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Nokia GSM/EDGE BSS11.5 System Documentation

Nokia Base Station Subsystem

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Contents

1 Changes in Nokia Base Station Subsystem

The document has been revised throughout to comply with the latest documentation standards.

BSS11.5 release's new features were added in the *Nokia Base Station Subsystem Solutions* section.

2 Overview of Nokia Base Station Subsystem

Nokia Base Station Subsystem Description describes Nokia solution for the GSM network's Base Station Subsystem (BSS). The purpose of this description is to give a general overview of the parts and operations of Nokia BSS. In addition, other operational entities and services related to the BSS are described.

In this description, the abbreviation GSM stands for the GSM 800, GSM 900, GSM 1800 and GSM 1900 systems. In addition, GSM 800/1900, GSM 900/1800 and GSM 800/1800 for Nokia UltraSite EDGE Base Station and for Nokia MetroSite EDGE Base Station are presented.

Nokia Base Station Subsystem consists of the base station controller (BSC), transcoder submultiplexer (TCSM), base station (BTS), cellular transmission (CT), power systems, antenna line, the network service and management system (Nokia NetAct) and network planning. In this document, general network element names are used for Nokia equipment.

Nokia can provide a complete BSS network including:

- Radio network elements: BSC and a wide range of BTSs.
- Integrated cellular transmission including short- and long-haul microwave radios, copper-based transmission and PDH cross-connection. For optical transmission there are full SDH product families from Marconi and Tellabs.
- Integrated and stand-alone power systems, battery backup and site support solutions
- Full range of antenna line elements
- GSM-WCDMA Inter-System Handover software application, which enables the interworking between the 2G and 3G networks.
- Management of all of the above with Nokia NetAct network service and management system.

Related topics:

- *GSM Network architecture*
- *Nokia Base Station Subsystem elements*
- *Nokia Base Station Subsystem solutions*
- *Nokia Base Station Subsystem compatibility with other NSSs and GPRS Core networks*
- *Nokia Base Station Subsystem interfaces*
- *GSM system security*
- *Nokia's services for operators*
- *Nokia Base Station Subsystem quality*
- *Nokia environmental issues*

3 GSM network architecture

The GSM network is functionally divided into three elements. Base Station Subsystem (BSS) is one of the main functional elements of the GSM network. The other elements in the GSM network are the network switching subsystem (NSS), GPRS core network to SGSN and network service and management subsystem (Nokia NetAct).

The main function of the BSS is to connect the mobile subscriber's mobile station (MS) to the GSM network and through it to the mobile switching centre (MSC), and to GPRS core network, serving GPRS support node (SGSN). The BSS also takes care of the mobility management of the cellular network including, for example, handover management and various measurements.

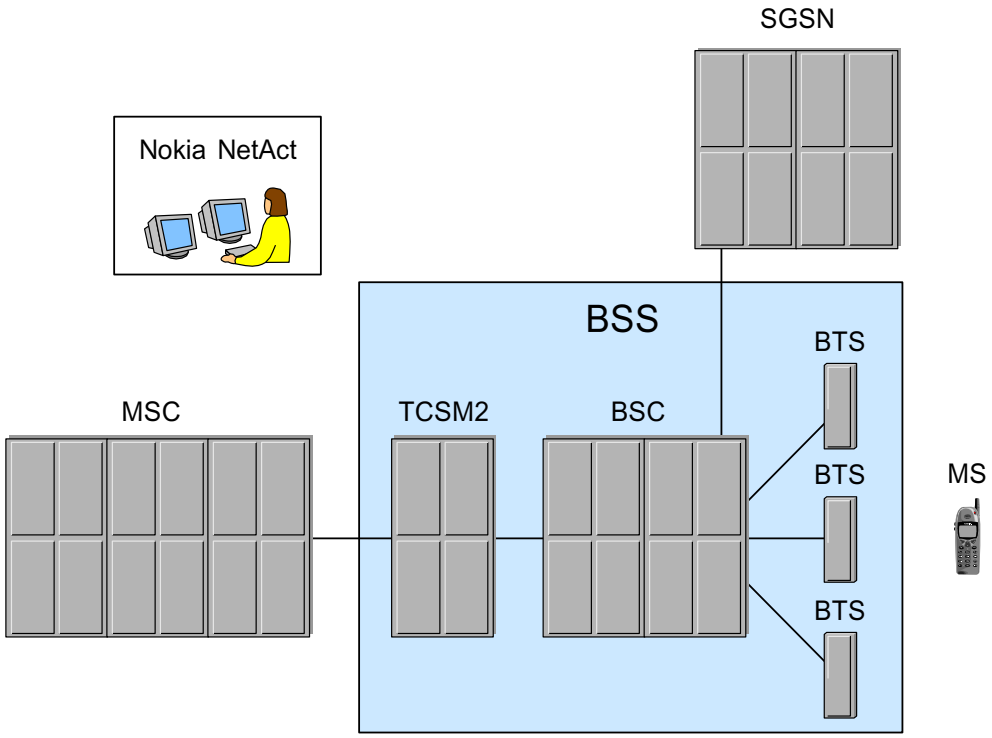

Figure 1. Nokia Base Station Subsystem in the GSM network

3.1 Advantages of Nokia Base Station Subsystem

The high capacity Nokia Base Station Subsystem is based on a fully integrated system approach, offering a unique system solution with built-in intelligence and flexibility. The use of advanced features with the greatest potential for capacity, coverage and quality result in the maximum performance of the GSM network.

Nokia BSS comprises a number of base stations (BTS), base station controllers (BSC), transcoder submultiplexers (TCSM), power systems, antenna line and cellular transmission (CT). Nokia BSC and TCSM have been designed to allow a flexible locationing within the GSM network. For example, the TCSM can be co-located on the same site with the BSC or MSC to economise transmission costs.

The modular design of Nokia equipment has many advantages. It facilitates the upgrading of hardware and software, causing minimal disturbance to the network. The modularity also makes Nokia equipment easily expandable. Due to the modularity, the size of Nokia BSC, Nokia TCSM and Nokia BTS is relatively small and compact, which make it easy to place and thus enables fast roll-out.

Nokia equipment conforms to the GSM specifications. For more information on the subject, see *Nokia Statement of Compliance.*

The individual BSS network elements are linked together with cellular transmission (CT) or leased line connection. The Nokia integrated transmission solution provides an automatic path protection by the formation of loops with secure radio links. The base station integrated cross-connection functionality reduces the transmission costs between the BTSs and BSCs.

The provision of high quality services to end users is also enabled by the capability of full mobile services availability, achieved by protecting the BTS against mains voltage breaks and keeping services running. The Nokia power systems have been specified, tested and optimised to secure the Nokia BTS site element functions, ensuring safe DC distribution for BTSs and LTEs.

Prerequisites for the availability of the BSS network elements are simplicity and speed of the servicing procedures, such as fault repair time. In Nokia BSS this is guaranteed in many ways. Built-in redundancy functionalities and efficient supervision functionalities minimise the time spent in maintenance. In addition, reliable network elements and automatic fault detection and recovery procedures cause less need for site visits. As a result, the network maintenance is more economical.

Nokia Network Planning System aids the operator to plan the network to be as cost-effective as possible. The network service and management system (Nokia NetAct) provides the means to implement and modify the plans to the network.

Nokia Customer Operations provides planning, implementation, training and technical support services as a part of the complete Nokia BSS system solution.

4 Benefits of having Nokia Base Station Subsystem and Network Switching Subsystem (NSS)

There are several benefits of having both Nokia Base Station Subsystem (BSS) and Network Switching Subsystem (NSS) in the same GSM network. For example, Nokia NetAct can handle the whole Nokia GSM and GPRS Core networks, resulting in operational costs reduction and overall cost-efficiency. All Nokia network elements are compatible with each other; their features are also designed to support each other. This becomes more and more important with the advanced GSM features, such as data services. For more information on network interworking, see *Nokia Base Station Subsystem Compatibility with other NSSs and GPRS Core networks*.

Substantial savings can be made when using Nokia equipment throughout the network. Firstly, common components and spare parts can be used in several Nokia equipment. Secondly, uniform platforms and software reduce the efforts in employee training and make the network easier to operate. Thirdly, the Nokia network is very flexible in operations and planning as expansions are made when needed. The network investments are also made only according to real requirements.

The Nokia network also saves in site costs. For example, the compact Nokia equipment enables the use of small sites, optimising the site usage. Due to many system solutions that enhance the coverage and capacity of traditional BSS sites with Nokia equipment, less sites are needed.

5 Nokia Base Station Subsystem elements

5.1 Nokia Base Station Controller

Nokia Base Station Subsystem consists of the base station controller (BSC), transcoder submultiplexer (TCSM), base station (BTS), cellular transmission (CT), the network service and management system (Nokia NetAct) and network planning.

Based on Nokia's long experience in cellular networks, Nokia Base Station Controller (BSC) is designed for the efficient use of radio resources, easy operability and maintainability. It is also designed to gather and convey comprehensive information about the quality of service. Moreover, it is cost-efficient and has high capacity. Nokia Base Station Controller is a stable, mature product, with field-proven high reliability and multivendor functionality.

Nokia BSC provides a connection between the MSC, the BTSs, and the SGSN.

The main function of the BSC is to control and manage the BSS and the radio channels. It transfers signalling information to and from the mobiles and manages handovers between the cells.

BSC3i

Nokia High Capacity Base Station Controller BSC3i is a solution for the evolving GSM markets. The maximum circuit handling capacity of a BSC3i is 660 TRX, 3920 Erl. The BSC3i has a compact one-cabinet design; it is also modular in order to enable easy expansion. It has built-in IP connectivity for enhanced feature support with IP-based interfaces. It uses transmission and radio resources efficiently in order to enable a flexible traffic mix between voice and data. It has a swift fault detection and hot standby units to allow minimal system downtime.

BSC3i is based on BSC S10.5 or later software. It includes the same features as BSC, BSC2i and BSC2E/A products.

Figure 2. Nokia Base Station Controller, BSC3i

For more information, see *BSC3i.*

BSC2i

Nokia Base Station Controller DX 200 BSC2i is a digital switching product for GSM networks. Nokia BSC belongs to the DX 200 Switching System Product Family based on a Fault Tolerant Computing Platform, which constitutes a base for a Switching Platform.

Figure 3. Nokia Base Station Controller, DX200 BSCi, BSC2i

Nokia Base Station Controller is easily expandable due to the modular architecture of the DX 200 Switching System Product Family and the use of the latest hardware components. In the design of Nokia Base Station Controller great attention has been paid to the reliability of operation.

The distributed architecture of Nokia Base Station Controller is implemented by a multiprocessor system. In a multiprocessor system the data processing capacity is divided among several computer units, each of which has a microcomputer of its own. For example, the call handling capacity depends on the number of call control computer units. By adding more call control computer units the capacity of Nokia Base Station Controller can be easily increased.

