TESSCO

Massive Capacity Can Be Easier with 4G-Optimized Microwave Backhaul

DragonWave

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End user demand for ubiquitous broadband connectivity, to support a range of new applications and devices, is driving the next generation of mobile networks including LTE and WiMAX. As these deployments begin to take shape, operators will be reevaluating their backhaul networks to ensure that future requirements will be met.

When considering new backhaul solutions, service providers must consider the significant differences in the performance, cost, capacity and ability to deliver on the many other unique requirements of a 4G-connected world.

Microwave will continue to be the preferred backhaul technology for 4G networks globally.

As a key technology used extensively in backhaul networks around the world, packet microwave has quickly evolved to support growing capacity demand, improve network efficiency, and help operators reduce their capital and operational costs. This paper will examine the business and technical challenges introduced by next generation networks, followed by an overview of how 4G-optimized microwave backhaul will address many critical issues faced by tomorrow's service providers.

4G NETWORKS WILL BRING NEW CHALLENGES TO OPERATORS

Over the last few years, mobile applications have grown from 0 to 200 million downloads per month and the average data consumption per user has increased by a factor of five[1]. This surge in traffic has largely been driven by a single device – the smart phone, which incidentally has plenty of room to grow given the current penetration rate of only 20%. The larger discontinuity will however be the transformation of mobile networks from single purpose utilities to more open platforms supporting a much broader range of devices and applications.

Over half a billion unconnected consumer devices, ranging from video cameras to digital pictures frames, are sold every year; many of these will soon be coming online.

Figure 1: Data usage will increase dramatically as new devices come online.[2]

The explosion of new devices, applications and network traffic that we are starting to see will have significant implications to operators in terms of their network capacity, operational complexity, service level commitments, and business models.

Most backhaul networks are not up to the task

4G access technologies are viewed as the solution to the massive traffic increases that mobile network operators are seeing. Throughput rates of 100 Mbps or higher are regularly quoted, yet there is a larger challenge that is rarely given much thought; the real bottleneck for 4G networks is the current backhaul infrastructure.

Leased line and traditional microwave backhaul solutions have served operators well for 2G and some early 3G deployments. However, this infrastructure was put in place for a very different service mix – one that was dominated by TDM voice and where bandwidth requirements were measured in kbps. With networks shifting rapidly to a data and packet domain (as shown in figure 2), and demanding much higher levels of throughput to deal with unpredictable applications bandwidth consumption, the lack of scalability of existing systems will start to be a major impediment to the introduction of new services.

Bandwidth per base station is projected to grow at a compounded annual rate of 85% between 2009 and 2013.

