NOKIA

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BSS Description

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Summary of changes

Changes between document issues are cumulative. Therefore, the latest document issue contains all changes made to previous issues.

Changes between issues 10A (2015-08-27) and 10B (2016-05-04)

BSC Site Solutions

- Chapter has been updated.

Changes between issues 10-1 (2014-02-27) and 10A (2015-08-27)

- DN2 and CO2 product information has been removed from the Cross-connect nodes chapter.

Changes between issues 10-0 and 10-1

BSS SW Release

- Chapter *BSS SW Release* has been updated to RG30(BSS) level.

1 BSS description

The purpose of this description is to give a general overview of the parts and operations of the GSM network's Base Station Subsystem (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 Flexi EDGE BTS, Flexi Multiradio BTS and BS2xx@Flexi BSC are also presented.

The BSS solution consists of the base station controller (BSC), transcoder submultiplexer (TCSM), base station (BTS), transmission, power systems, antenna line, the network service and management system (NetAct) and network planning. General network element names are used for Nokia equipment here.

Nokia can provide a complete BSS network including:

- radio network elements: BSC and a wide range of BTSs
- integrated transmission including short-haul and long-haul microwave radios, copper-based PDH transmission, copper and fiber-based Ethernet, PDH cross-connection and SDH products
- integrated and stand-alone power systems, battery backup and site support solutions
- full range of antenna line elements.
- GSM-UTRAN inter-system functionalities.
- management of all the above with NetAct network service and management system.

Advantages of BSS

The high capacity BSS 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.

The BSC and TCSM have been designed to allow flexible locationing within the GSM network. For example, the TCSM can be co-located on the same site with the BSC or MSC to economize transmission costs.

The modular design of Nokia equipment has many advantages. It facilitates the upgrading of hardware and software, resulting in a minimal disturbance to the network. The modularity also makes the equipment easily expandable. Due to the modularity, the size of the BSC, the TCSM and the BTS is relatively small and compact, which makes them easy to place and thus assist with providing the possibility for a fast roll-out.

The 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 transmission or leased line connection. The integrated PDH transmission solution provides an automatic path protection by the formation of loops with secure radio links. The base station integrated PDH cross-connection functionality reduces the transmission costs between the BTSs and BSCs. The integrated packet based transmission even further reduces total cost of ownership.

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 power systems have been specified, tested and optimized to secure the BTS site element functions, ensuring safe DC distribution for BTSs and line terminal equipment.

Prerequisites for the availability of the BSS network elements are simplicity and speed of the servicing procedures, such as fault repair time. In the BSS solution this is guaranteed in many ways. Built-in redundancy and efficient supervision functionalities minimize 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, network maintenance is more economical.

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

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

2 GSM network architecture and BSS elements

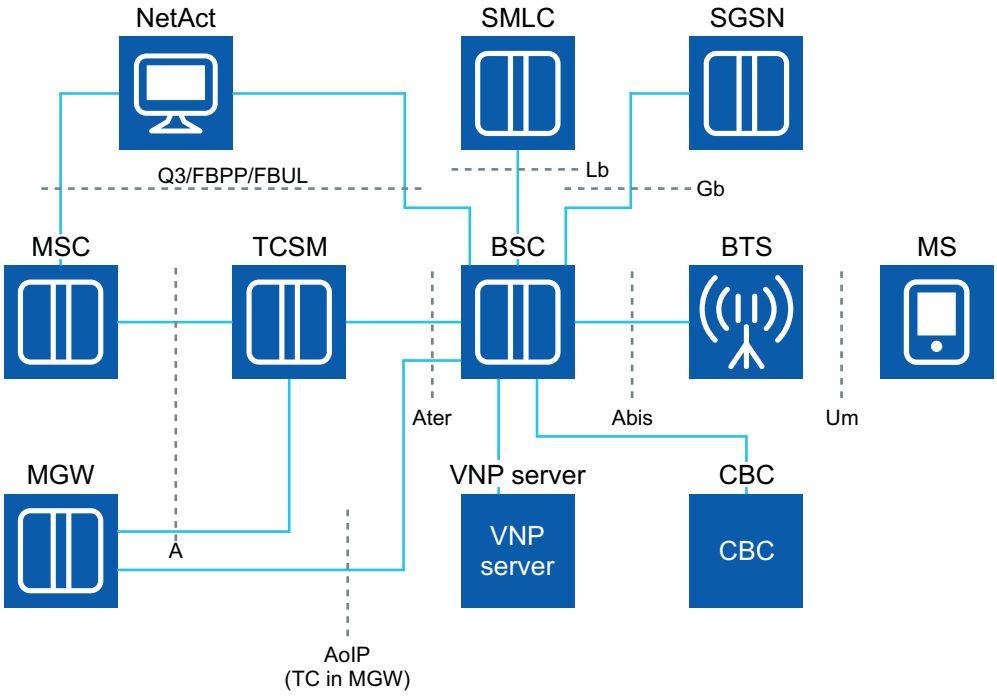
2.1 GSM network architecture

The GSM network is functionally divided into four 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 (provided by NetAct).

The main function of the BSS is to connect the mobile subscriber's mobile station (MS) to the GSM network and provide connections 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.

For more information on the various interfaces, see BSS interfaces.

Figure 1 Nokia Base Station Subsystem in the GSM network



2.2 Base Station Controller

The BSS solution consists of the base station controller (BSC), transcoder submultiplexer (TCSM), base station (BTS), transmission, the network service and management system (NetAct) and network planning.

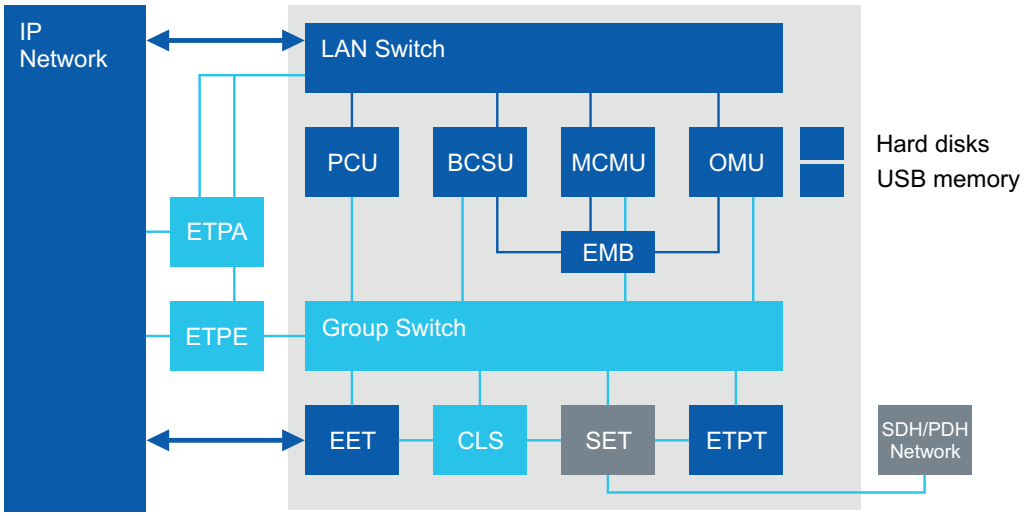
The BSC is designed to efficiently use radio resources, and also provide easy operability and maintainability. Further, it is also designed to gather and convey comprehensive information about the quality of service. Moreover, it is cost-efficient and has high capacity. The BSC is a stable, mature product, with field-proven high reliability and multivendor functionality.

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.

The BSC is connected to a BTS via the Abis (CS and PS traffic) interface. CS traffic goes to the core network through the A interface (CS traffic towards MSC/MGW) or through the A over IP. A over IP provides cost savings in transport, maintenance and operability as IP-technology is more cost effective, easily configurable and flexible than TDM networks. PS traffic goes to the core network through the Gb interface (PS traffic towards SGSN) over FR or through the optional Gb over IP. Gb over IP provides an optimized way of transporting packet-switched traffic via a flexible and dynamic IP pipe. An integrated LAN switch in BSC3i and Flexi BSC provides access to the operator's IP network as the first level LAN switch.

The BSC contains several different functional entities. Figure *Functional entities of BSC* illustrates these elements in the Flexi BSC.

Figure 2 Functional entities of Flexi BSC



The transcoder (TCSM) is usually installed on the MSC site but viewed as a functional unit of the BSC.

Flexi BSC

The Flexi BSC is a solution for all GSM markets. The maximum circuit handling capacity of a Flexi BSC has been extended to support upto 4200 TRXs, while providing the highest traffic handling capacity of 25000 Erl. The Flexi BSC 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.

Figure 3 Flexi BSC

For more information, see Product Description of Flexi BSC.

Multicontroller BSC (mcBSC)

Multicontroller BSC, implemented on top of the revolutionary and modular Multicontroller Platform is a future-proof, high capacity radio network controller, offering high flexibility, scalability, reliability and performance. Multicontroller Platform as such combines a compact and scalable hardware platform with modular and flexible radio network controller software to create a network controller implementation with unrivalled modularity and space efficiency.

Figure 4 Multicontroller BSC

Full IP based Multicontroller Platform enables native support for BSC packet transport on all interfaces and can be configured to serve high voice and data traffic volumes and manage high number of cells. Multicontroller BSC provides capacity for 4400 TRXs and over 26000 Erlangs. Modularity enables easy capacity extensions to meet changing traffic and use patterns. And, when the need comes to adopt a new technology, Multicontroller BSC can be converted into a 3G Multicontroller RNC.

