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Nokia Siemens Networks GSM/EDGE BSS, rel. RG10(BSS), operating documentation, issue 03

Feature Description

Feature Descriptions for UltraSite EDGE Base Station

DN04195135

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⚠ Important Notice on Product Safety

Elevated voltages are inevitably present at specific points in this electrical equipment. Some of the parts may also have elevated operating temperatures.

Non-observance of these conditions and the safety instructions can result in personal injury or in property damage.

Therefore, only trained and qualified personnel may install and maintain the system.

The system complies with the standard EN 60950 / IEC 60950. All equipment connected has to comply with the applicable safety standards.

The same text in German:

Wichtiger Hinweis zur Produktsicherheit

In elektrischen Anlagen stehen zwangsläufig bestimmte Teile der Geräte unter Spannung. Einige Teile können auch eine hohe Betriebstemperatur aufweisen.

Eine Nichtbeachtung dieser Situation und der Warnungshinweise kann zu Körperverletzungen und Sachschäden führen.

Deshalb wird vorausgesetzt, dass nur geschultes und qualifiziertes Personal die Anlagen installiert und wartet.

Das System entspricht den Anforderungen der EN 60950 / IEC 60950. Angeschlossene Geräte müssen die zutreffenden Sicherheitsbestimmungen erfüllen.

Table of Contents

This document has 134 pages.

Summary of Changes . . . 9
1 General information . . . 10
2 New Features in Nokia UltraSite EDGE BTS SW CX6 . . . 11
2.1 BSS20094 Extended Cell for GPRS/EDGE . . . 11
2.2 BSS20872 Robust AMR Signalling . . . 13
2.3 BSS20635 Common Configurations in Hardware Configurator . . . 15
2.4 BSS20588 TRAU Bicasting in AMR FR/HR Handover . . . 16
2.5 BSS20476 End to End Downlink Abis Performance Monitor . . . 17
2.6 BSS20482 BTS ID shown in BTS Manager . . . 18
2.7 BSS20997 Check of PSU/TRX Configuration in UltraSite . . . 19
2.8 BSS21060 BTS Hardware Configurator Support for XML . . . 20
2.9 BSS20951 RTC Support in ECELL . . . 21
2.10 Windows 2003 Server Support . . . 22
3 Features in Nokia UltraSite EDGE BTS SW CX5 CD3.0 . . . 23
3.1 BSS21295 Support of Multi Radio Combiner (MRC) . . . 23
4 Features in Nokia UltraSite EDGE BTS SW CX5 CD1.0 . . . 24
4.1 BSS20991 UltraSite EDGE BTS Mini Support . . . 24
5 Features in Nokia UltraSite EDGE BTS SW CX5 . . . 25
5.1 BSS20063 Space Time Interference Rejection Combining . . . 25
5.2 BSS20043, BSS20702 BTS clock tuning enhancements . . . 27
5.3 BSS20730 Support for UltraSite WCxT triple wideband combiner . . . 28
5.4 BSS20040 User Access Level Control (UALC) . . . 29
5.5 BSS20694, BSS20973 RSSI enhancements . . . 30
5.6 BSS20713 Automatic Abis Update . . . 31
5.7 Support for additional filter units in 900 MHz sub-bands . . . 32
5.8 BSS20499 Improved TRX test presentation . . . 33
5.9 BSS20854, BSS20866 Modifiable T200 timer . . . 34
5.10 BSS20048 Separate radio link timeout parameters for AMR and EFR . 35
5.11 BSS11088 GPRS: Coding Schemes CS-3 and CS-4 . . . 36
5.12 Feature Enhancement to BSS9059 BTS resets . . . 37
5.13 BSS20371 BSS Site Synchronisation Recovery Improvement . . . 38
5.14 BSS12158 IMSI Based Handover . . . 39
5.15 BSS11121 IDD with Baseband Hopping . . . 41
5.16 BSS11102 Extended Cell Range for UltraSite EDGE BTS . . . 43
5.17 BSS11052 Dynamic Frequency and Channel Allocation (DFCA) . . . 45
5.18 RSSI enhancements . . . 47
5.19 FXC STM-1 and Bridge transmission card pair HW support in UltraSite EDGE BTS . . . 48
5.20 BSS11134 Antenna Hopping for UltraSite BTS . . . 49
5.21 BSS11086 Support for Enhanced Measurement Report . . . 52
5.22 BSS11073 Recovery for BSS and Site Synchronisation . . . 54
5.23 BSS11047 Intelligent shutdown for UltraSite BTS . . . 56

5.24 Remote Download of Configuration Files . . . 58
5.25 BSS10101 GSM-WCDMA interworking . . . 59
5.26 BSS7005 Intelligent Frequency Hopping (IFH) . . . 61
5.27 Enhanced Automatic Frequency Correction (E-AFC) . . . 62
5.28 Mixed mode BB hopping . . . 64
5.29 Support for BB2F . . . 65
5.30 BSS11037 Remote BTS Manager . . . 66
5.31 BSS10083 Enhanced General Packet Radio Service (MCS 1-9) . . . 68
5.31.1 Incremental Redundancy (IR) . . . 68
5.31.2 Link Adaptation (LA) . . . 69
5.32 BSS10045 Dynamic Abis allocation . . . 71
5.33 BSS10104 Nokia Smart Radio Concept for EDGE (Nokia SRC) . . . 73
5.34 BSS10087 GSM/EDGE 800 . . . 75
5.35 BSS10063 RX antenna supervision by comparing RSSI . . . 76
5.36 BSS10046 Multi BCF Control . . . 77
5.37 BSS10022 Frame Erasure Rate (FER) Measurement for FH . . . 78
5.38 BSS10016 Tri Band - Common BCCH . . . 79
5.39 BSS10004 Adaptive Multi Rate Codec (AMR) . . . 80
5.40 EDGE HW support . . . 82
5.41 SiteWizard . . . 83
5.42 TX antenna VSWR measurement . . . 84
5.43 Site-specific notepad . . . 85
5.44 BSS9068 BTS SW management . . . 86
5.45 BSS9067 Runtime diagnostics and BTS alarms . . . 87
5.46 BSS9066 Supervision of transmission units . . . 88
5.47 BSS9065 Transmission operability . . . 89
5.48 BSS9064 Real time update to BTS . . . 90
5.49 BSS9063 Abis loop test . . . 91
5.50 BSS9062 BTS supervision . . . 92
5.51 BSS9061 Temperature control system . . . 93
5.52 BSS9060 TRX test . . . 94
5.53 BSS9059 BTS resets . . . 96
5.54 BSS9058 BTS fault recovery . . . 97
5.55 BSS9056 Autodetection of site configuration . . . 98
5.56 BSS9055 Clock synchronisation between base stations . . . 99
5.57 BSS9011 Intelligent Coverage Enhancement Plus (ICE+) . . . 100
5.58 BSS9006 General Packet Radio Service (GPRS) . . . 102
5.59 BSS9003 Power system management for SiSu/IBBU (from NMS) . . . 103
5.60 BSS7048 CCCH improvements . . . 104
5.61 BSS7037 14.4 kbit/s GSM data services . . . 105
5.62 BSS7036 Dynamic SDCCH allocation . . . 106
5.63 BSS7003 High Speed Circuit Switched Data (HSCSD) . . . 107
5.64 BSS6083 Mobile Station (MS) speed detection . . . 108
5.65 BSS6074 Active channel interference estimation . . . 109
5.66 BSS6071 Enhanced Full Rate codec . . . 110
5.67 BSS6035 Freeform RF hopping . . . 111

5.68 BSS6025 Short Message Service Cell Broadcast with Discontinuous Receiving (SMS-CB DRX) 112
5.69 BSS5850 Satellite Abis 113
5.70 BSS5730 Remote interrogation of serial and version numbers 114
5.71 BSS5590 C2 cell reselection parameter 115
5.72 BSS5072 Better Random Access Channel (RACH) detection 116
5.73 BTS2503 Compressed Abis timeslot allocation 117
5.74 BTS2139 Boot software 118
5.75 BTS2138 Transmission control: alarm handling via Q1 data channel 119
5.76 BTS2133 Short Message Service (SMS) point-to-point 120
5.77 BTS2067 Fast Associated Control Channel (FACCH) call setup 121
5.78 BTS2049 Remote transmission control and configuration 122
5.79 BTS2043 BTS External Alarms and Controls (EAC) 123
5.80 BTS2041 BTS local blocking 124
5.81 BTS2039 BTS SW background downloading 125
5.82 BTS2038 Transmission control: alarm handling via LAPD 126
5.83 BTS2037 Air interface measurement pre-processing 127
5.84 BTS2033 Short message cell broadcast 128
5.85 BTS2030 BTS Manager local password 129
5.86 BTS2024 Synthesised frequency hopping 130
5.87 BTS2023 Downlink and uplink DTX; TCH/FS, speech 131
5.88 BTS2020 RX antenna diversity 132
5.89 BTS2013 Baseband frequency hopping 133
5.90 BTS2012 BTS time base reference from PCM 134

List of Figures

Figure 1 Extended Cell two TRX configuration with two EGTCHs 11
Figure 2 TRAU bicasting in AMR FR/HR handover 16
Figure 3 TRX Test window 33
Figure 4 Cyclic Antenna Hopping configuration with cyclic RF hopping 49
Figure 5 Enhanced Measurement Reporting 52
Figure 6 Synchronised BSS example in UltraSite chain 54
Figure 7 Load and coverage reason handovers 59
Figure 8 E-DDAFC interface overview between CHDSP and EQDSP 63
Figure 9 Remote BTS Manager connection 66
Figure 10 Incremental Redundancy scheme 69
Figure 11 Data rates and protection levels for Modulation and Coding Schemes . 70
Figure 12 Dynamic Abis pooling 71
Figure 13 Multi BCF configuration. 77
Figure 14 Common BCCH configuration. 79
Figure 15 Site-specific notepad. 85
Figure 16 TRX Test window 94
Figure 17 Autodetected site configuration in the Supervision - Equipment window in BTS Manager 98
Figure 18 Intelligent Coverage Enhancement Plus (ICE+) 100
Figure 19 2 TRXs using combiner bypass (coverage) and 4 TRXs using 6-way wide-band combining (capacity) arranged in an ICE+ configuration 101
Figure 20 Power System Management for SiSu/IBBU (from NMS) 103
Figure 21 Typical data throughputs for 14.4 kbit/s (non-transparent) and 9.6 kbit/s coding (Note: this will depend on the NW radio conditions) 105
Figure 22 Nokia Automatic Link Adaptation 105
Figure 23 Dynamic SDCCH allocation 106
Figure 24 MS speed detection used for handover decision 108
Figure 25 SMS-CB DRX Schedule Period 112

List of Tables

Table 1 Peak data rates for single slot EGPRS 68
Table 2 Summary of Absolute Radio Frequency Channel Numbering 75
Table 3 Channel and speech codec modes for AMR 80
Table 4 Corresponding maximum data rates with different channel coding . . 107

Summary of Changes

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

Changes between 7-0 and 7-1

Minor updates were made in Section 5.52 BSS9060 TRX Test.

Changes between issues 6-0 and 7-0

The following CX6 features have been added as new chapters in the current release. See *Features in UltraSite EDGE BTS SW CX6* for more information.

- BSS20094 Extended Cell for GPRS/EDGE
- BSS20872 Robust AMR Signalling
- BSS20635 Common Configurations in Hardware Configurator
- BSS20588 TRAU Bicasting in AMR FR/HR Handover
- BSS20476 End to End Downlink Abis Performance Monitor
- BSS20482 BTS ID shown in BTS Manager
- BSS20997 Check of PSU/TRX Configuration in UltraSite
- BSS21060 BTS Hardware Configurator Support for XML
- BSS20951 RTC Support in ECELL
- Windows 2003 Server Support

The following CX5 features have been added as new chapters in the current release. See *Features in UltraSite EDGE BTS SW CX5 CDxx* for more information.

- BSS21295 Support of Multi Radio Combiner (MRC)
- BSS20991 UltraSite EDGE BTS Mini support

The following features have been removed:

- Enhanced Symbol Spaced Receiver (ESSR)
- BSS10074 Support of PBCCH/PCCCH

Feature BSS11102 Extended Cell Range for UltraSite EDGE BTS updated.

Technical Notes

This document does not contain any Technical Notes in CX6.

Change Notices

This document does not contain any Change Notices in CX6.

1 General information

This document describes the features of UltraSite EDGE Base Station Software (BTS SW) in different releases.

For more information on all the features, refer to GSM/EDGE BSS System Documentation and BSC/TCSM Product Documentation sets.

Operating and Application SW

BSS13 Software consists of Operating Software and Application Software:

- Operating Software means software that includes the basic functionalities and enhancements.
- Application Software means software that consists of value-adding functionalities.

This requires no user actions in the BTS. The BSS13 system features will be available in the following network element releases: S13, CXM6, CX6.

For general guidelines related to licensing, refer to *BSS Licensing* in the BSS System Documentation.

2 New Features in Nokia UltraSite EDGE BTS SW CX6

2.1 BSS20094 Extended Cell for GPRS/EDGE

Extended cell for GPRS/EDGE has been built on top of the existing extended cell feature. This means that the same method is used for creating the normal and extended service areas, and the same parameters are used for dimensioning the cell for both PS and CS services. For reference, see *BSS11102 Extended Cell Range for UltraSite EDGE BTS* feature.

The two service areas are part of the same cell and both areas are served by the same BCCH. In practice this means that MS movement between the service areas is handled as intra-cell reallocation instead of cell reselection.

Only the BCCH BTS of an extended cell may serve the extended service area, that is, the TRXs serving the extended service area must be accommodated by the BCCH BTS. The minimum extended cell configuration includes two TRXs – one for the extended service area and one for the normal service area – but multiple TRXs may be used in both service areas. The basic two-TRX extended cell would be configured as shown in the figure below.

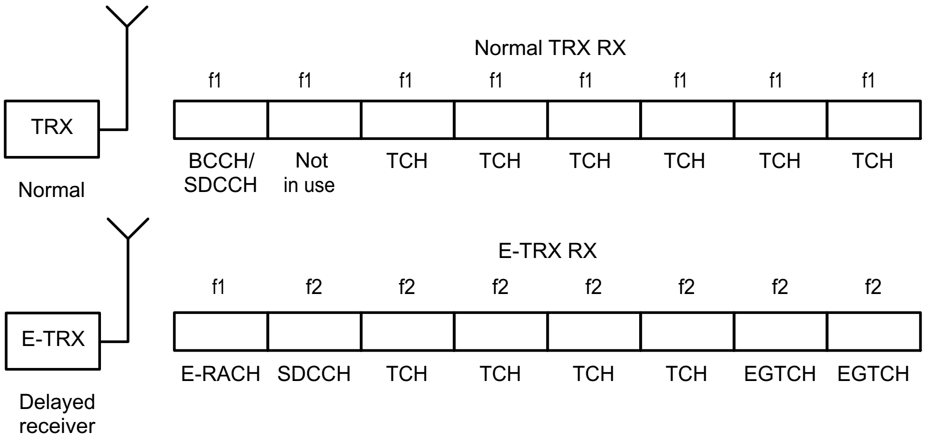


Figure 1 Extended Cell two TRX configuration with two EGTCHs

- RTSL 0 of the TRX serving the normal service area (N-TRX) configured as BCCH/RACH/SDCCH.
- RACH, through which access bursts are received from the extended service area, occupies RTSL 0 of the TRX serving the extended service area (E-TRX). E-RACH is tuned to the same frequency as the BCCH/RACH. The DL direction of the E-RACH RTSL is not used for any purpose: BCCH serves both service areas.
- RTSL 1 of the BCCH N-TRX is left unused since its reception overlaps with that of E-RACH on the same frequency.
- Six timeslots in both TRXs can be used for actual GSM/GPRS user traffic.

Extended cell GPRS/EDGE channels (EGTCHs) constitute a fixed PS timeslot territory, that is, the territory upgrade and downgrade procedures, which are used for dynamically adjusting CS and PS territories according to the traffic situation, are not applied to EGTCHs, and EGTCH timeslots are therefore blocked from CS use.

During uplink TBF resource allocation, the correct service area of the MS is determined on the basis of access signalling: the MS is located in the normal service area if access signalling is received through RACH (N-TRX) and in the extended service area if access signalling is received through E-RACH (E-TRX). During downlink resource allocation, the correct service area is determined either by reading the service area from an existing MS context, or by paging the MS if no context exists or if the location information in the context is considered invalid.

Timing Advance (TA) indicates the MS distance from the BTS. Timing advance has a range of 0-63 TA units in both service areas. The need for TBF reallocation from one service area to the other is determined by monitoring the TA for an MS: when the TA reaches a predefined upper limit for an MS located in the normal service area, it is reallocated to the extended service area; when the TA reaches a predefined lower limit for an MS located in the extended service area, it is reallocated to the normal service area.

In order to provide the BSC with the required TA-information, Dynamic Abis must be applied to all TRXs used for PS traffic in both the extended and normal service areas of an extended cell.

2.2 BSS20872 Robust AMR Signalling

BSS13 feature Robust AMR Signalling consists of four sub-features:

1. FACCH and SACCH repetition for “repeated ACCH” capable mobiles on AMR TCH
2. FACCH repetition for legacy mobiles on AMR FR
3. FACCH repetition for legacy mobiles on AMR HR
4. FACCH Power Increment on AMR TCH

FACCH/SACCH repetition and FACCH Power Increment proposals are specified together as single repeat/power increment functionality so that BTS can optimise use of the power increment and repetition according to BTS Tx power level, mobile capability and channel (AMR FR, AMR HR) used.

Role of BSC is to provide parameters related to this feature to BTS. BSC checks mobile’s capability and sends parameters related to this feature to the BTS at the beginning of a call (Channel Activation message) and the BTS then uses the commanded features according to the radio conditions. BTS indicates usage of FACCH/SACCH repetition and soft combining of repeated blocks in Measurement Result message to the BSC. This information is used for monitoring of Robust AMR signalling.

With FACCH repetition the time taken to get a command to mobile increases, so repetition should only be applied when needed. Uplink SACCH repetition reduces frequency of measurements from the mobile, so it should also be used only when needed. Repetition of the same measurement reports affects also averaging of measurements and reaction speed of handover and power control algorithm.

Repeated AMR SACCH and FACCH in 3GPP Release 6

With 3GPP Release 6 and onwards, Mobiles and BTSs can ask for SACCH frames to be repeated exactly on transmit, so that the original frame and its repeat can be decoded together using Incremental Redundancy (soft combining) type decoding, similar to the IR defined for EDGE data. Similarly transmit repeat and Incremental Redundancy on decode can also be used with downlink FACCH frames.

This gives about a 4 dB improvement in the C/I needed to decode the SACCH and FACCH, so that these channels are as robust as the lowest rate AMR codecs.

BSS13 supports the 3GPP protocol for repeated SACCH and FACCH, and will use the Incremental Redundancy on the uplink SACCH when needed for good normal operation of the control channels.

Repeated AMR FACCH for Existing Mobiles

For mobiles designed according to ‘old’ 3GPP releases (i.e. releases up to and including release 5), 3GPP have enhanced the radio interface protocol so that the downlink FACCH can be repeated, to give the mobile two chances to decode the FACCH before each link timeout and retry of the protocol. This gives about a 2 dB improvement in the C/I needed to decode the FACCH, so that this channel is more robust and the dropped call rate in handovers is reduced.

BSS13 will use the repeated downlink FACCH, when the Mobile is indicating poor downlink quality by requesting a low-rate AMR CODEC.

The 2 dB improvement in C/I is not enough for reliable operation with the very lowest rate AMR/FR codecs, so Nokia Siemens Networks also offers the FACCH Power Increment feature for existing mobiles.

FACCH Power Increment for Existing Mobiles

With this feature, for 3GPP Release 5 and earlier mobiles BTS Tx power for (downlink) AMR FACCH bursts can be increased by 2 dB, up to the maximum power capability of the TRX. The Power Increment is not used when transmitting on the BCCH frequency.

This will give improved C/I for FACCH, so that dropped call rate in handovers is reduced, but without adding significant interference to other ongoing calls. Combining this feature and the Repeated AMR FACCH for existing mobiles, BSS13 offers up to 4 dB improvement in C/I for FACCH decode, and corresponding reduction in Handover dropped call rate.