Nokia Base Station Controller is a stand-alone network element in the BSS. It is connected to the surrounding network elements with standard PCM interfaces. This offers flexibility and cost-efficiency in transmission. Nokia Base Station Controller has an X.25 and a LAN connection to Nokia NetAct called Q3 interface. The Q3 interface is used for data transfer between Nokia Base Station Controller and Nokia NetAct.

For more information on Nokia Base Station Controller, see *High Capacity Base Station Controller, BSC2i, BSCi.*

Table 1. High capacity BSCi and BSC2i

TRX number (max.)	512, or 256 FR , or HR 512 (ANSI) FR (ANSI)
Erl	3040

Table 1. High capacity BSCi and BSC2i (cont.)

Size (height x width x depth)	2200 mm x 1200 mm x 500 mm two racks 2020 mm x 1200 mm x 500 mm (ANSI)
Power consumption	max. 620 W max. 595 W (ANSI)

Table 2. BSC3i

TRX number (max.)	660 FR 330 HR
Erl	3920
Size (height x width x depth)	2000 mm x 900 mm x 600 mm one rack
Power consumption	1700 W

5.2 Nokia Transcoder Submultiplexer

Nokia Transcoder Submultiplexer DX 200 TCSM2 is used on the A interface between the BSC and the MSC to enable the full use of network capacity. Nokia Transcoder Submultiplexer performs transcoder functions in the base station subsystem and provides a submultiplexing scheme that is used between the transcoder and the BSC.

The Nokia Transcoder Submultiplexer units are functional units of the BSC, but can be located either at the BSC or MSC site. Submultiplexing is used between the BSC and TCSM to reduce transmission costs. The reduction is greatest when Nokia Transcoder Submultiplexer is located at the MSC site. Submultiplexing also reduces the amount of pulse code modulation (PCM) circuits needed between the MSC and BSC sites.

Nokia Transcoder Submultiplexer converts the 64 kbit/s traffic channels arriving from the MSC into 16 kbit/s or 8 kbit/s channels and multiplexes these channels to fit the PCM line time slots going towards the BSC. The same principle in reverse applies to the other direction (from the BSC to the MSC).

Nokia Transcoder Submultiplexer performs speech coding according to the speech compression methods mentioned in the GSM specifications. It also supports Full Rate (FR), Half Rate (HR) and Enhanced Full Rate (EFR) codecs. In addition, Nokia features Acoustic Echo Canceller (AEC), Noise Suppression (NS) and Adaptive Gain Control can be used in Nokia Transcoder Submultiplexer to further improve network speech quality for mobile subscribers.

The modular architecture of DX 200 Switching System Product Family enables the easy expanding of Nokia Transcoder Submultiplexer, whose capacity depends on the number of equipped plug-in units.

Nokia Transcoder Submultiplexer supports the downloading of the entire software from the BSC or a PC via the Visual Display Unit (VDU) interface. The operation and maintenance functions of Nokia Transcoder Submultiplexer are also co-ordinated with the BSC.

A standard rack can house eight Nokia Transcoder Submultiplexer units, which may belong to different BSSs. Nokia Transcoder Submultiplexer units that handle the A interface of one BSC usually fit into one rack.

For more information on Nokia Transcoder Submultiplexer, see *TCSM2 Functional Description*.

Table 3. Technical information of TCSM2

TCH number (max.)	960 (FR) 1680 (HR)
Size (height x width x depth)	2030 mm x 880 mm x 500 mm
Power consumption	360W (FR) 940W (HR)

5.3 Nokia Base Station

The base station (BTS) is connected to the base station controller (BSC) via the Abis interface. The BTS also connects the mobile subscriber's mobile station (MS) to the GSM network through the Radio interface and performs the radio functions of the BSS.

Nokia offers a great variety of base station types for both indoor and outdoor use in different climatic or other environmental conditions. Micro base station solutions for capacity enhancement and coverage extension are also available.

All Nokia BTSs are fully controllable from Nokia NetAct and the BSC site with a remote connection. The required software can be downloaded either from the BSC or from Nokia NetAct through the BSC. Man-Machine Interface (MMI) or Site Wizard enables commissioning, fast fault localisation, and efficient testing.

5.3.1 Nokia UltraSite EDGE Base Station

Triple-mode Nokia UltraSite GSM/EDGE Base Station is a compact high capacity base station for multiple standards. Combinations of GSM, EDGE and WCDMA configurations can exist in the same cabinet. Nokia UltraSite GSM/EDGE Base Station supports GSM/EDGE on 800, 900, 1800 and 1900 MHz frequency bands and it also has capability for 900/1800, 800/1800 and 800/1900 dual bands. Nokia UltraSite GSM/EDGE Base Station Indoor can additionally host WCDMA carriers. Nokia UltraSite EDGE Base Station supports sectored and omni-configurations.

The Nokia UltraSite GSM/EDGE Base Station Indoor and Nokia UltraSite GSM/EDGE Base Station Outdoor cabinets can house up to 12 GSM/EDGE TRXs; alternatively, they can be configured to house up to 6 GSM/EDGE TRXs and an integrated battery backup system (IBBU). Moreover, without the IBBU, Nokia UltraSite GSM/EDGE Base Station Indoor and Outdoor can house up to 6 GSM TRXs and 6 WCDMA carriers. A 1-6 TRX Nokia UltraSite GSM/EDGE Base Station Midi Indoor and Nokia UltraSite GSM/EDGE Base Station Midi Outdoor are also available.

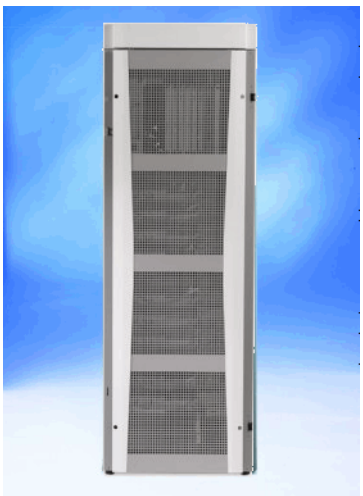

Figure 4. Nokia UltraSite GSM/EDGE Base Station Indoor

Figure 5. Nokia UltraSite GSM/EDGE Base Station Outdoor

Nokia UltraSite GSM/EDGE Base Station is optimised for high capacity and wide coverage macrocellular applications. The number of sites is reduced, a seamless voice and data coverage area is provided, and high call quality is maintained because of an improved link budget.

The extremely wide coverage area built by Nokia UltraSite GSM/EDGE Base Station, with 44.5 dBm (28.2 Watts), provides a wide service area per site and a large user base coverage. With Nokia Smart Radio Concept (SRC), Nokia UltraSite GSM/EDGE Base Station provides even up to 5 dB extra coverage.

Nokia UltraSite GSM/EDGE Base Station provides high capacity with a reduced number of BTS cabinets and sites. It is a compact, high capacity voice and data BTS, containing up to 12 TRXs per BTS cabinet. The cabinets can be chained for large configurations with up to 108 TRXs in 9 BTS cabinets.

Nokia UltraSite GSM/EDGE Base Station can also be used when the existing Talk-family sites need to be expanded. Nokia UltraSite GSM/EDGE Base Station can be placed side by side with the Talk-family sites and can be integrated into a Talk-family site as an extension cabinet.

With the versatile Nokia UltraSite transmission options, the most suitable transmission media can be used. Nokia UltraSite GSM/EDGE Base Station can house up to 4 transmission units. The supported transmission medias are microwave radios (Nokia FlexiHopper Microwave Radio and Nokia MetroHopper Radio) and wireline (E1/T1). A separate SDH ADM or TM multiplexer can be used for optical transmission.

Nokia UltraSite GSM/EDGE Base Station provides full data support with HSCSD, GPRS, and EGDE compatibility, with simple plug-in unit extensions. Nokia's soft capacity features, such as Intelligent Frequency Hopping (IFH), are fully supported. Advanced coverage enhancing features, such as Nokia Intelligent Coverage Enhancement (ICE) and the Nokia Smart Radio Concept (SRC) options, are also supported.

BSS11134: Antenna Hopping for UltraSite BTS is an application software targeted at optimising capacity and performance. Antenna Hopping enables the TRXs in an RF hopping BTS to transmit with all the TX antennas in the BTS. Antenna Hopping uses the existing Baseband (BB) hopping functionality in the BTS.

BSS11047: Intelligent Shutdown for UltraSite and MetroSite BTS is another application software in the UltraSite. It is used to minimise the BTS site power consumption and optimise the service level if the mains power fails. By reducing the service level when the mains has failed, the battery backup power can be made last longer than when using a full service level.

Table 4. Technical information of Nokia UltraSite EDGE Base Station

TRX number	1 -12 per cabinet 108 TRXs per site 36 TRXs per sector can be divided between different bands	1 -6 sectors per cabinet combining by-pass and wideband combining 2:1 1 -3 sectors per cabinet with wideband combining 4:1 1 -2 sectors per cabinet with remote tune combining 1 sector can have 1 -12 TRXs
Size (height x width x depth)	1940 mm x 770 mm x 750 mm 1800mm x 600 mm x 518 mm 1180 mm x 600 mm x 620 mm 1320 mm x 770 mm x 750 mm	Nokia UltraSite EDGE Base Station Outdoor Nokia UltraSite EDGE Base Station Indoor Nokia UltraSite EDGE Base Station Midi Indoor Nokia UltraSite EDGE Base Station Midi Outdoor

5.3.2 Nokia MetroSite EDGE Base Station

Nokia MetroSite EDGE BTS is a compact and powerful base station with a pleasant appearance that blends easily into almost any environment. Its small size makes the site acquisition easier and faster for the operator.

Nokia MetroSite EDGE BTS is an ideal solution for areas where capacity is needed, such as downtown street corners, shopping centres, and underground stations, because of its optimised RF performance, high capacity, compatibility with Nokia soft capacity solution features and versatile installation options.

Nokia MetroSite EDGE BTS can be used to provide coverage for macrocellular networks, such as gaps in the network or roadside sites. It can also be used to build fill-in coverage in urban or suburban areas where the site locations for conventional base stations are hard to find or a quick roll-out is needed.

Installing MetroSite next to the antennas - either on rooftop or mast-top - will minimise the feeder losses, thus easily providing a similar coverage area as a traditional macro base station installed on the ground or in a basement. For transmission, Nokia MetroSite supports Nokia FlexiHopper and MetroHopper microwave radios, as well as E1/T1 leased line i/f.

BSS11047: Intelligent Shutdown for UltraSite and MetroSite BTS is an application software for MetroSite. It is used to minimise the BTS site power consumption and optimise the service level if the mains power fails. By reducing the service level when the mains has failed, the battery backup power can be made last longer than when using a full service level.