The simple architecture of Multicontroller Platform addresses to reduce operational costs by making commissioning and installation easy and fast. Also, spare part management is highly cost effective due to low amount of different parts. Multicontroller BSC also provides a smooth evolution for existing networks - when installed as an extension for Flexi BSC, the Multicontroller BSC provides flexible increase in capacity and adds multicontroller capabilities to protect GSM capacity investments.

A standalone multicontroller BSC in new installations provides all the control-plane, user-plane and management-plane functionality required from a fully operable base station controller. When Multicontroller BSC is used as an extension for Flexi BSC, part of management and control functionalities remains in Flexi BSC side. Flexi BSC - Multicontroller BSC combination forms one logical BSC utilizing the efficient capabilities of both Flexi BSC and Multicontroller BSC parts.

With full IP-based Multicontroller BSC, all the interfacing are based on IP over Ethernet transmission - Packet Abis/Ethernet, AoIP, Packet Ater and Gb/IP. When Multicontroller BSC is combined with Flexi BSC also TDM (time division multiplex) based interface options are available for the legacy radio network served by the Flexi BSC part in the combined Flexi BSC - Multicontroller BSC installation.

For more information, see # *Product Description of Multicontroller BSC*.

2.3 Transcoder Submultiplexer

The Transcoder Submultiplexer (TCSM) is used on the A interface between the BSC and the Mobile Switching Centre (MSC) or Multimedia Gateway (MGW) to enable the full use of network capacity. The TCSM performs transcoder functions in the base station subsystem and provides a submultiplexing scheme that is used between the transcoder and the BSC.

The TCSM 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 the TCSM is located at the MSC site. Submultiplexing reduces the amount of transmission capacity (Ater interface) needed between the MSC and BSC sites by 75%.

The TCSM converts the 64 kbit/s traffic channels arriving from the MSC into 16 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).

The TCSM performs speech coding according to the speech compression methods mentioned in the GSM specifications. It also supports Full Rate (FR), Half Rate (HR), Enhanced Full Rate (EFR), Adaptive Multi Rate (AMR), and Wideband AMR (WB-AMR) codecs. In addition, Acoustic Echo Canceller (AEC), Noise Suppression (NS), Tandem Free Operation (TFO) and Automatic Level Control (ALC) can be used to further improve network speech quality for mobile subscribers.

For more information on the TCSM, see Product Description of TCSM3i High Capacity Transcoder Submultiplexer.

2.4 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.

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

2.4.1 Flexi EDGE BTS

Flexi EDGE BTS is a unique and very modular base station for GSM/EDGE capacity and coverage. Its modular design makes site acquisition and installation easier, reducing the time needed for rolling out network coverage in a new area. Flexi EDGE BTS allows using existing site space sparingly and efficiently. It is the ideal solution for all networking scenarios.

Figure 5 Flexi EDGE BTS

A functional Flexi EDGE BTS can be built with just two logical modules: Flexi EDGE System Module and Flexi EDGE Sector Module. The Sector Module is a logical unit consisting of two building blocks: Dual TRX Module (DTRX) and Dual Duplexer Module. Typically one Sector Module is needed per sector. Sector extensions are done just by adding more Dual TRXs and optional Wideband Combiners (WBCs). Another option is to use the Remote Tune Combiner Module together with Dual TRX Modules; the Dual Duplexer Module is then not needed.

Flexi EDGE BTS is highly integrated. As an example, it supports up to 24 TRXs (12 Dual TRXs) in the volume of a traditional single BTS cabinet. There is virtually no limit to site capacity, due to synchronised Flexi EDGE BTS chaining.

Flexi EDGE BTS is optimised for high capacity as well as high coverage for macrocellular applications. It also enables evolution paths by providing a flexible expansion capability. It is possible to expand sector by sector so that traffic in only one sector is impacted at the time and the traffic in the whole BTS is not affected.

Flexi EDGE BTS continues to provide top-of-class RF performance with balanced link, similar to existing UltraSite EDGE BTS. In standard Capacity mode, it provides TRX output power of 47 dBm and sensitivity of -115.5 dBm.

Double Power TRX and coverage features secure an even higher performance for coverage-limited scenarios. The feature BSS20870: Double Power TRX for the Flexi EDGE BTS extends the range of possible coverage-based solutions that can be employed within the Smart Radio Concept (SRC).

In addition, the feature BSS20903: Adjustable Intelligent Shutdown for Flexi EDGE BTS enables more efficient handling of TRX resources in BTS shutdown in case of mains failure if Battery Backup Unit is in use. The solution increases flexibility and assists the operator to retain revenues.

Flexi EDGE BTS offers a range of transmission interface alternatives. The supported interfaces are microwave radio and wireline interfaces (E1, T1 and Ethernet). Flexi EDGE System Module includes one transmission slot. Flexi EDGE Transport has been optimized for tail and small chain/loop sites.

Flexi EDGE BTS can also be used when the existing Ultrasite EDGE BTS or BS2xx need to be expanded for additional capacity as well as an aggregated transmission.

2.4.2 UltraSite EDGE BTS

Triple-mode UltraSite EDGE BTS is a compact high capacity base station for multiple standards. Combinations of GSM, EDGE and CDMA configurations can exist in the same cabinet. UltraSite EDGE BTS 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. UltraSite EDGE BTS supports sectored and omni-configurations.

UltraSite EDGE BTS can be housed in indoor or outdoor cabinets. UltraSite EDGE BTS cabinets can house up to 12 GSM/EDGE TRXs, or up to 6 GSM/EDGE TRXs and 6 WCDMA carriers. A 1-6 TRX UltraSite EDGE BTS Midi Indoor and Outdoor and 1-4 TRX UltraSite EDGE BTS Mini Outdoor are also available. Pole installation is possible with Mini Outdoor.

Figure 6 UltraSite EDGE BTS Indoor

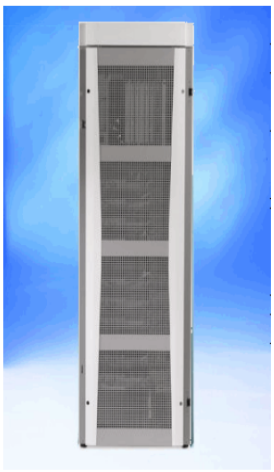


Figure 7 UltraSite EDGE BTS Outdoor

UltraSite EDGE BTS is optimised for high capacity and wide coverage macrocellular applications. Because of an improved link budget the number of sites are reduced, a seamless voice and data coverage area is provided, and high call quality is maintained.

UltraSite EDGE BTS 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.

With the versatile UltraSite transmission options, the most suitable transmission media can be used. UltraSite EDGE BTS can house up to 4 transmission units. The supported transmission medias are microwave radios, wireline (E1/T1) and optical STM-1 interface. A SDH ADM or TM multiplexer can be used for optical transmission.

The extremely wide coverage area built by UltraSite EDGE BTS, with 45.7 dBm (37.15 W output power, combining by-pass), provides a wide service area per site and a large user base coverage. Using intelligent downlink diversity and 4 way uplink diversity with Smart Radio Concept (SRC), UltraSite EDGE BTS provides a coverage gain of up to 5 dB in both uplink and downlink direction.

UltraSite EDGE BTS provides full data support with HSCSD, GPRS, and EDGE compatibility. The soft capacity features, such as Intelligent Frequency Hopping (IFH), are fully supported. Advanced coverage enhancing features, such as Intelligent Coverage Enhancement (ICE) and the Smart Radio Concept (SRC) options, are also supported.

The feature BSS11134: Antenna Hopping for UltraSite BTS is 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 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.

Beyond this, the feature BSS20151: Adjustable Intelligent Shutdown, enables a more efficient handling of TRX resources in BTS shutdown in case of Battery Backup Unit mains failure. The solution increases flexibility and assists the operator to retain revenues.

Table 1 Technical information of UltraSite EDGE BTS

Number of TRXs	1 -12 per cabinet 108 TRXs per site can be divided between different bands	1 - 6 sectors per cabinet with 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

2.4.3 MetroSite EDGE BTS

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.

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 soft capacity solution features and versatile installation options.

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, MetroSite supports E1/T1 interfaces and optical STM-1. MetroSite can house one transmission plug-in unit.

MetroSite EDGE BTS supports 1-4 TRX per cabinet upto 12 TRXs with cabinet chaining.

2.4.4 Flexi Multiradio BTS

Flexi Multiradio BTS is a base transceiver station that is part of the Nokia Flexi BTS platform for GSM/EDGE, WCDMA and LTE networks. It is a mutiradio or muticarrier BTS that can use all these network technologies either in dedicated or concurrent mode of operation.

Flexi Multiradio BTS utilizes modular Flexi BTS platform design principles common with Flexi EDGE and Flexi WCDMA BTSs. It is seen as two separate logical network elements with common radio resources. Multiradio BTS concept simplifies the antenna system complexity dramatically. No additional external combiners are required and multiple RA technologies can share the same feeders and antennas in the same band.

Its modular design makes site acquisition and installation easy, and reduces the time needed for rolling out network coverage in a new area. It allows using existing site space efficiently and the existing Flexi BTS modules can be installed together with Flexi Multiradio BTS modules.

It is installed with weather proof modules and casings, hence a dedicated BTS cabinet is not necessary. It has a broad operational temperature range and can be used in varied climatic conditions.

