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Enhancing Network Performance in UMTS Networks

Synchronizing Node B Base Stations Will Improve QoS

Summary

- Node B base stations must hold 50 ppb frequency accuracy over the life of the equipment
- Exceeding this limit results in dropped calls, impaired data services, and lost customers
- Transition to high capacity IP/Ethernet backhaul drives the need for independent synchronization at the base station

Advanced mobile operators are racing to deploy third generation (3G) high-speed data service offerings in order to acquire and retain lucrative mobile professional users. Mobile professionals are the most profitable customers and the most discriminating – they are the least likely to tolerate poor quality of service (QoS).

Historically, synchronization and timing has been widely accepted as a fundamental component in telecommunication networks for the reliable and seamless transmission of voice, video and data. Today, precise synchronization is a rising consideration for 3G mobile operators in order to achieve network performance that will parallel wireline services. Progressive 2G and 3G operators are taking direct control of synchronizing BSC and MSC switching centers through deployment of independent synchronization elements in their networks. The overlooked area in 2G GSM networks has been synchronization of the radio base stations themselves to assure the same level of service quality on the air interface.

Synchronizing UMTS Node B Base Stations

UMTS Node B Base Stations must hold carrier frequency accuracy of +/- 50 ppb (parts per billion) over the ten-year service life of the equipment. If individual base stations drift outside the specified 50 ppb limit, mobile hand-off performance will decay, resulting in high dropped-call rates, impaired data services, and lost customers.

Legacy GSM base stations have traditionally derived their long-term frequency accuracy from locking a relatively low performance quartz oscillator embedded in the base station to a recovered clock signal from the T1/E1 leased line backhaul facility. Without the recovered clock to hold the oscillator on frequency, the base station would drift out of specification in a matter of months requiring costly service calls to manually adjust the oscillators.

Today, wireless network operators are faced with a new timing challenge. The problem occurs as the quality of synchronization on the backhaul facility degrades with the rapid evolution of transport network topologies and providers. Various timing viruses and transients increasingly present on backhaul facilities today can traverse through the clock recovery circuits and negatively impact frequency stability of the RF carrier resulting in dropped calls. Dropped calls are a key contributor to customer dissatisfaction resulting in user churn (users dropping one operator's service in favor of another's). Table 1 shows a summary of the evolving backhaul environment, and the relative ability to recover high quality synchronization. GSM operators today are experiencing a rising need to install independent synchronization solutions such as GPS based retimers at their base station sites to "clean up" sync problems on backhaul feeds provided by local PTTs/LECs or OLOs/CLECs so services aren't degraded.

Timeframe	Base Station Backhaul Transport	BTS Sync Reliability/Availability
Yesterday	Tightly controlled transport provided by the PTT/ILECs	Reliable sync recovery
Today	Complex menu of alternate backhaul providers and transport topologies	Uncertain sync recovery
Tomorrow	High-capacity, low-cost IP/Ethernet backhaul pipes	Sync recovery no longer available

TABLE 1 Mobile operators need to take direct control of synchronization at their base station sites to assure high QoS.

The Move to IP Backhaul

Transport networks are rapidly evolving to IP rich topologies. This offers mobile operators the increased backhaul capacity they require for deployment of high bandwidth data services and the cost advantage of IP transport. However, the move to Ethernet backhaul will eliminate the option for base station clock recovery from the backhaul facility. Operators will need to move to an independent source of synchronization at the base station to meet the UMTS 50 ppb requirement (Figure 1).

IP Backhaul isolates base stations from their traditional source of synchronization