2.3 BSS20635 Common Configurations in Hardware Configurator

The Hardware Configurator application includes the most commonly used HW configurations for use as templates by the Configuration Wizard. This feature adds four new HW configuration templates:

- 1+1+1 - With 2 antennas per cell, for diversity Rx
- 3+3+3 (2:1) - With Wideband Combiner Units
- 3+3+3 (2:1 - WBT) - With Wide Band Triple Combiner (WCxT) units
- 4+4+4 (2:1 - WBT) - With Wide Band Triple Combiner (WCxT) units

2.4 BSS20588 TRAU Bicasting in AMR FR/HR Handover

AMR speech codec is a key voice codec in Nokia Siemens Networks GSM/EDGE BSS. AMR packing/unpacking functionality is one of the most important system level capacity/quality tools of the Nokia Siemens Networks AMR system feature. AMR packing/unpacking uses intra-cell handovers in order to change speech coding between AMR HR and AMR FR.

In order to reduce Audio breaks during HO, the BSC establishes unidirectional connection in downlink towards the target channel (Bicasting) before the handover. For AMR FR/FR (or AMR HR/HR) handover this bicasting means that TRAU frames carrying 16k (or 8k) TRAU coming from the transcoder (TC) are transmitted by the BSC simultaneously to the source and target channels 16k (or 8k) format depending on the channel rate.

This method, shown diagrammatically below, tries to ensure that valid speech frames are being transmitted in DL over the air interface before the MS moves from the source to the target channel.

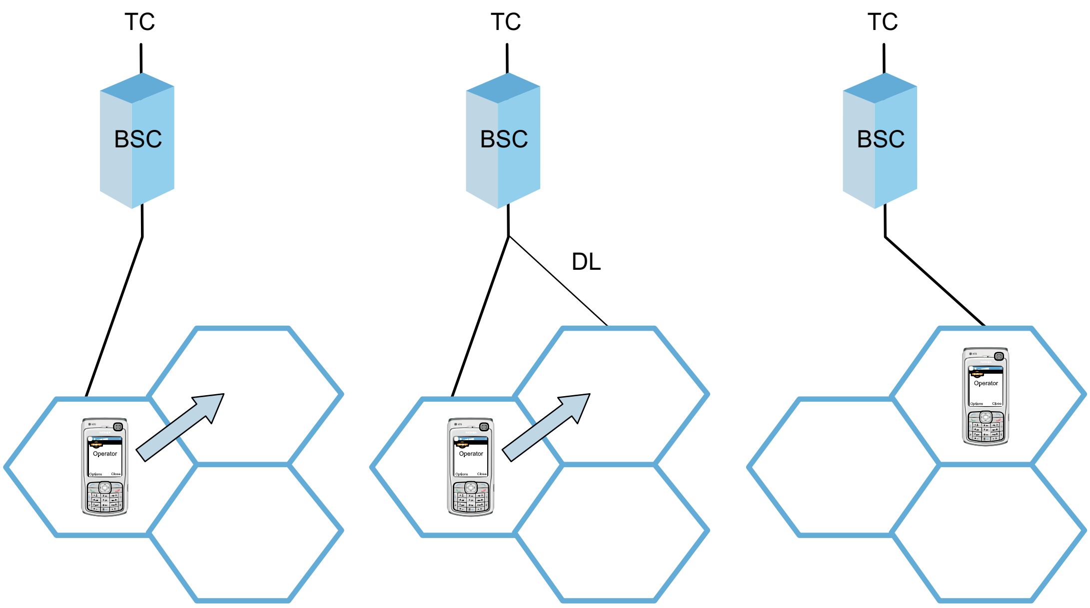


Figure 2 TRAU bicasting in AMR FR/HR handover

With this approach, it possible to reduce the potential for breaks in the Audio in DL during handover. TRAU Bicasting in AMR FR/HR handover feature makes it possible to establish unidirectional connection also in AMR FR/HR intra-BSC handovers. When this feature is used source and target BTSs and TC are all using 8 kbit/s TRAU frame format for the Abis and Ater transmissions during the AMR packing/unpacking handover. In practice this means that 8 kbit/s TRAU frames are submultiplexed onto 16 kbit/s Abis channel of BTS that is sending/receiving TCH/AFS radio frames.

2.5 BSS20476 End to End Downlink Abis Performance Monitor

BSS 20065, in BSC S11.5 SW, implements counters in the BSC that check the uplink signalling channels (channels using LAPD), keeps the results in a set of counters, and every 24 hours checks the number of errors (L1 errors) against an alarm threshold.

BSS 20476 is an equivalent feature for the Downlink Abis.

The BTS keeps downlink counters for each LAPD connection that terminates in the BTS. The counters measure the number of received bytes, the number of L1 errors and the number of T200 timeouts. The BTS reports the counter numbers, per channel, every hour between 10 minutes before the hour and the top of the hour according to the BTS real-time clock. The BSC then passes the report on to NetAct for further processing.

2.6 BSS20482 BTS ID shown in BTS Manager

At present, the BTS MMI shows "Sector" number for each Sector, but the BSC shows "BTS" number. The "BTS" number can be different from the "Sector" number. With this feature the BTS MMI will show both "Sector" number and "BTS" number, to avoid any confusion between an operator using BTS MMI and an operator using the BSC MML or NetAct. The mapping between the "Sector" number and the "BTS" number is as sent in the Abis O&M interface in the BTS CONF data message. The range of the "Sector" number is from 1 to 248 and the range of the "BTS" number is from 1 to 2000.

2.7 BSS20997 Check of PSU/TRX Configuration in UltraSite

This feature cross-checks the number of PSUs and TRXs in UltraSite BTS.

If there is only a single PSU of type PWSA, PWSB or PWSC and there are more than 6 TRXs then the configuration is considered as invalid, and the BTS raises a 7062 BCF Notification alarm with description:

- Incompatible unit presence detected in the BTS.

This gives a warning to the operator for invalid configurations in which it is possible for the BTS to work correctly at low traffic times, but hidden faults and alarms at high traffic times may arise when the current drawn by the TRXs exceeds the capacity of the single PSU.

2.8 BSS21060 BTS Hardware Configurator Support for XML

Previously the HW Configurator supported two file formats, one for saving the HW Configuration file in .hwc format and one for saving the passive unit information in .hwi format.

With BSS21060 feature the information can also be read or saved in XML file format with the extension .ewb, so that it is possible to use the HW Configurator to create and edit Easy Wizard Hardware template files.

2.9 BSS20951 RTC Support in ECELL

With this feature RTCs can be used with the Extended Cell feature, for both Normal and Extended area TRXs.

This is useful for Extended Cell sites where there is high traffic with most of the traffic in the extended area, for example where an off-shore island is served by a BTS on the mainland.

2.10 Windows 2003 Server Support

BTS Manager and HW Configurator are run by on-site engineers in Windows laptop computers, and by NetAct operators in the NetAct Windows Application Server. With this feature the CX6 BTS Manager and HW Configurator are updated to run on a NetAct server running Windows 2003 Server.

The CX6 BTS Manager and HW Configurator will also run on Windows 2000 and Windows XP computers.

3 Features in Nokia UltraSite EDGE BTS SW CX5 CD3.0

3.1 BSS21295 Support of Multi Radio Combiner (MRC)

Support for new type of MRC combiners has been implemented in CX5 CD3.0: A MultiRadio combiner (MRC) has been developed to enable the sharing of common antenna systems for GSM-WCDMA co-site situations.

For this purpose a modified triple wideband combiner will be used that fits into the slots used for baseband cards. The user will identify this type of configuration via the HW Configurator by using a check box which will be present when a Flexi WCDMA BTS upgrade is installed in the lower part of the cabinet.

4 Features in Nokia UltraSite EDGE BTS SW CX5 CD1.0

4.1 BSS20991 UltraSite EDGE BTS Mini Support

UltraSite Edge BTS Mini is a small lightweight base station with up to 4 TRXs giving the full UltraSite RF performance. With masthead mounting it gives outstanding coverage and substantially reduces the cost of deployment and operation.

5 Features in Nokia UltraSite EDGE BTS SW CX5

5.1 BSS20063 Space Time Interference Rejection Combining

The Space Time Interference Rejection Combining (STIRC) is a licence-based application software in the BSC that enables/disables the use of STIRC technology in the BTS.

The STIRC is an uplink (UL) receiver performance enhancement to the Interference Rejection Combining (IRC) technology. When enabled, the STIRC technology is deployed in the UL by BTS. When disabled, the current IRC technology is deployed by the BTS.

The new technology improves the spectral efficiency of the network via link performance enhancement that significantly improves the interference (co-channel & adjacent channel) rejection capability of EDGE UltraSite and MetroSite BTSs in the uplink direction. For example, the improved link level interference rejection performance of the STIRC with GMSK modulation will give on average a gain of 4 to 9 dB for co-channel interference compared to the IRC in 2-way Uplink Diversity (2UD) configurations. STIRC will also give similar or better gain compared to IRC when used in UltraSite 4-way Uplink Diversity (4UD) BTS configurations with GMSK modulation. In addition, the current GMSK normal burst receiver sensitivity levels are not affected.

The STIRC can also help to maintain the link balance (UL and DL) needed with the deployment of Single Antenna Interference Cancellation (SAIC) technology in mobiles that improves interference cancellation capabilities in the downlink (DL).

The STIRC licensing software will be operational once the STIRC option is enabled at the BSC. The BSC will allocate the STIRC license from its available pool and send the STIRC option in the BTS_CONF_DATA to the BTS.

This feature affects alarm handling so that STIRC alarms can be cancelled without reset.

Implementation

The STIRC feature can be enabled or disabled for the site any time the BTS is running because it does not require locking the sector or TRX. The BSC will send the STIRC option for each sector in the BTS_CONF_DATA. When receiving this option, the BTS O&M SW checks for each TRX in the sector for which STIRC is enabled, whether the HW configuration is valid for the STIRC feature. If an invalid configuration (non-edge TRX in Metrosite or BB2A card in Ultrasite) is used, an alarm is raised on the specific TRX(s) and these specific TRX(s) are blocked, and STIRC is enabled on rest of the TRX(s). BTS O&M SW enables the STIRC algorithm by informing CHDSP and EQDSP of each valid TRX in the sector.

Note that the STIRC algorithm implementation requires 32-bit precision numerical calculations to minimise quantisation errors, while for the IRC algorithm 16-bit precision is sufficient. Thus, for STIRC implementation 32-bit precision is used for all the functions, some of which are common to the IRC algorithm also. As a result of this, slight gain (up to 0.2 dB) in CCI and ACI performance can be observed even when the IRC algorithm is used (STIRC=N).

In order to achieve the STIRC gain, Rx Diversity should be in use (RDIV=Y).

Requirements

No new requirements are identified for the BTS Manager or BTS HW Configurator.

This feature is supported by the following BTS generations and SW:

- UltraSite CX5 with EDGE TRXs (BB2E/BB2F and TSxB) and Hybrid TRX (BB2E/BB2F and TSxA).
- MetroSite CXM5 with EDGE TRXs
- BSC S12

Interaction with other features

- All valid hopping combinations for the supported TRX types are supported.
- BSS synchronisation helps in achieving full STIRC gain.
- For UltraSite BTS, STIRC supports the E-Cell.

Benefits

The STIRC diversity algorithm improves the interference rejection performance and thus the overall network spectral efficiency and quality.

The STIRC ensures better uplink quality, particularly in high user density/interference limited scenarios, and better average user data throughput, as well as improved traffic and control channel performance. It also provides a possibility to use less mobile Tx power for quality-based uplink power control, which leads to reduction in the overall interference level in uplink and improves the mobile battery life.

5.2 BSS20043, BSS20702 BTS clock tuning enhancements

BTS SW CX(M)5 includes the following enhancements for the BTS clock tuning:

- Remote Clock Control: enables the setting of the DAC word value through the remote BTS Manager.
- Fast Tuning: an automated frequency based tuning where the 26 MHz oven oscillator is frequency-synchronized with the 2.048 MHz PCM clock within a few minutes.

5.3 BSS20730 Support for UltraSite WCxT triple wideband combiner

The BTS Manager and HW Configurator support the WCxT unit, which consists of three separate 2:1 combiners in the same unit. Each of three 2:1 combining sections in the WCxT unit provide the same combining functionality as the current WCxA, and they can be used separately as 2:1 combiners or cabled to form a compact 4:1 combiner.

Note that the WCxT triple wideband combiner works also with BTW SW versions earlier than CX5. However, the WCxT units must then be defined as three separate WCxA units in HW Configurator.

5.4 BSS20040 User Access Level Control (UALC)

The User Access Level Control (UALC) is a solution to prevent unauthorised users from making changes that can affect the remote management and traffic. The UALC is for a remote connection only, in a local connection it is not in use.

The UALC defines two levels of access rights for the users of BTS managers, cellular transmission equipment node managers and the BTS HW Configurator:

- Full Access (Read and Write) means that all the functionality that the manager applications offer is available to the user.
- Limited Access (Read only) allows only to read information from an element.

The UALC can be enabled or disabled at the time of the installation of SiteWizard. This information is stored by a registry key in the PC/Laptop. If the UALC is disabled, the user has full access rights. If it is enabled, an UALC user group (NokiaBTS_Admins) is added to the PC/Laptop, and a user having Windows administration rights can add users and maintain their access rights in the UALC user group. After that, only the users that are members of the NokiaBTS_Admins group, have the full access to the manager applications.

5.5 BSS20694, BSS20973 RSSI enhancements

BTS SW CX5 includes the following enhancements to RSSI:

- The number of samples needed for a reliable RSSI estimate is a selectable value in BTS Manager: 80K, 160K, 350K or 750K samples.
- In addition to the newest and last reliable RSSI values, the raw values that are collected every 10 minutes from the TRXs are displayed in the RSSI Comparison Values window from within BTS Manager.

For more information, refer to the sections BSS10063 RX antenna supervision by comparing RSSI and RSSI enhancements.

5.6 BSS20713 Automatic Abis Update

The Automatic Abis Update simplifies the update of Abis allocation. It removes the need to open the BTS Manager and invoke the Update Abis operation when the Abis configuration is changed with UltraSite transmission unit managers.

The SW reads the Abis allocation from the master FXC card when receiving the BCF, OMU or TRX startup BTS_CONF_DATA messages, but before validating the BTS_CONF_DATA message contents. This removes the need to open the BTS Manager and invoke the Update Abis operation, when the Abis configuration is changed with UltraSite transmission unit managers. This feature is supported for the FXC transmission cards.

5.7 Support for additional filter units in 900 MHz sub-bands

The HW Configurator supports the units of 900 sub-bands for the Remote Tune Combiner (RTC) unit and the Dual Variable Gain Duplex Filter (DVx) unit. The HW Configurator newer than 4.1 shows the exact unit types for the units RTJx, RTHx, DVJx and DVHx.

5.8 BSS20499 Improved TRX test presentation

The TRX test presentation has been improved. The field displays for the TRX test Results have been changed from **Main Sensitivity** to **Main Rx Result**, and from **Diversity Sensitivity** to **Diversity Rx Result**.

The figure below shows the TRX Test window.

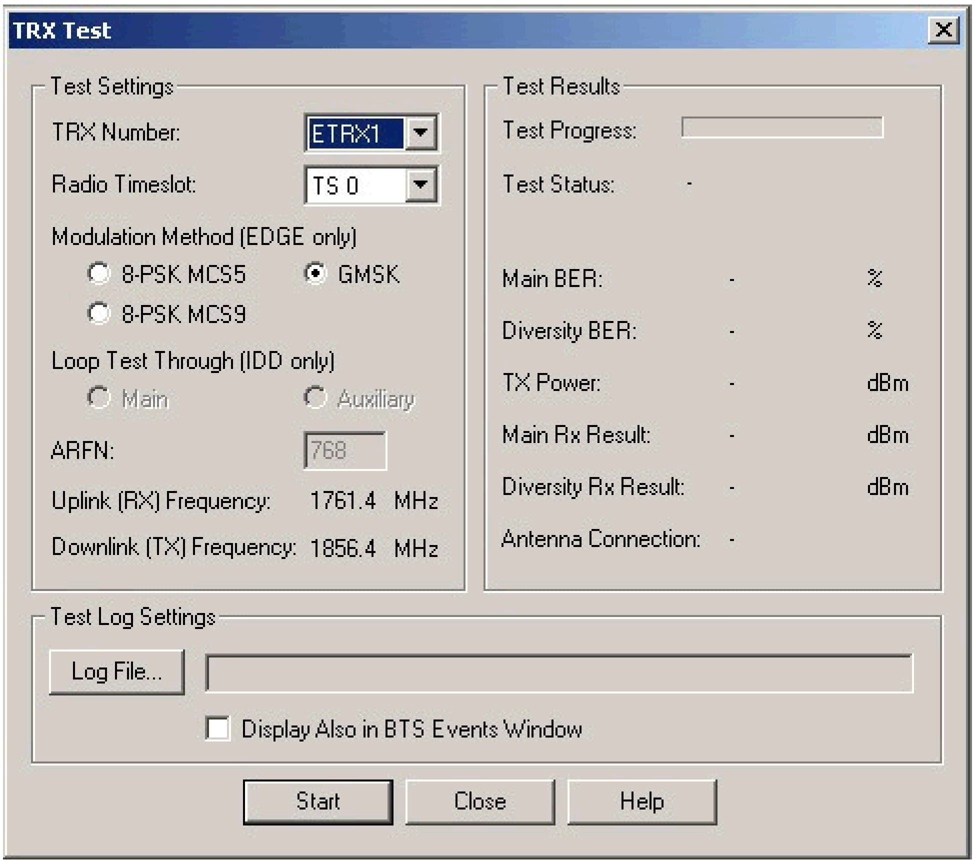


Figure 3 TRX Test window

The test covers digital RF parts and includes:

- Tx Level
- Bit Error Rate (BER) for the main and diversity Rx
- Estimate (Rx Result) of the Rx level needed by a single receiver for a good quality decode of a full rate speech, based on the measured noise and interference level of an idle radio channel, for main and diversity Rx.

For more information, refer to the section BSS9060 TRX test.

5.9 BSS20854, BSS20866 Modifiable T200 timer

It is now possible to modify the Link Access Protocol on the Dm channel (LAPDm) T200 values in the BSC to ensure that the message transfer in the air interface is not stopped too early. Previously, the LAPDm T200 values were defined in the BTS SW configuration file, which required a new SW build. The values are modifiable for full rate, half rate and SDCCH channels. The downloaded FACCH T200 is used for both full rate and half rate, and the one downloaded SDCCH T200 value is used for both SAPI0 and SAPI3 messages.

5.10 BSS20048 Separate radio link timeout parameters for AMR and EFR

The Base Transceiver Station (BTS) and Mobile Station (MS) use the Radio Link Timeout (RLT) value received in the System Information type 6 (SI6) message to supervise the radio link during a call. The value sets the limit for the amount of unsuccessfully decoded Slow Associated Control Channel (SACCH) frames. Once the limit is reached, the channel is released.

The current BTS SW CX(M)4.1 takes the RLT value from the TRX-specific SI6 message that is received in the TRX initialisation phase from the BSC. This value is used in the supervision of all air interface connections in the TRX. The problem with this implementation is that Adaptive Multi Rate (AMR) calls are sometimes released due to problems in the SACCH, although the connection would otherwise work normally. The AMR calls can endure more problems in the SACCH than normal Full Rate (FR) or Half Rate (HR) calls.

With the Separate radio link timeout parameters for AMR and EFR, the BSS can use a different RLT value for AMR calls. The RLT for AMR calls can be set to a higher value than the RLT for other connections.

Although the feature name also refers to Enhanced Full Rate (EFR), the BSC implementation does not support setting a separate RLT for EFR calls. The BTS implementation does not take into account the connection type. It always assumes that the BSC is sending a connection-specific RLT if a connection-specific SI6 is received. The BSC has a separate parameter (ARLT) where the user can set the RLT value to be used with the AMR calls. For all other channels, the BSC uses the existing RLT parameter value.

The Separate radio link timeout parameters for AMR and EFR is an application software product and requires a valid licence in the BSC.

5.11 BSS11088 GPRS: Coding Schemes CS-3 and CS-4

General Packet Radio Service (GPRS) provides four coding schemes, from CS-1 to CS-4. In previous BSS releases only CS-1 and CS-2 GPRS coding schemes were supported because of Abis frame restrictions. The introduction of Dynamic Abis makes it possible to use CS-3 and CS-4.

