Nokia Siemens Networks
LTE 1800 MHz

Introducing LTE with maximum reuse of GSM assets

White paper

Table of contents

1. Overview

The introduction of LTE is driven by the need to deliver faster mobile broadband services than GSM and WCDMA networks. This white paper introduces technology solutions for LTE1800 MHz, including information on 1800 MHz spectrum deployment options and Nokia Siemens Networks' solutions for traffic migration from GSM to LTE.

The Nokia Siemens Networks white paper on LTE1800 MHz provides guidance on how operators can introduce LTE and how to support dual functionality of GSM and LTE in their radio networks. Furthermore, this white paper addresses the core network impacts of traffic migration from GSM to LTE and how to integrate LTE management into operators' network management systems in a cost efficient way.

2. 1800 MHz spectrum

Band 3 at 1800 MHz provides 2x75 MHz wide spectrum for FDD (Frequency Division Duplexing). Thus operator licenses are quite large.

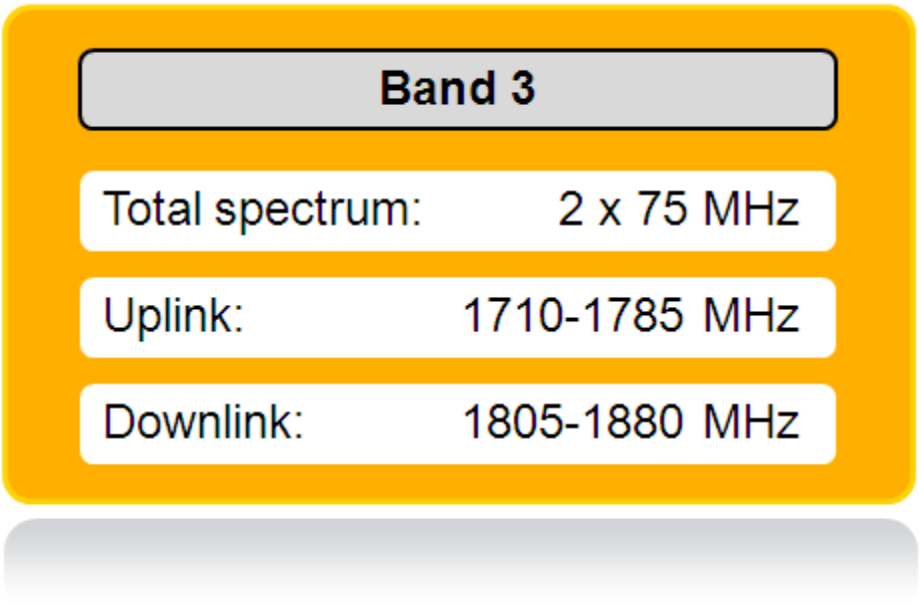

Table 1: 1800 MHz spectrum

License allocations on the 1800 MHz band are generally less fragmented than for example on the 900 MHz band. Typically the 1800 MHz license includes non-fragmented 10 to15 MHz spectrum. Thanks to the flexible carrier bandwidth of LTE, all or a suitable portion of 1800 MHz band can be reallocated for LTE use. Even LTE 5 MHz may introduce an improved user experience while lowering the cost of service delivery compared to HSPA Rel 6.

Some portion of the licensed spectrum may have been fragmented apart from the major portion. These smaller fragments are most suitably used by continuing GSM and EDGE operation (Figure 1).

