SubMenu

NOKIA

# High Capacity Base Station Controller, BSC3i (ETSI/ANSI)

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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 made between issues 5 and 4

Added a clarifying sentence to the capacity section.

### Changes made between issues 4 and 3

Removed all references to the Gb over IP feature.

### Changes made between issues 3 and 2

Added the note after the first paragraph of the chapter on functionality: The BSC3i does not support the first generation TCSM product, which is no longer supplied with new installations.

### Changes made between issues 2 and 1

#### Changed name

The name of the document has been changed from *BSC3i* to *High Capacity Base Station Controller, BSC3i (ETSI/ANSI)*

# 1 Description of the BSC3i

The Nokia GSM/EDGE Base Station Controller, BSC3i, is a modern fault-tolerant system for GSM 800, GSM 900, GSM 1800, and GSM 1900 networks. The Nokia BSC3i is based on modular software and hardware architecture. The distributed architecture of the Nokia BSC3i is implemented with a high-capacity and redundant multiprocessor system - the DX 200 Computing Platform. The system enables the distribution of processing capacity to several computer units with dedicated tasks.

The DX 200 Product Family covers a wide application area in GSM/EDGE mobile networks and fixed telephone networks. The DX 200 product family contains products for digital mobile applications, such as Base Station Controller (BSC), Transcoder Submultiplexer (TCSM2), Mobile Switching Centre (MSC), Home Location Register (HLR) and 2G Serving GPRS Support Node (SGSN).

The main function of the BSC3i is to control and manage the Base Station Subsystem (BSS) and the radio channels. Based on Nokia's long experience in cellular networks, the BSC3i is designed for efficient use of radio resources and is easy to operate and maintain. The Nokia BSC is a stable, mature and highly reliable product. One major feature of the BSC3i is its field-proven multivendor functionality.

Together with the functionally distributed modular architecture of the DX 200 Computing Platform and the latest commercially available industry standard hardware components, the BSC3i is easily expandable and cost-efficient and has high capacity.

Please note that there are different product descriptions describing different versions of the Nokia GSM/EDGE Base Station Controller. For information about these other versions, refer to *Base Station Controller, BSC2E/A, BSCE* and *High Capacity Base Station Controller, BSC2i, BSCi.*

**Use of the terms BSC, BSCE, BSCi, BSC2E/A, BSC2i and BSC3i**

The terms BSC, BSCE, BSCi, BSC2E/A, BSC2i and BSC3i are explained in the table below.

Table 1. The Nokia GSM/EDGE BSC product family

| BSC | Base Station Controller, a general term for all Nokia GSM/EDGE BSC versions | |
|---|---|---|
| *General name* | *Product name* | *Explanation* |
| BSCE | BSCE | First generation Nokia DX 200 BSC |
| BSCi | BSCi | High Capacity (upgraded and improved) version of the first generation Nokia DX 200 BSC |
| BSC2 | BSC2A | American National Standards Institute (ANSI) version of the second generation Nokia DX 200 BSC2 |
| | BSC2E | European Telecommunications Standards Institute (ETSI) version of the second generation Nokia DX 200 BSC2 |
| BSC2i | BSC2i, ANSI version | American National Standards Institute (ANSI) High Capacity version of the Nokia DX 200 BSC2 |
| | BSC2i, ETSI version | European Telecommunications Standards Institute (ETSI) High Capacity version of the Nokia DX 200 BSC2 |
| BSC3i | BSC3i, ANSI version | American National Standards Institute (ANSI) High Capacity version of the Nokia GSM/EDGE BSC3i |
| | BSC3i, ETSI version | European Telecommunications Standards Institute (ETSI) High Capacity version of the Nokia GSM/EDGE BSC3i |

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Architecture of the BSC3i

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# 2 Functionality of the BSC3i

The BSC3i can be located flexibly in the GSM network. It can be installed as stand-alone, on the same site as the Base Transceiver Station (BTS) it controls, or at a remote location, which can be either co-located or non-co-located with the MSC. The most common solution is to locate the BSC remotely from the MSC near the BTSs it controls and install the TransCoder SubMultiplexer (TCSM) at the MSC site. Submultiplexing can then be used between the BSC and TCSM to reduce transmission costs.

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Note

The BSC3i does not support the first generation TCSM product, which is no longer supplied with new installations.

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The BSC3i manages a variety of tasks ranging from channel administration to short message service. The BSC3i software is based on the S10.5 BSC software release. The main functionalities included in the BSC S10.5 release are explained in brief below.

**Management of terrestrial channels**

- indication of blocking on the A interface channels between the BSC and the MSC
- allocation of traffic channels between the BSC and the BTSs
- pool support for A interface circuits
- concept support for flexible channel assignments, for example, half rate and high speed circuit switched data

### Management of radio channels

- Management of channel configurations, that is, how many traffic channels and signalling channels can be used in the BSS. This is done in connection with radio network configuration.

- Management of traffic channels (TCH) and stand-alone dedicated control channels (SDCCH). This function can be subdivided into the following tasks:

  - resource management
  - channel allocation
  - link supervision
  - channel release
  - power control

- Management of broadcast control channels (BCCH) and common control channels (CCCH). This function can be subdivided into the following tasks:

  - channel management
  - random access
  - access grant
  - paging
  - Management of PCCCH/PBCCH for (E)GRPS

- Management of frequency hopping:

  The BSC is in charge of frequency hopping management which enables effective use of radio resources and enhanced voice quality for a GSM subscriber.

- Handovers

  The frequency of the mobile is changed in connection with handovers which are executed and controlled by the BSC. Such a handover can be one of the following three types:

  - intra-BSC, intra-cell (both intra-TRX and inter-TRX), which means that the handover takes place within the area controlled by the BSC and the mobile stays in the same cell
  - intra-BSC, inter-cell, which means that the mobile stays in the area of the BSC but moves from one cell to another
  - inter-BSC, both outgoing and incoming, which means that the mobile moves into the area of another BSC

### Management of signalling channels between the BSC and the BTSs

The BSC supervises all 16, 32 or 64 kbit/s permanent point-to-point LAPD signalling connections, consisting of one connection per Transceiver Unit (TRX) and BTS Operation and Maintenance Unit (OMU).

### Maintenance

The BSC offers the possibility for the following maintenance procedures:

- fault localisation for the BSC
- reconfiguration of the BSC
- reconfiguration support to the BTS
- updating of the software in the BSC, TCSM2 and BTS

### Operation

During normal operation, the BSC3i offers various possibilities for the operator:

- modification of the parameters of the BSC and the BTS
- modification of the radio network parameters
- configuration of the BSC hardware
- administration of the BSC equipment

### Interface for the CBC

The BSC3i has an X.25 and a LAN connection to the Cell Broadcast Centre (CBC). The interface between the BSC and the CBC is based on the OSI layer 4 protocol.

The CBC interface offers operators a centralised means of operating Cell Broadcast. In addition, the Cell Broadcast Interface offers improved tools for requesting and reporting of CBCH-related loading and error conditions. The CBC can also request information on the amount of transmission for each CB.

### Interface for Nokia NetAct

The BSC3i has an X.25 and a LAN connection to Nokia NetAct. The interface between these two network elements is based on the OSI protocol. This interface enables the following events:

- file transfer capability for downloading software and data into the BSC and the BTSs
- file transfer capability for measurement and observation results

### User interface

The BSC has a user-friendly interface with plain-text messages and commands, which are easy to learn and use. This user interface complies with the recommendations of the International Telecommunication Union (ITU-T).

You can find more information on the user interface and commands in the *MML commands* section of the BSC library.

#### Measurements and observations

In order to run the network effectively, that is, to minimise costs and maximise service quality to the subscriber, you need information on the performance and service level of the BSC and the radio network. Useful information is, for example, how much traffic different cells carry, is there congestion on the SDCCH or TCH channels, and how many handovers are successful and how many fail. Traffic measurements provide this information.

When you analyse the information, you can, for example, find out if the load is distributed evenly or if there are problems in load distribution, that is, if the network has both heavily and lightly loaded parts. If the load distribution is not even you can make changes to the dimensioning of the network in order to balance it and to improve performance. When you observe certain traffic characteristics over a period of time, you are able to forecast the time when new resources or extensions must be introduced into the network.

The BSC measures traffic, observes signalling events, and traces a specific call. It then forwards these results to Nokia NetAct for further processing. The measurements are grouped together to allow better functionality and handling. This gives you an easier selection of the measurements you need at a particular time. BSC measurements are independent of each other even though they are handled via the same user interface.

You can find more information on the measurements and observations of the BSC in the *Counters/Performance Indicators* section of the BSC library.

#### Short Message Service (SMS)

The BSC forwards mobile originating and mobile terminating short messages transparently.

#### Cell Broadcast Messages (CB)

Cell Broadcast provides the BSC with the short message service cell broadcast (SMSCB) capabilities defined by GSM recommendations. The SMSCB is a basic teleservice that is used for broadcasting short messages to mobile stations in a specified area within the PLMN. The input is MMI, local, or remote. Optionally CBC can be used as the input for CB messages.

#### Circuit Switched Data Services

The BSC supports the following bearer services, including both transparent and non transparent data services, defined in GSM Specification ETS 300 904 with applicable ETSI/3GPP specifications:

- Data Circuit Duplex (300-9600 kbit/s) Transparent/Non transparent
- High Speed Circuit Switched Data

- 14.4 kbits/s Data Traffic Channel
- Telefax Automatic Group 3, Transparent
- Short Message Service Functionality

#### Full Rate/Half Rate/EFR

The BSC supports Full Rate traffic channels, Half Rate traffic channels, and Enhanced Full Rate traffic channels.

#### Adaptive Multi Rate Codec

Adaptive Multi Rate Codec (AMR) introduces a new set of codecs and adaptive algorithm for codec changes and thus can provide significantly better speech quality and more capacity on the air interface. With AMR we can achieve very good speech quality in full rate (FR) mode even in low C/I conditions or increase the speech capacity by using the half rate (HR) mode and still maintain the quality level of current FR calls. Optimal interworking with power control and handover algorithms together with enhanced quality measurements (FER Measurement feature) will provide full benefits and interworking with prior Nokia top-of-the-world capacity features including Intelligent Frequency Hopping (IFH). The Adaptive Multi Rate (AMR) codec consists of a family of codecs (source and channel codecs with different trade-off bit-rates) operating in the GSM FR and HR channels. The idea behind the AMR codec concept is that it is capable of adapting its operation optimally according to the prevailing channel conditions.

