BTS Backhaul by Satellite

Improving QoS &

Optimizing Bandwidth

The Mobile Market is experiencing solid growth in emerging countries. As an illustration, GSMA predicts the number of connections in Africa to jump from 620 Million in 2012 to 900 Million in 2015. Fierce competition between mobile operators as well as government and NGO initiatives encourage the development of mobile networks in underserved areas. In order to connect users in rural areas where basic telecommunication infrastructure is missing, mobile operators are relying on satellite communication to backhaul their GSM base stations.

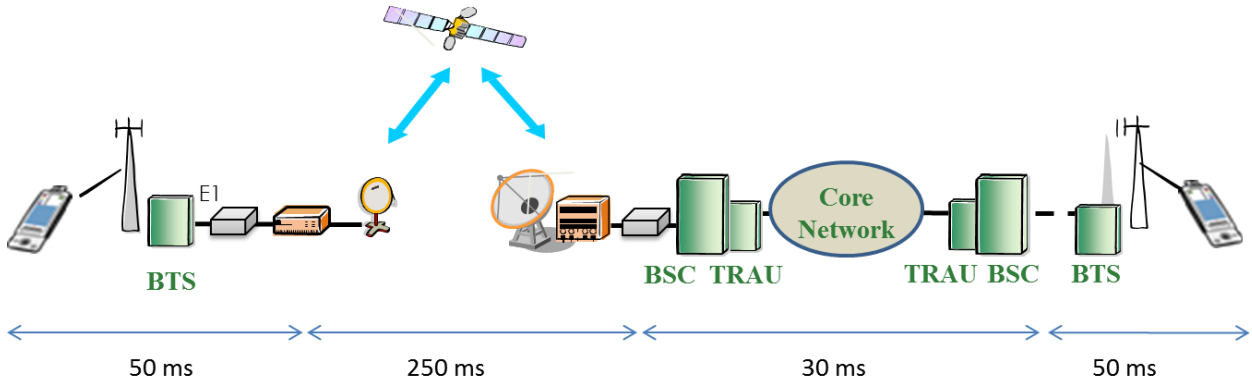
Cell & Sat developed a Local Switching function optimizing local communications on the link between BTS and BSC that improves the end-user experience as well as reduces the amount of bandwidth on the satellite link. Local Switching is performed at the interface with the BTS. During a conversation between two mobile devices connected to the same satellite terminal, only signaling is sent to the GSM network while the voice traffic is looped locally. On the BSC side, silent frames are generated and transmitted together with signaling in order to insure full transparency with the GSM network. The solution is compatible with all GSM networks.

This document describes the Local Switching benefits to end-users and GSM mobile operators.

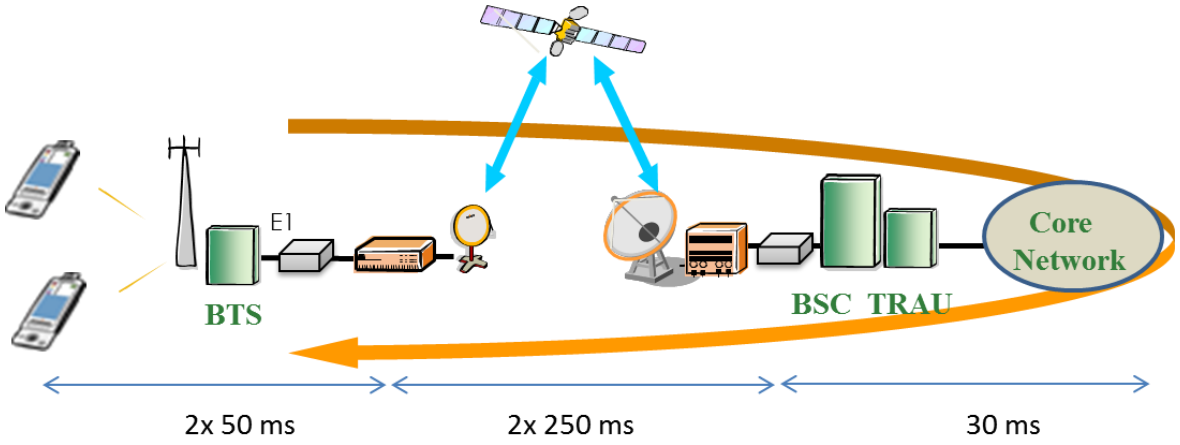
Voice quality perceived by end-users

Satellite communication services used today for backhauling of GSM base stations rely on geostationary satellites (GEO) located at altitude of approximately 36000 kilometers. It generates a propagation delay of approximately 250 ms to be added to the normal delay of the GSM network.

