Backhaul: the flexible options

As new cellular technologies emerge, backhaul can become an issue. JON HOWELL looks at some of the latest point-to-point and multipoint solutions

CONTENT downloads and web-surfing on mobile devices have become a realistic possibility since the introduction of next generation technologies such as 3G and HSDPA. The side-effect of this is a massively increasing need for backhaul bandwidth.

Operators need solutions that are easy to install and upgrade as demand increases. They also need great flexibility as usage patterns change and wireless solutions provide minimal deployment times and also avoid the nasty problems that cabled solutions have to endure, such as digging up municipal areas to lay the infrastructure.

Point-to-multipoint (PTMP) technology offers cost advantages over alternatives such as leased lines. It needs less equipment and gives more options for managing capacity and future expansion. For example, Hughes' AirReach Broadband 9800 (AB9800) is a microwave radio solution that offers point-to-multipoint broadband backhaul to carriers. With a PTMP system, operators get a flexible and efficient transmission solution that will help them cope with growing demand for high capacity and the ability to support a mix of ATM, TDM, and Ethernet traffic. It will also give them the flexibility to expand the network cost-effectively.

PTMP is also well suited to urban situations where the density of 2G/3G base stations can be relatively high, with distances between nodes often being as small as 0.4 to 3km. Point-to-point (PTP) can suffer from needing a transmitter-receiver pair for each base station whereas multipoint can have one hub for many base stations. On the occasions where connectivity is only desired between two points then a PTP solution like the Motorola PTP 500 (see Out of sight, page opposite) can offer the needed functionality.

Hughes' AB9800 system supports ATM, TDM, and Ethernet transport. Transporting all three types of traffic over the same backhaul network using the same radio equipment can cut network complexity. This can allow the operator to carry GSM traffic over TDM, and UMTS traffic over either ATM or as TDM directly over SDH. For corporate applications, metro Ethernet services or leased line E1 services can also be carried on the same AB9800 platform. Hughes sees the ability of the product to be managed under a common network management system through a northbound OSS interface as a key advantage. The system is reportedly already in use with the Nokia NetAct as well as NetCool OSSs.

Deployment topology

A PTMP typical deployment would include a number of hub stations that provide a broadband wireless footprint for the planned service area. Each hub station would have one or more sectors each with a set of AB9800 radios, or hub terminals, and an optional built-in ATM concentrator unit to consolidate ATM traffic from individual sectors. Each hub terminal operates on its own radio channel and will provide connections for one or more remote terminals.

The hub stations are connected to the central office by a transport network that can be TDM, ATM, or Ethernet-based, with an element management system (EMS) at the central office to manage the entire network. Hughes' solution operates on a Sun Workstation, running under Solaris, and supports full FCAPS functions as well as a GUIs for network management.

A remote terminal provides the user interfaces and includes: E1-CES, E1-TDM, E1-ATM, E1-
IMA, E3-ATM, STM-1 ATM, and Ethernet, all of which are supported with a full set of QoS levels. Customer traffic may include 2G, 3G, Wimax, Wi-Fi, metro Ethernet, leased line ATM or TDM, etc. Hub stations support three modes, TDM, ATM and IP, and can migrate from one to another without requiring an equipment upgrade to the hub terminals. In fact, several modes can be handled at the same time.

The ABR800 system supports an air interface with three modulation options, QPSK, 16-QAM, and 64-QAM on the same carrier. The three modulations are supported on the same RF channel on a burst-by-burst basis. The advantage here is that the system can carry the range of QPSK and the capacity of 64-QAM, allowing the RF plan to be optimised for any given sector.

### Hard wear

Each hub station is likely to be connected to several hub terminals. Each of these consists of one indoor unit (IDU), one outdoor unit (ODU) and a sectorised antenna. One ter inal is required for each 28MHz RF carrier and it supports triple modulation with a capacity of 92Mbps. The sectors can be 90° or 180°, giving flexibility of deployment. Additional options are available to share two ODU's on a single antenna or to split the output of an ODU to multiple antennas. The ABR800 PTMP system supports 1:1 and 1:N redundancy at the hub station. The hub terminals are also available with an ATM concentrator unit included. The ACU-HT provides the standard radio functionality of a terminal (28MHz RF channel with up to 92Mbps capacity) as well as ATM concentration.