#### Dual Band GSM/EDGE 900/1800 and GSM/EDGE 800/1900

The BSC supports the Dual Band network. The Dual Band operation supports dual band mobiles able to perform handovers between the GSM 900 and GSM 1800 bands as well as between 800 and 1900 bands during a call.

#### Tri-Band

The Tri-Band feature supports the use of the ETSI-specified GSM900 frequency band extension, the area of 880-890 MHz uplink and 925-935 MHz downlink where available. This means that a total of 50 radio frequency channels are included in this E-GSM900 band. For a GSM operator, the E-GSM900 extension band can represent the most cost-effective way of adding capacity to his system if the Primary GSM spectrum is used.

#### Common BCCH

There is an option to allow GSM 900 and GSM 1800 TRXs to share the same BCCH in the same cell. This functionality could be considered a progression from the integrated dual band BTS and EGSM 900 frequency band support (Tri Band). The Common BCCH feature is also supported for GSM/EDGE 800/1900 frequency bands.

### High Speed Circuit Switched Data

The optional high speed circuit switched data (HSCSD) feature provides accelerated data rates for end-user applications. HSCSD supports both transparent and non-transparent data services. A multiple set of basic resources is reserved for one HSCSD call, and up to four time slots can be used for an HSCSD call. HSCSD can be combined with 14.4 kbit/s data service for higher data speed rates.

### Intelligent Underlay Overlay

The Intelligent Underlay-Overlay (IUO) feature allows the operator to reuse frequencies more intensively and hence achieve a higher radio network capacity. In IUO the operating spectrum of a network is divided into regular frequencies and super-reuse frequencies. The overlay network uses regular frequencies and offers a continuous coverage area. The underlay network uses the super-reuse frequencies which are reused very intensively to provide the extended capacity.

### Intelligent Frequency Hopping

The Intelligent Frequency Hopping (IFH) feature provides the benefits of IUO and frequency hopping at the same time: the operator can enjoy powerful radio spectrum efficiency and the quality benefits of frequency hopping, avoiding frequency-dependent fading in the radio path.

### Advanced Multilayer Handling

The Nokia Advanced Multilayer Handling (AMH) concept is a part of the Soft Capacity features. It is used to redistribute traffic to the appropriate layer or frequency band according to the prevailing load of the network. AMH provides the network operator with the tools to relieve the load of the congested cells and smooth out the load over the network, in other words provides the operator with both improved quality and capacity.

### General Packet Radio Service (GPRS)

Data and internet services will be the areas of future growth in mobile communications. Mobile data is the key to open the door to the high revenue corporate sector and to value-added services for consumers.

GPRS is a major step forward in mobile data. It gives customers the benefits of instant IP connectivity on-the-move and of being continuously connected. GPRS provides the possibility of being charged only for transferred data in addition to more efficient use of limited air interface resources.

GPRS provides packet radio access for a GSM/GPRS mobile. The benefit of GPRS is that it can use the same resources that circuit-switched connections do by sharing the overhead capacity. This means that one mobile uses the resources only for a short period of time, that is, when there is data to be sent or received. The sharing of resources together with a very fast method of reserving radio channels makes the air interface usage even more efficient.

### EDGE (EGPRS)

Enhanced Data Rates for Global Evolution (EDGE) provides services such as Enhanced GPRS (EGPRS) allowing much higher data rates than current GPRS configurations. In EGPRS, the maximum standardised data rate per time slot will triple and the peak throughput, with all eight time slots in the air interface, will be up to 473 kbit/s. The basic concept, therefore, is to provide a higher data rate on the 200kHz carrier. EDGE, using 8-PSK modulation, enables gross data rate of 69.2 kbit/s per radio time slot by transmitting 3-bits/symbol with the existing symbol rate. With multi-slot reservation, EDGE offers an evolution path for GSM to support medium rate multimedia applications. The user can send more data per radio time slot with the same amount of air time used and operators do not need to invest in another frequency band and license to offer higher data rate services like mobile multimedia.

### Dynamic Abis Allocation

Dynamic Abis allocation is a solution for higher data rates of EGPRS to ensure cost-efficient and flexible Abis transmission capacity addition. The Dynamic Abis functionality allocates Abis transmission capacity to cells when needed instead of reserving a full fixed transmission link per TRX.

As data rates per radio time slot can vary between 8.8 and 59.2 kbit/s, traditional static Abis allocation does not use transmission resources efficiently. The Dynamic Abis feature uses existing Abis more efficiently by splitting PCMs into permanent time slots for signalling and voice or data, and a dynamic pool for data. The pool can be shared by a number of transceivers. The Dynamic Abis transmission solution saves up to 70% in the Abis transmission expansion cost as it allows Abis dimensioning to be performed near to the average data rates instead of peak rates. This also applies to the number of 2M BSC interfaces needed.

Dynamic Abis is implemented as a software feature. Quality of service is improved by the Dynamic Abis method, which uses allocation of circuit switched connections under real-time centralised control. The implementation of shared transmission channel connection pools is supported by Nokia cellular transmission cross-connection products and made easy with the Nokia NPS/10 transmission network planning tool.

### Support of PCCCH/PBCCH

This feature will bring dedicated CCCH capacity for (E)GPRS services.

PCCCH comprises logical channels for packet common control signalling. The following common control channels are available:

- PRACH is used by the MS to initiate uplink transfer for sending data or signalling information. Packet Access burst and Extended Packet Access burst are used on PRACH.
- PPCH is used to page an MS prior to downlink packet transfer. PPCH uses paging groups in order to allow usage of DRX mode. PPCH can be used for paging of both circuit switched and packet data services.
- PAGCH is used in the packet transfer establishment phase to send a resource assignment to an MS prior to packet transfer.

PBCCH broadcasts packet-data-specific System Information (for example C31 and C32 cell re-selection criteria).

The new cell re-selection criteria C31 and C32 are provided as a complement to the current GSM cell re-selection criteria. C31/C32 provide a more general tool to make cell planning for GPRS as similar to existing planning in GSM as possible. C31 is a signal strength criterion used to decide whether prioritised cell re-selection shall be used. For cells that fulfil the C31 criterion, the cell with highest priority class shall be selected. If more than one cell has the highest priority, the one of those with the highest C32 value shall be selected. If no cell fulfils the C31 criterion, the one among all cells with the highest C32 value shall be selected.

### MS Location Services

MS Location Services (LCS) allows a GSM subscriber and/or valid mobile equipment to be positioned with a certain Quality of Service. Positioning may be initiated by the subscriber, the network, or an external party utilising the Mobile Positioning Function. Positioning is subject to various restrictions based on capability, security, service profiles, and so on. LCS will allow the location of a GSM mobile station (MS) to be determined at any time whilst the MS is within the radio coverage area of the GSM HPLMN or VPLMN. Important applications of Location Services are, for example:

- Government Applications:
  - Emergency calls (E911 requirement by FCC in US)
  - location of emergency calls with the RMS accuracy 125m
  - Electronic surveillance
- Operator Applications:
  - Home zone calls
- Commercial Services:
  - Fleet management, tracking packages
  - Information on the nearest hotel, petrol station and so on
  - Car Navigation
  - Emergency roadside service
  - Search for stolen property

Different MS Location methods have different benefits and drawbacks. No single method is suitable for all applications. Nokia BSS10.5 includes the E-OTD method, and improved cell ID + TA method for legacy phones with Enhanced TA (E-TA). That means that TA correction will be done to improve legacy MS location accuracy. The method includes location calculation using air interface measurements, for example RxLev and MS speed information. Support for the stand-alone GPS method is also implemented. The signalling between SMLC and MS is similar for E-OTD and the stand-alone GPS method. All methods calculate a 2-dimension location estimation. A 3-dimension location calculation is under further development.

**Inter-System Handover**

Inter-System Handover means a handover from GSM BSS to WCDMA RAN and vice versa.

In order for an operator to provide seamless coverage in areas where WCDMA is not available, for example in rural areas, inter-system handovers provide a method of extending the radio network coverage area by making a handover from the WCDMA network to the GSM network.

Additionally, in situations where the WCDMA network and GSM network overlap, an inter-system handover from GSM to WCDMA can be made in order to relieve the traffic load in the GSM system.

There are quite substantial benefits of inter-system handover. The benefits include:

- seamless coverage extension for 3G with existing GSM network (or vice versa)
- capacity extension for GSM with load sharing between 3G and GSM
- 3G services to all dual-mode subscribers

Both the circuit switched (handover and MS cell re-selection) and packet switched (MS cell re-selection) modes will be supported.

The above-mentioned BSC functionalities consist of basic and optional functionalities. These functionalities and options are described in more detail in BSS feature descriptions.

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# 3 Architecture of the BSC3i

The Nokia BSC3i is based on a modular software (SW) and hardware (HW) structure. Because there are exact specifications for the interfaces between different modules, new functions can easily be added without changing the architecture of the system. Thus, the BSC3i can have a long operational lifespan and still always have up-to-date features.

The distributed architecture of the BSC3i is implemented by a multiprocessor system. In a multiprocessor system the data processing capacity is divided among several computer units, each of which has a microcomputer of its own. Call handling capacity depends on the number of Call Control Computer Units. The capacity of the BSC can easily be increased by adding more Call Control Computer Units to the BSC.

Figure 1 Block diagram of the GSM/EDGE BSC with Bit Group Switch below shows the block structure of the BSC3i. The most important functional units of the BSC are:

- Bit oriented Group Switch (GSWB), which is used for switching speech and data, and connecting signalling circuits
- Base Station Controller Signalling Unit (BCSU), which handles the BSC signalling functions. The optional Packet Control Unit (PCU) is included in every BCSU, when (E)GPRS service is implemented. It handles the (E)GPRS packet control functions in the BSC.
- Marker and Cellular Management Unit (MCMU), which controls and supervises the GSWB and implements radio resource management (RRM) functions, being responsible for cells and radio channels. Two integrated LAN switch units are configured in both MCMU units. The MCMU also acts as a BSC SYM (system maintenance) unit in case of OMU failure.
- Operation and Maintenance Unit (OMU), which serves as an interface between the user and the BSC, but also works as a SYM unit of BSC and automatically supervises the BSC
- The high-speed Message Bus (MB), which interconnects the functional units of BSC
- The Ethernet Bus, which interconnects the Ethernet interfaces to the integrated LAN switch units

- Exchange Terminals (ET), which connect transmission systems to the GSWB
- Clock and Synchronisation Unit (CLS), which generates the clock signals for the BSC
- Transcoder (TCSM2) which, though it is a separate network element usually installed on the MSC site, is normally viewed as a functional unit of the BSC (for further information, please refer to the TCSM2 user documentation)

Functional units (FU) are composed of individual HW and SW modules.

