RADIO FREQUENCY SYSTEMS
The Clear Choice®

MICROWAVE BACKHAUL
The conundrum that is African wireless

Written by Daniel Wojtkowiak, Global Product Manager Radio Link Networks **July 2009**

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Executive Summary

Despite what some wireless infrastructure suppliers would have the industry believe, Africa is a very different marketplace for wireless communications architectures to the rest of the world. Incredibly varied terrains and network topologies across the continent, coupled with extremes of temperature, and the steady but extremely protracted decommissioning of legacy 2G, and even 3G cell sites, all conspire to make wireless network installation and management in Africa an unusually complex and demanding task.

In parallel, certain demographic and infrastructure realities of the continent offer unique advantages for rapid, cost-effective backhaul buildup. Unless distance considerations apply, sturdy microwave – having proven its 4G-readiness – is a very attractive choice for operators, offering faster deployments than fiber-based backhaul, and lower costs than satellite-based backhaul connections.

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A discussion on how to measure front-to-back of cellular and PCS antennas

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Radio Frequency Systems (RFS)

Incredibly varied terrains and network topologies across the continent, coupled with extremes of temperature that have the research and development managers of most electronics suppliers reaching for their headache tablets, all conspire to make wireless network installation and management in Africa a task that is not for the faint-hearted.

But whilst it is now possible to deploy an electronic mobile exchange and a cluster of connected cell sites in most areas of Africa in a relatively short timeframe, the network backhaul that connects the EMX with the rest of the wireless network – and the outside world – requires a lot of planning and careful installation.

The reason is that, whilst cellular base stations and wireless infrastructures generally are developing at a rapid rate, with 4G (aka LTE) now starting to to sit alongside 3G and 2G cell sites in various configurations, most of the network backhaul systems deployed across the continent of Africa will still be in active usage long after the legacy 2G – and probably even 3G – cell sites are decommissioned.

Network backhaul links must, therefore, be designed for deployment on a multi-decade basis. The systems being installed today across Africa will still be in use well into the 2020s (and beyond), even if the nature of the network traffic they carry at that time is quite different to today's mix of voice, text and mobile data communications.

Our current observations suggest that as tariffs become ever more competitive across Africa, and the revenue per minute collected by carriers continues to fall, backhauling data will become increasingly more expensive for carriers and thus erode their profit margins.

Backhaul options explained

Whilst wireless carriers in the West face the costs of deploying 4G networks against the backdrop of falling ARPUs, African carriers are better placed than their Western peers because their need for fiber-based backhaul connections is lower. This is good news, since fiber-based backhaul links can be an expensive option – typically USD40,000 across a year for a 34Mbps connection.

On top of this, the adoption of point-to-multipoint backhaul in Africa has given carriers full control of their backhaul networks and control of the costs as well.

Microwave-based backhaul is proven technology that has already proven it is 4G-ready. But it is not the only network backhaul solution suitable for low traffic wireless service deployments. The cost of satellite-based backhaul has been falling for some time, making a satellite backhaul an option where longer transmission hops of more than 100 kilometers or more are involved. Back in 2006, for example, Angola Telecom – one of the largest operators in the Sub-Saharan region – became one of the first African telcos to adopt satellite-based backhaul on its network, using satellite modems equipped with higher-level modulation and advanced forward error correction to help reduce satellite transmission costs. And in early 2009, Etisalat selected a satellite-based backhaul system for its Nigerian wireless network – although here it is interesting to note that the satellite drop is designed to interconnect three major cities in Nigeria, with microwave remaining the mainstay of the operator's in-country network backhaul.

In general, unless distance considerations apply, microwave is the flavor of choice for operators, offering faster deployments than fiber-based backhaul, and lesser costs than satellite-based backhaul connections.

It's because of these advantages that Africa makes a lot more use of microwave-based backhaul connections than in better-populated areas of the world, as no one in their right financial mind is going to dig up the ground in rural areas to deploy network backhaul resources! And, whilst microwave hops can function at a variety of frequencies ranging from 6 to 40 GHz (focusing on the popular 6, 15, 18, 23 and 38GHz frequency ranges) most existing wireless network backhaul deployments in today's Africa have tended to be in the 6 to 8.5GHz range, working across 30-50 kilometer hops, and serviced using 8-12 foot dishes.