Table 5. Technical information of Nokia MetroSite EDGE Base Station

Number of TRXs	1 - 4	Up to 12 TRXs with cabinet chaining
Size and weight	871 mm x 310 mm x 215 mm and 954 mm with a cable cover 40 kg	Approx. 18 kg without TRXs
Power consumption	400 W (typical) 550 W (max)	4 pcs. 10 W GSM/EDGE TRXs

5.3.3 Nokia Talk-family Base Station

A Nokia Talk-family BTS site can be upgraded to EDGE functionality with the installation of Nokia UltraSite EDGE BTS (housing GSM/EDGE-capable TRXs) as an extension cabinet on the site. Site compatibility is achieved by synchronising a Nokia Talk-family BTS and Nokia UltraSite EDGE BTS, and by using existing antenna and feeding structures. The synchronised BTSs share a single BCCH (per sector) and function in the network as a single cell. The site is then seen as one object by the NMS and the BSC (Multi BCF control feature). In this configuration, the Nokia Talk-family TRXs support voice, 9.6 kbit/s data, HSCSD, and GPRS.

The Nokia Talk-family and Nokia UltraSite EDGE BTS co-siting solution provides the following benefits to GSM network operators:

- Full capacity
  - All GSM/EDGE TRX configurations are supported, since there are no limitations on the maximum number of GSM/EDGE TRXs in the Nokia UltraSite EDGE BTS cabinet. Depending on the business and network requirements, operators can use a combination of GSM and GSM/EDGE TRXs.
- Full coverage
  - Nokia UltraSite EDGE BTS offers a better link budget of 2 dB; since the received signals are shared within the same cell, better coverage is achieved.
- Full functionality
  - The Nokia UltraSite EDGE BTS solution offers Dynamic Abis functionality which is an efficient way to enhance the Abis data handling capacity and subscriber data rates.

The figure *Co-siting of the Nokia UltraSite and Talk-family example* shows an example of the Nokia UltraSite EDGE BTS and Nokia Talk-family BTS co-siting.

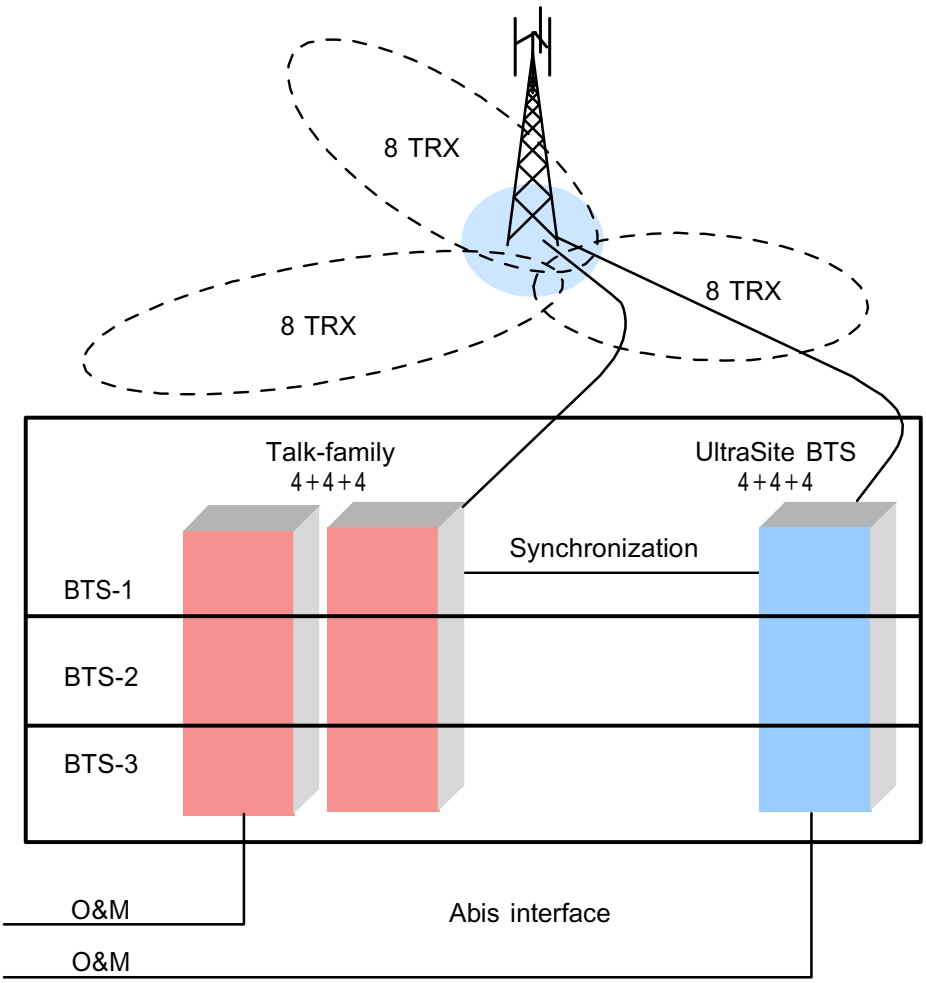

Figure 6. Co-siting of the Nokia UltraSite and Talk-family example

5.4 Nokia Base Station Subsystem cellular transmission

The Nokia Base Station Subsystem cellular transmission system interconnects the network components: base stations, base station controllers, and mobile switches.

5.4.1 Base station transmission

The Nokia BTSs contain a fully integrated cross-connection functionality that brings savings in the GSM/EDGE transmission costs. The BTS can operate as a transmission relay, cross-connect, and add-drop multiplexer (ADM) offering a wide range of different branching, grooming, and add-drop functions. The add-drop functions range from 2Mbit/s level down to 8kbit/s level. The multidrop function can be used in BTS chains or in loops where several BTSs are connected on a single 2 Mbit/s line.

The BTS transmission equipment can be managed from Nokia NetAct integrated network management system, which simplifies network maintenance and operation.

FXC units with cross-connection

The FXC units include a very powerful cross-connection system with a granularity of 8 kbit/s.

- FXC E1/T1 (4 x 2M/1.5M), symmetric wire line transmission, 120/100 Ohm
- FXC E1 (4 x 2M), asymmetric wire line transmission, 75 Ohm
- FXC RRI (16 x 2M), radio link transmission (Flexbus connection for 2 outdoor units)
- FXC STM-1: Unit with 2 STM-1 interfaces for fibre optic cable (L-1.1 laser interface), SDH standard compliant, add/drop and cross-connection at VC-12 layer, synchronisation functions.
- FXC Bridge: Bridge for the signals between the SDH part of the BTS and the PDH cross-connect of the FXC equipment. Includes Q1 management and cross-connection on 8 kbit/s, 16 kbit/s, 32 kbit/s and 64 kbit/s granularity.

This unit is always used with the FXC STM-1 card.

FC units

The FC units were designed to be used with Nokia MetroSite BTS. With Nokia UltraSite BTS, the use of a FXC unit is recommended because of EDGE evolution.

Two FC units are available:

- FC E1/T1 (1 x 2M/1.5M), wire line transmission (can be used with the Nokia MetroSite BTS and Nokia UltraSite BTS)
- FC STM-1: a unit with 2 STM-1 interfaces for fibre optic cable (L-1.1 laser interface), SDH standard compliant, add/drop and cross-connection at VC-12 layer, synchronisation functions (only to be used with Nokia MetroSite BTS. CXM 4.1 SW or later is required.).

5.4.2 Nokia microwave radios

The Nokia microwave radios are so called split-mount equipment which always consist of a microwave part and antenna mounted outdoors, and a baseband functionality mounted indoors. The indoor solution can be either integrated or standalone. The outdoor and indoor parts are interconnected with a single coaxial Nokia Flexbus cable.

The indoor units of Nokia PDH microwave radios, Nokia FlexiHopper microwave radio and Nokia MetroHopper radio are integrated into Nokia UltraSite GSM/EDGE Base Station, Nokia MetroSite GSM/EDGE Base Station and Nokia Talk-family base stations as plug-in units that fit directly to the base station cabinet.

The Nokia MetroHub standalone TDM cross-connect node also provides housing for the plug-in indoor units with Nokia Flexbus interfaces for Nokia FlexiHopper and Nokia MetroHopper microwave radios.

A 19 in. rack-mountable standalone indoor unit (FIU 19) provides a separate E1 access to MetroHopper and FlexiHopper microwave radios if a standalone transmission solution is required.

PowerHopper, the Nokia SDH radio indoor unit, needs a separate 19 in. installation space as well as the external third party SDH multiplexer which provides the E1 access to the STM-1 input of the radio.

The Nokia microwave radios can be centrally managed by Nokia NetAct.

Nokia FlexiHopper microwave radio

The Nokia FlexiHopper PDH microwave radio family includes models for 7, 8, 13, 15, 18, 23, 26 and 38 GHz frequency bands. The radio transport capacity of all Nokia FlexiHopper frequency variants is 2x2, 4x2, 8x2 or 16x2 Mbit/s. This can be selected by using the node manager or the network management system (Nokia NetAct) without any hardware changes. The Nokia FlexiHopper radios use forward error correction (FEC) and interleaving to improve signal quality which make them an ideal media for transporting E1 traffic carrying the Abis interface.

Nokia MetroHopper radio

The capacity of the Nokia MetroHopper PDH radio is 4x2 Mbit/s. It uses a 58 GHz frequency band, which does not require co-ordinated frequency planning and thus minimises the approval and planning procedure. The 58 GHz band has the unique natural characteristic of additional oxygen absorption. This attenuation limits feasible hop lengths to less than 800 m (depending on climate conditions). Nokia MetroHopper is an optimal solution for the GSM/WCDMA microcellular access.

Nokia PowerHopper

Nokia PowerHopper is an SDH radio that provides STM-1 (155 Mbit/s) transmission capacity. It consists of an outdoor unit and a 19 in. rack-mountable standalone indoor unit. The interconnection between these two units is made by using a single coaxial cable that also feeds power to the outdoor unit. The STM-1 interface of the indoor unit can be connected directly to the STM-1 interface of an external SDH add-drop multiplexer which can provide various smaller capacity interfaces to be transported over STM-1. The Nokia PowerHopper SDH microwave radio is available for 7, 8, 15, 18, 23, 26 and 38 GHz frequency bands. The protection method against equipment faults is 1+1 HSB.

5.4.3 Nokia cross-connect nodes

The Nokia BSS Abis transport is based on PDH or SDH technology. The main aspect in implementing the BSS transport network is that the BSC ET port allocation meets the desired BTS and that the BSC synchronisation can be delivered through the network to the BTSs. The optimisation and management of the transport network capacity is made by using cross-connection devices. Nokia BTSs provide inbuilt cross-connection and grooming functionalities for capacity optimisation and traffic (loop) protection. Nokia BSC supports the Nokia Q1-managed DN2 and MetroHub, providing polling functionality also for other network elements not polled by the BTS. The loop protection functionality of MetroHub and DN2 matches with Nokia BTSs, which are usually used as loop slaves. Other standard PDH cross-connection devices, such as Tellabs 8100 Managed Access System, can be used as transparent PDH layers. Transparent layers refer to devices that provide the bit stream and synchronisation, but which Nokia BSS does not specifically support.