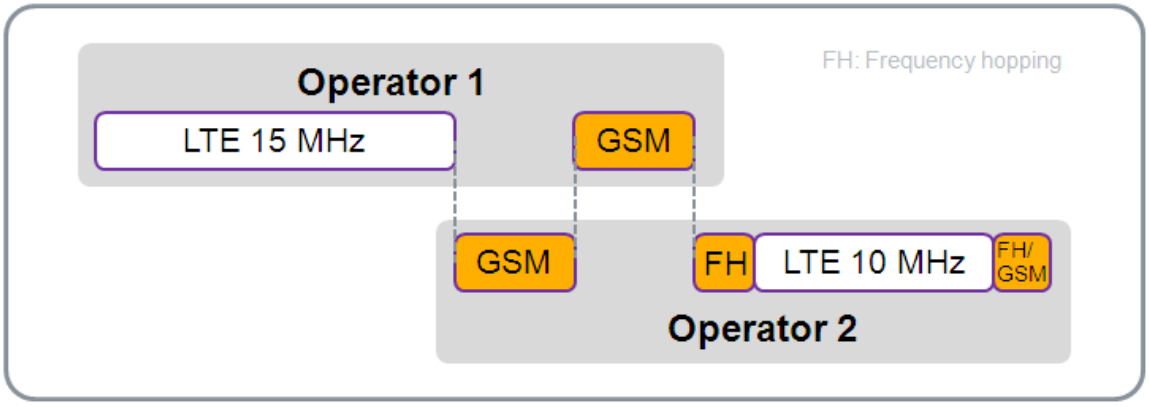

Figure 1: Simple example of fragmented spectrum allocation

1800 MHz as high mobile band is typically deployed for urban and suburban capacity extension of GSM, and potentially as overlay to 900 MHz coverage layer. One should also note that 1800 MHz spectrum used for LTE has some coverage benefit over the 'default' LTE 2600 MHz band and even over the 2100 MHz UMTS band.

LTE at 2600 MHz, WCDMA at 2100 MHz and GSM at 1800 MHz provide the same scale of coverage. Thus co-sited multi-technology deployment is a valid alternative. When evaluating LTE 2600 MHz and LTE 1800 MHz cases, LTE 1800 MHz provides roughly 3 dB better link budget in comparison to LTE 2600 MHz. This leads to benefits like device battery savings or enhanced indoor bit rates.

Downlink 2x2 MIMO is typically deployed in LTE networks, as devices must support 2-antenna reception anyways. This speaks for multi-technology multi-carrier power amplifier implementation in the transmitter of the eNB.

LTE spectrum should be refarmed next to power-controlled GSM frequency hopping carriers. The dominating interference mechanism due to the vicinity of the GSM carrier to LTE is minimized, as shown with operator 2 in Figure 1.

3. Traffic Migration

The 1800 MHz band has initially been deployed for extending GSM and EDGE capacity beyond the 900 MHz coverage layer. As a next step WCDMA and HSPA introduction at 2100 MHz may have covered further traffic growth and thus possibly relaxed pressure on the GSM layers.

Today WCDMA/HSPA carries the major share of mobile data volume. The 2100 MHz band has provided increased capacity through new spectrum. 900 MHz refarming to WCDMA and HSPA contributes through improved spectral efficiency and extended high bit rate coverage.

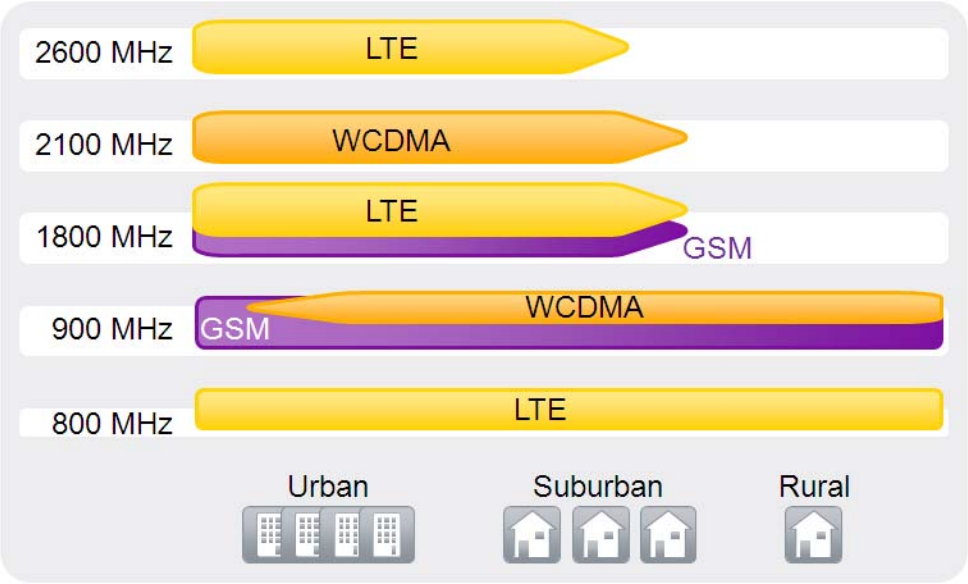

Figure 2: Favorable bands and technologies per environment

WCDMA 2100 MHz introduction and WCDMA 900 MHz refarming are typically focused on different environments: the first one to urban and the latter one to rural areas. When more mobile devices become WCDMA capable, the load of GSM layers can be offloaded, while starting LTE 1800 MHz refarming from urban towards suburban areas. At the same time spectral efficiency of GSM can be improved by enhanced features such as Dynamic Frequency and Channel Allocation (DFCA) or Orthogonal Sub-Channel (OSC).

