Enhancing Satcom SIGINT

Unlocking the electromagnetic environment for SIGINT

090126

PPMSYSTEMS.COM

The challenges of coaxial-based satcom SIGINT systems

With the ever increasing usage of the electromagnetic spectrum across civil, defence, and national security applications, the need to effectively monitor this spectrum is constantly growing.

Regulators need to be able to enforce safe and fair usage, whilst national security and intelligence agencies can use it to gather communications and data of intelligence value.

Reduced Detection of Signals of Interest (SoIs)

As SoIs travel through coaxial cable from the antenna across to the modem or receiver for signal processing, they are attenuated to a greater and greater extant as the cable length and / or frequency increases. This hides SoIs in the noise floor, preventing modems or radios from detecting them.

Sub-Optimal Antenna Placement

Due to the RF performance limitations of coaxial cabling, antennas often have to be placed close to the modems or radios to minimise signal degradation.

This often introduces new limitations, as the antennas are no longer optimally placed to receive signals, for example if they have to be placed near to an emitter, or in the shadow of a building or hill.

Fixed Point-To-Point (P2P) Network Topologies

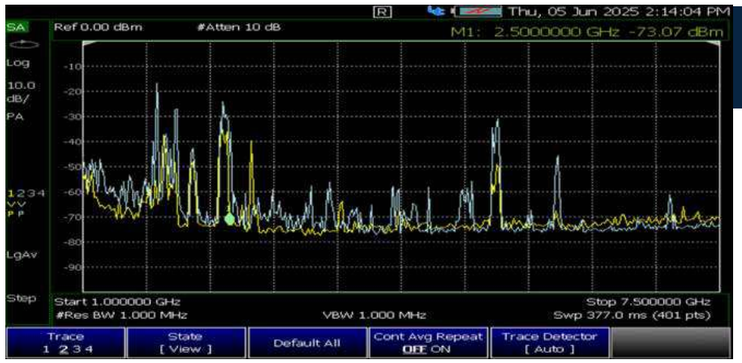
Typical satcom SIGINT solutions often use coaxial cabling in a fixed point-to-point network topology, often linking specific antennas in sub-optimal positions to wideband modems / receivers.

This means that capable modems / receivers are typically linked to a banded antennas, or poorly positioned antennas, limiting the scope of the modem or receiver.

The solutions provided by an RFoF based satcom SIGINT system

Increased Detection of Signals of Interest (SoIs)

Losing only 0.02 dB over 10m compared to a loss of 3.6 dB over 10m for coaxial cables*, an RFoF based solution has no negligible attenuation on the SoI. This means that all signals captured by the antenna can be detected by the modem / receiver, drastically increasing the amount of SoIs detected.



Fibre vs Coax - Same Antenna, Same Location

Signals of interest (SoIs) being missed by the coaxial feed, but being delivered to the receiver/ modem in the fibre feed.

Coaxial feed

Fibre feed

Optimised Antenna Placement

The lossless nature of the fibre optic cabling used in an RFoF solution removes any constraint on distance between antennas and the modems / receivers. This enables the antenna position to be optimised to reduce interference from other RF emitters, and to improve ‘field of view’ for unimpaired signal reception.

Any-to-Any Network Topology

An RFoF based solution allows any antenna to be mapped to any modem / receiver in less than a second. This dynamic cross-spectrum antenna mapping enables the monitoring system to be rapidly optimised to maximise the amount of valuable data collected from the spectrum.