CS1 and CS2 offer data rates of 9.05 and 13.4 kbit/s per timeslot. With the rates of 15.6 and 21.4 kbit/s, CS-3 and CS-4 provide a considerable gain in data rates for GPRS mobile stations not supporting EGRPS (the mandatory RLC header octets are excluded from the data rate values).

Coding Schemes CS-3 and CS-4 is an application software product and requires a valid licence in the BSC.

Implementation

- The Coding Schemes CS-3 and CS-4 can be implemented in two alternative ways. It is possible to use CS-3 and CS-4 in either GPRS territory or GPRS and EGPRS territories.
- TRXs running CS-3 and CS-4 must be EDGE TRXs, so all TRXs in GPRS and/or EGPRS territories must be EDGE TRXs.
- Coding Schemes CS-3 and CS-4 cannot be managed with BTS MMI.

Interaction with other features

- CS-3 and CS-4 do not fit to one 16kbit/s Abis/PCU channel and require the use of Dynamic Abis Allocation and EDGE TRXs.
- EDGE TRXs must be defined as separate BTS object in the BSC when added to Segment. The BSC has 248 BTS objects.

Benefits

The new GPRS coding schemes can boost the GPRS throughput bit rates by maximum of 60% compared to using only GPRS coding schemes CS-1 and CS-2. It is estimated that in practice, with average real network conditions (average C/I value distribution), a throughput increase of 0-30% can be achieved, depending on network’s C/I values.

For more information, refer to BSS System Documentation or BSC Product Documentation.

5.12 Feature Enhancement to BSS9059 BTS resets

OMU Reset from the BTS Manager

The OMU Reset command has been added to the UltraSite BTS Manager. The command can be found under the BTS Manager Objects menu commands when the BCF is in the Supervisory state.

This command will reset the Operations and Maintenance functions of the base station site without interrupting call services and user traffic.

Active alarms for the site will be cancelled by the reset. After the reset is complete, persisting faults will be reported once again.

Any changes to the BTS HW Configuration file made using the HW Configurator application will come into effect following an OMU reset.

O&M counters and timers will be cleared and reset by this action. For example, if the RX Antenna Supervision by Comparing Receiver Signal Strength Indication (RSSI) feature is enabled and an OMU reset is performed, the newest and last reliable RSSI values will be cleared and the periodic hourly timer which triggers the RSSI averaging and threshold checking function will be restarted.

5.13 BSS20371 BSS Site Synchronisation Recovery Improvement

This BSS11.5 feature is a 'recovery improvement' to the BSS11073 Recovery for BSS and Site Synchronisation. The target of the improvement is to reduce site downtime as a result of the loss of GPS. With this feature, the BSS synchronisation can be maintained by using the Abis as a frequency reference, even though the GPS signal to the LMU is lost for up to 24 hours. If the GPS signal is regained during the 24-hour period, the BSS synchronisation will revert to the GPS. The changeover from the synchronisation to an external LMU to the synchronisation with a lock to the Abis clock is made without affecting service.

Implementation

- The LMU Signal Loss (GPS Fix Loss to Clocks out alarm) timer is set up as part of the site configuration. The recommended value for S11.5/CX4.1 is 120 seconds.
- The transmission units in the BTS are set up so that they synchronise their internal 2.048 MHz clock with the incoming transmission network clock.
- The site is set in the BSC as in LMU-Abis Synchronisation mode (Improved Synchronisation recovery is used), and is operating normally in LMU Sync state with the LMU receiving GPS signals.
- The BSC 'Loss of LMU Sync Alarm Limit' timer is set up. The default value is 1 hour.
- The BSC 'BCF Restarted due to Loss of LMU Sync' timer is set up. The default value is 24 hours.
- A new Information Element (Optional Sync Settings) is included as an optional element in the existing BTS_CLOCK_REQ message.

These allow the control of the clocks so that the BTS can change between the LMU clocks and internal clocks synchronised to the Abis PCM without resets.

Requirements

The transmission link(s) to the BTS site must meet the Jitter and Wander requirements of ANSI T1.403 for T1 links, or ITU G.823 for E1 / 2048 kbit/sec hierarchy links.

This feature is supported by the following BTS generations and SW:

- UltraSite CX4.1
- BSC S11.5
- BSS 11.5
- LMU 4.3

The following chaining configurations are not supported:

- Chaining with Talk-family BTSs
- Mixed UltraSite and MetroSite chaining configurations
- MetroSite

Interaction with other features

Improved BSS Synchronisation Recovery is used in any networks which use BSS Synchronisation with or without DFCA.

For more information, refer to section BSS11073 Recovery for BSS and Site Synchronisation.

5.14 BSS12158 IMSI Based Handover

The IMSI Based Handover (IBHO) enables handover control between the networks of different operators according to the identity of a subscriber. If a mobile subscriber belongs to a Subscriber Group (SG) and its International Mobile Subscriber Identity (IMSI) can be recognised, it is possible to make handovers to either the GSM or the WCDMA networks.

With the IMSI Based Handover, a mobile subscriber in a visited network can be commanded to measure selectively only specified Public Land Mobile Network (PLMN) cells and to make a handover accordingly to those specified (home or authorised) PLMNs. The input for the selective measurement control is the PLMN id that is included in the IMSI of the subscriber.

With the IMSI Based Handover, using Authorized Networks (ANE) Lists and Subscriber Groups, a host GSM operator is able to define that a BSC performs handovers only to the cells that are permitted for the subscriber. Each Subscriber Group is attached to an ANE List, which contains all the network PLMN identifiers of the alliance.

The networks involved in the IMSI Based Handover can be GSM or other radio technology networks, for example WCDMA networks. The IMSI Based Handover application software consists of two parts depending on the network type the handover is directed to:

- Support for IMSI Based GSM-GSM Handover
- Support for IMSI Based GSM-WCDMA Inter-System Handover

The IMSI Based Handover is a licence-based application software in the BSC. The implementation of the IMSI Based Handover in the BTS only requires changes in the Telecom SW.

Requirements

BSC SW version S11.5 is required for IMSI Based Handover.

32 kbit/s TRXSIG links are required in the cells where IMSI Based Handover is enabled.

Interaction with other features

- In GSM-WCDMA Inter-System Handover (ISHO), ISHO must be enabled for the IMSI Based Handover to WCDMA RAN cell to work.
- IMSI Based Handover to GSM should not be used simultaneously with DFCA.
- IMSI Based Handover to WCDMA can be used with DFCA without restrictions.
- IMSI-based selective neighbour measuring is not possible on the SDCCH. On the TCH, call-specific SI5x and MI messages are sent from the beginning of the channel reservation, and the mobile starts to measure call-specific neighbours and report with EMR as soon as it has received the SI and MI messages.
- A BCCH allocation frequency list cannot be used for active Mobile Stations (MSS) in the same cell as IBHO to GSM. IBHO to GSM functionality requires that active MSS use a BCCH frequency list that is constructed from the neighbour GSM cells defined for the BTS or SEG.

Benefits

The IMSI Based Handover will benefit roaming-based mobile services provisioning and network sharing concepts by enabling the handover control to direct subscribers from the shared or roamed network to the subscribers' home PLMN. The current solution is to allow the same handover path for all mobiles and let the mobiles find their home or authorised network in idle mode.

The main benefit of the IMSI Based Handover is that the access of the partners' subscribers can be limited to defined cells only in order to maintain service preference to own subscribers. The partners can prefer their own cells and thus optimise costs caused by network visits.

5.15 BSS11121 IDD with Baseband Hopping

The Nokia Smart Radio Concept (SRC) for EDGE optimizes the radio link performance for maximum coverage and Quality of Service, and facilitates capacity upgrades. The antenna diversity gain is applied in downlink enhancement through Intelligent Downlink Diversity (IDD). In the BSS10 release of IDD, simultaneous usage of IDD and Baseband (BB) hopping was not supported. In BSS11.5, IDD with BB hopping support is added for UltraSite CX4.1 SW. This is an upgrade to the IDD described as part of the BSS10104 Smart Radio Concept.

IDD and 4UD

IDD extends the cell coverage by boosting BTS downlink transmission performance up to 5 dB (min. 3 dB). A minimum of two EDGE transceivers and two antennas (or X-polarised antenna) are needed for one cell. The same downlink signal is transmitted simultaneously through two antennas. Typical UltraSite configurations are for example: 1+1+1 with combiner by-pass, 2+2+2 with 4-way diversity and 6 TRXs/cell with RTC for extreme coverage and capacity. Extension from 1 TRX/cell to 2 TRXs/cell needs 4 antennas per cell if the same downlink coverage area has to be met. Auxiliary transmission is delayed 1-1.5 symbol periods, which gives good performance for all modulation schemes. Random Phase hopping decreases correlation between the main and auxiliary transmitter. Correlation between the antennas has to be low.

4-way uplink diversity (4UD) means that 4 received signals are combined together by using Interference Rejection Combining (IRC) and Maximum Ratio Combining (MRC) combining techniques. 4UD can be used together with IDD, but cannot be defined without IDD.

BB hopping

In BB hopping, a transceiver transmits on a fixed frequency and a call is switched burst by burst through transceivers. Radio timeslots in different transceivers may form a hopping group. A radio timeslot is hopping inside the frequency hopping group from one transceiver to another according to the calculated hopping sequence. The number of frequencies in the hopping sequence is the number of unlocked transceivers in a hopping group. The BCCH timeslot does not hop, but BB hopping is possible on the BCCH transceiver for timeslots 1 to 7.

IDD with BB hopping

IDD-BB hopping is invoked, when the IDD TRXs are commissioned in a BB hopping sector. The BSC will send frequency hopping parameters for an IDD-BB hopping sector in the same way as it sends for normal BB hopping. The CHDSP receives the IDD-BB hopping configuration information through messages from the UC. There will be one HGP message for each hopping group and it will be sent to all Main TRXs in the IDD-BB hopping sector. There will be one FHC message for each Main TRXs and that will identify the Master TRX for the IDD-BB hopping sector. There would be no changes in the existing BB hopping calculation algorithm at CHDSP for IDD-BB hopping. The BB hopping groups are built according to the hopping parameters (MA list, HSN and MAIO) sent by the BSC.

Implementation

IDD is a BTS specific feature. The BTS can be configured to two different modes: IDD with 4UD and IDD without 4UD. 4UD without IDD cannot be used. The IDD and 4UD are not visible to the BSC, that is, there are no parameters or definitions at the BSC. Only the Main TRX is visible from the BSC. No Auxiliary TRX needs to be created in the BSC. The IDD set-up is done by the local BTS Manager. IDD information can be verified and modified when the BCF is locked, in commissioning state, and when the BCF SW is running and the BCF has been locked either in local or remote access.

Follow the steps below to configure the sector with IDD:

1. In the BTS Manager, select Undo Commissioning from the menu Commissioning-Wizard.
2. Set IDD and 4UD for TRXs 1-4 and click the 'Next' button.
3. Start commissioning.
4. After commissioning, select 'Supervision-IDD Information' from the menu.
    - Selecting the BTS Manager’s ‘Supervision- IDD Information…’ menu item displays the IDD information dialogue box.

In case of a non-EDGE TRX, an error message box 'Invalid IDD Configuration' displays the inability to set the IDD usage for non-EDGE TRX(s). For UltraSite, an attempt to set up IDD on a pair of TRXs that are connected via a single RTC or via hybrid combiner(s) to the same antenna is NACKed by the BTS as 'Invalid IDD Configuration'.

Interaction with other features

- An IDD-BB hopping sector cannot be configured with the following other sectors:
    - Non-hopping sector
    - RF hopping sector
    - AH enabled sector
    - IDD enabled (RF/NH) sector
    - BB hopping sector
- DFCA cannot be enabled on an IDD-BB hopping configured sector.
- An IDD-BB hopping sector can only be configured with another IDD-BB hopping sector.
- A TRX cannot be configured as an E-Cell TRX in an IDD-BB hopping sector.
- It is not possible to configure a non-IDD TRX (normal TRX) in an IDD-BB hopping sector. All TRXs should be IDD enabled.
- EDGE-capable TRXs are required for an IDD-BB hopping configuration.

5.16 BSS11102 Extended Cell Range for UltraSite EDGE BTS

The BSC supports the Extended cell radius in the Base Transceiver Station (BTS). Two cells with different timing advance ranges, that is, inner and outer cells, are used. An inner cell has a regular coverage area and an outer cell has an extended radius of the coverage area. The handover and power control algorithm in the BSC triggers a handover when the MS is approaching the inner cell while still being served by the outer cell. The triggering is based on the timing advance.

Extended cell is application software in the BSC.

Implementation

The extended cell implementation is based on one-BCCH and two-TRX solution. Different TRXs serve the normal and the extended area. The TRX, which serves the normal area, is normally configured with the BCCH/SDCCH and TCHs. The timing of the receiver of the TRX which serves the extended area (E-TRX) has been delayed so that it can serve the area beyond 35 kilometres. The timeslot 0 of E-TRX is tuned to the BCCH frequency in order to get RACH-bursts from the extended area. The timing of transmitters is the same in both TRX and E-TRX. If more capacity is required either in normal area or extended area, more TRXs can be added to serve those areas.

- The Extended Cell Range for UltraSite EDGE BTS is supported for all UltraSite frequency bands but only operates on EDGE capable hardware for the extended coverage area.
- MHA units should be used in the UltraSite BTS configuration to ensure transmitted signal strength can reach the maximum range.
- It is recommended that all TRXs in the Extended cell use the same configuration. If the Edge Baseband is used, then all TRXs should use Edge Baseband. Likewise, if IDD/4UD is used, then all TRXs should use IDD/4UD. Mixed DVxx and TRC combiners should not be used.

An optional information element (IE), ‘Extended Cell Radius’, is taken into use in the ‘Information Status’ message to the BTS Manager. From CX4.1 onwards, this IE is for all TRXs but indicates an extension radius of 0 Km for a TRX in the inner coverage area. For a TRX covering the outer area, the ‘Radius Extension’ is shown in Km.

GPRS and EGPRS can be used both in extended and normal area TRXs from CX6 onwards. RTC and be used in Extended cell from CX6 onwards.

Interaction with other features

The following features cannot be used simultaneously with the Extended Cell Range for UltraSite EDGE BTS:

- Baseband hopping
- RF hopping cannot be used in extended area TRXs (RF hopping can be used in normal area non-BCCH TRX(s) if present)
- Antenna hopping
- IUO

TRX Test:

- TRX Test cannot be commanded for a TRX configured to cover the extended outer area.

Benefits

The extended cell feature is best suited for applications in coastal areas, rural areas and corresponding ones where coverage exceeds typical GSM maximum cell size of 35 km.

5.17 BSS11052 Dynamic Frequency and Channel Allocation (DFCA)

Dynamic Frequency and Channel Allocation (DFCA) is a radio channel allocation software for dynamically assigning the optimum radio channel for a new connection.

DFCA uses interference estimations derived from mobile station downlink (DL) measurement reports and combines them with the timeslot and frequency usage information. DFCA channel allocation algorithm selects the radio channel for a connection from a dedicated channel pool based on carrier/interference (C/I) ratio criteria. The idea in DFCA channel selection is to provide enough quality in terms of C/I, so that each connection will meet its Quality of Service (QoS) requirements. The different degrees of interference tolerance of different connection types are taken into account in the channel selection process. Examples of the connection types are connections using enhanced full rate speech codec (EFR) or full rate (FR) and half rate (HR) connections using adaptive multi-rate speech codec (AMR).

The main DFCA functionality is located in the BSC. The DFCA channel allocation algorithm in the BSC controls the radio channel assignments of all DFCA TRXs in all BTSs controlled by the BSC. The BTSs using DFCA must be synchronised to a global clock reference provided by the GPS satellite system. This is achieved by having a Location Measurement Unit (LMU) installed in every BTS site. The LMU incorporates a GPS satellite receiver and provides a common clock signal that is used by all BTSs in the site.

DFCA is used for circuit switched traffic. Packet switched traffic is not handled by this software. The (E)GPRS territory is placed on a regular TRX which has been assigned to a separate portion of the frequency band and controlled by the conventional channel allocation algorithm. DFCA is a licence-based application software. Its use is controlled by a capacity licence based on the number of TRXs. To activate DFCA, the state of the licence must be set to ON.

DFCA frequency hopping is a new frequency hopping mode supported by UltraSite and MetroSite base stations with wide band combining from CX4.1 software release onwards. DFCA hopping is based on the basic principle of synthesised frequency hopping where the TRX unit changes the used frequency according to the given hopping sequence. With DFCA hopping, the TRX supports independent cyclic hopping sequences for each timeslot that can be freely selected with each channel activation. With DFCA hopping, the BSC can freely select the MA-list, MAIO and TSC for each TCH activation allowing the DFCA algorithm to choose the most suitable radio channel for each new connection or handover based on C/I criteria. This full channel selection freedom allows DFCA to achieve the best performance with DFCA hopping mode. The DFCA hopping mode is applied only in the TRXs dedicated to DFCA use (DFCA TRXs).

Requirements

- DFCA requires either UltraSite or MetroSite base station.
- The UltraSite base station requires wideband combining or no combiners.
- DFCA is not supported with RTC combiners.
- DFCA requires BSS synchronisation, which means that one LMU unit must be installed in every BTS site.

- Within a BTS, the use of DFCA is controlled on a 'per TRX' basis.
  In a BTS using DFCA, there are both DFCA and regular TRXs. The DFCA TRXs do not support any signalling channels and therefore the BCCH TRX of a BTS and a TRX carrying SDCCH channels must be a regular TRX.
  Also (E)GPRS is not supported in the DFCA TRXs. Depending on the requirements for the (E)GPRS territory size, this may require the operator to define another regular TRX, in addition to the BCCH TRX of a BTS for carrying (E)GPRS.
  The usage of DFCA frequencies for regular TRXs may cause some local DFCA performance degradation because of the uncontrolled interference.

Interaction with other features

The following features cannot be used in a BTS using DFCA:

- IUO/IFH: DFCA will replace these features
- Dynamic Hotspots
- Extended cell radius
- ICE
- Antenna hopping
- IDD (not used in MetroSite in CXM5)

The following features cannot be used in a TRX using DFCA:

- Dynamic SDCCH (not usable for the DFCA TRXs)
- FACCH call set up (not usable for the DFCA TRXs)
- Interference Band Recommendation: DFCA will replace this functionality
- Power optimisation in handover: DFCA will replace this functionality
- (E)GPRS: PS territory is not allowed in DFCA TRX but only in regular TRXs in DFCA

Benefits

- *Enhanced quality:* DFCA is able to handle different circuit switched traffic classes (EFR, HR, AMR, 14.4 kbit/s data) individually, and it provides the operator with means to differentiate between users. This is especially powerful when the full benefit of AMR connections is wanted without 100% AMR penetration.
  By guaranteeing a sufficient C/I level for each user, the network performance in terms of received signal quality (RXQUAL), frame error rate (FER) and dropped call rate can be significantly improved.
- *Capacity booster:* The criteria of sufficient C/I for each connection optimises also the interference caused to other connections. This leads to significant capacity gain, as the use of the valuable frequency resources is dynamically optimised.
  By decreasing the effective frequency reuse distance in the network, DFCA enables the operator to accommodate more circuit switched traffic by adding more TRXs to the existing BTSs without quality deterioration. Alternatively, more frequencies can be used on the regular layer, thus increasing the performance and capacity available for (E)GPRS.

5.18 RSSI enhancements

BTS SW CX4.1 includes the following enhancements to RSSI:

- The sample rate in RSSI is a selectable value. See BSS20694, BSS20973 RSSI enhancements.
- The minimum Rx level for valid RSSI difference measurement is -100 dBm.
- The threshold default value lower limit settable at the BSC has gone down from 5 to 3.

For more information, refer to the updated section BSS10063 RX antenna supervision by comparing RSSI.

5.19 FXC STM-1 and Bridge transmission card pair HW support in UltraSite EDGE BTS

The FXC STM-1 and FXC Bridge transmission units enable cross-connection between Plesiochronous Digital Hierarchy (PDH) and Synchronous Digital Hierarchy (SDH) transmission rates. The units work together to form a complete SDH STM-1 Terminal Multiplexer (TM) or Add/Drop Multiplexer (ADM) node inside Base Stations or MetroHub Transmission Nodes.