Nokia MetroHub Transmission Node is a dynamic 2 Mbit/s digital cross-connect, which is developed especially to support radio link based BSS transport networks. Its main traffic protection feature is the loop protection. MetroHub provides a flexible, expandable and cost-effective solution for the purposes of the GSM/EDGE operator. The maximum cross-connection capacity of MetroHub is 56x2 Mbit/s with switching granularity of 8 kbit/s. MetroHub has integrated transmission interfaces for E1, T1 and Flexbus. Nokia Flexbus is an optimised

interface for the Nokia FlexiHopper and MetroHopper radio link products. Every UltraSite GSM/EDGE contains a “virtual” MetroHub, which can be used for decentralised traffic collection, media change and grooming. This is helpful particularly when network configurations evolve towards WCDMA.

Nokia DN2 is a dynamic 2 Mbit/s digital cross-connect, which also has add-drop, primary multiplexing, and various protection features. DN2 provides a rack-based alternative for MetroHub. The maximum interface capacity of DN2 is 40x2 Mbit/s circuits. When the capacity exceeds the limit, multiple DN2s can be used. The switching granularity of Nokia DN2 is 8 kbit/s.

Nokia SXC T is a high capacity PDH cross-connect device with up to 1904x2 Mbit/s capacity and 64 kbit/s switching granularity. SXC T can be used as a replacement for a digital distribution frame, or for various PDH traffic routing purposes.

5.4.4 Optical line equipment

If there is a need for SDH transmission for capacity reasons and there are fibers available, Nokia recommends the world leading SDH and Dense Wavelength Division Multiplexing (DWDM) equipment from Marconi or Tellabs to be used in the mobile networks. The collaboration supports Marconi in developing these products towards the Mobile Networks requirements with the help of Nokia.

By working together on the transmission layer 1 issues in a partnership mode ensures that both companies understand the specific needs of mobile networks. It enables the companies to offer the most efficient solution in this area.

The comprehensive product portfolios of Marconi and Tellabs extend from modem size compact access SDH to terabit-sized DWDM systems.

5.4.5 Copper line equipment

Capacities of up to 2 Mbit/s can be transmitted through copper pair cables for distances of up to several kilometres using HDSL baseband modems. This is an economical solution in the access network, especially if existing copper cables can be used.

5.5 Nokia NetAct™ framework for network and service management

Nokia NetAct™ is a network and service management framework that addresses the operator's challenges to handle larger networks, greater complexity, more network elements, and the explosive growth in traffic and data expected in future networks. In an increasingly multivendor, multiservice and multi-technology environment it is even more important to have a single controlling OSS system. Openness, efficiency, modularity, and scalability are key issues of Nokia NetAct. Nokia NetAct provides a pre-integrated management solution that can be implemented quickly and cost-efficiently. This reduces the operator's time-to-market and allows them to focus on their core business.

The same evolving Nokia NetAct will support all existing and future network technologies and related services, thus providing a secured growth path for IP-based networks.

Nokia NetAct consists of functionality areas, such as Monitor and Reporter that provide management capabilities grouped together according to the most relevant operator processes. A unified mediation and adaptation layer serves as the interface towards different types of networks and network elements. It hides the network complexity and allows easy interoperability with various technologies and 3rd party systems.

The cornerstones of the Nokia NetAct management solution are:

- The entire network can be accessed and viewed with one system, Nokia NetAct. A clear view of the network and QoS indicators is always available.
- Open interfaces enable easier integration and allow operators to build the most suitable solution for their needs.
- Modularity and flexibility of architecture.

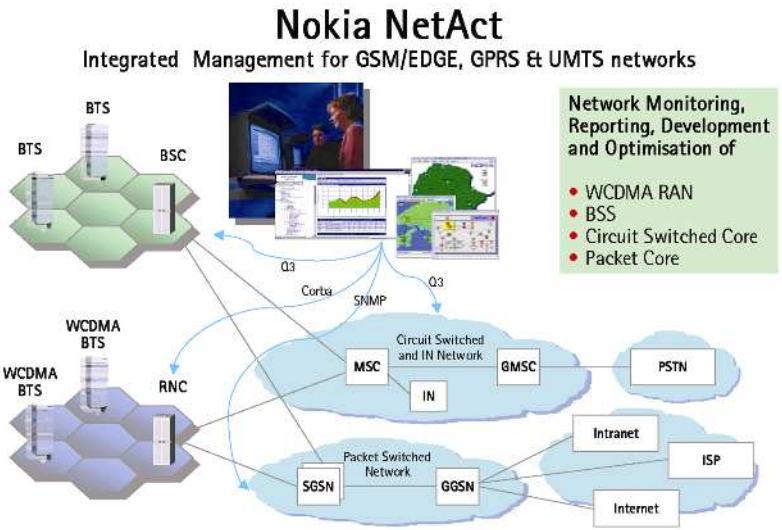

Figure 7. Nokia NetAct manages different network technologies

5.5.1 Nokia NetAct™ functionality for network and service management

Nokia NetAct's functionality areas provide management functionality that is available network-wide. The adaptation layer interfaces with the managed network and provides services for higher-level systems.

The purpose of *Nokia NetAct Planner* is to provide the best possible structure for a network, taking into account the coverage, capacity and quality requirements. An advanced tool set is provided for planning, for example, radio and transmission networks and microwave links. The close co-operation between NetAct Planner, other Nokia NetAct areas and radio network elements enables fluent interworking and reduces significantly the effort in transferring information between applications.

Nokia NetAct Configurator covers management functionality for both radio access packet core networks. The objective of Radio Access Configurator (RAC) is to provide full support for network roll-out, expansion and optimisation. Network-wide configuration management is an optimal solution for plan manipulation and regional border area handling, for example, automated handling of inter-regional dependencies. Optimizer is provided for statistical and/or network-wide optimisation of the managed network in order to deliver optimum performance and quality targets set by the operator. It offers detailed analysis methods and effective algorithms for solving performance problems in 2G, 3G and multi-technology networks.

Nokia NetAct Monitor provides a set of tools for pre-processing, storing and displaying real-time alarm and performance information from the network. The constant visibility of the network status enables efficient fault detection and analysis. The same monitoring tools can be flexibly used for regional and global monitoring needs. Nokia NetAct Traffica complements the monitoring solution by allowing the operator to monitor both the quality of service and the quality of network. NetAct Traffica is a versatile application for various operator processes, providing end-user specific information about successful and unsuccessful call attempts.

Nokia NetAct Tracing offers efficient means to manage, collect and view data from different network elements related to a specific subscriber or mobile phone in GSM, GPRS and 3G networks. It is possible to follow the progress of a phone call by collecting data and presenting it textually or graphically.

Nokia NetAct Service Quality Manager enables the operator to work in a proactive manner by showing the impact of network problems on end-user service, such as SMS or WAP. Service Quality Manager can calculate and display service levels, prioritise fault investigation, provide customer care information, and track important customer segments. All service relevant information that is available in the operator environment can be collected. With monitoring packages operators can monitor, for example, 3G services.

Nokia NetAct Inspector enables the operator to carry out proactive service verification through actively measuring the end-user services such as SMS/MMS and network communication protocols based on IP.The services are verified by using collection agents probing the services at regular intervals.

With *Nokia NetAct Reporter* a network-wide view of the network and service performance is always available. Operators can analyse and interpret data coming from multiple sources. Raw data becomes meaningful information that is visualised in various textual and graphical reports accessible via the Internet. These reports can reflect a variety of aspects, such as QoS or traffic profiles. Performance data for various vendors can be stored in a dedicated global database. Long-term data can be displayed in trend reports.

Nokia NetAct Administrator incorporates a centralised place for carrying out network-wide administrative tasks, such as system security, system capacity, backups, and the hardware and software configuration management of network elements. Inventory Manager can handle both active network elements and passive parts, such as spares and racks.

5.5.2 Nokia NetAct™ architecture

Nokia NetAct consists of a common core, a number of functionality areas and 3rd party tools that interface with each other via a common messaging bus. The core includes, for example, a common network model, network topology and standard interfaces. The centralised servers are high-end machines with sufficient capacity to handle the necessary number of interactive users. The Unified Mediation and Adaptation (UMA) layer provides scalability for the whole system.

Hardware solution

Nokia NetAct's hardware solution consists of one or more server clusters and operator seats. Regional clusters manage a specific region, while global clusters are intended for centralised network management tasks. When distributing the operations between regional and national management centres, the regional server clusters and 3rd party management systems are connected to the global cluster via a Data Communication Network (DCN). In the OSS3 releases the hardware setup contains the following features:

- High-availability servers (HP-UX)
- Application servers (Windows and HP-UX)
- Operator seats
- Storage Area Network (SAN) with disk array
- DCN backbone

5.5.3 Nokia NetAct™ Planner

Nokia NetAct Planner is an integrated set of tools for planning voice and data for both radio and transmission networks. It is a part of Nokia NetAct Framework.

Nokia NetAct Radio Planner provides planning for all types of GSM radio networks. It includes the planning of both real time and non-real time services that support the network evolution path from GSM to GPRS and ultimately the next generation EDGE technologies.

WCDMA Planner is designed for WCDMA radio network planning. This planning system is a part of the Nokia WCDMA system solution and has been developed in co-operation with both Nokia and a leading planning tool supplier, thus enabling the latest WCDMA technology usage. In addition to high quality radio network planning functionality, WCDMA Planner offers an evolutionary approach to planning and optimising networks based on data service requirements.

Nokia NetAct Link Planner provides efficient and flexible microwave link planning. It offers an advanced solution for line-of-sight checking, link frequency allocation, interference analysis, logical routing, link performance, and quality calculation.

Nokia NetAct Transmission Planner enables the planning of transmission and datacom networks, including dimensioning and network architecture comparisons. It covers the 2G and 3G Cellular, ATM/IP, and PSTN networks.

Nokia NetAct Quality Planner for field measurement analysis is an intelligent software package that provides automated detail and trend analysis of test mobile measurement files. It also produces diagnostic reports to resolve radio network problems.

Nokia NetAct Rollout Planner is a site acquisition and project process tracking tool for network roll-out and expansion projects, providing full visibility of project milestones, progress and productivity.

Nokia NetAct Planner runs on the PC/Windows platform using Oracle 8 database.

