Fiber Optic Sensing Association
Connect and Protect

WHY DIG ONCE?

Builders and carpenters have long been familiar with the admonishment to "Measure twice, Cut Once." This advice reminds us to double-check in advance to avoid unnecessary waste later.

Dig Once Defined: Policies and/or practices that minimize the number and scale of excavations along highway rights-of-way when installing telecommunications infrastructure.

"Dig Once" represents an identical idea. It reduces the number and scale of repeated excavations for the installation and maintenance of broadband facilities in rights-of-way. This protects roads and sidewalks by minimizing traffic and other disruptions related to construction. It creates a more efficient means of installing network infrastructure during construction by using available opportunities to place fiber or conduit inexpensively.

Conduit burial during construction lets communities dramatically reduce the cost of fiber optic cable installation. The added cost of including conduit during construction becomes negligible when compared to the cost of excavation later.

Effective "Dig Once" policies include being alert to the potential to install or obtain fiber and conduit along rights-of-way. It includes explicit, formal processes to assess these opportunities. These include road construction; road widening; undergrounding of utilities; and construction of new and existing utility infrastructure (electric, telecommunications, cable, water, sewer). Communities can work with local utilities and service providers to become aware of upcoming plans. For example, upcoming construction along rights-of-way can be tracked during the permitting process to flag future co-location opportunities.

A coordinated Dig Once initiative can provide capacity for multiple separate service providers. The potential benefits of this coordinated approach to conduit and fiber installation accrue not only to public agencies but also to participating private providers too.

- Cost Savings—Reducing the frequency that transportation and utility channels are opened is approximately ten times cheaper than adding broadband infrastructure after these have already been built. [i] These savings are the most pronounced in high-density areas when underground installation is the only available option.

- Increased Access to and Reliability of Broadband Networks— Laying fiber in rural areas gives residents access to broadband networks more quickly. Additionally, installing fiber in areas that already have broadband enhances network reliability.
- Public Benefits—Dig Once policies can cut government telecommunications costs and support public safety. Decreased road construction reduces traffic congestion and lengthens infrastructure lifespans by avoiding further construction disruptions.
- Economic Benefits— Broadband benefits existing businesses and encourages future economic activity in rural communities by drawing businesses to the area.

Legislative & Regulatory History

Until 1988, Federal policy did not permit States to allow utilities to install their infrastructure on Interstate highway rights- of- way. States were finally allowed then to include utility installation, provided it did not adversely affect traffic or highway safety. Approval was required, however, from the Federal Highway Administration (FHWA) to permit specific utility installations.

Beginning in 2009, Rep. Anna Eshoo (D-Ca) introduced the first of several Dig Once bills to expand the deployment of broadband internet service. Her initiative was boosted when President Obama signed an Executive Order to facilitate the deployment of broadband technology on Federal lands, buildings, rights- of-way, federally assisted highways, and tribal lands. The June 14, 2012 order required the FHWA to review "Dig Once" requirements in existing programs, as it related to the placement of below-ground fiber optic cable along highway and roadway rights-of-way (ROW).[ii] As a result, the Department of Transportation strongly encouraged states to work with service providers on joint highway and utility planning. They were expected to use innovative practices and technologies to minimize roadway excavation. Every state was required to have a policy for the accommodation and relocation of utilities on highways getting Federal aid. After a State's policy was approved, proposed utility installations no longer needed to be referred to the FHWA for approval.[iii]

As part of the Consolidated Appropriations Act enacted in 2018, additional Dig Once provisions became law.[iv] The Department of Transportation was directed to issue regulations "to ensure that states receiving federal-aid highway funds:

- Identify a broadband utility coordinator to facilitate the broadband infrastructure right-of-way efforts within the state;
- Register broadband infrastructure entities that seek to be included in those facilitation efforts;
- Establish a process to electronically notify such entities of the state transportation improvement program on an annual basis;
- Coordinate statewide telecommunication and broadband plans and state and local transportation and land use plans, including strategies to minimize repeated excavations that involve the installation of broadband infrastructure in rights-of-way; and
- Ensure that any existing broadband infrastructure entities are not disadvantaged."[v]

