Evolution Long Haul
All-Indoor vs. Split-Mount Configuration

Abstract

Multi-carrier, long-haul radio links can be housed in *all-indoor* or *split-mount* configurations. Considering current and future constraints and market requirements and trends, this paper determines a set of guidelines for selecting either of the configurations. Extensive experience with Ceragon's Evolution™ Long-Haul family provides a practical guide.

Long Haul Solutions – Deployment Considerations

Radio network planners design radio links based on a well-established set of guidelines. A long-distance radio link is designed to carry high-capacity voice and data over a varied terrain with various restrictions applying to radio sites and tower-accessibility. In addition to terrain and climate conditions, the environmental footprint must be taken into consideration when designing a site, especially in high-density urban areas.

Traditionally, the all-indoor site solution has been the de-facto option when planning and designing a backbone network. It is still a preferred solution in many projects that require quick and easy access to the installed equipment or where the costs associated with tower accessibility are too high.

However, in the majority of cases, the split-mount configuration proves to be more budget- and footprint-efficient. It allows network planners to be considerably more flexible when selecting the most appropriate configuration: split-mount to reduce installation and operating costs, versus all-indoor when tower access is too problematic.

When designing a new network or planning an upgrade, radio network planners are faced with many requirements and considerations including capacity, available spectrum, link and service availability, footprint and expenditure. Pressured by ever-increasing traffic and service demand, operators require new solutions to address the the challenge of accommodating increased traffic demand while minimizing expenses to carry that traffic. At the same time, network planners need to consider cost pressure, trends and technology advancements in order to provide cost-effective and future-proof solutions for operators.

Cost Pressure

Today, more and more traffic passing through radio links originates in data applications which generate far less revenue per bit than traditional voice traffic. In addition, as mobile communications continue to spread around the world, radio links are introduced into territories where voice ARPU is limited. Radio planners are challenged to be more cost-conscious when designing these radio links in order to decrease expenses associated with them and to bolster network profitability.

Migration to All-IP

The shift from TDM-based traffic to packet-based traffic is not only happening in the data world, but also impacts voice applications with converged all-packet-over-IP/MPLS network topologies. Traditional IP/MPLS deployments with SONET/SDH connectivity are being replaced with high-capacity, cost-efficient Ethernet. The move to all-IP forces network operators to undergo the expense and inconvenience of upgrading their field equipment, but this gives them an opportunity to take advantage of new technologies such as split-mount.