5.6 Nokia power supply systems and site support systems

Nokia power supply systems provide essential battery backup and site support functions for a variety of GSM and WCDMA base station configurations, including indoor and outdoor versions. In addition, Nokia Site Support System also provides space for transmission and customer equipment. Power System Management (PSM) is the remote management of the Battery Back-Up Units (BBUs) and Site Support Systems (SSSs) from Nokia NetAct. The PSM provides network operators with real time information on the power supply status, the option to control the power supply remotely, and to maximise the electrical efficiency of the batteries and charging system. This enables more reliable information on the power supplies, and thus, fewer service visits.

Nokia MetroSite Battery Back-up Unit, Outdoor and Indoor

Nokia MetroSite Battery Back-up Unit (BBU) is developed and designed specifically as an offline UPS for Nokia MetroSite solutions and functions. It supports Nokia MetroSite Base Station and Nokia MetroHub Transmission Node. On the outside the product looks the same as Nokia MetroSite Base Station and Nokia MetroHub Transmission Node. Nokia MetroSite BBU is a smart outdoor BBU with versatile mounting options. The small size, pre-installed units and ready factory set system configurations enable fast roll-outs. The maximum output power is 800W with up to 16Ah battery capacity.

Nokia UltraSite Support range

The Nokia UltraSite Support Outdoor battery back-up and site support systems are one of the major components offered by Nokia UltraSite. The Nokia UltraSite power systems ensure the network's continuous operation by providing uninterrupted power supply to the site.

The Nokia UltraSite Support systems are designed with a high degree of inbuilt environmental protection. It operates in a wide temperature range, and it has a fully EMC protected cabinet and modules. UltraSite Support uses the same cabinet design as UltraSite Base Station which harmonises the site requirements. The high power density minimises the required footprint and allows site expansions for new generation services.

Nokia UltraSite Support consists of a compact cabinet, a preconfigured power distribution unit, an intelligent controller, high power rectifiers and operator equipment space. For extended backup, an extension cabinet can be added.

The operation of the Nokia UltraSite Support systems is carried out through Nokia Power System Management (PSM). Remote operation through Nokia NetAct provides substantial savings in operational expenditures.

Nokia UltraSite Support BBU, Outdoor

Nokia UltraSite Support is a state of the art solution for supporting Nokia UltraSite applications from low capacity road sites to high capacity urban sites. Nokia UltraSite Support's flexibility enables variable applications due to its modular design.

With the basic cabinet and extension cabinet, the maximum output power is 15,6 kW with up to 368 Ah battery capacity. The cabinet facilitates up to 12 pcs of 1300W rectifiers and 10 HUs for customer equipment. The Power System Management's functionality is integrated into the cabinet controller unit.

Nokia UltraSite Support Optima and Support Supreme Site Support Systems, Outdoor

The Nokia Optima and Supreme site support systems support Nokia UltraSite WCDMA BTSs and in co-siting, Nokia UltraSite GSM/EDGE BTSs and Talk-family base stations. The modular systems use the same cabinet design as the Nokia WCDMA base station and consist of a Site Support cabinet with rectifiers, a cabinet controller unit, a power distribution unit, batteries and integrated customer equipment space. Specific configuration for the customer equipment space enables up to 11 HU in Optima and up to 18 HU in Supreme basic cabinets. An extension cabinet provides additional space for up to 21 HU in Optima and up to 35 HU in the Supreme extension cabinet.

The maximum configuration of Support Optima and Support Supreme consists of a basic site support cabinet, the 1st battery extension cabinet, the 2nd battery extension cabinet and LTE extension cabinet. The maximum output power of Support Optima is up to 7,8 kW with up to 552 Ah battery capacity. The Support Supreme maximum output power is up to 15,6 kW with up to 736 Ah battery capacity. The systems have Power System Management (PSM) functionality integrated into the cabinet controller unit (CCUA). The Nokia Empower battery back-up is the indoor variant for Nokia UltraSite Support Optima.

Nokia Empower range

The Nokia Empower 1100 and 1900 series are battery back-up systems for Nokia UltraSite Indoor (GMS, EDGE, and WCDMA) and Intratalk base stations. The modular system consists of a cabinet with space for rectifiers, a cabinet controller unit, distribution and other mechanics, and either an integrated battery compartment or a separate battery rack. Nokia Empower BBUs are operated with Nokia Power System Management (PSM) through Nokia Network Management System (NMS or Nokia NetAct).

Nokia Empower 1100–14

The high capacity Nokia Empower 1100–14 indoor BBU supports the Nokia BTS and BSC (RNC) sites in all areas from high capacity urban sites to rural areas. The latest technology is used to fulfill the special requirements of macro-cellular sites. The small footprint solution provides an output power up to 15,4 kW with up to 465 Ah battery capacity. There are several application softwares available and the PSM functionality is integrated for advanced remote real-time system management.

Nokia Power System Management

One of the key elements in providing high quality services is the ability to provide uninterrupted power supply to a base station site. To achieve constant and cost-effective network operation, it is essential to have a well-designed power supply with common management of other site elements. Periodic checking requires site visits which can be minimised by operating Nokia power supplies through the Nokia Power System Management (PSM) and the Nokia network management system (NMS or Nokia NetAct).

Nokia NetAct is the network's operational and maintenance part which is needed to control the whole network. The network operator measures and maintains the network quality and services offered through the network management system.

Nokia PSM provides network operators with reliable real-time information about the power supply status. It also provides maximum electrical efficiency of the batteries and the charging system, substantial reductions in service visits, and accurate preventive maintenance for eliminating unnecessary site visits, such as changing the batteries for a reason other than their age.

Nokia PSM transfers power supply data to NetAct via the Q1 bus and the PSMMan node manager provides a graphical user interface for the management of the Nokia power supply systems. The user can perform commissioning and maintenance tasks on Nokia power systems also locally at the site. The default commissioning values are stored and edited in a database. PSMMan has all the same functions which can be accessed remotely from the Nokia NetAct site and also locally at the site. In the third method, PSMMan is used remotely via a modem link connection to Nokia NetAct and PSM, for example from home.

5.7 Nokia Base Station Subsystem solutions

Nokia has developed advanced solutions, which solve both the initial roll-out needs and the future capacity needs in a cost-effective manner. Thus, Nokia is able to support operator business in years to come.

Nokia BSS supports the advanced new features, not only capacity, coverage and cost-efficiency, but also the operator service needs.

5.7.1 Coverage solutions

The coverage need varies a lot depending on the environment. Nokia offers a number of solutions for the BSS to enhance the outdoor coverage of the GSM network. Nokia coverage extension solutions are most applicable in suburban and rural areas. The complete Nokia BSS solution for coverage building includes planning services and tools, implementation services and products, and optimising services.

BSS coverage solutions include:

- Nokia MetroSite solution
- Nokia UltraSite solution
- Extended cell for UltraSite BTS
- Nokia Smart Radio Concept (SRC)
  - IDD for MetroSite
  - IDD with BB Hopping

- Masthead Amplifier (MHA)
- Mast Head Preamplifier
- Masthead BTS
- Intelligent Coverage Enhancement (ICE)
- TRX Transmit Booster Unit
- High Capacity Booster configurations
- Enhanced Coverage by Frequency Hopping
- Six sector support

5.7.2 Capacity solutions

Nokia offers a number of solutions for the BSS to enhance outdoor capacity of the GSM network. With cost-efficient capacity planning and implementation, the revenue of the operator increases.

BSS capacity solutions include:

- GSM/EDGE Dual Band
- Intelligent Frequency Hopping (IFH)
- Advanced Multilayer Handling
- Direct Access to Desired Layer/Band
- GSM/EDGE Common BCCH
- Multi BCF Control

5.7.3 Radio network performance solutions

BSS radio network performance solutions include:

- FER Measurement
- BSS Synchronisation
- Dynamic Frequency and Channel Allocation (DFCA)
- IMSI Based Handover
- Wireless Priority Service (WPS)
- Enhanced TRX priorisation in TCH allocation

- GSM/EDGE-WCDMA Interworking
- GSM/EDGE-WCDMA Interworking Enhancements
- Support for Enhanced Measurement Report
- Automated Planning
- Automated Planning enhancements
- Antenna Hopping for UltraSite EDGE BTS
- Chaining of Nokia MetroSite Base Station
- TSC Different from BCC
- GSM/EDGE 800
- Multi BCF Control
- Tri-Band
- GSM/EDGE Dual Band
- High Capacity BSC
- Handover and power control algorithms
- Intelligent Underlay Overlay (IUO)
- Intelligent Frequency Hopping (IFH)
- Synthesised Frequency Hopping for Talk-family and PrimeSite BTS
- Advanced Multilayer Handling (AMH)
- Direct Access to Desired Layer/Band
- High Capacity IntraTalk and CityTalk BTS with wideband combining 12 TRX per Cell
- Dynamic SDCCH Allocation
- MetroSite microcellular capacity solution
  - 58 GHz microwave access
  - 1-4 TRX capacity
- 12-TRX Cell with RTC Dual Duplexing
- Four-Way Wideband Combiner
- Nokia Talk-family BTS Synchronisation

5.7.4 Data solutions

Nokia provides efficient solutions for data transmission.

BSS data solutions include:

- High Speed Circuit Switched Data (HSCSD)
- Nokia GPRS
- Nokia EDGE
- Dynamic Abis Allocation
- Adaptive Multi Rate Codec (AMR)
- Support for PBCCH/PCCCH
- Priority class based Quality of Service (QoS)
- System Level Trace
- Enhanced Quality of Service (EQoS)
- Network-Assisted Cell Change (NACC)
- Network Controlled Cell Re-selection (NCCR)
- GSM/EDGE-WCDMA Inter-System NCCR (ISNCCR)
- Gb over IP
- GPRS Coding Schemes CS-3 and CS-4
- Support for PCU2
- Extended uplink TBF
- EGPRS Packet Channel Request on CCCH

5.7.5 Operability solutions

BSS operability solutions include:

- BTS object amount increase in BSC
- RX antenna supervision by comparing RSSI value
- Support for Cell Global Identity (CGI)
- Intelligent Shutdown
- Recovery for BSS and Site Synchronisation

- Multi BCF for MetroSite BTS
- Remote BTS Manager for UltraSite and MetroSite BTS
- Power System Management and Enhancement
- Comprehensive Centralised Network Management System
- NMS with Superior Radio Network Statistics
- Redundant/Floating TRX
- Trace Window for Dropped Calls
- Abis Loop Test for MetroSite
- TCSM2 routing tests of A-if circuits

5.7.6 Transmission solutions

BSS transmission solutions include:

- Dynamic Abis
- Integrated Microwave Radio and E1/T1 Transmission Solutions
- Integrated ISDN and HDSL modem for Talk-family and PrimeSite BTS
- Efficient Abis and Ater Timeslot Allocation with 16kbit/s Abis Telecom and O&M Signalling
- Satellite Abis
- FlexiHopper microwave radios
- MetroHopper microwave radios
- Nokia MetroHub Transmission Node