The unit is used to consolidate traffic from different sectors to the ATM backbone network, removing the need for an ATM Switch or ATM cross-connect. Traffic from one up to eight hub terminals is concentrated by the ACU-HT and placed onto a single STM-1 interface going to the core network. An alternate configuration can be used whereby traffic from six sectors is terminated on up to two STM-1 network interfaces.

The ABR800 hub station's architecture is said to be unique compared to typical multipoint systems in that it is distributed. Each RF channel is supported by a separate radio in a self-contained unit, and each terminal indoor unit has its own amplifiers, power supply, and network interfaces, allowing for a scalable system where a one-sector hub can be deployed in a 1u chassis.

According to Hughes, this means that a start-up sector can be deployed very economically without taking up huge amounts of rack space.

To increase transport efficiency, the multipoint system offers features such as statistical multiplexing gain, dynamic adaptive modulation and dynamic bandwidth allocation, allowing operators to generate additional revenue with minor software updates to their PTMP network.

Statistical multiplexing gain is brought by the standard ATM UNI interface at the hub site. Over-subscription of variable bitrate connections can be advantageous in the star network topology of point-to-multipoint where sharing a downlink can reduce wasted capacity.

Dynamic adaptive modulation (DAM) allows air capacity to be increased by taking advantage of favourable atmospheric conditions. If signal strength is strong then the higher order modulation, such as 64-QAM, can be used in order to increase data throughput. Plus, since data traffic may have less stringent availability targets than voice, further capacity gains can be expected by using DAM on data-only sites which may have previously used QPSK modulation. Dynamic bandwidth allocation allows the sharing of airbandwidth resources across a sector so that capacity can be assigned to remote terminals as necessary. This capability is especially important for mobile operators when deploying HSPA in their 3G networks. Dynamic bandwidth allocation can allocate additional capacity in each direction as needed by the 3G base station. The ABR800 ensures that there is a minimum capacity available for each service and when peak demands occur, the dynamic allocation will allocate extra unused capacity in real-time.

### Out of sight

For a fixed point-to-point solution, Motorola offers the PTP 500 which it describes as providing secure, high-speed, robust wireless backhaul. The product is aimed at carriers and is designed to work in non-line-of-sight situations over long distances, up to 250km, whilst coping with harsh weather conditions. Suggested applications include VoIP, telemedicine, or extending video surveillance systems into areas that are unreachable by wired infrastructure. For greater security in remote locations a lightning protection unit is also optionally available.

The PTP 500 is an Ethernet bridge which operates in the 5.4 and 5.8GHz bands and can support data rates up to 105Mbps. Motorola says that the unit delivers 99.999% availability in ‘virtually any environment’. The robustness and high-performance that the company claims for the wireless backhaul solution rest with features such as MIMO, intelligent orthogonal frequency division multiplexing, advanced spectrum management and adaptive modulation.

Motorola also offers its LINKPlanner predictive tool which is designed to determine link performance prior to purchase. It is based on geography, distance and transmission power, and customers can configure single and multiple links simultaneously to give an overall network view.

### Long haul links

According to 4RF, recent advances in radio frequency design and digital electronic integration have resulted in a new breed of point-to-point digital radio systems developed to provide highly efficient, reliable and cost-effective transmission solutions in the long haul microwave link bands below 3GHz. The company specialises in long-distance point-to-point radio solutions in licensed sub 3GHz frequency bands and says that its innovative technology can link distances over 100km in a single hop and delivers up to 65Mbps. It adds that its integrated networking features allow both IP (Ethernet) and traditional voice and data services to be supported on a converged, future proofed wireless platform.