The same modules can be used in indoor and outdoor sites for macro cellular and micro cellular solutions. The modules can be installed on floor, wall, poles and Flexi cabinets for indoor and outdoor (FCIA and FCOA).

Figure 8 Flexi Multiradio BTS

The Flexi Multiradio GSM/EDGE system module provides baseband capacity for 18 or 36 GSM/EDGE TRXs depending on the version (ESMB or ESMC respectively). The traffic capacity of Flexi Multiradio BTS depends on the radio capacity of the radio module, the baseband capacity and the transport capacity. The baseband capacity of GSM/EDGE and WCDMA/LTE are independent of each other as each technology uses separate system modules and transport.

Flexi Multiradio modules can be installed on a mast or a pole reducing the antenna feeder line length and thus increases the RF performance.

Flexi Multiradio BTS minimizes BTS site rental costs as a BTS-specific cabinet is no longer needed. The floor space required for large configuration is reduced. The existing site support and auxiliary cabinets with sufficient space and cooling can be used to house the modules, further increasing the efficiency of site space.

New installation options makes it possible to install the base stations to places that are better protected against vandalism and natural catastrophes. This means that a reduced shelter maintenance is required.

Common Nokia Flexi multimode for GSM/EDGE, WCDMA and LTE ensures that high capacity multimode sites can be built smoothly and cost-effectively. Evolution from GSM/EDGE to WCDMA and to further radio technologies such as LTE can be ensured rapidly and with minimal effort.

Flexi Multiradio can be cosited with the following BTSs:

- Flexi WCDMA BTS
- Flexi EDGE BTS
- Ultrasite WCDMA BTS
- Ultrasite EDGE BTS

Flexi Multiradio BTS can also be co-located with Nokia and other vendors' GSM or WCDMA BTSs on a shared site.

In addition, Flexi Multiradio BTS can be co-sited with the existing Ultrasite EDGE BTS in order to increase its capacity along with synchronous transmission.

Flexi Multiradio BTS GSM/EDGE system module uses the same transmission plug-in units as with existing Flexi EDGE BTS:

- FIEA
- FIPA
- FIFA
- FIQA
- FIYA

There are two variants of Flexi Multiradio system module; with integrated baseband processing capacity: ESMB for up to 18 and ESMC for up to 36 GSM/EDGE TRX capacities. ESMB/ESMC has an integrated transport unit which provides the physical transmission interfaces and the transport functionality of the BTS. Six different network interface alternatives are offered: E1 symmetrical, E1 unsymmetrical, T1, Fast Ethernet, Gigabit Ethernet and Flexbus (with the exception of FIQB and FIYB system modules). These transport interface variants are same as with Flexi EDGE system module ESMA.

Flexi Multiradio brings the following changes when compared to Flexi EDGE base station:

1. The radio technology is changed from single carrier power amplifiers to multi carrier power amplifiers. No external combiners are needed to combine the different TRX outputs to a common antenna line.
2. Baseband processing is now centralized to the system module instead of distributed to the radio modules as in Flexi EDGE BTS.
3. The interconnection between the system module and the radio module is changed from Ethernet based electrical connection as in Flexi EDGE BTS to optical OBSAI connection as in Flexi WCDMA BTS. Thus, Flexi Multiradio supports feederless sites without optical optional converter modules.

2.4.5 BS2xx@Flexi BSC

BTSplus is the product family name for all BR BTS variants, which are supported by Flexi BSC.

BS2xx@Flexi BSC means that BTSplus software is enabled to interwork with Flexi BSC product family so that the BR base station (BTSplus) can be connected to Flexi BSC via an adaptation of the BSS Abis interface. The eBSC is exchanged with the Flexi BSC so that the BS2xx base stations are connected to the Flexi BSC with software modifications but no hardware changes. This solutions represents a merging of the GSM/EDGE BR and BSS product lines but does not affect connections between BSS-BTS products and BSC3i.

This network solution allows for both BSS base station types (e.g. Flexi EDGE BTS) and BTSplus base stations to be operated by the same Flexi BSC within the same BSS architecture.

In such a scenario, NetAct is the OAM system used to manage the BS2xx connected to Flexi BSC product family. The overall OAM functionality is then provided both by NetAct, as well as via the BR LMT (LMT Evolution) integrated in NetAct.

The mediation function between the BSS Abis interface implementation and the BTSplus is implemented on the BTSplus itself. No hardware changes are required to the BTSplus for it to support the BSS Abis implementation. The Flexi BSC product family has been adapted, allowing it to manage the BTSplus as a new BSS BTS type, in addition to the base station types of the BSS product line:

- Flexi Multiradio BTS
- Flexi EDGE BTS

BS2xx consist of the following base station types:

- BS-240/BS-241
- BS-240 II/240 II B, 241 II/241 II B
- BS-240XL
- BS-240XL II/BS-240XL II B
- BS-40 II
- BS-40/41
- BS-82 II
- BS-82
- BS-240XS
- BS-288

With RG20(BSS), a cositing solution for BTSplus with Flexi EDGE BTS supports further extension of existing BTSplus site deployments.

An ETIP1 plug-in module, based on Circuit Emulation Service over Packet-Switched Networks (CESoPSN) technology, is equipped in the BSC3i/Flexi BSC instead of the usual E1/T1 or STM-1/OC-3 unit in order to provide a direct termination of IP connectivity. The corresponding CESoPSN interfacing capability is enabled in the BTSplus via the integrated CES-COBA + ETHCON modules.

2.4.6 Horizon BTS@Flexi BSC

The Horizon BTS at Flexi BSC product family feature supports migration of Horizon base transceiver stations (BTSs) and providing a network solution in which Horizon base stations are managed by BSCs of the Flexi BSC product family. This solution therefore represents merging of the GSM/EDGE BSS and GSR product lines.

The BSS controlled by Flexi BSC or BSC3i might consist of Horizon, BTSplus, Flexi EDGE, Ultrasite and Flexi Multiradio BTSs. Any of such mixed configurations is supported by BSC and NetAct. The BSC3i should have PCU2 to support Horizon BTS.

The Horizon BTS family hardware supports (E)GSM900 and GSM1800 bands.

The Horizon BTS family is divided into:

- Horizonmacro
- Horizon II family (Horizon II macro, Horizon II mini and Horizon II micro)
- Horizon 2G-nx BB

Figure 9 Horizon II macro (indoor)

Mix of cabinet types and radios at a Horizon BTS site is also supported. There is a possibility to have Horizonmacro site that consists of the Horizonmacro master with Horizon II family slaves, similarly the Horizon II macro site with a Horizon II macro master with Horizon macro slaves. Both such configurations support all radio types.

The radio unit types used by Horizon BTSs are CTU, CTU2 and CTU2D in Horizonmacro and CTU2, CTU2D and CTU8m used in the Horizon II family.

2.5 Single RAN introduction

Nokia Single RAN solution consists of multipurpose hardware with multipurpose software for GSM, WCDMA, LTE and CDMA technologies.

The Single RAN solution aims at reducing the amount of equipment required to operate one site. To achieve this, uniform equipment is used throughout the largest network area possible and the network elements are defined by the software package installed. Large, quantifiable operator savings on hardware equipment, power, installation, maintenance, and operational costs are the main advantages of introducing Single RAN. Additionally, the introduction of the Single RAN results in an increase of capacity and range per site. Owing to a short commissioning phase, common management interface, and easy upgrade procedures, the network becomes flexible and is able to respond to the rapidly changing traffic demand of the market. Single RAN features, such as RF sharing, introduce additional CAPEX and OPEX savings for operators, thanks to the use of shared hardware.

2.5.1 Nokia Single RAN enablers

Flexi Multiradio 10 BTS

Flexi Multiradio BTS is a part of Nokia macro BTS site solution. From a BTS site installation and hardware point of view, Flexi Multiradio BTS introduces a new way to build BTS sites using modules, without a specific BTS cabinet. Due to its small weight and size, modular design, and full frontal accessibility, Flexi Multiradio BTS is easy to install in various locations.

Flexi Multiradio BTS modules can be used with different BTS configurations for an integrated site solution. The existing site support and auxiliary cabinets can be used to house Flexi Multiradio BTS modules, or modules can be installed, for example, on a wall. The same multiradio modules are used in both indoor and outdoor sites.

Flexi Multiradio System Module

Flexi Multiradio 10 BTS System Module is responsible for data transmission, baseband processing, system operation and maintenance, and power distribution. Any Radio Access Technology is supported by installing the respective software package. Flexi Multiradio 10 BTS System Module hardware has been prepared for supporting the System Sharing feature, which makes it highly future-proof. Depending on the System Module variant, various capacity of baseband processing is offered.

Flexi RF Modules/Remote Radio Heads

Flexi RF Modules support all the three radio access technologies (RAT) (GSM/WCDMA/LTE) serving one to three sectors at a time. One Flexi RF Module can serve up to two RAT System Modules. That brings operators significant savings as operating two RF Modules is no longer a need. The hardware architecture of Flexi RF Modules/RRH differs in the filters used and the input power required by the module. The filter used depends on the operating bandwidth frequency. The power required by the module depends on site characteristics and the operator needs. The System Modules are installed in close vicinity of the RF Modules, so that there is no need to use feeders. Thus, additional cost savings are introduced.

