Backhaul Requirements for Anritsu Remote Spectrum Monitors Use for RF Signal Tracking Applications

Overview

There are various methods for geo-locating an RF signal of interest. Primary alternatives include Power of Arrival (POA), Time Difference of Arrival (TDOA), and Angle of Arrival (AOA). In most situations where modulated signal bandwidths are greater than 25 kHz, TDOA provides the best accuracy. For both TDOA and POA, a minimum of three spectrum monitor receivers are required to triangulate the signal, providing a fixed location. Although AOA may only require the use of one receiver, this method only provides bearing information. This application note will focus on the use of TDOA as a means for tracking a signal.

When tracking a signal physically in motion, TDOA is performed on a continuous basis. Each measurement updates the signal position, providing tracking points for the path taken. TDOA geo-positioning is performed using I/Q measurements. I/Q captures can be quite large, gathering many Mbits of data as a function of both capture bandwidth and bit resolution. The time spent to send all I/Q measurements back to a central location for analysis significantly impacts the tracker's ability to update new measurement positions and follow fast moving objects.

It is assumed here that the user has some familiarity with network communications. Supplemental documents that may assist with network setups include the following (all available on Anritsu's website):

- Remote Spectrum Monitor User Guide
- Remote Spectrum Monitors MS2710xA Configuration Quick Start Guide
- Time-Difference-of-Arrival (TDOA) Application Note (provides background into how signal tracking is conducted — 11410-01009)

Users may also want to review the Remote Spectrum Monitor Programming Manual and Online Help System for assistance in using system commands to configure the Remote Spectrum Monitor for the type of network communication protocols desired.

Drone Tracking Backhaul Methods

An important application for signal tracking is drone detection and mitigation. Once a drone is detected, its video signal is captured, processed, and transmitted (in an I/Q format). There are several methods to implement the backhaul channel which transfers measurement data back to a central server. Various backhaul methods are described below:

- Optical fiber links
- Microwave Point-to-Point (P2P)
- Ethernet
- Wireless modems

Typical setups for both drone detection and tracking is illustrated in the Figures 1 thru 4, below.

