Reducing Power Consumption in Microwave Networks

Abstract

This paper focuses on the importance of electrical power efficiency when planning and designing microwave networks. The paper provides an in-depth description of the Long Haul microwave radio power-saving technologies and covers the benefits of Ceragon's Long Haul split-mount solution over all-indoor configurations in terms of power consumption and power savings per site.

Power consumption considerations

As the demand for higher capacities pushes operators to upgrade their networks, they look for smarter, more cost-efficient wireless backhaul solutions. Today's transmission equipment must adapt to variations in traffic load and weather conditions and maintain the best quality of experience, while reducing overall operation cost.

Power consumption is one of the major issues to address when selecting microwave equipment. This is especially true for installations that do not have access to commercial power and rely on solar energy or diesel generators for their power supply. Typical long-distance multicarrier systems demand for about 100 watts per carrier to operate, hence choosing a 'power friendly' transmission solution becomes a top priority for operators concerned with lowering their expenses.

In its *Backhaul Requirement No.88*, the NGMN Alliance (Next Generation Mobile Networks) specifies that: "The hardware of NGMN Backhaul solution should support several power consumption modes adapted to the current traffic, the environmental conditions, etc. and

should automatically switch to the mode with the lowest possible power consumption when possible."[1]

Understanding the challenges facing its customers and the need for power-smart solutions, Ceragon took special care to address this issue by designing a radio that would consume 30% less power than competing long-haul microwave equipment. Ceragon's Long Haul platform features high transmit power with only 70W per carrier for a complete system providing significant overall savings on the cost of electricity alone while adding efficient power and heat management capabilities.

Improving power efficiency with dynamic biasing

Wireless transmission infrastructure is used to establish high-capacity, point-to-point connections in mobile and other telecommunication networks. Due to limited availability of spectrum resources, there is always a need for high spectral efficiency. This, in turn, demands the use of highly linear power amplifiers. Such amplifiers are traditionally operated in 'Class-A' and have poor Power Added Efficiency (PAE). To address the issue of linear added power (in proportion to capacity), Ceragon has developed a viable and cost-efficient enhancement scheme. This technology, called the **Dynamic Biasing Scheme**, amplifier bias voltages are functions of the signal envelope level. The use of unique bias power supply leads to a significant reduction in overall power consumption.

A point-to-point microwave radio unit that generates 1W of output power (30 dBm), typically has an overall power consumption in the range of 70-80W of which about half is used in the power amplifier. Efficiency improvement of amplifiers with the linearity properties of Class-A is a very attractive approach for wireless infrastructure radios. An amplifier runs in Class-A if the output-signal amplitude is a linear function of the input signal amplitude across the entire signal swing. This ideal situation requires that the current in the amplifier device does not saturate nor go through zero. Traditional implementations of Class-A amplifiers have constant bias supply circuitry per the general rule for all amplifier types. The real benefit of the Dynamic Biasing Scheme is that the power supply to the amplifier can work with sufficient speed and high efficiency as the total power efficiency calculation has to include added power dissipation in the supply circuit.

Efficiency enhancement by Dynamic Bias is implemented in Ceragon's Evolution™ radios saving approximately 15W of dissipated power compared with static Class-A solutions.

[1] "NGMN Optimized Backhaul Requirements", R88

Ceragon's unique offering to reduce power consumption

Dynamic biasing

Ceragon has applied a biasing scheme whereby the amplifier bias voltages are functions of the signal envelope level. The use of this Dynamic Biasing increases the efficiency of the amplifier stage from 3.3% to 10%, thus leading to significant reduction of overall power consumption. This technological improvement has made Ceragon Long Haul radios the most power-efficient radio on the market today **with at least 30% lower power consumption than competing all-indoor installations**.