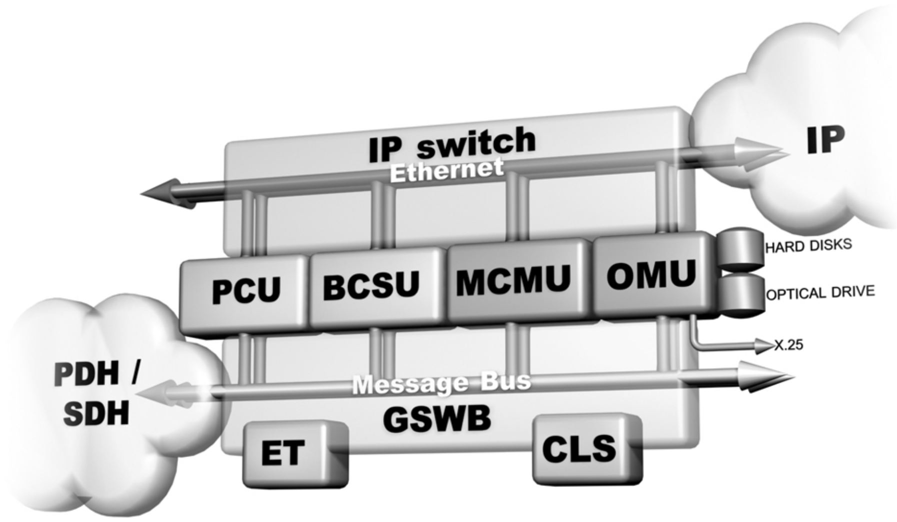


Figure 1. The BSC3i with IP-Switch and Bit Group Switch

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The functional units and cartridge types used in the BSC3i are described in the following sections, which provide the information on both the basic configurations of the functional units (or cartridges) and the extension possibilities. The units and cartridges are presented in alphabetical order.

## 3.1 Bit Group Switch

The Bit Group Switch conveys the traffic passing through the BSC and switches the tones to the subscribers of the exchange and to the trunk circuits. The Bit Group Switch also establishes the necessary connections to the signalling units and the internal data transmission channels, and is responsible for the submultiplexing functions of the BSC. The Bit Group Switch switches on 8, 16, 32, and 64 kbit/s level.

The operation of the Bit Group Switch is controlled and supervised by the Marker and Cellular Management Unit. The MCMU performs all necessary connecting and releasing functions.

The Bit Group Switch Cartridge, SW1C-C, consists of power supply (PSC1-S) and four SW64B plug-in units, which all have 32 4 Mbit/s interfaces. The capacity of the GSWB is 256 2 Mbit/s PCMs.

The Bit Group Switch of the BSC3i is a fully digital, one-staged, and non-blocking time switch with full availability. Its great advantage is its simplicity. After the Bit Group Switch has identified the correct time slots, it can always connect them in a uniform manner without using a special search path.

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## 3.2 Call Control Computers

In the BSC3i, the call control functions are executed by microcomputers, called Call Control Computers. The Call Control Computers have an identical Central Processing Unit (CPU), which is based on the most suitable commercially available Intel microprocessors. The CPU board contains a microprocessor and a local Random Access Memory (RAM). Each Call Control Computer also contains the additional units that are required for performing specific tasks.

All the different plug-in units of each Call Control Computer are interconnected by a Compact PCI bus.

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### 3.2.1 Marker and Cellular Management Unit (MCMU)

The Marker and Cellular Management Unit (MCMU) controls and supervises the Bit Group Switch and performs the hunting, connecting and releasing of the switching network circuits. The range of the tasks it handles makes up a combination of general marker functions and radio resource management functions.

The MCMU is connected to the other computer units of the exchange, OMU and BCSU, through the message bus. It performs the control functions of a switching matrix and the BSC-specific management functions of the radio resources.

The hardware of the MCMU consists of three modules: a microcomputer, a Switch Control Interface, and a Message Bus Interface (see Figure 2 Structure of the MCMU).

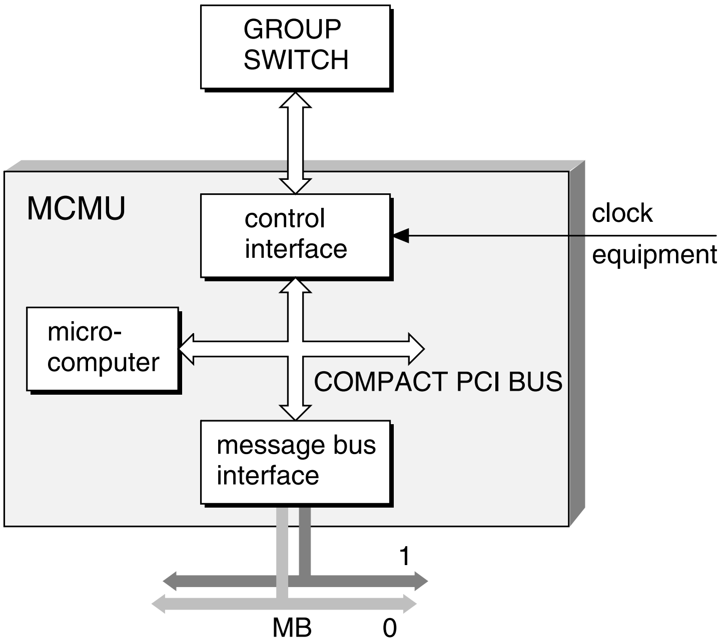


Figure 2. Structure of the MCMU

The marker functions of the MCMU control the Bit Group Switch. These control functions include the connection and the release of the circuits of the switching matrix. When the MCMU performs the marker functions, it exchanges messages with other Call Control Computers via the Message Bus (MB).

The Switch Control Interface writes the required connections into the switch control memory and reads its contents. The switch control interface also performs various tests on the switching network, defined by the microcomputer, and generates the required timing signals.

The cellular management functions of the MCMU are responsible for cells and radio channels that are controlled by the BSC. This responsibility is centralised in the MCMU. The MCMU reserves and keeps track of the radio resources requested by the MSC and the handover procedures of the BSC. The MCMU also manages the configuration of the cellular network.

The cellular management functions of the MCMU do not require any specific hardware in addition to the standard DX 200 microcomputer and a Message Bus Interface Unit (MBIF).

One BSC3i always includes two MCMUs that are permanently connected to the duplicated pair of the Bit Group Switches, the active MCMU to the active GSWB and the passive MCMU to the passive GSWB.

Redundant Ethernet interfaces connect the MCMU to the duplicated LAN switch units.

### LAN switch units

The integrated LAN switch provides access to the operator's IP network as a first level LAN switch. It provides uplink interfaces to the IP network (router) or to an additional LAN switch via the BSC3i connector panel. The LAN switch collects data from the computer and packet control units and sends it further to external routers and the IP network via 100 Mb/s uplink connections. Redundant LAN-switch units provide ports of 10/100BaseT/Tx interfaces with RJ45 connectors via the BSC3i connector panel. There are in total 4 + 4 10/100BaseT/Tx uplink ports to the operator's IP network.

The hardware implementation of a LAN switch contains 2 pcs of LAN switch (ESB20) plug-in units situated in both MCMU cartridges. An active MCMU unit is backed up by a redundant MCMU containing a similar configuration. The active MCMU and its LAN switch interconnects the active LAN connections and the redundant MCMU connects the redundant LAN connections. One LAN switch plug-in unit is dedicated for collecting user-plane traffic from packet control units and another for collecting data from computer units. Figure 3 The LAN Switch Units of the MCMU clarifies the LAN connection principle in the BSC3i.

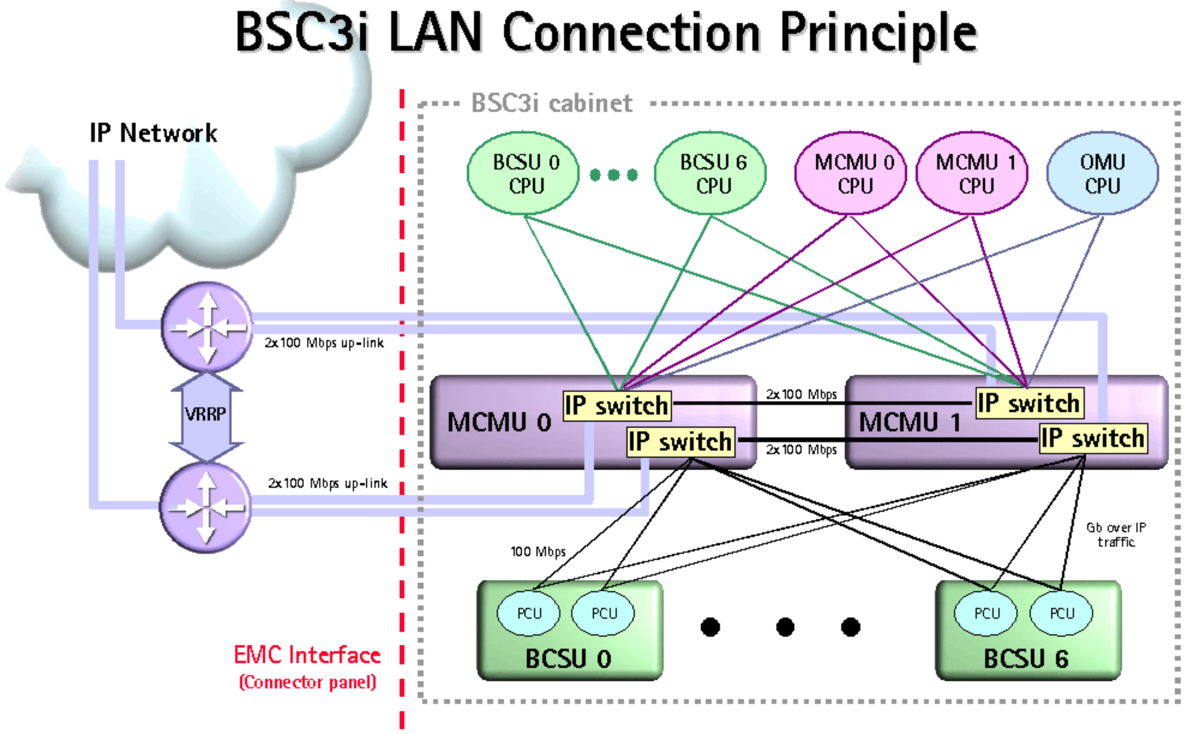


Figure 3. The LAN Switch Units of the MCMU

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### 3.2.2 BSC Signalling Unit (BCSU)

The BSC Signalling Unit (BCSU) performs those BSC functions that are highly dependent on the volume of traffic. One BCSU can handle traffic in a maximum of 110 transceivers (TRXs). The BCSU is housed in a cartridge of its own. It consists of two parts, which correspond to the A and Abis interfaces. The optional Packet Control Units (PCUs) are included in the BCSU.

