Network sensing standardization in ITU-T SG15

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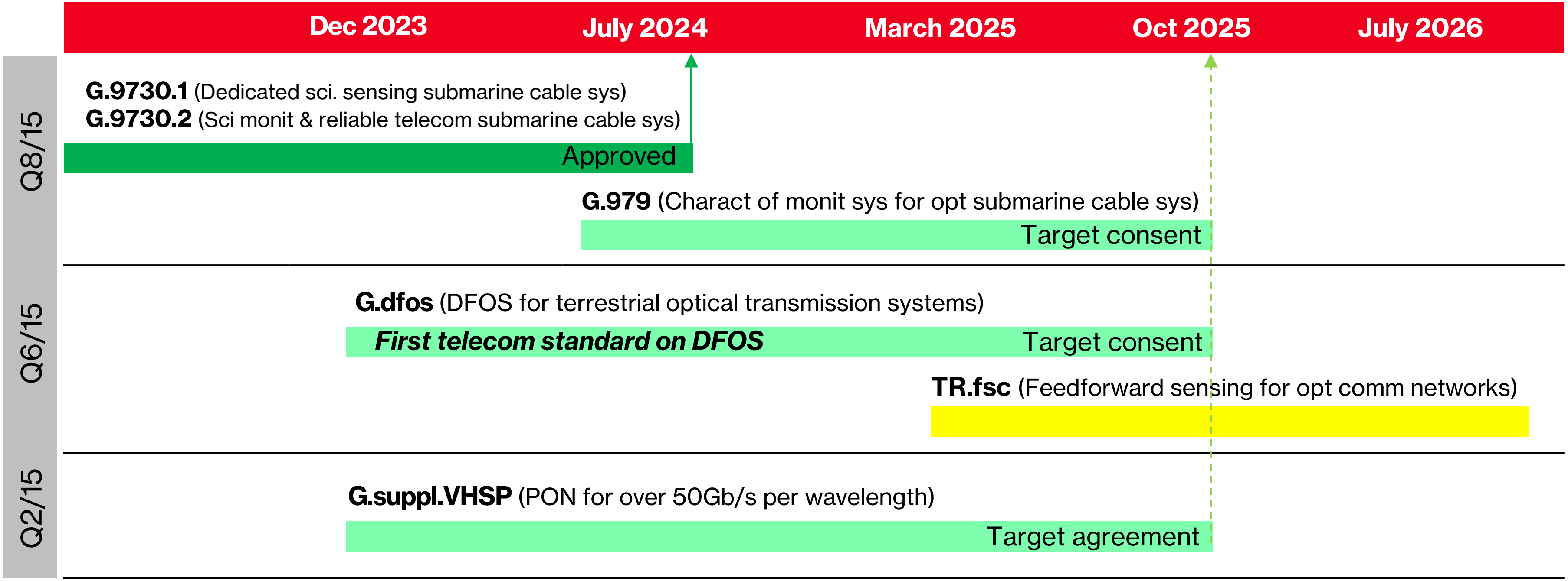
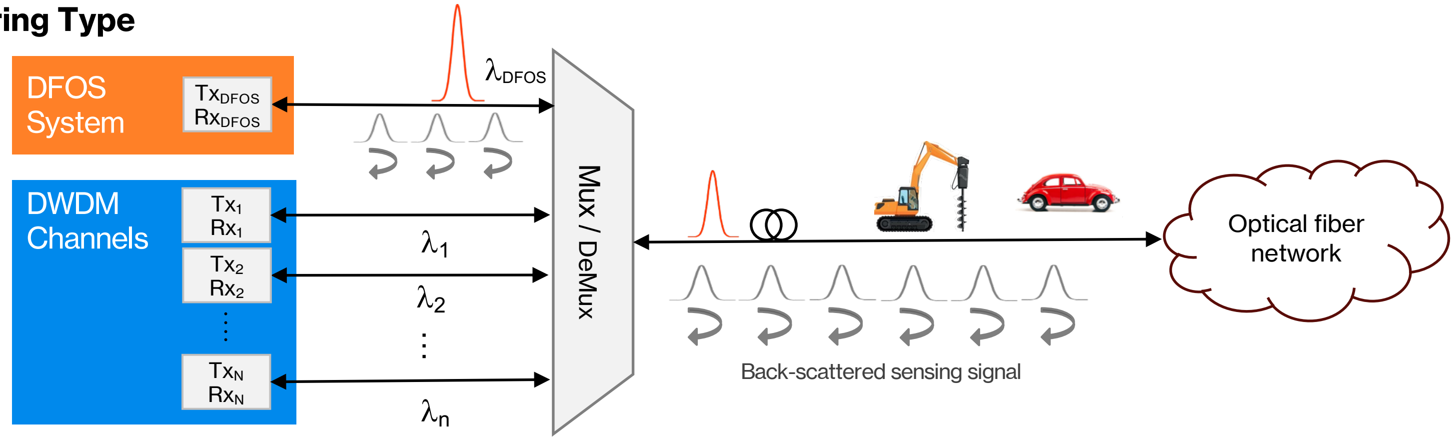
Sensing related standards in ITU-T SG15

