Providing Efficient Cellular Transport over Satellite: The Combined Ericsson and iDirect Solution

November 2008

Advancing a Connected World

iDIRECT

Introduction

GSM (Global System for Mobile) cellular service is the most pervasive technology in the metropolitan mobile communications market today. It is also the standard of choice in developing markets. As the edge of existing networks continue to press outward, satellite becomes the de facto solution to extend to more remote regions.

Ericsson is the largest individual supplier of GSM networking equipment. A key component of Ericsson's strategy to capture the next billion users is to enhance their product line to make the rural marketplace profitable for cellular operators. This is a very different market from the typical metropolitan areas served today, and the estimated Average Revenue Per User (ARPU) is significantly lower than the ARPUs in metropolitan areas. Ericsson has made significant enhancements to the hardware and software associated with the interface between the Base Station Controller (BSC) and the Base Transceiver Station (BTS) to reduce the capital expenditures and operating expenditures of rural networks. This enables networks using them to be profitable even with very low ARPUs, when combined with a cost efficient IP transport system.

To leverage these new developments, the solution relies on an efficient satellite IP transport system that can dynamically balance data needs across multiple remote systems. Ericsson has partnered with iDirect to supply this connectivity. The combined system has been thoroughly tested, beginning in the development phase of the cellular system, to ensure that the combined solution set is effective and reliable.

This technology brief provides a description of the technical requirements for GSM cellular backhaul over satellite and outlines why the Ericsson / iDirect solution is well positioned to cost effectively and efficiently satisfy cellular backhaul requirements.

Expanding the Footprint

To expand the reach of the network, the Abis interface between the BSC and multiple BTSs must be extended in the most cost-efficient manner possible. Terrestrial microwave radio is adequate in areas that can be easily accessed over a small number of radio hops, but most of the more remote areas are far beyond their reach or are not in the line of sight. For these reasons, microwave radio is very limiting as a method to expand the cellular footprint into remote areas.

Satellite transmission, on the other hand, is an ideal candidate for these applications because it is distance independent. It can be deployed quickly and is immune to the challenges posed by remote locations and terrestrial obstacles. Satellite is an outstanding alternative in situations where TDM connections require very long lead times to install. For example in some areas, E1 or T1 connections can take over a year to deploy after they have been ordered. Satellite backhaul for BTS sites in these areas allows a carrier to get to market quickly and efficiently - ahead of the competition.

Satellite connectivity for GSM is not a new application. Single Channel per Carrier (SCPC) satellite connection has historically bridged the gap where traditional terrestrial networks were not viable options. By its nature, SCPC supports only one transmission link or BTS per frequency channel, requiring that each link be engineered to accommodate the busy hour traffic of the attached BTS. The net result is that costly satellite bandwidth goes unused during non-peak hours, and the cellular operator pays for the inherent inefficiency out of their bottom line.

New satellite technology allows for a much more economical deployment with a greater range of flexibility. iDirect's unique IP-based Deterministic TDMA provides an efficient single "pipe" solution to backhauling cellular traffic over satellite, while SCPC provides multiple smaller pipes that are less efficient unless the bandwidth requirement is significant and stable.

The interconnecting network that transports the A.bis information must be dynamic in order to take advantage of the new logical ability to vary the bandwidth requirements based on system load. TDM is no longer a practical solution since it is statically allocated. IP over Ethernet, however, is an ideal medium, as it is inherently designed with flexible frame sizes and dynamic bandwidth allocation mechanisms.

Varying radio base station (RBS) sizes, like pico, micro, and macro RBSs, can be implemented on one network, providing a cost-effective solution for a wide range of cell sites and traffic. Sites with low traffic can be now be profitably implemented with Pico base stations, especially when sharing cellular backhaul bandwidth in an IP satellite environment. Pico cells are ideal for rural areas with low Average Revenue Per User or for dedicated bandwidth to small/medium businesses for data and voice.

