

New Microwave Power Devices Can Satisfy Networks' Backhaul Cravings

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Backhaul, the path over which cell sites transfer data traffic to and from a central point, will be served in the coming years primarily by fiber optic networks and microwave point-to-point (PtP) links as wireless traffic continues to escalate at unprecedented levels. In many cases, especially North America, this trend will sever a long-standing commitment to T1-based backhaul systems. Fiber optic and microwave links each have their own unique characteristics in the backhaul application, but both share the ability to handle IP-based (data) traffic with high data transfer rates.

TriQuint Semiconductor continues to develop a broad line of components dedicated to microwave PtP applications and recently introduced three new RF power amplifiers for the 10,11,13,15, and 23 GHz PtP radio bands that combine high RF power output, linearity, and gain, with excellent power dissipation -- all key benefits for microwave radio manufacturers. The product line complements the company's high-performance optical modulator driver amplifiers for 10, 40, and 100-Gb/s fiber optic systems also targeted for backhaul applications.

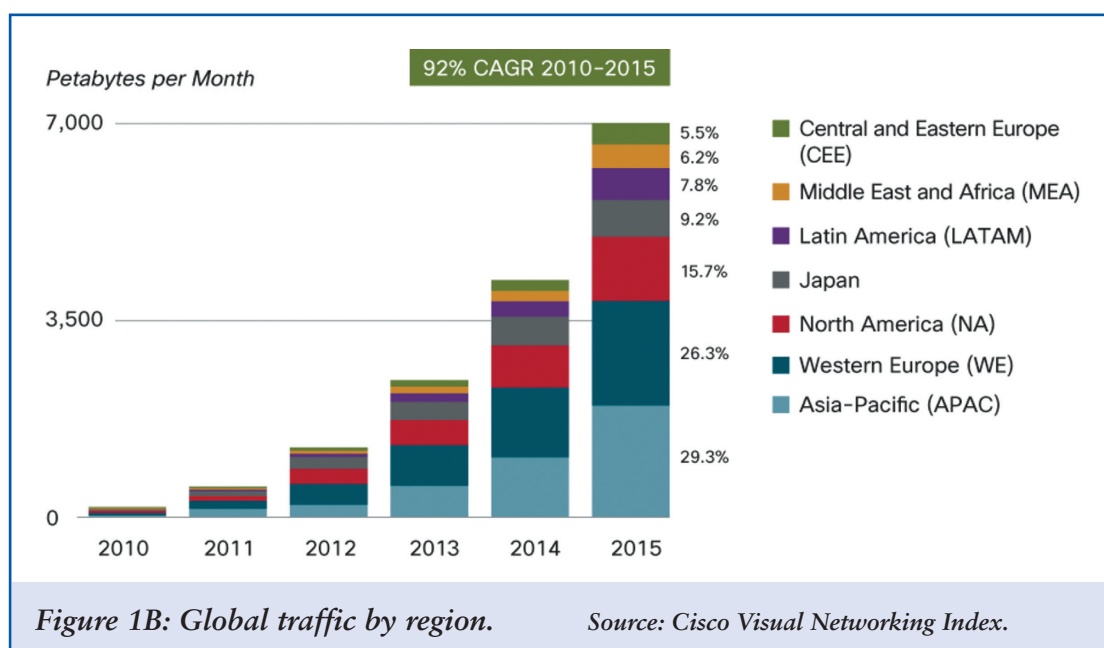
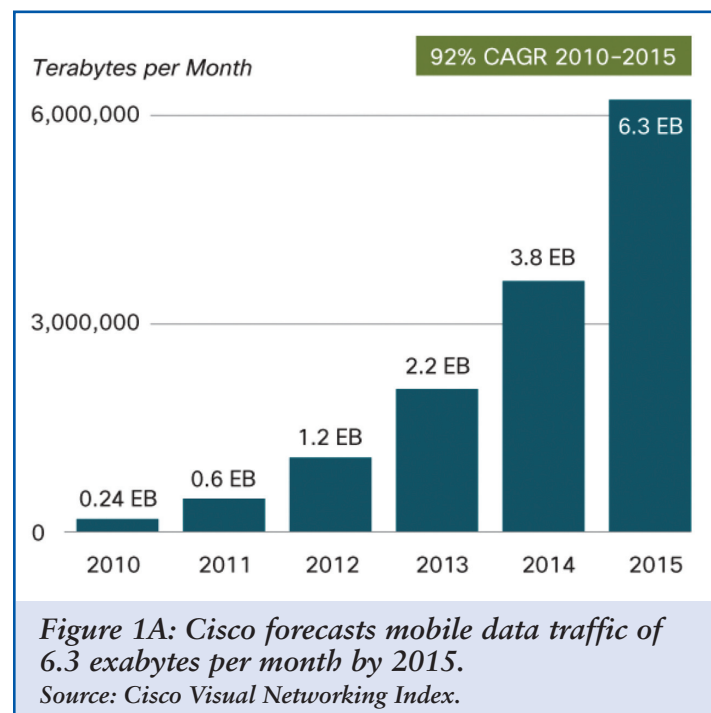
To Exabytes...and Beyond

It was only a few years ago that the primary complaint wireless carriers had with backhaul was its expense relative to other capital and operating costs, requiring huge numbers of dedicated T1 lines. Not only are T1's expensive, they are being overtaxed by the amount of data generated by mobile devices. Today carriers have a bigger problem brought on by the enormous success they enjoy thanks to the tremendous popularity of smartphones. The explosive growth of data traffic generated primarily by smartphones and tablets enabled by high-speed services such as HSPA+, LTE, and WiMAX are leading the capacity gap.

