

# Distributing RF signals over Fiber in mission-critical applications



# Greater resilience. Better performance. More secure. Less cost.

Radio Frequency (RF) signals have been distributed over coaxial cables for decades, but for today's mission critical government/military/intelligence operations it can be limiting, expensive, and can pose security risks. To overcome these limitations, RF systems engineers are turning more and more to RF distribution over optical fiber (RFoF). In RFoF systems, electro-optical (E/O) converters are used to convert RF to optical at the signal source, then transmitted along

a length of single-mode optical fiber to the destination where optical-electrical (O/E) converters convert signal back to RF. Optical fiber's main advantages include extremely low transmission losses and immunity to electromagnetic, radio or other types of signal interference. These benefits bring improved security, performance, readiness, and resilience at lower overall costs.

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# Why distribute RF signals over fiber?

**Greater bandwidth and distance** — Optical fiber can carry significantly more bandwidth than coaxial cables with less signal impairments. This reduces the need for expensive amplifiers and other signal condition equipment while allowing the signals to span much greater distances.

**High security** — Optical fibers are much more difficult to tap than coaxial cables and any disturbance is much easier to detect and locate.

**Future proof** — Transmission of RF signals over optical fibers is independent of the RF signal format, frequency, and bit rate so the optical fiber can be used to transmit virtually any commercial RF signal. As RF signal formats change over time and bit rates increase, the same optical fiber infrastructure can be used without any need to be upgraded. Operators can even distribute different signal types through the same fiber infrastructure for maximum flexibility.

**Cable cost and size** — Optical fiber cables are a fraction of the size and weight of coaxial cables and are much simpler and less costly to install and maintain. Optical fiber cables are also inherently more reliable than coaxial and much less susceptible to corrosion and other environmental effects.

## Coax vs. fiber comparison

	Coaxial cable	Single mode fiber
Representative distance bandwidth products	100 MHz km	100,000+ MHz km
RF attenuation/km @ 1 GHz	>45 dB	0.4 dB
Cable diameter (inch)	1/2	1/8
Cable weight (lbs/km)	450 lbs/km	15 lbs/km
Minimum bend radius (inch)	7	1
Data security	Low	Excellent
EMI immunity	OK	Excellent

## Superior Distribution Efficiency

Wavelength Division Multiplexing (WDM) allows users to combine up to 80 or more channels onto a single fiber.

# Why switch in fiber vs. switch in copper?

Switching in fiber using all-optical switches allows users to take full advantage of the benefits of fiber optics end-to-end, including:

- High level of security from antenna to receiver
- Redundant paths are easy to configure and inexpensive
- Future proof: any frequency, any data rate, any modulation format – today and in the future – end-to-end
- All-optical switches have an extremely compact form factor (1u for a 48x48 switch) and ultra-low power consumption

