UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING

COLLABORATION WORKSHOP

NATIONAL ENERGY TECHNOLOGY LABORATORY

Dr. Paul Dickinson is an industry leader with over 35 years of expertise in materials technology, optical fiber and cable, conduit pathway infrastructure, and distributed fiber sensing technology. As the Founder and Principal of Smart Infrastructure Solutions, Paul provides strategic consulting services to the industry and is a leading spokesperson for innovative infrastructure. Additionally, Paul serves as both Chairman of the Advisory Council and as a Board member for the Fiber Optic Sensing Association (FOSA), as well as an Advisory Council Member for the Alliance for Innovation and Infrastructure, while holding memberships across multiple other infrastructure-specific trade organizations where he advocates for advanced infrastructure technology. Previous roles include significant positions at Dura-Line, OFS, Lucent Technologies, and AT&T Bell Labs, and Chairman of the Board of FOSA. Paul holds a BS in Chemistry from Cornell University and a PhD in Polymer Science from the University of Connecticut.

Panel on Distributed Fiber Optics and Infrastructure

June 1-2: Energy Innovation Center, Pittsburgh PA

Paul Dickinson, PhD

Founder and Principal – Smart Infrastructure Solutions

Board Member and Chair of Advisory Council – Fiber Optic Sensing Association

Advisory Council Member – Alliance for Innovation and Infrastructure

Smart Infrastructure Solutions, LLC

FOSA Fiber Optic Sensing Association Connect and Protect

Aii

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Organization and Committee Memberships

- Fiber Broadband Association (FBA - Telecom)
- Edison Electric Institute (EEI - Power)
- Intelligent Transportation Society of America (ITS America - Transportation)
- Association for Computer Operations Management (AFCOM – Data Centers)
- Common Ground Alliance (CGA – Infrastructure Damage Prevention)

Smart Infrastructure Solutions, LLC

Why FOSA Matters to UPISC & the Industry

- A non-profit industry association formed in 2017 in Washington D.C.
- All things Fiber Optic Sensing
- Raising Awareness and driving adoption
  - Technology Webinars
  - Advancing Public Policy
  - Education Webinars
  - Speaking Engagements
  - Promotion of FOSA Members
- Global membership - open to those who invent, develop, make, install, support and use distributed/quasi-distributed fiber optic sensors
- Hands-on, share your voice - members organize, manage, and collaborate regularly

FOSA Members – June 2026

APSENSING.

Berkeley UNIVERSITY OF CALIFORNIA

CLEARFIELD

CORNING

Fiber Optic Sensing Association
Connect and Protect

dura-line
An Orbia business.

EOSS

ETH zürich

FEBUS optics

Fiberflux

FOSINA
Sense the World

GoFoton

hifi

LUNA

NBG
Safeguarding Critical Infrastructure

Network Integrity SYSTEMS
We Bring Security To Light™

NODE●LOGY

NOVACOMM
Connecting the Globe

OZ Optics LIMITED
OZ Optics

prysmian

samm teknoloji

SENSONIC

SINTELA

Texas 811

TU Graz
Graz University of Technology

verizon

VIAVI

Consultant Members

ACI MONITORING
Advanced Civil Infrastructure Monitoring GmbH

CAROLINA UTILITY CONSULTING

Eastplace Consultants

INDEXIMATE

Lumetec.

optical strategies℠
navigate the maze℠

PROP SYSTEMS
PREDICTING RUPTURES ON OPERATING PIPELINE SYSTEMS

verityaptus

FOSA Advisory Council

Elite Expertise Driving Innovation Forward

The newly formed Advisory Council brings together industry leaders with deep expertise across emerging critical infrastructure sectors: **Telecom, Power, Pipelines, Transportation**

Chair – Paul Dickinson

- **Mark Boxer** – Technical Manager, Lightera; Board Member, Fiber Broadband Association
- **Kyle Coggins** – Director, Damage Prevention & Line Locating, CenterPoint Energy
- **Scott Kotrla** – Fellow in Optical Transport Planning, Verizon
- **Arie Makovoz** – Transmission Line Engineering Department Manager, Consolidated Edison of NY
- **Shane Siebenaler** – Manager Fluid Dynamics, Southwest Research Institute
- **Lynne Yocum** – Fiber Optic Director, Utah Department of Transportation

The Modern Phone Analogy

What if your optical fiber network could do more than communication and connection?