Furthermore, whilst some carriers will talk excitedly about IP-based communications taking over from circuit-switched links – with value-added network backhaul features such as port-based quality of service prioritization to ensure minimal latencies for specific services – the actual data flowing across a typical point-to-point or point-to-multipoint microwave hop in a network backhaul system does not matter. Data is, after all, just data.

African demand for backhaul remains positive

Despite the economic downturn affecting the West, the market for wireless backhaul networks in Africa remains buoyant. For example, earlier this year, Morocco's Wana network announced that it was enhancing the performance of its backhaul point-to-point network to prepare for its new mobile broadband service. Wana's microwave-based backhaul network was first extended in 2008 using 10.5GHz equipment, but now the carrier is looking to use 26GHz microwave hops to handle the increased data traffic its mobile broadband service will generate.

In theory, this is good news for Wana. But the reality is that next generation networks such as mobile broadband – which typically makes extensive use of high speed packet access technology – pose a problem when it comes to backhaul requirements, as they increase the level of complexity against a backdrop of requirements for higher throughput, improved QoS, lower latency and lower expenditure.

Meanwhile, in April of this year, Africell announced that it was planning to boost the reach and capacity on its wireless networks in Gambia and Sierra Leona, requiring a USD1.9 million investment in backhaul resources starting in December 2009.

Microwave radio link networks, then, have become the lifeblood of the telecommunications industry, particularly with the rise of powerful wireless data technologies.

The cost versus robustness issue

Most good microwave systems suppliers' ranges incorporate multiple antenna sizes and different performance classes, all of which add up to a set of flexible choices for flexible network design. In addition, latest generation elliptical waveguide technology can achieve the radio-to-antenna link in a single run directly from the equipment building to tower-mounted antenna.

Elliptical waveguides are normally available in a wide selection of frequency bands throughout the 3-40 GHz microwave bands. For example, in the case of our company's offerings, three versions of the elliptical waveguide are available to carriers for their network backhaul: standard, low VSWR (voltage standing wave ratio) and overmoded.

Standard and low VSWR waveguides differ only in terms of their testing and guaranteed attainable VSWR. Standard waveguide is recommended for low and medium capacity radio relay systems, while the premium elliptical waveguide assemblies are recommended for high capacity radio systems, such as metro and urban deployments in Africa.

Overmoded waveguides, meanwhile, offer exceptionally low attenuation characteristics compared with conventional waveguides.

The waveguide operates above the cut-off frequency of higher order modes using the lowest attenuation characteristics of the waveguide. Connectors for overmoded waveguides include filters, which eliminate distortion due to mode conversion.

This makes overmoded technology suitable for those terrains where longer-than-normal microwave hops are required, or where attenuation – perhaps due to the torrential rain seen in the early parts of the afternoon in parts of Africa – causes signal dropouts.

Construction of the waveguide is a contributing factor in microwave hop performance. Our own elliptical waveguide, for example, is constructed of pure electrolytic copper strip, which uses a special process to butt weld, corrugate and form into an approximate elliptical shape. The copper waveguide is then covered with a black polyethylene jacket for protection during transport and installation.

There are considerable differences in the quality of microwave solutions on the market, with some designed at a budget price point, and others for network longevity and robustness at a higher price. In some parts of the world, where sheltered transmission facilities are available, a budget microwave system may be appropriate. However in Africa, where a diverse range of temperatures and climatic conditions can apply, premium build quality is recommended. This is especially relevant in a region where wireless networks in many areas have yet to be upgraded to 3G.

And, as LTE (4G) technology is progressively rolled out, it is quite probable that the microwave network backhauls being deployed today, will still need to be in regular use in 20-years time, even though the nature of the network traffic – together with the wireless network topologies they support – will have changed significantly.

Against this backdrop, deploying budget microwave system hardware that will require the hardware swapping out in five or ten-years' time is a false economy in the longer term.