Where 1800 MHz spectrum is free or becomes available, it can be used for LTE. The bandwidth alternatives of 5, 10 and 15 MHz support providing enhanced user experience beyond today's HSPA networks.

When an operator acquires a new 1800 MHz license the case is simpler and even an LTE-only operation at 1800 MHz becomes a feasible option.
As further migration step, GSM and LTE dual mode BTS may be updated to LTE-only BTS. Alternatively, WCDMA and LTE dual mode is feasible as intermediate or longer-term option.

4. Deploying LTE-GSM in 1800 MHz

4.1. Site and antenna sharing for installed assets protection

Installed antennas covering the 1800 MHz band, feeders and other site assets can be reused through a variety of known installation practices. Alternative solutions cover both partial refarming to GSM-LTE dual mode or to LTE-only. Reuse of existing GSM BTS equipment should be supported when modernization to a full RF sharing solution isn't feasible.

Obviously, transport sharing for multiple technologies should also be supported. LTE 1800 MHz refarming typically introduces LTE transport as a new functionality on site basis.

4.2. Radio Frequency sharing for ultimate energy efficiency

The most efficient solution is multi-technology and multi-carrier Power Amplifier (PA), where combination losses are avoided. The multi-carrier PA (MCPA) is even more beneficial in a setup including LTE, where LTE is more frequently configured to operate in MIMO mode. Here the 2-antenna downlink transmitter is the typical setup. The MCPA solution is also easily combined with a feederless site configuration.

Nokia Siemens Networks provides a highly integrated Flexi Multiradio BTS solution, which is optimal for multiple access technology use cases like GSM and LTE dual mode. A multi-carrier and multi-technology RF sharing solution at 1800 MHz band is available already.

4.3. Minimum guard bands for efficient spectrum usage

The LTE air interface is well scalable in terms of bandwidth. As an OFDMA technology LTE assumes small nominal guard band (10 %, excluding 1.4 MHz case). The operator license can be shared highly efficiently between LTE and GSM portions with the RF sharing solution.

In the un-coordinated case it is 3GPP recommended practice that the center frequency of the outmost GSM carrier is allocated 200 kHz apart from the spectrum boundary. In case of the LTE carrier the same 200 kHz distance is required from the edge of the nominal LTE bandwidth, like 10 MHz for example.

The un-coordinated scenario is for example valid between operators having adjacent spectrum within the 1800 MHz band. It also applies to none co-site scenarios, which aren't carefully planned.

Flexi Multiradio BTS enables even smaller guard bands when LTE and GSM carriers are inherently coordinated in an RF sharing case or in other equivalent co-site setups. In the coordinated case the GSM interference to the outer resources of the LTE downlink is the dominating criterion for the guard band, while the spectral density of the GSM carrier is much higher than of the LTE carrier.

4.4. Traffic management with multiple technologies and frequency bands

Mobility mechanisms in idle and connected mode should provide service continuity over multiple technologies and bands. Coverage based mobility is the basic mechanism. In the new technology rollout phase LTE capable devices should camp and communicate in LTE access whenever there is suitable coverage.

To ensure smooth operation with the existing networks, a comprehensive set of cell reselection mechanisms in idle state and handover types within each access technology and between access technologies must be supported. Both intra-frequency and inter-frequency mobility mechanisms are specified for each technology. Furthermore, service based handovers are also specified to ensure voice continuity.

Load balancing is needed especially between GSM/EDGE and WCDMA/HSPA, while LTE 1800 MHz refarming typically reduces overall GSM capacity.

Nokia Siemens Networks solutions are designed to provide a comprehensive set of options in the operator's toolbox.

