White Paper

# Securing SLAs over Point-to-Multipoint Wireless Networks

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## Abstract

With broadband connectivity demand rapidly increasing, Service Providers (SPs) are faced with the challenge of meeting high Service Level Agreement (SLA) requirements in Point-to-Multipoint (PtMP) wireless networks.  Main SLA attributes include availability, capacity, delay and delay variation (jitter).  What's more, business customers expect these SLAs to be met with decreasing costs per bit.

This document describes the biggest SP challenges when securing SLAs over licensed and license-exempt wireless networks, and how RAD's Airmux-5000 Point-to-Multipoint Ethernet radio was designed to meet these challenges.

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# 1. The Challenges

Unlike wired networks, wireless networks are subject to a number of physical conditions that affect performance. Securing SLAs over wireless networks can be difficult since such conditions (described below) are hard to model.

## 1.1 Fading

Conditions such as slow or fast, flat and frequency-selective fading may decrease the radio signal's reception quality.

## 1.2 Multipath

A phenomenon that results in radio signals reaching the receiving antenna by two or more paths, it can occur in near Line of Site (nLOS) and Non Line of Site (NLOS) scenarios. In both cases, the signal reflections are received along the main path signal, therefore causing a "multipath" fading that reduces signal quality.

## 1.3 Interference

There are several types of interference. One occurs as a result of co-located equipment with a physically short range installation (e.g., on the same pole) and demands for high frequency re-use. Another type of interference is due to uncoordinated networks (mainly in unlicensed bands) from other vendors' equipment.

In most cases, such interference is local to a specific site or path. This leads to an additional challenge in a PtMP system – isolating the interference effect to just one individual link so that performance degradation won't spill over to all other links in the sector.

## 2. The Solutions

There are a number of field proven techniques that can and should be used to address the challenges of securing SLAs. These techniques combine OFDM and high transmission power to handle multipath and fading effects and include unique air interface features that perform interference mitigation.

- **Advanced ARQ –** This enables the utilization of high modulation even in interfered environments. Operation in higher modulation allows shorter transmissions, which are less sensitive to interference bursts. The ARQ also ensures end-to-end error-free transmission.

- **Adaptive Modulation –** While transmission at the lowest possible modulation scheme (e.g., BPSK 1/2) yields the most robustness, transmission at high modulation (up to 64 QAM) enables shorter transmissions (of the same amount of data), and results in less exposure to interference. This means that in some scenarios, selection of lower modulation yields the highest throughput, while in other scenarios the higher modulation yields the best performance. Taking into account the propagation and quality of the channel, as well as the current interference level, systems using Adaptive Modulation can select the best modulation on each transmission per Subscriber Unit (SU).

- **Diversity and Spatial Multiplexing –** These techniques allow for capacity increase (doubled capacity on the same modulation) and improved link robustness in multipath scenarios. Antenna Diversity or MIMO is selected per SU.

- **Inter- and Intra-Site Synchronization –** This feature eliminates the TX to RX interference which affects any TDD-based system (TX and RX in the same frequency).

All of the above-mentioned techniques help to optimize the individual performance of each SU in a sector, and are utilized by the Airmux-5000.

# 3. Preventing the Deterioration of a Specific Link from Affecting the Entire Sector

**Figure 1A** below illustrates a typical point-to-multipoint wireless network in which a particular sector has 16 SUs, each with an SLA of 6 Mbps. The total sector capacity is 100 Mbps and is based on 64 QAM modulations.

Now consider what happens when one of the SUs temporarily experiences high interference and can operate only on BPSK modulation. During this time, as illustrated in **Figure 2B,** nearly all sector resources are consumed in order to meet the SLA of the interfered SU. This results in lower sector capacity and prevents all other SUs from meeting their own SLAs.

RAD's Airmux-5000 averts this problem by isolating each SU from the others in terms of both throughput and delay. As shown in **Figure 1C,** only the interfered SU will yield a lower throughput during the time of the interference, while the remaining 15 SUs keep their SLAs intact. Moreover, the latency of all SUs remains unchanged.