The A.bis over IP system has completely re-engineered the A.bis interface, both at the physical level by replacing traditional TDM connections with IP over Ethernet, and at the logical level, by replacing TDM channelization with dynamic packetization. These changes have been implemented in such a way that the basic structure of the GSM network is left intact. It's a simple upgrade/ enhancement that can be retrofitted into existing cellular networks or used in new green field networks with equal ease. A basic description of the new system is shown below:

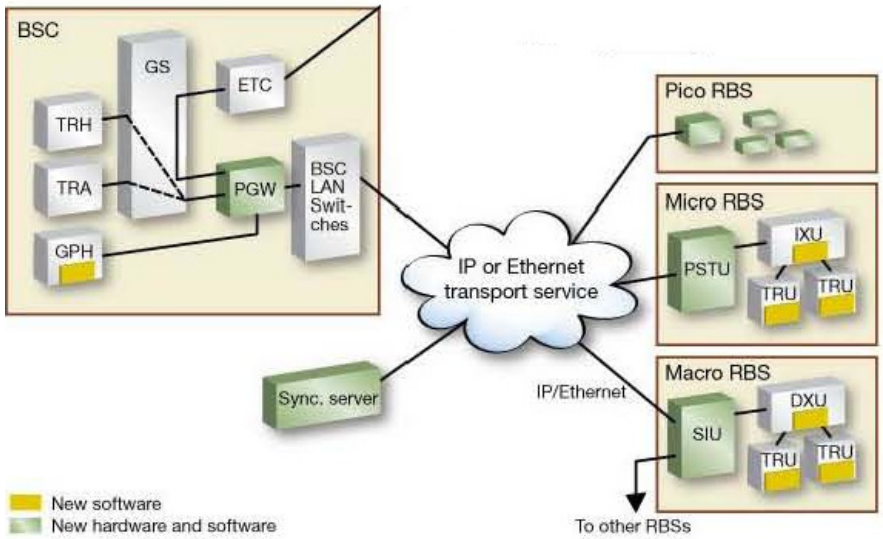

Figure 1 – Ericsson A.bis over IP system configuration

As shown above, the Ericsson solution fits perfectly into the existing GSM architecture. By adding a Packet Gateway (PGW) at the BSC, traditional TDM based BTS systems as well as new, packet based BTSs, can be supported simultaneously. The packet interface can be included as a feature on new BTSs, or retrofitted into existing BTSs with a simple interface addition like the Packet Switched Termination Unit (PSTU) or Site Integration Unit (SIU) and a software upgrade, protecting the cellular provider's installed base.

The key feature of this new interface is how it dramatically changes the way bandwidth is transported on the A.bis interface. With the A.bis interface now packetized and placed into Ethernet frames, the ideal satellite transport system is an iDirect network. The iDirect network, with its deterministic TDMA, sophisticated QoS and rapid bandwidth allocation algorithms, is ideal for transporting the new A.bis over IP data stream. This combination of products can reduce the satellite bandwidth needs for a cellular backhaul system by up to 80% compared to an SCPC solution, without sacrificing network quality.

Additionally, where the technologies make sense, iDirect also supports Mesh and SCPC connections out of the hub solution. These can be easily added as required, all managed under the award-winning iDirect iVantage Network Management System.

Ericsson / iDirect Solution

To save even more bandwidth, the SIU at RBS sites can be used to support local switching between RBSs in a cluster which reduces the backhaul requirement and improves the service quality for customers calling their neighbors. The *Abis over IP* solution enables operators to use IP and Ethernet transport networks to connect RBSs to the BSC and thereby benefit from the lower costs of IP based transport services. With a dynamic satellite solution, shared transport with WCDMA, EDGE/GPRS and other cellular technologies can be integrated, providing an economical and flexible solution.

Bandwidth Efficiency

Given that the A.bis information is now optimized, packetized, and in an IP format, an efficient transmission must be established between the BTS and BSC. Until recently, simple SCPC satellite connections were set up between these entities. While SCPC is suited to bridge the gap technologically, it is costly to operate. Since it forces the network designer to allocate bandwidth for the remote site based on its peak utilization, it frequently results in bandwidth inefficiencies and increased operational expenses.

The integrated Ericsson A.bis over IP solution, along with the iDirect satellite remote is a powerful combination fully equipped to handle the exact application described above. By using TDMA (Time Division Multiple Access) technology to dynamically allocate bandwidth to remote sites based on actual utilization, a GSM network equipped with iDirect modems can achieve significant savings over a traditional SCPC connection. Spreading “non-correlated traffic” (voice, data and signaling traffic) over a network can also reduce the overall bandwidth requirement by another 10% - 40%. With this technology, replacing the legacy SCPC satellite connections currently being used in some systems with Deterministic TDMA (D- TDMA) can often provide a very fast return on investment, and significant cost savings for the long term.