IT ALL BEGINS WITH AWARENESS

- Description of DFOS and use cases
- Concept of multi-use infrastructure corridor monitoring with collocated fiber
- Critical need to enhance overall U.S. infrastructure resilience and security
- Public policy next step suggestions

LANDING PAGE LINK **DIRECT TO WHITE PAPER**

Protect, Monetize, Optimize: An Introduction to Distributed Fiber Optic Sensing for Fiber Network Operators

FBA | ACADEMY

PRESENTATION BY:

Mark Boxer – Technical Manager Solutions and Applications Engineering – Lightera

Paul Dickinson, PhD – Strategic Business Consultant for Dura-Line and Founder and Principal – Smart Infrastructure Solutions

White Landing Page Link

Webinar Link

Protecting the Infrastructure Powering the Digital World

Smart Infrastructure Solutions, LLC

Using DFOS to Detect Threats Before They Become Downtime

AFCOM VIRTUAL COMMITTEE MEETING

MAY 14, 2026

MAY 14, 2026

Paul Dickinson, PhD

Strategic Business Consultant for Dura-Line and

Founder and Principal – Smart Infrastructure Solutions

AGENDA FOR UPISC PANEL OVERVIEW – SETTING THE STAGE

- What is distributed fiber optic sensing?
- What are the inter-vertical driving forces for more sensing?
- What are the hurdles or pushbacks for scaling now?
- What are technical companies and organizations doing to overcome them?
- Where do we see emerging market adoption occurring next and how?
- What can we collectively do to move technical adoption forward?

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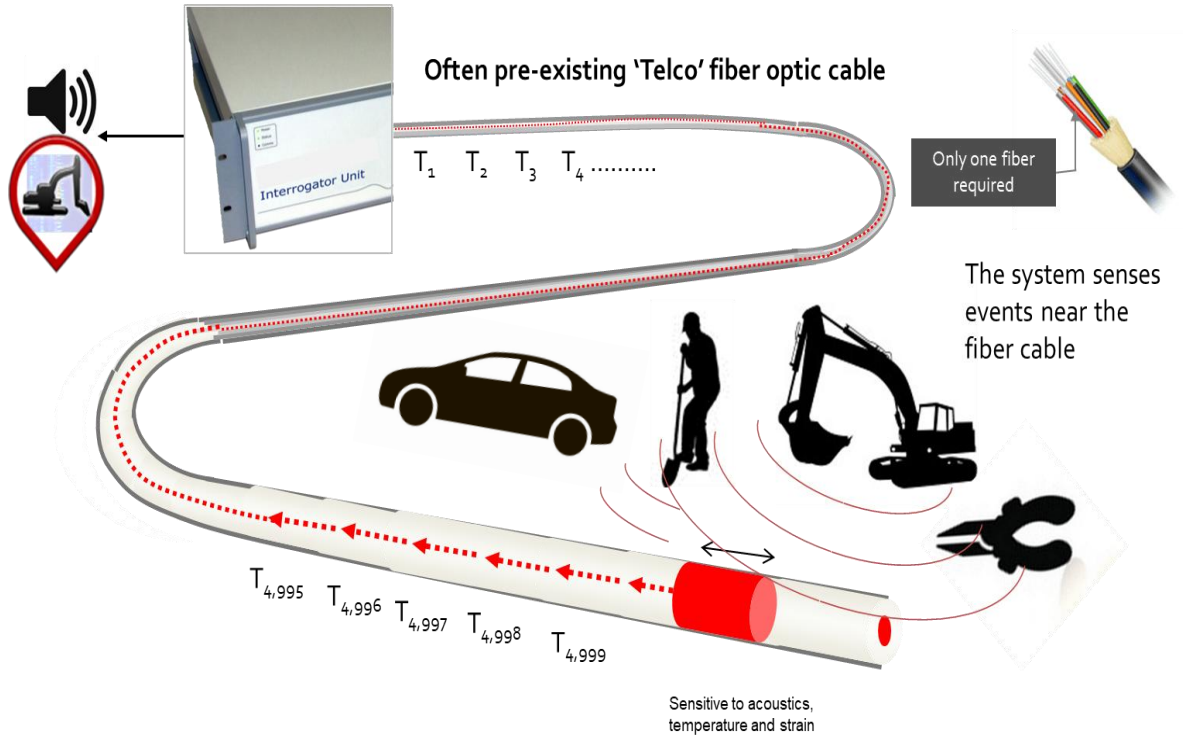
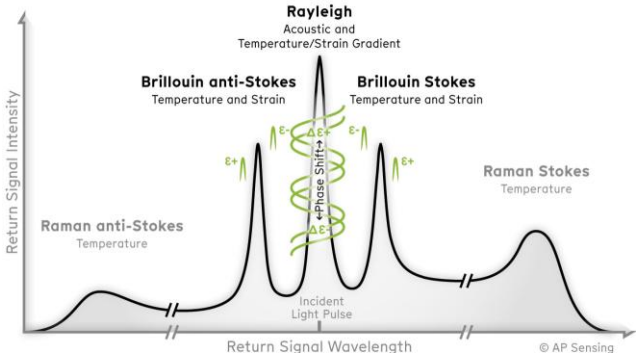
How DFOS Technology Works

THE TECHNICAL FOUNDATION

Optical fiber doubles as a continuous distributed sensor.