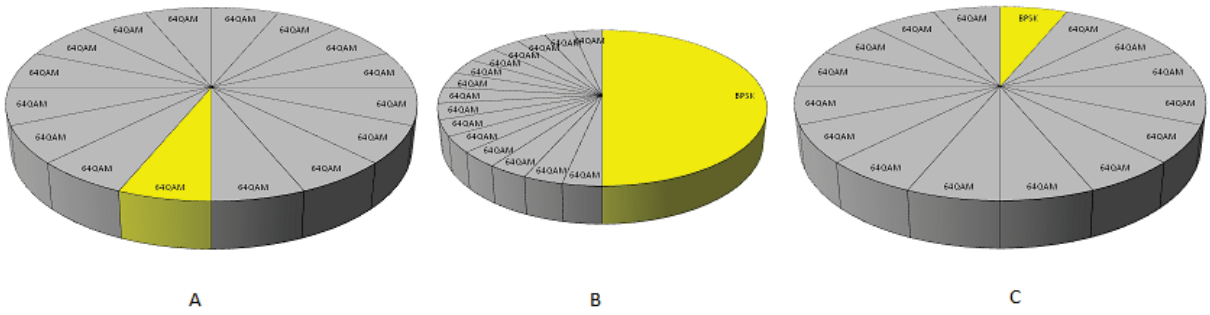


*Figure 1:*
*With Airmux-5000, inferior performance of a single user doesn't affect other users in the sector*

Secured delay or latency is important for time-sensitive applications (e.g., VoIP or Video over IP) and to ensure the performance of standard TCP-based applications (e.g., file downloads). The chart in Figure 2 depicts the required round trip delay per throughput. The TCP throughput is limited by the window size (max 64 Kbyte in IPv4) divided by the round trip delay. Note that Airmux-5000 latency is lower than that required by the TCP layer.

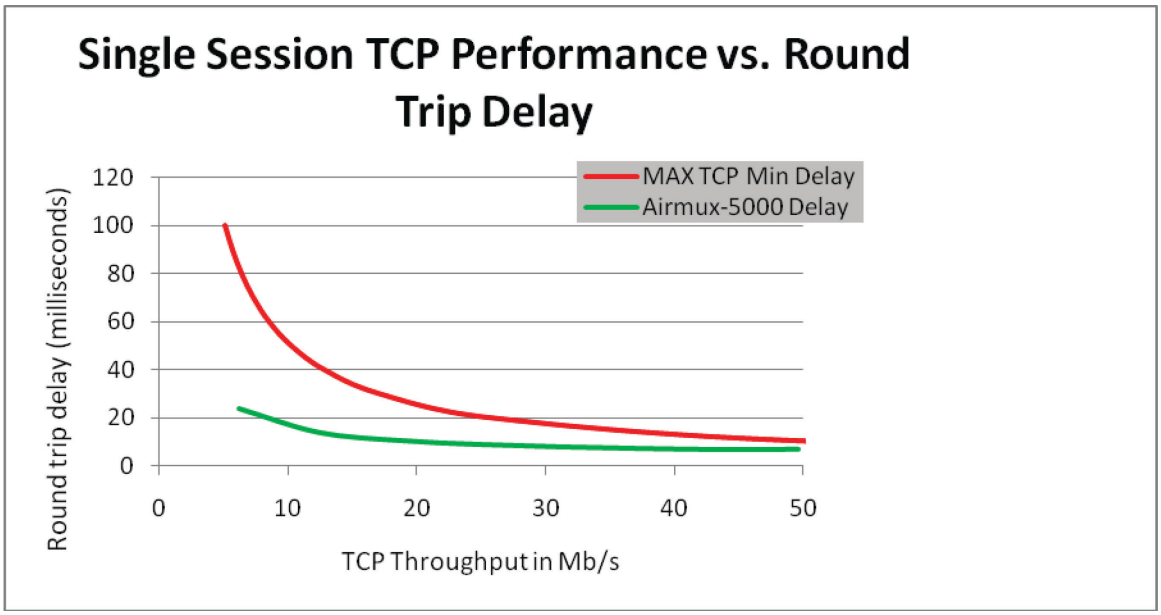


***Figure 2:*** *Airmux-5000 latency allows maximum TCP throughput*

## 4. Conclusion

SLAs for wireless networks should be secured through network engineering and according to the actual behavior of the equipment. High transmission power and sensitivity, flexible channel bandwidth and multiband operation all help enable SLA planning.

It is also important for point-to-multipoint wireless solutions to support a feature set that addresses factors such as interference and fading that can negatively affect SLAs. Applicable features include Advanced ARQ and Adaptive Modulation, Diversity and Spatial Multiplexing, as well as TDD Synchronization.

Finally, it is critical to isolate each SU in a sector to protect throughput and delay for the entire sector, and prevent the deterioration of a single link from adversely affecting the other links. RAD's Airmux-5000 was designed with all of this in mind, and incorporates all of the features and functionality necessary to secure SLAs in PtMP wireless networks.

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