

Mobile Data Backhaul: The Need For E-Band

by Emmy Johnson

We've been hearing about the bandwidth bottleneck for years, and as LTE and more broadband intensive applications are rolled out, rapidly increasing mobile data traffic will continue to threaten the stability of the network. This is especially a critical issue in urban centers where subscribers and mobile data traffic are the most concentrated.

Thanks to the increasing popularity of smart phones from the likes of Apple and Samsung, mobile data is expected to continue to grow unabated the foreseeable future. Cisco's most recent mobile data forecast predicted that mobile data will grow 13x over the next five years, from 0.9 Exabytes per month in 2012 to 11.2 Exabytes in 2017. Thus the question becomes, how do operators keep up with this level of exponential growth while keeping mobile services on par with customers' expectations?

There are several ways that operators are combatting this growth, through innovation in both the RAN and backhaul segments of the networks. The concept of small cells through heterogeneous networks is undoubtedly the most touted modernization, and although this is new, and very promising, there are still regulatory and cost details that need to be worked out to create cost-effective ROIs, especially in the outdoor model.

In the interim, another, but not as sexy, solution exists in the backhaul - replacing legacy SDH microwave links with faster, packet based millimeterwave radio links. While it's true that fiber is the preferred mode of backhauling traffic, it is not always available and cost effective. In many instances, the fiber is 100 feet too short, or it's available across the street or two buildings over, and an extra hop to get to the fiber access point is required. This is often where SDH microwave was used, and up until 18-24 months ago, the capacity that it offered was more than enough. However, since it's said that network traffic degrades to the slowest point in the network, it doesn't help to have an ultra-high capacity fiber ring when the slowest hop is sub-par.

If fiber is still not available, and if microwave is not fast enough, then what is the solution? Enter millimeterwave radios. For radio vendors, efforts for this type of application have centered on the 71 -86 GHz frequencies or the E-Band due to its licensing regulations and ultra high capacity attributes. Although there are licensing exceptions (i.e. Russia), this frequency is typically licensed or at least lightly licensed worldwide.

While radios in this frequency have been available for over a decade from early market entrants like Aviat, Bridgewave, Ceragon, E-Band Communications, and Loea, the frequency never got much attention for a few reasons. Since the E Band is so high on the spectrum, the frequencies are excellent conduits for carrying ultra high capacity (1 Gbps+) traffic at very short distances (typically 2 - 3 km); however, they were originally designed for one-off hops serving enterprise and government networks, with no real thought to conserving spectrum. Because demand was project based and therefore limited, cost effective pricing was challenging and due to limited market demand, no-off-the-shelf chips were available which exacerbates an expensive radio model.

Previously, the 60-90 GHz range, was known as sort of a spectrum wasteland, due to its very short distance limitations. Because the spectrum was thought to have little if any long-range demand, technical requirements for radios, in terms of spectrum efficiency, was minimal. Radios earned their technological stripes by the fat pipe concept, which meant that the typical radio didn't have to be all that discriminating, as long as it could use a really wide channel for capacity and QoS purposes. Due to the market's characteristics this was acceptable and not questioned.

A Shift in the Competitive Landscape

However, now that the need for ultra high capacity radios has become an unofficial requirement with a potentially large market backing it, the call for more spectrum savvy radios is in order. Traditional wisdom would have us assume that the legacy pure-play millimeterwave equipment vendors have this market clenched; however, every time there is a technology shift, as is occurring with the E Band market, it opens the field up to new market leaders and a new competitive landscape. Thus, we have seen traditional microwave vendors throw their hats into the millimeterwave ring with various levels of commitment from OEMing/private labeling traditional millimeterwave vendors' radios to designing their own millimeterwave radios.

Tier 1 Equipment providers like Ericsson, NEC, Huawei, and Alcatel-Lucent (via OEM), will be the biggest challengers in the E-Band market, with their end-to-end networking solutions and global sales forces. Microwave vendors like DragonWave, Intracom, SIAE, and Siklu bring amped up radios with strong networking features. Siklu not only brings radios, but also develops its own chipsets.