- Transmits high-frequency light pulses through a single fiber, many times per second
- Monitors tens of kilometers at meter-level spatial resolution, continuously and in real time
- Analyzes backscattered light to detect vibration, strain, and temperature changes along the fiber
- Applies AI-driven signal processing to automatically identify and classify events along the right-of-way
- Delivers geo-referenced alerts directly to operator dashboards via integrated GIS
- Converts continuous environmental data into actionable intelligence for rapid field response





Continuous + comprehensive + real-time monitoring

Why Existing Tools are Not Enough

- Traditional OTDR-style fiber monitoring often detects issues only after attenuation has already changed, meaning damage may already be occurring or done.
- Current methods such as cameras, point sensors, aerial/ground patrols, and smart PIGs each provide value, but they are either sparse, periodic, or reactive.
- The gap is continuous, real-time, long-distance coverage between point instruments and periodic inspections.

Existing Technology Combined with DFOS Solution:
Continuous + Comprehensive + Real-Time monitoring along every meter

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A Hidden Infrastructure System Under Growing Strain

Beneath our feet and above our heads runs more than 10.9 million miles of critical U.S. infrastructure — pipelines, power lines, water systems — largely invisible, aging rapidly, and essential to modern life.

United States:

Oil & Gas Pipelines: 3.4M miles

Electrical Grid: 6.0-6.2M miles

Water/Wastewater: 2M+ miles

Railroad Track: 140,000 miles

Bridges: 623,000 structures

Total: ~10.9 million miles (18M km)

Global:

Oil & Gas Pipelines: 2.17M miles (3.5M km)

Electrical Grid: 53M miles (*86M km)

Total: ~55 million miles (~90M km)

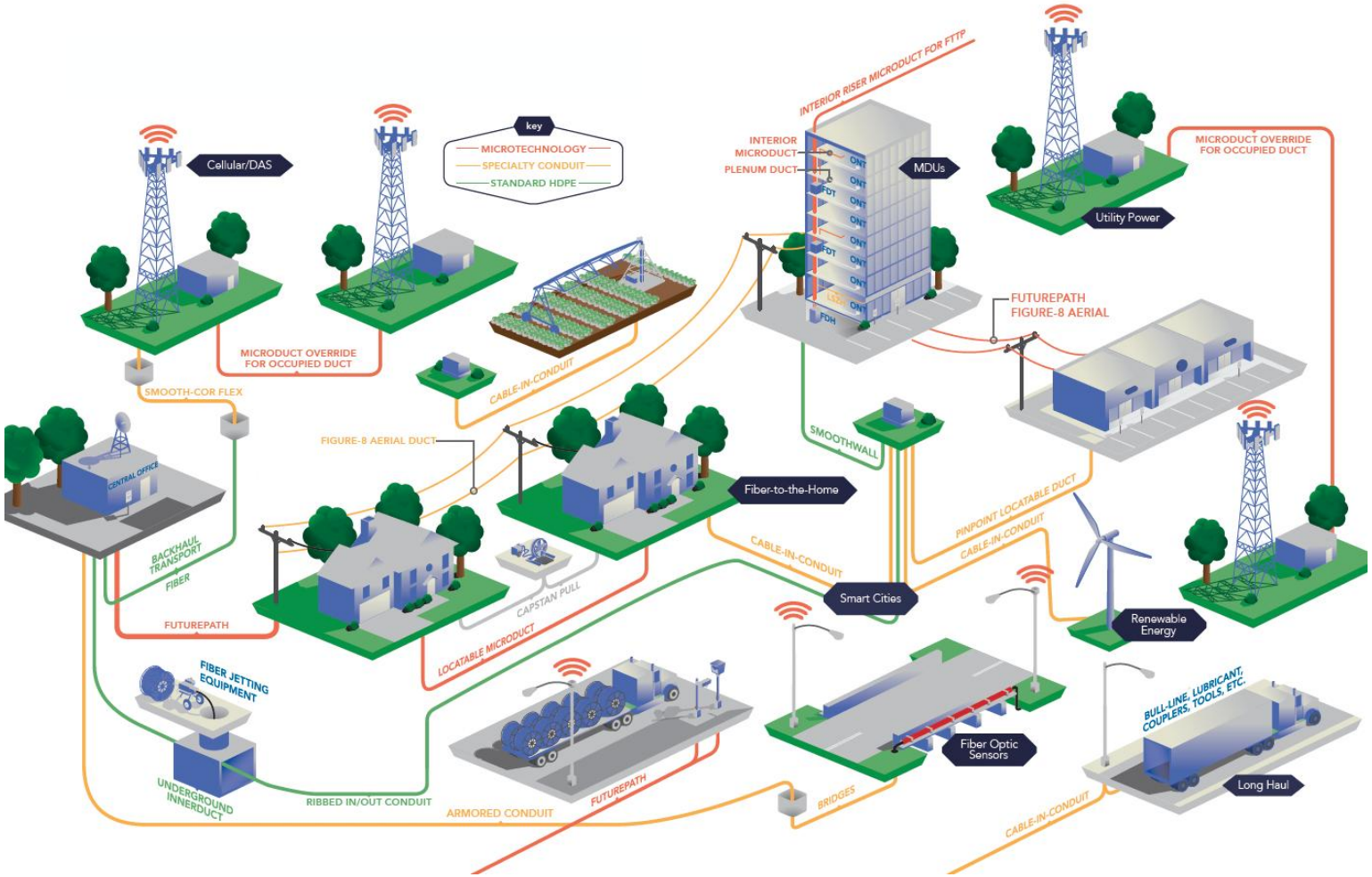
- PHMSA Annual Reports 2024 | EIA U.S. Energy Infrastructure | ASCE 2025 Infrastructure Report Card
- Pipekom Global Pipeline Database | [PMC Nature Journal 2023
- * IEA/Rystad claims ~80-86M km

