March 22, 2021

Docket Management Facility,
U.S. Department of Transportation,
1200 New Jersey Avenue SE,
West Building Ground Floor,
Room W12-140,
Washington, DC 20590-0001

Re: Comments of the Fiber Optic Sensing Association to the Office of the Secretary (OST), U.S. Department of Transportation (DOT) on the document, Automated Vehicles Comprehensive Plan (Comprehensive Plan). Docket No. DOT-OST-2021-0005.[i]

Dear Secretary Buttigieg:

The Fiber Optic Sensing Association ("FOSA") appreciates the opportunity to submit comments to the Office of the Secretary, U.S. Department of Transportation (DOT), on the document, Automated Vehicles Comprehensive Plan (Comprehensive Plan). [Docket No. DOT-OST-2021-0005; FR Doc. 2021-01115 Filed 1-19-21].

Founded in 2017, the Fiber Optic Sensing Association (FOSA) is a non-profit organization to educate industry, government, and the public on the benefits of fiber optic sensing technologies that enhance public safety, promote the security of critical facilities and infrastructure and protect the environment. Our members include organizations that manufacture, install, test, evaluate, support, and use fiber optic sensing systems and equipment.[ii]

FOSA commends the DOT for its forward-thinking identification of the necessary steps required for working towards the safe and full integration of Automated Driving Systems (ADS) into the surface transportation system. Appropriately the Comprehensive Plan establishes Departmental goals related to ADS, identifies actions to meet those goals, and provides real-world examples of how these Departmental actions relate to emerging ADS applications. We welcome the opportunity to participate in and contribute to this conversation.

FOSA recommends the DOT establish and maintain metrics tracking the availability of "fiber enabled" interstate roadway. Future-proofing our nation's highways involves placing fiber optic cables along roads when the opportunity presents itself to do so economically. This will significantly lower future infrastructure upgrade costs. Among other benefits, it will support the build-out of 5G wireless networks due to the need for much higher antenna density and drive the installation of more additional broadband enabling fiber optic cables. FOSA further recommends that DOT track in a publicly available format the availability and location of "fiber enabled" interstate roadway. Such a forward-looking approach is a natural extension of DOT's existing "Dig Once" initiatives.

I. What is Distributed Fiber Optic Sensing (DFOS)?

Distributed fiber optic sensing (DFOS) systems are sensor technologies used worldwide to monitor infrastructure constantly and consistently. Applications include roads, bridges, railways, pipelines, power stations, terrestrial and subsea power cables, international borders, critical infrastructure, and telecom networks. DFOS systems connect laser interrogator units (IUs) to a fiber optic cable converting the optical fiber to an array of distributed sensors. The fiber becomes the sensor when the interrogator units inject laser light into the fiber to detect events over very long distances.

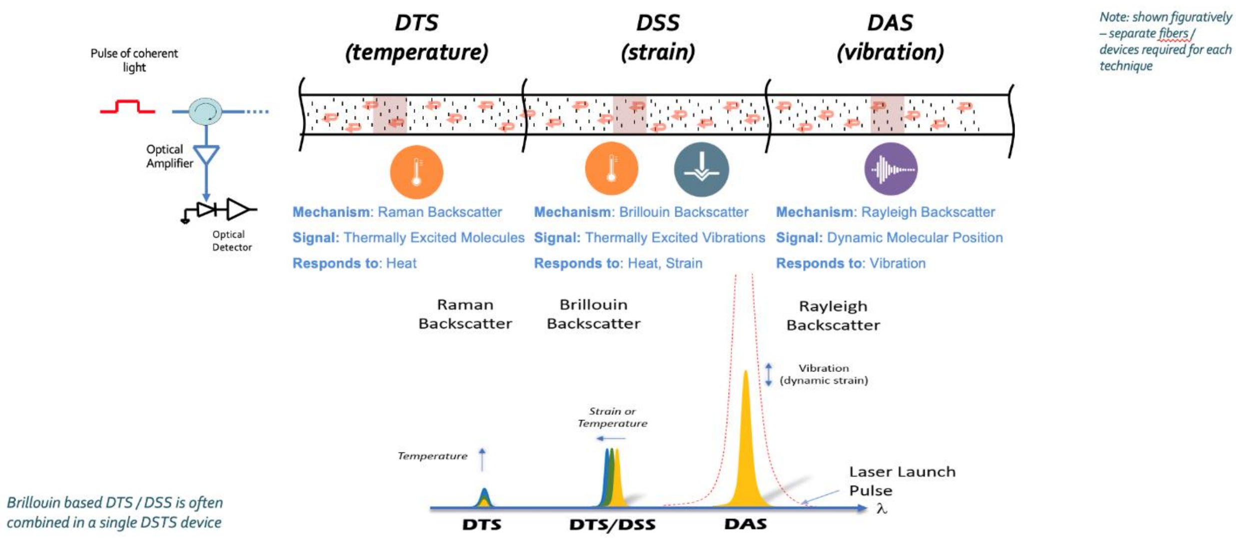
More specifically, DFOS systems consist of a fiber optic cable, IUs, and intelligent monitoring software. The IU pulses light around 10,000 times/second down the fiber optic cable. Changes in vibrations/acoustics, temperature, or strain at or near the fiber optic cable are identified and classified in real-time by intelligent monitoring software. The system's operator is alerted to what the event is and its precise location. These technologies can often span hundreds of miles and provide real-time readings at roughly 3-foot (1 meter) intervals along the entire span.