A Revamping is in Order

So with revamped technology and the availability of off-the shelf chips, the previous 1st Generation radios are being phased out in favor of smarter, faster, smaller, and less expensive 2nd Generation radios. Early market entrants like Aviat, BridgeWave, Ceragon, and E-Band have moved with the technology and have introduced sophisticated radios to meet the demands of mobile operators' backhaul requirements.

Vendors have designed their radios to meet mobile operators' key capacity requirements as well as have added many networking features, which at an aggregate level, translate to carrier class reliability. These include features like adaptive modulation, QoS,

synchronous Ethernet support, Layer 2 switching capabilities, and more. Despite the carrier class functionality and increased capacity, costs have decreased slightly, thanks to integration and off-the-shelf chip companies like Broadcom and Qualcomm.

Prices are expected to decrease more rapidly, once volume pricing commences. Although the features found in 2nd Generation radios are attractive to the same

verticals as those targeted by 1st Generation radios, SLR expects the bulk of revenue generated from the 2nd Generation radios to stem from the infill of mobile backhaul fiber gaps in the short-term and small cell backhaul in the long-term.

E-BAND MARKET THEN AND NOW

Target customers continue to include fixed line operators, mobile operators, service providers, enterprises, government and military entities, schools, utilities, hospitals, and municipalities. While applications from the early market of E-Band radios have not changed drastically, what has changed, is more cohesive global regulation of the band,

Carrier Class Functionality Table 1

Key Networking Specifications For Carrier Class Functionality	1 st Generation Specifications	2 nd Generation Specifications	Sustainable/Scalable 2 nd Generation Specifications
Modulation	QPSK/BPSK	Adaptive Modulation - 64 QAM or Higher	Adaptive Modulation - 64 QAM or Higher
Capacity	Less Than 1 Gbps or less of throughput	1+ Gbps, but under 2Gbps	2 Gbps+
Channel Width	Fixed or Variable Channels 250 MHz – 1000 MHz	Variable Channels 250 MHz – 500 MHz	Variable Channel Size < 250 MHz
Latency	>150 μSeconds	21 - 150 μSeconds	20 μSeconds or Less
Synchronous Ethernet Support	Simple Network Management	E2E Frequency & Phase Synchronization features enable and 1588v2	E2E Frequency & Phase Synchronization features enable and 1588v2
Traffic Shaping	Simple Quality of Service and/or Best Effort	Quality of Service and/or Bandwidth Acceleration	Advanced Quality of Service and/or Bandwidth Acceleration
Integrated Switch Functionality	None or Layer 1	Layer 2	Layer 3
Hitless Adaptive Modulation	Not Enabled	Enabled	Enabled
Physical Size	>12" or 30 cm	12" or 30 cm	< 12" or 30 cm
Security	None	Other form of security besides AES	AES 128-bit and 256-bit
Power Consumption	35+ Watts	21-34 Watts	20 Watts or Less

Source: Sky Light Research, LLC

more spectrum efficient radios with lower cost points, and a solid market driver – ultra high capacity backhaul in urban centers due to increasing mobile data traffic.

E-Band Millimeterwave radios will be used in urban settings for the following types of applications:

- ✓ The last mile gap between the fiber backbone and commercial buildings not accessible by fiber. Whether this is a fiber ring or a hop across the street, an E-Band radio compliments fiber by filling in the gaps of the network. This approach is typically much less costly than laying new fiber.
- ✓ Redundant networks to fiber for mission critical data.
- ✓ Networks that need to be deployed quickly, eliminating the wait time for various approvals, permits, etc. that often accompanies fiber.
- ✓ Ultra high capacity hops in shared networks among two or more operators.
- ✓ Mobile & small cell backhaul.