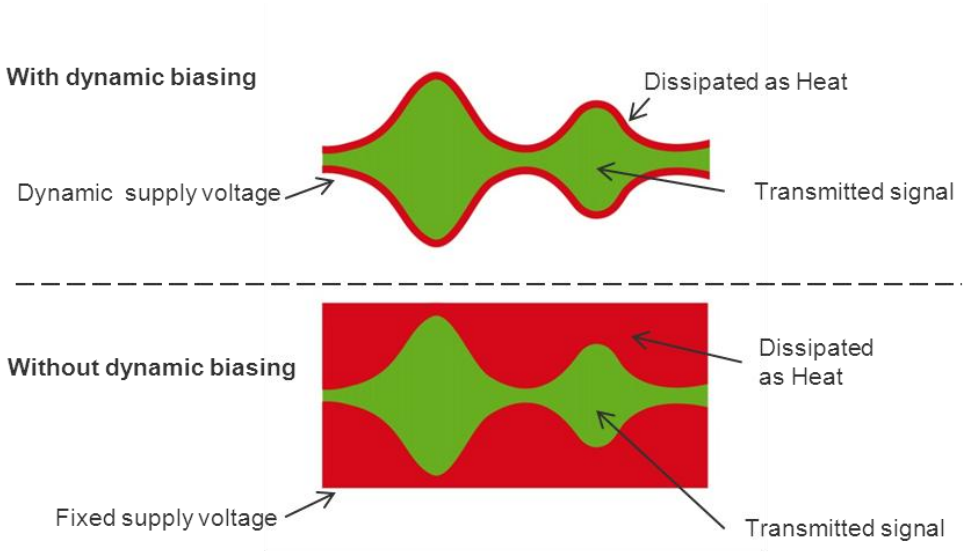


Figure-1 Dynamic Biasing to achieve reduced power consumption

Significant OpEx Reduction with Less Environmental Impact

Let us look at how Ceragon's unique offering of dynamic biasing not only improves power efficiency, but also saves thousands of dollars per cell site. Consider this example: in a typical eight-carrier site, the network operator can reduce power consumption by up to 30% per carrier. Assuming an average price of $0.2 per kwh, this can add up to about $560 a year in electricity costs alone. Remote sites, powered by an auxiliary power generator, can reduce diesel fuel consumption by as much as 280 liters/year, thus saving an additional $500 annually. For a solar powered site, the difference in CAPEX can amount to $22,400. Apart from the direct savings, operators get a greener site as Ceragon's dynamic biasing technology saves about 1 ton of CO_2 emission per year.

Long Haul in a split-mount configuration

In typical cases, trunk systems are installed in all-indoor configurations. This is mainly because these systems use high-power radios that require forced cooling. Ceragon's Dynamic Biasing technology allows for designing compact radio units that address the heat- dissipation problem. Enabling the radios to operate outdoors as well (in split-mount configuration) eliminates the need to use fans for cooling. This provides operators with the advantage of a more flexible and cost-effective option when designing their long distance links, i.e., **a multicarrier high-power system in a split-mount configuration with 44% lower power consumption than any competing solution**. Ceragon is the only vendor to offer the flexibility of choosing between all-indoor and the unique split-mount configuration for multicarrier high-power, high-capacity systems. The table below provides a concise comparison of Ceragon split-mount and all-indoor solutions as it highlights the most obvious benefits of Long Haul split-mount over all-indoor.