5.7.7 Value added services and quality solutions

BSS value added services and quality solutions include:

- Lb interface
- Text Telephony (TTY)
- Enhanced Full Rate Codec
- Acoustic Echo Cancellation (AEC)
- 9.6 kbit/s data and 14.4 kbit/s GSM Data Services

- High Speed Circuit Switched Data (HSCSD)
- Improved RACH detection
- A5/0, 1 and 2 Encryption Algorithms
- SMS Point-to-Point
- SMS-CB DRX
- Nokia GPRS
- Tandem Free Operation (TFO)
- Noise Suppression (NS)
- Mobile Location Services (MLS)

5.7.8 Indoor solutions

BSS indoor solutions include:

- Nokia GSM Office solution
  - Nokia InSite base station
  - Autoconfiguration
  - Channel Finder
  - Automatic Picocell Planning

5.7.9 Site solutions

BSS site solutions include:

- 2nd gen. base station
- Talk-family base station
- Nokia MetroSite base station
- Nokia UltraSite base station
- Nokia InSite base station

5.7.10 BSC

Software related to BSC in BSS include:

- Enhanced T1/E1 Connectivity for BSC3i

5.7.11 Advanced features

Software related to Advanced features in BSS include:

- GSM-WCDMA Inter-System Handover
- Voice Coding

5.8 BSS radio management feature compatibility

BSS radio management feature interactions

Certain radio management features interact, which limits the simultaneous use of some of the features. The features concerned are the following:

ICE	Cells with different Tx power sharing the same coverage area
ICE+	Cells using High and Low power TRXs, with 1 BCCH
HSCE	Handover Support for Coverage Enhancements (HSCE) is the BSC feature that supports ICE+.
ECFH	Enhanced Coverage by Frequency Hopping. Mobiles that require the best coverage are allocated to a hopping TRX.
Dual Band	Support for 800/1800, 800/1900, or 900/1800, in separate cells (2 BCCHs)
Common BCCH	Support for 800/1900 or 900/1800, in a single cell (1 BCCH)
IUO/IFH	Intelligent Underlay Overlay / Intelligent Frequency Hopping
FACCH Call Setup	When all SDCCH channels are allocated, the BSC can allocate TCH and use its FACCH for call setup.
Dynamic SDCCH	When SDCCH loading is high, the BSC can re-configure a TCH channel as a set of SDCCH channels.

5.8.1 Mixed transmit power, coverage or frequency

Many BTS configurations have TRXs that differ in power, coverage, and/or frequency band serving the same general coverage area.

ICE, ICE+, HSCE

The ICE feature used separate cells (separate BCCHs) for high and low power TRXs. The ICE+ configuration (in [BSS9 and later]) extended the ICE feature, so that the high and low power TRXs could be put in a single cell (a single BCCH) by using the HSCE feature in the BSC to allocate mobiles to suitable (low power or high power) TRX.

Only the ICE+ configuration (single BCCH) should now be used in networks.

- HSCE uses the same code and parameters as the ECFH feature (see below). It is not possible to set up both HSCE and ECFH within the same cell.
- HSCE can be used with Dual Band.
- HSCE/ICE+ can be used with Common BCCH. Direct Access to the super reuse layer is only supported inside the BTS_Object with the initial SDCCH, which must be in the BCCH band.
- HSCE/ICE+ cannot be used with IUO/IFH.
- HSCE can be used with FACCH Call Setup and Dynamic SDCCH.

ECFH

The ECFH feature was specified so that the mobiles using Full Rate (FR) speech and needing maximum coverage were allocated to RF Hopping TRXs - not the BCCH TRX - in cells where all TRXs had the same Tx power.

- ECFH uses the same code and parameters as the HSCE feature (see above). It is not possible to set up both HSCE and ECFH within the same cell.
- ECFH can be used with Dual Band.
- ECFH can be used in the BCCH BTS_Object (sector) of a Common-BCCH cell.
- ECFH cannot be used with IUO/IFH.
- ECFH can be used with FACCH Call Setup and Dynamic SDCCH.

Dual Band

The Dual Band feature (in BSS 9 and later) uses separate cells (separate BCCHs) for different frequency TRXs, with the Direct Access to Desired Layer/Band feature to facilitate call setup.

Dual Band can be used for the Macrocell/Microcell network control (a separate band for each layer), or for the controlling of the Macrocell network using two frequency bands.

For Macrocell sites with the TRXs of both bands synchronised, the Common BCCH feature is now recommended in place of Dual Band because only a single BCCH is needed. Dual Band can be used with the following features:

- ICE+/HSCE
- ECFH
- Common BCCH
- IUO/IFH
- FACCH Call Setup
- Dynamic SDCCH

Common BCCH/Multi BCF

The segment features Common BCCH Control and Multi BCF Control enable a general way to set up a cell (a single BCCH) with TRXs of different bands and in different cabinets.

- HSCE/ICE+ can be used with Common BCCH; however, the direct access functionality of HSCE/ICE+ is not supported.
- ECFH can be used in the BCCH BTS_Object of a Common BCCH cell.
- Dual Band can be used with Common BCCH.
- IUO/IFH can be used with Common BCCH, but with restrictions; see IUO/IFH.
- FACCH Call Setup can be used in the BCCH BTS_Object of Common BCCH.
- Dynamic SDCCH can be used in the BCCH BTS_Object of Common BCCH.

Common BCCH Notes

1. FACCH Call Setup and Dynamic SDCCH can also be used in a Common BCCH BTS_Object which is in the same frequency band and is of the same site type as the BCCH BTS_Object.
2. Channel allocation to BTS_Objects within 1 BCF that are for the same band but different power levels does not take into account the different power levels.
3. With Common BCCH using two frequency bands, the BCCH should be located in the lower band for best performance.

5.8.2 Spectrum capacity features

IUO/IFH

The Intelligent Underlay Overlay (IUO) feature is designed to allow tighter reuse of radio frequencies in the network.

IFH is an IUO with the possibility of frequency hopping in both regular layer and super-reuse layer IUO TRXs.

- IFH/IUO cannot be used with HSCE/ICE+ feature.
- IFH/IUO can be used in Dual Band.
- IFH/IUO can be used with Common BCCH with restrictions:
  - The Child Cell concept is not supported in BSC with Common BCCH.
  - Direct Access to the super reuse layer is only supported inside the BTS_Object with the initial SDCCH, which must be in the BCCH band.

Note

The initial SDCCH is usually in the BCCH BTS_Object.

- IFH/IUO can be used with FACCH Call Setup.
- IFH/IUO can be used with Dynamic SDCCH.

5.8.3 FACCH Call Setup feature compatibility

FACCH Call Setup and Dynamic SDCCH can be used on radio channels which use the Cell Allocation (CA) broadcast as a part of the BCCH Sys_Info messages.

FACCH Call Setup and Dynamic SDCCH can be used with:

- HSCE (ICE+)
- Dual Band (within each cell)
- Common BCCH, within the BTS_Object which includes the BCCH TRX, and also in a Common BCCH BTS_Object that is in the same frequency band, and is of the same site type as the BCCH BTS_Object
- IUO/IFH

FACCH Call Setup and Dynamic SDCCH cannot be used with:

- Common BCCH BTS_Object(s) that are of different frequency band, or of different site type than the BCCH BTS_Object.

5.9 Nokia Base Station Subsystem compatibility with other NSSs and GPRS Core networks

Nokia BSS needs to be compatible not only with Nokia Network Subsystem (NSS) but also with other suppliers' NSSs. In addition, Nokia BSS has to be fully compatible with the network service and management system (Nokia NetAct) and other support equipment. Therefore the compatibility issues are an essential part in the design of Nokia BSS and its network elements. Nokia BSS compatibility is defined per release level.

Nokia BSS is based on the GSM/EDGE specifications set by the 3GPP. These specifications are designed to guarantee the interoperability of equipment from different manufacturers in the same GSM network.

As a company, Nokia is committed to the idea of open interfaces. In the GSM network the interface between the Mobile Switching Centre (MSC) and the Base Station Subsystem (BSS), the so-called A interface, can be considered such an open interface. Therefore Nokia has carried out extensive testing concerning the A interface. Nokia has tested its BSS with all the major switch suppliers on the market during several years. Nokia MSC has also been proved to interwork with other manufacturers' BSSs. At the moment Nokia BSSs work in live operational networks around the world with Alcatel, Motorola, Siemens, Ericsson, and Nortel MSCs.

In BSS multivendor integration Nokia follows the so-called Ladder Model when introducing new software releases. It means that whenever Nokia produces new software, Nokia is the driving force in ensuring compatibility on specification level. Furthermore, Nokia is active in making the required verification arrangements.

5.10 Nokia Base Station Subsystem interfaces

GSM standard open interfaces and Nokia-specific interfaces are used in Nokia BSS.

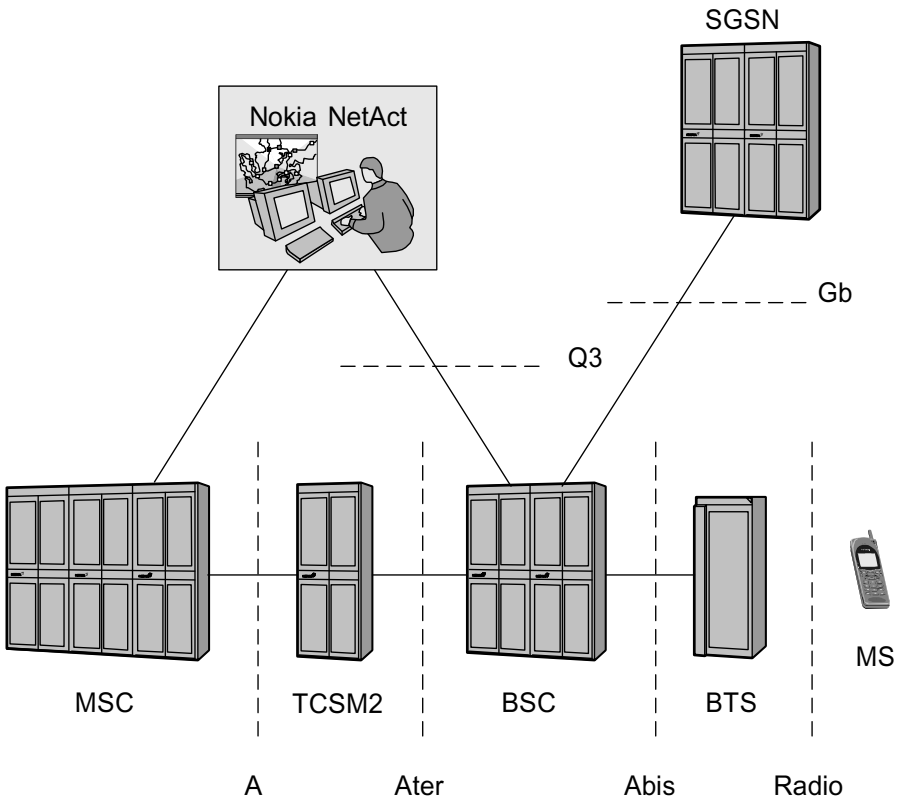

Figure 8. Interfaces in Nokia Base Station Subsystem

5.10.1 A interface

The interface between the mobile switching centre (MSC) and the base station controller (Nokia Base Station Controller) is implemented according to the GSM specifications.