The Aging Crisis: Infrastructure Beyond Design Life

Infrastructure Type	% Over 50 Years	Average Age	Design Life
U.S. Oil & Gas Pipelines	55-60% (built pre-1970)	45-50 years	50-80 years
U.S. Electrical Transmission	70% over 25 yrs	40-50 years	40-60 years
U.S. Water/Wastewater	20% beyond useful life	45 years	75-100 years
U.S. Bridges	42% are 50+ yrs	Varies	*50-75 years
European Pipelines	Majority pre-1980	40 years	50-80 years

EGIG 12th Report 2024 | CONCAWE Performance Report 2022 | PHMSA Data | ASCE 2021
* 45% over 50 years per ASCE 2025

Conduit Pathways and Fiber Cable are Everywhere



Broadband, Datacom, Wireless Backhaul, SCADA, FTTH…

Vulnerability is Rising as Infrastructure Expansion Accelerates

- U.S. pipeline incidents total 600–700 per year; third-party intrusion and natural forces account for a preventable share — earlier warning could reduce damage.
- AI and data center growth are placing new demands on power systems, data center interconnect routes, and transmission build-out.
- The grid, telecom backbone, and utility corridors must simultaneously expand capacity and improve reliability and security.
- **Underground excavation costs the U.S. more than $30 billion annually in direct and indirect damages — and that figure will grow as build rates accelerate.**

We are operating a 20th-century infrastructure network under 21st-century demands

DFOS Creates Value Across Every Infrastructure Sector

Multiple Vertical Markets

Optical fiber doubles as a continuous distributed sensor.

Telecom: dig-up prevention, route security, break localization, faster repair, service assurance, and spare-fiber monetization

Power utilities: cable temperature monitoring, vibration detection, fault precursors, thermal runaway prevention, and enhanced grid resilience

Pipelines(gas/oil/water): leak detection, third-party intrusion detection, right-of-way monitoring, reduced incident exposure, and compliance support.

Transportation and structures: roads, rail, tunnels, bridges, dams - traffic insight, structural health monitoring, unauthorized access detection.

Design New Build for BOTH Communication and DFOS to Maximize ROI

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Vertical Market Business Cases have not been Articulated

- The sensing industry has not fully articulated the value proposition to end users or enablers
- Different value prop for vertical markets
  - Broadband providers, ROW owners, utilities…
  - Modeling is in progress via FOSA
- Interrogators are expensive, but price is falling
  - Multi-port and optical switching can spread costs on a wider network base

What is it worth to end users for outage reduction, opex savings, and enhanced safety?