Active Antenna System

The Flexi Multiradio Antenna System is the next step in the evolution of radio networks, providing higher capacity and coverage while reducing site costs. The Nokia Multiradio Antenna System enhances mobile network performance by integration of the base station's radio frequency elements into the antenna. It provides an alternative to Flexi RF Modules and RRHs, or can be used in combination with traditional Flexi RF units.

The Flexi Multiradio Antenna System is a complete radio unit with integrated antenna arrays, transceivers, power amplifiers, and filter modules, including the integrated Common Module (CM) for processing the Active Antenna System (AAS) specific functions. The integrated antenna array supports active and passive combinations.

Box Controller Node

Both mcBSC and mcRNC products can be hosted on the same Box Controller Node (BCN) hardware platform. Using the same hardware units allows to host 2G and 3G controller modules in the same cabinet, reducing the site costs. The network element type depends on the software package installed on the BCN. Thus, the upgrade from 2G to 3G network is easy, requiring only software update. BCN`s modular architecture allows increase of capacity by connecting a few nodes in a stack. Such scalability allows to expand the network only when the number of users increases and to actively react to growing traffic demands.

The BCN is a generic, scalable hardware platform suitable for implementing a wide range of processing-intensive products serving as controller-, gateway- or server-type entities in telecommunication networks. Although the network context varies, the products have much in common so that a common hardware platform is viable.

Network elements can consist of one BCN module (small network elements) or several BCN modules (large network elements with large processing power requirements).

Availability requirements have a strong impact on the BCN module hardware configuration and interconnection solutions. The power feed operates in load-sharing mode and the BCN module is operational even if one of the power supply modules breaks down. Processors within a BCN module are independent of each other so that a faulty processor has no effect on the performance of the rest of the module.

Note: For more information, see *Multicontroller RNC Hardware Description* in *WCDMA RAN Operating Documentation* and *Multicontroller BSC and Multicontroller TC Hardware Description* in *GSM/EDGE BSS Operating Documentation.*

2.5.2 Single RAN features

The current shared Single RAN features are the following:

- QoS aware Ethernet Switching BSS101417, RAN1769, LTE649)
- Synchronization Hub (BSS21439, BSS30450, RAN1707, LTE612)
- RX Diversity Sharing GSM-WCDMA (BSS21403, RAN2514)
- RF Sharing GSM-WCDMA (BSS21403, RAN1770)
- RF Sharing GSM-LTE (BSS21520, LTE447)
- RF Sharing WCDMA-LTE (RAN2126, LTE435)

For more information on the features, see the Feature Descriptions documentation in WCDMA RAN Operating Documentation, GSM/EDGE BSS Operating Documentation and LTE Radio Access Operating Documentation.

2.6 Transmission

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

For more information, see BSS transport solutions in *Transport Network Solution for BSS*.

2.6.1 BSC transmission

In the backbone transport network, transmission is generally based on the plesiochronous digital hierarchy (PDH) technology (E1/T1 over PDH), or on the synchronous digital hierarchy (SDH) technology or more recently Ethernet. The BSC3i's and Flexi BSC's maximum configuration includes a maximum of 800 PCM connections used on external interfaces (E1/T1) with ET units or a maximum of 16 optical STM-1/OC-3 interfaces.

The STM-1/OC-3 interface is the optical interface to the SDH/SONET network. One STM-1 interface can carry 63 E1 PCMs and one OC-3 interface 84 T1 PCMs.

Gb over IP solution enables IP transmission for user data and signaling between BSC and SGSN.

The A interface between BSS and MGW can also be based on IP/Ethernet. This requires the new ETP-A hardware unit in either TCSM3i or Flexi BSC. A over IP can either be provided by Flexi BSC using transcoding function in the CN or by TCSM3i. Both control and user planes are included in 3GPP Rel 8.

When transcoding is in CN, then Packet Abis must be used for Abis implementation and Transcoder Free Operation (TrFO) is also supported in this configuration.

Packet Abis is the new transport concept in which codec is packed into packet directly instead of TRAU frame. The Abis frames conveying traffic and signaling information between BTS and BSC are subjected to packetization process prior to sending them to the transmission path. As a result of packetization, the incoming CS/PS/control frames are converted to new (Packet Abis specific) formats which are encapsulated and form IP packets eventually transmitted over Abis.These principles are valid regardless of the physical media used.

Packet Abis is supported by Flexi BSC. A new hardware unit called Exchange Terminal for Packet Transport (ETP) is required to be plugged in BSC to support Packet Abis. ETP is fully integrated with BSC and can freely co-exist with the existing exchange terminals ET16/ETS2/ETIP. Packet Abis and Legacy Abis (Dynamic Abis, CESoPSN) can run on the same BSC at the same time.

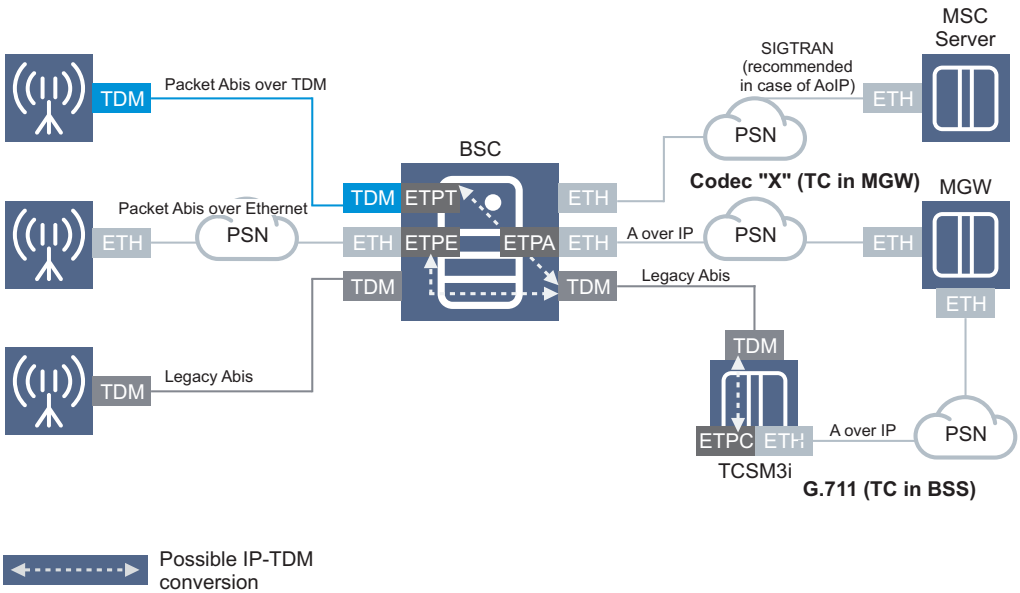
Packet Abis has no direct impact on TCSM. Ater interface is either TDM-based or PWE-based (CESoPSN) or AoIP.

Circuit Emulation Service over Packet-Switched Networks (CESoPSN) is the intermediate step between TDM-based and PSN-based transport. CESoPSN allows to replace TDM backhaul with PSN one while Packet Abis simplifies such configuration and optimizes bandwidth usage to the far extent. CESoPSN can be used for legacy BTS to further utilize the installed HW base and at the same time to ensure seamless availability of IP transport.

The TCSM3i for combined BSC/TCSM installation option provides optical A interface connectivity also towards the core network. With this configuration, Flexi BSC and TCSM3i are installed together and the maintenance of the optical connections is done by the BSC. The TCSM capacity in a combined BSC/TCSM installation can be shared with several remote BSCs. Integrated IP/Ethernet transmission units are available for both Ater and A interfaces of the TCSMi, enabling full scale integrated IP/Ethernet implementation.

Note: Multicontroller BSC transport is based only on IP/Ethernet.

Figure 10 Base Station Controller transmission



2.6.2 Base station transmission

The BTS transmission subsystem is used in the BTS as an interface to the Abis links towards the BSC. FIYA, FIQA, FIYB and FIQB plug-in units are used in Flexi EDGE BTS. Flexi Multiradio BTS uses the same plug-in units as Flexi EDGE with the exception of FIYB and FIQB.

The BSC-BTS Abis transmission configuration is a mixture of point-to-point, multidrop chain, or multidrop ring subnetworks. The BSC sees BTSs through 2 Mbit/s PDH ET ports which carry data to and from the BTSs. In case of Packet Abis, the communication happens through IP transport.

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

UltraSite/MetroSite/MetroHub transmission 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 wireline transmission, 120/100 Ohm
- FXC E1 (4 x 2M), asymmetric wireline transmission, 75 Ohm
- FXC RRI (16 x 2M), radio link transmission (Flexbus connection for 2 outdoor units)
- FXC STM-1 for UltraSite and MetroHub: 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, synchronization 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.

Flexi EDGE BTS transmission plug-in units

One transmission plug-in card is fully integrated to the Flexi EDGE BTS System Module. FIQB/FIYB plug-in cards provide as synchronization method synchronous Ethernet and IEEE1588 Timing over Packet in addition to other existing methods. The following variants are available:

- 8 x E1, 2 Mbit coaxial 75 Ohms wireline transmission (FIEA)
- 8 x E1, T1, 2 Mbit/ 1,5 Mbit balanced 120/100 Ohms wireline transmission (FIPA)
- 4 x E1/ T1, balanced with 120/ 100 Ohms plus 2 x Fast Ethernet 100 BaseT, 1 x Gigabit Ethernet optical SFP (FIQA)
- 4 x E1, coaxial 75 Ohms plus 2 x Fast Ethernet 100 BaseT, 1 x Gigabit Ethernet optical SFP (FIYA)
- 2 x Flexbus interfaces 16 x 2Mbit/s (FIFA) for Microwave Radio Outdoor Unit
- 4 x E1/T1, balanced with 120/100 Ohms plus 2 x Fast Ethernet 100 Base T, 1 x Gigabit Ethernet optical SFP (FIQB)
- 4 x E1, coaxial 75 Ohms plus 2 x Fast Ethernet 100 Base T, 1 x Gigabit Ethernet optical SFP (FIYB)

The solution supports grooming down to 16kbit/s and PDH loop protection whereas the Flexi EDGE BTS acts as loop slave. The solution is optimized for tail and chain sites.