There are three basic types of DFOS systems:

1. Distributed Acoustic Sensing (DAS)
   DAS systems convert fiber optic cable into a series of thousands of sensitive microphones or vibration sensing locations. Various activities and events along assets can be listened to and tracked using specially developed algorithms. Detected events include vehicle and foot traffic, digging, excavation, tunneling, seismic activity, rockfalls, anchoring of ships, and landslides. DAS can also be used for asset condition monitoring by detecting events such as cable faults, broken rails, damaged rolling stock, pipeline liquid and gas leaks, and much more.

2. Distributed Temperature Sensing (DTS)
   DTS is a fiber-optic sensing technology for measuring temperature profiles along fiber-optic sensor cables installed near linear assets as well as on two- or three-dimensional objects. Significant applications of DTS are power cable and overhead line temperature monitoring, fire detection in fuel storage facilities, tunnels, and buildings, monitoring of industrial equipment such as ovens and reactors and oil and gas in-well production, as well as leak detection at pipelines and storage tanks.

3. Distributed Strain Sensing (DSS)
   DSS is a fiber optic sensing technology that measures changes in strain at any point along the length of a fiber optic cable. DSS is commonly used for monitoring large structures where changes in strain may be indicative of impending failure. Aging and modern infrastructure like bridges, tunnels, roadways, power cables, pipelines, dams, and levees are all assets that can benefit from DSS monitoring. Similarly, industrial process monitoring and pipeline deformations, tunneling, subsidence, and landslides can be detected by DSS measurements.



DFOS technology is not limited by line of sight or remote power access. It can be deployed in continuous lengths over hundreds of miles with closely spaced detection at every point along its path. Electricity is only required to power the interrogator equipment connected at the end of the system. Simultaneously, the fiber optic cable installed along the assets to be monitored is entirely passive, requiring no electricity, and immune to the effects of radiofrequency and electromagnetic interference. The technology can even use existing dark telecommunication fibers.

II. The DFOS Contribution to an Automated Vehicles Comprehensive Infrastructure

As more and more self-driving cars and autonomous vehicles take to the roads, infrastructure changes are necessary to accommodate their arrival safely. One of the most significant issues facing the industry is tracking autonomous vehicles' precise location in transit. At present, much of the tracking relies on GPS to provide location data. But GPS alone is not accurate enough for a self-driving car. GPS-enabled smartphones only have an accuracy of five meters under an open sky in dense urban environments. Cloud cover and tall buildings can significantly interfere with and affect the signal's clarity, reducing the trust accorded data.

Autonomous Vehicles

The aggregation of data points from multiple sources can enhance autonomous vehicle safety. By taking data captured from cameras, traffic lights, over-roadway sensors, and inductive loop detectors and combining it with the data from onboard sensors — which transmit position, acceleration, and speed to remote operating systems — a journey can be condensed into a singular viewpoint. All traffic generates acoustic or seismic data as it passes over roads, therefore, Distributed Acoustic Sensing (DAS) can easily add value to all autonomous vehicle monitoring. In contrast to these alternative sensing methods, DAS can sense continuously over every single point along a road’s entirety. Additionally, if using fiber optic of existing telecommunication infrastructure, DAS obviates the prohibitive deployment, maintenance, electrical power, and connectivity required of multitudes of those sensors.

DAS also can provide an independent audit of the autonomous vehicle position. Significantly DAS can look much further ahead and around bends, where the onboard sensors are blind and show the response of other road users to AV that shares the road with them. DAS also can potentially detect all the road users, whereas only some vehicles, bicycles, pedestrians or animals have GPS have GPS now. As such, DAS is a more socially equitable sensing modality, being in-line with the DOT's technology principle of enhancing mobility and accessibility.

DAS provides vehicle position information and detects the speed of all road users as well as noise related to accidents. This information could be helpful to slow down and redirect autonomous vehicles before approaching traffic jams and mitigate many crashes involving driver error, judgment, or other human-related causes. This follows the DOT's vision for ADS, i.e., transportation system efficiency and mobility and its highest priority – safety.