Component Selections & Proximity Matter

- Range and sensitivity can vary greatly
  - Interrogator specs, fiber and cable type, deployment environment, proximity to asset
- We've spent decades isolating fibers from the environment. Sensing requires the opposite
  - Conduit, Gel-free, Gel-filled, Tight buffer…
- Conventional telecom fiber will work in most use cases
  - Engineered & enhanced backscattered fibers can significantly improve sensitivity if required
- Dedicated fibers vs. wavelength channels

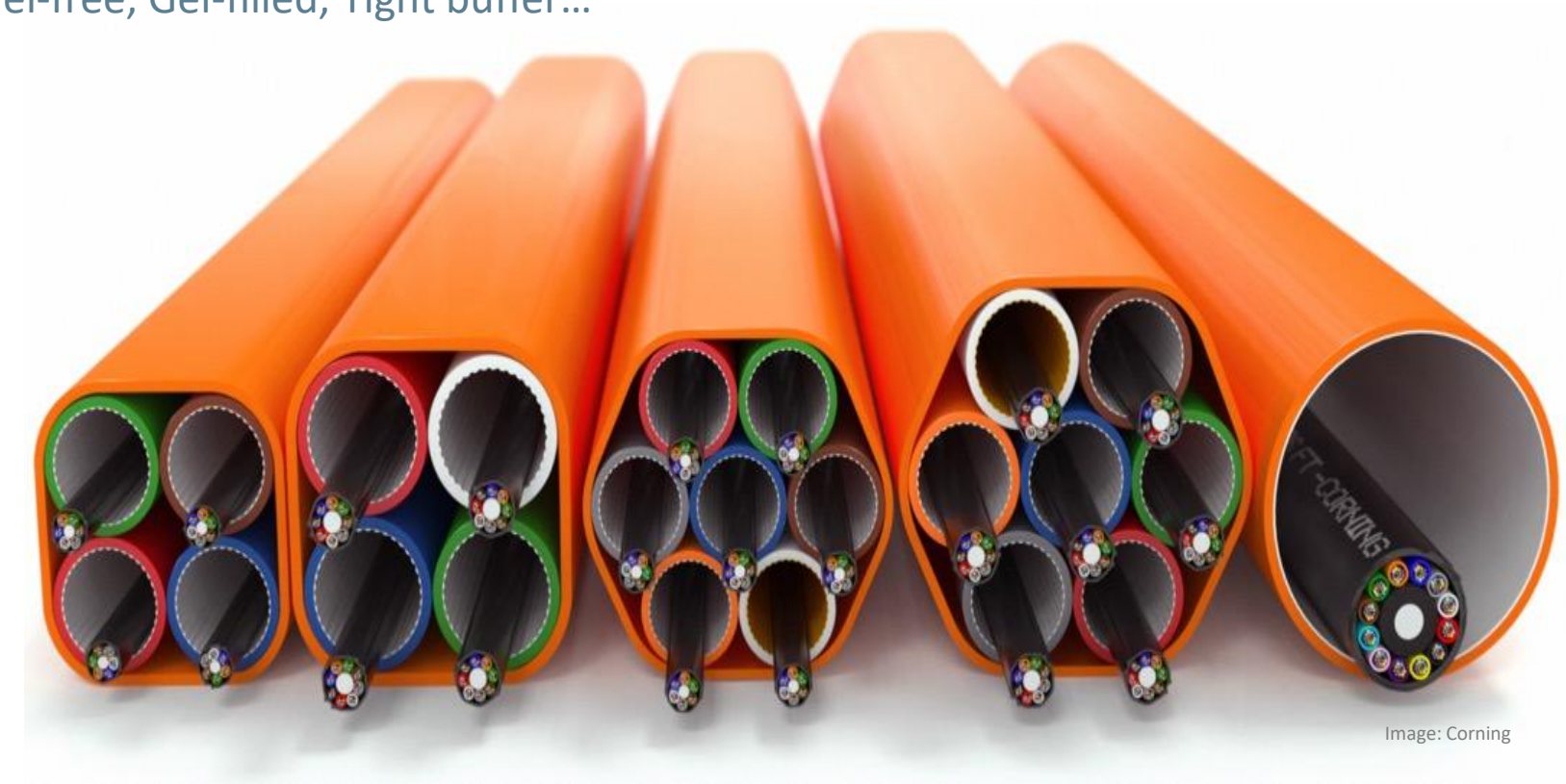
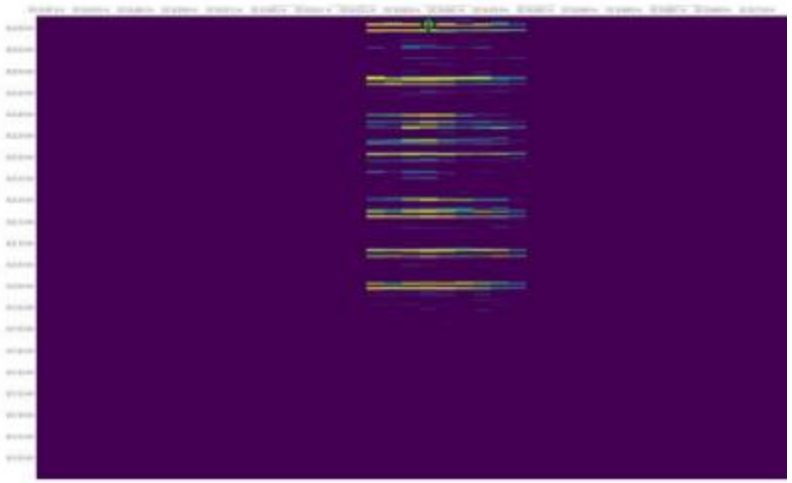