Note, that for Gigabit Ethernet interface, an additional compatible small form-factor pluggable optical transceiver (SFP) is required.

Flexi Multiradio BTS transmission

The Flexi Multiradio BTS integrated transmission function is located in Flexi Multiradio System Module (ESMB/C). The Flexi Multiradio BTS has been optimized for tail and chain sites. The transmission sub-module, which is a part of the System Module (ESMB/C), has the following variants available:

- 8 x E1/T1 balanced, 120/100 Ohms (FIPA)
- 8 x E1, coaxial 75 Ohms (FIEA)
- 2 x Nokia Flexbus Interfaces, 16 x 2 Mbit/s (FIFA)
- 4 x E1/T1, balanced with 120/100 Ohms plus 2 x Fast Ethernet 100 Base T, 1 x Gigabit Ethernet optical SFP (FIQA)
- 4 x E1, coaxial 75 Ohms plus 2 x Fast Ethernet 100 Base T, 1 x Gigabit Ethernet optical SFP (FIYA)

Note, that for Gigabit Ethernet interface, an additional compatible small form-factor pluggable optical transceiver (SFP) is required.

PWE

PWE is the abbreviation for Pseudo-Wire Emulation. This protocol is used to send TDM data (E1/T1) over a packet-based network (UDP/IP/Ethernet).

PWE function is realized by new TRS plug-in unit type, which gets inserted into the System Module. There are currently four variants of PWE unit:

- FIQA and FIQB - PWE unit with Ethernet and balanced PDH interfaces.
- FIYA and FIYB - PWE unit with Ethernet and unbalanced PDH interfaces.

The PWE unit allows BTS to extract synchronization clock from any interface (Ethernet or PDH).

Packet Abis

Packet Abis transport consists in new protocols for transferring data over the Abis link. All traffic (speech, data, signaling) is essentially reformatted and repacked to be sent packet-wise over the Abis interface. The principle can be used over PSN transport networks as well as maintaining the widespread TDM transport.

Packet Abis consumes much less bandwidth than PWE. However, both the features aim at encapsulation of the TDM payload into IP/Ethernet.

BS2xx

E1/T1 transmission system is available as transport interface between BSC and BS2xx. There are no changes needed at the BTS/BSC side to establish Abis over E1/T1. BS2xx can control upto 8 E1/T1 lines.

Although BS2xx support only 8 E1/T1 interfaces, these E1/T1 links can be tributaries of a higher order network like SDH. Connection between BS2xx and Flexi BSC is established using Dynamic Abis (for traffic and LAPD multiplexing for signaling). The following Abis configurations are supported:

- Star
- Multidrop
- Cross-connect

PCM lines are created on the Abis interface between the BS2xx and the Flexi BSC product family, to carry traffic channel and signaling data in both directions. PCM 30 is carried on E1 transmission lines with a throughput of 2 Mbit/s. PCM 24 is carried on T1 transmission lines with a throughput of 1.5 Mbit/s.

BS2xx equipped with CES-COBA/ETHCON modules can be also connected directly to BSC3i/Flexi BSC by means of CESoPSN.

2.6.3 Base Station Synchronization

The following basic synchronization techniques are available:

- Legacy E1/T1 TDM or SDH line
- GPS equipment (LMU unit or 2 MHz/ 1 PPS signal)
- Separate TDM link established to carry the synchronization signal only
- IEEE 1588 Timing-over-Packet (ToP)
- Synchronization using adaptive clock recovery (ACR)
- Synchronization to 2 MHz source
- Synchronous Ethernet (SyncE)

The synchronization capabilities of a specific BTS depends on BTS type and interface unit applied.

2.6.4 Cross-connect nodes

The BSS Abis transport is based on PDH, SDH or IP/Ethernet 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 synchronization can be delivered through the network to the BTSs. The optimization and management of the transport network

capacity is made by using cross-connection devices. The BTSs provide inbuilt cross-connection and grooming functionalities for capacity optimization and traffic (loop) protection. The BSC supports the Q1-managed MetroHub, providing polling functionality also for other network elements not polled by the BTS. The loop protection functionality of MetroHub matches with the BTSs, which are usually used as loop slaves. Other standard PDH cross-connection devices 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.

MetroHub Transmission Node

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 software 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, STM-1, and Flexbus. Every UltraSite EDGE BTS 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.

2.6.5 Line equipment

Optical line equipment

If there is a need for SDH transmission for capacity reasons and there are fibres available, Nokia is able to provide the world leading SDH and Dense Wavelength Division Multiplexing (DWDM) solutions.

Furthermore, 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.

2.6.6 BSC Site Solutions

In a BSC site, the following equipments might be needed, depending on application case:

- TCSMs
- L2/L3 equipments like multilayer site switches (MLS)
- Security Gateway (SGW)
- External Synchronization Master (Ethernet backhaul)
  - PTP Master (PTP-M)
  - Adaptive Time Server (ATS)
- Site Support Equipment Manager (SSE-M)
- SDH Add/Drop Multiplexer (ADM)

BSC site is connected to BTSs and to CN/Net Act via a Packet Network or a PDH/SDH network.

L2/L3 Equipment

The BSC site solution assumes a deployment of a pair of L2/L3 site equipment for the BSC connection to the packet transport (backhaul/backbone) network.

It is recommended to use Multilayer site switches which can be based on Nokia or Cisco products. Such multilayer switch pair has to be able to connect all BSC external interfaces as well as all interfaces to/from optional equipment at the BSC site (e.g. SGW, PTP Master (PTP-M), Adaptive Time Server (ATS), SSE-M).

Nokia SR 7750 are considered suitable L2/L3 equipment for IPv4/IPv6 dualstack solution.

Cisco 7600 series router models are considered as suitable to fulfill the needs of the BSC site external L2/L3 equipment. Cisco 7609 is the chosen solution for 3G (RNC site external equipment) and therefore the ideal candidate when coming to BSC-RNC co-siting.

Cisco 7609 is a multilayer switch i.e. one single physical device but including switching and routing functionalities. Switch Virtual Interface (SVI) is the interface between Internal Router and Internal Switch. An IP address is assigned to each SVI.

Cisco 7600 provides a multitude of options to scale WAN connectivity from DS-0 to OC-192 adn LAN connectivity from 10 Mbps Ethernet through 10 Gbps Ethernet.

Cisco catalyst 3750 switch is deemed as suitable with limitations that in some use cases it does not provide the full set of required features (e.g. SyncE, Ethernet OAM).

Security Gateway

GSM network can be backhauled with IP/Ethernet. Mobile operators may use third party service providers for backbone and backhaul. Internet Protocol Security (IPSec) can be used to protect the BSC traffic against fake senders, traffic manupulation and eavesdropping.

External Synchronization Master (Ethernet backhaul)

The BSC transport site solution foresees three different ethernet synchronization methods:

- IEEE1588 Timing-over-Packet (ToP) Precision Time Protocol (PTP)
- Adaptive Clock Recovery (ACR)
- Synchronous Ethernet (SyncE)

And, Nokia recommends:

- Symmetricom TP5000 as PTP master
- A-2200 in case of Adaptive Clock Recovery
- SyncE master integrated on ETP unit

External Synchronization device for IEEE1588 ToP solution: Symmetricom TP5000

Symmetricom TimeProvider 5000 (TP5000) is the IEEE 1588-2008 PTP master recommended in Nokia. As in WCDMA technology, it is recommended as well in GSM.

The Symmetricom TP5000:

- Ensures transparent synchronization across packet network for Layer2 and Layer3
- Can be used as an external master clock at BSC side or hub site
- Can be used for inbuilt slave clocks

- Is required with leased backhaul in case service provider does not offer synchronous service

The Symmetricom TP5000 consists of one HW box and related SW.

In order to use 1588 at BTS, the BTSs have to be Flexi EDGE equipped with FIYB/FIQB.

The used protocol stack is UDP/IPv4 over Ethernet.

TP5000 should be co-located to BSC(s) or also hosted in a remote site (e.g. in CN), in case of co-location, TP5000 is considered as part of BSC transport site solution. TP ports in MLS are used to connect the Symmetricom TP5000.

TP5000 is capable of FCAPS (Fault, Configuration, Accounting, Performance and Security) management. The main features are:

- Alarms, event history log, and alarm synchronization
- Configuration (IP port status, PTP status, PTP client list, VLAN config (16 VLANs) and state, Unicast Client config etc.), firmware upgrade
- Inventory reports
- Radius client for username and password authentication
- Telnet session
- SSH session
- User access security and profile

Symmetricom TP5000 FM is supported by NetAct from OSS5.2

A-2200

The A-2200 Carrier Ethernet Edge Switch is part of the complete Nokia end-to-end packet transport solution that comprises access, aggregation core and management for enterprise, mobile backhaul and converged networks. However, A-2200 can also operate in stand-alone environment.