The A interface part of the BCSU is responsible for the following tasks:

- performing the distributed functions of the Message Transfer Part (MTP) and the Signalling Connection Control Part (SCCP) of SS7
- controlling the mobile and base station signalling (Base Station Subsystem Application Part, BSSAP)
- performing all message handling and processing functions of the signalling channels connected to it

The Abis interface part of the BCSU controls the air interface channels associated with transceivers (TRXs) and Abis signalling channels. Every speech circuit on the Abis interface is mapped one-to-one to a GSM-specific speech/data channel on the air interface. The handover and power control algorithms reside in this functional unit.

The hardware of the BCSU consists of the following modules (see Figure 4 Structure of the BCSU):

- a microcomputer
- a LAPD (Link Access Protocol on the D-Channel) interface
- a LAPD (Link Access Protocol on the D-Channel) interface
- a combined SS7/LAPD interface for control of the ET
- the Message Bus interface
- the Packet Control Unit(s)

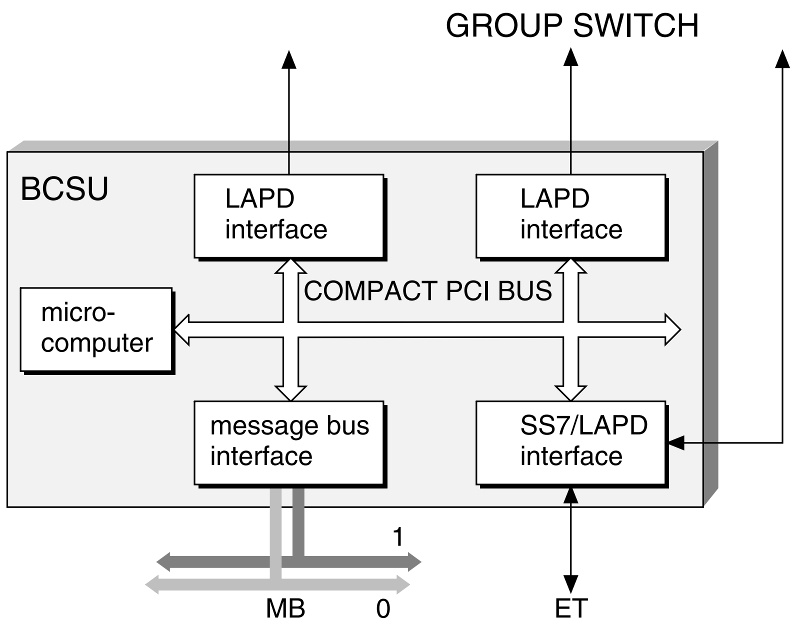


Figure 4. Structure of the BCSU

The interface units, that is, the SS7 and the LAPD protocols, are connected to the switching network via PCM connections. Similarly redundant Ethernet interfaces connect the BCSUs to the duplicated LAN switch units.

The SS7 interface module is for the A interface. It contains a preprocessor, which is capable of handling a maximum of four signalling channels (64, 128 and 256 kbit/s). The signalling terminal is semipermanently connected to the time slots used for signalling.

The BCSU uses the LAPD Interface to supervise the 2 Mbit/s circuits (time slot 0 handling) connected to the Bit Group Switch.

The BCSU is equipped with LAPD interface terminals. The standard equipment of the BCSU includes two dedicated terminals for LAPD interfaces for signalling towards BTSs and towards ET2s, and one shared terminal for both Abis and Ater interface directions. Both LAPD dedicated signalling terminals can handle a maximum of 64 LAPD links. The bit rate of a single link can be either 16 kbit/s, 32 kbit/s, or 64 kbit/s. The layer 2 LAPD functions are performed by the signalling terminal, but application-specific messages are handled by the microcomputer of the BCSU.

According to the N+1 redundancy principle (see the section Redundancy principles), there is one extra BCSU compared to the number set by the dimensioning rules. The additional unit is used only if one of the active units fails.

### Packet Control Unit (PCU)

In the BSC3i there can be four logical Packet Control Units (PCUs), composed of two physical PCU-B plug-in units, per BCSU. A logical PCU is an entity handling the same functionality in the BSC as a physical PCU plug-in unit in older Nokia BSC models. In the Gb interface, one logical PCU handles one NSE. The PCU unit performs all the data processing tasks that are related to the (E)GPRS traffic. It implements both packet switched traffic-oriented Gb and Abis interfaces in the BSC. A PCU includes microprocessors and digital signal processors integrated to the same plug-in-unit to handle the tasks. The main functions are GPRS traffic radio resource management, for example connection establishment and management, resource allocation, scheduling, data transfer, MS uplink power control, Gb load sharing (uplink) and flow control (downlink). PCUs must be configured to every BCSU installed, but only the activated ones are to be used. This requirement comes from the general N+1 redundancy principle of the fault tolerant DX 200 Computing Platform.

Back to 3.2Call Control Computers.

Back to 3Architecture of the BSC3i.

## 3.3 Operation and Maintenance Unit (OMU)

The Operation and Maintenance Unit (OMU) is an interface between the BSC and a higher-level network management system and/or the user. The OMU can also be used for local operations and maintenance. The OMU receives fault indications from the BSC. It can produce local alarm printouts to the user or send the fault indications to Nokia NetAct. In the event of a fault, the OMU automatically activates appropriate recovery and diagnostics procedures within the BSC. Recovery can also be activated by the MCMU if the OMU is lost.

The tasks of the Operation and Maintenance Unit (OMU) can be divided into four groups:

- traffic control functions
- maintenance functions
- system configuration administration functions
- system management functions

The OMU consists of microcomputers similar to the Call Control Computers. In addition, the OMU contains I/O interfaces for local operation.

The Operation and Maintenance Unit (OMU) consists of the following modules (see Figure 5 Structure of the OMU):

- microcomputer
- alarm interface
- Message Bus Interface
- peripheral device interface
- analog X.25 interface (modem to PSPDN or LAN)
- Digital X.25 interface (time-slot-based O & M interface)
- Ethernet interface

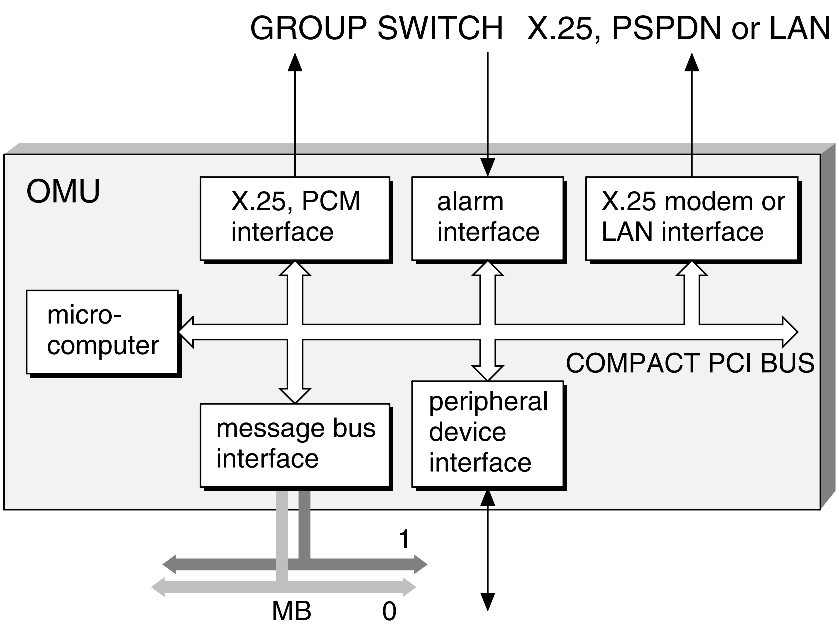


Figure 5. Structure of the OMU

The alarm interface module connects internal wired alarms to the OMU from the BSC cartridges, power supply, air conditioning equipment, etc. This module provides both input and output interfaces for external alarms to Nokia NetAct. The OMU communicates with the Call Control Computers of the BSC via the Message Bus.

The CPU controls the peripheral device interface module, which is used to connect disk units, visual display unit, and printer to the OMU. A mirrored pair of Winchester disk units, and one magneto-optical disk unit can be controlled by the OMU. The disk units are installed in the same OMU cartridge using dedicated plug-in unit adapters.

The visual display unit and printer interfaces are standard asynchronous serial interfaces complying with the ITU-T Recommendation V.24.

The analog X.25 modem interface module provides an X.25 Data Terminating Equipment (DTE) interface for the packet switched network (PSPDN) with a physical layer of V.24, V.24 restricted, V.35, or X.21.

The digital X.25 PCM-based O & M interface module is used for the network management interfaces implemented in time slots. This module provides an X.25 connection via the A interface time slot. It also provides an O & M interface for the transcoders and the transmission equipment.

The LAN interface module provides an ethernet interface according to IEEE802.3. Redundant LAN interfaces from the CPU are interconnected to the duplicated LAN switch units.

Back to 3Architecture of the BSC3i.

