# Standardization of Distributed Fiber Optic Sensing System for Terrestrial Optical Networks
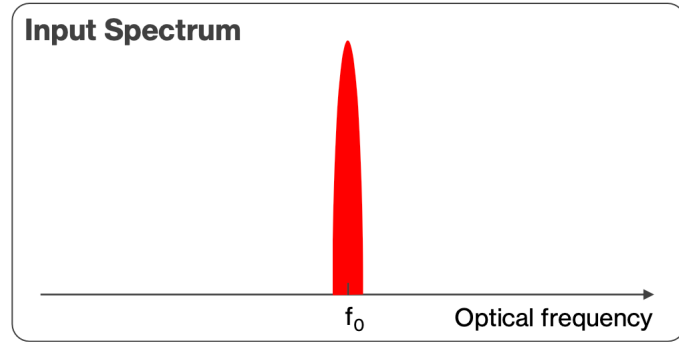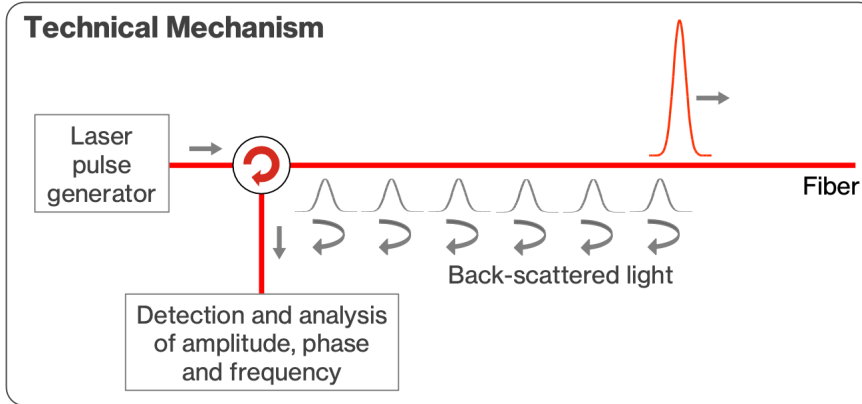
**OFC**

**Panel:**

**F5G Intelligent and Green Networks towards 2030**

Jun Shan Wey, TJ Xia, Glenn Wellbrock

Verizon Communications

26 March 2024. San Diego, CA

# Distributed fiber optic sensing (DFOS) is a well-known technology

**Technical Mechanism**

Laser pulse generator → Fiber

Back-scattered light

Detection and analysis of amplitude, phase and frequency

**Input Spectrum**

$f_0$ — Optical frequency

**Functions of Back-Scattered Light Detection**

*Rayleigh for acoustic effects (and vibration)*

*Raman for temperature*

*Brillouin for strain and temperature*

$f_{R-}$    $f_{B-}$    $f_0$    $f_{B+}$    $f_{R+}$

| Type of Back-Scattering | Frequency Characteristics | Sensitive to |
|---|---|---|
| Rayleigh | No frequency shift | Acoustic effects (and vibration) |
| Brillouin | Small frequency shifts | Strain, Temperature |
| Raman | Large frequency shifts | Temperature |
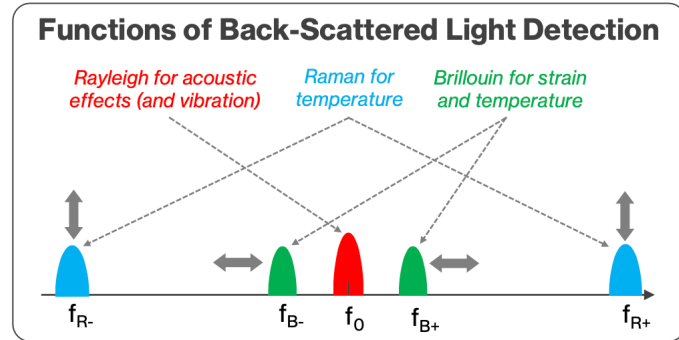
# Network reliability and operational efficiency are the foundation for F5G-Advanced applications.

# DFOS plays a pivotal role.

J. S. Wey, T.J. Xia, G. Wellbrock, "Standardization of Distributed Fiber Optic Sensing System for Terrestrial Optical Networks", F5G Panel, OFC 2024
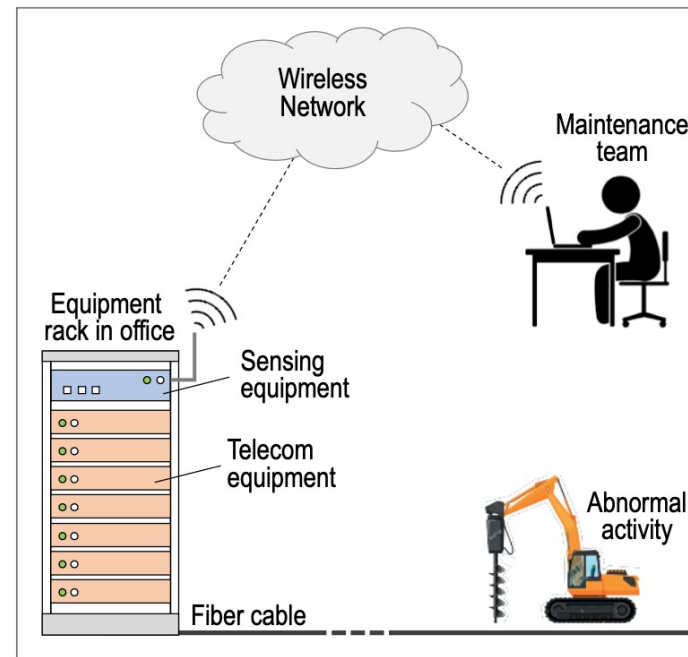
# DFOS for telecom fiber network