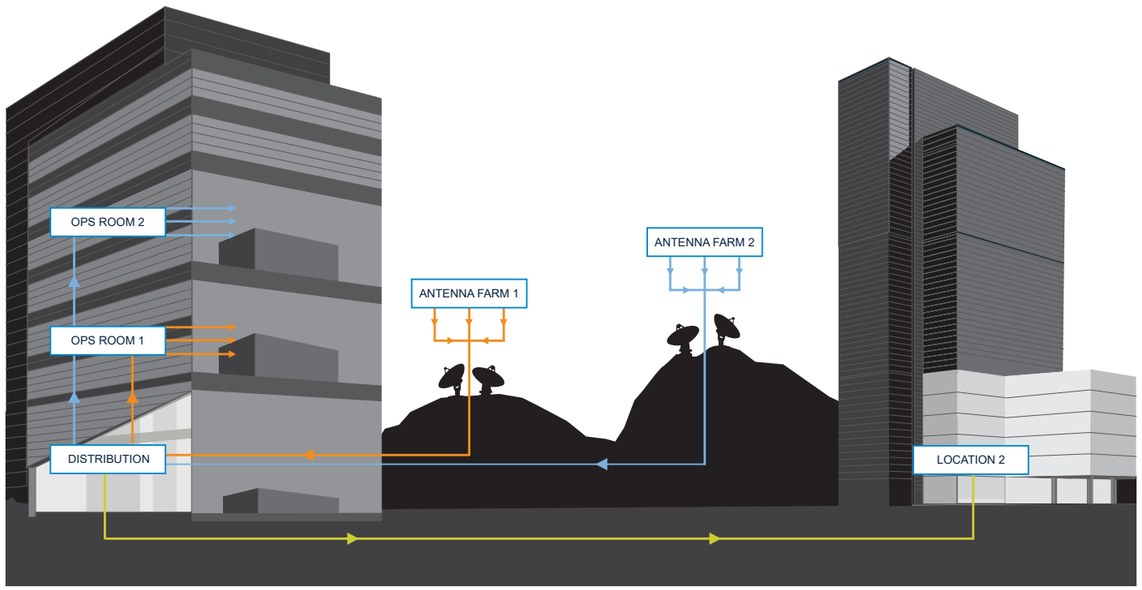
This dynamic signal routing, or any-to-any mapping, removes the previous limitations and unlocks the full capability of modems / receivers.

*LMR-400-DB coaxial cable and fibre optic cable at 6 GHz

Large, permanent monitoring site

Below is a static installation with multiple antennas (or antenna farms) that could be used for satcom SIGINT, satellite communications, ballistic missile early warning etc. These sites typically have one or more central and secure data centres or hubs that process / analyse the received signals.

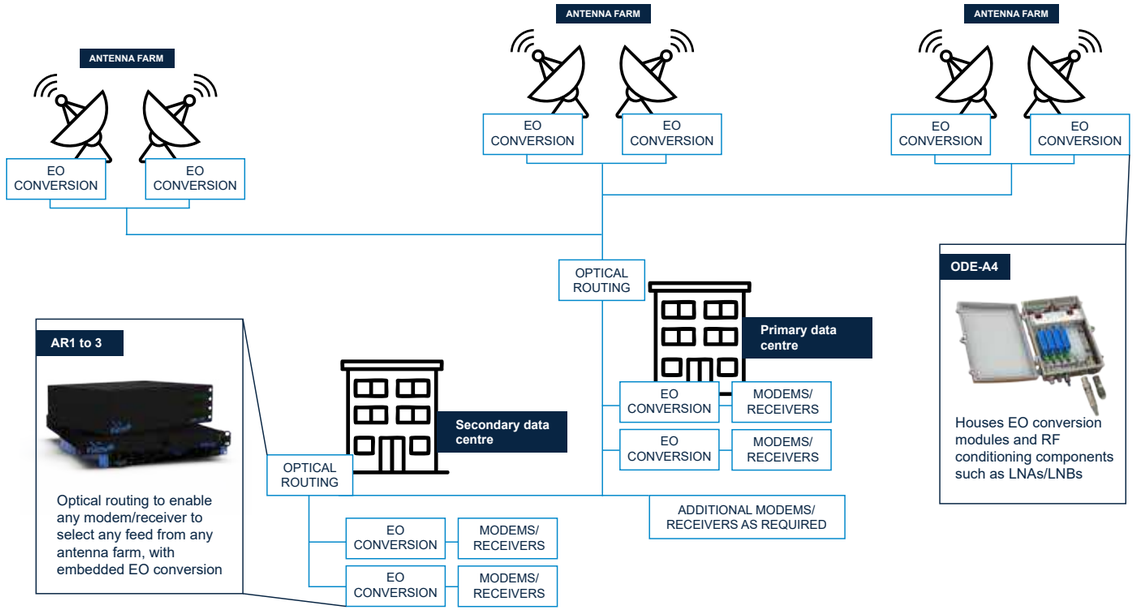
The central data centres or hubs need to receive the feeds from the multiple antennas / antenna farms at distances up to multiple miles away, with minimal to no signal degradation. There may also be benefit in distributing these feeds to multiple 'ops rooms' within each data centre, as each room may be using the signals for different purposes. This concept is illustrated below.