## 3.4 Message Bus (MB)

A duplicated high-speed Message Bus (MB) is used for data transfer between the OMU and the Call Control Computers of the BSC3i (see Figure 6 Structure of the Message Bus system).

The length of each message is determined individually by a message length parameter at the beginning of the message. The sender and the receiver of the message are indicated in the address field of the message. The receiver can be a single microcomputer, or it can be a group of microcomputers specified by the broadcast address.

The hardware of the Message Bus consists of several parallel twisted pairs, which carry the actual data and also control the information required for the message transfer.

In the event of a failure, the hot standby Message Bus takes over the functions of the active bus without interfering with the ongoing calls.

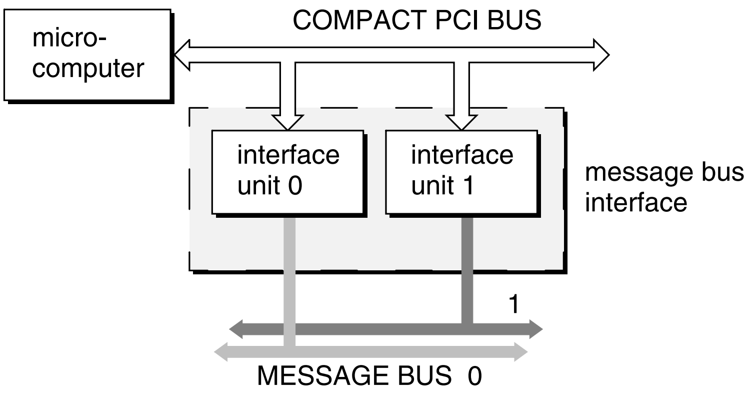


Figure 6. Structure of the Message Bus system

Back to 3Architecture of the BSC3i.

## 3.5 Exchange Terminal (ET)

The ET performs the electrical synchronisation and adaptation of external PCM lines. It performs the HDB3 (ET2E), or B8ZS or AMI (ET2A) coding and decoding, inserts the alarm bits in the outgoing direction and produces PCM frame structure. All ET2 plug-in units contain two separate ETs.

All 2,048 Mbit/s (in the ETSI environment) or 1,544 Mbit/s (in the ANSI environment) interfaces for the MSC, the SGSN and the BTSs are connected to the Exchange Terminals. The Exchange Terminals adapt the external PCM circuits to the GSWB and synchronise to the system clock. Synchronisation is included in the bit frame.

The ETs of the BSC3i are housed in ET4C-B cartridges. One ET4C-B cartridge can contain up to 32 ET2E-S, ET2E-SC or ET2A plug-in units; however in the second ET4C-B cartridge only 30 plug-in units can be activated. Thus there can be a maximum of 62 ET2-units in active use.

Each ET is connected to the switching network and the Clock Unit of the BSC3i via permanent, wired connections. The ETs are also connected to the LAPD interface via a LAPD link. Two types of connectors, symmetrical and coaxial (75/120 SL), are available for the ET2Es.

In the incoming direction, the ET2 decodes the 2,048 Mbit/s (ETSI) or 1,544 Mbit/s (ANSI) signal of a circuit into data signals. The decoder decodes the line code (HDB3 in the ETSI environment, B8ZS or AMI in the ANSI environment) into binary form. At the same time, the ET2 is synchronised to the bit rate of the incoming signal.

In the outgoing direction, the ET2 receives a binary PCM signal from the switching network and generates the PCM frame structure. The resulting signal is converted into a line code (HDB3 in the ETSI environment, B8ZS or AMI in the ANSI environment) and transmitted further onto the 2,048 Mbit/s (ETSI) or 1,544 Mbit/s (ANSI) circuit.

Back to 3Architecture of the BSC3i.

## 3.6 Clock and Synchronisation Unit (CLS)

The Clock and Synchronisation Unit (CLS) distributes timing reference signals to the functional units of the BSC3i. It can operate plesiochronously or synchronously with the timing references it receives from the digital PCM trunks. Four PCM reference inputs with priority order are provided for the timing reference signals. The oscillator of the CLS is normally synchronised to an external source, usually an MSC, through a PCM line. Up to three additional PCM inputs are provided for redundancy.

The processor chooses the highest-priority interface which is in order, for the phase lock from the six synchronisation inputs. The options are the following:

- A maximum of four 8 kHz synchronisation signals are received from the Exchange Terminals. The interface with the Exchange Terminal is symmetrical or current-controlled.
- A signal n x 4 kHz (n = 2, 3,..., 4 096) divisible by 4 kHz is received from up to two frequency standards (FS). The interface with external frequency standard is separated by a transformer and both a balanced and unbalanced synchronisation signal can be connected to it.

The Clock & Tone Generator (CL3TG) plug-in unit meets the requirements of the ITU-T Q.500 Series Recommendation with respect to the Time Interval Error (TIE), the jitter, the wander, and the transfer function. In the plesiochronous operation mode, the frequency shift of the CL3TG is $5 * 10^{-9}$ within each 24-hour period, if the temperature of the environment does not vary. CL3TG with external synchronised input is available by using the external synchronisation input connector from the CPRJ45 panel. It can be implemented either by symmetrical or asymmetrical PCM connection (RJ45 or BNC connector).

Back to 3Architecture of the BSC3i.

## 3.7 Peripheral devices

The peripheral devices of the BSC3i are:

- disk units
- magneto-optical (MO) disk unit
- printer
- visual display unit
- external alarm unit
- Side Cable Conduit for raised floor installations

### Disk units

The BSC3i has a duplicated system disk unit (Winchester). The software can be loaded locally to the BSC by using a magneto-optical disk.

The system disk units contain the operative software as well as fallback software of the BSC and BTS software including the BTS HW database. Traffic measurements are also stored on the system disks. All the disk drives are connected to the OMU, which controls the system disk units.

### Magneto-optical disk

The BSC has a magneto-optical disk drive to facilitate temporary service operations, for example data updates/downloads.

### Printer (optional)

A printer can be connected to the OMU. The interface complies with the ITU-T Recommendation V.24. There are three V.24 interfaces and one V.11 interface available for the printer on top of the equipment cabinet.

### Visual display unit (optional)

In the BSC, a visual display unit is used as a user interface. With a VDU terminal, the user can perform normal operational functions with MML commands and diagnostic tests on various units.

Visual display units can be connected to the OMU in the same way as printers by using interfaces that comply with the ITU-T Recommendation V.24. There are three V.24 interfaces and one V.11 interface available for the visual display unit on top of the equipment cabinet.

### External alarm unit (optional)

The optional external alarm unit (EXAU) provides a visual alarm of the fault indications of the BSC. The EXAU panel is located in the telecommunications site rooms, outside the network element. It is easy to install to all wall materials.

### Side Cable Conduit for raised floor installations (optional)

If there is a raised floor in the equipment room, the incoming and outgoing cables can be placed under the floor and connected to the equipment racks through a vertical cable conduit, which can be placed at either side of the BSC3i cabinet.

Back to 3Architecture of the BSC3i.

# 4 Interfaces relating to the BSC3i

The policy of open standard interfaces has been adopted for the design of the BSC3i. The BSC3i provides interfaces for the MSC, Nokia NetAct, the Base Transceiver Stations (BTSs), the Serving GPRS Support Node (SGSN), and the Cell Broadcast Centre (CBC).

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Description of the BSC3i

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The BSC3i software

Configurations, capacity and performance of the BSC3i

The mechanical design and power supply of the BSC3i

Reliability of the BSC3i

The BSC3i operating environment

The BSC3i documentation

*The BSC3i interfaces:*

## 4.1 A interface

The A interface between the MSC and the BSC is implemented according to the GSM standards. Because the A interface is open, the Nokia BSC3i can be used with any switching centres supporting the ETSI/3GPP standardised A interface.

### Layered interface structure in A interface

The interface between the DX 200 MSC and the Base Station Subsystem, BSS, is defined in accordance with the Signalling System No.7 (SS7), which is similar to the layered OSI protocol model. The Message Transfer Part (MTP) and the Signalling Connection Control Part (SCCP) provide the signalling network functions required to carry the messages of the Base Station Subsystem Application Part (BSSAP) layer.

OSI Layer 1 represents the physical layer. It is a digital interface at 2048 kbit/s (ETSI) or 1544 kbit/s (ANSI), based on the ITU-T Recommendation G.703. This interface is normally used as an A interface between the MSC and the BSS, providing a 64 kbit/s transmission rate on each channel. Additionally, wide SS7 links (128 or 256 kbit/s) can be configured, if the NSS supports them.

OSI Layer 2 is based on the MTP level 2 of SS7. The MTP level 2 provides a mechanism for reliable transfer of signalling messages between the MSC and the BSS. At least two signalling links are normally provided between the BSS and the MSC for both capacity and reliability reasons.

OSI Layer 3 of the signalling network includes the SCCP and MTP level 3. Together, the MTP and the SCCP functions provide both connectionless and connection-oriented network services. These services are used to transfer circuit-related and non-circuit-related signalling information and other types of information between the MSC and the BSS.

### Functions of the application parts of the A interface

The Base Station Subsystem Application Part (BSSAP) provides procedures for the A interface, which are in accordance with GSM standards.

Back to 4Interfaces relating to the BSC3i.

## 4.2 Abis interface

The Abis interface telecommunication part between the BSC and the BTS is implemented according to the 08.5X Series of GSM Recommendations. The Abis O & M part is Nokia property which supports additional features like the Site Test Monitoring unit, alarm consistency, remote transmission equipment management, and BTS database management.

### Layered interface structure in Abis interface

The interface between the BSC3i and the BTS is defined in accordance with the OSI protocol model.

Layer 1 represents the physical layer. It is a digital interface at 2048 kbit/s (ETSI) or 1544 kbit/s (ANSI), based on the ITU-T Recommendation G.703. Submultiplexing is used on the Abis interface as a standard solution, because each speech channel reserves only 16 kbit/s (FR channel or DR channel) or 8 kbit/s (HR channel) in the ETSI environment, 16 kbit/s in the ANSI environment.

Layer 2 is based on the LAPD protocol. The LAPD protocol is implemented to provide the data link functions required to carry layer 3 messages. The BSC3i can handle LAPD signalling links with the bit rates of 16 kbit/s, 32 kbit/s and 64 kbit/s.