FXC STM-1 performs the main SDH functions, whereas FXC Bridge forms a bridge for the signals between the SDH part and the PDH cross-connect part of the node. The two units are always used together.

The main features of FXC STM-1 and FXC Bridge are:

- Two optical long-haul STM-1 interfaces (L-1.1, 1310 nm).
- Support for Automatic Laser Shutdown (ALS).
- Support for SDH STM-1 Terminal Multiplexer (TM) and STM-1 Add/ Drop Multiplexer (ADM) node types.
- Fully non-blocking cross-connections on TU-12 level between both STM- 1 aggregate interfaces and the add/drop traffic.
- SDH S12 SNC/I+ (Inherently monitored Subnetwork Connection protection) supported (protection on VC-12 level).
- Up to 20 x TU-12 (2M) drop capacity from SDH. Support for grooming via PDH cross-connections for the add/drop traffic with the following granularity: 8k, 16k, 32k, 64k, Nx64k.
- Interface statistics collected in compliance with ITU-T G.826.
- Easy management of settings and transmission configuration (locally and remotely) with the Nokia Q1 management protocol. Management is carried out with a Nokia NetAct compatible node manager.
- Remote and local software download.

Requirements

When SDH functionality (FXC STM units) is introduced into the FXC nodes in BTS or MetroHub, certain equipping limitations exist. These equipping limitations (and the resulting equipping rules) are caused by the FXC Node Control Functionality (NCF) slot restriction and by the fact that the FXC STM-1 unit does not support full NCF.

The FXC STM node consists of two units, FXC STM-1 and FXC Bridge. Both units must be installed to bring SDH functionality into BTS or MetroHub. In this release, only one unit of each type can be installed.

The general requirements for installing the FXC STM units into an FXC node are:

- Always install the FXC STM-1 unit in one of the middle slots because it does not support NCF and should not block the first, or in future releases, the last slot reserved for it.
- Install the FXC Bridge unit in the first slot. In a later release, this allows you to synchronise the SDH node clock to a PDH interface located on an FXC (PDH) unit.
- The first slot must contain a unit with NCF (for example, FXC (PDH) unit or FXC Bridge).
- Upgrading an already existing PDH node with SDH is not possible.

5.20 BSS11134 Antenna Hopping for UltraSite BTS

Antenna Hopping for UltraSite BTS is an application SW targetted at optimising network capacity and link performance.

Antenna Hopping (AH) is an enhancement to Radio Frequency (RF) hopping. Antenna Hopping uses the existing Baseband (BB) hopping functionality in the BTS.

The Antenna Hopping feature enables the TRXs in an RF hopping BTS to transmit with all the TX antennas in the BTS. If the number of RF hopping frequencies is low or hopping frequencies are correlated (for example adjacent frequencies), Antenna Hopping can improve the frequency hopping performance and it has been optimised with different frequency hopping parameters in mind.

Furthermore, with the Antenna Hopping feature it is possible to achieve space diversity to the regular RF hopping configuration, which means that there is a distance that separates two or more transmitting antennas, providing uncorrelated signals. It is also possible to use cross-polarised antennas.

At the base station, the number of hopping frequencies, propagation environment, the antenna height and the antenna spacing make the correlation coefficient of the radio channel. Antenna Hopping can make this correlation lower. In a fading channel, the lower correlation of received concecutive bursts in the mobile receiver results in improved service performance and better user experience.

The Antenna Hopping feature can be used with or without the RF hopping feature. The restrictions with the interaction of Antenna Hopping with other features are listed in section *Antenna Hopping implementation*.

The minimum configuration for this feature is 2 TRXs/cell, where both TRXs are used for Antenna Hopping. The basic idea of the Antenna Hopping feature is presented in the following figure:

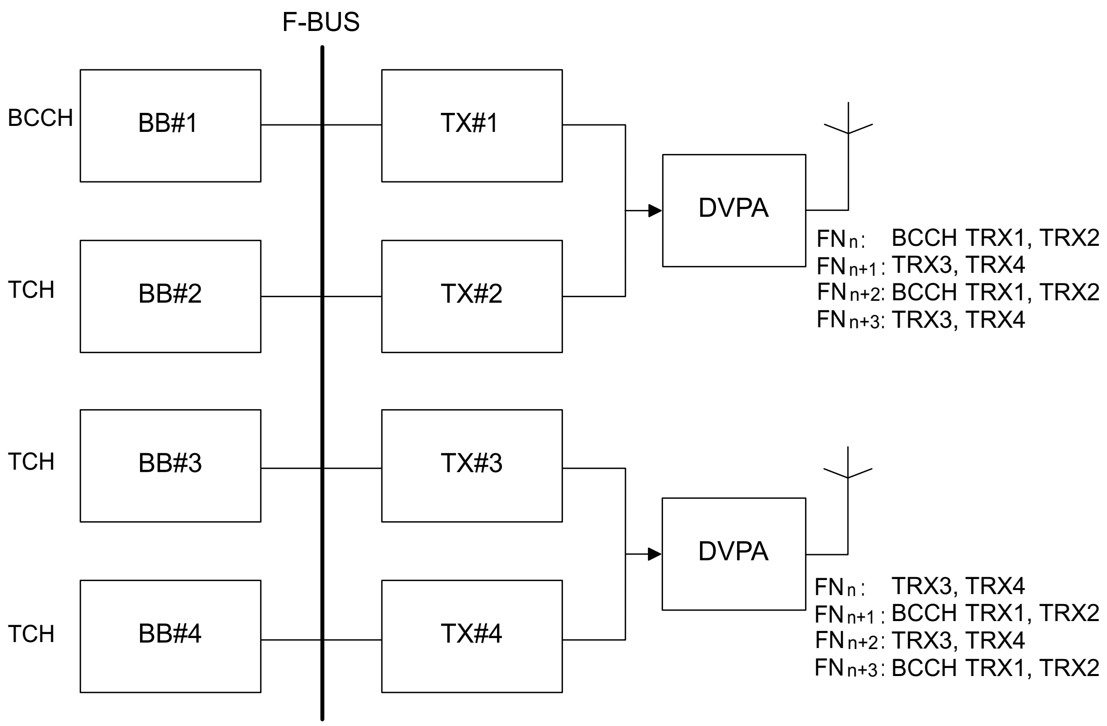


Figure 4 Cyclic Antenna Hopping configuration with cyclic RF hopping

Configuration

The Antenna Hopping feature is only supported by EDGE versions of UltraSite BB2 and TRX. Non-EDGE TRXs can be used in the same cabinet, but not as part of an Antenna Hopping sector.

The Antenna Hopping algorithm uses a cyclic antenna switch pattern when moving transmission and reception from one TRX to another. The Antenna Hopping algorithm does not take into account an external configuration (such as the use of combiners), it simply moves the transmission from one TRX to another. It is the external configuration which determines if this results in transmission\reception to\from another physical antenna. It should be noted that while antenna hopping, the transmission and reception for a timeslot is always made to\from the same TRX (antenna).

The Antenna Hopping for UltraSite BTS feature can be used with or without the RF hopping feature. With RF hopping, cyclic and all random frequency hopping sequences can be used together with Antenna Hopping. Antenna Hopping pattern will be automatically optimised based on the frequency hopping sequence. The BCCH TRX is included in the AH configuration, that is the BCCH transmission is moved from one antenna to another antenna (TRX).

Antenna Hopping uses the standard BB hopping configuration process, and the BB hopping mechanisms to route data between TRXS. An external configuration connects to physical antennas.

The Antenna Hopping for UltraSite BTS feature can be used with all GMSK and 8PSK coding schemes simultaneously, but with MCS7 to 9 there is no performance gain due to the weak channel coding used by these channels.

Antenna Hopping implementation

The BTS O&M requests BTS configuration data from the BSC. The BSC sends the configuration data including the AH enable/disable information. The O&M checks the current BTS configuration and raises an alarm if an invalid configuration, such as IDD or BB hopping, exists in the AH sector. The O&M SW configures the TRXs on a per sector basis. The CHDSP SW calculates the hopping sequences using the O&M configuration information, and configures the BTS TRX HW (baseband, RFM) in real time to perform the RF hopping and data routing to the appropriate TRXs via FBus.

The following features cannot be used simultaneously with Antenna Hopping:

- Remote Tune Combiner (RTC) configurations
- Intelligent Downlink Diversity (IDD) in the same BTS cabinet
- Dynamic Frequency and Channel Allocation (DFCA)
- Baseband hopping
- TRX test
- TRX loop test

Benefits

The Antenna Hopping feature helps to avoid network level interference and link level frequency selective fading.

With the Antenna Hopping for UltraSite BTS feature, the user can achieve in average 2 dB gain on the link level. With low antenna correlation, Antenna Hopping can gain 1.5 to 4 dB depending on the mobile speed (typical urban, 3 to 50 km/h, no FH) compared to a single antenna.

With Antenna Hopping, it is possible to gain better network level spectral efficiency on the BCCH layer. In a very narrow band environment (3.6 MHz), better network capacity can be achieved by tightening the BCCH re-use (for example from 5/15 to 4/12) without an extra TRX as required by Intelligent Downlink Diversity (IDD). By tighter BCCH re-use, more frequencies can be used in the hopping traffic layer, thus providing better capacity for narrow band networks.

5.21 BSS11086 Support for Enhanced Measurement Report

The Support for Enhanced Measurement Report (EMR) feature provides the system with enhanced serving and neighbour cell measurements. This is achieved by requesting the Mobile Station (MS) to use the EMR for reporting downlink measurements.

The Enhanced Measurement Report also provides the system with information such as Downlink Frame Erasure Rate (DL FER), the usage of Bit Error Probability (BEP) instead of RX Quality during the DTX frames, and the support for reporting WCDMA RAN neighbour cells. In addition, the EMR also provides an extended range for the serving and neighbour cells downlink signal strength and the possibility to report altogether up to 15 GSM and/or WCDMA RAN neighbour cells in one report.

These reports can be used by the network to enhance the generic performance of the existing system, enable GSM/WCDMA interworking, and enhance several existing or new Nokia features, such as:

- Automated planning
- Dynamic Frequency Channel Allocation (DFCA)
- FER measurement
- Intelligent Underlay Overlay (IUO) and Intelligent Frequency Hopping (IFH)

The major difference between the Enhanced Measurement Report (EMR) and the Measurement Report (MR) is that the EMR only reports on the neighbours it is told about. When the EMR reporting is requested, in addition to the neighbour cell BCCH frequencies, the BSC also sends valid Base Transceiver Station Identity Codecs (BSICs) of the neighbouring cells to the MS. Furthermore, the MSS are also provided with the Real Time Difference (RTD) information of the neighbour cells that are under the same BSC as the serving cell and in LMU synchronisation with it. The request for using the EMR for reporting, BSIC, and the RTD information of the neighbour cells, as well as all user definable parameters for EMR reporting, are sent to the MS in a 'measurement information' message on the TCH channel.

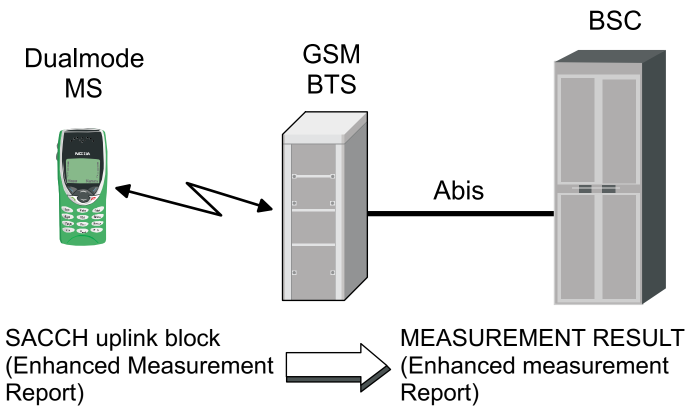


Figure 5 Enhanced Measurement Reporting

Averaging of the Enhanced Measurement Reports:

- The user can decide the averaging period to be used for the EMR using an MML command. It can range from 480 ms to 1920 ms in 480 ms steps.

The user equipment supporting the Enhanced Measurement Report is based on 3GPP release '99 or newer.

Interaction with other features:

- The network does not order an MS to use the EMR for reporting when an Idle BCCH Allocation List or a Measurement BCCH Allocation List is used in active state in the serving cell.
- With Common BCCH Control, when a call is in a non-BCCH frequency band, the serving cell BCCH frequency is added to the BCCH frequency list.
- When the EMR is used for reporting, also the serving cell BSIC is added to the BSIC list before sending it to an MS.

Benefits

- Improved generic performance of the system
- Improved GSM/EDGE/WCDMA interworking
- Improved performance of statistics

5.22 BSS11073 Recovery for BSS and Site Synchronisation

The main purpose of the Recovery for BSS and Site Synchronisation feature is to offer automatic recovery:

- when the Location Measurement Unit (LMU) clock signal is lost, to get the chained BTS cabinet (site) into an unsynchronised mode
- when the LMU clock signal is again available, to return the chained cabinet back into a synchronised mode

The feature also offers synchronisation recovery for a Multi BCF site.

When the BTS chain is defined in the BSS radio network database, this feature automates the recovery if the BTSs in the chain are synchronised and the clock signal is lost and regained. On the other hand, if the chain is not defined or the BSS or Site synchronisation of the chain has not been activated, the used functionality of the BSS and Site synchronisation is on a BSS10.5 level and the user has to lock and unlock the sites in correct order to enable the system synchronisation. The BSC receives the information for recovery from Q1 and BTS alarms.

This feature can be used together with the Dynamic Frequency and Channel Allocation (DFCA) when the LMU is defined as a clock source in the BSS radio network database and the BCF is in a synchronised mode, and with the Multi BCF configuration, provided that all the unlocked BCFs are defined to the same chain operating in a synchronised mode.

For TalkFamily BTS chain the maximum is 6 BTSs, and for UltraSite BTS chain a maximum of 9 BTSs. TalkFamily BTSs cannot be placed after UltraSite in the clock chain.

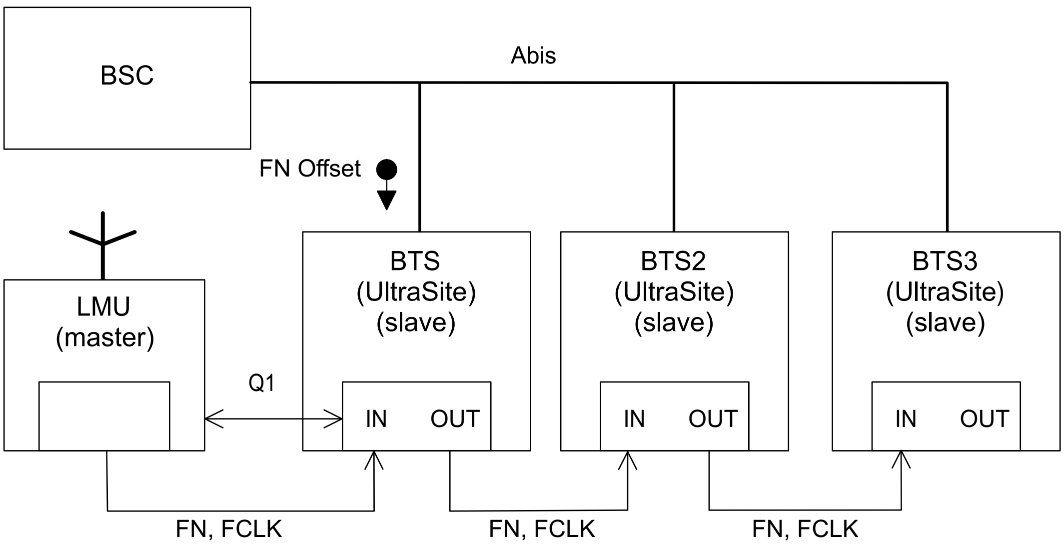


Figure 6 Synchronised BSS example in UltraSite chain

The BSS is synchronised by a Global Positioning System (GPS), that is LMUs are installed to every site with GPS antennas. The clock source is a GPS satellite via LMU. When LMU feeds the clock, all BTSs are working as slaves. When the LMU clock feed is lost, the BSC starts a timer. The synchronised operation continues uninterrupted based on the BTS internal clock. If the BSC timer expires, the first BTS in the chain becomes a clock master and starts supplying the clock signal to the other BTSs. The

BTS synchronisation status indication in BSC is changed to 'unsynchronised'. When the LMU clock is recovered, the BTS becomes again synchronised.

In order to take the Recovery of BSS and Site Synchronisation feature into use, the user needs to define the LMU area configuration in BSS synchronisation, define the synchronisation configuration (BSS or Site synchronisation), activate the synchronisation of the chain, and add a slave BCF to a synchronisation-enabled chain in the BSC.

The operator can also define the BCF to work in an independent mode, which means that the BCF's synchronisation source is an external PCM. The independent BCF cannot be defined to a clock chain and no synchronisation recovery action is performed.

This feature supports the following BTS generations and SW, when the chain is defined:

- UltraSite with CX4
- MetroSite with CXM4
- TalkFamily DF7
- When BSS synchronisation configuration is used, LMU SW 4.0 is required with the feature

Benefits

Automatic recovery for the loss of LMU clock, when the BTS chain is defined in the BSS radio network database:

- Automatic BSC controlled recovery to unsynchronised operation
- Automatic BSC controlled return back to synchronised operation
- Timeslot offset parameter sending to LMU
- BTS synchronisation configuration and mode information available from the BSC by MML and NetAct

5.23 BSS11047 Intelligent shutdown for UltraSite BTS

A BTS can be equipped with a battery backup system to provide protection against a mains power break.

The purpose of the intelligent shutdown feature is to maintain the BTS site operation for as long as possible by reducing capacity (units turned off or reduced to low power consuming modes) so that only the essential site functions are maintained.

The reduction of the site capacity is controlled by the BSC, which commands individual transceiver units to be shut down or started up.

On a BTS site basis, the operator can define the service level of the site to be maintained while the battery backup is in use. The operator can also define two timers, allowing the execution of the shutdown procedure in phases, reducing capacity in a controlled way. Three service level options are available:

- Full service – Service is maintained at full capacity for as long as the battery power supply lasts. The two timers are ignored.
- BCCH backup – The BTS maintains full capacity until the first timer expires. After that, all active calls on non-BCCH transceivers are handed off. The non-BCCH transceivers are blocked from carrying any new calls and the BSC commands the BTS to shut them down. The BCCH TRX(s) are maintained to offer minimum service.
- Transmission backup – The second timer starts after the first one has expired. After the expiry of the second timer, all active calls on BCCH transceivers are handed-off. The BCCH transceivers are blocked from carrying new calls and the BSC commands the BTS to shut them down. Only the BTS transmission equipment power is maintained to secure the functionality of a transmission chain for as long as the batteries last.

When the mains power is restored, the BSC commands the BTS site to power all the shut down equipment and return back to full service.

Battery backup configurations for UltraSite:

- UltraSite Support
- UltraSite with Integrated Battery Backup Units
- 3rd Party Battery Backup Solution

The UltraSite Support system and the integrated battery backup units are autodetected by the UltraSite BTS. When using a 3rd party battery backup solution, an external alarm line is designated to indicate a mains power loss/restoration from that equipment. This is specified in the configuration data sent to the BTS from the BSC during the initial start-up or reset of the BTS. In case the mains power is lost, a 'mains breakdown' alarm is sent from the battery backup system to the BTS and further to the BSC, which then triggers the shutdown procedure.

BTS shutdown implementation in UltraSite BTS:

- Transceivers all share the same power supply and cannot be individually powered off.
- In a shutdown state, no calls are allocated to a transceiver and its RF is off. For a BCCH transceiver, the BCCH broadcasting is stopped.
- One fan provides cooling for two transceivers. If both transceivers are 'shut down', the cooling fan is turned off.

- When running on a battery supplied power, the optional BTS Cabinet Heater will not operate.
- The intelligent shutdown feature has no impact on sites with chained UltraSite BTSs, as individual cabinets cannot be powered off.

Benefits

The operation is optimal during both short and long mains breaks. Timers allow executing the shutdown procedure in several phases. Each phase reduces the battery power consumption.

With intelligent shutdown you can define the service level to be applied on a mains failure to optimise the trade-off between the service level and battery power lifetime. A short mains break will not reduce the service unnecessarily, whereas during a longer break, the essential functions, such as BCCH or transmission chain, are maintained for as long as possible.