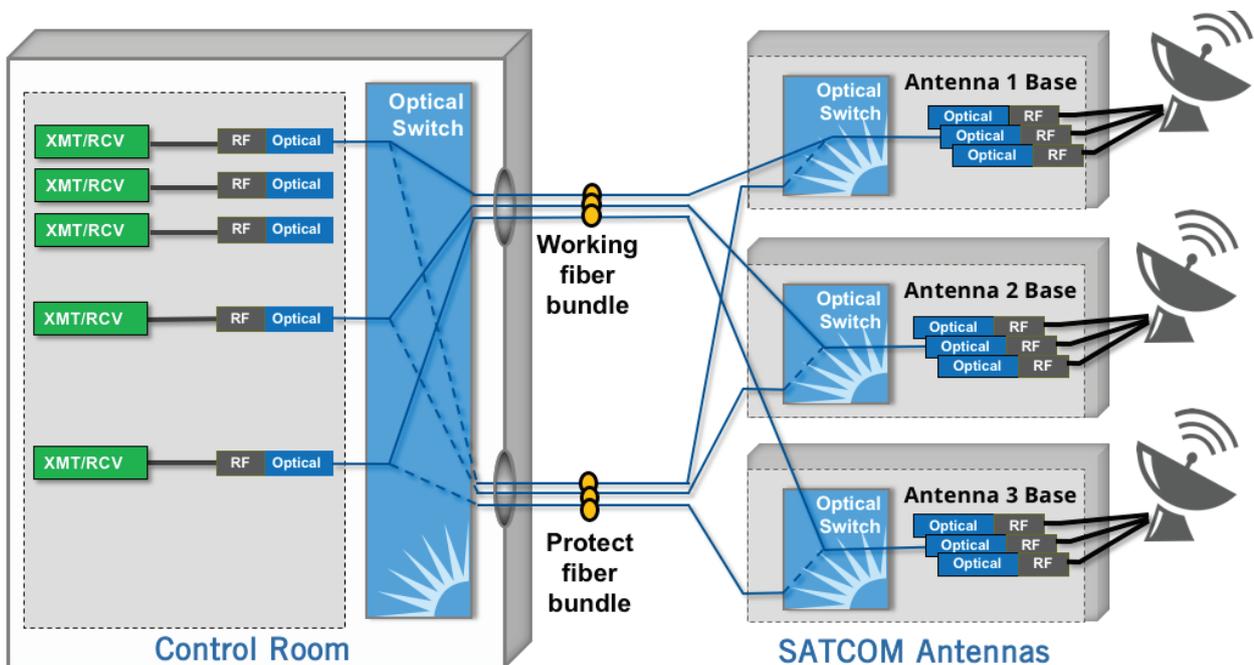


Fig. 1: Typical optically-switched satellite ground station RF-over-Fiber architecture

# The ultimate all-optical switch for RF-over-Fiber applications

The analog nature of RF-over-Fiber requires a switching infrastructure that does not degrade the RF signal. This requires a high-performance, all-optical switch with ultra-stable operation as well as low back reflections and low insertion loss. HUBER+SUHNER Polatis' ultra-reliable switching solutions have been meeting the needs of mission-critical RFoF applications in some of the most rugged environments for over 15 years. All-optical switches provide the superior specifications and features required for this application, including:

**Lowest insertion loss** – Less than 1 dB optical insertion loss minimises signal impairment

**Unmatched performance** – The only all-optical matrix switch with virtually no jitter and very low return loss

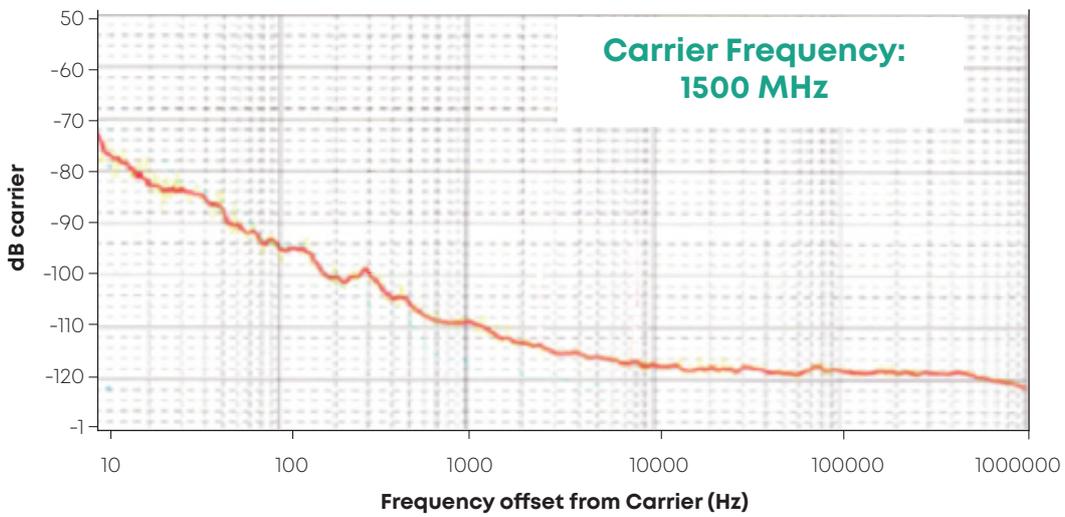
**Ultra-low cross talk** – Better than 100 dB RF isolation between channels at any frequency

**Broad range of matrix sizes** – Unparalleled choice of symmetric and asymmetric port configurations for any size deployment

The patented Directlight™ high-performance switching technology minimises impairments to RFoF signals traversing the switch connections. HUBER+SUHNER Polatis' technology uses integrated position sensors to directly align optical collimators to make and hold dark-fiber connections which eliminates the need for signal dithering that can degrade RFoF signals. This is a critical advantage over MEMS-based all-optical switching technologies that use mirror dithering as part of the alignment process, to make and hold connections, which adds unwanted signal modulation. In RFoF systems this MEMS-based excess modulation is mixed directly with the RF signal, adding to the signal noise floor and degrading the RF signals as shown in Fig 2.