ISDN connections can also be used as the bearer for the Abis interface. The interface between the BSC and the ISDN network is based on ITU-T's Digital Subscriber Signalling System No. 1 (DSS1) Network layer Q.931 (03/93) and Data link layer Q.921. Connection between the BSC and the BTS have to be unrestricted digital 2 x 64 kbit/s.

#### Functions of the telecom application parts

The following procedures are provided for the Abis interface:

- radio link management procedures
- dedicated channel management procedures
- common channel management procedures
- TRX management procedures

#### Functions of the O & M application parts on Abis Interface

The application parts of the Abis interface contain the following O & M functions:

- fault management
- fault reporting
- BTS recovery
- BTS test handling
- configuration management
- software configuration management
- radio network management including extensions and parameters
- performance management

Back to 4Interfaces relating to the BSC3i.

## 4.3 Gb interface

The Gb interface between the BSC (PCU) and the Serving GPRS Support Node (SGSN) is implemented according to 08.16 and 08.18 of GSM Recommendations. It is an open interface connecting the BSS and GPRS core network.

**Layered interface structure in Gb interface**

The interface between the SGSN and the Nokia Base Station Subsystem, BSS, is defined in accordance with the OSI protocol model. The protocol stack comprises the following layers: BSSGP, Network Service and L1. The Network Service layer further divides into two: Sub-network Service and Network Service Control. The Sub-network Service uses a Frame Relay based protocol.

**Sub-network Service Layer, Frame Relay**

The physical layer is implemented as one or several PCM lines with G.703 interface. On top of the physical layer in the Gb interface, direct point-to-point Frame Relay connections or intermediate Frame Relay network can be used.

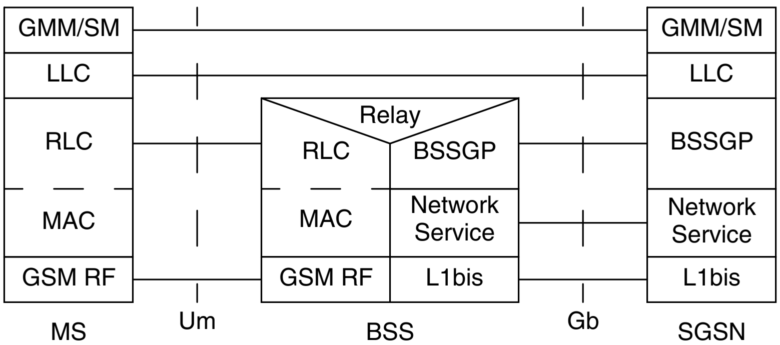


Figure 7. The protocol stack on the Gb interface

Network Service Control is responsible for virtual circuit management and GPRS-specific addressing, which maps cells to virtual connections. BSSGP is a layer 3 protocol for delivering data packets and associated control information.

Back to 4Interfaces relating to the BSC3i.

## 4.4 Q3 interface

The BSC3i provides the following types of interfaces between Nokia NetAct and the BSC, depending on the network operator's requirements:

- a digital X.25 connection via a semipermanent time slot on the A interface
- an analog X.25 interface, connected directly or via the Packet Switched Public Data Network, PSPDN
- a LAN interface, connected via the LAN Switch

The Nokia NetAct interface is of the Q3 type. The implementation of this interface is based on the O & M framework of the ITU-T and the International Standards Organization (ISO).

#### Network interface

The X.25 protocol is used on the interface between the BSC3i and Nokia NetAct. Either the PSPDN or the PCM-time-slot-based connection can be used. In the case of PSPDN connections, the physical interface can be V.24, restricted V.24, V.35, or X.21 and in the case of PCM time slot connections, the physical interface is G.703.

The BSC also supports the LAN interface. The physical interface supported is Ethernet IEEE802.3.

The connections can be made redundant as an option.

The X.25 software in the BSC3i can be configured to function as the DTE or the DCE.

#### Interface with a full OSI Stack

The upper layers of the OSI model, above the network layer, are implemented in the BSC3i. The upper layers use the X.25 protocol or LAN as a sub-network.

The following protocols are implemented:

- transport protocol, X.224 (TP0, TP2 and TP4)
- session protocol, X.225
- presentation protocol, X.226
- association control service element (ACSE), X.227
- remote operations service element (ROSE), X.229
- file transfer, access and management (FTAM), ISO 8571
- common management information service element (CMISE), ISO 9596

The FTAM protocol, using ACSE, is used for transferring files between the BSC3i and Nokia NetAct.

The CMISE protocol, using the ACSE and the ROSE, is used for Network Management.

Back to 4Interfaces relating to the BSC3i.

## 4.5 CBC interface (BSC-CBC)

The BSC Cell Broadcast Centre Interface provides an interconnection between the BSC and Cell Broadcast Centre (CBC). The implementation is according to GSM Specification 03.41 and permits the open interconnection between BSC and CBC.

In the BSC, the CBC connection is made through the OMU using current Q3 interface plug-in units AC25 and AS7. The CBC connection shares the same transport media as Q3, only a new logical connection is introduced. If a non-redundant Q3 connection is used, more transmit capacity can be gained by using a dedicated plug-in unit for the CBC.

**Network interface**

The interface between the BSC and the CBC is similar to the interface between the BSC and Nokia NetAct.

**Interface with OSI layer 4**

The protocol used between the BSC and the CBC is the XTI-interface. The XTI-interface uses the services of the OSI Transport Layer. The CBC Application can be developed using the XTI Application Programming Interface (X/Open Transport Interface) to interconnect the application to the OSI Transport Layer.

Back to 4Interfaces relating to the BSC3i.

# 5 The BSC3i software

### System software

In the BSC3i, each computer unit has common system software. This uniform system software provides a standard, easy-to-use operating environment for the application software. The uniform operating environment facilitates the development and maintenance of the application software and helps the user understand the operation of the software.

### Platform architecture

The BSC3i is based on a fault-tolerant computing platform, which constitutes a base for the switching and offers a wide range of cellular and fixed network applications. The operating system is a platform for other system level software and all the application software.

The most significant functions of the operating system are:

- scheduling the processor time
- synchronisation of processes
- exchange of messages between processes located in one computer or in separate computers
- time supervision
- creation and deletion of processes
- memory allocation and protection
- observation of message traffic and processor load
- initialisation of the operating system

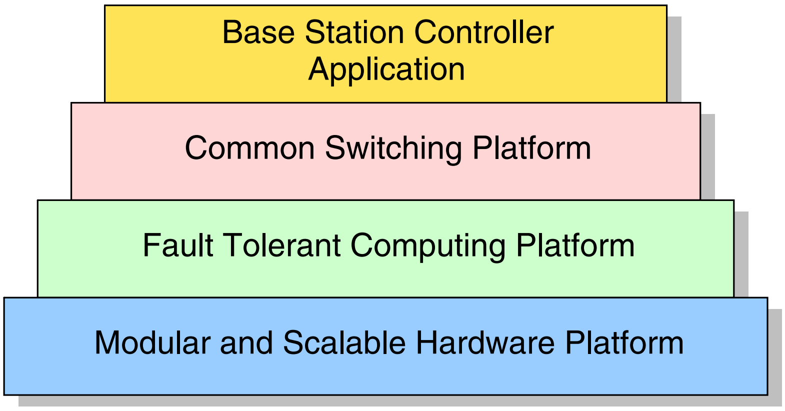


Figure 8. The BSC3i conceptual model

**Layers**

A layer is an up-level hierarchy level of the system platform. It divides the monolithic platform into smaller modules. Layers can be developed relatively independently.

**Databases**

The base systems contain different types of data. In the case of the BSC3i the database includes, for example, reduced routing and cellular data. The database also includes data needed for the control and operation of the BSC3i.

In this context, the files are RAM memory arrays. Some files are loaded from a disk unit after restarting the control computer. Other files are updated on the disk when the contents are changed.

**Description and programming languages**

In design and documentation of the the BSC3i software, readability and visual quality of the programs are enhanced by using special description languages in addition to the actual programming language. These description languages also facilitate effective software design and allow the use of automatic tools for development and testing.

*More information on the BSC3i:*

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Functionality of the BSC3i

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# 6 Configurations, capacity and performance of the BSC3i

In the BSS, the BSC is a stand-alone network element that is connected to the surrounding network elements by means of standard PCM interfaces.

The compact BSC3i is only available in one cabinet configuration. It can be equipped flexibly with a number of TRXs and trunk circuits.

The Nokia BSC3i, High Capacity BSC can be equipped with:

- a maximum of 660 TRXs
- a maximum of 248 BTSs
- a maximum of 248 BCFs

See *Engineering for BSC3i* for a description of the configurations.

**Capacity of the BSC3i**

With reference to the model below, the maximum processing capacity of a BSC3i is 3920 Erl/117000 BHCA, giving full support to 660 FR TRXs.

Table 2. Circuit switched processing capacity of the BSC3i

| Reference model of call traffic (call mix and parameters): | |
|---|---|
| Mean holding time | 120 s |
| Proportion of MS originated calls | 70% |
| Proportion of MS terminated calls | 30% |
| Proportion of handovers (HOs) | 1.5 HOs per call |
| Proportions of location updates (LUs) | 2 LUs per call |

Table 2. Circuit switched processing capacity of the BSC3i (Continued)

| | |
|---|---|
| Proportion of IMSI detaches | 0.1 detaches per |
| For terminating call attempts, the no-answer call attempts to paging requests | 63% |
| SMS call rate | 1 req./subs./1 hour |

The above-mentioned traffic processing capacity of the BSC can be achieved with all S10.5-level features activated and with the new BSC3i hardware environment. The maximum traffic processing capacity of the BSC3i supports 660 full rate TRXs or 330 half rate TRXs. However, some future features might have an influence on the capacity of the BSC3i. Circuit switched data calls are taken into account in the reference model of call traffic in the following way:

- one data call with one radio time slot is seen as one mobile originating or terminating call
- one full rate data call is seen as one mobile originating or terminating call
- one high speed circuit switch data (HSCSD) call with two or more radio time slots is seen as several calls, based on how many time slots are reserved for the call. For example, if two time slots are reserved (2*14,4 kbit/s) the call is seen as two mobile originating or terminating calls.