Example solution – Distributed RF for large scale satcom SIGINT

PART NUMBER: M543070

Supports more than 160 antenna feeds from different antenna farms, providing each one of these feeds to more than 1000 modem / receiver end points across multiple data centres. Each end point is able to individually select the desired antenna feed to maximise useful data gathered.

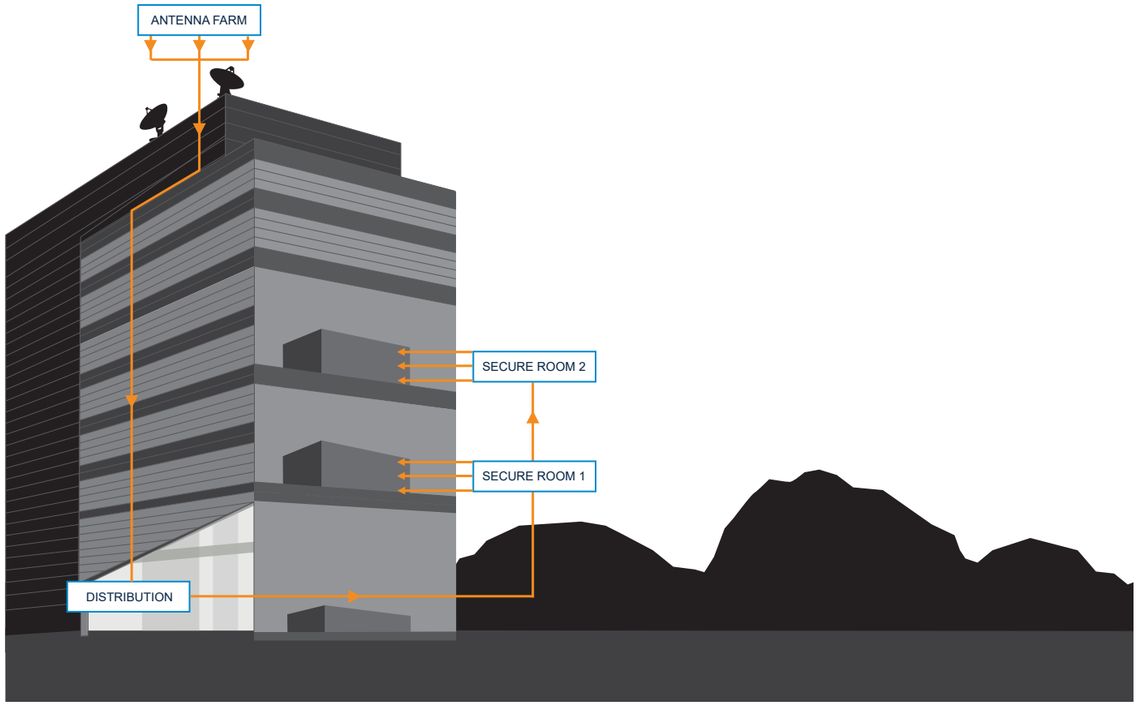


Frequency range	L-band, noting modular architecture where EO conversion modules can be swapped to support antenna feeds from DC to 40 GHz.
RF performance	NF of 42.6 dB, unity gain, P1dB of -4.2 dBm, IIP3 of 6.8 dBm, and SFDR of 92 dB/Hz$^{2/3}$. Performance can be further tuned to customer requirements.
Environmental	IP65 with operating temperature -40°C* to +55°C (-40°F to +131°F) for all external elements (ODE-A4)
Timing distribution	10 MHz reference and 1 PPS from source in the Primary Data Centre distributed to the LNBs at each antenna for increased accuracy / reduced phase noise.
Time stamping & coherence	Accurate timestamping by software balancing of the fixed / constant antenna to modem transmission delay that is minimal (tens of ns). Time / phase coherence options available, tailored to required accuracy.

Smaller or temporary monitoring site

Often locations that have a primary purpose other than satcom SIGINT, but benefit from having this functionality. For example Critical National Infrastructure monitoring for potential threats, or individual buildings that are well positioned to collect signals with potentially valuable data.

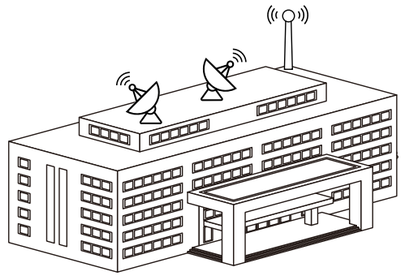