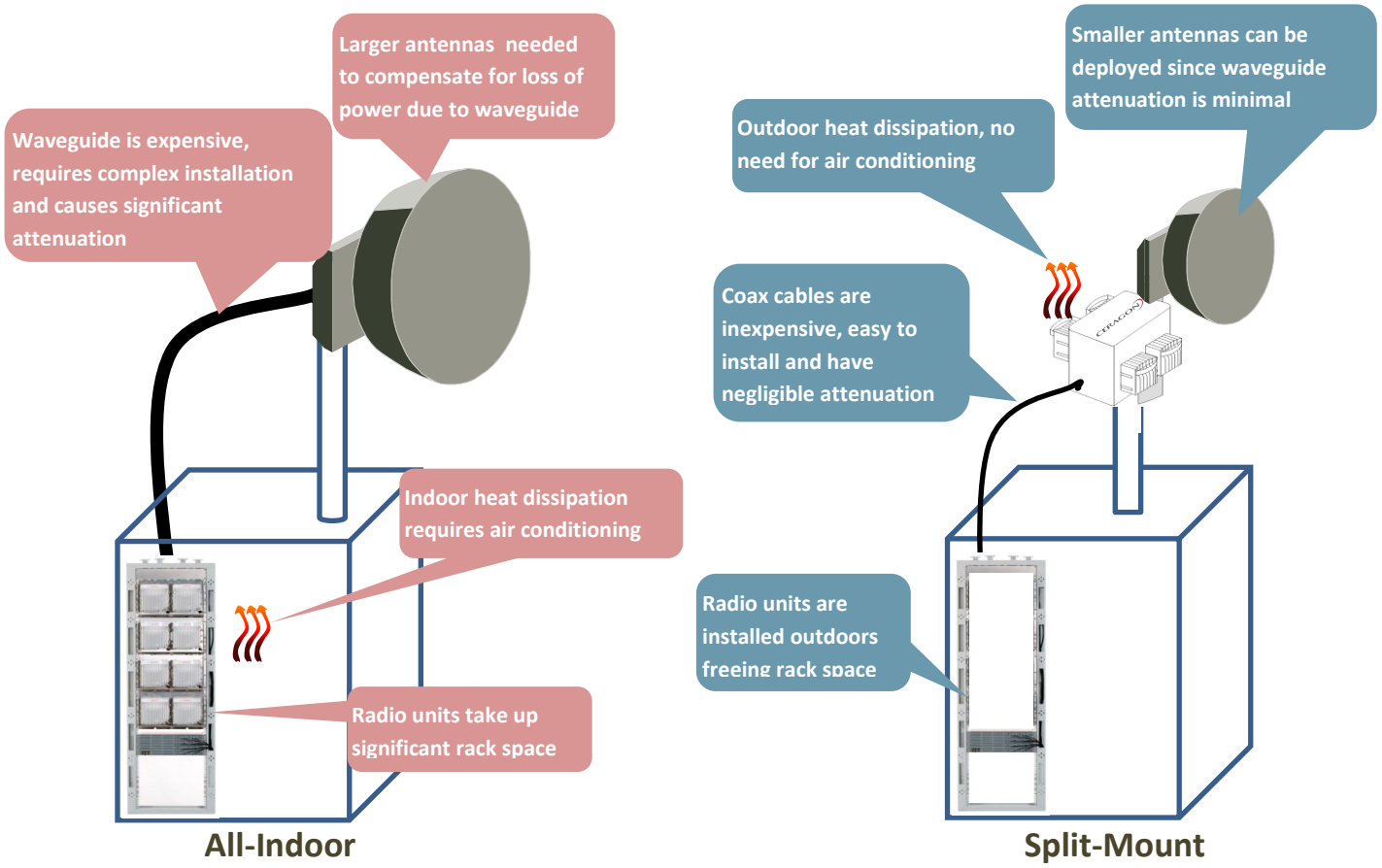
Radio Equipment Improvements

Traditionally, there are four main concerns that dictate the dominance of all-indoor solutions: output power, multiplexing of radio units into a single antenna port, equipment reliability and the simple fact that high-power radios were too bulky to be used outdoors. Until recently, there was no alternative to all-indoor solutions that could deliver the performance required for long-haul applications. To provide a split-mount solution suitable for high-power, long-haul applications, vendors had to address radio design issues such as high-power heat dissipation, size and weight of RF units, radio branching (circulators, filters, etc.) and, of course, radio-unit reliability.

Ceragon - First in the Industry with a Long-Haul, Split-Mount Solution

Several years ago, Ceragon created an industry breakthrough by delivering its first split-mount solution for long-haul applications. Driven by the increasing market demand for flexibility and link cost reduction, Ceragon designed a truly optimized high-power, compact, split-mount solution.

Ceragon's long-haul transceiver unit was the first high-power radio to provide adequate heat distribution in no-air-conditioning environments. This meant that, for the first time, radio units could be used outdoors in the most demanding conditions without the use of cooling fans. This innovative, patented technology led to significant reductions in power consumption making the new solution ideal for locations with no access to commercial power. Improved system gain also accommodated smaller antenna sizes which meant cost and footprint reductions for operators.



FUNCTIONALITY - Split-Mount vs. All-Indoor Comparison

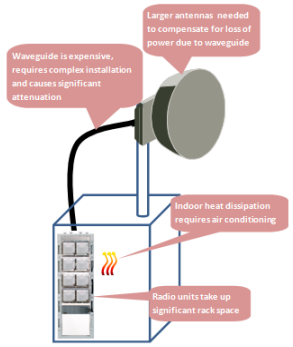
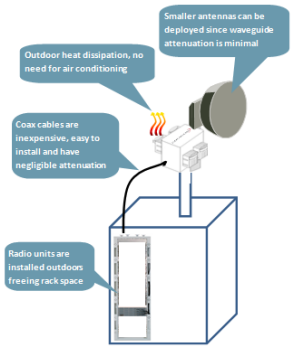
Ceragon offers both split-mount and all-indoor long-haul solutions. The table below compares the two configurations. It is easy to see that in cases where tower access is relatively simple or power is not easy to provide, split-mount solutions outperform all-indoor solutions. In other cases, a more detailed cost comparison is required and is also presented.