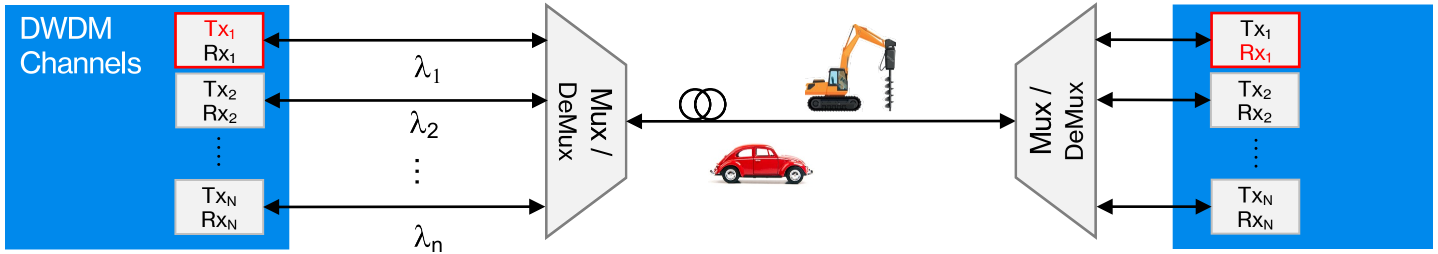


Types of distributed fibre optic sensing (DFOS)

Backscattering Type



Feedforward Type



First telecom standard on DFOS

G.dfos recommendation

Backscattering sensing

System architecture:

- Uni-direction, bi-directional data traffic
- DFOS signal co/counter propagating with data traffic