As outdoor small cells emerge, much of the focus will be on the unlicensed, 60 GHz V-Band, however, there will be room for E-Band radios as well. These radios will not be as ubiquitous as 60 GHz, due to the unlicensed nature of V-Band radios and their lower cost of deployment, but E-Band will be attractive for network points which require higher capacity and licensed links. Radios for small cell backhaul will have four main requirements: inexpensive, ultra compact, high capacity, and very easy to deploy.

HOW BIG IS THIS GOING TO BE?

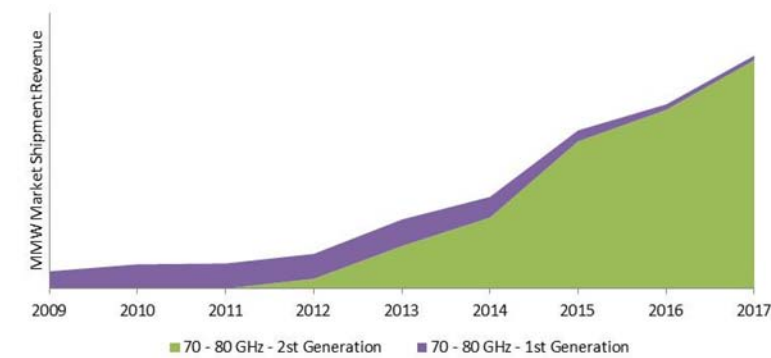
Like most markets, the E-Band market, has gone through several phases:

- ❖ Initially (late 1990's, early 2000's) it was over-hyped, resulting in the elimination of a handful of competitors.
- ❖ From there it transitioned into a stagnant market that was not progressing due to no killer application and legacy radios that did not meet the ROI objectives.
- ❖ Currently, it can be defined as a market with much near-term and long-term potential (thanks to a newly defined killer application: rapidly increasing mobile data backhaul), but is still on the front side of the demand curve.

The opportunity is ripe, and SLR believes that the total millimeterwave market (60-90 GHz) could reasonably surpass the half billion dollar mark in the next five years.

Several factors drive this forecast, but the critical factors are:

1. The business case for millimeterwave radios is stronger than it has ever been. Although prices that meet a successful ROI remain challenging, they are being met.
2. An authentic killer application. The need for ultra high capacity backhaul alternatives to fiber is critical as mobile data continues to proliferate.

Figure 1. E-Band Forecast Curve

Source: Sky Light Research

Microwave radio equipment vendors understand that gaining a piece of this pie is essential to their long-term voracity for growth. It's no secret that macro cell equipment investments have been pressured on all sides from the RAN to the backhaul as operators are spending their closely scrutinized budgets on

areas where they get the biggest bang for their buck – crowded urban centers with high data usage – which is exactly where E-Band radios will be used.

Due to required networking features and high capacity standards often sought by mobile operators, 1st Generation radios will continue to be cannibalized by less expensive, more advanced 2nd Generation radios. Although 60 GHz radios are not shown in the forecast, these will contribute positively to the overall millimeterwave forecast filling in holes with unlicensed radios in high data areas that are not reachable with fiber.

Looks Great, But What Does it Mean?

Figure 2 segments the market's available radios into four categories – 1st Generation, specialized radios, 2nd Generation, and Advanced 2nd Generation. The radios are plotted on two axes- capacity and carrier class functionality. The vertical axis plots capacity and the middle horizontal grid line represents the standard capacity (1 Gbps) of a 2nd Generation radio. The horizontal axis plots a formulated score for advanced networking features or carrier class viability on a scale of one to five. The middle vertical grid line represents the baseline score (3.0) for carrier class features of 2nd Generation radios.