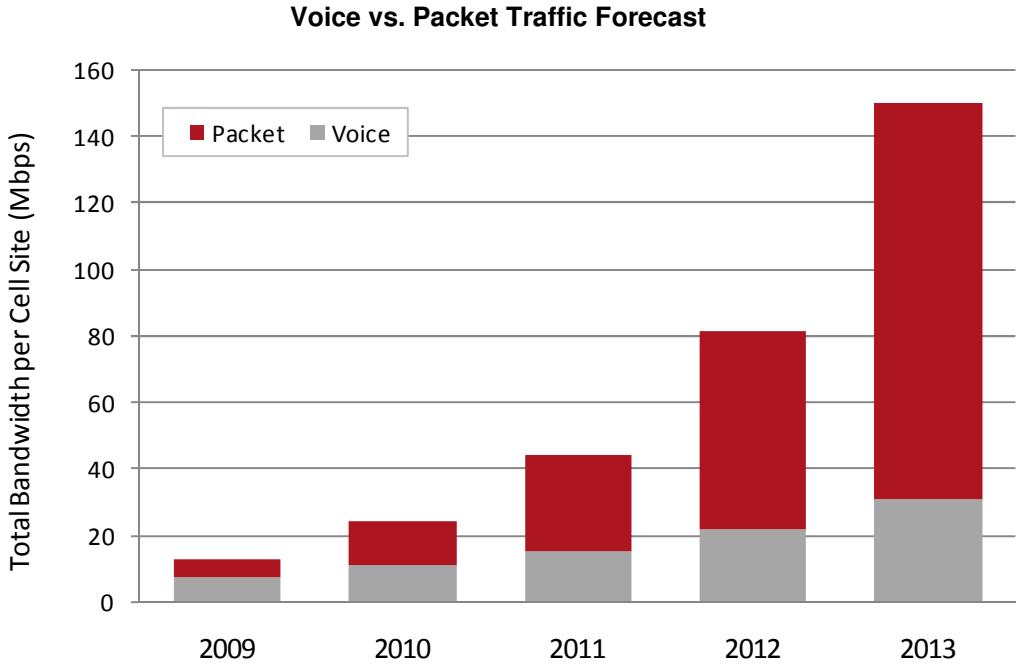

Figure 2: Data is growing three times faster than voice, reaching 80% of total traffic by 2013[3].

While capacity and scalability are important, these are not the only areas where traditional backhaul networks will fail to measure up; legacy backhaul infrastructure also lacks the latency, availability, and advanced QoS performance demanded by emerging 4G applications.

Current business models are unsustainable

What started as a small gap between revenue and capacity growth with 3G networks, threatens to be become a chasm for 4G network operators. Data services currently account for 30% of mobile revenue, yet they consume almost 50% of the wireless capacity (as illustrated in figure 2). As data services growth continues to accelerate, the decline in revenue per bit delivered will see an equivalent decrease.

This rapid increase in bandwidth per subscriber is driving revenue per bit to much lower levels.

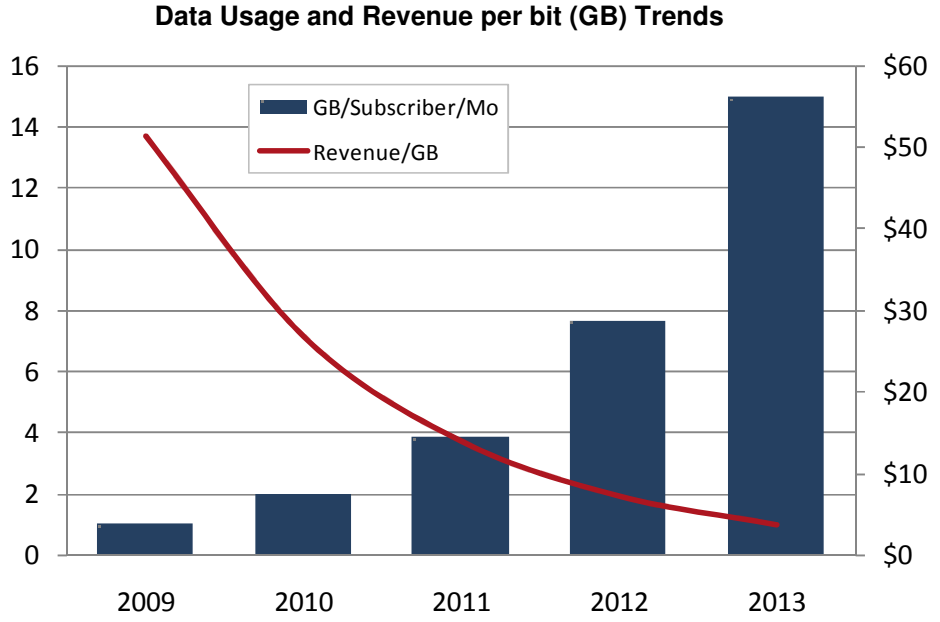

Figure 3: Relationship between subscriber data usage and service provider revenue/GB.[4]

The traditional response by mobile operators has been to add additional T1/E1 leased lines or move to higher capacity OC-3/STM-1 circuits. Applying this approach to next generation mobile, where bandwidth per base station will exceed 100 Mbps, would drive backhaul costs to unsustainable levels.