Image: Corning

Interoperability and Standardization

- Currently no standardization or universal event libraries
  - Tech vendors have unique and proprietary approaches
- AI can help us scale rapidly with broader scale deployment
  - Tech vendors have unique classification methodologies
- Can generate terabytes of data, depending on application
  - Actionable insights are less data intensive
  - Longitudinal analysis requires dealing with data



Waterfall diagram of raw signal data, paired with an alarm management tool that transforms it into actionable intelligence for technician response. (Courtesy of Network Integrity Systems)

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Why This Matters Now for Brownfield and Greenfield - The Current Data Center Catalyst

INFRASTRUCTURE UNDER PRESSURE

Data centers are being built faster than at any time since the rural electrification era — on top of an aging infrastructure base.

- 10M+ miles of critical underground infrastructure in the U.S. — pipelines, power, water — largely invisible and increasingly stressed
- 70% of U.S. electrical transmission is over 25 years old, much of it is past design life
- AI-driven data center power demand: ~860 TWh (2025) → ~1,587 TWh (2030) — an 85% increase
- U.S. data centers will account for ~50 GW of new power capacity needed by 2030 — half of all new build

AI is forcing a physical rewiring of the grid at a pace not seen in decades.

Data Center Infrastructure Is Under Constant Threat

THE STAKES

- Accidental excavation damage
- Environmental impact
- Security breaches
- Increasing operational complexity

> ***Outages don't just start at the server — they often start in the infrastructure.***

The Cost of Doing Nothing

VULNERABILITY IS RISING

More infrastructure being built faster, monitored less.

- $30B+ per year in U.S. damages from underground excavation hitting adjacent utilities
- 600–700 pipeline incidents per year in the U.S. — many from third-party intrusion or natural forces
- Telecom backbones expected to scale faster while remaining more reliable and secure

Each unprotected fiber route remains a single point of failure for the network it carries

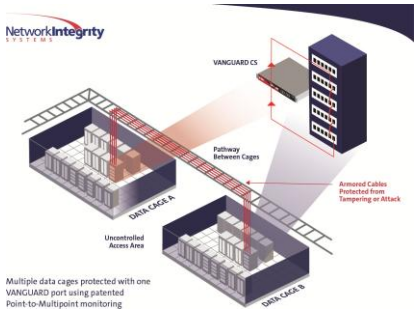
We are operating 20th-century infrastructure under 21st-century demands.

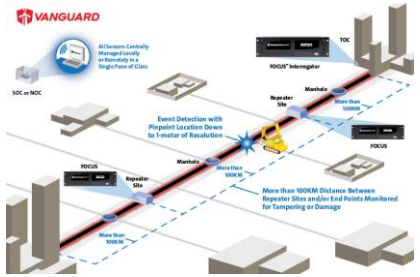
Data Center Vertical Market Example: From DFOS to Complete Infrastructure Protection

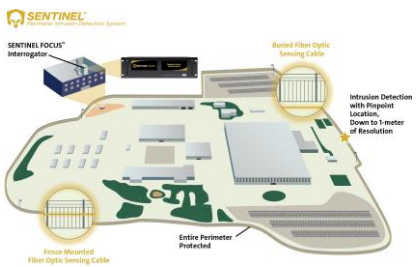
EXTENDING THE POWER OF FIBER SENSING

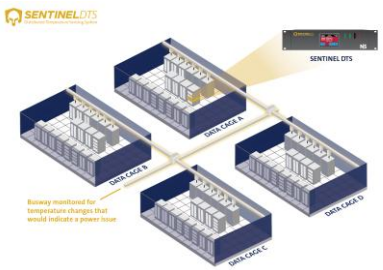
Distributed Fiber Optic Sensing (DFOS) *transforms existing fiber into a real-time sensing layer — providing continuous visibility across your infrastructure.*

Companies like Network Integrity Systems (NIS) build on that foundation to deliver broader FOS protection of everything that impacts uptime:









1 **Data networks between cages (LAN networks)**

Detect cuts, taps, and tampering along fiber paths

2 **Data Center Interconnect (Long-haul infrastructure)**

Protect interconnects and long-haul network infrastructure

3 **Perimeters around data centers and cages**

Detect climbing, cutting, tunneling, and approach or a perimeter

4 **Access points such as pull boxes, cabinets or manholes**

Monitor manholes, pull boxes, cabinets (verified open/close state)

5 **Busbars and other power Infrastructure**

Continuous temperature monitoring of bus bars and electrical pathways

Built for Real-World Environments

FIBER SENSING, DESIGNED FOR REAL OPERATIONS

- No power in the field
- No batteries, no active electronics outside
- Minimal hardware footprint
- Centralized intelligence
- Massive coverage (inside + outside plant)
- Reduced manpower requirements
- Works on existing standard fiber

Less infrastructure to maintain. More infrastructure protected.

Industry Adoption Is Accelerating

PROVEN AT SCALE

Distributed fiber optic sensing is moving from pilot to broader adoption across multiple sectors.

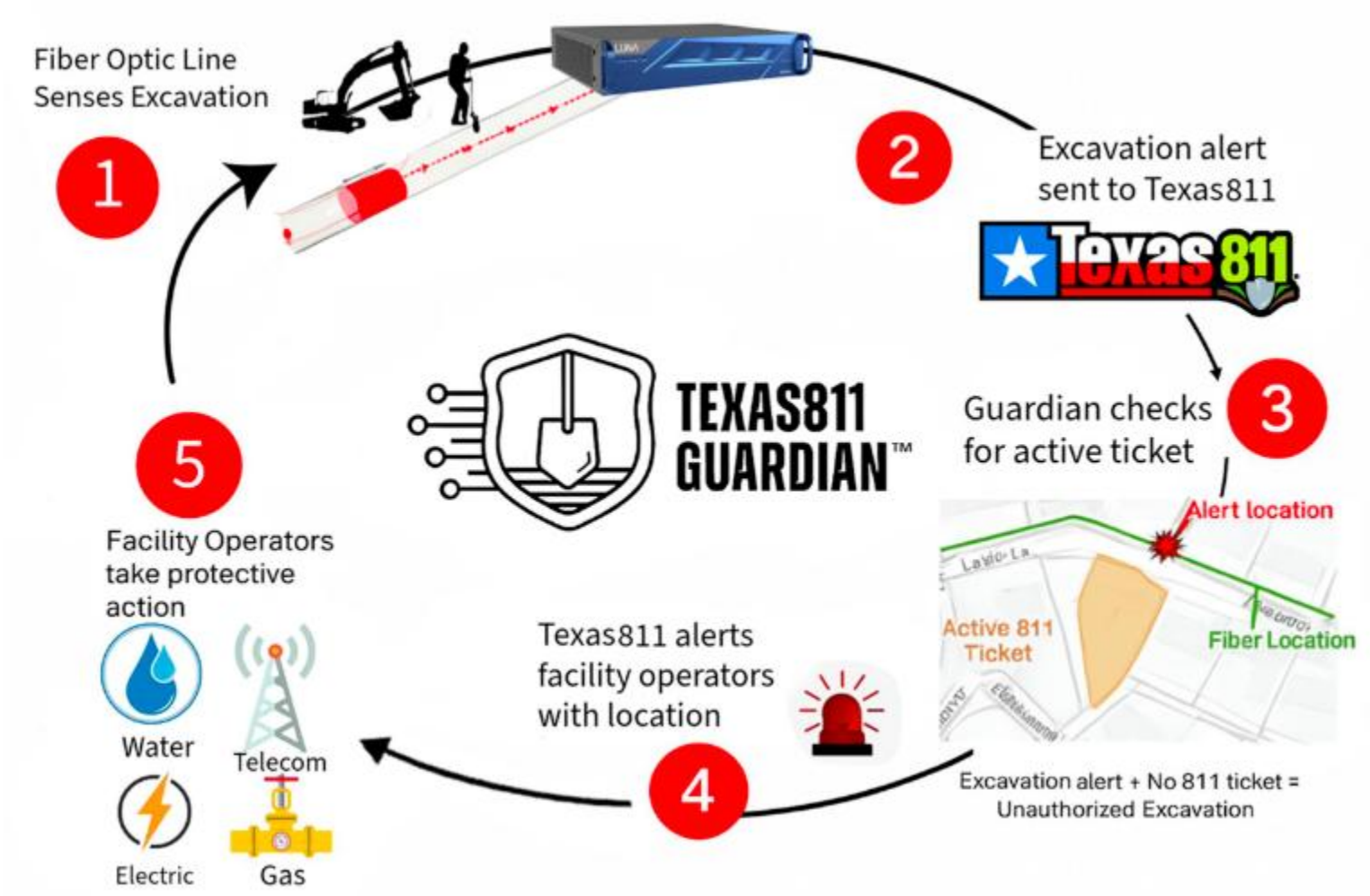
- Texas 811 Guardian Program — statewide damage prevention initiative linking event classification to network providers
- Fiber Optic Sensing Association (FOSA) — driving 2026 standardization and ROI valuation across vendors
- Increasing adoption by municipalities and right-of-way owners seeking secure multi-use routes
- Used in U.S. government and high-security environments for 20+ years
- Trusted by hyperscalers and mission-critical operators protecting data center infrastructure

