COMMSCOPE®

White Paper

Sentinel® Antennas Address Growing Capacity Challenge in Today's Microwave Backhaul Network

Dipesh Rattan, Product Line Manager, CommScope

POWERED BY ANDREW®

Contents

Introduction

Reducing the side lobe levels of a point-to-point microwave antenna often provides strong opportunities to increase data throughput (capacity) and reduce the average antenna size in the network. Very simply, the upgrade improves spectrum utilization, thus reducing its cost, as well as reducing the overall cost of rolling out and running the network. This paper provides insights to these effects, using illustrations that incorporate the Sentinel® Class 4 antenna from CommScope.

Wireless data usage is growing, with bandwidth-hungry applications that require more effective spectrum utilization. At the same time, microwave frequency bands allocated for mobile backhaul are becoming congested. Consequently, it is critical to find more efficient ways to handle this finite resource and deliver benefits for both operators and users, especially considering limitations on spectrum correlates to limitations on capacity. However, addressing the challenge is difficult, as licensed radio spectrum—typically a recurring cost—is expensive.

An antenna's RPE is the characteristic that determines the effect of interference on the link. It is a mask around the antenna's radiation pattern, indicating the envelope of the lobes—from -180 to +180 degrees.

Role of antenna radiation pattern in microwave backhaul

The advancement of antenna technology has resulted in a marked improvement in signal energy distribution. This can be seen from the radiation pattern envelopes (RPE) of ETSI Class 2, Class 3, and Class 4 antenna specifications. **(Figure 1)**. Equally important, lower side lobes can now be achieved cost effectively.