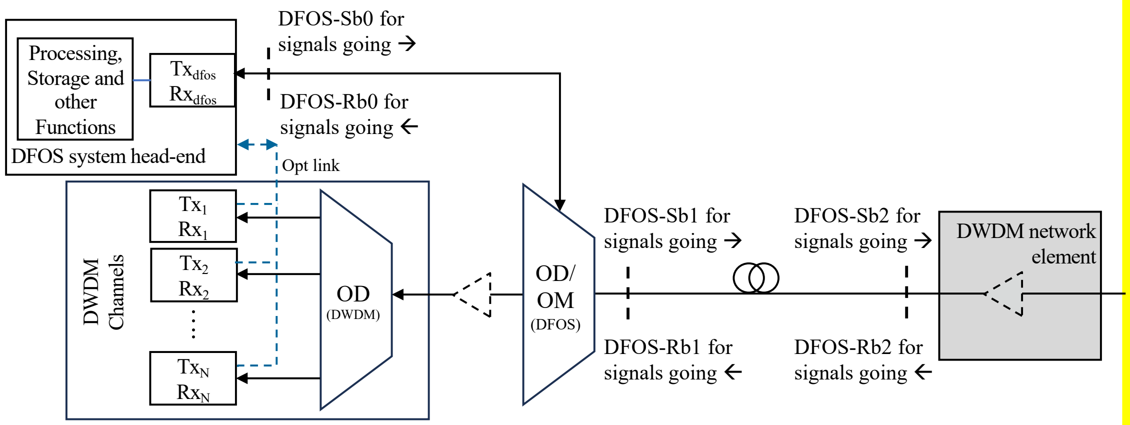
Fibre type: G.652, G.654, G.657

Wavelength allocation

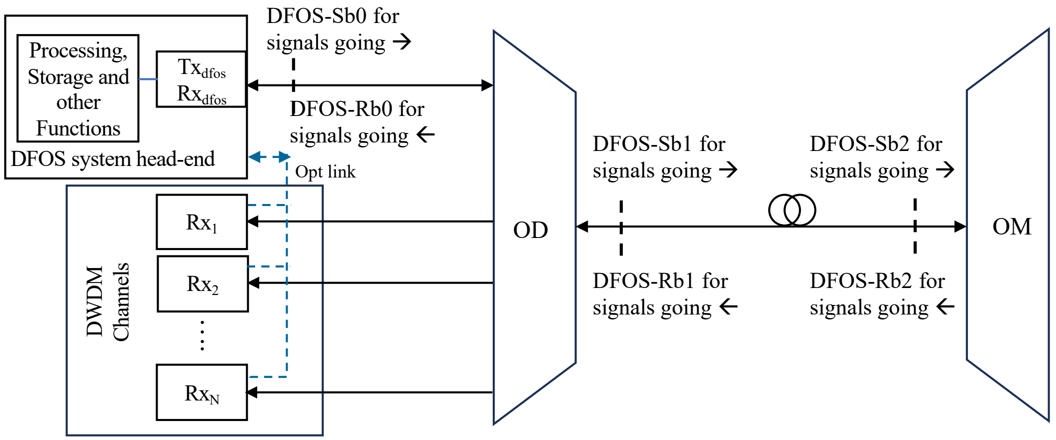
Optical interface parameters

verizon

Out-of-band, counter propagating

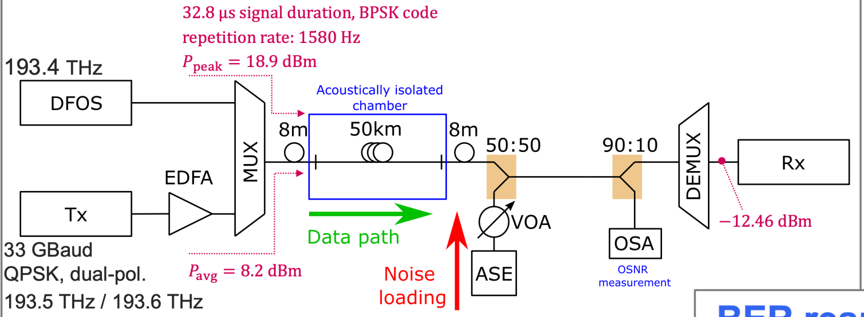


In-band, counter propagating



Nonlinear interference from DFOS to DWDM signal – test result

G.Dfos testbed setup



XPM dominant nonlinearity induced BER errors in co-propagating scenario

Figures courtesy of ADTRAN

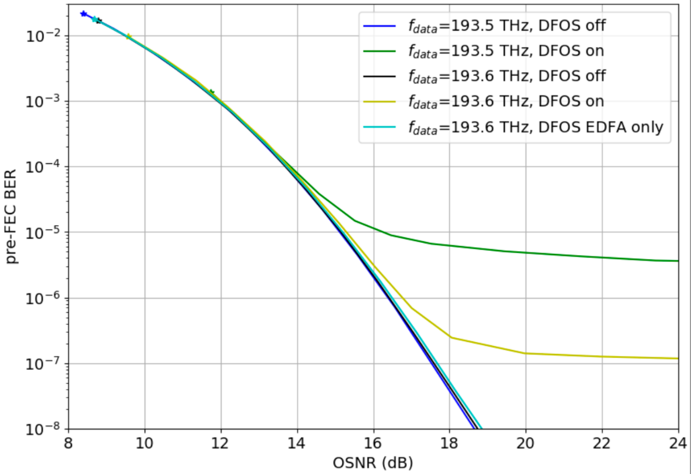
C-0079, ITU-T SG15 plenary, Mar 2025

BER results 200 GHz spacing

- Only EDFA of DFOS is switched on
- ASE noise is multiplexed at 194.3 THz

No input signal → EDFA → Circulator → to MUX

- ASE noise at DFOS wavelength does not impact BER



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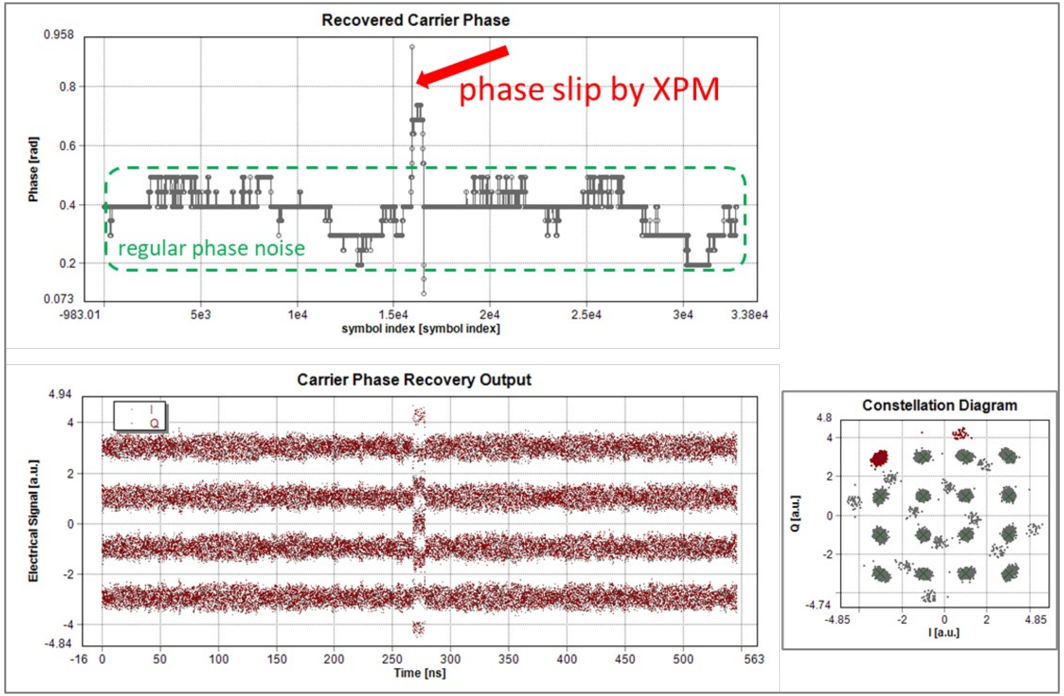
Nonlinear interference from DFOS to DWDM signal – simulation

Simulation setting:

- 40× 400ZR transceivers, 75 GHz spacing
- DWDM channel under test: 193.6 THz (center channel)
- DFOS signal frequency: 193.6 THz + 75GHz
- DFOS probe pulse: 10ns duration, 17dBm peak launch power (typical). Linewidth of 10 kHz, 1 MHz, 10 MHz

Figures courtesy of HUAWEI
C-0079, ITU-T SG15 plenary, Mar 2025

- XPM from DFOS pulse introduces sharp carrier phase slips on adjacent co-propagating DWDM channel