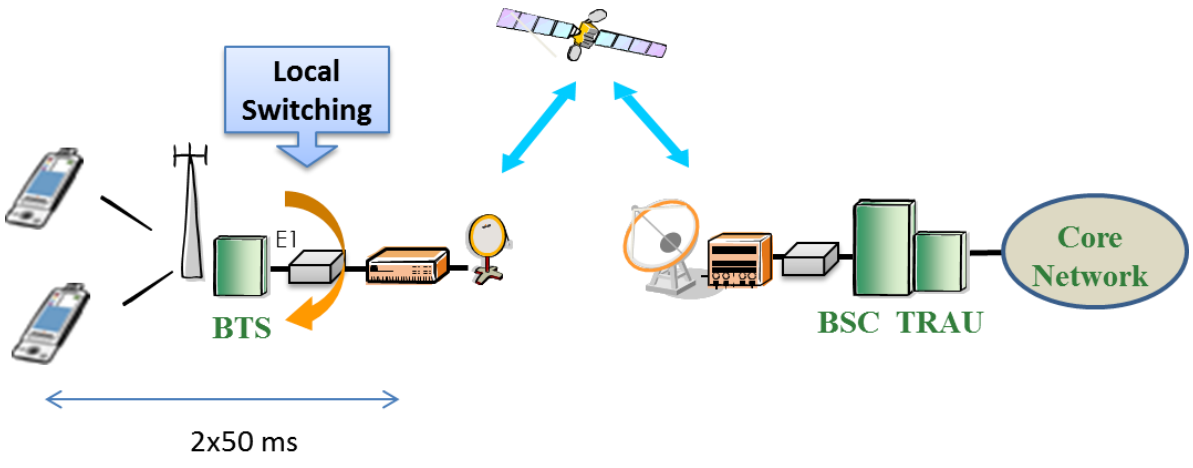
The figure below illustrates the one way end to end delay between 2 GSM users, one being connected to a base station backhauled by satellite. The mean transit delay in one direction is around 380 ms.



In the case of local communication between 2 GSM users connected to a BTS backhauled by satellite as illustrated hereafter, the voice traffic is going through the satellite to the core network and back again adding an extra propagation delay of 250 ms for a total of 630 ms. As we will see later, this level of latency has a significant impact on the quality of service as perceived by the end-users.



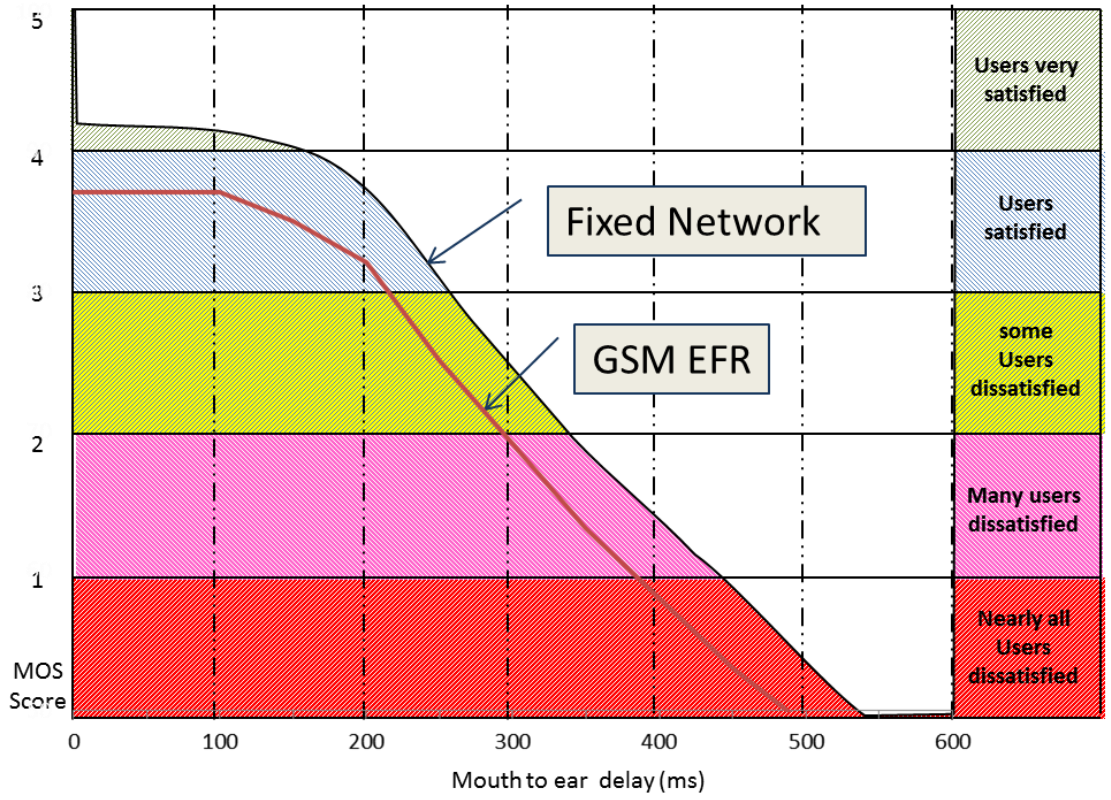
As shown below, the Local Switching solution allows for reducing the one way transit delay for local calls in the range of 100 ms.



