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More mobile capacity? Don't forget about backhaul

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VP discusses the options for the 'forgotten component' of the RAN

The convergence of new cellular technologies promising to bring high capacity delivery to the mobile subscriber will enable the introduction of new broadband mobile services and open new business opportunities for mobile operators.

Mobile operator revenues from emerging wireless services are predicted to grow to more than $61 billion in 2008, according to a market analysis report by Forrester Research. This prediction comes as no surprise to those in the wireless/mobile industry that continue their rapid development of next-generation mobile devices and voice, data, and video applications.

For example, HSDPA, which will soon follow WCDMA, will provide delivery of DSL-like capacity to subscribers. With IMS deployment for Release 5 onward, the mobile triple play over IP becomes a reality; further fixed-mobile convergence will enable mobile operators to deliver in both the wireless and wireline domains. Mobile operators have the opportunity for a new world of broadband mobile services that deliver high-speed data, video, and TV directly to the mobile subscriber.

What does surprise many people is the significant impact these new robust devices and bandwidth-hungry applications will have on cellular backhaul transmission – commonly referred to as "the forgotten component" of the Radio Access Network. This forgotten component is where mobile operators currently spend approximately 70% of their annual budget for operating expenses. Can the entire transmission infrastructure handle additional unpredictable demands for traffic and capacity required by these new wireless services? How can mobile operators continue with efficient service delivery and maintain competitive advantage with their existing backhaul? Clearly, the weakest segment in upgrading the cellular network to support new broadband mobile services is the backhaul network.

The Backhaul Crunch

The backhaul is the terrestrial network connecting the cell sites with the mobile switching centre (MSC) at the core network. This network is based on SONET/SDH rings on the upper part of the network, and a tree topology at the lower part that distributes the traffic to end cell sites. Cellular backhaul traffic is carried by long lines of 10s, 100s or more kilometres across multiple hops of copper, microwave, satellite, or fibre infrastructure. Because cellular traffic is compressed, the overall traffic in the backhaul network is relatively low. A typical 2G base station service with an average population of around 1,000 subscribers requires a connection of a few E1/T1 lines (or a few megabits per second).

To implement and operate their backhaul networks, operators might lease capacity from fixed-line operators or own it themselves. When owning the backhaul infrastructure, the most commonly used technology is that of microwave links, which are relatively inexpensive to install but are limited in their support of the increased capacity needs of the new cellular technologies.

According to Philip Marshall of the Yankee Group: "Today the lion's share of T1 and E1 base-station backhaul is supported by leased-line circuits provided by wireline service providers. Leased-line infrastructure represents between 6% and 12% of a typical service provider's operational expenditures. Globally this accounts for $22 billion in operational expenditures for wireless service providers."

Additional components of the backhaul network are aggregation and switching, deployed in several levels of aggregation sites/hubs that concentrate the traffic coming from the lower levels. Initial

deployment of 3G equipment is usually collocated with 2G sites. In a traditional TDM network of 2G technology, aggregation is performed by TDM access cross-connects; in the newly deployed 3G networks, a packet switching solution based on ATM/IP technologies is used to concentrate the traffic. Initial phase aggregation in 3G networks usually includes ATM switches at the core sites, adjacent to the RNC, to groom the ATM E1 to STM1 and to save on the CAPEX of the interfaces on the RNC.

Migration to 3G

There are significant challenges to the cellular backhaul network amid provisioning of new broadband mobile services. As 3G traffic demand grows, additional backhaul connectivity will be added to the 3G cell sites, new micro and pico cells will be added, and additional packet-based aggregation will be added to the backhaul network to improve traffic flow and to reduce transmission expenses. This increase in capacity delivery and the cost reduction of air interface does not apply to the backhaul network. Upgrading the backhaul network to support the needed capacities will be very expensive. A recent study by GeoResults forecasts that spending by U.S. mobile operators for leasing backhaul capacities will increase from $2 billion in 2005 to $16 billion by 2009.

The challenging aspect of the 3G network is traffic unpredictability and its implications for network planning and dimensioning. The practical approach to 3G backhaul is to start with a single or a pair of E1/T1 connections and increase backhaul capacity based on utilization reports. As simple as it is, the addition of an overlaid 3G network across the same transmission infrastructure is not optimal from a capital (CapEx) or operational (OpEx) expenditure perspective. Statistical multiplexing of both 2G and 3G traffic over shared facility links enabling a converged backhaul is by far a more efficient way to introduce 3G in a cost-controlled manner.

With self-owned microwave-based networks the backhaul capacity/cost is even more complicated. Since the networks are already working to maximum capacity, especially in the microwave rings area, and the only viable alternative for expansion is to dig down and establish fibre optic connections. In busy urban areas with very high densities of subscribers this high CapEx option may be the only alternative despite potentially very high right-of-way costs. In less dense and rural areas, and over long distances, the costs would be prohibitive.

Guidelines for Backhaul Solutions

Solutions addressing the challenges of the cellular backhaul network must economically balance backhaul capacity expansion with its utilisation during 2G to 3G transition and within various 3G evolution phases. Reasonable investments must be made to increase the capacity of the backhaul infrastructure by increasing leased capacity, upgrading microwave technologies, and adding fibre links where microwave technologies have been exhausted. To minimise capital and operational expenses of the cellular backhaul, mobile operators need a unified 2G/3G backhaul solution that is technology-agnostic and addresses cellular backhaul evolution phases while maximising the reuse of the existing 2G backhaul infrastructure.

Cellular switching solutions exist today that can improve traffic flow and maximise the network performance of the available upgraded backhaul infrastructure. The switching solution should provide:

- Increased network efficiency and capacity to improve service delivery and reduce network expenses;
- Improved network flexibility to handle changing traffic demand, and allow rapid introduction of new mobile services;
- QoS support for all cellular technologies, i.e. 2G, 3G and beyond, 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 utilise the infrastructure for all services and reduce costs related to the operation of multiple overlaid networks.

The combination of application-layer switching (layer 4-7) with traditional TDM/ATM/IP switching (layer 2-3) multiplies network performance by maximizing network efficiency, providing full network flexibility, and enabling real-time network resource allocation based on support of QoS for the 2G and 3G voice, data, video, and signalling traffic.

Another benefit of cellular backhaul switching is its ability to distinguish between voice, data, and

signalling frames and forward them all in a single unified pipe, providing QoS support based on the classification of the cellular voice, data, and signalling traffic. Cellular backhaul switching capability can provide the flexibility to deliver the best possible performance in any congestion situations by automatically negotiating the QoS trade-offs to deliver optimal performance of essential services and maintain network integrity under any circumstances. Cellular backhaul switching is indispensable to upgrading the aging backhaul network to the point where it can carry the inflated traffic that 3G and 3.5G wireless technology will generate, and can breathe new life into the old wireline networking infrastructure.

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