support the same principle: use the initial civil construction project to create several independently usable fiber pathways.



9. Conclusion

HDD and bundled microduct are most valuable when evaluated together. HDD can minimize the surface disruption required to establish an underground route. Bundled microduct can maximize the capacity, flexibility, and useful life of that route.

The preferred bundle may be four-way, seven-way, or a higher-count design. The individual microducts may be 18/14mm, 14/10mm, or another size selected for the intended cable system. Those choices will vary by region and application. The strategic objective remains consistent: install an efficient underground route and preserve multiple pathways for future fiber growth.

The Nogales installation demonstrates this combined approach at a demanding cross-border location. One trenchless crossing created the route; one bundled-microduct installation created seven independent pathways. That model can be adapted to highways, railways, waterways, municipalities, campuses, industrial facilities, data-center corridors, and developing broadband markets worldwide.

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