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FEATURE | CELTRO

COPING WITH RAPID EXPANSION IS ONE OF THE BIGGEST HEADACHES IN A 3G WORLD.

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The 3G migration challenge

With the rollout of 3G cellular networks worldwide, the radio portion of the networks between the subscribers' handsets and the cell tower has been expanding at unprecedented rates. WCDMA, the technology behind UMTS and 3G, has brought capacities of hundreds of Kbps to the handset—compared with the 16 Kbps voice channels on 2G. Fast on the heels of WCDMA is HSDPA, the 3.5G radio technology that brings to handsets performance comparable to that of wireless LANs and allows the provisioning of true broadband mobile services. Together, WCDMA and HSDPA will have increased bandwidth delivery to the end user by up to 100 times over GSM.

The explosive increase in transmission rates has created a growing opportunity for high-bandwidth mobile services. In light of commoditised voice services and declining tariffs, operators are eager to exploit the financial potential of the new services with their increased ARPU, and are certain to provision and promote them aggressively.

Moreover, 3G technology reduces the unit cost of delivering traditional voice and data services, helping mobile operators to remain competitive when VoIP commoditises the traditional market of telephony services. It is not surprising that operators in responsive markets are quick to deploy 3G technology, which increases their mobile capacity.

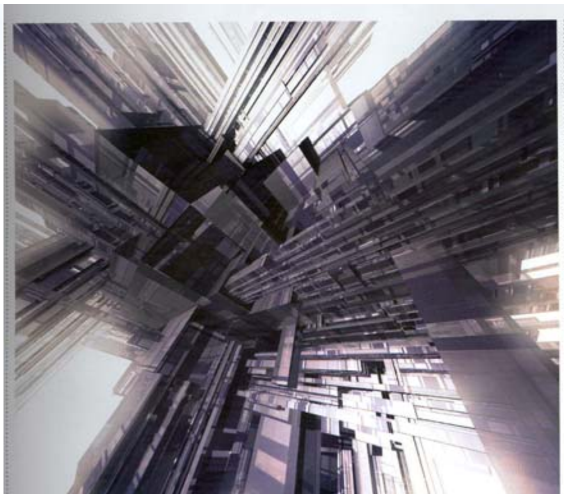
This massive increase in the throughput of the cellular radio segment of the network cannot be matched by the terrestrial backhaul network. As a result, the capacity and service delivery bottleneck shifts from the radio segment to the backhaul network, driving mobile operators who are rolling out broadband services to plan significant increases in transmission network expenses.

The cellular backhaul network is the terrestrial network connecting the remote cell sites with the Mobile Switching Centre (MSC) at the core site. Like other access networks, the backhaul is based on SONET/SDH rings on the upper part of the network and a linear tree topology at the lower part that distributes traffic to end cell sites. However, several unique characteristics differentiate the cellular backhaul network from the wireline access network.

Cellular networks, designed to support the mobility of their subscribers, use a small number of switching centres and span a large geographical area of cell sites to obtain cellular coverage, resulting in long backhaul lines of 10s, 100s or more kilometres across multiple hops of copper, microwave, satellite, or fiber infrastructure.

Because cellular traffic is compressed, a typical 2G base station, which services on the average a population of about 1,000 subscribers, requires a connection of a few megabits (or a few E1/T1 lines).

In 2G networks, backhaul network dimensioning was based on worst case scenarios, that is, the backhaul capacity (number of E1/T1) was planned to support the maximum capacity that could be delivered by the air interface (number of TRXs).



To implement and operate their backhaul networks, operators have two basic options: to lease capacity from fixed line operators or to own the backhaul infrastructure.

Leasing of E1s is readily available from large carriers, and the network is relatively easy but expensive to expand.

When owning the backhaul infrastructure, the most commonly used technology is that of microwave links. These are relatively inexpensive to install and operate, but may be limited in overall capacity when the network migrates to HSDPA.

Aggregation and switching form another component of the backhaul network. Between the end base station and the MSC there are usually several aggregation sites/hubs that concentrate the traffic coming from the lower network levels. In traditional TDM (2G) networks, aggregation is performed by TDM access crossconnects; in 3G networks packet switching solutions based on ATM/IP technologies are used to concentrate the traffic.