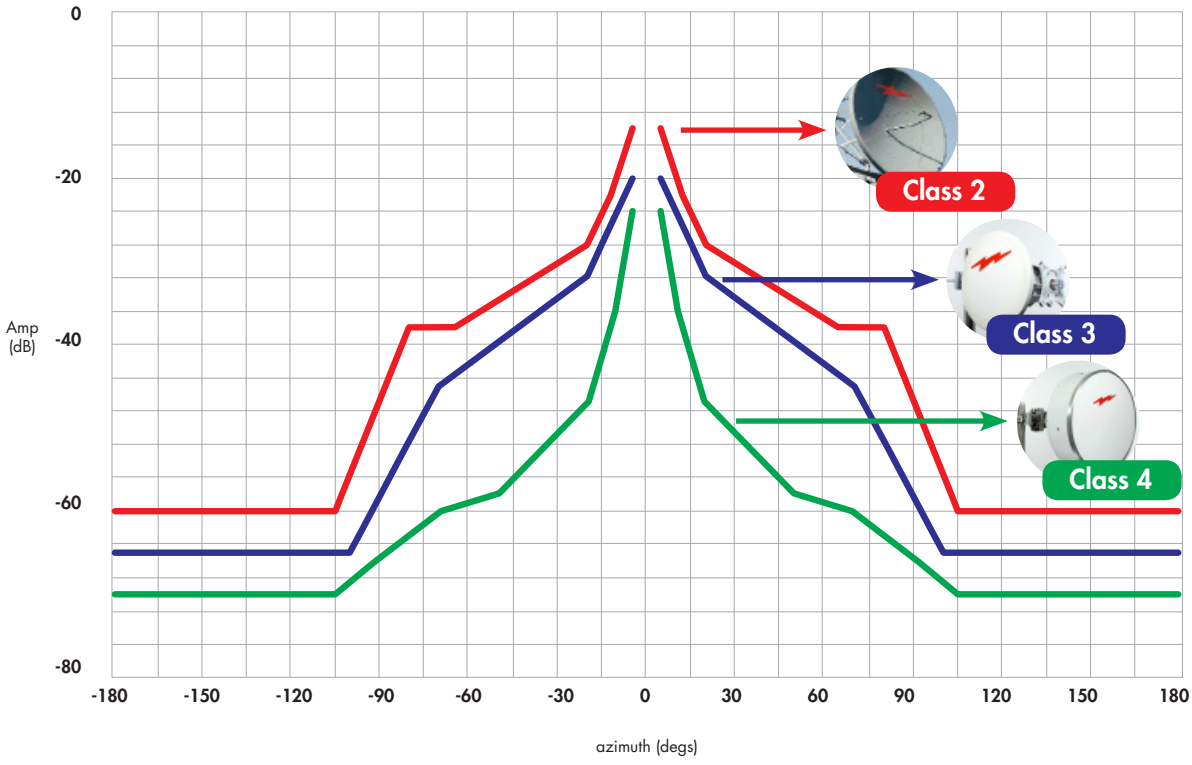

Figure 1. Example of antenna RPEs with different ETSI classification

Shannon's Law for Capacity

The theoretical maximum capacity of a communication link is defined by Shannon's Law, which establishes a relationship between channel bandwidth (B) and carrier-to-noise ratio (C/N), which is the total received ratio of signal level to noise level:

$$\text{Capacity} = B \times \text{Log}_2 \left(1 + \frac{C}{N}\right)$$

B=Channel bandwidth; C=Carrier power (RSL); N=Noise in RX_R

In today's era of digital communication, information flows as a group of bits, called symbols. To quantify capacity thresholds, one must encapsulate the maximum number of bits in symbols. These symbols ride on higher frequency signals called carriers, and it is important to extract this information while minimizing noise before they reach the receiver. Modulation and encoding schemes, signal noise, and the precise extraction of signal information all impact capacity.

In a typical microwave point-to-point link, the carrier power or received signal level for a given link can be increased by transmitting more power, using a higher-gain antenna or increasing the sensitivity of the receiver. The received signal level (RSL) fluctuation depends upon the condition of the radio link, including changing weather conditions in the area.

Recall that, in the microwave mobile backhaul domain, multiple links operate side by side. This introduces the risk of interference (I), which must be included in any noise calculation within the carrier-to-interference ratio (C/I).

The radiation pattern becomes tighter from Class 2 ETSI specifications to Class 3, and then from Class 3 to Class 4. Hence, a Class 4 antenna has a tighter distribution of energy than a Class 3 antenna, which reduces interference. And it is the driver behind a significantly higher signal-to-noise ratio than is possible with lower-Class antennas under the same microwave link conditions **(Fig. 2)**.

