

FSO Backup with 802.11 Radio System

Perceptions

One of the perceived limitations of Free Space Optical (FSO) systems is lack of availability in heavy fog conditions. This has slowed the adoption of FSO in markets where fog is a frequent occurrence.

In an inner city environment, with short links (<500metres) fog is unlikely to cause significant outages, due to the effects of wind channelling through the streets and sunlight heating buildings. However, once link lengths start to rise towards 1km, a solution is needed to allow communication for business-critical links.

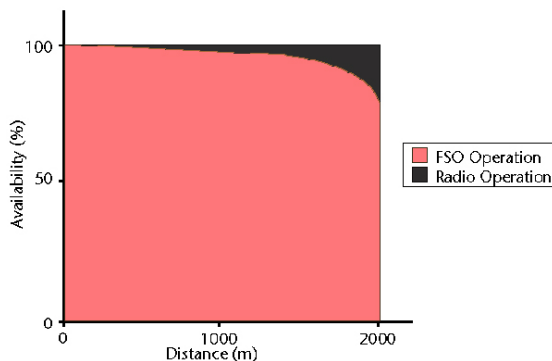
Fog is a very localised phenomenon, depending on the local microclimate. It is usually evident at the time of pre-installation site survey if it may be a problem, and steps need to be taken to provide a contingency plan.

Cost effective radio backup

As Free Space Optical systems inherently provide high availability, a 1+1 backup approach is only needed to 'top up' availability in the rare cases that visibility affects communications. A lower bandwidth system is adequate for the job, providing backup for a sensible cost.

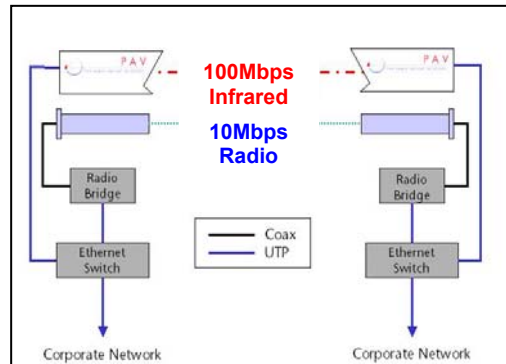
ISM band radio (IEEE 802.11b) is a technology that at first glance is a competitor to Free Space Optical technology, providing short distance, line of sight connectivity.

Availability Graph for a Hybrid FSO/Radio System



The current most popular 802.11b product is, however, limited in bandwidth, typically restricting data throughput to approximately 6Mbps. The ISM band radio provides a half duplex Ethernet interface (10BaseT). This technology is not affected by fog, so provides an ideal backup channel for FSO products.

The radio system provides 'top up' bandwidth for occasions when the FSO operation is impeded by poor visibility. The combination of technologies allows availability figures of close to 100% to be quoted.



System overview

Overcoming Ethernet limitations

One of the limitations of Ethernet technology is that parallel paths are not tolerated. An FSO link cannot be directly installed alongside a radio link, as this would create a loop, creating problems within the network. A sensible strategy for switching operation between the two links must therefore be implemented. This is likely to be dictated by the customer's networking strategy.

Spanning Tree Protocol

If the customer has a mature network, a mechanism called Spanning Tree Protocol (STP) can be used. Spanning Tree monitors the network for loops, and automatically shuts down interfaces causing problems. The link that is shut down can be influenced by assigning 'costs' to each link, closing down low bandwidth paths in favour of a faster link.

Business-critical intelligent switching

For networks where the FSO link is business-critical, a 40 second downtime may not be acceptable. At this point PAV can specify a pair of intelligent switches to provide an intelligent backup service. These switches have the ability to 'bond' the two channels together into a single logical link, and manage the dataflow within. A failure on the FSO link will be noticed, and data switched to the backup within a second. This switchover will not be noticed by the majority of network users. When the FSO link returns, the link is monitored for a period of time to ensure it is stable before the data is switched back.

All weather data integrity resolved

These two components allow PAV to provide a seamless backup solution for all Ethernet FSO links, ranging from 10Mbps to 1Gbps, ensuring data integrity in all weather conditions.

PAV Free Space Optics

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System components

The Radio backup system comprises the following for each link head.

- Ethernet switch
- Radio Bridge
- Transmitter/Receiver Antenna
- Coax Cabling from Radio Bridge to Antenna
- UTP connection from Infrared Link Head to Ethernet Switch
- UTP connection from Radio Bridge to Ethernet Switch



Specification		
Model	PAVBackup	
Product code	PL-Back	
Indoor unit	N/A	
Interface characteristics	Interface Connector	Ethernet 802.3 – 10BaseT RJ45
	Radio characteristics	
	Frequency Channels	2400 - 2483.5 MHz
	Modulation Technique (CCK, DQPSK, DBPSK)	Direct Sequence Spread Spectrum
	Spreading	11 – Chip Barker Sequence
	Media Access Protocol	Adaptive Dynamic Polling (TurboCell)
	Bit Error Rate	$\geq 10^{-5}$
	Nominal Output Power	15dBm (FCC), 8dBm (ETS, FR)
Physical Specifications	Dimensions H x W x L	130 x 175 x 45 mm
	Weight Kg	10Kg
Environmental Specifications	Operating Temperature	0° to +40°C
	Storage Temperature	-10° C to +50°C
Power Supply	100V AC to 240V AC	
Indicators	LED	Power on
	LED	Ethernet LAN Activity
	LED	Wireless LAN Activity
Range (FCC and unregulated conditions) 14dBi Directional Antenna	Data Rate Mbps	Distance (Km)
	11	5.5
	5.5	7.6
	2	11
	1	15
Antenna specifications	Length	457mm
	Frequency Range	2400 – 2500MHz
	Gain	14dBi +/- 1dBi including cable and connector
	Polarisation	Vertical
	Cable	RG58A/U

PAV Data Systems maintain a continuous process of research and development, and as such, all specifications within this document are subject to change without notice.