Nokia A-2200 Carrier Ethernet Edge Switch can be used as PW end point for BTSs that use Adaptive Clock Recovery (ACR) mode providing the PW encapsulated TDM stream and it can act as SyncE master as well.

Configuration for A-2200 in BSC transport site solution includes equipment redundancy and A-2200 equipment is connected to one MLS via ethernet connection and receives inputs (PDH or SDH) from BSC or TDM (leased) lines. Link aggregation towards MLS is recommended. AT ports in MLS are used to connect the A-2200.

In order to provide the TDM input for PW CES, the types of TDM modules supported are: 16 E1/T1, 8 E1/T1 and 4 STM-1/OC-3.

2.7 NetAct framework for network and service management

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

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 NetAct management solution are:

- The entire network can be accessed and viewed with one system. 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.

2.7.1 NetAct architecture

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

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). The hardware contains the following:

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

2.7.2 NetAct functionality for network and service management

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.

NetAct Planner

The purpose of 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 NetAct areas, and radio network elements enables fluent interworking and reduces significantly the effort in transferring information between applications.

NetAct Multiradio 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.

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.

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.

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.

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.

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

NetAct Configurator

NetAct Configurator covers management functionality for both radio access packet core networks. The objective of Configurator 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.

NetAct Optimizer

NetAct 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.

NetAct Monitor

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.

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.

NetAct Tracing

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.

NetAct Service Quality Manager

NetAct Service Quality Manager enables the operator to work in a proactive manner by showing the impact of network problems on end-user services. 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.

NetAct Inspector

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.

NetAct Reporter

With 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.

NetAct Administrator

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.

2.8 Power systems

Power systems delivered by Nokia provide essential battery backup for a variety of GSM and WCDMA base stations and BSC (RNC) configurations, including indoor and outdoor versions. In addition, power systems also provide space for transmission, customer equipment, and base station modules based on the Flexi platform.

Micro power supply system, Outdoor and Indoor

Micro power supply system is used as Battery Back-up Unit (BBU) for Flexi EDGE and WCDMA base stations, MetroSite (GSM, EDGE, WCDMA) base stations, and MetroHub Transmission Node.

Micro BBU provides versatile mounting options such as pole, wall or floor mounting. The maximum output power is 6 kW with up to 100 Ah battery capacity.

Macro OEM power supply systems, Outdoor

Outdoor power supply system series can be used either as a traditional BBU with batteries or as a Site Support System (SSS) with some 19-inch units mounted. Power supply systems support UltraSite EDGE and WCDMA, Flexi EDGE and WCDMA.

The modular systems consist of a cabinet with space for rectifiers, a controller unit, DC distribution, and batteries. Various optional kits are also available, for example, to provide space for transmission, customer equipment, or Flexi BTS modules.

The maximum output power is up to 16 kW with up to 680 Ah battery capacity in one cabinet. Specific configuration for the customer equipment provides space up to 13HU with a battery capacity of 510 Ah or 6HU with up to 680 Ah. Having Flexi BTS modules mounted up to 12HU still allows for installing up to 510 Ah battery capacity and with full 21HU configuration 340 Ah.

Macro OEM power supply systems, Indoor

Indoor power supply system series are battery back-up systems for UltraSite Indoor (GSM, EDGE, and WCDMA), Flexi EDGE and WCDMA, and BSC (RNC).

The modular system consists of a cabinet with space for rectifiers, a controller unit, DC distribution unit and batteries. The small footprint solution provides an output power of up to 16 kW with up to 680 Ah battery capacity. Indoor systems also have various optional items available to complement the solution. Specific configuration allows the installation of Flexi BTS modules up to 21HU with a battery capacity of 340 Ah or with 12HU configuration 510 Ah.

FPRA Flexi Power Rectifier

OEM-based Flexi power rectifier is 3HU-high and 19-inch wide compact module housing up to three rectifier units, a controller and DC distribution. FPRA is used in Flexi BTS applications but can be used with other BTS types as well.

The same FPRA module can be used in both indoor and outdoor environment. The module can be placed in multiple locations such as SiteStar battery cooling cabinet, FCIA, FCOA, FCSA, wall, pole, and stack.

3 BSS SW Release

The RG30(BSS) offers the following advantages for the operators:

- Enhanced voice capacity and spectrum efficiency, maximizing the utilization of the existing infrastructure and providing CAPEX/OPEX efficient capacity upgrade solutions through improvements of the unique Orthogonal Sub Channel capability as well as implementation of ongoing VAMOS standardizations.i
- Enhanced transport solutions, saving both CAPEX and OPEX cost
- Improved operability for monitoring, tracing and measurements
- Further evolution with Multicontroller BSC complemeting the featureset
- New operational modes for Flexi Multiradio BTS supporting more frequency variants plus High Power RRHs

RG30(BSS) EP1 builds upon the capabilities provided by RG30(BSS), enhancing the value through:

- Improved interworking with LTE supporting different transition scenarios (e.g. refarming, handover, RF sharing support, ..)
- Improvements for Voice services
- Improvements for Synchronization to support DFCA and transport scenarios
- New operational modes for Multiradio BTSs
- Complementing mcBSC scenarios and IP transportation functionality
- Improving serviceability

RG30(BSS) operator value

- BTS Solution
  With the RG30(BSS) release, the Flexi EDGE BTS and Flexi Multiradio BTS provides the necessary interfacing for ongoing improvement features for the Orthogonal Sub Channel (OSC) and Packet Abis capabilities. In addition to that certain features lead to improved needed HW resources and/or sharing HW over multiple sites and therefore optimizes needed OPEX for network extension.
- Radio Network Performance
  With Admission Control for EGPRS and Enhanced packet scheduling the service for premium users can be improved. The improvements in Orthogonal Sub Channel (OSC) feature provides better penetration for OSC usage and therefore further optimizes savings in the network. Furthermore the spectral efficiency will be improved by the OSC feature and so frequencies can be freed up for other services like LTE.
- Operability
  The Dynamic PCU2 Pooling feature reduces the administration time for pooling of PCU resources and further improves the efficiency of PCU usage. Therefore it reduces both CAPEX and OPEX. Certain improvements for monitoring, tracing and measurements are introduced making the handling of the overall system more smooth and easy. With Flexi Multiradio BTS auto detection and centarlized User Management the system administration and rollout becomes more automated and reduces CAPEX.
- Transmission Solutions
  Several features are introduced with RG30(BSS) to transfer TDM based transport network into IP based transport with minimal need for new HW investment.

RG30 EP1(BSS) Operator Value

- BTS Solution
  RG30 EP1 enhances the feature support for Flexi Multiradio 10 BTS as well as for Flexi Compact BTS. The RF sharing scenarios and DFCA will be supported with Flexi Compact BTS. Moreover, the energy consumption is improved by intelligent MCPA TRX shutdown and RET is now aupported for Flexi Multiradio BTSs.
- Radio Network Performance
  OSC will be optimized (multiplexing improvements and improved HW support of combined EDGE scenarios) and more synchronization possibilities will be provided for DFCA. The LTE interworking is further enhanced through the ‘Fast Return to LTE’ and Nearest Offset BTS’ features.
- Transmission Solutions
  IPSec alignment with UMTS and LTE solutions will be provided. Loop protection mechanism will be supported in RRH scenarios.
- BSC Solution
  More PCU capacity will be provided with mcBSC.
- Operability
  Measurement and tracing capabilities are improved and Symptom Data Collection is automated.

For more information, please refer to the following:

- *RG30(BSS) Features Under Development*
  Introduces the new features provided with RG30(BSS) and describes the benefits.
- GSM/EDGE BSS, Rel. RG30, Operating Documentation
  Provides feature and functional descriptions for all supported BSS features and functionalities. Each description explains the functionality in the BSC and/or in the BTS, its benefits and requirements, and also the related alarms, counters, parameters, and MMI. Selected feature descriptions contain a BSS-level description and system impact. Instructions for the activation of the features, as well as Flexi EDGE BTS hardware installation and operation are also included.
- UltraSite EDGE BTS and MetroSite EDGE BTS Product Documentation (NED)
  Provides information on the UltraSite EDGE and MetroSite EDGE BTS hardware installation and operation.

4 BSS compatibility with NSS

Nokia BSS and 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, NetAct can handle the whole Nokia GSM and GPRS Core networks, resulting in operational costs reduction and overall cost-efficiency. All BSS and NSS network elements are compatible with each other and are designed to support each other. This becomes more and more important with the advanced GSM features, such as data services.

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 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 network also saves 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.

Other NSSs and GPRS Core networks

The BSS is not only compatible with the Nokia NSS but also with other suppliers' NSSs. In addition, the BSS is fully compatible with the network service and management system (NetAct) and other support equipment. Compatibility issues have been taken into consideration for the system design of the BSS and its network elements. The 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. Nokia has carried out extensive testing concerning the A interface. Nokia BSS has been tested with all of the major switch suppliers on the market for a number of years. Nokia MSC has also been proved to interwork with other manufacturers' BSSs. At the moment Nokia BSS is successfully operating in live networks around the world with Alcatel-Lucent, Motorola, Ericsson, and Nortel MSCs.

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

5 BSS radio management feature compatibility

BSS radio management feature interactions

Certain radio management features interact with one another, which impacts the simultaneous use of some of the features. The features concerned are the following:

ICE	Intelligent Coverage Enhancement, 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 Set-up	When all SDCCH channels are allocated, the BSC can allocate TCH and use its FACCH for call set-up.
Dynamic SDCCH	When SDCCH loading is high, the BSC can re-configure a TCH channel as a set of SDCCH channels.