These specific characteristics of the cellular backhaul network impose severe constraints on the ability of operators to expand their networks in a cost-effective way in order to accommodate increasing traffic demands.

Initial deployment of 3G equipment is usually co-located with the 2G sites. Most Node Bs are deployed in the same sites as the 2G base stations, and the same hub and core sites are used for 2G and 3G equipment. The 3G controller, the RNC, is deployed only in core sites, resulting in longer 3G backhaul lines, while the ATM 3G backhaul network is overlaid on the existing TDM 2G network.

Because in most cases initial 3G traffic demand is low, only one E1 is used to connect the Node B, and site connectivity is increased based on actual traffic demand. Unlike 2G, 3G backhaul dimensioning is based on the actual measured and forecast traffic demand; it does not support worst case scenarios of the high traffic demand that fully exploits the delivery capabilities of the air interface.

Initial phase aggregation in the 3G network usually includes ATM switches at the core sites, adjacent to the RNC, in order to groom the ATM E1 to STM1 and to save on the CAPEX of interfaces on the RNC.

As 3G traffic demand grows, new micro and pico cells will be deployed, additional backhaul connectivity will be added to the 3G cell sites, and packet-based aggregation solutions will be introduced to the backhaul network to improve traffic flow and network performance.

Unlike the radio segment, scaling the backhaul network to support the needed capacities is very expensive. A recent study by GeoResults forecasts expenses of US mobile operators on leasing backhaul capacities to increase from $2bn in 2005 to $16bn by 2009.

With owned microwave based networks, the backhaul situation is even more complicated. Microwave networks are largely maxed out in many critical areas of the backhaul networks. The only other viable option for expansion available to operators is to establish their own fibre optic connections. Replacing existing microwave backhaul links with fibre optic connections entails significant investment that requires a dramatic increase in capex expenses.

There are significant challenges to the cellular backhaul network to support the migration to new broadband mobile services and there is no single magic solution to address them, but rather a combination of increasing infrastructure capacity and deploying switching solutions at aggregation sites to improve traffic flow and network performance.

Reasonable investments must be made to increase the capacity of the backhaul infrastructure by increasing leased capacity, upgrading microwave technologies, and adding fiber links where microwave technologies have been exhausted.

The objectives for deploying a successful backhaul switching solution include: Increased network efficiency and effective capacity to improve service delivery and reduce network expenses; improved network flexibility to better handle changing traffic demand and to allow rapid introduction of new mobile services; support of QoS for all cellular technologies, to properly allocate, in real-time, the scarce backhaul network resources according to operator defined priorities; converging 2G, 3G cellular traffic and beyond into a unified backhaul network to efficiently use the infrastructure for all services and to reduce costs related to the operation of multiple overlaid networks.

New generation backhaul networks are ATM/IP packet based. Backhaul switching solutions for these networks are based on Multi Service Switches (MSS) that can switch and aggregate TDM, ATM, and IP traffic. The main features of MSS solutions are: TDM/ATM/IP switching to converge all traffic types into a unified packet-based backhaul network; statistical multiplexing of mobile traffic to maximise network efficiency; dynamic bandwidth allocation to maximise network flexibility so as to best handle changing traffic demands and enable the rapid introduction of new services; QoS support and traffic management capabilities to best handle traffic load and network resource allocation, especially in congestion scenarios; adaptation of circuit-based TDM traffic to packet technology by means of circuit emulation services (CES) or pseudo wire technologies.

Such aggregation improves traffic flow efficiency by using TDM grooming for 2G traffic and packet statistical multiplexing for 3G traffic. MSS uses circuit emulation or pseudo wire technologies to carry switched TDM traffic of legacy GSM technology over the new packet networks. In addition, by employing statistical multiplexing these switching solutions maximise network efficiency.

These switching solutions converge 2G and 3G traffic into a unified backhaul network that is highly efficient and flexible, and which maximises network performance capabilities on the existing backhaul infrastructure. ■