DIG ONCE ECONOMIC MODELS

No one single, best economic model works in all areas of the country. However, for below-ground, wireline installations along highway rights-of-ways, three general approaches by governments exist:

1. Publicly owned and operated networks
   Government installs, owns, and maintains conduit and in some cases, fiber optic lines as well. Government assumes the commercial risk of unused conduits.
2. Privately-owned and operated networks
   The conduit is installed, owned, and maintained by a private entity, and fiber optic lines are also privately owned and operated with minimal government involvement. In certain cases, as part of the agreement for using public rights-of-way, the private entity may install extra conduit for the public entity to have for its own use. A private company assumes the commercial risks of underused conduits.
3. Resource Sharing
   Resource sharing, sometimes referred to as bartering or trading, is a type of agreement that governments make with service providers for the exchange of the use of rights-of-way or existing infrastructure with fiber optic services. These services often provide state transportation departments with connections to ITS infrastructure, such as operations facilities, cameras, and message signs along roadways. It has proved successful in many areas of the country for expanding ITS networks into rural areas.

DIG ONCE PROJECT CONSIDERATIONS

Dig Once opportunities need to be prioritized to avoid wasting resources where conduit use is unlikely. For example, the availability of nearby utility poles at a reasonable attachment cost will reduce Dig Once's cost-benefit appeal. Projects extending only a short distance or that are isolated from existing fiber and conduit infrastructure have reduced attractiveness. Similarly, projects in lower-density areas, or that are distant from government facilities, community anchor institutions, or large developments typically receive a lower priority.

To ensure that Dig Once projects are both financially feasible and consistent with a community's goals, these factors should be reviewed:

- Ability to place fiber optic cable and/or conduit over long, continuous stretches;
- The proximity of a possible Dig Once project to government and community anchor facilities that can benefit from a possible broadband connection,
- Interest in conduit from partners or customers (e.g., government departments, or communications service providers)
    - Conduit placement for building fiber into key development sites, data centers, or similar facilities;
    - Beneficial project cost (i.e., prioritizing projects with lower-than-average costs)

    - Synergies with opportunistic major projects, such as highway, mass transit, or bridge replacement;
- Lack of cost-effective alternatives due to physical constraints in the vicinity (e.g., targets of opportunity such as bridges or freeway underpasses) or lack of capacity on utility poles along the route;
- Ability to bridge major rights-of-way crossings, such as railroad, water, highway, or interstate. These can be more difficult for private telecommunication carriers to navigate on their own, making partnerships with government more attractive.

State Case Studies

Individual states have responded in a variety of ways to the opportunities that "Dig Once" offer. Arizona, Massachusetts, Minnesota, and Utah demonstrate four different approaches.

Arizona

Arizona's Dig Once policies are targeted specifically at expanding broadband access to rural communities. The policy states that during road construction projects along rural highways, the DOT can coordinate with telecom companies to install conduit and enables the agency to lease the conduit to telecom providers at a cost-based rate.[vi]

In 2012 Arizona's Digital Highway bill allowed the state to install broadband conduits in connection with rural highway construction if funds were received to cover the cost. The installation of broadband at the time of the project was not required, only authorized. The installation would not be paid for with existing highway or state general funds, but could be paid through a federally-funded, state program managed by the Arizona Strategic Enterprise Technology (ASET)'s Digital Arizona Project. Arizona's Department of Transportation would be requested to bury multiple empty fiber-optic conduits along specified state highways using existing ROW wherever possible.[vii]

Arizona owns conduit and leases it to providers at a cost-based rate. The State may also allow providers to relocate their own conduit within the right-of-way at the providers' expense.[viii] The initial funding is the State's responsibility but shifts to broadband providers "regarding planning and relocating of broadband conduit and any related provider facilities within the right-of-way . . . if future highway improvements make the relocations necessary."[ix]