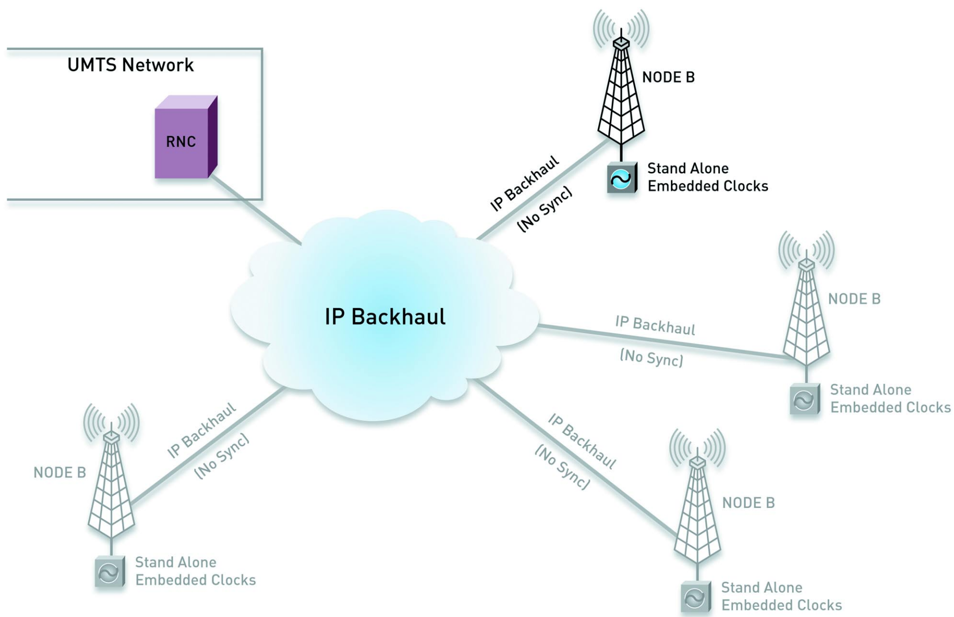

FIG. 1 The transition to high capacity IP backhaul drives the need for stand alone embedded clocks in UMTS Node B base stations.

In addition to traditional span line clock recovery, UMTS Node B infrastructure suppliers are introducing high quality embedded clock options. Many of these options mirror CDMA 2000 designs where GPS clocks provide a time-of-day reference needed for call hand-offs. CDMA networks have always relied on embedded GPS based clocks with precision rubidium or quartz oscillators, making them inherently prepared for the evolution to IP backhaul from a sync quality point of view. Table 2 provides a summary of base station clock options for UMTS.

Node B Sync Technology Options	Strengths	Weaknesses
Span Line Timing	• Lowest cost solution relying on existing backhaul network to provide synchronization	• Unpredictable and reliant on the facilities provider(s) • No longer an option when the backhaul shifts to IP/Ethernet transport
Embedded Rubidium Oscillator	• Most robust solution • Install and forget • Greatest stability over 10+ year service life of the base station	• Moderate initial Capex increase
Embedded Quartz Oscillator	• Lower initial equipment cost	• Likely to drift and result in higher dropped-call rates over time • High Opex (Truck rolls to tune the oscillators)
Embedded GPS	• Stratum 1 traceable • Provides time and location data	• Higher Opex to install and maintain GPS antenna runs • Reliant on GPS
External GPS Retimer	• Buffers and retimes the T1/E1 backhaul line to Stratum 1 level timing quality • Improves performance of legacy base stations (vendor agnostic)	• Higher cost than embedded solutions • No longer an option when the backhaul shifts to IP/Ethernet transport

TABLE 2 Compact Rubidium oscillators provide the most robust solution over the life of UMTS Node B base station equipment.

Utilizing rubidium based oscillators is the most robust solution for independent synchronization of UMTS base stations, as rubidium oscillators are proven to meet the 50 ppb requirement over the full service life of the equipment. Quartz oscillators, on the other hand, are subject to higher native aging rates and warm-up/restabilization characteristics that make it difficult to assure compliance to the 50 ppb requirement for more than a few years. This exposes network operators to QoS degradation and potentially high maintenance costs associated with manually calibrating quartz oscillators to bring them back on frequency after only a few years in the field. The danger to the operator is that this type of failure is undetectable until QoS issues reach a critical threshold.

As mobile operators transition to 3G, network stability and performance for high-speed data services will be key differentiators. Operators are increasingly reluctant to slave their base station stability to a recovered clock from the backhaul facility provider. What's more, the ongoing transition to lower cost IP backhaul options will in many cases eliminate any clock recovery from the backhaul feed. UMTS Node B base stations are moving to independent clocks to assure high QoS, with rubidium oscillators providing clear performance advantages over the life of the equipment.

Rubidium oscillators provide the most robust independent synchronization solution for high performance networks

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