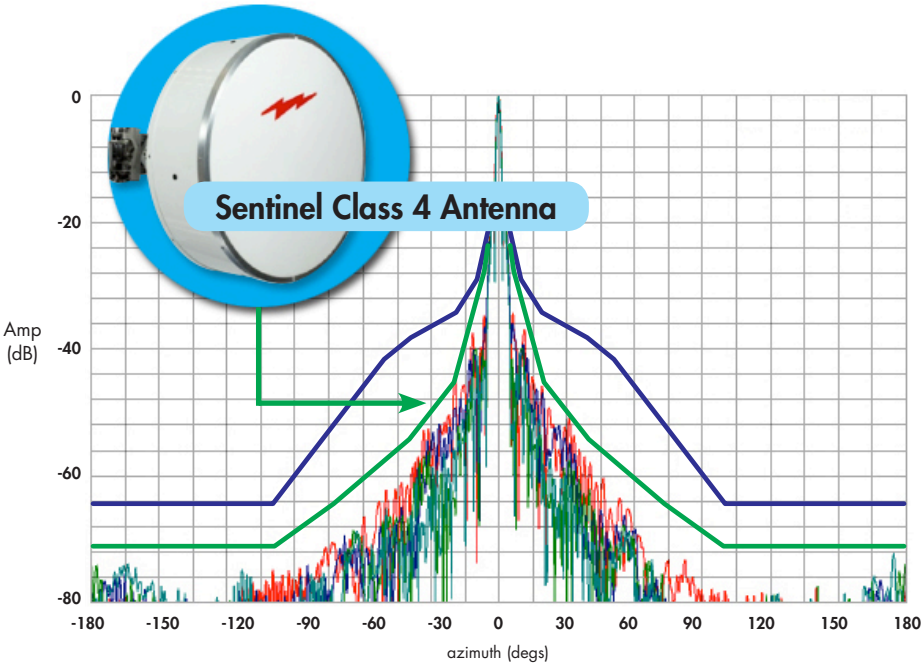

Figure 2. 2ft 23GHz Measured Patterns

Efficient spectrum utilization enhances capacity

Sentinel Class 4 antennas from CommScope deliver a significant improvement in antenna performance. Since 2012, several networks have been deployed using Sentinel microwave antennas. These antennas are fully compliant with ETSI Class 4 standards and have dramatically lower side lobes than ETSI Class 3 antennas. In a typical mobile backhaul network, a node is connected to different sites **(Figure 3)**. Antennas with low side lobe levels allow better reuse of the same frequency channel and thus allow more beams carrying the channel to arrive successfully without interference occurring. (This scenario is theoretical but it helps illustrate the point.)

The channel's reuse factor will depend on two main variables:

- The antenna's RPE
- The required interference attenuation between adjacent links

Consider, for example, a node in a star network and the maximum number of links it can support by reusing the same frequency channels in the 23 GHz band. When using 2-foot

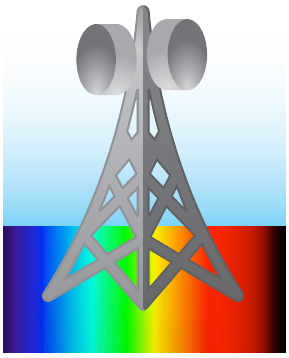

Figure 3. A node of typical mobile backhaul network

antennas with required attenuation in co-channel hops of 40 dB, the possible angular separation between links with antennas of varying ETSI classifications, which define their side-lobe levels, becomes evident **(Figure 4)**.

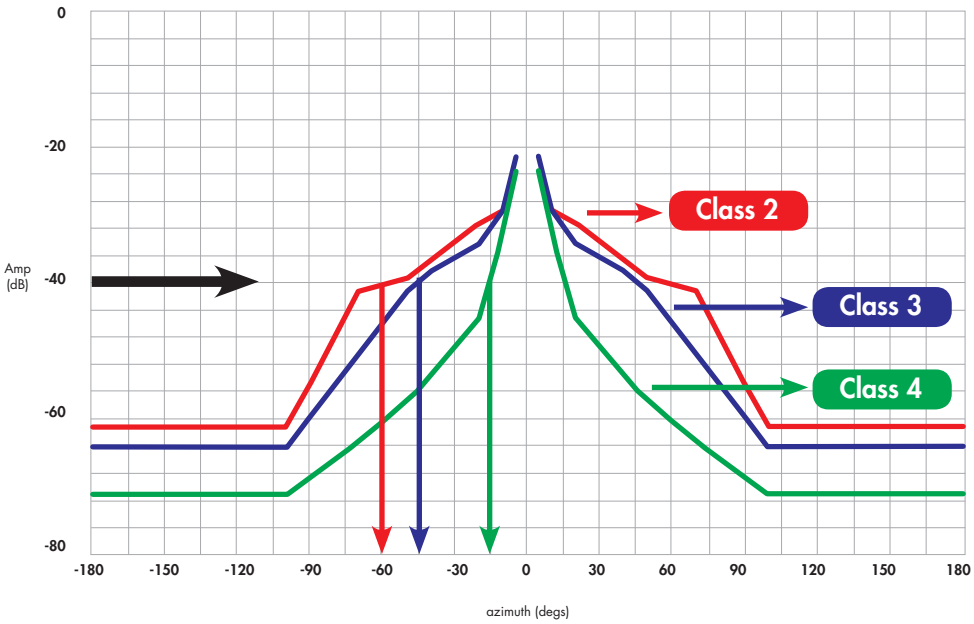

Figure 4. Minimum angular separation required to achieve 40dB isolation from an adjacent antenna.