5.24 Remote Download of Configuration Files

With the Remote Download of Configuration Files, the BTS can be commissioned with a minimum number of site visits.

The configuration file is set up by the BTS HW Configurator part of the SiteWizard, and stored on the BTS.

The Remote Download of Configuration Files feature provides, with certain restrictions, the capability to perform BTS HW Configurator functions from a PC connected to the NetAct network operation management centre.

General:

- A remote access facility is added to the existing BTS HW Configurator.
- The SW application runs in the SiteWizard Windows PC, either remotely attached to the NetAct OMS, or locally attached to the BTS.
- Supports UltraSite BTS.

The main functions included are:

- Upload HW Configuration file from the BTS.
- Create or amend configuration file in the PC.
- Save HW Configuration file in the PC.
- Download HW Configuration file to the BTS.
- Fetch BTS Passive Unit information.
- Create or Amend BTS Passive Unit information.
- Send BTS Passive Unit information.

Limitations in the remote BTS HW configuration:

- Bar Code Reader input is not available when in remote attach mode (the menu item is 'greyed-out'). The Bar Code reader input is not supported in a remote mode, because it is not possible to read the bar codes of on-site units from a PC in the network operation management centre.

5.25 BSS10101 GSM-WCDMA interworking

In order for an operator to provide seamless coverage in areas where WCDMA is not available, such as rural areas, inter-system handovers are introduced. This feature facilitates handovers between GSM BSS and WCDMA RAN. Also, when the WCDMA and GSM networks overlap, an inter-system handover from GSM to WCDMA can be made to release traffic load in the GSM system.

Benefits of the inter-system handover include:

- seamless coverage extension for 3G with the 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 and Network controlled cell re-selection) modes are supported. BSC SW release S11.5 is required for Network controlled cell re-selection.

In idle mode, thresholds for a mobile to select the best cell (MS cell re-selection) are based on field strength. The main principles in the idle mode cell re-selection are:

- the operator is able to define the cell re-selection thresholds by Radio Network (RNW) parameters
- those parameters are sent to the mobile in the System Information (Sys Info) or Packet System Information messages

For initial cell re-selection, the system information broadcast indicates that dual mode capable mobiles should select a certain BSS.

In BSS10.5, coverage based handovers (from WCDMA to GSM) combined with load based handovers (from GSM to WCDMA) are supported.

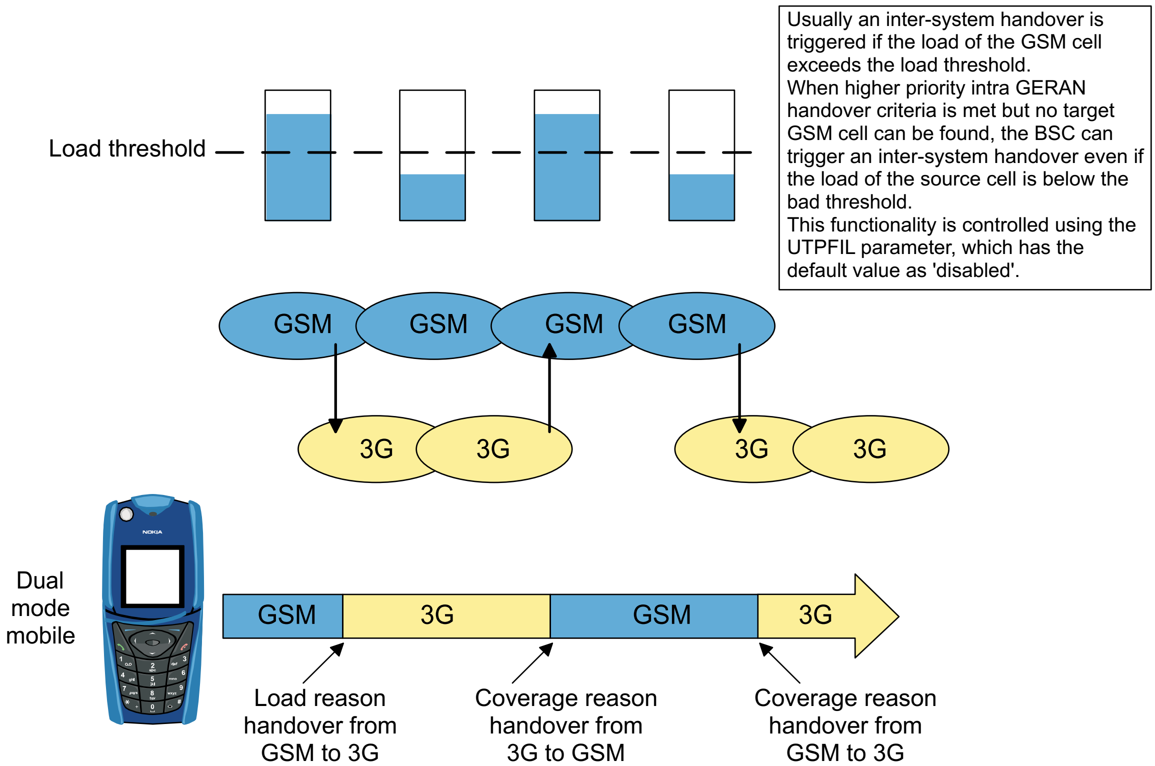


Figure 7 Load and coverage reason handovers

In handover preparation, the controller (RNC or BSC) commands the mobile to measure the neighbouring cells belonging to other systems. The mobile sends the inter-system measurement results to the RNC or BSC. Based on the measurement results, the BSC or RNC handover algorithm is able to decide whether to initiate an inter-system handover or not.

A handover attempt from GSM to WCDMA is initiated:

- if the signal strength of the adjacent WCDMA cell is greater than the operator defined threshold
- if the load of the serving GSM cell exceeds the load threshold for speech and transparent data calls

A handover from WCDMA to GSM is seen as an inter-BSC handover in the target system. Cell re-selection is performed by a Mobile Station (MS) autonomously. Parameters C32/C31, which are broadcast on PBCCH, are provided as a complement to the current GSM Packet Switched cell re-selection criteria.

5.26 BSS7005 Intelligent Frequency Hopping (IFH)

Intelligent frequency hopping is designed to allow the operator to reuse frequencies more intensively, and therefore achieve a higher radio network capacity. Another benefit of frequency hopping is to avoid frequency dependent fading on the radio path.

Currently, Intelligent Underlay Overlay (IUO) cannot be used simultaneously with frequency hopping in the same cell. This feature enables the operator to use both Baseband (BB) and Radio Frequency (RF) hopping with IUO.

The different interference characteristics of the regular and super-reuse layers in IUO require that the network plan for frequency hopping is constructed separately for each layer. This feature allows the use of separate Mobile Allocation Frequency Lists of RF hopping for the layers of an IUO cell. BB hopping is implemented by treating the regular layer as a normal cell and the super-reuse layer as a new hopping group.

The operator can set the regular and super-reuse layers in IUO individually to hopping. The BTS cell cannot have BB hopping and frequency hopping simultaneously in use.

5.27 Enhanced Automatic Frequency Correction (E-AFC)

The E-AFC feature, or in full name, Enhanced Decision Directed AFC (E-DDAFC), is an EDGE receiver algorithm enhancement to support high speed users of Gaussian Minimum Shift Keying (GMSK) based speech and data services, such as someone on a train

E-AFC supports the following channels:

- Signalling (FACCH, SDCCH, SACCH)
- FR, EFR and AMR speech codecs
- (HS)CSD

E-AFC also supports Baseband hopping and 4UD.

(E)GPRS channels and Non-EDGE mode are not supported in the initial implementation of this feature.

The RF performance of the BTS is impaired by various phenomena that introduce frequency errors such as:

- Doppler shifts caused by the mobile user physical moving
- Fixed offsets in the Mobile Station transmitter crystal oscillator

The Automatic Frequency Correction (AFC) algorithm estimates the frequency errors and attempts to cancel these in the received signal path.

The current DDAFC algorithm implementation calculates frequency offset estimates and applies correction on a burst-by-burst basis. This is performed solely by the EQDSP. The effectiveness of this algorithm is degraded as the magnitude of the frequency offsets increases, that is the speed of the mobile increases.

The E-DDAFC enhances the existing DDAFC algorithm by tracking the frequency offset over a number of bursts. This solution involves both the EQDSP and CHDSP.

A long-term coarse (average) frequency offset value is calculated and updated on each new burst received per user. This 'average' value is used to apply a coarse correction to subsequent bursts from the same user prior to the current burst-by-burst correction system, which makes any fine adjustments necessary.

The E-DDAFC re-uses the current DDAFC burst-by-burst estimator as it is.The EQDSP additionally calculates and updates the coarse frequency offset and sends this coarse frequency estimate via Fbus to the CHDSP for storage in the AFC database. The CHDSP associates each coarse frequency offset with a particular user and current burst on air, retrieves the AFC coarse correction from the AFC database and sends this correct value back to the EQDSP in advance of each Uplink burst.

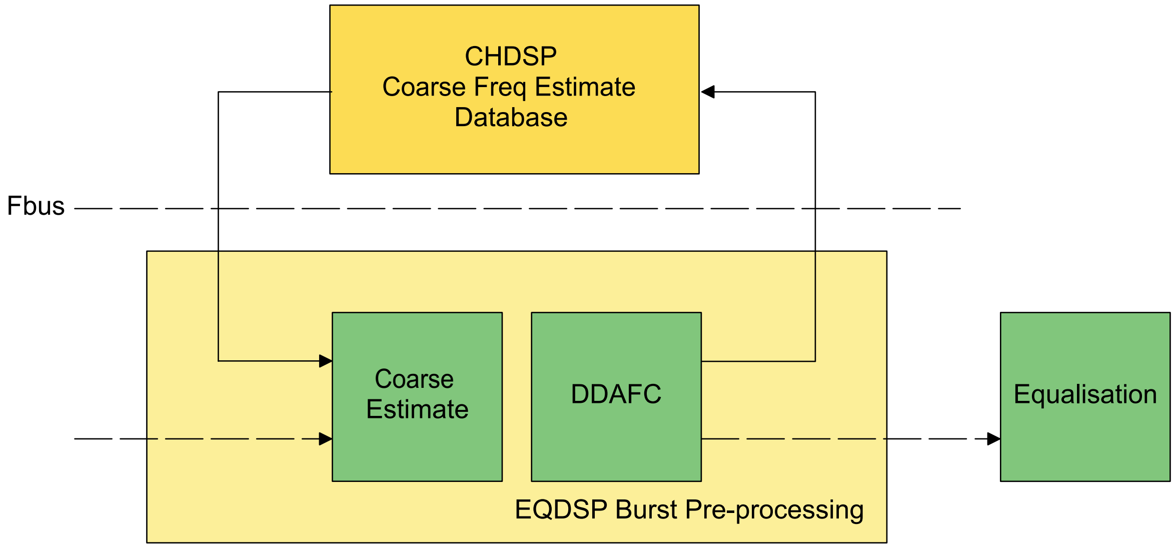


Figure 8 E-DDAFC interface overview between CHDSP and EQDSP

5.28 Mixed mode BB hopping

The mixed mode Baseband (BB) hopping feature enables GSM and EDGE TRXs to be included in the same GMSK-only BB hopping sector. GMSK-only means that EDGE operation is not allowed (not configured), so that only circuit switched and GPRS traffic is supported. The EDGE TRXs must use BB2F baseband units, since this feature is not supported by the BB2E baseband unit.

5.29 Support for BB2F

The BB2F is a product harmonisation version of the BB2E unit and has all the same functionality of the BB2E.

5.30 BSS11037 Remote BTS Manager

The Base Transceiver Station (BTS) equipment can be controlled locally at the site by the user, via BTS Manager. To minimise the need for site visits, it is necessary that the BTS Manager functions are also accessible remotely.

The Remote BTS Manager feature enables to monitor and test the BTS remotely, by connecting the remote BTS Manager to the BTS via the Network Management System (NMS/2000) or NetAct. A PC with the BTS Manager software is used as a user terminal. Nokia's General Communication Server (GCS) SW Suite is used for providing both local and remote connections to the BTS.

The remote BTS Manager is implemented on the basis of the existing Q1 transmission equipment protocol. BTS Manager commands are encapsulated within this protocol that is further encapsulated within a number of different signalling protocols (TCP/IP, X25, Abis). Therefore, it is possible to remotely centralise the control of several BTSs from one location.

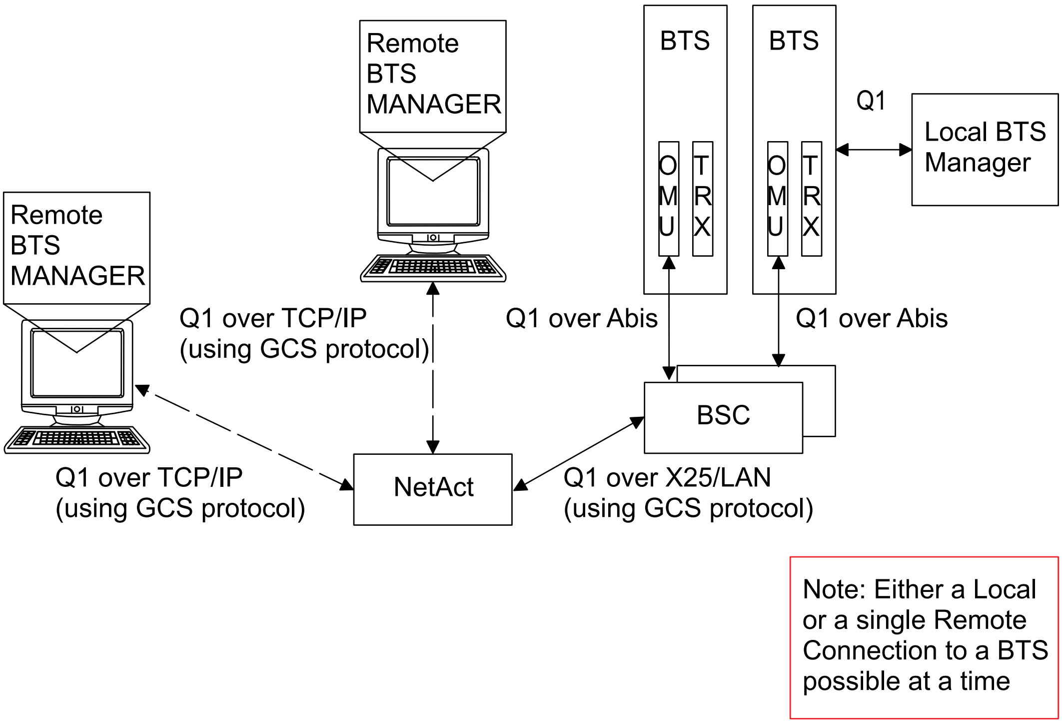


Figure 9 Remote BTS Manager connection

The user can connect to a remote BTS using the BTS Manager application, via a menu item and/or a toolbar button, or via the command line. The user is informed, via the BTS Manager User Interface (UI), of the remote connection status, when information is being requested from the remote BTS, and when received information from a remote BTS is being processed by the BTS Manager. The remote BTS Manager supports all the features available via a local connection, with the exception of the following:

- SW loading
- BTS commissioning
- Undo BTS commissioning
- Control Abis interface (enable/disable)
- LMB speed change

- Local block/unblock

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

At the BTS, the messages sent from or to the remote BTS Manager are re-routed, but handled in the same way as with the local connection.

5.31 BSS10083 Enhanced General Packet Radio Service (MCS 1-9)

Enhanced General Packet Radio Service (EGPRS) supports high rate packet data services across varying channel conditions. EGPRS is built on top of the packet switched data service, GPRS. As shown in the table below, EGPRS supports higher data rates compared to the basic GPRS, using several Modulation and Coding Schemes (MCSs), which vary from 8.8 kbps up to 59.2 kbps in the radio interface.

MCS	Modulation	Code Rate	Family	User Rate
1	GMSK	.53	C	8.8 kbps
2	GMSK	.66	B	11.2 kbps
3	GMSK	.80	A	14.8 kbps
4	GMSK	1	C	17.6 kbps
5	8PSK	.37	B	22.4 kbps
6	8PSK	.49	A	29.6 kbps
7	8PSK	.75	B	44.8 kbps
8	8PSK	.92	A	54.4 kbps
9	8PSK	1	A	59.2 kbps

Table 1 Peak data rates for single slot EGPRS

Gaussian Minimum Shift Keying (GMSK) modulation provides the robust mode for wide-area coverage, while 8 Phase Shift Keying (8PSK) provides higher data rates.

The MCSs are organised into families to allow a re-segmentation of the data block for link adaptation. Since higher protection means lower throughput, the protection that best fits the channel condition is chosen for maximum throughput.

5.31.1 Incremental Redundancy (IR)

Incremental Redundancy (IR) is an efficient combination of two techniques: Automatic Repeat reQuest (ARQ) and Forward Error Correction (FEC). In the ARQ method, when the receiver detects the presence of errors in a received data block, it requests a re-transmission of the same data block from the transmitter. The process continues until an uncorrupted copy reaches the destination. The FEC method adds redundant information to the user information at the transmitter, and the receiver uses the information to correct errors caused by disturbances in the radio channel.

In the IR scheme (also known as Type II Hybrid ARQ scheme), only a small amount of redundancy is sent first, which yields a high user throughput if the decoding is successful. However, if the decoding fails, a re-transmission takes place according to the ARQ method. Using IR, the re-transmission of the data block is different from the initial transmission. The transmitter sends additional redundancy that is decoded at the destination with the previously received information to allow for error correction. Since the combination includes more information than any individual transmission, the probability of correct reception is increased.

The IR mechanism in EGPRS is designed around nine Modulation and Coding Schemes (MCSs). The basic characteristics of each MCS are its fixed data rate and fixed protection level. For each of the MCSs, it is possible to reach the same data rate with the same protection level, but with a different protection scheme.

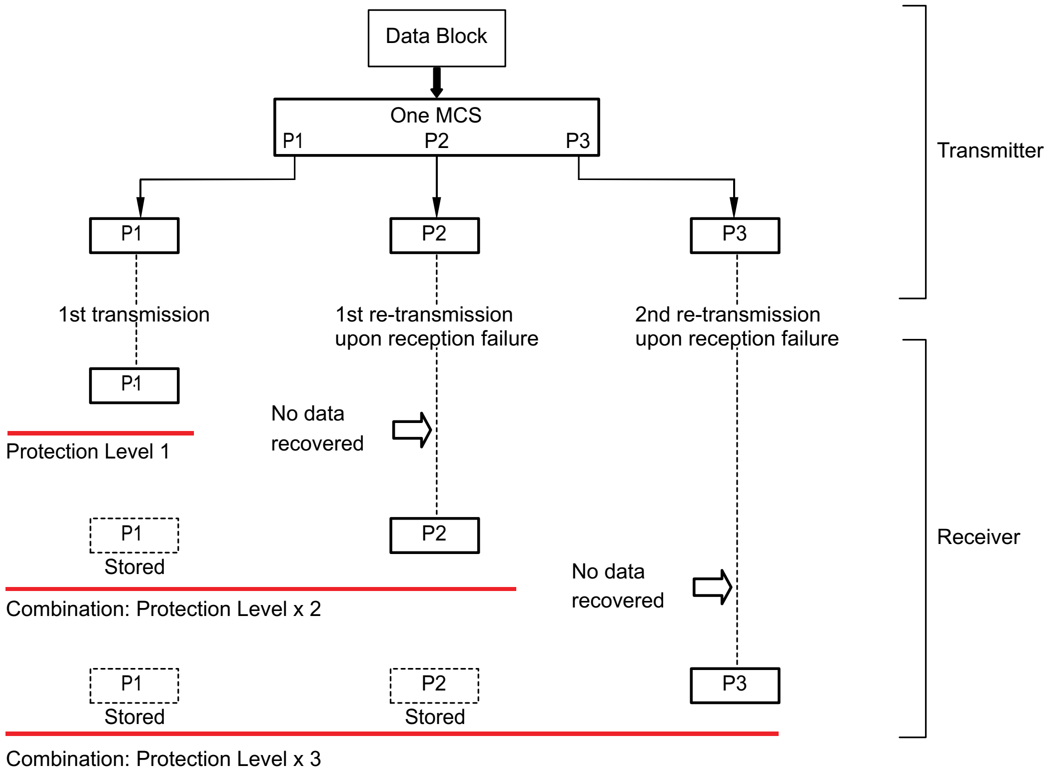


Figure 10 Incremental Redundancy scheme

There are three protection schemes (P1, P2 and P3) for an MCS, as shown in the figure above. The data block is first protected with the P1 of a certain MCS, and sent over the air to the receiver, which tries to recover the data. If this phase fails, the received P1 is stored in the receiver's memory for future use, and the transmitter sends the data block protected with the P2 of the same MCS. The receiver combines the received P2 with the stored P1 and tries to recover the data from the combination of P1 and P2 .This process continues until the data is recovered.