4.5. GSM traffic compression

Dynamic Frequency and Channel Allocation (DFCA) and Orthogonal Sub-Channel (OSC) are key techniques to enhance spectral efficiency of GSM and EDGE. DFCA enables denser reuse of GSM carriers in a reduced spectrum due to LTE refarming. OSC enables Dual Half Rate concept for voice calls, which allows carrying up to two times the number of half rate channels, i.e. 4 voice channels per GSM timeslot.
In downlink orthogonal transmission by QPSK modulation is applied, in uplink the dual user MIMO concept is used. The OSC feature can be implemented through software update only. About half of all GSM devices support OSC already today.

5. Core Solution

From Evolved Packet Core (EPC) perspective the 2G/3G/LTE deployment can be done either with combined or separated SGSN/MME element. The main difference is that SGSN handles both user plane and control plane while MME handles only control plane traffic.

During the traffic migration from 2G/3G to LTE, the demand for the S/PGW capacity is expected to increase as LTE provides higher spectrum efficiency compared to 2G/3G. With LTE users are always-on IP connected to EPC, whereas in 2G/3G the users are typically attached to GPRS without PDP context. Due to this, the need for bearer and signaling capacity is increased in EPC.

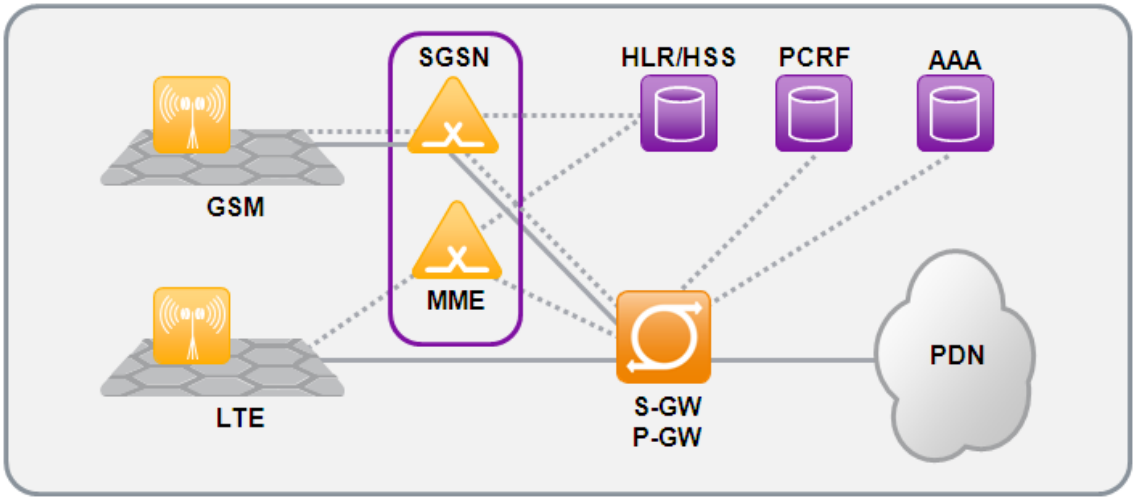

Figure 3: Core network with multiple radio access technologies

The SGSN may locate in the existing site from where traffic is routed to Serving gateway. The MME location is not dependent on the user plane, which means that it can either be centralized in the data center or combined with SGSN on regional level.

Nokia Siemens Networks EPC products Flexi Networks Server (Flexi NS) and Flexi Network Gateway (Flexi NG) are based on the common ATCA platform. Flexi NS provides flexible capacity allocation between control plane and user plane with common software for MME, 2G SGSN and 3G SGSN. Flexi NG with unique 4D scaling provides common gateway functionality supporting gateways for 2G/3G, HSPA, HSPA+, I-HSPA and LTE.

6. OSS and SON Solutions

The introduction of LTE, its concurrent operation with 2G and 3G networks together with the general cost pressure forces operators to significantly reduce their operational expenses. Important building blocks for cost reduction will be smooth evolution and efficient re-use of existing management solutions and platforms, and a set of new innovative applications, including Self Organizing Network (SON) capabilities, covering 2G, 3G and LTE Radio Technologies.