Service providers operating traditional microwave backhaul networks struggle with high site leasing costs driven by large antennas and a substantial equipment footprint. Inefficient use of spectrum is another growing concern as spectrum leasing costs rise in response to decreasing availability.

Finally, those operators looking to build their own fibre infrastructure generally have to contend with extremely high costs and painfully slow deployments.

Faced with these challenges and a need to evolve their current business model, mobile operators will look to monetize new high-value services. But in order to make this possible, they need to transform their network to one that is designed for the next generation of mobile applications. The other critical element to their evolution strategy is to reduce the cost per bit delivered – and since backhaul typically represents the largest cost in a mobile network[5], implementing a lowest total cost of ownership backhaul solution will be a high priority.

4G-OPTIMIZED MICROWAVE BACKHAUL: A KEY PART OF THE SOLUTION

Next generation packet microwave solutions that have been engineered for 4G network backhaul address several critical operator challenges by offering the following:

Capacity is an important aspect of 4G-optimized backhaul, but there are several other critical areas that service providers should consider.

- ***Packet based architecture—***The growing dominance of data traffic has established a clear direction to 4G mobile networks. Packet based mobile network architectures enable operators to deliver IP-based services much more efficiently and at much lower cost points than alternative backhaul options by taking advantage of statistical multiplexing. Packet microwave solutions also eliminate the overhead associated with traditional SONET/SDH systems.

- ***High capacity and scalability—***Backhaul must be cost effective from day one and provide simple remote scalability on demand. Some of today's microwave solutions allow operators to burst to higher bandwidth rates and will automatically scale the network based on average usage trends. With throughput levels reaching up to 2 Gbps per channel, current packet microwave systems have the capacity to support a single base station or aggregate traffic from multiple sites today and well into the future.

- ***Low latency—***Native IP packet microwave systems enable ultra-low latency over the link. This 4G-optimized capability allows business critical applications such as voice-over-IP, video-over-IP and future time-sensitive applications to perform at high levels. Keeping this priority traffic on the native Ethernet transport layer greatly reduces the risk of incurring delays associated with segmentation and re-assembly, or frame adaptation.

- ***Operational simplicity—***Converged packet networks offer several significant operational advantages. Having a single traffic plane and one element management system (EMS) greatly reduces the complexity of operating a backhaul network. In addition, many next generation microwave solutions also have integrated switching in order to reduce the number of boxes in the network, further simplifying operations.

- ***High spectral efficiency***—Spectrum is a valuable non-renewable resource, and like any other precious commodity, it is must be properly managed. Advanced radio features such as Cross Polarization Interference Cancellation (XPIC) allow operators to essentially double their capacity within their existing spectrum. Third generation packet microwave systems are also beginning to offer bulk and overhead bandwidth optimization features which can further multiply capacity to varying degrees, depending on the traffic mix. In addition, IP radios are not limited to the traditional SONET/SDH rates (i.e. 155 Mbps per 28 MHz channel), allowing for greater flexibility and higher throughput per channel. These spectral efficiency improvements are illustrated in figure 4.

Higher spectral efficiency is one of the key advantages of packet microwave systems. New techniques such as bandwidth optimization are taking capacity per channel to much higher levels.