4RF says that with selectable modulation and high system gain, sub-3GHz systems offer working ranges of more than 250km, depending on terrain and antenna heights. These path hops are not cost-effective to implement at frequencies.
above 3GHz where intermediate sites and associated infrastructure would otherwise be required. As all the equipment may be mounted indoors, capex and on-going maintenance savings are possible when compared to split-mount link implementations common at 5.8GHz and above.

Licensed vs unlicensed links

"Using unlicensed links as an alternative to conventional digital microwave radio links operating in licensed allocations is tempting, often proposed as a means to save money and avoid formal licensing procedures", says 4RF CTO, John Yaldwyn. "In theory, the interference rejection capabilities of spread spectrum systems allow for uncoordinated use in the Industrial Scientific and Medical (ISM) frequency allocations around 2.4GHz and 5.8GHz as well as the newer wireless LAN allocation at 5.4GHz. However the unlicensed nature of operation in these bands results in a free-for-all between other wireless LAN equipment, cordless phones, and even microwave ovens," he adds.

Although the level of interference may be acceptable at the time of installation, 4RF says that there is no protection against interference that might be encountered a year, a month, or even a day after installation. It says that the potential for interference can only be mitigated by engineering links with very high fade margins, resulting in ranges considerably shorter than manufacturer's typical claims. This situation is in contrast with a licensed frequency allocation from a competent licensing authority where the applicant can expect a continuing level of protection against future assignments and a level of protection from interference. The long term costs and risk of interference limits applications to those of a temporary nature, says Yaldwyn. "In today's security conscious environment the idea of relying on unlicensed links for critical infrastructure or public safety applications is an invitation for interference induced failure which will inevitably occur at the least opportune moment."

It is now an industry axiom that antennas dominate link costs, with antennas and installation exceeding the cost of the radio equipment. A point often overlooked is the cost impact of antenna choice. Antennas operating at the low frequency bands have a wider beam width for a given antenna size when compared to higher bands, reducing the requirements for tower stiffness allowing savings in new installations. In fact, many such systems may be mounted on simple wooden or steel poles.

Overcoming the challenges

Celtro specialises in solutions that are designed to increase backhaul performance and capacity over existing infrastructure. It has commercial deployments throughout Russia and the CIS where its DynaMat systems have been deployed since 2004. Its customers include Russia's three largest operators: Beeline, MTS and MegaFon.

Celtro says that the technologies that are fighting for Russian backhaul include the entire spectrum of evolving mobile technologies. Operators want the most up-to-date technology currently available such as NodeBs that support HSDPA 7.2Mbps; IP/MPLS, VPN Layer 2 and 3; media gateways, pseudowires, etc. According to the company, working in the Russian market offers several major challenges. Firstly, there is the slow-paced rollout of 3G broadband services due to lack of frequencies and this is preventing massive adoption of third generation solutions. In addition, there is the region's geography which covers very expansive territories with long distances between sites. This makes support very difficult. There is also the problem of poor or no internet infrastructure in some areas.

When it comes specifically to backhaul, mobile operators have to overcome a number of hurdles, according to Celtro. Firstly, it says that ARPU in Russia and CIS is very low at USDS-10 per month. It is therefore difficult for the operator to introduce new services which would have additional charges. Secondly, because of a lack of other alternatives, the mobile infrastructure is used to access the internet and this has adverse effects on the mobile network – particularly the transport network. Thirdly, the company says that optics is high in the region because of the very expensive E1 costs that have to account for long distances between sites, difficult geographical terrain and the lack of reliable resources. It adds that only two companies in Russia sell E1s, making competition and cost reduction impossible. The situation in CIS is even worse with only one PTT provider per country. This makes it "totally impossible" to reduce costs. Celtro also says that the large percentage of prepaid customers in the market makes it very difficult for operators to plan and manage their networks. Finally, bad climate conditions make it impossible to reach some sites at certain times of the year, making carrier-class equipment a definite requirement. Most installations are deployed only during the summer months.