Different types of connections are provided as follows:

- a maximum of 124 PCM connections used on A and Abis interfaces
- a maximum of 256 PCM connections connected to the non-blocking switching matrix
- 4 + 4 10/100-BaseT/X Ethernet connections are provided for the IP interfaces

The GSM network has been originally specified (GSM 08.08) and designed to use 64 kbit/s CCS7 links in the A-interface. Due to various reasons, the CCS7 links can be congested in the A-interface. The situation can be improved with higher capacity CCS7 links on the A-interface between the BSC and MSC:

- a maximum of 16 SS7 signalling links. Optionally wider 128 or 256 kbit/s signalling links can be configured instead of standard 64 kbit/s links.

LAPD signalling links can be configured to 16, 32 or 64 kbit/s speeds. Introduction of HR will enable TRX configurations of more than 18 radio channels which leads to increased load in measurement reporting. Because of this, the capacity of a 16 kbit/s signalling link is not sufficient in all cases. Therefore it is recommended that also with HR the TRX configurations should be restricted to the maximum of 18 radio channels if 16 kbit/s signalling links are used. With TRX configurations of more than 18 radio channels a 32 kbit/s LAPD link is highly recommended for supporting the telecom signalling which half rate requires. The overload of the signalling link can be monitored by the Telecom LAPD link supervision with a possibility to set an alarm in an overload situation.

In the BSC3i the packet handling capacity is provided by Packet Control Units (PCUs):

- packet handling capacity and connectivity per each logical PCU is 64 BTSs, 128 TRXs, and 256 traffic channels (16 kbit/s) for GPRS/EDGE use
- maximum capacity with full configuration (12 physical PCU units, 24 logical PCU units) is 256 x 24 = 6144 traffic channels (16kbit/s) per BSC3i for GPRS/EDGE use

The packet handling capacity mentioned above can be achieved with the new HW environment. However, some future features might have an influence on the packet handling capacity of the BSC.

*More information about the BSC3i:*

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Functionality of the BSC3i

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The mechanical design and power supply of the BSC3i

Reliability of the BSC3i

The BSC3i operating environment

The BSC3i documentation

# 7 The mechanical design and power supply of the BSC3i

The mechanical structure of the BSC3i is hierarchical, based on plug-in units, cartridges and cabinet. The dimensions of different units and cartridges are in accordance with the recommendations of the IEC (International Electrotechnical Commission). The BSC3i is easy to install, operate, and maintain. Special attention has been paid to thermal resistance and immunity to various types of interference.

### Plug-in units

The BSC3i is constructed by using a total of 15 plug-in unit types, including the DC/DC converters. The size of these plug-in units is either 233 mm x 220 mm, 100 mm x 220 mm, 262 mm x 226 mm, or 235 mm x 247 mm.

The printed circuit boards (PCBs) of plug-in units are multilayered. They are covered with a protective coating that makes the PCBs easy to handle and protects the foils from scratches. The connectors are of the Euro-connector, and 2 mm Hard Metric type.

### Cartridges

Most of the functional units consist of one cartridge that contains a selection of PCBs. A fixed cabinet position has been assigned to the cartridge of each functional unit.

The cartridges of the BSC3i are of the following types:

- CC3C-A cartridge for BCSU
  - width: 259 mm, height: 270 mm
- CM2C-A cartridge for OMU
  - width: 400 mm, height: 270 mm
- CC4C-A cartridge for MCMU
  - width: 198 mm, height: 270 mm

- CLOC-B cartridge for the Clock and Synchronisation Unit
  - width: 135 mm, height: 270 mm
- ET4C-B cartridge for Exchange Terminals
  - width: 360 mm, height: 270 mm
- SW1C-C cartridge for the Bit Group Switch
  - width: 198 mm, height: 270 mm

Additionally, there is a marking rail at the upper front edge of each cartridge, so the total height of the front of a cartridge is 300 mm.

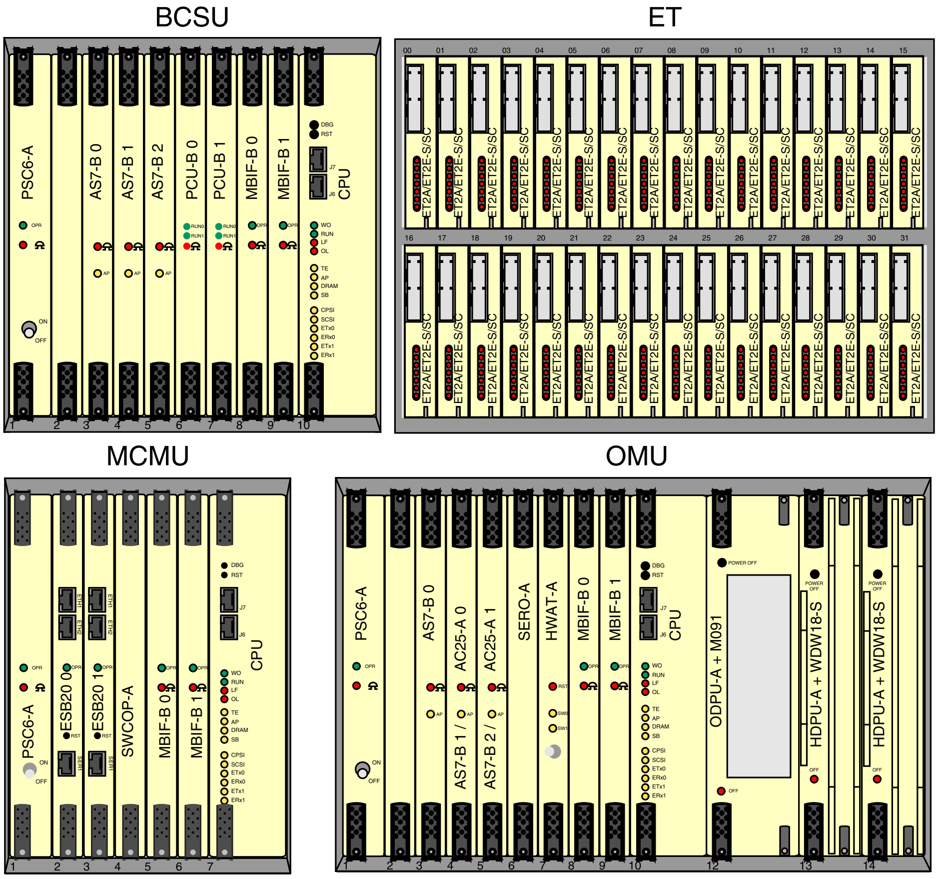


Figure 9. Cartridges and functional units of the BSC3i (1/2)

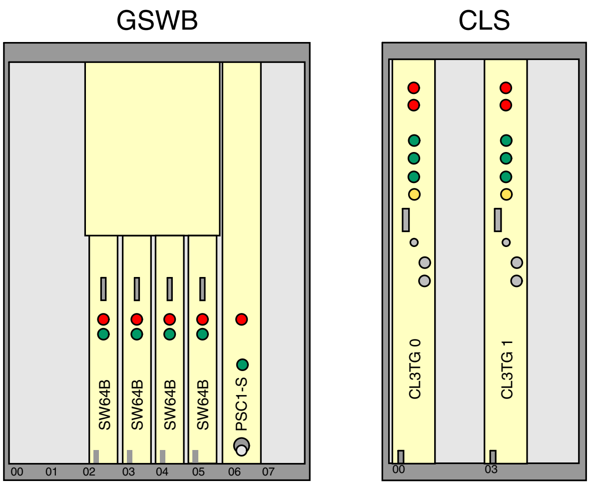


Figure 10. Cartridges and functional units of the BSC3i (2/2)

#### Cabinet

The BSC3i cabinet is based on an indoor, ventilated cabinet variant IC209-A. Only one cabinet is needed. The frame of the cabinet consists of side rails, made of plated steel sheet, that support an upper shelf and a lower shelf with adjustable legs.

The closed space in the cabinet configuration is surrounded by the side plates, the doors, the upper cable conduit, and the baseboard. The doors are perforated to facilitate cooling.

The height, width and depth of a standard BSC3i cabinet are (with cabling and doors): 2000 mm x 900 mm x 600 mm.

If more than one BSC3i is located on the same site, the cabinets can be connected to each other. Each BSC3i constitutes a closed EMC-shielded space.

If there is a raised floor in the equipment room, the incoming and outgoing cables are placed under the floor and enter the equipment cabinet through a side cable conduit. The width of the side cable conduit is 75 mm. The power supply cables must also be brought in through the side cable conduit. The side cable conduit does not belong to the EMC protection.

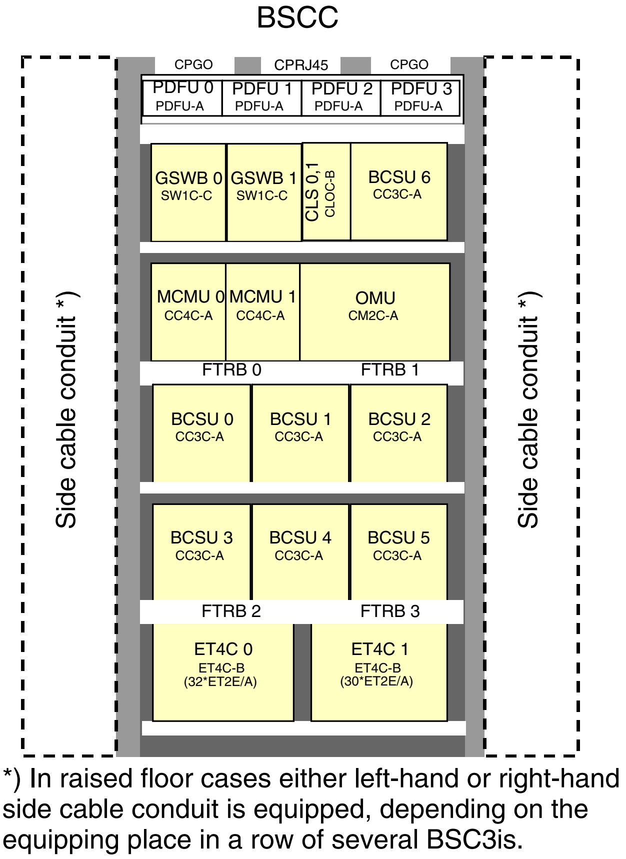


Figure 11. Cabinet layout of the BSC3i

### Cabling

Standard length cables are used for the internal cabling of the BSC3i. The internal cables of the cabinet are installed at the factory. Within a cabinet, the cabling is installed from each cartridge to the next one.