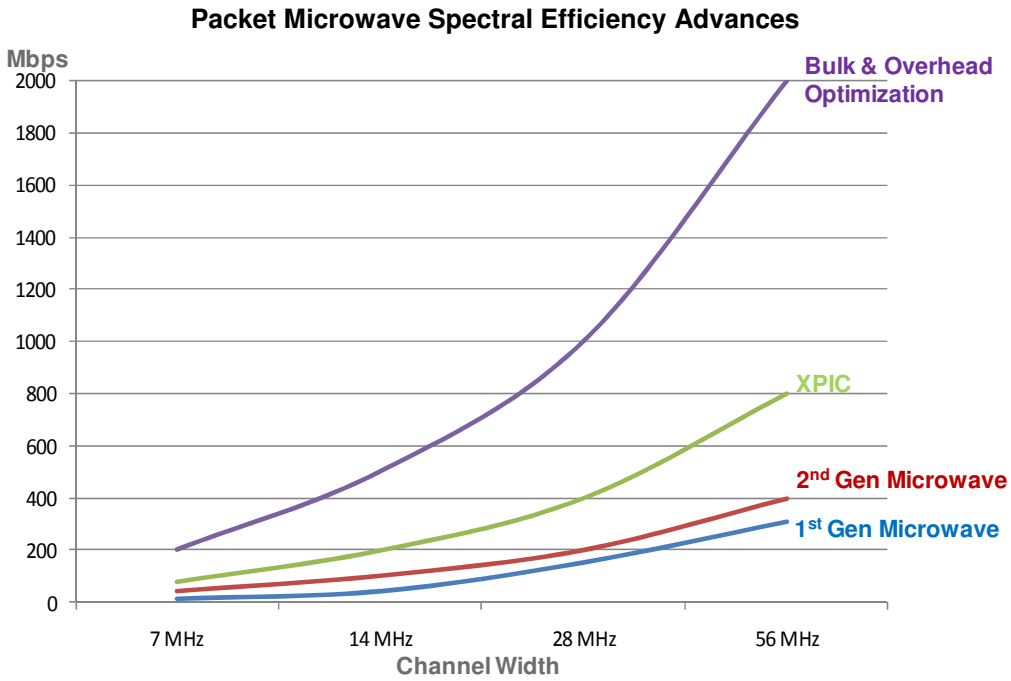

Figure 4: Spectral efficiency by channel bandwidth and technology.

Techniques such as adaptive modulation and adaptive transmit power offer additional gains for operators by taking advantage of higher modulation schemes during normal operating conditions. Next generation microwave radios also provide high modulation rates in small channel sizes, ensuring maximum spectral efficiency at all levels.

- ***Advanced queuing and quality of service (QoS) support—***Integrated bandwidth management features are a valuable tool for next generation operators looking to manage multiple service levels, traffic types, and user profiles. These features include multiple levels of prioritization (based on 802.1p/q, MPLS or Differentiated Services Code Point), advanced flow control via 802.3X, expedite queues, VLAN queuing and Weighted Fair Queuing. In order to maintain priority traffic at all times, 4G-optimized microwave backhaul solutions should also support QoS-aware adaptive modulation.

- ***Intelligent nodal switching and high availability ring & mesh—*** Integrated Ethernet switching and nodal intelligence, allows packet-based traffic to be interconnected and routed without the need for additional third-party equipment. Eliminating boxes from the network results in lower equipment cost and simplified management and operations. In addition, this integrated functionality can support the active use of working and protection channels by prioritizing traffic in the event of a failure, virtually eliminating any wasted capacity. 4G backhaul systems must also deliver carrier-grade (99.999%) availability with ring and mesh configurations and sub 50ms switch times.

- ***Seamless evolution path for existing services—***Service providers will continue to carry legacy services for many years to come. In order to simplify the transition to a packet-based architecture, pseudowire capability allows operators to effectively converge their TDM and IP traffic onto a unified network. Because synchronization is a building block of traditional networks, 4G-optimized backhaul solutions also support advanced network synchronization including Synchronous Ethernet (SynchE), which locks the timing of the Ethernet physical layer, and 1588v2 which is used to carry synchronization data.

- ***Lowest total cost of ownership (TCO)***—Combining several of the above mentioned elements produces a solution that achieves much greater operational efficiency. Adaptive modulation means smaller antennas and longer link spans for reduced site leasing costs; zero footprint deployment options further minimize this expense. High spectral efficiency maximizes spectrum investment and greatly reduces the need for new spectrum licenses. Additional operational savings are gained through remote management, remote scalability and the lowest power per bit. Lastly, high-capacity packet microwave solutions generally offer the lowest CAPEX per bit of any backhaul solution alternative. Figure 5 illustrates the TCO savings gained through each generation of backhaul.