To fully appreciate the impact of delay on the quality as perceived by the end-users, one can refer to the ITU standard dedicated to this subject.

ITU has defined a model in order to estimate the incidence of transmission delay on the perceived quality for voice conversations. ITU recommends that 400ms should not be exceeded for general network planning.

The following figure illustrates the user perceived quality depending on the type of network and the voice propagation delay between 2 users.



The Mean Opinion Score (MOS) defining the perceived quality is 4.3 for fixed Telephony. The score for a GSM network relying on terrestrial backhaul is between 2.9 and 4.1. In case of GSM backhaul by satellite the MOS is between 1 and 2.

Local communications with transit delays greater than 600 ms for local calls have a MOS score less than one, which is considered as unsatisfactory for almost all users. To measure the quality of a conversation between 2 users, a round trip delay of 1.2 second should be considered. As a consequence response time get longer during exchanges making communication between end-users quite uncomfortable.

The Cell & Sat Local Switching solution allows for reaching the required level of quality for local communications by reducing the latency for local calls in the range of 100 ms.

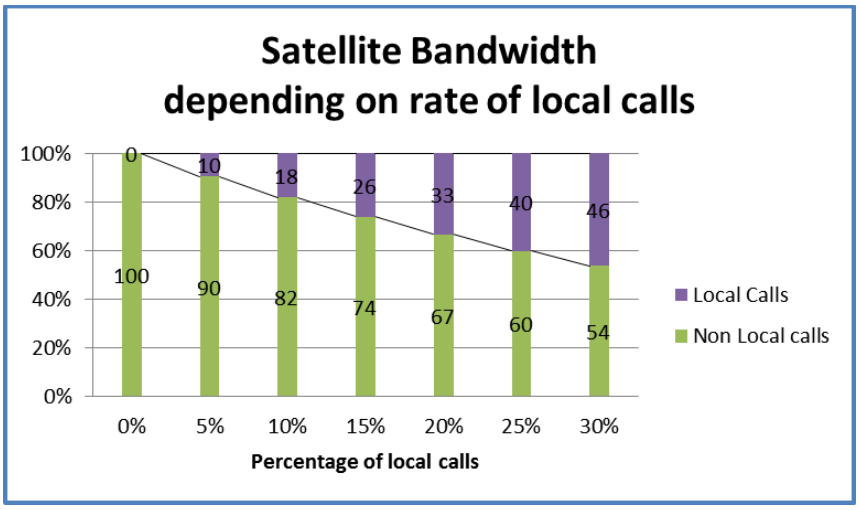
Satellite Bandwidth savings

The Local Switching solution (LS) reduces significantly the bandwidth utilization on the satellite segment. It complements Abis bandwidth optimization equipment implemented on the Abis interface between the BTS and BSC.

In order to appreciate the potential savings obtained by the Local Switching function, we will first analyze the required level of bandwidth for different rate of local calls without the implementation of LS.

The communication between a user A and user B backhauled through the same VSAT terminal will go through the satellite link once to reach the mobile switching center (MSC) where the call is routed then a second time through the satellite back to the second user. A local call therefore uses twice as much bandwidth as normal communication between distant users which traverse the satellite link once.

For example for 20% of local calls i.e 80% of long distance communications, the percentage of bandwidth used for local call represents 33%.