- Negligible XPM penalty in counter-propagating scenario



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Interface parameter specification (OOB, counter propagation)

Parameter	Unit	Value
General information		
Fibre type	–	G.652, G.654, G.657
Allowable sensing distance	m	sba
Interface at point DFOS-Sb1		
Max DFOS signal peak power	dBm	sba
DFOS central wavelength	nm	S-band wide: 1504.5–1517.5 (197.69–199.40 THz) S-band narrow: 1508-1514 (198.15–198.94 THz) L-band: 1614–1617.4 (185.35–185.75 THz) U-band: >1635 (183.49 THz)
Max duration of DFOS signal on-time	ms	sba
Mean power of DFOS signal during off-time	dBm	sba
Max impact to DWDM channel required OSNR in the presence of DFOS signal	dB	0.1

Parameter	Unit	Value
Interface at point DFOS-Rb1		
Max DFOS signal peak power	dBm	sba
DFOS central wavelength	nm	S-band wide: 1504.5–1517.5 (197.69–199.40 THz) S-band narrow: 1508-1514 (198.15–198.94 THz) L-band: 1614–1617.4 (185.35–185.75 THz) U-band: >1635 (183.49 THz)
Max duration of DFOS signal on-time	ms	sba
Mean power of DFOS signal during off-time	dBm	sba
Max impact to DWDM channel required OSNR in the presence of DFOS signal	dB	0.1
Max impact to DWDM channel sensitivity in the presence of DFOS signal	dB	0.1

sba: specified by application

Interface parameter specification (in-band, counter propagation)