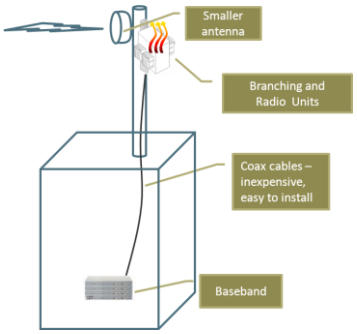
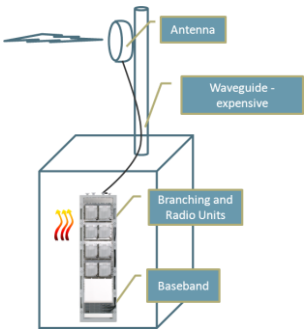
Ceragon's LH Solutions	Split-mount	All-indoor
Configuration		
Foot print	**Occupies only ¼ of a rack** – small footprint	Entire rack
Heat dissipation	**Heat outdoor** • No need for FANs – convection cooling only • Savings 29W/h per radio unit	**Heat indoor** • Added air-conditioning costs
Installation material	**~60% savings on material costs** • Antenna sizes - smaller antennas • Coax cable: simpler installation, lower equipment cost	• Larger antennas due to typical 5 dB loss per 100 m waveguide • Expensive wave- guide
Installation	Easy installation	Complex installation, yet easier access for maintenance

Table-1: Ceragon Long Haul split-mount vs all-indoor configuration

Test case: Power consumption saving

The table below considers a test case for an eight-carrier Long Haul system, comparing Ceragon all-indoor and split-mount configurations with a typical all-indoor system.

	Typical All-indoor	Ceragon LH All-indoor	Ceragon LH Split-mount
Power consumption per carrier	~100W	70W	55W – outdoor radio 15W – indoor baseband
Power consumption eight carriers	800W	560W	• 440W outdoor part – requires no cooling • 120W - serving baseband part only
Direct electricity savings	---	240W	240W
Heating, ventilation and air-conditioning (HVAC) power consumption	272W	190W	41W
Heating, ventilation and air-conditioning (HVAC) electricity savings*	---	82W	231W
Total savings radio link	---	322W (30% less)	471W (44% less)
Total savings per year in diesel (liters)	---	280 liters	413 liters
Total yearly electricity savings in USD per site**		**$ 563**	**$ 826**

Table-2: Eight carrier system: Ceragon LH systems vs typical all-indoor system

* HVAC with EER (Energy Efficiency Ratio) = 10

** Average price of $0.2 per kwh.

For an eight-carrier Long Haul system, the energy savings versus typical all-indoor solutions per site are as follows:

1. Operating electrical power savings: $4,205 over 10 years.
2. Heating, ventilation and air-conditioning (HVAC) electrical power savings: $1,430 over 10 years for an all-indoor site, or $4,051 over 10 years for a split-mount site.

This benefit totals $5,640 for an all-indoor site or $8,270 for a long haul split-mount site over a period of 10 years. For a typical backbone network with an average of 100 sites, this results in average $500,000 to $800,000 savings over 10 *years in energy costs alone!*

Comparing systems with different power consumption rates, we see that radio design and configuration selection (all-indoor vs. split-mount) can have a significant impact on the overall electrical power demands of the cell site. From the case studies presented, we can see that by comparing typical long haul radio (~100W consumption) with Ceragon's high-efficiency radio employing Dynamic Biasing (70W), substantial energy savings can be achieved, especially for large trunking systems.

Summary

With the telecom industry taking on its share of social responsibility and striving to conserve energy, power consumption is a key component of a backhaul solution. Obviously, low power consumption is also critical for achieving lower total cost of ownership. Smart wireless networks should have an advanced power consumption scheme based on real-time usage and environmental conditions. Smart power consumption schemes can provide up to 50 per cent reduction in power consumption.

Ceragon is continuously working to implement the most innovative advancements into its high-capacity long-distance radio technology. In addition to capacity and reliability, radios must be cost-efficient in terms of power consumption. Ceragon has implemented its patented power biasing scheme into its radios resulting in reduced power consumption by 30% compared to all other products currently available. The same technology allows the delivery of high-power radios that operate outdoors – adding even more savings and flexibility with up to 44% less power. This translates into significantly lower CO_2 emissions and hundreds of thousands of dollars – even millions – in OpEx spending.

ABOUT CERAGON

Ceragon Networks Ltd. (NASDAQ: CRNT) is the premier wireless backhaul specialist. Ceragon's high capacity wireless backhaul solutions "allowing" 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 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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