The PCM trunks and X.25 cables of the BSC3i enter the exchange room via a cable conduit and they enter the cabinet via earthing panels on top of the cabinet. Other station cables (external alarm cables, external synchronisation cables, uplink LAN cables and external peripheral cables) enter the cabinet via a connector panel on top of the cabinet. The power supply cables are terminated to the power supply connector on top of the cabinet.

### Structure of the power supply

Reliability, easy installation, and easy maintenance have been the main objectives in the design of the power supply system of the BSC3i.

All the voltages required for the BSC3i are generated from the DC voltage by high frequency transformers using chopper technique.

The input voltage is between 41.5 V and 72 V. Because the range is wide, the main battery voltage of the BSC3i can be 48 V or 60 V. In both cases, it is possible to use a direct floating battery.

The estimated power consumption of the BSCC cabinet with maximum equipment configuration is 1810 W.

**Cooling of cabinets**

The BSC3i includes forced cooling system to ensure optimum ambient temperature for its functional units. Forced cooling is more effective than natural convection cooling and allows higher heat dissipation. The BSC3i cabinet is equipped with four Fan Trays, FTRB, each of which contains three fans. Each FTRB is powered by a separate PDFU-A. The fans are n+1/L redundant, meaning that if one of them fails, the remaining 11 fans automatically start to operate at maximum speed, which is enough to provide sufficient cooling until a maintenance activity takes place.

To make the forced cooling efficient enough the empty cartridges have to equipped with cover plates. Correspondingly, in case there are empty slots in the cartridges, they have to be covered with shim plates.

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# 8 Reliability of the BSC3i

The simplicity and the fast speed of the maintenance procedures are the prerequisites for the availability of the Nokia BSC3i. Maintenance is improved by the modular structure of the equipment, automatic fault detection procedures, and by the elimination of downtime by using a hot standby unit in the event of a failure.

### Fault management

The DX 200 system is a loosely coupled, fault-tolerant distributed system with some centralised functions. The DX 200 System Maintenance functions conform with the idea of loose coupling of autonomous control computers. This means, for example, that state control mechanisms do not depend on any centralised hardware, control computers control their own software and are able to restart on their own by asking for the appropriate loading services, and an individual program block failure or an individual hardware failure has a minor effect on the overall operation of the whole system. The fault situation is hardly ever so bad or complex that the whole system has to be restarted.

In most cases, a restart in a program block, preprocessor, or a single control computer is enough. The control computer states are controlled from a centralised point which can be dynamically reallocated from the OMU to a pair of control computers when, for example, an OMU with no redundancy fails. This means that this centralised function has 3N redundancy. Only the control computers are autonomous as described above. The preprocessors run under the control of a master computer.

### Overload protection

The BSC overload protection handles excessive traffic or signalling load by limiting the load level of the BSC's main CPUs and preprocessors, and also provides information of excessive load, so that preventive actions can be taken. The main cause of this kind of load might be related to special end-user behaviour and is mainly related to radio network planning and dimensioning according to the required level.

For more information on BSS overload protection, refer to BSS (BSC) Traffic Handling Capacity, Overload Protection and Network Planning, section BSS overload protection.

### Redundancy principles

When the BSC3i was designed, great attention was paid to the reliability of operation. The following redundancy methods are used for various units:

- 2N principle for duplicated units, including an active unit and a spare unit
- N+1 or N+m redundancy principle for provision of one or more units, active or reserve, in addition to what is required by the correct dimensioning

All the critical parts of the switching system have an appropriate type of redundancy. The Exchange Terminals of the PCM trunk circuits and the terrestrial channels are not critical, however, because the failure of a single terminal does not prevent service. There are usually several PCM circuits available in each direction. Thus, the Exchange Terminals are without redundancy.

The BSC's connection to the IP network is implemented by providing a redundant local area network (LAN) connection. It is implemented with hardware and software that enable transparent use of redundant ethernet interfaces so that the CPU or PCU unit may be connected to different switches through a pair of ethernet interfaces working as if there was only one connection. By implementing a secondary route, a single point failure of the LAN connection can be avoided.

Power supply and the distribution of the basic timing signal are arranged so that the units backing each other up get their supply from different or redundant DC/DC converters and their basic timing signals from different distribution lines.

### System availability

The BSC3i is designed to meet the availability requirements of the ITU-T. The following design objectives have been adopted to ensure that the unavailability of the BSC is very low.

| | |
|---|---|
| MTBF | 8 350 000 h |
| Mean down time | 0.06 min/year |
| Availability | 0.999 999 880 |

The above calculations have been based on plug-in unit failure statistics with the complete configuration of the BSC3i (for example, the mean time to recovery for 660 TRXs has been assumed to be 1.0 hours).

Simplicity and speed of the maintenance procedures are the prerequisites for the availability of the BSC3i. The maintenance is improved by the modular structure of the equipment, automatic fault detection procedures, and elimination of downtime by using a hot standby unit in the event of a failure. The following general design objectives have been established for the maintenance of the BSC3i:

- mean active repair time less than half an hour
- fault localisation with the accuracy of a plug-in unit for 70 % of the faults
- fault localisation with the accuracy of four plug-in units for 95 % of the faults

For more detailed information see *BSC3i Availability Performance Prediction.*

#### Planned downtime

The BSC3i is based on the DX 200 Computing Platform that makes it possible to minimise the downtime caused by, for example, software upgrades. The BSC3i software can be downloaded without any disturbance to user data traffic, but the activation of new software requires computer unit restarts. Thanks to the trial configuration, the possible downtime can be minimised. The trial configuration means that first the new software is loaded into spare units, then a unit switchover is performed, that is, the spare units are switched into active state and vice versa, and finally the new software is loaded into the primary units.

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# 9 The BSC3i operating environment

**Equipment room**

The mechanical structure of the BSC3i does not place any special requirements on the ceiling, the walls, or the floor. No raised floor is needed.

The height of the room should be at least 2500 mm. This ensures that there is almost 500 mm of open working space above the cable troughs on top of the cabinet(s).

The BSC3i cabinet can be located in many different ways in the equipment room. However, take the following points into consideration when planning where to locate the BSC:

- future expansion of the BSC
- location of other equipment on the same site
- air-conditioning of the equipment room
- sufficient working space around the cabinet(s)

Location of the cabinet is discussed in more detail in *Engineering for BSC3i*.

Figure 12 Typical layout of a BSC3i site shows an example of the equipment layout of the BSC3i.

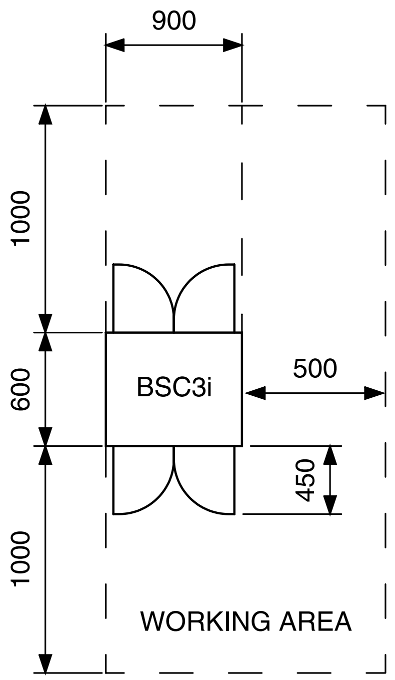


Figure 12. Typical layout of a BSC3i site

### Environmental conditions

The internationally recognised and comprehensive description of the environmental conditions is covered by the following ETS standards:

- *ETS 300 019-1-1, 1992, Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment Part 1-1; Classification of environmental conditions, Storage*
- *ETS 300 019-1-2, 1992, Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment Part 1-2; Classification of environmental conditions, Transportation*
- *ETS 300 019-1-3, 1992, Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment Part 1-3; Classification of environmental conditions, Stationary use at weatherprotected locations*

### Climatogram

Changes of temperature and relative humidity affect the reliability of the equipment. The relationship between the availability, performance and the environment is defined in the climatogram in Figure 13 Climatogram of the BSC3i. The functional ambient temperature is -5…+45°C. No start-up below 0°C temperature is allowed.

A Nominal conditions: The equipment meets the functional reliability and life cycle requirements in accordance with the product specifications. These conditions must be maintained 85 % of time.

B Normal conditions: The equipment meets the functional requirements in accordance with the product specifications.

C Exceptional conditions: The main functions of the equipment are not jeopardized. The duration of these conditions is limited to 1 % of time or 48 h consecutively.

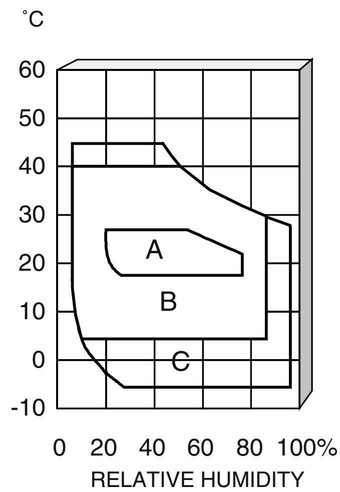


Figure 13. Climatogram of the BSC3i

### Electromagnetic environment

EN 300 386-2, 1997, Equipment Engineering (EE); Telecommunication network equipment; Electromagnetic Compatibility (EMC) requirements; Part 2: Product family standard.

ANSI C63.4 (FCC Rules in Title 47, Part 15, Subpart B, 2001), Class A.

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# 10 BSC3i documentation

**BSC3i is discussed in the following sections of the BSC software library:**

BSS (BSC) Traffic Handling Capacity, Overload Protection and Network Planning

TCSM Support in BSC

BSS Transmission Management

BSC Commissioning

BSS Integration

Radio Network Administration

GSM/EDGE Feature Description

Hardware Configuration Management

**BSC3i is discussed in the following sections of the BSC hardware library:**

Site Requirements for BSC and TCSM2

Engineering for BSC3i

Installing BSC3i

BSC3i, Jumper Settings for the Cartridges

BSC3i, Jumper Settings for the Plug-in Units

BCSU (BSC3i)

CLS (BSC3i)

GSWB (BSC3i)

MCMU with GSWB (BSC3i)

OMU (BSC3i)

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