Parameter	Unit	Value
General information		
Fibre type	–	G.652, G.654, G.657
Allowable sensing distance	m	sba
Interface at point DFOS-Sb1		
Max DFOS signal peak power	dBm	sba
Min DFOS central frequency	THz	191.5 for (C) 186.0 for (L)
Max DFOS central frequency	THz	196.2 for (C) 191.5 for (L)
Max DFOS spectral excursion	GHz	±12.5 for 50 GHz grid ±25.0 for 100 GHz grid
Max duration of DFOS signal on-time	ms	sba
Mean power of DFOS signal during off-time	dBm	sba
Max impact to DWDM channel required OSNR in the presence of DFOS signal	dB	0.1

Parameter	Unit	Value
nterface at point DFOS-Rb1		
Max DFOS signal peak power	dBm	sba
Min DFOS central frequency	THz	191.5 for (C) 186.0 for (L)
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Max DFOS spectral excursion	GHz	±12.5 for 50 GHz grid ±25.0 for 100 GHz grid
Max duration of DFOS signal on-time	ms	sba
Mean power of DFOS signal during off-time	dBm	sba
Max impact to DWDM channel required OSNR in the presence of DFOS signal	dB	0.1
Max impact to DWDM channel sensitivity in the presence of DFOS signal	dB	0.1

sba: specified by application

G.dfos recommendation

Feedforward sensing

- In scope
- In an informative Appendix
- Not specified in the 1st version

TR.fsc tech report

Feedforward sensing

- Use cases
- Technology analysis
- Path to standardization

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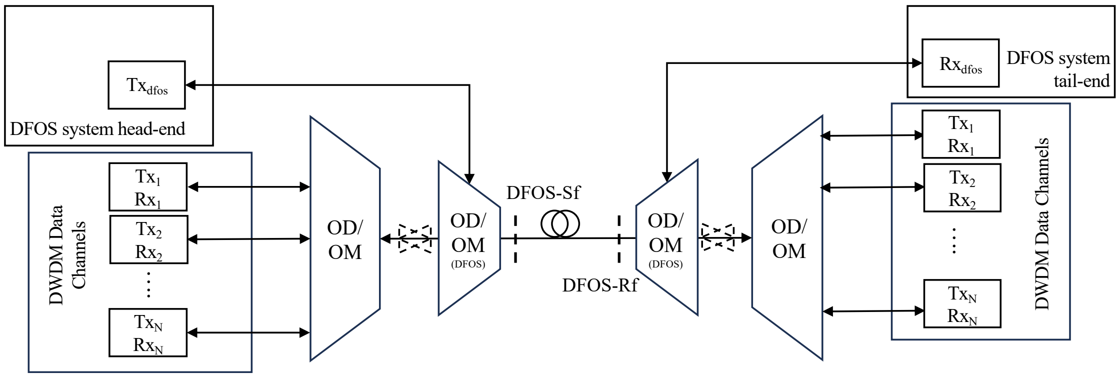
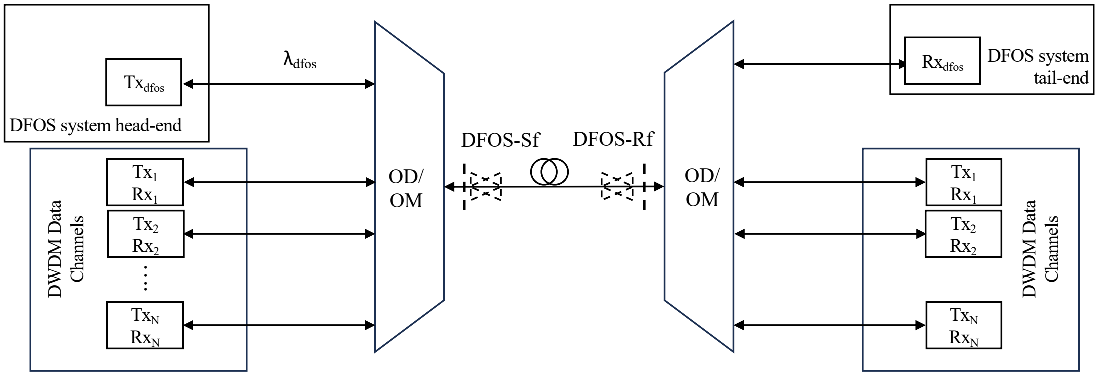
Out-of-band