Because of the Nokia BSS implementation, the actual A interface is located between the MSC and Nokia Transcoder Submultiplexer (TCSM). The physical interface consists of one or more PCM lines.

5.10.2 Lb interface

The Lb interface is used to connect a standalone SMLC to a BSC. Furthermore, the Lb interface feature contains a controlling functionality for the allocation of location requests between Position Based Services in BSC and the external stand-alone SMLC.

The Lb interface also supports:

- communication with LMU units in the BSS
- assistance data point-to-multipoint broadcasting for GPS data
- handling of deciphering keys for ciphered broadcasting data from stand-alone SMLC

The Lb interface is an application software in BSC. Its optionality is controlled with the 2nd class parameter LB_USAGE.

For more details, see *User interface of Location Services in BSC*, *BSS11114: Lb Interface to BSC* and *BSC-SMLC Interface Specification* in the BSC documentation set.

5.10.3 Ater interface

Ater interface is a Nokia-specific interface. It is located between Nokia Transcoder Submultiplexer and Nokia Base Station Controller. The physical interface consists of one or more PCM lines.

5.10.4 Abis interface

The Abis interface telecommunication part between Nokia Base Station Controller and Base Station (BTS) is implemented according to the GSM specifications. The physical interface is a PCM line.

The Abis operation and maintenance (O&M) part is Nokia-specific supporting additional features, such as alarm consistency, remote transmission equipment management, and BTS database management.

5.10.5 Radio interface

The Radio interface is implemented according to the GSM specifications. The BTS forms the Radio interface through air to the mobile station (MS).

5.10.6 Q3 interface

The implementation of Q3 interface is based on the O&M framework of the ITU-T and the International Standards Organisation (ISO). It is located between Nokia Base Station Controller (BSC) and the network service and management system (Nokia NetAct).

Nokia Base Station Controller (BSC) provides the following types of interfaces between Nokia NetAct and Nokia Base Station Controller, depending on the network operator's requirements:

- an X.25 connection via a semipermanent time slot on the A interface
- an X.25 interface, connected directly or via the Packet Switched Public Data Network (PSPDN)
- a Local Area Network (LAN) interface

5.10.7 Q1 interface

The Q1 interface is a Nokia-specific interface. It is a transmission management bus connecting Nokia NetAct with Nokia PDH transmission elements. Transmission Unit (TRU) and Hopper microwave radios are also connected to Nokia NetAct via the Q1 interface.

5.10.8 Gb interface

The Gb interface is an open interface between a BSC and a Serving GPRS Support Node (SGSN). It is implemented using Frame Relay (FR). Frame Relay can be either point-to-point (PCU-SGSN) or there can be a frame relay network located between the BSC and SGSN. The protocol stack comprises of BSSGB, NS, and L1. The physical layer is implemented as one or several PCM-E1 lines with G.703 interface.

5.10.9 User interface

The network element's local user interface is usually an option to using the Graphical User Interface (GUI) from Nokia NetAct. The whole GSM network can be managed through Nokia NetAct GUI.

A standard terminal (VT 52 or VT 100) is used as a network element's man-machine interface (MMI) terminal. Nokia Base Station Controller (BSC) and Nokia Transcoder Submultiplexer (TCSM) have a user-friendly interface with plaintext messages and man-machine language (MML) commands, which are easy to learn and use. The user interface complies with the recommendations of the International Telecommunication Union (ITU-T).

The Base Transceiver Station (BTS) equipment can be controlled locally at the site by the user, via Nokia BTS Manager or remotely by Remote BTS Manager. Nokia General Communication Server (GCS) SW Suite is used for providing both local and remote connections to the BTS.

Nokia BTS Manager has a graphical user interface and runs on a PC in Windows environment. The PC is connected to Nokia BTS Manager via the local management port (LMP) on the BTS interface unit. Nokia BTS Manager is used for commissioning the BTS and for carrying out maintenance functions locally at the BTS.

Remote BTS Manager enables the monitoring and testing of the BTS remotely, by connecting to the BTS via Network Management System (NMS/2000) or NetAct. A PC with the BTS Manager software is used as a user terminal.

It is not possible to perform the BTS commissioning remotely, because the BTS must be commissioned before the BSC is able to send remote BTS Manager commands to it.

Element Managers (also called Node Managers) are used for operating, commissioning and carrying out maintenance functions on different transmission elements. Transmission managers include: FXC STM-1 Manager, FXC Bridge Manager, FXC RRI Manager and Nokia E1/T1 Manager.

Related transmission managers include: Nokia MetroHub Manager, UltraSite BTS Hub Manager, Transmission Loader (Tresman), FXC E1/T1, FXC RRI Manager and FC STM Manager.

5.11 GSM System Security

In the GSM system much attention has been paid to the security and call privacy. Both the speech and equipment are secured against misuse as stated in the GSM specifications.

5.11.1 Call security

Ciphering is one of the security procedures designed to protect the subscriber's identity and data. It is an optional procedure in GSM. When the ciphering is active, all information exchanged between the mobile and the network on the dedicated radio channels is encrypted. A key previously set between the network and the mobile station (MS) is used to encipher and to decipher the encrypted information. The encryption algorithms applied to a GSM network are extremely sophisticated and make it virtually impossible to break the code.

Nokia Transcoder Submultiplexer (TCSM) performs speech coding according to the speech compression methods mentioned in the GSM specifications. It restricts tapping into the radio network. The GSM system also applies temporary caller identities in the course of a call, which makes it impossible for an outsider to trace the call.

5.11.2 Operation and Maintenance security

To ensure security in the DX 200 system, that is, for Nokia Base Station Controller and Nokia Transcoder Submultiplexer, a number of precautions have been designed to minimise security risks. There is, for example, a special authority system in the man-machine interface (MMI) system for operation and maintenance.

To avoid external misuse, the MMI system can be operated only by a person with a defined user ID and password. Internal security is ensured by restricting the rights of the users, that is, some users may use only certain man-machine language (MML) commands.

The users may also be divided into groups, usually according to their expertise. The groups are given certain profiles that define which commands the users can use according to their need. If the MML terminals are situated in a place with open access, profiles may be defined also for them.

The login to Nokia NetAct system is password protected. For more safety, the password is allocated only for a specified period of time and cannot be used after it has expired. Generally the login to Nokia NetAct and its applications can be controlled by the NMS system administrator. It is possible to define, for example, separate user groups for certain geographical areas or for certain applications only.

At the base station site, external alarms can be used to indicate overheating, excess humidity, or vandalism, for example.

5.12 Nokia’s services for operators

Nokia offers a wide range of support services, solutions, and tools to help network providers differentiate in today’s fast-changing business environment. The services are focused on important aspects of the customer’s business cycle helping them to:

- plan the network evolution path for a smooth and well-managed roll-out of new technologies
- deploy the networks by synchronising the entire network delivery process for fast time to profit
- maintain the network's targeting service availability and protect the network investment
- train personnel to improve their performance and efficiency and support a smooth technology evolution
- integrate commercially successful IP-based mobile services
- optimise network and service performance levels
- operate the network efficiently and effectively

Nokia's comprehensive service support combines a global partner network, an experienced and committed staff and consultants worldwide, and Nokia Online Services, which provides round-the-clock support via the Internet. Nokia uses globally consistent processes and tools to provide high quality and efficient service support, facilitating customers to realise the full potential of their network investment.

All Nokia services are planned and deployed taking the environmental aspects into consideration. The services are created according to an active, open and ethically sound approach to environmental protection; hence they are compatible with the Nokia Environmental Principles.

5.12.1 Planning GSM/EDGE BSS networks

Nokia offers leading-edge network planning services and tools to ensure that the GSM/EDGE BSS solution is optimised for smooth roll-out and successful launch. With the help of Nokia planning services, operators can optimise their system performance and asset usage.

Nokia Network Planning Service has an overall system approach which covers the planning of the entire network. The portfolio consists of the following services:

- Nokia Network Pre-Planning Service
- Nokia Network Planning Service
- Radio Network Planning
- Transmission Network Planning
- Core Network Planning
- Switching and Intelligent Network Planning
- Nokia Network Pre-launch Optimisation Service
- Nokia Network Evolution Service
- Nokia Roll-out Network Planning Consultancy

5.12.2 Deploying and integrating GSM/EDGE BSS

Nokia offers a full range of network deployment services to ensure smooth network roll-out. Nokia chooses the right partners and subcontractors to help customers reach their goals for intelligent network strategy, rapid roll-out, and cost-effective network operations. In the area of project management, for example, Nokia is backed up by a global network of internationally recognised implementation partners and key subcontractors. These partnerships provide significant competences, experience, and resources for flexible and cost-efficient implementation of the networks.

Nokia offers the following deployment services:

- Nokia Project Management Service
- Nokia Implementation Service
- Nokia Relocation Service
- Nokia Replacement Service
- Nokia Multivendor Integration Service
- Nokia Site Acquisition Service
- Nokia Construction Works Service

5.12.3 Maintaining GSM/EDGE BSS systems

Nokia Care Services ensure that the network keeps pace with technological advancement, while securing service availability. Once the network is up and running, the service support combines the benefits of Nokia's end-to-end customer care model and Nokia Online Services, which provide 24/7 support via the Internet. Working with the mobile operator, Nokia Care Manager helps to develop maintenance plans, track service performance, handle reporting, and make proposals for network enhancement activities.

Nokia Care Services portfolio covers the following services:

- Nokia 3rd Party Equipment Support
- Nokia Care Management
- Nokia E-Technical Support
- Nokia Emergency Support Service
- Nokia Help Desk Service
- Nokia Recycling Service
- Nokia Software Expertise Service
- Nokia Software Installation Service
- Nokia Software Release Service
- Nokia Spare Part Management
- Nokia Spare Part Supply
- Nokia Swap Service

In addition to the Care Services portfolio, Nokia offers a Take Back Service to manage the end-of-life treatment of obsolete products and ensure environmentally sound business.

5.12.4 Training operator personnel

Nokia can provide training solutions that are cost-effective and customised to the operator's needs. The following services can be customised for specific competence gaps and training needs:

- Nokia Competence Assessment Service
- Nokia Competence Development Consultancy Service

- Nokia Customised Learning Solution
- Nokia e-Learning Service
- Nokia Licensing and Certification Service
- Nokia Training Service

Competence development ensures that you have the right know-how in place at the right time. As the technology evolution continues, this will play an important part in enhancing your competitiveness and helping you make the most of new opportunities. For a full list of training opportunities available, please see Nokia Online Services global training catalogue.