The numbers are staggering and even unfathomable, fostering the use of multipliers such as "peta-", "exa-", and soon "zeta"- bytes. The most recent Cisco Visual Networking Index estimates that mobile data traffic alone will increase 26-fold by 2015 at a compound annual growth rate of 92%, reaching 6.3 exabytes per month by 2015. An exabyte is 1 million terabytes or 1 billion gigabytes. There will globally be nearly one mobile device per person by 2015 and more than 7.1 billion wireless-enabled devices. In 2010 the amount of

worldwide data traffic exceeded global analog (voice) traffic; the numbers are escalating in an unprecedented manner. Mobile network connection speeds are predicted to increase 10-fold by 2015 and two thirds of it will be video. The amount of mobile data traffic generated by tablets alone in 2015 (248 petabytes per month) will be about the same as all global mobile data traffic in 2010 (242 petabytes per month).

Although traffic has been increasing consistently throughout the last decade, the iPhone and its competing



devices are viewed by most analysts as a defining moment for wireless carriers. The extraordinary sales of iPhones propelled data traffic to unprecedented levels, and this was quickly boosted by the proliferation of phones based on Google's Android platform. Not only did network operators scramble to handle the user traffic, they had to quicken the pace of exploring backhaul alternatives, of which fiber and microwave were (and are) the obvious choices for macro-level backhaul. Fiber offers great long-term potential, as it has enormous traffic capacity. However, as fiber nodes are rarely conveniently close to cell sites, microwave links provide a viable alternative and hold the edge over fiber for ease and cost of deployment for wireless network applications. Various microwave bands through 86 GHz are allocated for PtP service. Lower

frequencies offer narrower bandwidths but through a variety of techniques can achieve data rates of multi-gigabits per second.

Higher frequencies have wider channels that allow greater data rates to be achieved, but they operate over shorter distances, are more susceptible to disruption from precipitation, and are currently more expensive. Nevertheless, microwave solutions can provide a competitive solution due to short installation times, low capex costs, and broad frequency spectrum selection. Microwave radios are also very reliable and require little maintenance.

Filling In the Gaps

In addition to standard cells, carriers will need to (and are in fact already deploying) large numbers of micro and pico cells to act as "gap fillers" to complement their larger

brethren. However, adding huge numbers of smaller base stations creates its own backhaul challenges since by nature they tend to be mounted on utility poles, buildings, or other structures that more than likely will not provide access to a fiber network. This has not been lost on enterprising entities ranging from cable Multiple System Operators (MSOs) to manufacturers of innovative backhaul solutions that have developed products for offloading traffic from these smaller sites.

One solution uses the inherent high-data-rate properties of IEEE 802.11n (WiFi) at 5 GHz as a PtP or meshed point-to-multipoint solution to deliver more than 100 Mb/s of backhaul capacity over surprisingly long distances by using “smart” high-gain antennas, beamforming and other techniques. Cable MSOs have also jumped into the fray and generate about \$200 million in backhaul revenue using their massive installed hybrid fiber coax plant and already serve more than 11,000 cell sites in the U.S.

Another approach to solving the backhaul dilemma involves combining satellite and microwave assets for ‘hybrid backhaul’. For example, multiple, closely-spaced base stations within a single microwave link distance of about 20 miles can be aggregated using microwave PtP radios and connected to the core network via satellite links. True satellite backhaul can also be employed, which is a means to connect geographically-isolated communities, and is considered for larger communities or regions that are far from the core network.

Wanted: Cost-Effective Solutions

It’s important to note that within all of these scenarios (except pure fiber), microwave technology is a key component of the solution, which is why microwave PtP is currently providing almost three quarters of cellular backhaul in Europe and more than 50% globally. With such fierce competition in the “backhaul space”, designers of