The frequency reuse factor, or the maximum number of links that can be used on a particular frequency channel on a node with antennas having different side lobe levels, is shown in **(Figure 5)**. The ultimate level of enhancement depends on the attributes of each independent network.

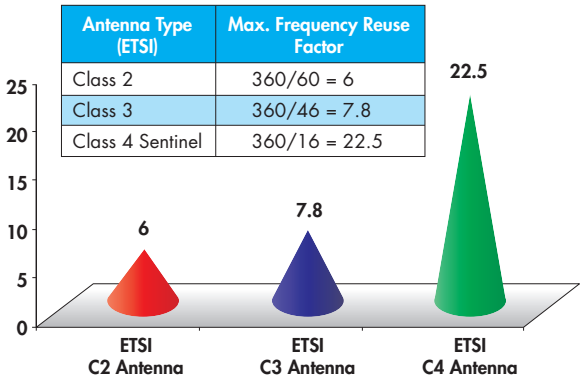

Figure 5. Example of maximum frequency reuse factor, demonstrating large potential cost savings

In another case study of a different complex 23 GHz network topology, first running with 2-foot ETSI Class 3 antennas and then with Sentinel Class 4 antennas, IQ.Link®XG, the Comsearch® network planning software, demonstrated that 30 percent to 40 percent more links can be assigned. The result is a 42 percent reduction in spectrum use, regardless of the number of 28 MHz available channels **(Table 1)**.

Channels	Number of links with Class 3 antennas	Number of links with Class 4 antennas	% Improvement
1	136	190	39.7
2	241	323	34.0
3	321	449	39.9
4	382	493	29.1

Table 1. The incremental improvement from Class 3 to Class 4 relative to the number of channels

The importance of antenna side lobes in a point-to-point radio link is increasing. As interference in a network grows, capacity per geographic area drops. Quality antennas, with their low side lobes, provide immunity to interference **(Figure 2)**, thereby achieving a higher signal-to-noise ratio. Sentinel, therefore, represents a significant dual opportunity for operators by efficiently utilizing spectrum and delivering:

1. Increased capacity by boosting maximum frequency re-use by a factor of three (three times as many links can be added in the same spectrum); and
2. Reduced costs for growing capacity by lowering spectrum requirements over a given number of links.

Conclusion

Growing demand for increased capacity requires a strategic backhaul network optimization plan. As spectrum availability constricts, operators must seek every opportunity to maximize their existing spectrum utilization. Purchasing additional bandwidth is expensive—and soon, it may be impossible. ETSI Class 4-compliant Sentinel technology delivers bottom-line benefits while protecting a network from demand surges that could otherwise cause major outages.

Sentinel antennas from CommScope allow operators to strategically plan for their long-term backhaul network needs while protecting both their capital and operating budgets.

* These figures have been validated with IQ.Link®XG, Comsearch's network planning software, on a 23 GHz network using 753 links with similar radios but with varying capacities of 2E1, 4E1, 8E1 and 17E1.

We're proud to be a part of your network's story.

Here at CommScope, we embrace our role as a trusted resource, partner, and facilitator. We create the infrastructure that connects the world and evolves with every advance in technology. By investing all of our capabilities, resources, relationships, and products into your toughest challenges, we continue our long history of solving problems together—paving the way for new ideas and fresh ways of thinking.

We're a trusted resource and partner around the world because we're invested in you: your people, your networks, your success. It inspires us to build relationships and infrastructure…connect people and technologies across protocols, oceans, and time zones…and share what we learn along the way.

This is our promise to you.
This is CommScope.

COMMSCOPE®

www.commscope.com

Visit our website or contact your local CommScope representative for more information.

WP-108340-EN (09/14)