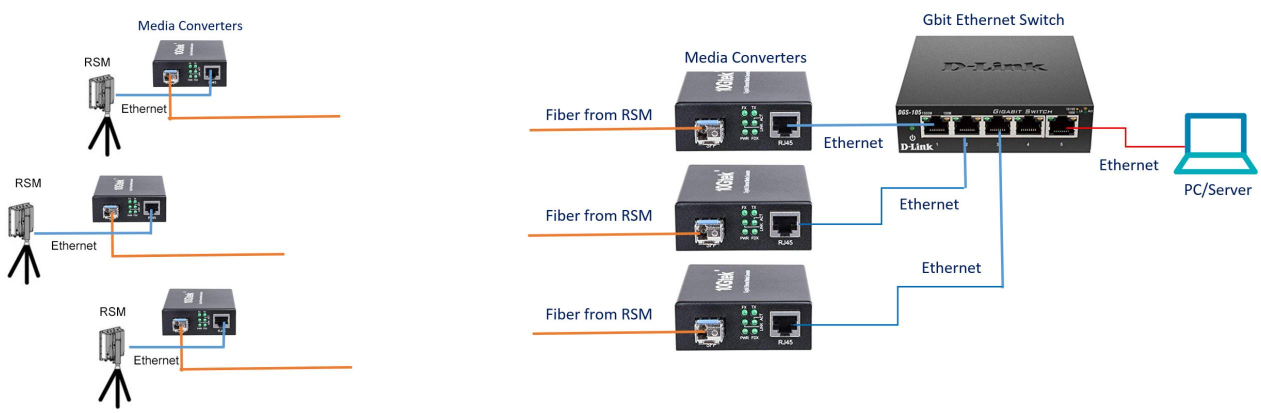

Figure 1. Example for RSM Backhaul Using Optical Fiber

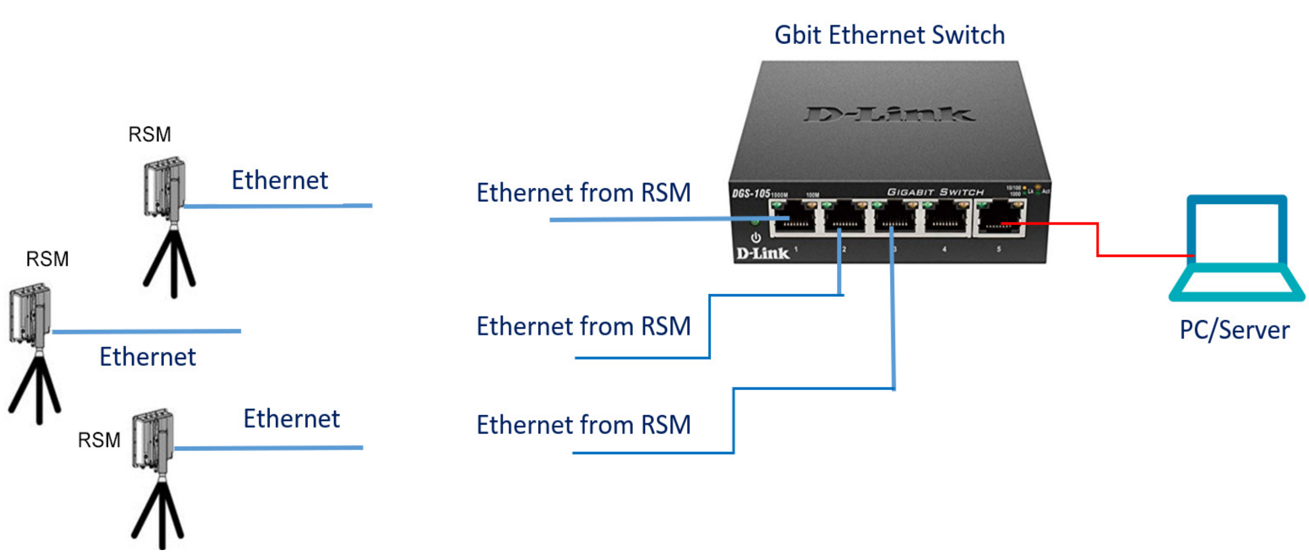

Figure 2. Example for RSM Backhaul Using Ethernet Cabling

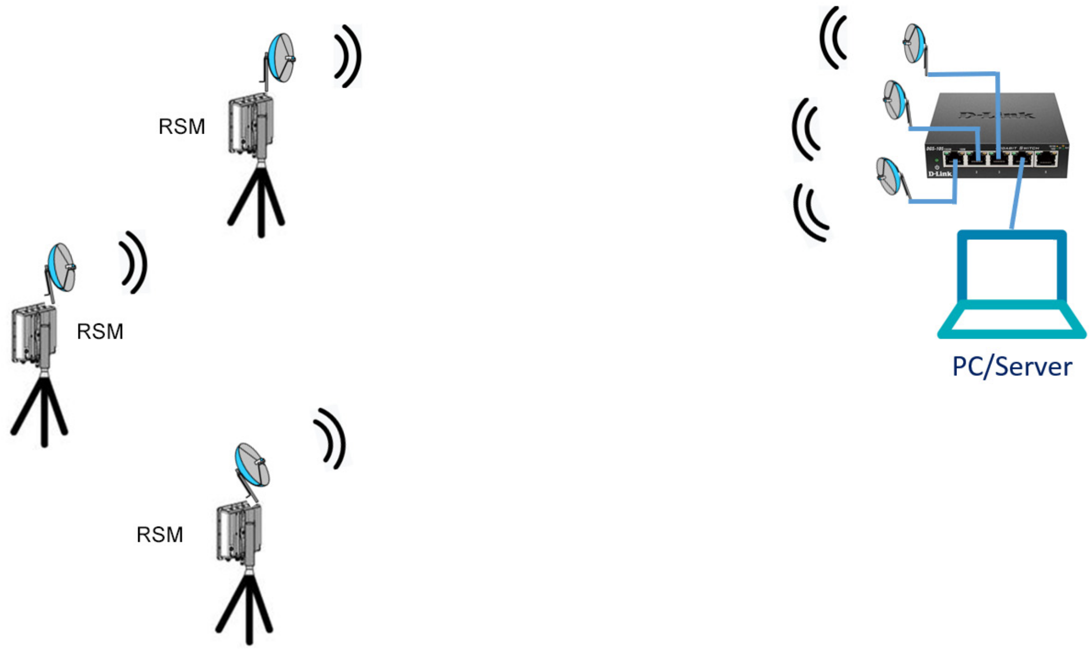

Figure 3. Example for Microwave P2P Backhaul Using P2P Microwave Radio Links

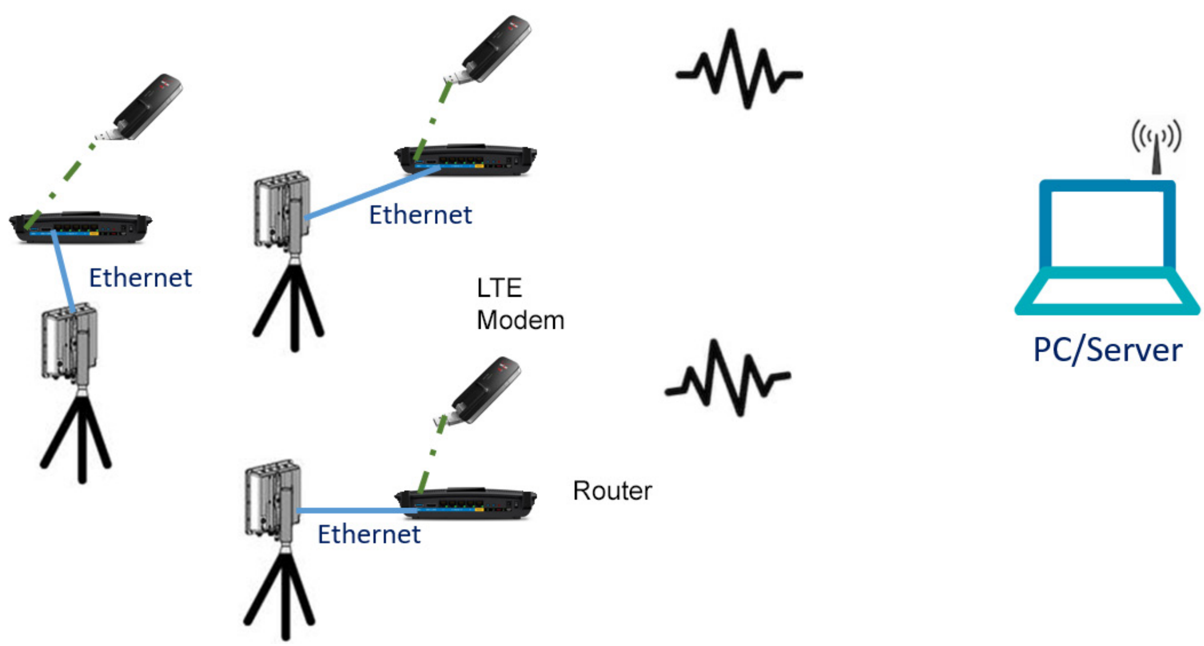

Figure 4. Example for RSM Backhaul Using USB LTE Modems

Actual connections to each RSM and to the central server/PC are shown in detail in the next section. Accessories required will be detailed while also illustrating the different components required to connect into the system.

Optical Fiber

Optical fiber comes in various grades and mechanical capabilities. Users will need to know whether the fiber will be used underground, above ground subject to physical impediments (e.g., laid across a heavily trafficked road), or be used in a more protected location. Clearly, pricing for the fiber will vary according to the degree of stability needed as well as its robustness to weather elements.

To use fiber in a closed system, each deployed Remote Spectrum Monitor will need a pair of Ethernet-to-fiber converters or media converters (see Figure 5 for an example). The converter takes the Ethernet output from the Remote Spectrum Monitor and converts the signal so that it can then be transferred via fiber to a PC/server location for processing. A second converter is then used at the PC location to translate the fiber signal back to Ethernet. For three Remote Spectrum Monitors deployed in the field, six converters are required using a server not co-located near one of the monitors. There are several important parameters that must be considered when using a media converter that include:

- Ethernet conversion speed (use only a converter capable of 10/100/1000 Mbit)
- Types of fiber the converter can accommodate (typically 1310/1550 nm)
- Distance over which the converter can communicate (20 km, typical)

Figure 5. One Example of a Gigabit Ethernet Media Converter

At the receiving end of each IQ backhaul, an Ethernet switch is required to combine each signal for input into the PC/server. A Gigabit plug-and-play switch should be used (Figure 6 shows a switch example).

Figure 6. Gigabit Switch

Both the media converter and switch are relatively inexpensive, however, care must be taken to place these devices in a waterproof enclosure if deployed outdoors.

Several rolls of fiber will also be needed. Depending on the environment and signal power, Remote Spectrum Monitors used for detecting drones can be deployed at approximately 500 m on a triangle side. If one of the Remote Spectrum Monitors is co-located near the PC/server, two rolls of fiber are needed, otherwise, three rolls are required.