4th generation microwave systems are an order of magnitude more cost effective per bit than traditional backhaul solutions.

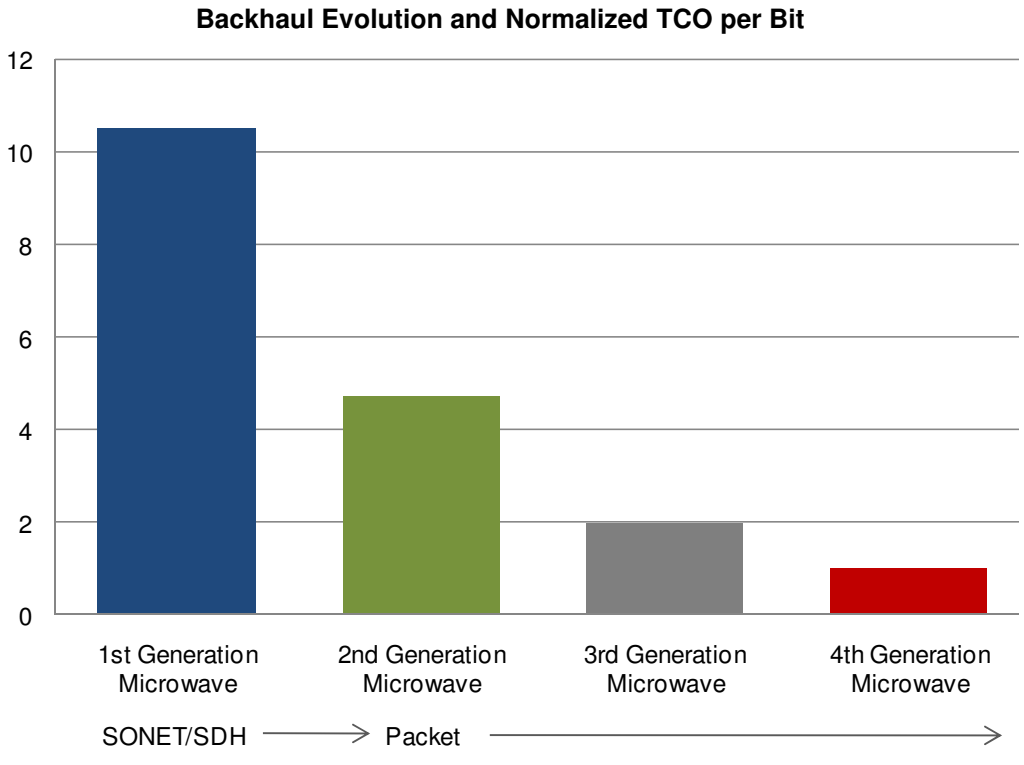

Figure 5: TCO improvements through each generation of microwave.

SUMMARY

4G networks, and the applications they enable, are demanding new levels of performance that will quickly drive many existing backhaul implementations to obsolescence. Engineered to meet the requirements of tomorrow's networks, 4G-optimized microwave backhaul solutions address the technical and business challenges faced by next generation mobile operators with:

A packet based architecture
High capacity and scalability
Low latency
Operational simplicity
Legacy service support for network evolution
High spectral efficiency
Advanced queuing and QoS support
Intelligent ring/mesh switching for carrier-grade availability
Lowest total cost of ownership

As a result, service providers can focus on offering new high-value services to their rapidly expanding subscriber base – and they can do so with the full confidence that their backhaul network will meet their evolving needs well into the future.

[1] Mobile Dashboard: Wireless Trends and Directions, 2009 by Mobile Ecosystem
[2] Source: Clearwire 4G World Presentation & Cisco's Global Mobile Data Traffic Forecast Update.
[3] Cisco's Global Mobile Data Traffic Forecast Update
[4] Wireless Sector View, Bank of America - Merrill Lynch, Aug, 2009 & DragonWave internal analysis
[5] IEEE Spectrum (spectrum.ieee.org)