If after P3, the data still cannot be recovered, P1 is sent again and combined with the stored P1, P2 and P3 (which reaches a protection level of about four times P1), and so on until the data is recovered.

5.31.2 Link Adaptation (LA)

The Link Adaptation (LA) mechanism works to provide the highest throughput and lowest delay available by adapting the protection of the information to be sent according to the link quality. The upcoming channel quality is accurately predicted from various measurements of the past link. This prediction determines the relevant protection of the information to be sent. Therefore, enabling LA requires accurate link quality measurements and a set of Modulation and Coding Schemes (MCSs) with different degrees of protection.

Accurate link quality measurements

The use of new efficient EGPRS measurements provides an accurate prediction of the upcoming link quality in several propagation channels with various speeds (such as typical urban and rural areas, and hilly terrain).

Data rates and protection levels

Nine Modulation and Coding Schemes (MCSs) are designed for EGPRS. When a data block is sent, the information is encoded, using one of the MCSs, to resist channel degradation, and modulated before transmission over the air interface. Because the resources are limited, the higher the level of protection for information, the less information is sent. MCS-1 to MCS-9 range from a high protection/low bit rate, to no protection/high bit rate, as summarised in the figure below.

Scheme	Modulation	Data Rate (kbps)	Code Rate	Family
MCS-1	GMSK	8.8	.53	C
MCS-2		11.2	.66	B
MCS-3		14.8	.80	A
MCS-4		17.6	1	C
MCS-5	8PSK	22.4	.37	B
MCS-6		29.6	.49	A
MCS-7		44.8	.76	B
MCS-8		54.4	.92	A
MCS-9		59.2	1	A

Protection decreases

Figure 11 Data rates and protection levels for Modulation and Coding Schemes

In EGPRS, it is possible to switch between any of the MCSs, from one data block to another, as it is in GPRS. However, in GPRS, once a data block is segmented to fit one particular coding scheme, it is not possible to switch the coding scheme on reception failure, and therefore the re-transmission takes place with exactly the same protection as for its initial transmission. In EGPRS, on the other hand, it is possible to change the MCS. This is useful, because the level of protection needed in a re-transmission may be different due to varying channel conditions and the existing protection from earlier incremental redundancy transmissions.

5.32 BSS10045 Dynamic Abis allocation

Dynamic Abis allocation is a solution for higher data rates of Enhanced General Packet Radio Service (EGPRS) to ensure cost efficiency and flexible Abis transmission capacity addition. The Dynamic Abis functionality allocates Abis transmission capacity to cells when needed, instead of reserving full fixed transmission link per transceiver (TRX).

With enhanced data rates per radio timeslot varying between 8.8 and 59.2 kbit/s, the traditional static Abis allocation does not use transmission resources efficiently. The Dynamic Abis feature uses the existing Abis more efficiently by splitting Pulse Code Modulations (PCMs) into permanent timeslots for signalling and voice, and by providing a dynamic pool for data. The pool can be shared by a number of TRXs. The Dynamic Abis transmission solution saves up to 70 % of the Abis transmission expansion cost, because it allows the Abis dimensioning to be performed closer to the average data rates, instead of at peak rates. This also applies to the reduced number of 2M BSC interfaces needed.

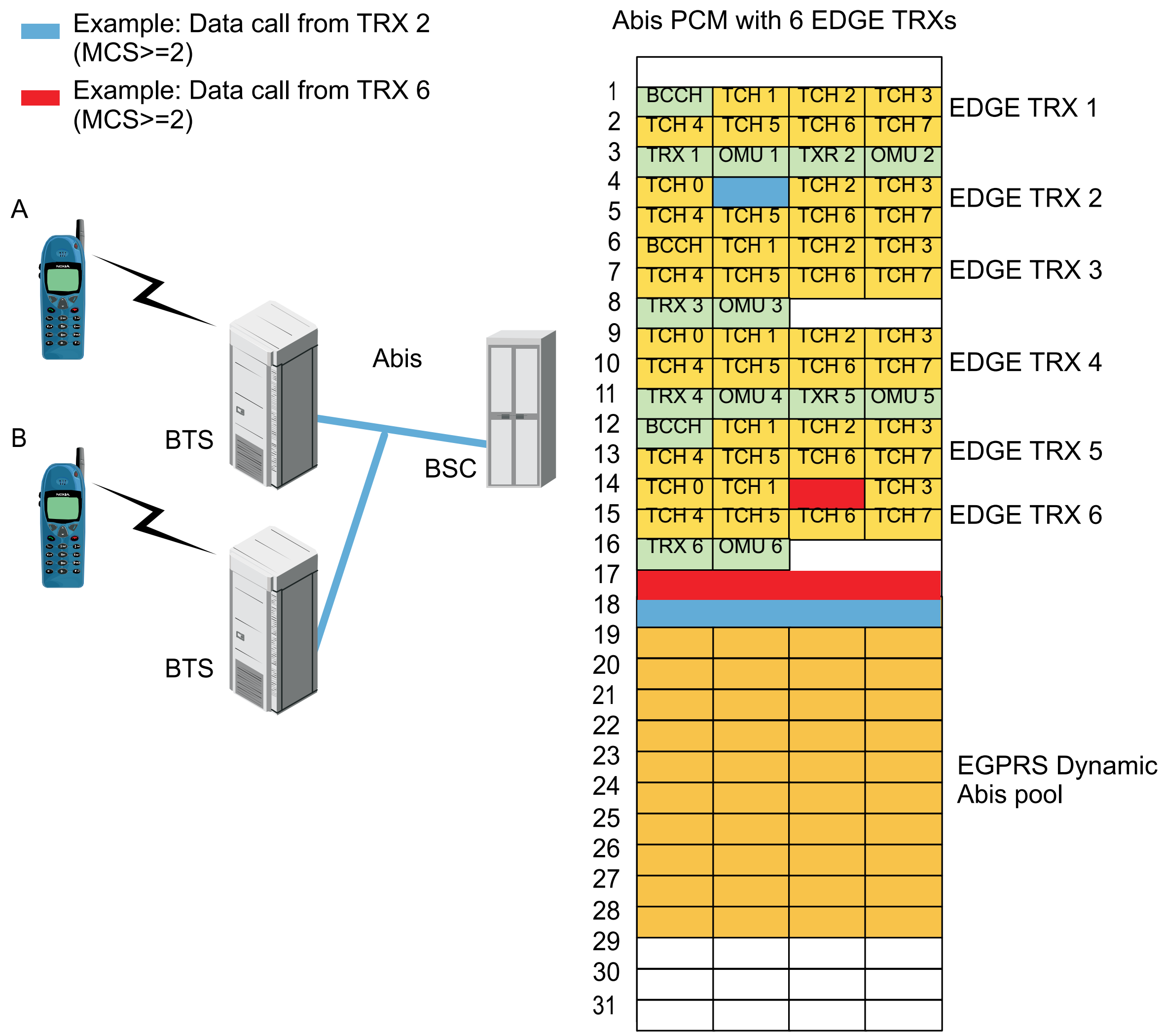


Figure 12 Dynamic Abis pooling

Abis channel mapping is implemented so that the standard GSM TRXs are connected to the Base Station Controller (BSC) normally with a 16 kbps point-to-point link from the

TCH to the BSC. Because the basic capacity is reserved for signalling (TRXSIG, BCFSIG), EDGE TRXs are configured slightly differently. When required, the BSC allocates Abis capacity for data calls from the dynamic pool. The capacity for calls can be reserved in 16 kbps blocks. For every EDGE TRX, there is a fixed 16 kbps allocation for TRXSIG and, in addition, capacity needed for calls is reserved from the Dynamic Abis pool. The Dynamic Abis pool can be shared between several EDGE TRXs located at various sites.

The maximum number of TRXs per Dynamic Abis pool is 32, due to signalling requirements of the Base Station Controller Signalling Unit (BCSU).

5.33 BSS10104 Nokia Smart Radio Concept for EDGE (Nokia SRC)

Nokia Smart Radio Concept (SRC) is an important new feature for getting the maximum EDGE benefit, first phase supported by Nokia Siemens Networks UltraSite EDGE Base Station with BSS10 hardware and software.

SRC is a novel feature that will enhance the radio performance of the BTS, both in EDGE and GSM mode. The Nokia SRC includes a combination of increased signal power and diversity solutions applied in both uplink and downlink directions. The Nokia SRC supports frequency hopping. The Nokia SRC for EDGE is used to improve radio link performance to ensure maximum coverage, system capacity, improved data throughput and high service quality. The Nokia SRC can significantly improve the spectral efficiency of narrow band networks. For utilising the Nokia SRC, EDGE capable equipment with an auxiliary transceiver is required.

4-way Uplink Diversity (4UD) and Interference Rejection Combining (IRC)

In the BSS10, the uplink Base Station performance is enhanced by using a unique combination of Interference Rejection Combining technique with 4-way uplink diversity reception. Sensitivity will be further optimised by using high-gain UltraSite Masthead Amplifiers for reduced cable losses.

Co-channel or adjacent channel interference can create strong cross correlation between input signals, degrading thus the uplink performance. The Interference Rejection Combining is an extension to the Maximum Ratio Combining (MRC) method, which rejects the interference and constructively combines multiple input signals from different antenna sources into one signal. The IRC decorrelates input signal branches (IRC step) and performs the signal combining (MRC step) for decorrelated branches. If there is no interference, the IRC behaves like a normal Maximum Ratio Combining without loss in terms of sensitivity performance. The 4-way Uplink Diversity utilises pair-wise IRC combining result from the auxiliary and main transceivers, where the Post Detection Maximum Ratio Combining process is finally done for two IRC combined signals.

The gain of IRC depends on the Dominant Interference Ratio and angular spread of interference [PAR]. In typical interference limited conditions, the IRC can provide up to 7dB gain over MRC combining. The 4UD can provide up to 3dB sensitivity gain over 2-way reception due to doubled received signal power. An additional 1 to 2dB diversity gain can be added depending on the radio propagation, resulting thus in 4 to 5dB overall gain over traditional 2-way diversity reception for all physical channels and radio timeslots.

The 4UD is an ideal method for a dual X-polarised antenna concept providing major capacity, coverage and quality enhancements with added data throughput.The increased uplink sensitivity also improves mobile station battery life.

Intelligent Downlink Diversity (IDD)

The auxiliary transceiver and antenna diversity gain is also applied in downlink by using a feature called Intelligent Downlink Diversity (IDD). In the IDD, the cell coverage area is extended by sending the same downlink signal through two transmitters simultaneously for additional signal power. The auxiliary transmitter introduces controlled delay and hopped phase to the original signal for additional diversity gain. As a result, the auxiliary transmitter doubles the transmitted signal power and creates an artificial, independently fading multipath propagation component, which can be resolved by any legacy mobile station receiver. Increased signal power and diversity gain will improve the performance of all physical radio channels and timeslots for different propagation conditions.

All logical traffic and control channels in all radio timeslots are transmitted through two transceivers, which are connected to spatially separated antennas. Also, the BCCH carrier is transmitted through two transceivers for enhanced BCCH coverage.

The IDD boosts downlink performance by 3 dB due to doubled transmitted signal power obtained from the auxiliary transceiver. Additional 2 to 3 dB diversity gain can be added, resulting thus in 5 to 6 dB gain in average for radio timeslots.

The IDD is an ideal method for a dual X-polarised antenna concept providing major capacity, coverage and quality enhancements with added data throughput.

Cell configuration for Nokia SRC (IDD/4UD)

Two antennas in downlink and four antennas in uplink are needed for one cell. Also two X-polarised dual antenna elements can be used. Low correlation between the antennas is preferred, but the SRC gain is not lost even with high correlation. Typical configurations in one UltraSite EDGE base station cabinet are, for example: 1+1+1 with combiner by-pass, 2+2+2 with 4-way diversity and 6 TRXs/cell with RTC for large coverage and high capacity needs.

5.34 BSS10087 GSM/EDGE 800

This feature supports the use of the 800 MHz frequency band in BSS. For the 800 MHz band, the system operates in the following frequency bands:

Uplink: 824 - 849 MHz. The mobile station transmits, the base station receives.

Downlink: 869 - 894 MHz. The base station transmits, the mobile station receives.

The carrier frequency is designated by the absolute radio frequency channel number (ARFCN). Fl (n) is the frequency value of the carrier ARFCN n in the lower band, and Fu (n) the corresponding frequency value in the upper band.

800 MHz	Fl(n) = 824.2 + 0.2*(n-128)	$128 \le n \le 251$	Fu(n) = Fl(n) +45

Table 2 Summary of Absolute Radio Frequency Channel Numbering

As a main rule, all the existing BSS features applicable to MetroSite and UltraSite BTS are also supported in the 800 MHz band.

5.35 BSS10063 RX antenna supervision by comparing RSSI

The purpose of this feature is to monitor the Rx antenna condition. Rx antennas can be monitored for major problems by taking a long-term average of the difference between the Main Rx RSSI and the Div Rx RSSI. This feature provides continuous antenna supervision for the BTSs, which have main and diversity in use. It also offers an alternative solution for Tx monitoring in cells that use duplexing. This detects, for example, antennas with poor VSWR and inadequate feeders.

The monitoring is based on the principle that all received bursts, where the Rx level of main or diversity branch is above the defined limit value (-100 dBm), are accepted as samples and used in the averaging process. The differences of the TRXs connected to the same antennas are counted up, and the average difference per main and diversity antennas is calculated. If the difference is above the threshold (default value 10 dB), an alarm is activated. The threshold default value of 10 dB can be changed by a parameter at the BSC between 3-64. The functionality of the feature can be disabled by using the maximum value.

It is still possible that both antennas are damaged simultaneously and the difference algorithm cannot detect the fault. For this reason, the BTS also observes the assignment and handover success rate per antenna. Excessive failures are detected by Bias-T unit, and an SWR alarm is raised.

5.36 BSS10046 Multi BCF Control

Multi BCF Control feature allows the combination of several BTSs into one logical cell, allowing the operator to increase the capacity of a cell while maintaining the maximum spectral efficiency. The feature increases the cell capacity for UltraSite EDGE BTSs to 36 TRXs while requiring no extra BCCH. Multi BCF also provides a path for site expansion from Talk-family to UltraSite EDGE BTS and therefore an evolution path to EDGE services.

The operator can arrange base stations so that the TRXs in different base stations (operating on the same frequency band) can serve the same cell with a single BCCH. At the base station site the operator makes some installations, for example synchronisation is needed between the base stations. All the base stations will have a separate O&M link to the BSC. At the BSC, the operator uses a new SEGMENT (SEG) object, where the operator sets all the BTS objects sharing the same BCCH.

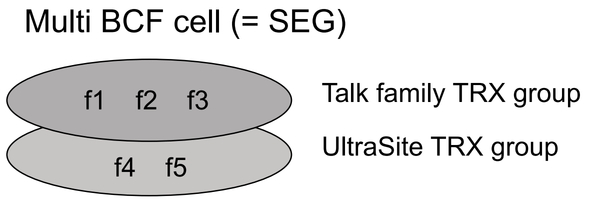


Figure 13 Multi BCF configuration

5.37 BSS10022 Frame Erasure Rate (FER) Measurement for FH

Features such as frequency hopping, AMR and GPRS are changing the efficiency of the error correction mechanism and, as a result, the BER measurement is no longer a good indication of the quality experienced in the network.

This feature offers the ability to report the uplink FER from the BTS to the BSC, which provides more realistic measures of voice quality and allows handovers and power control based on FER rather than BER-based Rx-quality. FER represents the percentage of frames being dropped due to a high number of non-corrected bit errors in the frame.

5.38 BSS10016 Tri Band - Common BCCH

Common BCCH functionality is introduced in the ETSI GSM specification 03.26. The option is to allow GSM 900 (PGSM and EGSM) and GSM 1800 TRXs to share the same BCCH, that is to effectively be in the same cell. This can be seen as a progression from the integrated dual band BTS and EGSM 900 frequency support.

The main advantages of the common BCCH functionality are:

- Improved trunking gain
- Use of signalling channels is optimised by sharing them between bands
- Tighter reuse of all carriers in the non-BCCH bands
- Better call quality due to decreased handovers

In order to ensure proper operation of the network, the operator should take into account issues related to the difference of propagation between the different bands when performing cell planning.

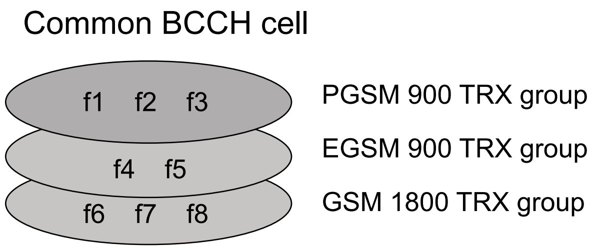


Figure 14 Common BCCH configuration

Frequency hopping between bands in the same sector is not supported.

5.39 BSS10004 Adaptive Multi Rate Codec (AMR)

This feature introduces a new set of codecs and an adaptive algorithm for codec changes, which can provide a significantly better speech quality. With AMR, very good speech quality can be achieved with full rate calls even where the C/I ratio is low, or the speech capacity can be increased by using the half rate mode and still maintain the quality of current FR calls.

Generic AMR description

AMR consists of 8 different speech codec modes with a total of 14 channel codec modes, which are listed in the following table:

Channel mode	Channel codec mode	Source coding bit-rate, speech	Net bit-rate, in-band channel	Channel coding bit-rate, speech	Channel coding bit-rate, in-band
TCH/FR	CH0-FS	12.20 kbit/s (GSMEFR)	0.10 kbit/s	10.20 kbit/s	0.30 kbit/s
	CH1-FS	10.20 kbit/s	0.10 kbit/s	12.20 kbit/s	0.30 kbit/s
	CH2-FS	7.95 kbit/s	0.10 kbit/s	14.45 kbit/s	0.30 kbit/s
	CH3-FS	7.40 kbit/s (IS-641)	0.10 kbit/s	15.00 kbit/s	0.30 kbit/s
	CH4-FS	6.70 kbit/s	0.10 kbit/s	15.70 kbit/s	0.30 kbit/s
	CH5-FS	5.90 kbit/s	0.10 kbit/s	16.50 kbit/s	0.30 kbit/s
	CH6-FS	5.15 kbit/s	0.10 kbit/s	17.25 kbit/s	0.30 kbit/s
	CH7-FS	4.75 kbit/s	0.10 kbit/s	17.65 kbit/s	0.30 kbit/s
TCH/HR	CH8-HS	7.95 kbit/s (*)	0.10 kbit/s	3.25 kbit/s	0.10 kbit/s
	CH9-HS	7.40 kbit/s (IS-641)	0.10 kbit/s	3.80 kbit/s	0.10 kbit/s
	CH10-HS	6.70 kbit/s	0.10 kbit/s	4.50 kbit/s	0.10 kbit/s
	CH11-HS	5.90 kbit/s	0.10 kbit/s	5.30 kbit/s	0.10 kbit/s
	CH12-HS	5.15 kbit/s	0.10 kbit/s	6.05 kbit/s	0.10 kbit/s
	CH13-HS	4.75 kbit/s	0.10 kbit/s	6.45 kbit/s	0.10 kbit/s
(*) Requires 16 kbit/s TRAU. Therefore it is not seen as a feasible codec mode and will not be supported by Nokia Siemens Networks BSS10.					

Table 3 Channel and speech codec modes for AMR

Codec mode adaptation for AMR is based on received channel quality estimation in both Mobile Station (MS) and BTS, followed by a decision on the most appropriate speech and channel codec mode to apply at a given time. In high-error conditions, more bits are used for error correction to obtain error robust coding, while in good transmission conditions, only a small number of bits is needed for sufficient error protection and more bits can be allocated for source coding.