DAS can also detect pedestrians or animals' intrusion into speedways at every point along the entirety of roads and highways, i.e., not just at traffic light intersections. This follows the DOT's intended technology principles, i.e., protecting users and communities via prioritizing safety.

Several types of DFOS (DAS, DTS, DSS) can be further used to continuously monitor road conditions. Potholes, rockfall, subsidence, icing, and fire in tunnels can be detected and precisely localized in real-time. This information could be beneficial in further increasing the safety of autonomous driving.

Social value: The deployment of optical fibers by, for example, telecom providers can be inequitable, as telecom providers may be more motivated to deploy optical fibers to areas that are more likely to afford monthly service fees. However, optical fiber sensing can be a value add for telecom providers. As it relates to autonomous vehicles, the use of optical fiber sensing to enable autonomous vehicles can be dually used for telecom providers, bridging the digital divide and overcoming the disparity of optical fiber deployment.

Reliability: Autonomous vehicles will be enabled via 5G networks. Optical fibers will enable these networks. The reliability of 5G networks is inextricably intertwined with autonomous vehicles. Therefore, optical fiber sensing can increase the reliability of 5G networks, thereby increasing autonomous vehicles' reliability.

Privacy: A major issue with camera sensors is privacy. While cameras have advantages, they also present the prospect of privacy intrusions. Optical fiber sensing does not acquire personally identifiable information, such as faces. DAS, sensing the acoustic or vibrational changes generated by vehicles as they travel, does not collect data from cell phone, cameras, or other similar connected and potentially privacy-intrusive devices. As a result, DAS also conforms to the DOT's technology principles of ensuring privacy and data security, i.e., protecting driver, passenger, passive third party, and pedestrian data.

III. Dig Once

A. FOSA Supports DOT "Dig Once" Policies"

The Fiber Optic Sensing Association strongly supports DOT's Dig Once efforts. FOSA concurs with the FHWA's threshold conclusion in its Dig Once proceeding that: ..…" [i]t is in the public interest for utility facilities to use jointly the ROW of public roads and streets when such use and occupancy do not adversely affect highway or traffic safety, or otherwise impair the highway or its aesthetic quality, and does not conflict with Federal, State, or local laws and regulations."[iii] This statement also appropriately captures the Dig Once objectives contained in the Mobile Now Act.[iv]

At the most basic level, Dig Once reduces the number and scale of excavations along highway rights-of-way when installing telecommunications infrastructure. In effect, it applies the admonishment familiar to builders and carpenters to "Measure Twice, Cut Once." In the context of infrastructure construction, this advice reminds us to double-check in advance to avoid unnecessary waste later.

The potential benefits of a coordinated approach to conduit and fiber installation accrue to public agencies and participating private telecommunications providers and adjacent communities. A coordinated Dig Once initiative can also provide capacity for multiple separate service providers. Advantages include:

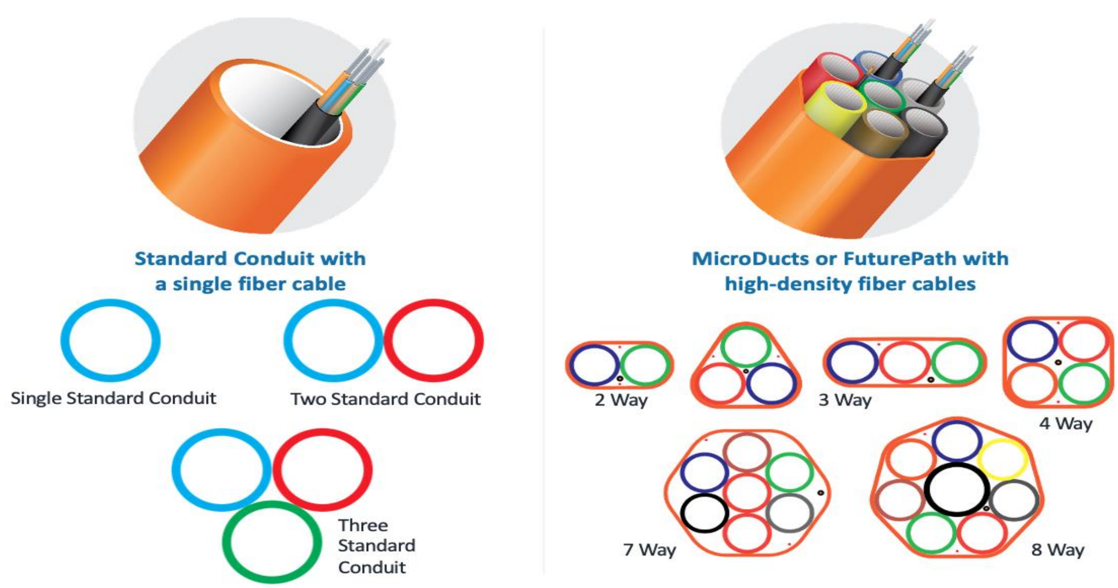
- Cost Savings—Reducing the frequency that transportation and utility channels are opened is approximately ten times cheaper than adding broadband infrastructure after these have already been built.[v] These savings are the most pronounced in high-density areas when underground installation is the only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

- Increased Access to and Reliability of Broadband Networks— Laying fiber in unserved areas gives residents access to broadband networks more quickly. Additionally, installing fiber for communities that already have broadband enhances network reliability and promotes broadband competition, which will lead to more choices and lower prices for consumers.
- 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 unserved communities by drawing businesses to the area.