Massachusetts

According to the Massachusetts Department of Transportation's (MassDOT) State Department of Transportation Utility Accommodation Policy, the agency may require the installation of excess capacity (or empty conduit) and the announcement of co-build opportunities during "clear zone" installations to accommodate multiple telecommunications service providers during the same installation process.[xxi]

Additional installations are not allowed on that segment of right-of-way until all existing cable and conduit capacity has been exhausted. The policy further leaves open the possibility of

requiring telecommunications service providers to provide other providers with reasonable notice (not less than 90 days) of a co-build opportunity associated with the anticipated or planned opening of the right-of-way within an area where the installation will be limited to one time.

Telecommunications service providers and fiber optic facilities are treated differently in terms of ownership of conduit. Lease Agreements are utilized for the accommodation of fiber optic facility installation, operations, and maintenance along State highways, at a market-based rate.[xii] Sublease agreements are also allowed.[xiii]

Minnesota

The Minnesota DOT has an extensive policy on the accommodation of fiber optic facilities on interstate rights-of-way that includes an open and competitive process that permits providers to install their infrastructure at the time these are open for other utility work.[xiv] The state's Office of Broadband Development (OBD) coordinates with the state's DOT for "Dig Once" measures in planning, relocation, installation, or improving broadband conduit within a right-of-way. The Office of Broadband Development evaluates procedures and criteria for contracts or lease agreements with telecom companies and as well as for pricing requirements. It also allows for co-location of fiber and conduit with other utilities in the same trench.

According to the OBD, implementation of the policy has run into barriers due to a lack of funding to deploy, track, and manage the conduit.[xv] Despite those challenges, the OBD has made progress in addressing permitting delays and begun planning for the infrastructure necessary to support autonomous vehicles.

Utah

Utah's state government began implementing Dig Once policies ahead of the 2002 Salt Lake City Olympics. The state's DOT has since expanded the policy, requiring the installation of oversized conduit for certain road construction projects, while interested telecom parties can then extend that infrastructure to neighboring communities. The state's DOT owns the conduit and leases it to telecom companies that want to use it. The state's Telecommunications Advisory Council reviews and approves valuations and trades between the state's DOT and telecom companies for conduit access and maintains a map of fiber locations.[xvi]
The state's DOT is required to allow approved broadband providers to install conduit "into the same general location on the interstate system, coordinate their planning and work, install in a joint trench, and equitably share costs."[xvii] The UDOT installs an empty conduit during highway construction. The State installs small sections of conduit and broadband providers cooperate in helping to extend the infrastructure and provide services to rural communities.[xviii] It also trades existing or planned conduit and fiber on a foot-by-foot basis, as well as trading fiber optic on a foot-by-foot strand basis. Trade agreements are for 30 years with automatic five-year renewals.

Both conduit ownership and funding are mixed. Sometimes broadband providers install the conduit, and in other cases the State or local government does.

Appendix 1: **Dig Once Next Steps Checklist:**

Considerations for States with an Interest in Advancing the Deployment of Broadband in Highway and Public Rights-of-Way (ROW)[xix]

1. Develop a statewide policy on broadband with input from stakeholders.
2. Develop a statewide plan to facilitate the provision of broadband services to all citizens in the State by identifying corridors where broadband infrastructure is most needed.
3. If applicable, review, update, and/or modify State utility accommodation policies.
4. If applicable, review and propose modifications to State legislation to facilitate accommodating broadband facilities in highway and public ROW.
5. If applicable, publish broadband plans and/or State utility accommodation policies on the state websites and provide links to these materials.
6. Include broadband stakeholders and service providers in the transportation planning and project development process.
7. If applicable, coordinate transportation and highway construction plans with other statewide telecommunication plans, such as Statewide Interoperability Communication Plans, Fusion Center Plans, and State Next Generation 911 plans.
8. Make information on the location of conduits, fiber lines, and planned highway projects available electronically.
9. Consider new technology and construction practices, such as micro-trenching and horizontal directional drilling that would allow for the safe and efficient accommodation of broadband infrastructure in the public ROW.
10. Consider newer conduit product types, such as bundled MicroDucts, that provide maximum flexibility for both adding future fiber cables and also for providing increased pathways.
11. Coordinate with utilities to minimize the number and scale of repeated excavations that involve the installation of broadband in the public ROW.
12. Consider developing or updating a State DOTs Asset Management System to collect pertinent broadband data, such as size, type, location of spare ducts, and live and dark fibers.
13. When updating environmental Programmatic Agreements, consider whether incorporating broadband would be useful.