In an iDirect network supporting GSM traffic, the remote systems communicate with the hub multiple times every second and relay their demand for payload traffic. The hub then allocates the appropriate number of time slots for data transmission based on the real time demand, and dramatically reduces the need for satellite bandwidth.

Performance during Congestion

When trunk lines begin to fill to capacity, it is the responsibility of the switching systems to react and ensure that the trunks do not become a bottleneck for traffic. In the Ericsson / iDirect solution, the Ericsson equipment is aware of the available bandwidth and is constantly monitoring performance. If the Ericsson system detects that the network is beginning to congest, or if packets are being delayed or lost, it can quickly react to prevent congestion. And with iDirect’s flexible and simplified Network Management System (NMS), the award- winning iVantage™, customers can view traffic across the entire network and customize advanced Quality of Service (QoS) parameters. iDirect’s QoS segmentation and re-assembly algorithms enable the system to interrupt large data frames to prioritize voice traffic, eliminating unused time slots and enabling more efficient multiplexing of signaling channels.

If the Ericsson BSS detects that there may be some congestion on the system, it can then take the following actions to reduce the link bit rate:

- New calls are set-up to use the Half Rate codec
- The system dynamically reduces existing calls from Full Rate to Half Rate
- AMR Full Rate calls move to 8kbps Abis (reduced codec set)
- Move EDGE from higher MCS to lower MCS
- Move GPRS from higher CS to lower CS

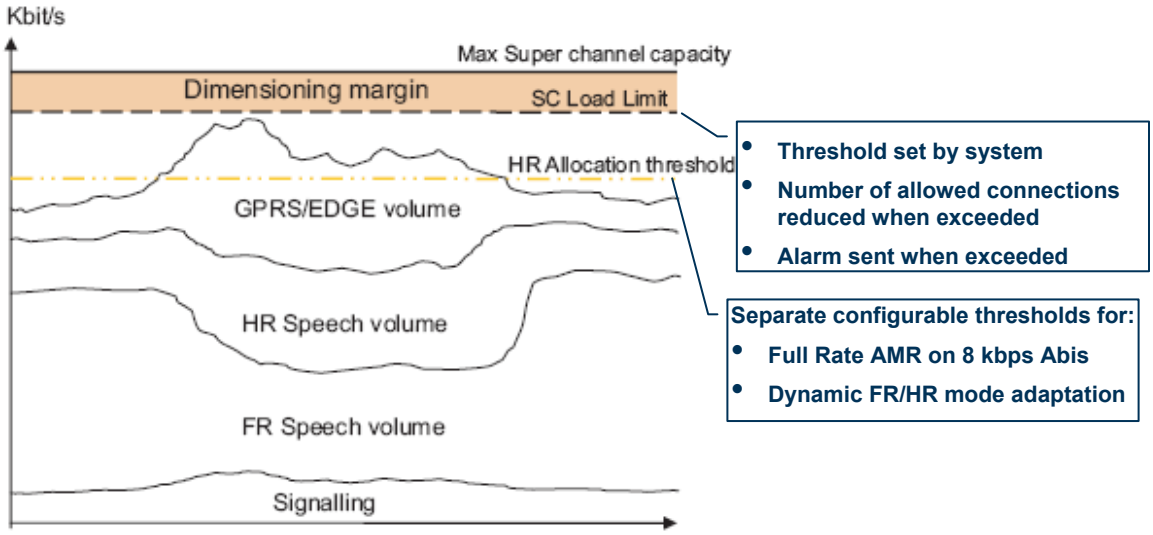

Figure 2 – Packet A.bis Trunk Utilization

With these tools, network reliability can be guaranteed even during times of peak utilization, just like in today's TDM-based networks.

Conclusion

With many of the world's major metropolitan areas already covered, the GSM marketplace is growing rapidly into remote areas. In the past, it's been difficult to cost effectively address these areas. But now, with the enhancements provided by the integrated Ericsson / iDirect solution, a new opportunity has emerged for carriers to now profitably go after the rural marketplace.

This combined solution not only provides cost savings. It implements the IP technology in an efficient, intelligent way that preserves and protects the GSM traffic, and ensures the highest standards for availability and call quality are met.