We note that the presence of fiber optic cable, or even the availability of conduit, will facilitate emerging broadband applications, such as smart roads. As a result, Dig Once installations can help "future-proof" transportation arteries.

B. Conduit Use Recommended

FOSA strongly encourages Dig Once policies promoting using conduits to enable future fiber optic cable installation. Conduits are narrow pipes and initially need not contain fiber optic cable housed within them. However, fiber cable can be installed within these conduits either at the initial installation or at a future date. These conduits provide mechanical protection of the fiber cable, both during the installation of the fiber cable and over its entire life.



Typically, direct buried fiber cables require additional design enhancements to withstand environmental conditions, whereas a conduit can provide that environmental, tensile, and crush protection itself. The conduit itself is relatively inexpensive, so installing conduits for later use can save providers hundreds of thousands of dollars in construction costs.

Telecommunications providers, however, will sometimes only use cable and not conduits in their installations. If a local government is not familiar with engineering standards, it can contract with a provider to install conduits that others can use. In addition to installation, government agencies will need to work out responsibility for mapping the conduit and maintenance location. A service-level agreement or service-level management agreement can address these issues. By anticipating the future and installing conduits to furnish extra permanent pathways, networks can adapt to changes more quickly.

As the U.S. Government Accountability Office (GAO) has concluded, "For instance, if companies have access to a state-owned conduit, they may be able to deploy fiber through that conduit without completing steps such as environmental impact studies, which would have been completed at the time of conduit installation."[vi]

As GAO has further noted, "Officials in some localities also stated that access to locally owned conduit has reduced local government telecommunications costs. Second, some officials stated that a dig once policy might lead to decreases in broadband prices and/or increased broadband performance for consumers because of potentially increased competition resulting from the availability of conduit open to all broadband providers. Third, officials in some localities, as well as industry stakeholders, stated that increased access to broadband benefits existing businesses and could draw new businesses to the area, both of which could increase local economic activity."[vii]

To promote a better understanding of the issues and considerations associated with "Dig Once," our association has developed three documents:

- **FOSA DIG ONCE PRIMER** (Attachment 1)[viii]
- **DIG ONCE POLICY: 16 STATE MODELS** (Attachment 2**)**[ix]
- **FOSA – DFOS Installation Considerations for Highways** (Attachment 3)[x]

IV. Conclusion

Our association welcomes the opportunity to work supportively with the Department of Transportation, the Federal Highway Administration, and state & local transportation agencies toward the safe and full integration of Automated Driving Systems (ADS) into the surface transportation system.

As noted above, FOSA supports Dig Once policies to reduce the number and scale of excavations along highway rights-of-way. Beyond this, though, Dig Once policies can expand the availability of broadband telecommunications. Additionally, it can further future-proof transportation infrastructure's access to advanced intelligent transportation and smart city applications. Beyond this, FOSA recommends that DOT establish and maintain metrics in a publicly accessible format tracking the availability and location of "fiber enabled" interstate roadway.

Sincerely,

/s/ Mark Uncapher

Mark Uncapher,
Executive Director

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[i] Request for Comments on the Automated Vehicles Comprehensive Plan document, Federal Register: 2021-01115. RIN: N/A. Docket Number: DOT-OST-2021-0005

[ii] For more information about the Fiber Optic Sensing Association, see https://www.fiberopticsensing.org/

[iii] NPRM at 85 FR 49329

[iv] The Consolidated Appropriations Act, 2018 (Pub. L. 115-141), Division P, Title VII ("MOBILE NOW Act"), Section 607, Broadband Infrastructure Deployment (47 U.S.C. 1504)

[v] https://www.fhwa.dot.gov/policy/otps/workplan.cfm

[vi] United States Government Accountability Office, Broadband Conduit Deployment, June 27, 2012, GAO-12-687R, at https://www.gao.gov/assets/600/591928.pdf

[vii] Ibid

[viii] On the FOSA website at https://www.fiberopticsensing.org/p/cm/ld/fid=726&tid=357&sid=3216

[ix] On the FOSA website at: https://www.fiberopticsensing.org/p/cm/ld/fid=726&tid=357&sid=3217

[x] On the FOSA website at: https://www.fiberopticsensing.org/p/cm/ld/fid=836&tid=358&sid=2885