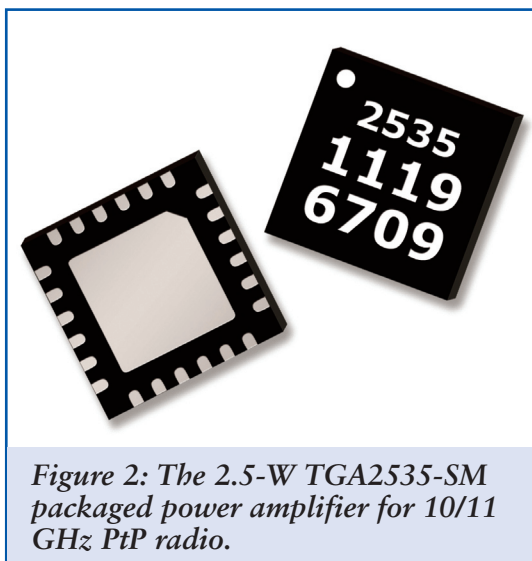


Figure 2: The 2.5-W TGA2535-SM packaged power amplifier for 10/11 GHz PtP radio.

microwave radios are constantly working to improve their PtP solutions to offer the most compact, highest performance, cost-effective solutions that consume as little power as possible. The requirements for low acquisition, installation, and operating cost are crucial, as carrier electricity bills are already one of the largest single operational costs for most networks.

TriQuint continues to work to meet these increased performance demands required by next-generation microwave radio systems as demonstrated by three new product releases. The new TGA2535-SM (Figure 2) is a 5x5-mm QFN packaged power amplifier that operates from 10.0 to 11.7 GHz. It provides saturated power output of 34 dBm (2.5 W) with a third-order intercept point of 43 dBm, 25 dB of small-signal gain, and operates at a quiescent bias condition of 6 VDC at 1300 mA.

The TGA2524-SM (Figure 3) is housed in a 3x3-mm QFN package, operates from 12 to 16 GHz, delivers 26.5 dBm (500 mW) of saturated power with a third-order intercept point of 37 dBm, small-signal gain of 23 dB, at an industry-leading quiescent bias condition of 5 VDC at 320 mA. Finally, the TGA4533-SM is housed in a 4x4-mm QFN, operates from 21.2 to 23.6 GHz, delivers 32 dBm (1.6 W) of saturated

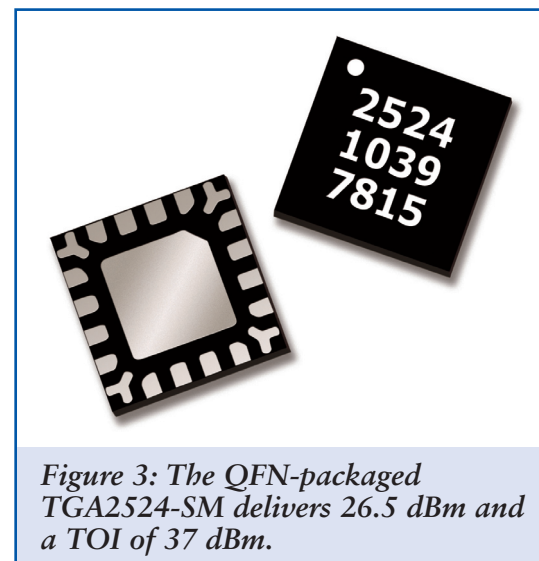


Figure 3: The QFN-packaged TGA2524-SM delivers 26.5 dBm and a TOI of 37 dBm.

power with a third-order intercept of 41 dBm, small-signal gain of 22 dB, and operates with a quiescent bias point of 6 VDC at 900 mA, offering best in class linear performance for a packaged 1-W power amplifier.

All three devices are internally matched for simplified circuit design and offer gain regulation via gate voltage adjustment. Both TGA2535-SM and TGA4533-SM have integrated power detectors with a dynamic range of more than 30 dB for use in power sense applications. A snapshot of key performance metrics is shown in Table 1.

Summary

Wireless-enabled devices ranging from smartphones to tablets share a common requirement for internet connectivity that results in monumental amounts of data traffic. Traffic loads have already escalated to unprecedented levels, even while purists might maintain that true “fourth generation” networks with even greater capacity requirements have not yet arrived. When this occurs with the release of LTE-Advanced by 2015, achievable wireless data rates are expected to equal those of wired networks such as cable, potentially generating far more traffic.

To accommodate such astronomical amounts of data, carriers face one of the greatest challenges in their history: increasing backhaul capacity while managing capex and opex costs and at the same time keeping the customer experience in line with expectations for “anytime-anywhere” connectivity. RF power amplifiers and other innovative solutions from TriQuint Semiconductor are helping provide designers with the components they need to simplify RF connectivity in new generations of microwave and millimeter-wave radios. More information about TriQuint’s PtP devices can be found at www.triquint.com.

Table 1: Key PtP GaAs pHEMT Amplifier Specifications

	TGA2535-SM	TGA-2524-SM	TGA4533-SM
Frequency range (GHz)	10.0 to 11.7	12 to 16	21 to 23.6
P3dB RF output (dBm, W)	34, 2.5	26.5, 0.5	32, 1.6
Small-signal gain (dB)	25	23	22
Bias (V/mA)	6 VDC at 1300 mA	5 VDC at 320 mA	6 VDC at 900 mA
Output TOI (dBm)	43	37	41
Package	5 X 5 mm QFN	3 X 3 mm QFN	4 X 4 mm QFN

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