From security pilot to standard infrastructure practice.

How the TX 811 Guardian System Works

- Texas811 Guardian receives the alert of excavation activity and immediately queries the active 811 ticket database
- If no active one-call ticket is found, email and text alerts are sent to members so resources can be deployed.

Texas 811 Guardian: End-to-End Workflow



Revenue Opportunities for Network Providers

Multiple proven business models enable network providers to monetize DFOS. Here are a few.

- **Fiber Sensing as a Service (FSaaS):** Fiber provider deploys DFOS to protect its own network AND sells sensing-as-a-service to adjacent asset owners — generating a new, recurring revenue stream
- **Utility-Owned**: Asset operator procures interrogator hardware, software, and managed service directly
- **ROW-Owner Model**: Right-of-way owner procures and manages the full sensing stack for their corridor

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The Call to Action: What Happens Next?

The Infrastructure Reality

- 10M miles aging U.S infrastructure
- 1.5-1.7 PHMSA pipeline incidents/day
- Unprecedented AI-driven growth

The Technology Reality

- DFOS proven at scale (BRUA 800 km)
- Business cases will work today
- 25-40% fiber adjacency (transmission)*

The FOSA Contribution

- Increase value to fiber network
- Reduce risks
- Encourage regulatory compliance

Your Role:

Asset Owners & Fiber Providers:

✓ Assess high-consequence corridors
✓ Map fiber assets (fiber adjacency)
✓ Pilot 20-50 km deployment
✓ Engage and/or join FOSA
✓ Design in conduit & fiber near assets
✓ Help with fiber-to-asset co-location

Technology Providers:

✓ Refine business case tools
✓ Build reference customers
✓ Partner across value chain
✓ Engage and/or join FOSA

Regulators/Policymakers:

✓ Recognize DFOS in regulations
✓ Incentivize deployment
✓ Mandate fiber in funded projects
✓ Incentivize conduit near assets

The opportunity is now. Let's refine the business cases.
Then let's seize the opportunity.

- *The extent and type of the use cases will depend on proximity within the right-of-way of the conduit and fiber cable (e.g. leak detection, DTS)

Implementing and Preparing for the Future Today

- **Existing Infrastructure**
  - Partner with utilities and one-call facilitators like Texas 811 to map existing fiber routes against high-criticality utility rights-of-way (power, gas, water).
  - Identify viable FSaaS business opportunities where fiber is co-located with critical assets.
- **New Infrastructure**
  - Apply an enhanced "Dig Once" strategy — co-design conduit & fiber route locations alongside new utility infrastructure builds to maximize DFOS readiness and long-term FSaaS positioning.
- **Get Engaged Now**
  - Work within your vertical market orgs. Contact the Fiber Optic Sensing Association. Schedule demonstrations. Participate in the 2026 standardization process and ROI framework development.
  - Do the business case.

Summary: Unlocking Fiber's Full Potential

1. **Elevated Perspective:** Recognize fiber as a multi-modal infrastructure platform, not single-purpose for communications alone.
2. **Early Integration:** Incorporate DFOS design principles into new fiber builds and significant augmentations to existing networks. "Dig Once" takes on an additional meaning when enabling conduit and fiber cable to be in a location to provide additional value.
3. **Business Model Innovation:** Develop FSaaS and asset-sharing approaches that distribute costs and multiply revenue streams across stakeholder communities.
4. **Data-Driven Operations:** Deploy predictive analytics on continuous monitoring data to shift asset management from reactive to proactive.
5. **Resilience Investment:** Leverage sensing capabilities to build more resilient, adaptable infrastructure networks capable of supporting future technologies and applications not yet conceived

Thank You

Smart Infrastructure Solutions, LLC

Paul Dickinson, PhD

Founder & Principal – Smart Infrastructure Solutions

Contact Info

pdickinson@smartinfrastructuresolutions.biz

Fiber Optic Sensing Association (FOSA)

Alliance for Innovation and Infrastrucuture (Aii)