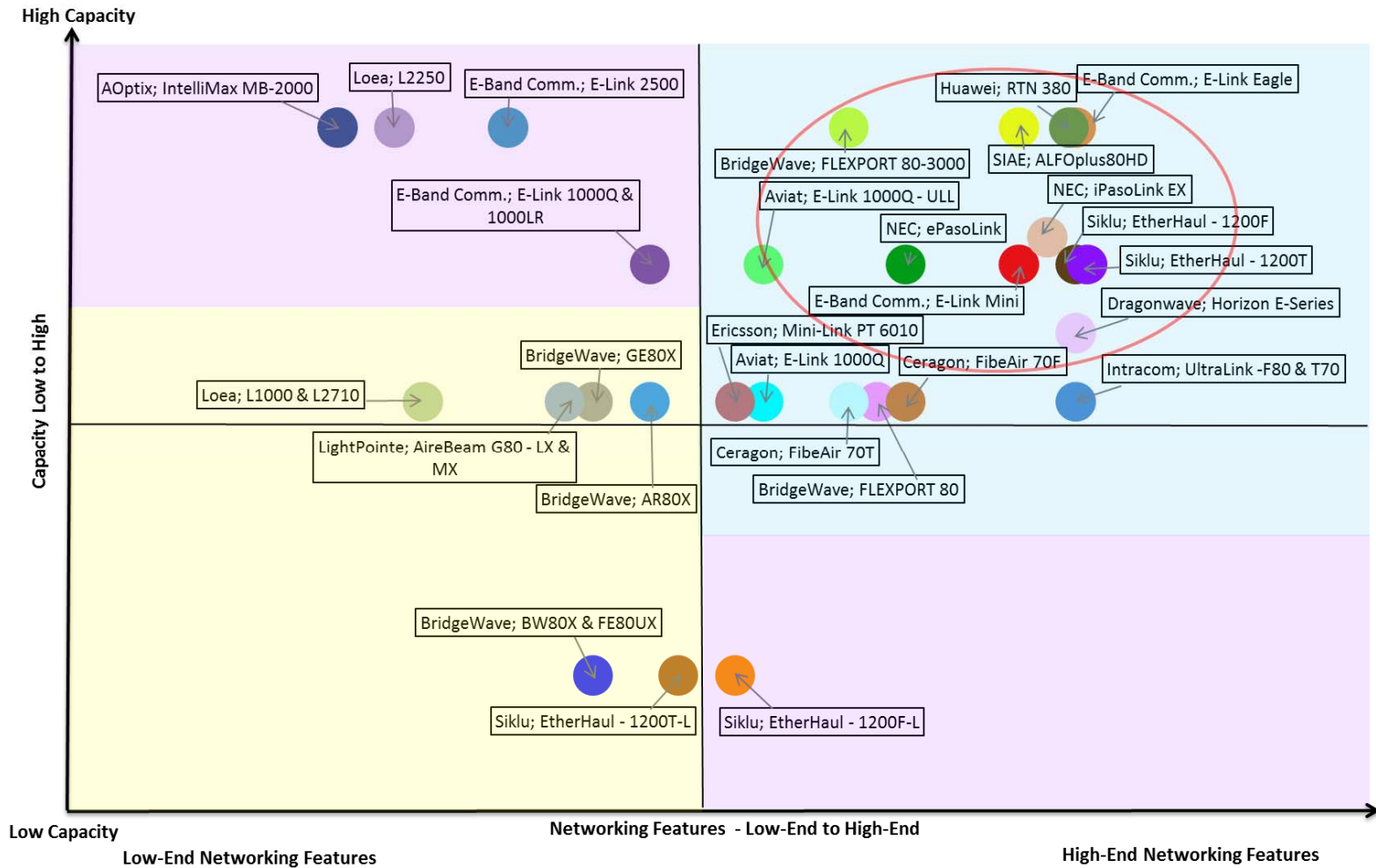
It's important to remember that many of the technical advancements in millimeterwave radios have come from off-the-shelf chips from vendors like Broadcom (via Provingent acquisition) and Siklu. Most of the millimeterwave radio equipment on the market today uses silicon from one of these chip vendors and therefore, have subtle differences among their radios. As Figure 2 demonstrates, the advancements of various radios looks large, but by comparison, the difference among the vendors in each quadrant is often less than one point. The difference is that while some vendors focus on security, others may focus on capacity, latency, 1588.v2 Ethernet Support, or one of the other characteristics outlined in the Carrier Class Characteristics table [see inset, page 3].