An in-band signalling channel is defined for AMR that enables the MS and the BTS to exchange messages on applied or requested speech and channel codec modes. The above mentioned selected speech codec mode is then sent, by using the in-band signalling channel, to the transmitting side, where it is applied for the other link. The BTS commands the MS to apply a particular speech codec mode in the uplink, but MS can only request BTS to apply a particular speech codec mode in the downlink because BTS has an option to override the MS's request. For each codec mode set there is an associated set of decision thresholds for mapping the channel quality measurements to the Mode Commands/Requests.

Link Adaptation (LA)

There are two link adaptation modes: the ETSI specified fast LA and the Nokia proprietary slow LA.The fast LA allows in-band codec mode changes on every other TCH frame, but in the Nokia proprietary slow LA, the BTS allows in-band codec mode changes only on SACCH frame intervals. During both LA modes, the BTS indicates the first and the last used codec during the last measurement interval and the average quality.

Packing of Full Rate (FR) AMR calls to Half Rate (HR) AMR calls due to cell load

Spontaneous packing of FR AMR calls to HR AMR calls is triggered when the cell load is high enough, that is the number of free full rate resources reduces below the value of the parameter *Lower limit for FR TCH resources* (according to the BTS level parameter, if it contradicts the BSC level parameter). Packing continues until the cell load is low enough, that is the number of free full rate resources increases above the value of the parameter *Upper limit for FR TCH resources* (according to the BTS level parameter, if it contradicts with the BSC level parameter).

A packing request is valid until it is overwritten by a new one. A packing request, which indicates the amount N as 0, is used to remove any pending packing requests.

Unpacking of HR AMR calls to FR AMR calls due to call quality

Spontaneous unpacking of HR AMR calls to FR AMR calls is triggered when the quality of a HR AMR call degrades below the *intra HO threshold Rx qual for AMR HR*. Cell load does not have an effect.

5.40 EDGE HW support

This feature provides SW support for the GSM/EDGE capable UltraSite HW, that is a baseband unit BB2E and a radio unit TSxB. Both GSM and GSM/EDGE capable units may co-exist in the same BTS cabinet.

5.41 SiteWizard

The main function of the SiteWizard is to be as an umbrella application for the different BTS managers and cellular transmission equipment node managers, and the BTS HW Configurator. The functionalities of the SiteWizard consist of site commissioning and local maintenance, as well as defining cabling and unit information.

5.42 TX antenna VSWR measurement

The UltraSite BTS can provide BCCH antenna supervision by VSWR monitoring by using optional Bias-T unit hardware (BPGV for GSM 900 and BPDV for GSM 1800/1900 bands). These Bias-T units can be used with or without masthead amplifiers. The VSWR alarm limit is anything greater than 2.6, which translates into a return loss of less than 7dB. This limit is set in hardware and is not adjustable. If the VSWR exceeds the limit, this indicates a problem in the cable path between the BTS antenna port and the antenna. Typical causes for this are broken cables, broken connectors, and the ingress of water in the antenna cable path.

The BCCH antenna can only be supervised reliably if the BCCH power level is within the acceptable range of power levels (0 to 6). Alarm handling software polls VSWR alarms every 10 seconds. If five (5) consecutive polls show that the alarm is active and the BCCH power level is within the acceptable range, then the alarm is considered to be real and is reported to the BSC and BTS Manager.

VSWR alarms are handled as TRX object level alarms. When a VSWR alarm is considered to be real, an alarm 7606 'TRX faulty' shall be reported for all TRXs that have their TX or RX path defined in the BTS configuration to be connected to an antenna with an active VSWR alarm.

5.43 Site-specific notepad

With site-specific notepad the maintenance personnel can write down any site-related maintenance information or make notes for future reference on site visits (see the figure below).

The site-specific notepad is accessed under Tools menu in BTS Manager. There can be only one text file that opens when the notepad is opened. However, new information can be added to the existing file and still keep the old information if the maximum length of text (1280 characters) is not exceeded. The text file is saved to the BOI non-volatile memory.

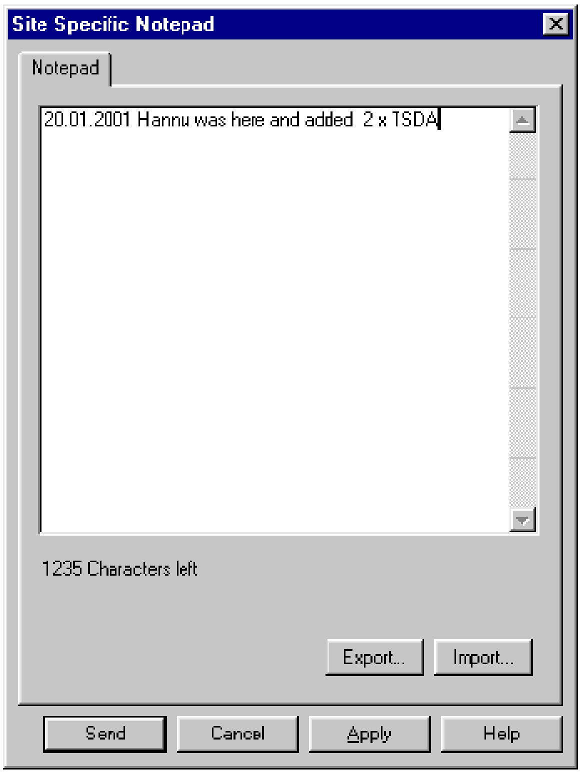


Figure 15 Site-specific notepad

5.44 BSS9068 BTS SW management

The BOI non-volatile memory can contain two BTS SW versions.

SW downloading is executed after BCF reset if the BOI does not have correct SW. The BTS SW can also be background downloaded to the BOI when a BTS SW package is being deployed to the BCF.

Downloaded BTS SW application files are stored in the BOI non-volatile memory. The files are also copied to the BB2x. Local BTS SW backup minimises BTS boot-up time because there is no need to download the BTS SW package from the BSC after each reset.

Transmission SW can be downloaded to the transmission units transparently via Q1.

5.45 BSS9067 Runtime diagnostics and BTS alarms

Alarm diagnostics filters alarms, reporting only those alarms that directly affect the BTS service level, that is object level BTS alarms. Only one critical alarm per object can be active at a time.

When the fault causing the alarm has been corrected, or a faulty unit has been replaced, the alarm is cancelled either manually or automatically.

When an object level BTS alarm is displayed at the BSC, the alarm text includes also a fault reason, that is a description of what has caused the alarm. This information can be used in troubleshooting. For more information, refer to *UltraSite BTS, Alarm Descriptions*.

5.46 BSS9066 Supervision of transmission units

UltraSite EDGE Base Station supervises the transmission equipment that can be either internal or external. External transmission equipment is Q1 compatible, has its own power supply and is controlled from the interface unit via Q1 connection. The alarms generated by the transmission units are transmitted to the BSC that further transfers them to the NMS/2000.

Supervision of transmission units supplied by other manufacturers

When transmission units supplied by other manufacturers are supervised via External Alarm and Control (EAC) lines, the alarms can be sent to two possible destinations; either to the BSC and NMS/2000 or to the NMS/100. When the alarms are sent to the BSC and NMS/2000, the BOI supervises the alarm handling and alarms are reported as normal external alarms.

When alarms are sent to the NMS/100, it supervises the alarms and the BOI directs the alarm to the transmission unit, as the EAC lines become active. During the next poll request from the NMS/100, the alarm will be reported as a transmission unit alarm.

The functionality described above is implemented by defining a new parameter for each external alarm. The parameter defines whether the alarm is reported as a normal external alarm or whether it is treated as an external transmission alarm that has been passed through to transmission units (and further to NMS/100).

5.47 BSS9065 Transmission operability

This feature contains the following two sub-features:

- UltraSite Transmission Equipment Support
- UltraSite Transmission Equipment Statistics with new measurement types specific to UltraSite. This sub-feature acts as an enlargement to the existing features and offers information on the signal quality of the UltraSite Transmission system.

UltraSite transmission equipment is measured with several counters as follows:

1. All equipment can be measured within a 24-hour period. This measurement gives a fixed set of counters, which are near-end G.826 signal quality counters. These counters are:
   - Total time
   - Available time
   - Errored seconds
   - Severely errored seconds
   - Background block errors
   - Errored block
2. A certain set of UltraSite transmission equipment can be defined. UltraSite transmission equipment refers either to the whole equipment or part of it (functional entity and supervision block). It is also possible to define the counters that are collected from the equipment. To do this, the operator has to know the topology of the transmission network so that the measurement subject can be chosen.

5.48 BSS9064 Real time update to BTS

The BSC sends the current time (date and time) to UltraSite EDGE Base Station (BTS) during the initialisation procedure. The BTS initialises its real time clock accordingly. The real time can be used in various purposes, such as in commissioning reports.

5.49 BSS9063 Abis loop test

Abis Loop Test verifies the Abis transmission setup and quality.

Abis Loop Test is carried out automatically during commissioning. The test can also be carried out manually from the BSC.

5.50 BSS9062 BTS supervision

UltraSite EDGE Base Station monitors and tests itself during operation without a separate command as described below.

Continuous monitoring

Both SW and HW carry out monitoring. Most of the monitoring procedures are so effective that no additional testing to find the faulty unit is needed. The following items are monitored continuously:

- Internal buses of the base station
- Transmission equipment and interfaces
- RF parts
- Mast head amplifiers
- UltraSite Support and UltraSite EDGE Base Station Integrated Battery Backup (IBBU)
- Dual Baseband Unit (BB2x) and the digital parts of the Base Operations and Interface Unit (BOI)
- Combining units (RTxx, DVxx and LNAs)
- Temperature (heating and cooling) system of the base station
- Power supply voltages
- Reference Oven Oscillator

If any of the supervision tests above fail, the alarm handling runs further tests.

Mains breakdown

A typical short voltage drop (that lasts less than 20 ms) does not cause any detectable harm to the operation and does not cause an alarm. In case of a mains breakdown, UltraSite EDGE Base Station cannot send an alarm to the BSC without battery backup (either integrated or external).

5.51 BSS9061 Temperature control system

UltraSite EDGE Base Station monitors its temperature continuously with several sensors located in several BTS units (BOI, Power Supply Unit (PWSx), Dual Baseband Unit (BB2x), Transceiver Unit (TSxx), and Remote Tune Combiner (RTxx)). The BTS controls its temperature with cooling fans and heaters to provide as stable operational conditions as possible. Heating and cooling is controlled gradually depending on the ambient temperature to ensure low temperature gradients and noise level.

If the temperature of a unit rises too high, a temperature alarm is issued. If the BOI is overheated, the BCF is blocked. If either the BB2x or the TSxx are overheated, the associated TRXs are blocked. Power Supply Units have their own internal shutdown and recovery in case they are overheated.

If the BTS starts up in an extremely cold environment, power supply to units is prevented and the units are heated to the minimum operating temperature.

5.52 BSS9060 TRX test

The total performance of the TRX is tested with a multi-purpose TRX test. The test covers digital and RF parts and includes:

- Tx Level
- Bit error Rate (BER) for Main and Diversity Rx
- Estimate (Rx Result) of the Rx level needed by single receiver for good quality decode of Full Rate speech, based on measured Noise + Interference level of the (idle) radio channel, for main and diversity Rx

The TRX test time is about 15 seconds.

When the TRX test is carried out according to a regular schedule it can be used in TRX performance supervision.

Both RX branches are tested separately during the same TRX test. If diversity is not configured, only the main branch is tested.

The power level during the TRX test is the same as the BCCH power level. To avoid unwanted disturbances to the TRXs the training sequence is not the same as the one normally used.

The figure below shows the TRX Test window.

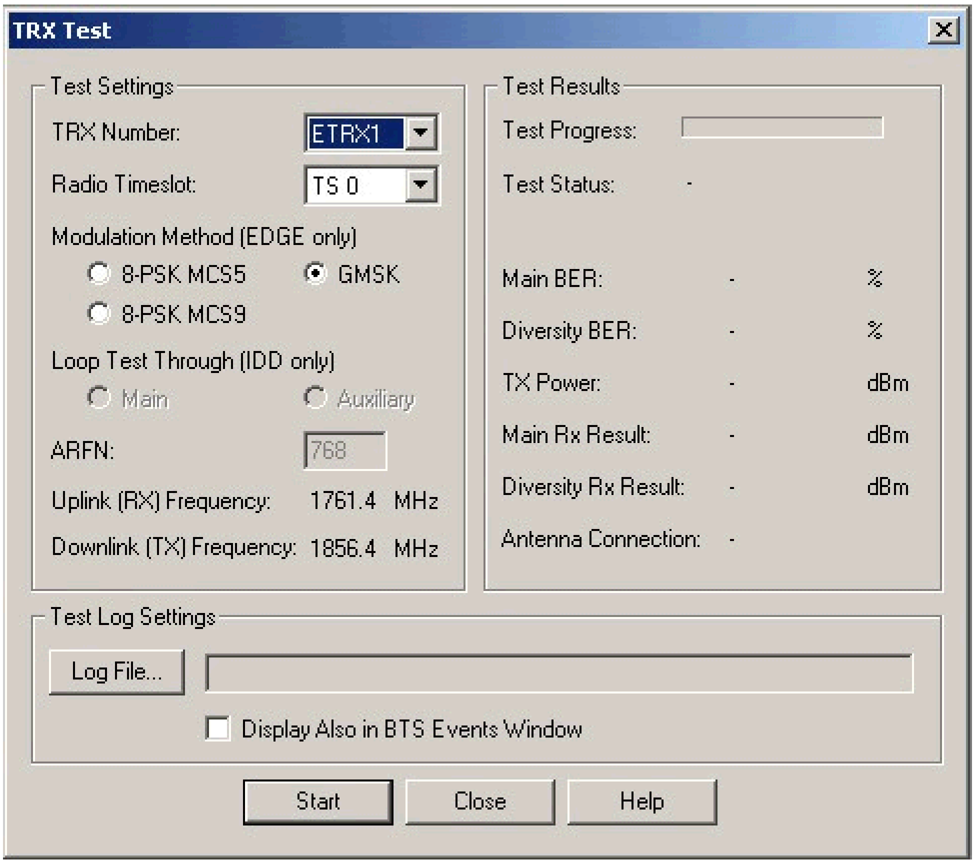


Figure 16 TRX Test window

All TRXs in a BTS can be tested either remotely from the BSC or NMS/2000 or locally with BTS Manager.

The TRX test can be performed only in TCH timeslots. Two free timeslots are needed for the test.

TRX test is not possible at all when baseband hopping is used. When IDD with RF hopping is used then RTSL 0, 1 and 2 cannot be tested for most TRX.

5.53 BSS9059 BTS resets

The BTS and its units can be reset locally with BTS Manager or remotely from the BSC or NMS/2000 via Abis.

The reset types are as follows:

- BCF, BTS and TRX can be reset separately (BCF reset means resetting all units, in practise it is a site reset.)
- BB2xs or TSxxs cannot be reset separately, they are handled as a TRX unit
- BOI can also be restarted with BTS Manager without a site reset. This is an OMU reset that restarts only the BOI SW. It is used for activating the new configuration file.

Transmission units cannot be reset with BTS SW.

For information about OMU Reset, see Feature Enhancement to BSS9059 BTS resets.

5.54 BSS9058 BTS fault recovery

BTS fault recovery minimises the effect of service level faults in the BTS. Fault diagnostics ensures that an appropriate recovery action is carried out. The faulty object is blocked before any recovery actions. After the recovery, the object is released. If the recovery does not succeed, a BTS alarm is issued.

For more information on fault recovery and BTS alarms, refer to *UltraSite EDGE BTS, Alarm Descriptions.*

MENU

5.55 BSS9056 Autodetection of site configuration

UltraSite EDGE Base Station detects the site configuration automatically, including all active units and versions, their serial numbers and the GSM frequency band used. This information is stored in the HW info file in the Base Operations and Interface Unit (BOI) non-volatile memory, and it can be displayed in BTS Manager (see Supervision - Equipment View in the figure below).

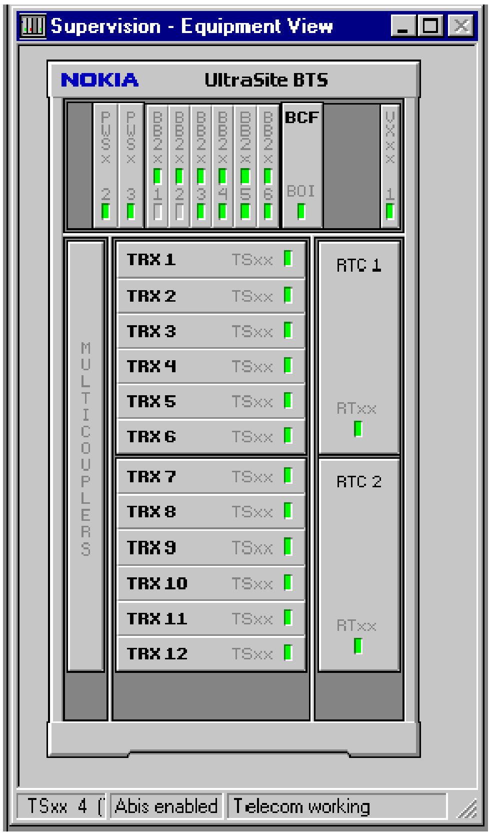


Figure 17 Autodetected site configuration in the Supervision - Equipment window in BTS Manager

Operator-specific settings, such as external alarm line settings, need to be set from the BSC or NMS/2000, for example with Remote MML-session.

A possible change in any of the units or in the configuration causes an automatic system data update in the BOI non-volatile memory. The configuration is detected both in normal start-up situations and when extra capacity (that is more TRXs) is added, units are removed, or a faulty unit is replaced with a new unit.

UltraSite EDGE Base Station system data is backup copied to Dual Baseband (BB2x) unit. This makes it possible to replace the BOI without re-commissioning.

Also, the transmission configuration is backup copied to the BOI.

5.56 BSS9055 Clock synchronisation between base stations

This feature enables synchronous handovers between base stations. Furthermore, the sectors defined to different base stations can use common hopping frequencies with RF-hopping, which increases the channel capacity. Maximum site configuration is 9 UltraSite EDGE BTSs in a chain or 1 Talk-family BTS + 5 UltraSite EDGE BTSs.

UltraSite EDGE Base Station has an external clock interface that can be used to synchronise the air interface between several UltraSite EDGE Base Stations located on one site.

When several UltraSite EDGE Base Stations are synchronised, the master base station (master BTS) functions as the frame clock source to the slave BTSs. The master BTS transmits the frame clock and frame number signals to the external clock line, while the other BTSs (slave BTSs) receive these signals. The slave BTS uses the received frame clock signal as a reference clock signal to adjust its main frequency source. The master BTS uses reference clock signal derived from the Pulse Code Modulation (PCM) signal.

After modifications to Talk-family BTS, it is possible to synchronise a UltraSite EDGE Base Station to a Talk-family BTS to serve the adjacent sectors. In this case the clock master is always a Talk-family BTS because there is a permanent timing difference between UltraSite EDGE Base Station and Talk-family BTS. Only UltraSite EDGE Base Station can compensate the timing difference by delaying the internal timing.

Physical properties

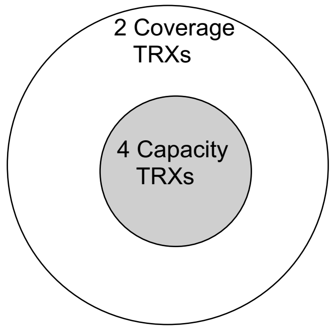
Maximum cable length for the total system is 100 meters. Synchronisation chain between the BTSs is made using RS-485 connection for the transferred clock signals.

Synchronisation recovery

If there is a failure in the synchronisation between the base stations, the slave BTS generates an alarm and the BSC then blocks all TRXs of the alarming BCF. When the fault disappears, cancellation to the alarm is sent to the BSC. The BSC then unblocks the TRXs under the alarming BCF object.

5.57 BSS9011 Intelligent Coverage Enhancement Plus (ICE+)

With ICE+, it is possible to divide the TRXs belonging to the same sector into two groups to provide both coverage and capacity sharing one common Broadcast Control Channel (BCCH) (see the figure below).



ICE+

Figure 18 Intelligent Coverage Enhancement Plus (ICE+)

The TRXs at the coverage area use bypass configuration to provide more output power to the antenna connector.