5.1 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 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 Set-up 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 Set-up and Dynamic SDCCH.

Dual Band

The Dual Band feature uses separate cells (separate BCCHs) for different frequency TRXs, with the Direct Access to Desired Layer/Band feature to facilitate call set-up.

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 Set-up
- Dynamic SDCCH

Common BCCH/Multi BCF Control

The segment features Common BCCH 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 Set-up can be used in the BCCH BTS_Object of Common BCCH.
- Dynamic SDCCH can be used in the BCCH BTS_Object of Common BCCH.

FACCH Call Set-up 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.

Channel allocation to BTS_Objects within one BCF that are for the same band but different power levels does not take into account the different power levels.

With Common BCCH using two frequency bands, the BCCH should be located in the lower band for best performance.

5.2 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 that the initial SDCCH is usually in the BCCH BTS_Object.
- IFH/IUO can be used with FACCH Call Set-up.
- IFH/IUO can be used with Dynamic SDCCH.

5.3 FACCH Call Set-up feature compatibility

FACCH Call Set-up 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 Set-up 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

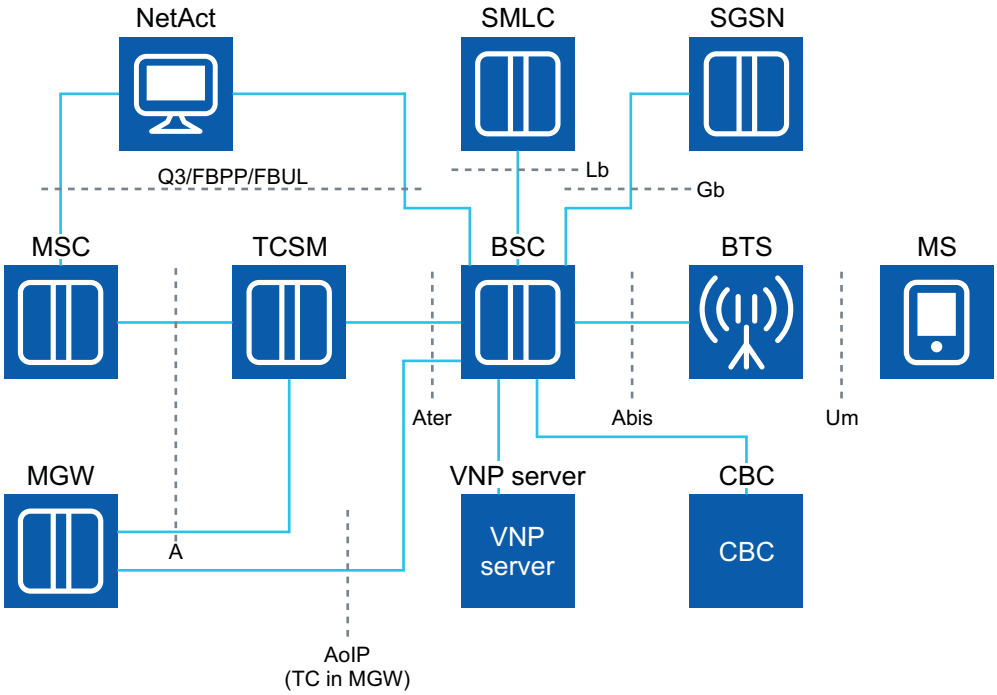
FACCH Call Set-up and Dynamic SDCCH cannot be used with:

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

6 BSS interfaces

GSM standard open interfaces as well as Nokia specific interfaces are used in the BSS.

Figure 11 Interfaces in Base Station Subsystem



A interface

The interface between the mobile switching centre (MSC) or Multimedia Gateway (MGW) and the base station controller (BSC) is implemented according to the GSM specifications.

The Transcoder Submultiplexer (TCSM) is located normally at the MSC site, because of the superior transmission savings possible with submultiplexing between the TCSM and the BSC. A physical A interface used to consist of PCM lines or optical lines between network elements. But with the introduction of the AoIP feature in RG20(BSS), the A-interface between BSS and MGW can also be based on IP/Ethernet. The AoIP interface between the MSS/MGW and the mcBSC is implemented according to the 3GPP standards. Together with the signaling over IP (SIGTRAN), it offers an all IP transport towards the core network. There are two scenarios for AoIP functionality:

1. AoIP Transcoder in BSS
   The transcoder function is located in the BSS. The transcoder is the A over IP termination point. The G.711/RTP/IP protocol is employed
   The benefit for this configuration is that it utilizes existing transcoder capacity when IP-connections in A-interface are used.

1. AoIP Transcoder in Core Network (MGW)
   The transcoder function is located in the core network (that is, the 3G network architecture). The BSC is the A over IP termination point. At the same time, the BSC hides the mobility from the core network. The CODECx/RTP/IP protocol is employed.

In AoIP, there is also specified Transcoder Free Operation (TrFO) for GSM. This improves voice quality because no tandem coding is needed and has a reduced latency. When TrFO is used then less transcoder capacity is needed in the BSS network.

Ater interface

Ater interface has a Nokia specific implementation. It is located between the TCSM and the BSC. Ater can be connected to Nokia MGW directly as well. The Ater implementation supports submultiplexing to achieve transmission savings. Also Satellite Ater is optionally available. A physical interface consists of PCM lines, packet network (PWE CESoPSN) or TDM optical lines between network elements.

Abis interface

The Abis interface telecommunication part between the BSC and the BTS is implemented according to the GSM specifications. The physical interface used can be a PCM line or more recently Ethernet.

The Abis over IP uses PWE (CESoPSN) for the packetization on TDM frame level. CESoPSN is intermediate step between TDM-based transport and PSN-based one. CESoPSN can be used for legacy BTS to protect the installed hardware base, and at the same time to ensure seamless availability of IP transport. Satellite Abis is also supported. EDGE dynamic Abis is used to enable high data bit rates and for efficient usage of Abis transmission.

Packet Abis makes possible to use a packet switched based transmission between BTS and BSC as well. This allows cellular network operators to migrate from traditional static TDM to PSN, and the low-cost transport of IP and Ethernet, in a more efficient and cost effective way than with the already available solution adopting PWE CESoPSN. Packet Abis over TDM is enabling to use existing PDH infrastructure while reducing the bandwidth need drastically. Offering both physical media enables a smooth migration path for the operator.

Multicontroller BSC uses only Packet Abis as a Abis interface.

The Abis operation and maintenance (O&M) part is Nokia specific and supports alarm consistency, remote transmission equipment management, and BTS database management.

Radio interface (Um)

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

Lb interface

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

Q3 interface

The implementation of Q3 interface is based on the O&M framework of the ITU-T and the International Standards Organisation (ISO). The O&M interface (Q3 interface) is the interface between NetAct and the BSC/Multicontroller BSC. Multicontroller BSC uses only LAN interface as a connection to NetAct.

The BSC provides the following types of interfaces between NetAct and the BSC, depending on the network operator's requirements:

- an X.25 connection via a semipermanent time slot on the A interface
- a Local Area Network (LAN) interface

File Based Plan Provisioning and File Based Configuration Upload

File-based plan provisioning enables the operator to download radio network configuration plans from NetAct to the BSC by using the file transfer protocol (FTP). If FTP is not available, File Transfer, Access and Management (FTAM) can be used.

File Based Configuration Upload can be used to update the NetAct RNW database by uploading BSS configuration management data of the BSC via FTP or FTAM.

Q1 interface

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

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) and IP transmission. 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 BSSGP, NS, and L1. The physical layer is implemented as one or several PCM lines with G.703 interface.

The Gb over IP interface's subnetwork is constructed with a UDP/IP stack. When the Gb interface is based on IP, an NS-VL is a UDP/IP address in the 2G SGSN and an NS-VC is a pair of UDP/IP addresses: one UDP/IP address in the BSS and one UDP/IP address in the 2G SGSN. That is, an NS-VC is composed by IP endpoint addresses, one IP endpoint address in BSS and other IP endpoint address in the SGSN.

With Gb over IP, a satellite connection is also supported.

Multicontroller BSC uses only Gb/IP as a Gb interface.

CBC interface

The BSC Cell Broadcast Centre Interface provides an interconnection between the BSC and Cell Broadcast Centre (CBC). The implementation is according to GSM specifications and permits the open interconnection between BSC and CBC.

Road traffic interface

BSS21333 Support for Real Time Road Traffic Information introduces a direct SIGTRAN-based interface between the BSC and a Vendor Network Probe (VNP) server. The interface enables the raw measurements and data events collected in the BSC to be sent to an external VNP server. The data can then be used for computing road traffic information in real time.

7 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.

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.

The 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.

Operation and Maintenance security

To ensure security for the Base Station Controller and the Transcoder Submultiplexer, a number of precautions have been designed to minimize 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 feature BSS21444: Packet Abis Security, introduces integrated IP security for Packet Abis over Ethernet applications. IPSec authentication provides measures against ‘man in the middle’ attacks and is implemented for the CS- and PS-Userplanes; C-Plane and M-Plane. IPSec encryption measures ensure privacy (against eavesdropping) and are implemented for the CS-Userplane. IPSec integrity measures provide protection against unauthorized data modification for the CS- & PS-Userplanes; C-Plane and M-Plane.