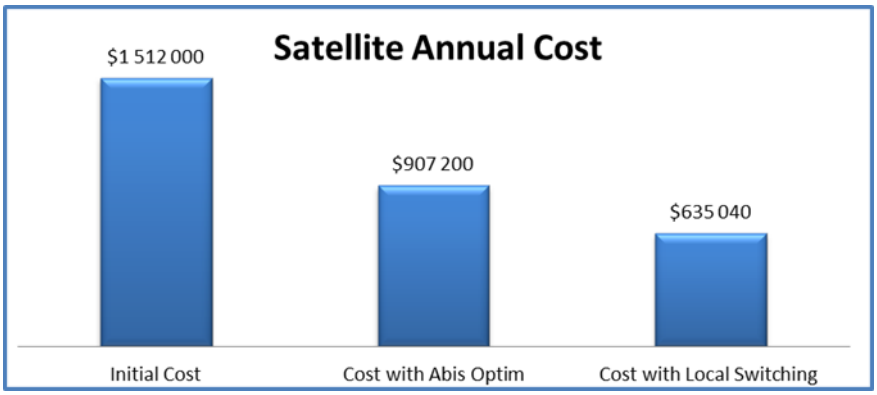
The above figure shows that a significant rate of local calls can have a big impact on the cost of satellite bandwidth.

The Local Switching solution can bring substantial savings on satellite cost as voice traffic for local calls is routed locally off-loading the satellite resource.

In the following illustration, the satellite savings is calculated on a concrete case:

- Number of sites: 50
- Number of TRX per site: 6
- Signaling overhead: 10%
- Satellite cost (MHz/month): $ 3000
- Local calls rate: 20%
- Modulation 16QAM, FEC 7/8

In this scenario, the annual cost of satellite bandwidth is $ 1,512,000 without optimization.
After Abis optimization and Local switching the cost is lowered to $635,040, i.e. 58% savings.



The local Switching function alone brings an additional 30% savings on top of Abis optimization.

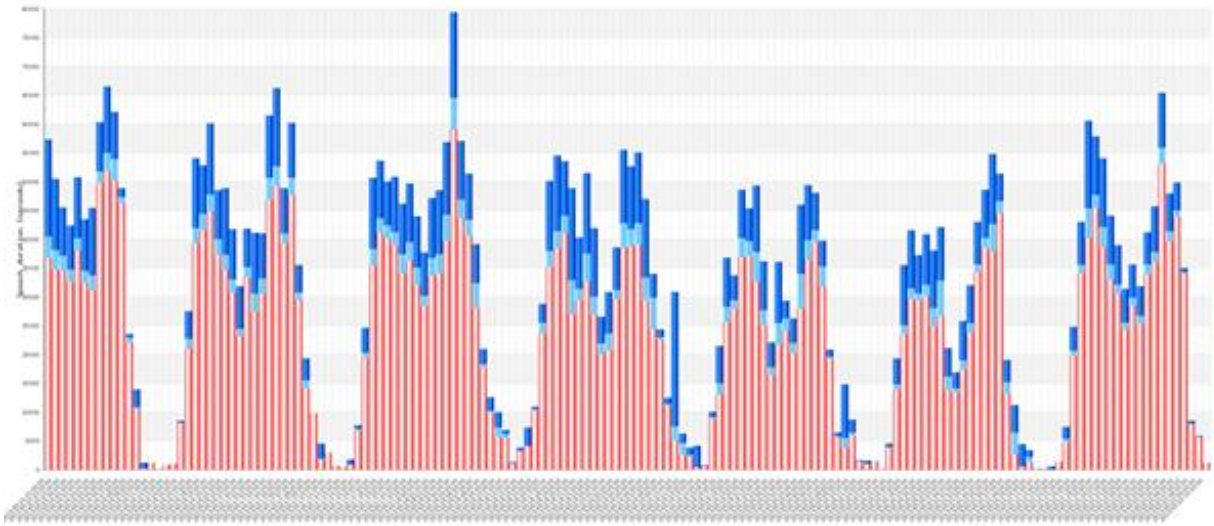
Bandwidth savings on the satellite link could as well compensate the increase of traffic due to data services whatever the type of GSM network: GPRS, Edge, 3G or LTE.

Cell & Sat provides on its website (www.cell-sat.com) a simulator allowing you to calculate potential savings based on your own environment.

Conclusion

Local Switching is a solution allowing mobile operators to extend their network coverage in underserved areas while preserving the quality of experience for end-users and managing the cost of satellite bandwidth used to backhaul base stations.

The hereafter graph generated gives a practical implementation example of the Local Switching function with a 7-day hourly traffic observation. It shows that 25% of communication duration – marked light and dark blue in the graph – take advantage of the quality of service and satellite transport cost improvements.



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About Cell & Sat

Cell & Sat is an innovation company with a dual expertise in cellular and satellite technologies.

With a special focus on the reduction of costs to operate GSM networks in rural areas, Cell & Sat provides optimisation products and services to cellular and satellite operators willing to implement efficient terrestrial or satellite GSM backhaul. The Cell & Sat solutions benefit from the company expert knowledge in GSM 2G/3G system design, satellite networking, IP QoS optimisation, distributed protocol design, high efficiency database implementation.

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