Appendix 2 -USING CONDUITS FOR DIG ONCE

Conduit is widely used to provide a Dig Once permanent pathway. Cables are commonly buried in ducts to provide further protection, allowing for a simple repair, and potentially providing upgrade paths. The conduit provides mechanical protection of the fiber cable, both during the installation of the fiber cable and over the entire life of the fiber cable. Typically, direct buried fiber cables require additional design enhancements to withstand environmental conditions, whereas the conduit can provide that environmental, tensile, and crush protection itself. This enables the fiber density to increase significantly for a given outer diameter cable.

A well-engineered plan will ensure the application can achieve benefits well in excess of the costs of the plan and the conduit network system deployment. Generally, the actual cost of the conduit network systems is only approximately three percent of the overall project costs. Conduit is widely used in most industries, accommodating simpler initial installations and providing a Dig Once permanent pathway.

It is common for cables to be buried in ducts to provide further protection, allowing for simple repair, and potentially providing upgrade paths. In some circumstances, ducts are only used for sections of deployment (e.g. under roads or rivers) where excavation would pose a difficulty, but increasingly ducts are being used for the entire route. This is possible because conduits can provide several benefits without a significant project cost impact.

Brief History of Conduit Network Systems

In the early to mid-1980s, tremendous growth occurred in the deployment of fiber optic cables, linking major metropolitan areas. Fiber optic cables were quickly becoming the technology of choice for streaming huge amounts of voice, video, and data. These cables were installed in very long lengths, up to 30,000 feet, with the goal of using as few splice points as possible to minimize signal attenuation. Because of the more fragile qualities of these long, thin strings of glass, individually no thicker than a strand of human hair, they needed more protection and different handling procedures than traditional jacketed metallic cables. There was an immediate need for a conduit system that offers improved installation efficiencies and cable protection.

In 1999, new technology was introduced to help solve the issue of overcrowded right-of-ways. Using the same installation methods and tools as traditional HDPE standard conduit, bundled MicroDucts under one oversheath maximized the fiber count in the same space. As technology advances, fiber optic cables are higher capacity in a smaller size, called MicroCables, and conduits are following in size, called MicroDucts. Multiple configurations allow for easy connection to existing networks and efficient transition to current technology.

This new method of deployment using MicroDucts in existing pathways was called “innerducts” and is still used today. Additionally, now conduit suppliers offer bundled MicroDucts under one oversheath for ease of placement and to maximize fiber count in limited underground and aerial spaces. Multiple variations of standard HDPE conduit and bundled HDPE MicroDucts are available. The installation methods and tools are the same for both.

In addition to traditional trenching, over the years newer installation methods also evolved to minimize the above and below ground surface damage, restoration requirements, and disruption to traffic: plowing, horizontal directional drilling (HDD), and MicroTrenching.

All conduit is not created equal, and the type of conduit can determine which type of fiber cable you need. Conduit has an inner diameter (ID) and an outer diameter (OD); the standard is to refer to the outer diameter when describing the conduit. A common engineering practice is to not fill each conduit subduct more than about 65 percent full of fiber cables. This space is necessary to air-jet, or pull, the fiber through the conduit without damaging the fiber.