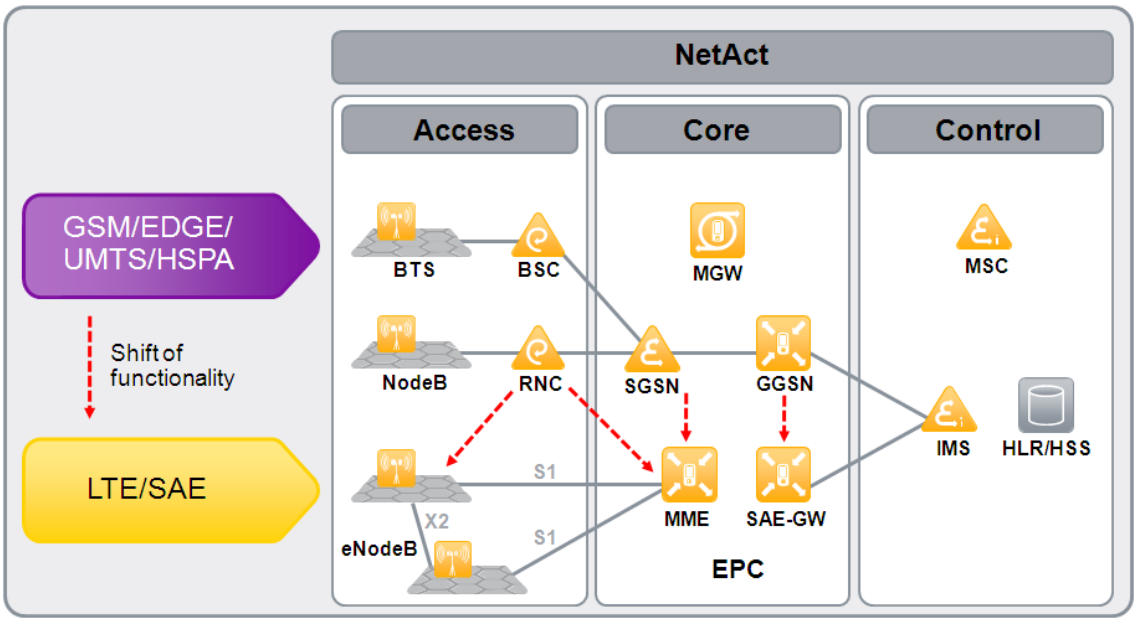

Figure 4: OSS and SON

Auto-configuration capabilities enable efficient automated network integration of new eNB by auto-connection and auto-configuration, core connectivity and automated neighbour site configuration. Self-optimisation can improve the service quality of the network. Self-healing speeds up the recovery from exceptional situations through the automatic detection, localization and removal of failures.

Nokia Siemens Networks' network management system NetAct has been designed to support the operators' processes to achieve these goals and to integrate the management of LTE as well as all the other radio technologies. This technology independence, which also covers transport, core and IP networks, makes NetAct a future-proof solution for operating the entire network. NetAct provides multi-technology and multi-vendor support by a single Operations Support System (OSS). A complete set of applications for all operations and maintenance areas is available for element, network and service management layers and the same applications are used regardless of network technology.

To help further lower costs and increase revenue across the whole spectrum of the business, NetAct is based on open interfaces and industry standards such as the Next Generation OSS (NGOSS), the Third Generation Partnership Project (3GPP) and TeleManagement Forum's eTOM model.

7. Summary

Nokia Siemens Networks acquired wide experience in implementing and upgrading complex mobile systems. The company is committed to smooth GSM to LTE migration and accommodates the essential enablers in its products:

- Highly integrated Flexi Multiradio BTS offers optimal multi-access solutions including GSM, WCDMA and LTE operation
    - Flexi Multiradio BTS also includes a highly integrated multi-technology baseband solution with integrated transport interface. The baseband module can be installed either indoors or outdoors.
    - Flexi Multiradio BTS provides high power efficiency. Outdoor installation options achieve further savings without cooling and feeder loss related overheads. Zero footprint installation can be realized for example through on-wall or pole mounting.
    - The RF module of the Flexi Multiradio BTS can be installed outdoors without extra cabinets and close to the antenna to avoid feeder losses.
- Flexi Multiradio BTS supports an efficient multi-carrier GSM-LTE RF sharing solution for the 1800 MHz band already today
- Core solution provides a smooth evolution from 2G/3G to LTE with common software for MME and SGSN
- NetAct OSS system features a comprehensive multi-access and multi-vendor capable element, network and service management for the entire network including radio, transport and core

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