Furthermore, with the feature BSS20980: Secured O&M IP Connections, the MMI session and FTP usernames and passwords can be encrypted, and with the feature BSS21143: Secure Remote MMI, Telnet can be replaced by Secure Shell (SSH) protocol in remote MMI sessions.

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 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 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.

8 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 Support portal, 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 policy.

8.1 Planning GSM/EDGE BSS networks

Network Design service product provides operator with the service solution that matches their business situation, enabling the operator to achieve CAPEX and OPEX savings through careful analysis of the needs and providing complete and optimum solution for radio, access, transmission, and IP network roll-outs and renewals.

Network Design covers the entire planning process, from network design in pre-acquisition, bidding, and negotiation phase to pre-planning, detailed planning and tuning. It covers all the technologies from radio access, fixed network access, transmission and IP backbone to core networks as well as cases where Nokia replaces own or other vendor’s equipment. It also covers the related network management system and the data communication network.

Network Design for Roll-out service supports operator to transfer the requirements derived from their business plan into the technical requirement of the network.

Network Design for Modernization service looks forward, focusing on preparing the network to meet the operator’s future needs. The service provides the operator with a complete and optimum solution for network renewals. The service divides into three solutions: network design for replacement, network architecture evolution, and network design for new feature introduction.

Network Design for In-Building (special mobile network business) supports operator to properly plan and prepare for implementation of an indoor/in-building mobile communications system for high traffic spots such as airports, commercial centres or shopping malls. Professionally designed and implemented in-building coverage and capacity facilitate smooth and transparent end user service availability and continuity inside buildings and premises where vast majority of the traffic is today generated.

8.2 Deploying 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 solutions:

- Managed Deployment Solution is a roll-out management solution in which Nokia takes full responsibility for project management of a deployment project.
- Network Build Solution provides the opportunity for fast network build-up and smooth introduction of new technologies.
- Network Consolidation Solution involves optimisation of existing equipment, replacement of aging equipment, and evolution on both the site and network level.
- Turn Key Solution consists of Network Planning, Site Deployment, Logistics, and Project Management.
- Outside Plant Solution covers passive network infrastructure within telecommunication projects, and enables the handling of the complexity in installing or upgrading (fiber-optic or copper) cable-based networks.

8.3 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 end-to-end customer care model and Nokia Support portal, which provide 24/7 support via the Internet. Working with the mobile operator, Nokia helps to develop maintenance plans, track service performance, handle reporting, and make proposals for network enhancement activities.

The Nokia Care Services portfolio covers the following services:

- Network Maintenance
- Advanced Network Maintenance
- Care Service Management
- Preventive Care
- Solution Care
- Serviceability Assurance

- Software Change Management
- Expert Support
- Repair & Return
- Spare Part Management
- Spare Part Supply
- Asset Recovery
- Life Extender

In addition to the Care Services portfolio, Nokia Equipment Take Back Solution manages the end-of-life treatment of obsolete products and ensures environmentally sound business.

8.4 Training operator personnel

Competence Development Services identifies competence development needs and creates customized learning solutions to match and realize the full potential of customer resources as technologies and markets change. The services include the following:

- Instructor Led Learning
- E-learning Services
- Competence Management Services
- Managed Learning Services

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 Support portal global training catalogue.

8.5 Integrating the GSM/EDGE networks

Consulting and Systems Integration enables the operators to improve operational efficiency and successfully launch and maintain optimal and secure end user services based on Nokia and complementary 3rd party products. We offer services in the areas of business and process consulting, competence development, network and service optimization, security solutions as well as integration and customisation of our own and complementary 3rd party products; driving a solutions approach.

8.6 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.

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

8.7 Operating networks

Nokia 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 offers the following Care packages:

- Basic Care is the minimum support package for network elements and provides the basis for a high network availability and operability. This package delivers the minimum reactive daytime support service for network elements.
- Essential Care is the recommended support package for network elements. It provides 24h/7d on-call services and dedicated Care elements. Many optional services are available.
- Advanced Care is the recommended support package for customized network solutions and provides a high network availability and operability through preventive maintenance for solutions. This package keeps network services running and focuses on solution maintenance with the best level of support. Many optional services are available.
- Complete Care is the recommended support package for network's lifetime maintenance, providing a high network availability and operability, and accelerating the speed of new end user services introduction. This package keeps network services running, including software upgrades and their implementation. Optional services are available.

Nokia core competence and strengths in delivering these services are based on the 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.

9 BSS quality

All Base Station Subsystem (BSS) network elements and their software are planned and produced according to specific quality standards. The 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.

9.1 Equipment

The stable, reliable, and high-quality BSS equipment reduces operation and maintenance costs. To achieve these characteristics, the best commercially available components and the latest cutting-edge technology are used in the BSS 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 the BSS. The network elements use for example, 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 BSS 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.

The BSS 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.

9.2 Software

The quality of the software in the BSS 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 product processes 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 the BSS equipment also enables high quality control.

9.3 Documentation

The quality of the BSS documentation is ensured by testing and inspections. The terminology used in the documentation is based on the recommendations of ITU-T and the applicable standards of ETSI, ICE, ISO, and GSM.

Refer to *Guide to GSM/EDGE BSS, BSC and TCSM Documentation* for more information on the delivery channels and formats and their use as well as identification and versioning system and methods for reporting problems in documentation or giving feedback on documentation.

9.4 Operation

The quality of service, as observed by the mobile subscribers, is one of the most important areas to successful GSM network operation. 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.

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.

9.5 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 provides its clients with a comprehensive set of assessment, analysis, and development services. For more information, see Services for operators.

10 Environmental issues

10.1 Nokia environmental policy

Nokia strives through the creation of innovative products to improve the quality of life the world over and maximize the benefits of Information and Communication Technology (ICT).

As a global company we are facing special responsibility for worldwide long-term challenges and take seriously our responsibility for environmental protection and resource stewardship.

Sustainability is the key to securing our company's future. Central to this thinking is meeting the demands of business in an ecologically and socially progressive manner. A demonstrated commitment to environmental protection will increase the competitive advantage of businesses and our customers and lay the foundation for a successful future.

Our global system for managing environmental protection ensures continuous improvement of our environmental performance. We design, develop, manufacture and market our products and services in a manner that meets or exceeds applicable regulations and minimizes the impact on natural resources.

Our management and employees act in accordance with this policy and observe the relevant regulations. We are taking also extended company responsibility and are requiring our contractors to act according to this policy.

10.2 Environmental management system

Nokia is increasingly concerned with achieving and demonstrating sound environmental performance by controlling the impacts of their activities, products and services on the environment.

Therefore ISO 14001 international standard covering environmental management, provides Nokia with the elements of an effective management system. Additionally all manufacturing sites of Nokia are certified by an external body according to ISO 14001.

10.3 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, environmental issues are an integral part of product processes.

10.4 Materials

Nokia has compiled a Substance List based on regulatory requirements and reasonable facts. The Substance List identifies substances that Nokia has banned, restricted or targeted for reduction in products/components delivered to Nokia.

10.5 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.
- provides the customer with information about electromagnetic fields.
- assists the customer in dealing with local authorities and communities by providing material, advice, and training on electromagnetic fields.
- aims to offer low impact antenna and mast solutions systematically as options.

10.6 Take-back information

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

Nokia Equipment Take Back Solution provides 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 Nokia Equipment Take Back Solution is offered in several modules representing end-to-end work flow of the process:

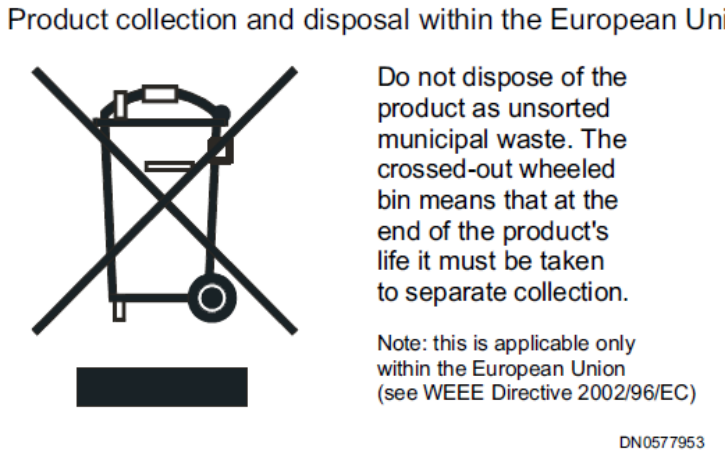
- Removal
- Collection
- Recycling
- Project Management

In Nokia or Other Vendor HW Replacement, that is, SWAP cases Take Back Solution brings in Collection and Recycling Service as Removal and Project Management are already included. The pricing is scalable according to the modules.

If customer chooses not to procure Nokia Equipment Take Back Solution from Nokia, customer agrees to dispose of any such equipment in a sound environmental manner, in compliance with all applicable laws.

Product collection and disposal within European Union, WEEE directive

Figure 12 Crossed-out wheeled bin



10.7 Restriction of Hazardous Substances

BSS system including products such as BSC, BTS, and Transcoder complies with the European Union RoHS Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment. The directive applies to the use of lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB), and polybrominated diphenyl ethers (PBDE) in electrical and electronic equipment put on the market after 1st July 2006.

For materials usage information of Networks Electronic Information Products imported or sold in the People’s Republic of China, see the documentation of individual network elements.