As fiber technology continues to evolve, the fiber cable diameter will continue to get smaller. Microfiber cables can fit many strands of fiber in small diameter conduit. MicroTechnology continues to improve. For decades, conduit has been the preferred manner of installing fiber cable underground and now even in aerial applications.

Installation Advantages
It is also easier to handle unexpected changes in the route, such as having to go around an obstacle, as compared to directly placing fiber cable.

The continuous run of fiber cable can help reduce the cost of splice points and improve the fiber loss budget and performance for the total system.

The conduit itself can be locatable, which allows the fiber cable to be constructed with only non-conductive dielectric materials which can allow easier to the fibers.

Protection of the Fiber
The conduit provides mechanical protection of the fiber cable, both during installation of the fiber cable and over the entire life of the fiber cable.

Typically, direct buried fiber cables require additional design enhancements to withstand environmental conditions, whereas the conduit can provide that environmental, tensile and crush protection itself. This enables the fiber density to increase significantly for a given outer diameter cable.

Permanent Pathways
Conduit provides for an always-present pathway for upgrades and changes whenever needed. For example:

1. Remove and change out a fiber cable that is damaged
2. Swap out with improved technology
3. Use the additional empty conduits for increasing capacity
4. Re-route the conduit pathway if there is a change in route

The Dig Once legislation stresses the importance of burying conduit once, with the possibility to add new cables, upgrade existing ones, and increasing capacity. By planning for the future by installing extra permanent pathways, the networks are able to adapt to changes more quickly.

Communication Needs
Communication needs could be for telecommunications, cameras, data transfer, security and many others.

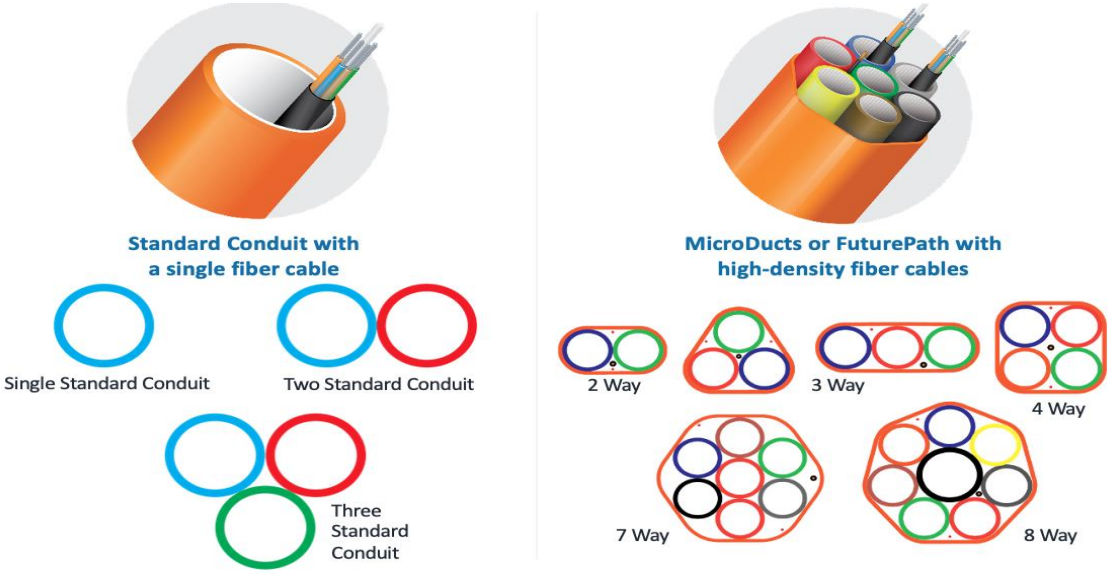
Revenue Opportunity
There is a financial opportunity that network and right-of-way owners are realizing and planning whereby empty pathways can be used, to grant access to difficult right-of-ways or be leased to carriers.

By installing multiple MicroDucts, take full advantage of the new high-density MicroCables that fiber cable providers are shrinking and improving year over year.