Long-Haul Solutions	All-Indoor	Split-Mount
Output Power	31dBm [6Ghz]	31dBm [6Ghz]
Waveguide Loss	2-10 dB	0.5 dB (Short, flex-waveguide between outdoor unit and antenna)
Extreme Conditions	Protected	More exposed to thunderstorms, hurricanes, etc.
Maintainability	No tower access required, just access to the equipment shelter	Requires access to the tower
Footprint	Entire rack	Small footprint occupies only ¼ of a rack
Installation	Complex installation but easier access for maintenance	Easy installation
Overall Performance	Some advantages in cases of limited tower access or extreme climate	Higher system gain and lower power consumption overall

Notes: All-indoor solutions suffer from waveguide loss that is linear with the distance from the equipment shelter to the antenna. In split-mount configurations, there is a negligible reduction in output power.

COST - Split-Mount vs. All-Indoor Comparison

The table below provides a concise cost comparison of Ceragon's long-haul split-mount and all-indoor solutions. It highlights the most obvious cost benefits of the split-mount over the all-indoor solution.

Ceragon's LH Solutions	All-Indoor	Split-Mount
		
Installation Materials (Accessories)	• Larger antennas due to typical 5dB loss per 100m waveguide • Expensive accessories (e.g., waveguide)	~60% savings on material costs • Smaller antenna size • Simpler installation & lower accessory cost (e.g., coax cable)
Space Cost	Requires full rack	Smaller footprint - occupies only ¼ of a rack
Heat Dissipation	Heat indoor • Fans • Additional air-conditioning expenses	Heat outdoor • No need for fans – convection cooling only • No need for air conditioning
Total Cost of Ownership	Although it requires more power, air-con and space, OPEX can be lower than with split-mount depending on the expenses associated with tower access	CAPEX investment can be reduced by as much as 60%. Some incremental cost may be incurred due to tower lease rates and maintenance operations

It is clear that split-mount provides a significant cost advantage in comparison with traditional all-indoor. Split-mount does not require expensive waveguides, only coaxial cable, resulting in lower material, installation and construction expenses. Split-mount's smaller footprint can offer considerable real-estate savings. Furthermore, since split-mount does

not require air conditioning, it offers a significant heat dissipation advantage thus reducing power requirements and further reducing operating expenditures.

Split-mount is significantly more cost-effective when the tower is self-owned and can be easily accessed. In cases where there is limited access to the tower or where access is strictly regulated, the all-indoor would necessarily be the preferred solution.

Summary

Ceragon successfully deploys both all-indoor and split-mount solutions allowing service providers, utilities, government agencies and mobile operators to select the most appropriate deployment scenario at the most advantageous cost point.

Throughout the years, all-indoor multicarrier systems have been the de-facto choice for carriers requiring long-distance, high-capacity communication. However, some deployments demanded a better utilization of real estate, lower power consumption, easier installation and, last but not least, a more economical solution. Ceragon has advanced the market by innovating a radio which can be deployed outdoors without cooling fans adding a real split-mount option for long-distance, high-capacity deployments. With this split-mount solution, operators can save up to 60% in their CAPEX investments while they enjoy significantly lower power consumption at each site.

ABOUT CERAGON

Ceragon Networks Ltd. (NASDAQ: CRNT) is the premier wireless backhaul specialist. Ceragon's high capacity wireless backhaul solutions allow cellular operators and other wireless service providers to deliver 2G/3G and LTE/4G voice and data services that enable smart-phone applications such as Internet browsing, music and video. With unmatched technology and cost innovation, Ceragon's advanced point-to-point microwave systems allow wireless service providers to evolve their networks from circuit-switched and hybrid concepts to all IP networks. Ceragon solutions are designed to support all wireless access technologies, delivering more capacity over longer distances under any given deployment scenario. Ceragon's solutions are deployed by more than 230 service providers of all sizes, and hundreds of private networks in more than 130 countries.

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APPENDIX - Waveguide and Antenna Loss and Gain

The tables below show the dB loss per 100m of waveguide for various frequency bands and a selection of 8 GHz antennas and their dB gain.

Frequency	Waveguide Loss Per 100m
L6/U6 GHz	5.0 dB
7 and 8 GHz	6.5 dB
11 GHz	10.5 dB

Frequency	Diameter (m)	Antenna Gain (dB)
8 GHz	1.2	36.5
	1.8	40.3
	2.4	42.9
	3.0	45.2
	3.7	46.3