# The ultimate all-optical switch for RF-over-Fiber applications

RF link performance with a HUBER+SUHNER Polatis switch in the path



RF link performance with a MEMS switch in the path

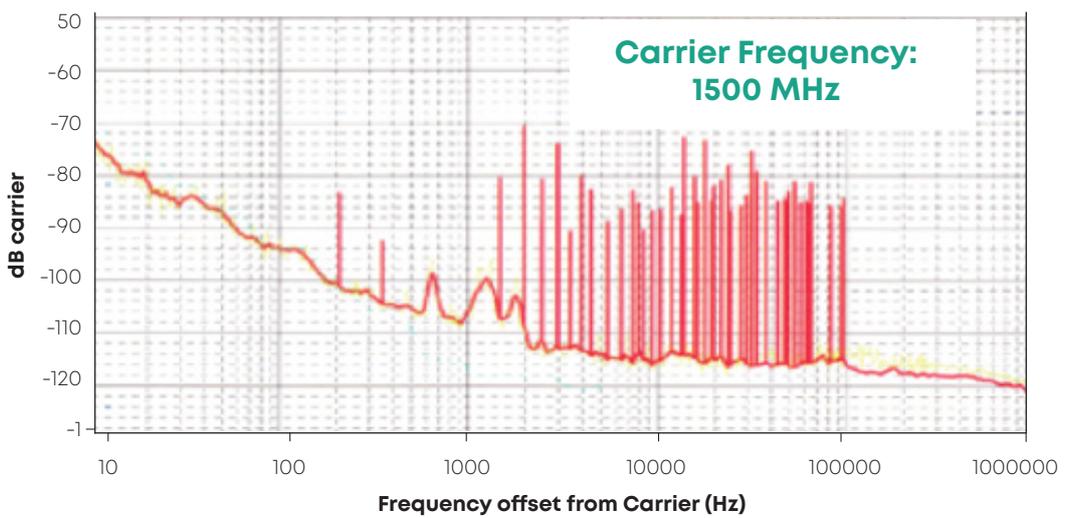
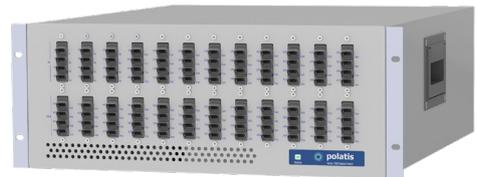


Fig. 2

# Use case – Satellite ground stations

With a fiber network and all-optical switching, organisations can now deploy highly secure solutions with capabilities that are not possible with traditional coaxial-based systems. In a typical satellite ground station deployment there are significant benefits of an all fiber-based approach that provide organisations with key advantages:

- Control rooms can be safely located further away from antennas
- Provisioning can be done remotely, automatically, and instantly – even from across the world
- Satellite dishes can be shared by different organisations
- Data can be easily rerouted around failures



Polatis switches are available from 4x4 to 384x384 matrix sizes



Example of a satellite ground station

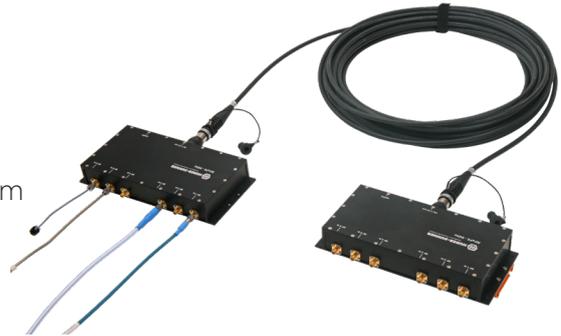
# **The HUBER+SUHNER advantage – End-to-end RF-over-Fiber solutions**

In addition to the superior all-optical switch products, HUBER+SUHNER can supply all of the other best-in-class RF and fiber optic components and systems needed for end-to-end RF-over-Fiber solutions. HUBER+SUHNER provides RF cables, connectors and RF-to-optical transceivers, multiplexers if running different channels on a single fiber, and a host of fiber and RF cabling and cable management products. The company offers complete turnkey solutions for RF signal distribution from antenna to control room.

# RF-over-Fiber solutions

## RF-over-Fiber (RFoF)

- Frequency range from 1 MHz to 20 GHz
- Available in simplex and duplex systems
- Single mode solution enabling distances of >100 km
- Standard modules available in 1, 6 and 12 ports\*
- QMA and Q-ODC-12 as standard connectors\*



## GPS-over-Fiber (GPSoF)

- Frequency at 1.5 GHz
- L1 + L2 Bands
- Single mode solution enabling distances of >100 km
- Available as a single port or 4 port receiver module
- QMA and FC as standard connectors\*



## LAN-over-Fiber (LANoF)

- Data rate: 1000 Base-SX (1 Gbps)
- Single mode, duplex solution enabling distances of up to 20 km
- Standard modules available in 1, 6 and 12 ports\*
- RJ45 and Q-ODC-12 as standard connectors\*



\* customised configurations, bands and connectors on request

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