It is important to realize that there are different types of conduits suited for different purposes:

- In a more traditional system, 1, 2, or 3 standard conduits could be installed together. However, the outside diameter of these conventional ducts is often quite large compared to the smaller outer diameter of MicroDucts now available. While these large dimensions, perhaps 1.5 inches or 2 inches in diameter, are still used in the industry, they were developed at a time when fiber cables were of much larger diameter with lower fiber density. Since typically only one cable is placed per duct, they actually limit the number of fiber cables that can be placed in a right-of-way.

- Smaller diameter MicroDucts are designed to take advantage of the advances the higher fiber density microcables that have much smaller outer diameter. Amazingly, there are 288 and 432 fiber cable diameters on the market on the order of 8 to 10mm, so by sizing the MicroDucts for better space utilization, you can achieve much greater overall fiber density in any right-of-way space.



[i] https://www.fhwa.dot.gov/policy/otps/workplan.cfm
[ii] https://obamawhitehouse.archives.gov/the-press-office/2012/06/14/executive-order-accelerating-broadband-infrastructure-deployment
[iii] 23 CFR 645.211
[iv] The full text of the Consolidated Appropriations Act can be found at https://www.congress.gov/bill/115th-congress/house-bill/1625. See Sec.607 for the Dig Once provisions
[v] As of July 6,2020 the regulations have not been issues.
[vi] ARIZ. REV. STAT. ANN. §§ 28-7381–82 (aka "Digital Arizona Highways Act of 2012")
[vii] *See* ARIZ. REV. STAT. ANN. § 28-7382(a) (using the word "may" instead of "shall" when referring to the installation of broadband conduit).
[viii] *See id*
[ix] See *Id.*
[x] *See* MASS. DEP'T OF TRANSP., MASSDOT UTILITY ACCOMMODATION POLICY 36 (2013), https://www.mass.gov/doc/utility-accommodation-policy-0/download (describing what proposals for new facilities, fiber optic strands, or access to empty fiber optic conduit must include).
[xi] *See id*
[xii] *See* U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-12-687R, PLANNING AND FLEXIBILITY ARE KEY TO EFFECTIVELY DEPLOYING BROADBAND CONDUIT THROUGH FEDERAL HIGHWAY PROJECTS 7 (2012), https://www.gao.gov/assets/600/591928.pdf
[xiii] *See* MASS. DEP'T OF TRANSP., MASSDOT UTILITY ACCOMMODATION POLICY 10 (2013), https://www.mass.gov/doc/utility-accommodation-policy-0/download (defining a "co-locator" as "[a]n individual, corporation, government agency, or entity such as a telecommunications service provider leasing or licensing space . . . within a wireline telecommunications conduit owned by [a] tenant. The co-locator is subject to rent and other provisions set forth by the sublease agreement or the license agreement. Co-locator is synonymous with subtenant and licensee.").
[xiv] 116J.39-116J.40: Coordination of Broadband Infrastructure Development https://www.revisor.mn.gov/statutes/cite/116J.391
[xv] MINN. OFFICE OF BROADBAND DEV., ANNUAL REPORT 16 (Jan. 15, 2020), https://mn.gov/deed/assets/broadband-annual-report-2020_tcm1045-416256.pdf.
[xvi] R907-64. Longitudinal and Wireless Access to Interstate System Rights-of-Way for Installation of Telecommunication Facilities; Section 72-7-108
[xvii] *See* UTAH ADMIN. CODE r.907-64-5(3
[xviii] UTAH BROADBAND ADVISORY COUNCIL, UTAH BROADBAND PLAN 8 (Jan. 14, 2020), https://broadband.utah.gov/wp-content/uploads/2020/02/Utah-Broadband-Advisory-Council-Plan-2020.pdf.
[xix] Letter from FHWA Administrator Mendez to State Departments Of Transportation, Aug. 20, 2013 https://www.fhwa.dot.gov/policy/otps/letter_admin.cfm