Methodology Note

Sky Light Research took the features listed in Carrier Class Characteristics Table on page 3 and assigned a score to each. These were then tabulated for a carrier class score – the higher the aggregated score, the further to the right of the chart the radio lies. Although the entire blue shaded area indicates a solid 2nd Generation radio, the sweet spot is that within the red circle. These radios scored high in both capacity and carrier class functionality, indicating that they may sustain their market value longer due to a combination of advanced networking features.

It should be noted that specifications were found in vendors' data sheets and claims that vendors made on surveys. Some of these claims were not able to be verified. If no information could be found, assumptions were made. No radio possessed every 2nd Generation networking characteristic listed in Table 1 [see page 3], but those that scored the highest (Advanced 2nd Generation) typically had the most features or more advanced features. Figure 2 correlates to the specifications outlined in Table 1 [see Carrier Class Characteristics Table, page 3].

Figure 2. Millimeterwave Radio Ranking Matrix



Source: Sky Light Research, LLC

First Generation Radios

First Generation radios are those that are in the yellow shaded area or the inner most area of the graph. Most of these radios have been shipping for several years and may be on the latter phase of the product lifecycle. These radios typically are expensive and geared more toward enterprise applications and have lower capacity and/or fewer carrier class characteristics. Although they may possess some of the characteristics in all three columns of the Carrier Class Functionality Table, they have more characteristics associated with 1st Generation radios than those in the other two categories.

Specialized Radios

Specialized radios are those that are in the purple shaded area. These radios are most similar to 1st Generation radios, but have either very high capacity and few carrier class features, or very low capacity and many carrier class features. They may be geared toward more specialized applications or they may be using a very wide channel in order to obtain the reported capacity. Like, 1st Generation radios, they too, may possess some of the characteristics in all three columns of the Carrier Class Functionality Table, but have more characteristics associated with 1st Generation radios than those in the other two categories, with the exception of capacity.

Second Generation Radios

Second Generation radios are those radios that are in the blue shaded area or at the top right quadrant of the graph. These radios have typically been designed to cater to the mobile operator space and may have been recently introduced. Many of the radios have additional capabilities and/or capacities through additional equipment and/or add-ons; however, SLR asked vendors to specify characteristics for their radio based on stand-alone radio features – that is, the performance level of the radio without the help of additional equipment. Although some of these radios may possess characteristics in all three columns of the Carrier Class Functionality Table, they have more characteristics associated with 2nd Generation radios than those in the other two categories.

Advanced Second Generation Radios

Advanced 2nd Generation radios are those radios that are inside of the red circle in the blue shaded area. These radios possess many of the same features as 2nd Generation radios, but have a few more scalable features or more 2nd Generation features than other radios. Like 2nd Generation radios, they have been designed to cater to the mobile operator space for small cell backhaul and may have just recently been introduced. Although these radios may possess characteristics in all three columns of the Carrier Class Functionality Table, they have more characteristics associated with 2nd Generation radios than their counterparts. Further many of these vendors have

roadmaps for multigigabit speeds, CPRI transport, and 256 QAM. For example, Huawei has 10 Gbps capacity, 256 QAM, 96dB system gain, active XPIC, full and sub channeling from 62.5 to 1000 MHz, CPRI transport and more already on the roadmap for their RTN 380.

About Emmy Johnson and Sky Light Research: Emmy is the Founder and Principal Analyst of Sky Light Research, a third-party analyst firm specializing in wireless point to point mobile backhaul technologies such as microwave, sub 6 GHz, and millimeterwave radios. The firm's popular services include quarterly market share reports and forecasts. Sky Light Research was founded in 2001 and is located in Scottsdale AZ, USA. For more information, please email info@SkyLightResearch.com or call +1.480.563.2251.