Microwave P2P

Microwave P2P can be used for backhaul. This can operate in the 60 GHz band as well as in the 2.4/5.8 GHz bands. Many P2P systems (transmitter and receiver pair) will use 2.4/5 GHz as a backup in the event of adverse conditions. When used at the lower frequencies, Wi-Fi connectivity can be established to further extend the link if needed. For P2P to operate effectively, line of sight between transmitter and receiver must be established. An example of a 60 GHz P2P antenna is shown here in Figure 7.

Figure 7. P2P Antenna

Considerations for choosing a P2P system include:

- Weather resistance — the antenna must be able to survive harsh environments.
- Ease of alignment — each transmitting antenna must point directly at its receiver counterpart. Alignment tools may be offered by the antenna vendor to facilitate this process.
- Power — distance over which the transmitter/receiver pair may be placed. To transmit over a 500 m distance, a rating by the vendor of a 1 km transmission is suitable to allow for margin (weather and RF environment impediments).
- Ports for 2.4 GHz antennas to allow for transmissions via Wi-Fi, if desired.

Many P2P antenna vendors report both their RF transmitter and receiver performance for their antenna pairs. These are specified individually for each frequency band (2.4/5.8/60 GHz). It is suggested that the 2.4/5.8 GHz bands not be used for backhaul. These transmissions could interfere with the drone signal, degrading tracking performance.

Ethernet

Twisted pair Ethernet has a maximum length of 100 m. This makes the use of Ethernet as a stand-alone solution for the Remote Spectrum Monitor backhaul a poor alternative. Ethernet can be used when connecting to a larger hub (such as a corporate network) where transmissions can take place. A typical scenario would be to place a Remote Spectrum Monitor at a building rooftop serviced by an internal LAN connection. Remote Spectrum Monitors can then be spaced across multiple buildings with an internal LAN connection. Consideration for the amount of bandwidth required by the I/Q transmissions should be made so as not to disrupt normal traffic in the network. A direct connection between the Remote Spectrum Monitor Ethernet port and the system switch can be made.

Wireless Modems

Use of wireless modems is not recommended for a commercial drone tracking operation. 4G LTE modems have been tested where tracking updates can be 2-3 times slower compared with fiber or P2P. Many operators advertise fast downlink rates, but uplink rates are also important in backhaul applications. A minimum of 5 MB/sec data rates on the uplink should be met. Without an "all you can eat" data plan, use of modems for backhaul can also be expensive. Figure 9 shows a typical USB modem. For users operating in various countries, the modem should be unlocked so that SIM cards from other cellular operators can be used. To communicate with wireless modems, a static IP address must be obtained from the local operator. With static IPs, a known address is available each time the modem is powered.

If using a wireless modem for backhaul, a router should be used. Routers allow the use of Dynamic Host Configuration Protocol (DHCP) configured addresses matched with Domain Name Server (DNS) servers (see section on Netowork Considerations below). Routers can be programmed to automatically use a specific DNS service, allowing the use of names (rather than numeric IP labels) for accessing the Remote Spectrum Monitor.

Network Considerations

Anritsu Remote Spectrum Monitors can be configured either with a static IP address or using a DHCP address. More information on configuring the Remote Spectrum Monitor for either static or DHCP service can be found in the Remote Spectrum Monitor Configuration Quick Start Guide (10580-00414) document located on Anritsu's website. Static IP addresses can be used in closed systems (no access to the internet). Care should be taken when configuring the Remote Spectrum Monitor with a static IP such that the address is not forgotten.

In most instances, DHCP will be used. DHCP is generally used along with a DNS. Once the Remote Spectrum Monitor receives power, it looks to the DNS server where the name is matched to an IP address thus facilitating communications. Rather than communication with the Remote Spectrum Monitor via an IP address, a name can be used. Amazon and Yahoo are examples of DNS names. Many corporate entities have their own DNS servers, however, third-party services can also be used.

Figure 8. Wireless USB Modem

Summary

The table summarizes backhaul alternatives. Many parameters will be dependent on the grade of material used. Costs are assumed for deploying backhaul for three remote spectrum monitors.

Backhaul Medium	Cost	Speed	Restrictions	Range	Ease of Deployment
Fiber	$1000	High	None	25 km	Moderate
P2P Microwave	$700	High	Line of Sight	1-2 km	Moderate
Ethernet	$150	High	None	100 m	Easy
Wireless Modems	*	Low	None	Unlimited	Difficult

* Cost of wireless modems highly dependent on carrier and data plan.

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11410-01133 Rev. A Printed in United States 2019-06