In-band



G.suppl.VHSP

Applying fibre sensing in PON

Use cases:

- Deployed PON infrastructure OAM
- Sensing as a Service (SaaS)

Requirements:

- In-service VHSP compliant ODN
- No interference to service traffic
- Localization accuracy
- ...

Technology analysis:

- Backscattering type sensing
- IMDD: DSP or polarization-based
- Coherent: polarization-based

Additional challenges:

- Splitter port differentiation
- ODN power splitter insertion loss

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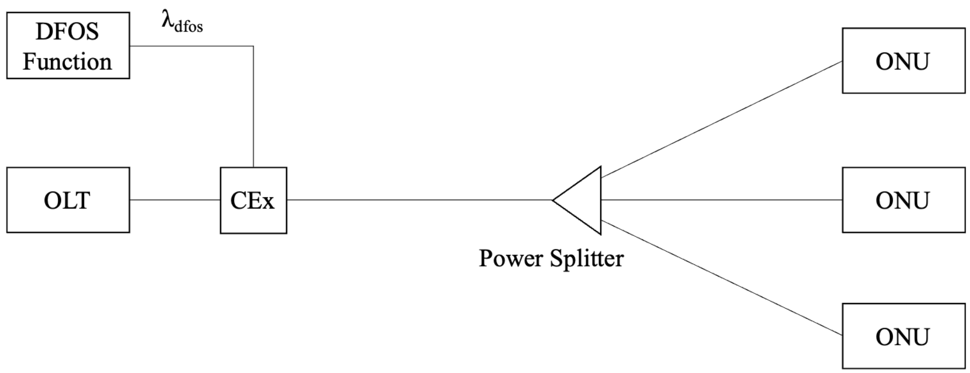
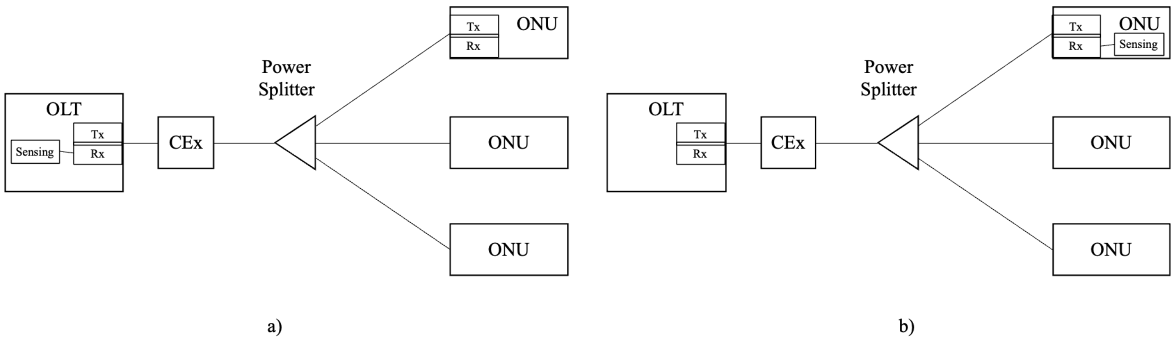
Back-scattering type sensing



Feed-forward type sensing



Closing remarks

1	ITU-T SG15 is leading telecom network sensing, incl. DFOS, standards development activities
2	Submarine network (Q8/15) • *G.979, G.9730.1, G.9730.2*: specify sensing functions & architectures for submarine cable systems to transport scientific sensing data Terrestrial network (Q6/15) • *G.dfos*: the first telecom DFOS Recommendation for terrestrial optical systems • *TR.fsc*: feedforward sensing technology study Access network (Q2/15) • *G.suppl.VHSP*: study DFOS for PON in access networks
3	Continue technology analysis and standards development in SG15

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