A typical example of this site has a small antenna farm on the roof of a building, and needs to pass the received signals down to one or more secure rooms inside the building without degradation to the signal. The cable runs to the modems / receivers in these rooms are typically a few hundred meters. This concept is illustrated below.

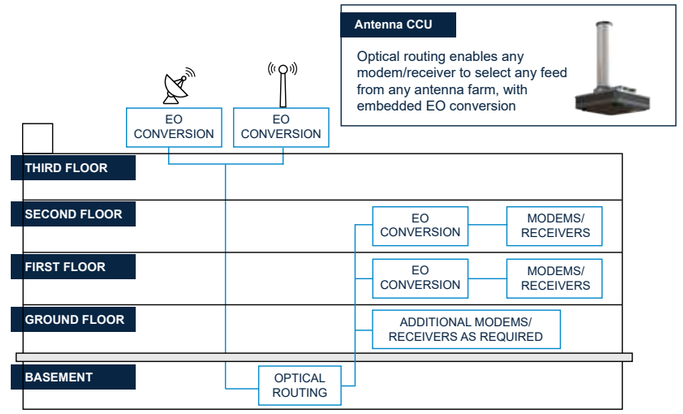


Example solution – Distributed RF for small scale satcom SIGINT

PART NUMBER: M543071

Supports more than 10 antenna feeds from the antenna farms on the roof, providing each one of these feeds to multiple modem / receiver end points in different secure rooms. Each end point is able to individually select the desired antenna feed to maximise useful data gathered.





Lossless splitter & fotonX-OS

Lossless optical splitting of each antenna feed with associated optical switch to select antenna feed

infonX

Electro-optic conversion up to 40 GHz for feed into modems/receivers

Frequency range	HF to 40 GHz
RF performance	NF of 3 to 17 dB frequency dependent, P1dB of -20 to -30 dBm, IIP3 of -20 to -10 dBm, and SFDR of 97 to 106 dB/Hz$^{2/3}$. Performance can be further tuned to customer requirements.
Environmental	IP67 with operating temperature -40°C* to +55°C (-40°F to +131°F) for all external elements (Antenna CCU)
Modular architecture	Easily swap antenna CCUs (without any other changes to the system) to keep the system current with the operational environment. New antennas added by scaling extant products in solution.
Time stamping & coherence	Accurate timestamping by software balancing of the fixed / constant antenna to modem transmission delay that is minimal (tens of ns). Time / phase coherence options available, tailored to required accuracy.

PPM Systems

ppmsystems.com
+44 (0)1793 784389
sales@ppmsystems.com