**Improve network reliability & operational efficiency**

- Monitor abnormal activities to prevent damages to fiber networks
- Identify specific fiber and cable
- Map geolocations accurately along fiber cable routes

**Future services**

- Motor traffic monitoring
- Intrusion detection
- Smart city applications



Source: G. Wellbrock and T. J. Xia, "Distributed Fiber Sensing Applications for Optical Networks," ECOC 2022

# DFOS standards are critical to driving growth, reducing cost, and enhancing sustainability within the industry ecosystem.

J. S. Wey, T.J. Xia, G. Wellbrock, "Standardization of Distributed Fiber Optic Sensing System for Terrestrial Optical Networks", F5G Panel, OFC 2024

# ITU-T SG15 initiated DFOS standardization in Dec 2023

**Q6 (Transport Network)**

New work item G.dfos:
Distributed fibre optic sensing system for terrestrial optical transmission system. Target to complete in 2025

**Q2 (Optical Access Networks)**

Expanded G.sup.VHSP scope to include fiber sensing in PON

**Q8 (submarine cable system)**

Agreed to add distributed fibre sensing in G.dsssc

**Q12 (Transport Network Arch)**

Identified existing Recommendations for potential DFOS inclusion

**Q14 (Mgmt & Control)**

Identified existing Recommendations for potential DFOS inclusion

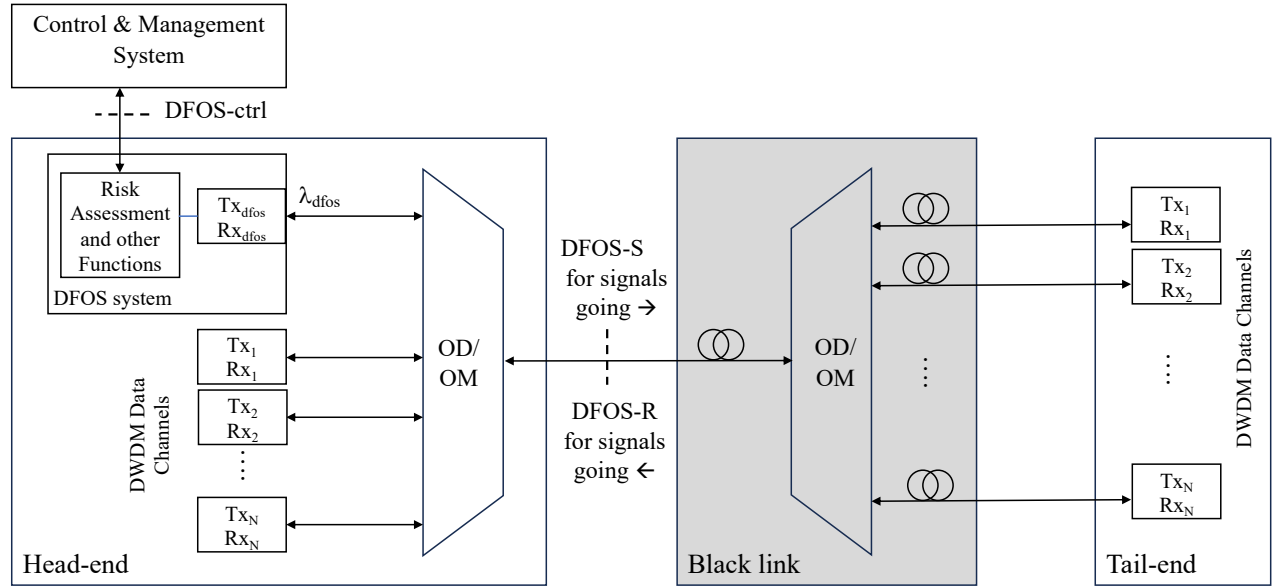**Q5 (Fiber cables), Q7 (O&M)**

Monitoring progress. No activity now.

# G.dfos reference architecture

**Optical parameters at DFOS reference points:**

- Wavelength assignment
- Transmitter parameters
  - o laser linewidth
  - o wavelength accuracy
  - o optical power
- Interference & crosstalk



G.dfos baseline draft

# Key requirements

**DFOS system should**

> operate on both in-service fiber and dark fiber

> monitor both trunk fiber and drop fiber in PON

> utilize out-of-band or in-band wavelength

> not cause interference to data traffic

> support methodology for risk level assessment

> provide timely risk alerts to operations teams

**DFOS enables telecom fiber infrastructure to become an intelligent sensing network.**