5.12.5 Integrating the GSM/EDGE networks

Nokia Solution Integration Services allow operators to increase their network usage and ARPU by helping them to design, deploy, and integrate commercially successful user services based on Nokia middleware products and solutions. The Nokia solution is customised to meet the operator's needs, integrating new IP-based networks and advanced IT systems with existing customer care, billing, operations and maintenance, and other support systems.

Nokia Solution Integration Services portfolio includes:

- Nokia End-User Services Consulting
- Nokia Solution Consulting
- Nokia Solution Integration Project
- Nokia Care for Customisations

5.12.6 Optimising networks

Nokia provides a comprehensive set of Network Performance Improvement Services for voice and data applications to support the operator to safeguard that the new services and technologies, together with the existing networks, form an integrated platform for their business. Nokia offers a complete end-to-end Network Optimisation Service covering the radio access network, core network, switching network, and transmission network. Furthermore, Nokia can also support the customer in an advisory capacity during every step of the optimisation process.

Nokia Quality Benchmarking and Performance Analysis Service provides valuable information about the network quality, allowing proper control of this multi-dimensional KPI "space". It is essential that the complexity of the multi-service environment is taken into account in the integrated optimisation approach. Nokia understands the need for operators to offer, in turn, high quality services to their customers in order to maintain a successful business. Nokia helps to achieve this goal by ensuring that the mechanism-based standards of Quality of Service (QoS) are implemented in all of the mobile network's domains.

- Nokia Network Evolution Path Service
- Nokia Network Optimisation Service
- Nokia Network Performance Analysis Service
- Nokia Network Planning Process Development Service
- Nokia Network Quality Benchmarking Service

5.12.7 Operating networks

Nokia’s services for network operations cover most mobile operators’ needs, from practical support to routine operations, consultative operations development for improving efficiency, and managed services offering – including even the outsourcing of the existing network operations organisation. Nokia’s service offering for network operations is summarised in the following table.

Customer need	Competent engineers to support daily operations	Improve the efficiency of network operations	Support for launching new services (systems)	Operate new system for a defined period (BOT Build - Operate - Transfer)	Managed service for network operations
Nokia service offering	Operations Support Service on-demand	Operations Development Services	Operations Start-up Package	CoCare™ Package	FullCare ™ Package

Nokia's core competence and strengths in delivering these services are based on Nokia's experience in operating networks on behalf of the customers, a leading mobile system knowledge, and an extensive OSS know-how. Nokia is a highly competent global service organisation, which is complemented by global and local partners.

Nokia has 15 public references for network operating services, including cases where Nokia is fully responsible for the network operations on behalf of its customer (FullCare ™ Operations and Maintenance Service Package) or operates the network in a build-operate-transfer mode for a defined period of time (CoCare™ Operations and Maintenance Service Package). Nokia has provided customers with consultative services in more than 50 customer projects during the last three years, and delivered Operations Support services for dozens of customers over the last decade.

5.13 Nokia Base Station Subsystem quality

All Nokia Base Station Subsystem (BSS) network elements and their software are planned and produced according to specific quality standards. Nokia BSS consists of reliable high-quality network elements and transmission. The high quality of service is improved by efficient supervision functions, reliable alarm system, automatic recovery, and redundancy functionalities. In order to run the network effectively, that is, to minimise costs and maximise the service quality to the mobile subscriber, the operator needs to know certain characteristics about the performance and the service level of the BSC and the radio network.

5.13.1 Equipment

The stabile, reliable, and high-quality Nokia equipment reduces operation and maintenance costs. To achieve these characteristics, the best commercially available components and the latest cutting-edge technology are used in Nokia equipment. The equipment also goes through a comprehensive integration and system testing before leaving for the customers.

Quality, reliability, and availability are enhanced in many ways in Nokia BSS. The DX 200 network elements use 2N or N+1 redundancy on all critical functional elements. There are also several standard and optional redundancy possibilities available for the BTSs. In the transmission, network redundancy can be achieved by loop protection. In addition, the modularity of the equipment and the use of a hot standby unit in the event of a failure enhances equipment reliability.

Built-in redundancy functionalities and efficient supervision functions in the Nokia network elements minimise the time spent in maintenance. In addition, the reliable network elements and the automatic fault detection and recovery procedures result in less site visits. As a result, the network maintenance is more cost-effective.

Nokia equipment also has an accurate alarm generation, as well as monitoring, statistics, and fault recovery systems. With the aid of these systems less time is consumed in fault localisation and recovery.

5.13.2 Software

The quality of the software in Nokia equipment is ensured by several procedures in its development. The software development is run as a process, constructed of many phases such as software design, implementation, and different types of testing. In addition to comprehensive testing, the quality of the software is ensured by reviews and inspections.

The phases of the software development product process are supported by methods, tools, and procedures, which follow set quality standards. Many GSM standards are also used in the software specification and designing phases.

The modularity of the software in Nokia equipment also enables high quality control.

5.13.3 Documentation

The quality of Nokia documentation is ensured by several procedures in its development. In addition to testing, the quality of documentation is ensured by reviews and inspections. The terminology used in Nokia documentation is based on the recommendations of ITU-T and the applicable standards of ETSI, ICE, ISO, and GSM.

Nokia Electronic Documentation (NED) is easy to use and it includes all the needed software for browsing the documents.

5.13.4 Operation

The quality of service, as observed by the mobile subscribers, is one of the most important areas to successful GSM network operation. Nokia NetAct helps the operator to detect, for example, service-related problems by providing the means to analyse measurements dealing with call attempts, dropped or blocked calls, and handover failure rates in real time.

Nokia NetAct also provides the operator with tools to manage the quality level of services. With the tools it is possible to set objectives for the desired level of quality and measure the quality of service by monitoring real-time data and long-term trends. There are also tools for planning and implementing corrective actions, so that the operator's network meets the market requirements.

5.13.5 Services

After the network launch, one of the most demanding tasks is to manage the fast growing and continuously changing network. To maintain the high quality of service and good network performance under all circumstances, Nokia Planning Services provide its clients with a comprehensive set of assessment, analysis, and development services.

5.14 Nokia environmental issues

Nokia's environmental goals and activities are aimed at reducing the environmental impact of Nokia products during their entire life cycle.

Life cycle thinking is based on understanding the influence of the environmental impacts at the different stages of the product's life cycle. Based on the analysis of the environmental aspects and their impacts, Nokia has identified focus areas for its environmental work. The current focus areas in Nokia Networks are environmental management systems at the production sites, supplier network management, design for environment, substance management, the environmental aspects of networks and sites, and the recycling of obsolete products.

5.14.1 Environmental management systems

By the end of 2000, all Nokia production sites had an ISO 14001 certified environmental management system (EMS). With new facilities, the policy is to build first an ISO certified quality management system as a basis for the EMS. Based on accumulated experience and expertise, an EMS can be built and certified at a new site within one year.

The contents of the EMS in place vary somewhat depending on local circumstances, such as legislation, regulations and waste treatment capabilities. However, Nokia has decided to apply Nokia standards if they are higher than the prevailing local standards.

5.14.2 Supplier network management

Nokia buys an increasing amount of components and assemblies from suppliers around the world. The suppliers' activities account for a substantial part of the environmental impact of Nokia products during their life cycle. Therefore, Nokia has formulated environmental requirements for its suppliers; the requirements are an integral part of Nokia's supply chain management practices. The

environmental guidelines are explained in the brochure Nokia Suppliers and Environment, which is available to all Nokia suppliers. In addition, quality and environmental auditing are also a part of the approval procedure required for becoming a Nokia supplier.

5.14.3 Design for Environment

Design for Environment (DFE) means the systematic integration of environmental objectives into product design. The purpose of DFE is to satisfy the requirements of customers and other stakeholders in a way that causes less environmental impact. In practice, DFE uses design practices leading, for example, to:

- minimised material and energy use
- maximised reuse and recycling
- minimised use of environmentally relevant materials

The DFE objectives have an impact on the product design specification along with other product features, such as performance, quality, usability, and cost effectiveness. In Nokia Networks, environmental issues are an integral part of NET Product Creation Process.

Environmental issues are also a criterion in designing product packaging. Nokia designs its packaging to be recyclable and seeks to reduce the amount and weight of packaging materials without compromising the requirement for adequate protection.

5.14.4 Substance management

Managing the substances contained by the product is an important part in designing environmentally compatible products. In addition to solid materials, such as metals and plastics, Nokia and its suppliers use hundreds of substances, preparations, and chemicals in the manufacture of the components, products and packaging. Many of these contain trace elements, which need to be identified before positive claims can be made about their purity. Detailed knowledge of their composition is helpful in designing products and manufacturing processes and in handling the manufacturing waste and used products at the end of life. Most components, for example, are inert and perfectly harmless in normal use, but some may have to be given special consideration in order to ensure proper end-of-life (EoL) treatment.

Nokia has compiled a Nokia Substance List (NSL) based on regulatory requirements and reasonable facts. NSL identifies substances that Nokia has banned, restricted, or targeted for reduction. It is divided into two sections, Restricted Substances and Monitored Substances.

5.14.5 Environmental aspects of networks and sites

Nokia supports the customers by enabling fast and easy site acquisition in an environmentally responsible way. In practise this means that:

- Nokia supports the customer in minimising the total impact of the network on the landscape and the environment.
- Nokia provides the customer with information about electromagnetic fields.
- Nokia assists the customer in dealing with local authorities and communities by providing material, advice, and training on electromagnetic fields.
- Nokia aims to offer low impact antenna and mast solutions systematically as options.

5.14.6 End-of-Life practices

Nokia Networks' customers can contract with Nokia for an environmentally responsible end-of-life (EOL) treatment for obsolete equipment. The purpose is to recover the obsolete products' material and energy content and to ensure the safe treatment of substances that can cause harm to people or the environment, if disposed untreated. In the life cycle perspective, the EOL treatment can compensate for some of the environmental impacts of the earlier stages of the product's life cycle.

Nokia Equipment Take Back Service provides Nokia Networks' customers with an end-to-end service that includes the removal of end-of-life products from the customers' network and ensures end-of-life treatment in an environmentally responsible way. The Equipment Take Back Service is offered in several modules representing the end-to-end workflow of the process:

- Removal
- Collection
- Recycling
- Project Management

The customers may elect to perform one or more modules themselves and procure services from Nokia to perform the remaining modules. In Nokia or Other Vendor HW Replacement, that is, swap cases Take Back Service brings in Collection and Recycling Service as Removal and Project Management are already included. The pricing is scaleable according to the modules.