The capacity TRXs are combined to the same TX antenna to provide more capacity. Due to TX combining, the coverage TRXs have a higher output power than the antenna connector.

The BCCH carrier is in the coverage area.

The figure below shows the cabling connections in an ICE+ configuration when 2 TRXs use combiner bypass for coverage and 4 TRXs use wideband combining for capacity.

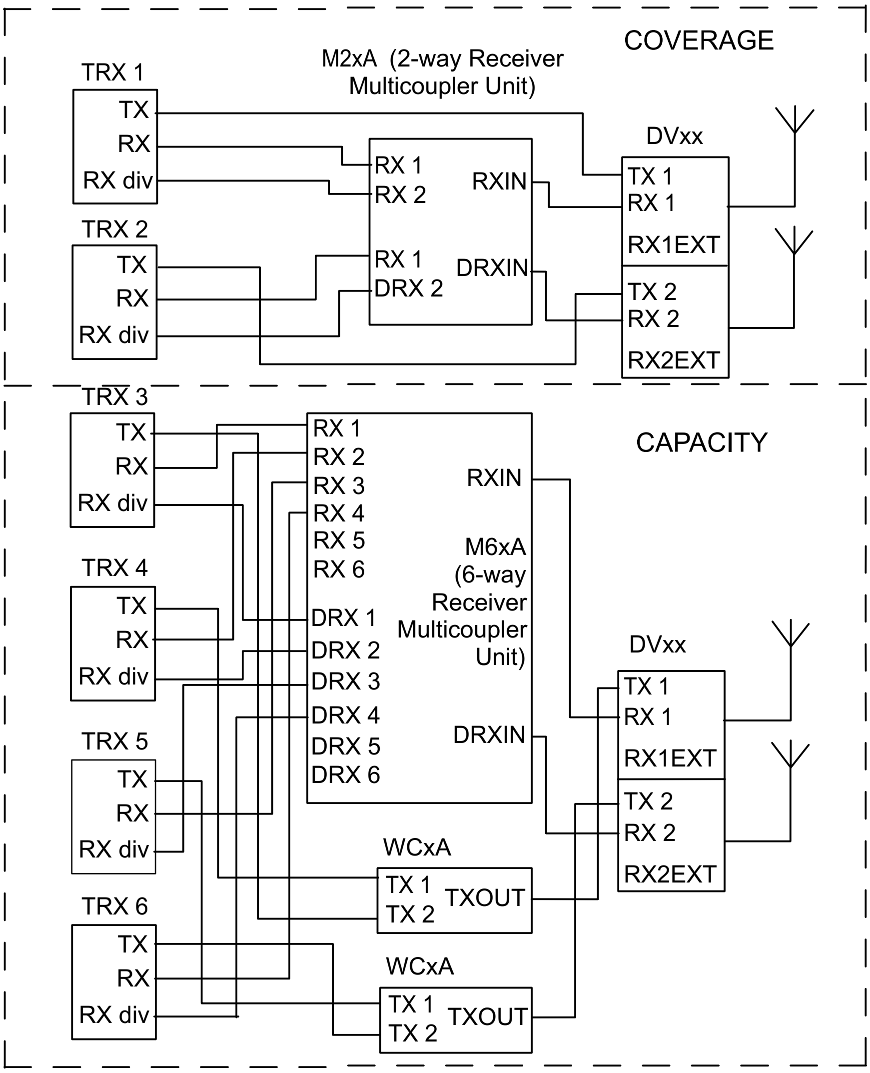


Figure 19 2 TRXs using combiner bypass (coverage) and 4 TRXs using 6-way wideband combining (capacity) arranged in an ICE+ configuration

5.58 BSS9006 General Packet Radio Service (GPRS)

GPRS provides packet radio access for GSM mobiles. The advantage of GPRS over traditional switched data transfer is the more efficient use of the air interface. All mobiles share the radio resources in a cell and spare capacity is allocated when a mobile needs to send or receive.

The Channel Coding Unit (CCU) in the BTS performs the channel coding for the following ETSI defined coding schemes:

- CS-1 (Channel Coding Scheme 1) 9.05 kbit/s
- CS-2 (Channel Coding Scheme 2) 13.4 kbit/s

In a packet transfer mode, the mobile must use the continuous timing advance procedure. This procedure is carried out on all Packet Data Channels (PDCHs).

5.59 BSS9003 Power system management for SiSu/IBBU (from NMS)

Power System Management (PSM) is a remote management system for the IBBUs (Integrated Battery Backup Units) and SiSu (Site Support) which removes the need for a site visit for the simple power system related tasks.

The solution utilises the internal Q1 bus for remote control and the data transmission between NMS-BSC-BTS-IBBU/SISU.

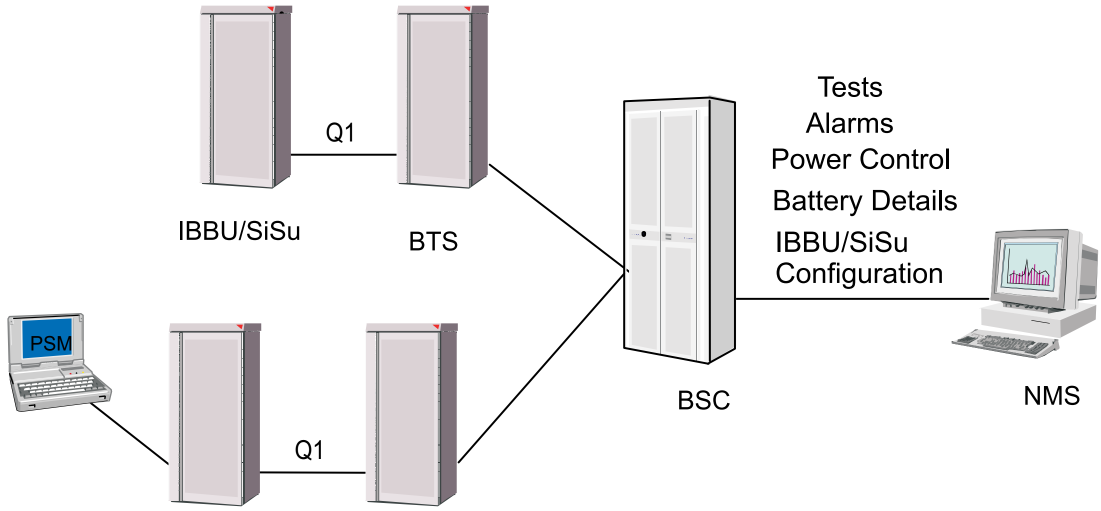


Figure 20 Power System Management for SiSu/IBBU (from NMS)

5.60 BSS7048 CCCH improvements

The Common Control Channel (CCCH) scheduling algorithm has been improved to allow priority for access grant messages over paging messages when there are no BTS access grant resources available. The paging channel (PCH) throughput is improved, especially for combined BCCH/CCCH channels. This is achieved by allowing a block reserved for access grant messages to be used for paging messages when there are no current access grant messages. The feature has altered the paging buffer so that pages are deleted because they cannot be transmitted to air within the defined maximum paging delay. Even though the pages are deleted, there may be sufficient buffer space.

The performance of the CCCH can be monitored with several new counters provided by the BTS. These counters are sent to the BSC in the message 'CCCH_LOAD_IND'. The number of paging messages that had to be deleted because of excessive paging load is calculated and reported. The average and maximum occupation of paging buffers is then reported as percentages.

5.61 BSS7037 14.4 kbit/s GSM data services

This feature is a new channel-coding scheme which enhances the speed of one timeslot from 9.6 kbit/s to 14.4kbit/s. This enhancement is reached by reducing the number of error correction bits of the existing 9.6 kbit/s channel coding.

The 14.4 kbit/s channel coding has less error correction than 9.6 kbit/s coding so there will be some areas on the cell edges where using 9.6 kbit/s coding will give a higher data throughput. The figure below shows the results of Nokia Siemens Networks simulations. Note that for transparent mode the maximum user throughput is 14.4 kbit/s, but in non-transparent mode the maximum user throughput is 13.2 kbit/s. The maximum throughput is based on the amount of available space in the coding block. Non-transparent data requires space for error checking, but transparent data does not.

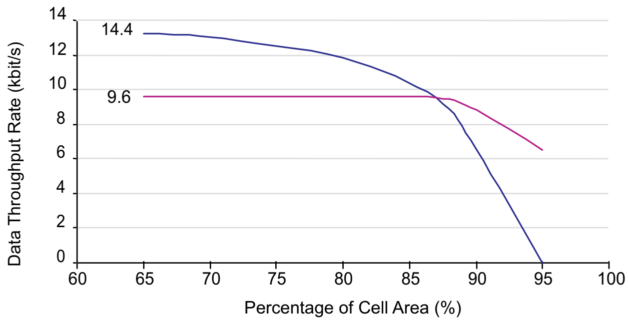


Figure 21 Typical data throughputs for 14.4 kbit/s (non-transparent) and 9.6 kbit/s coding (Note: this will depend on the NW radio conditions)

Nokia Siemens Networks has developed a proprietary feature, Automatic Link Adaptation (ALA), that optimises the data throughput by automatically choosing the channel coding most suitable to the radio conditions and by control of the power levels. This is shown in the figure below.

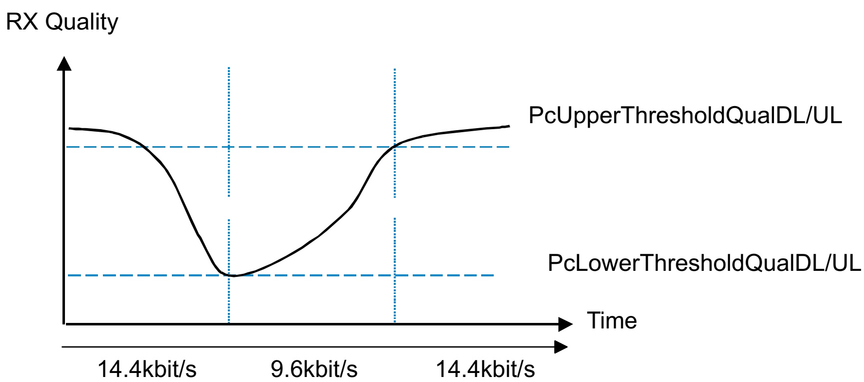


Figure 22 Nokia Automatic Link Adaptation

14.4 kbit/s data service can be combined with High Speed Circuit Switched Data (BSS7003).

5.62 BSS7036 Dynamic SDCCH allocation

Dynamic Stand-alone Dedicated Control Channel (SDCCH) allocation allows the SDCCH resources to be configured according to the actual SDCCH traffic situation of a cell. When the BTS temporarily needs greater SDCCH capacity than normal, the idle Traffic Channel (TCH) resources are configured for SDCCH use by the BSC. An example of this is shown in the figure below. A maximum of two additional SDCCH/8 can be configured. When the SDCCH congestion situation is over, the extra SDCCH resources are configured back to TCH resources. This feature can be used with both combined and non-combined Broadcast Control Channel (BCCH).

The operator is only required to configure the BTS to the minimum static SDCCH capacity sufficient to handle the normal SDCCH traffic.

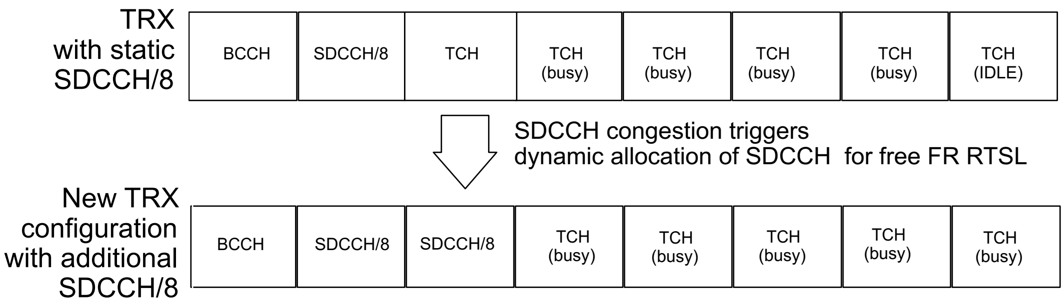


Figure 23 Dynamic SDCCH allocation

Extra SDCCH resource is allocated only when the existing SDCCH is fully loaded. When the dynamic SDCCH radio resource is totally free again, it is immediately reconfigured for TCH use. Thus, the maximum number of TCHs is always in use depending on the actual need of the SDCCH resources at each moment.

The feature benefits traffic cases in which signalling is the only transmission to the network, for example Short Message Service (SMS) traffic and location updates. In some special places, such as airports and stations, the location updates can produce sudden short-term SDCCH congestion. This can now be handled without any need to configure extra permanent SDCCH capacity.

5.63 BSS7003 High Speed Circuit Switched Data (HSCSD)

The High Speed Circuit Switched Data feature provides accelerated data rates for end-user applications. The current trend is for increased demand for high data rate applications like the World Wide Web (www), file transfer and facsimile.

The BSS implementation is to reserve a multiple set of basic resources for one high-speed data call. The data rate and the number of reserved timeslots vary between one and the defined maximum of the user application. The variable rate is needed for various common procedures, for example for handovers to a new cell if the requested data rate cannot be given immediately. The BSS implementation of HSCSD supports the simultaneous usage of a maximum of 4 radio timeslots (RTSLs) per HSCSD call.

The table below presents the corresponding maximum data rates with different channel coding. For details of 14.4 kbit/s data rates see BSS7037.

Number of RTSLs	9.6 kbit/s	14.4 kbit/s
1	9.6 kbit/s	14.4 kbit/s
2	19.2 kbit/s	28.8 kbit/s
3	28.8 kbit/s	43.2 kbit/s
4	38.4 kbit/s	57.6 kbit/s

Table 4 Corresponding maximum data rates with different channel coding

Both asynchronous and synchronous bearer services and transparent and non-transparent data services are supported. Transparent HSCSD uses fixed data rate throughout the duration of the call, but with non-transparent HSCSD, the data rate can be changed automatically during the call, for example due to increased traffic. The radio interface is either symmetric or asymmetric according to the Mobile Station (MS) capability.

During basic channel allocation, the system tries to keep consecutive timeslots free for multichannel HSCSD connection. If there are not enough appropriate free channels to fulfil the requested data rate, a non-transparent HSCSD connection is started with fewer channels than requested. At least one channel is allocated for a non-transparent HSCSD call request if there are available resources in the cell. By use of the resource upgrade procedure, the data rate of the HSCSD connection can be increased when an appropriate channel is available.

In a congested cell, the HSCSD load can be adjusted by BSC parameterisation. The resource downgrade procedure is used to lower the HSCSD connection data rate to release radio channels for other connections. If a transparent connection cannot be established in a cell, a directed retry can be attempted.

5.64 BSS6083 Mobile Station (MS) speed detection

The purpose of this feature is to determine the speed of the Mobile Stations (MSS) in GSM networks so that the fast moving MSS can be directed to macro cells and the slower moving MSS respectively to micro cells. The benefit of this feature is that it decreases the number of handovers in a micro-cell network and thus increases the network capacity.

The BTS estimates the MS's speed by using the Crossing-rate algorithm. The algorithm is based on a comparison between the signal levels obtained from each burst and their averaged value over one SACCH multiframe. The algorithm counts the rate at which the signal level crosses the averaged signal level. The crossing rate is relative to the MS's speed. The BTS sends the measured MS-speed information to the BSC by including it in the 'Meas_res' message. The MS-speed indication can vary between 0 and 254 km/h (0 – 159 mph) in 2-km (1.25-mile) steps. If measurement averaging is used, MS-speed measurement results are also averaged (see the figure below).

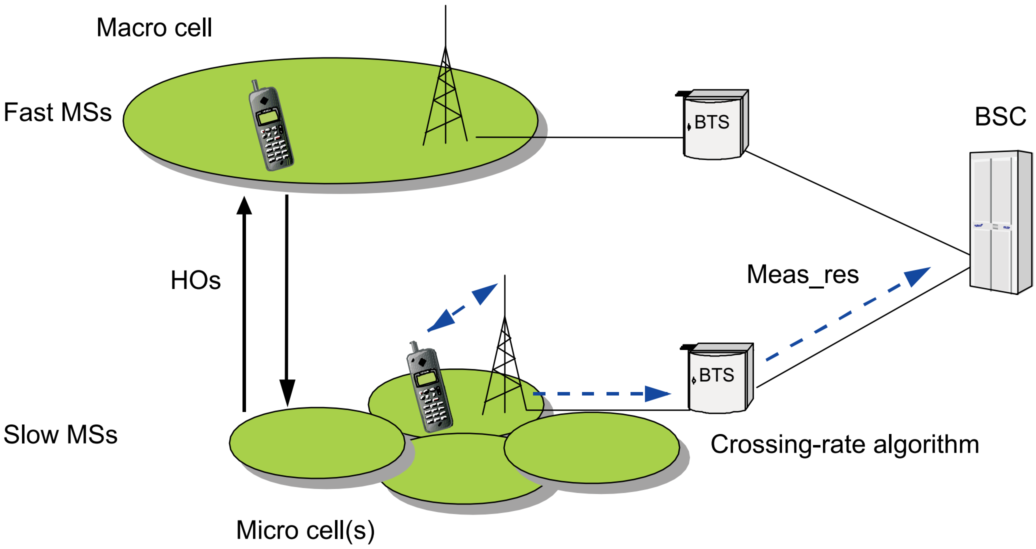


Figure 24 MS speed detection used for handover decision

The handover-decision algorithm in the BSC takes into account the MS-speed results sent by the BTS. Furthermore, the MS-speed based handover parameters (nx, px, upper speed limit (USL) together with lower speed limit (LSL)) and the adjacent cell layer definitions are also used with this feature.

The handover (HO) and power control (PC) algorithm determines the need for the handover as follows:

- If px averaged MS-speed indications out of last nx averaged MS-speed indications exceed the USL, the MS is considered as a fast moving MS and the call will be handed over to a suitable upper-layer cell (macro cell) if any.
- If px averaged MS-speed indications out of last nx averaged MS-speed indications are lower than the LSL, the MS is considered as a slow moving MS and the call will be handed over to a suitable lower-layer cell (micro cell) if any.

Layer information and the umbrella handover criteria are used as the target cell selection criteria. This means that the RX level in the target cell has to exceed the umbrella handover requirement HO_UMBRELLA_LEVEL defined for every adjacent cell.

The algorithm does not work with frequency hopping.

5.65 BSS6074 Active channel interference estimation

This feature enables the BSC to get information on the interference levels of an active TCH channel. This makes it possible for the BSC to activate the next call in the best TCH channel immediately after the channel has been released.

The active-channel interference estimation feature utilises idle TDMA frames on TCH channels and also the silent periods when the MS is using DTX. The BTS calculates the interference levels and reports them to the BSC in the 'RF_resource_indication' message. Previously, this message contained interference-band information on idle channels only. Now the results of the active-channel interference level measurement are always included in this message when there are measurement results available.

If uplink DTX is not activated, the active-channel interference cannot be measured for half rate calls.

5.66 BSS6071 Enhanced Full Rate codec

This feature introduces a new full-rate speech codec to the BSS, called Enhanced Full Rate (EFR) speech codec. The codec uses the existing GSM 900/1800 full rate channel coding but provides a considerably better performance in all channel conditions. Moreover, in good channel conditions, the codec ensures equal or even better quality than Adaptive Differential Pulse Code Modulation (ADPCM).

TCSM2 (Transcoder Sub-Multiplexer 2) SW can be upgraded for the EFR.

As for the Air-interface dimensioning, no special attention to the EFR channels need to be paid. The A-interface and transcoders have to be dimensioned according to each pool type.

The EFR can coexist with the previous Half Rate (HR)/Full Rate (FR) 'dual codec'.

The Mobile Switching Centre (MSC) provides basic information on the codec type. If no information about the codec types supported on circuit group basis over the A-interface is available at the MSC, then all A-interface channels must be equipped with the TCMS2.

The Base Station Controller (BSC) decides the codec type based on:

- The input from the MSC
- The BSS speech codec capabilities
- Radio channel configurations and their availability (FR/HR)

During handovers, the BSC may change the speech codec. For intra-BSC handovers, the BSC uses the previously stored information from the MSC/VLR (Visitor Location Register) on the speech codec preferences.

The BSC forwards the information on the codec type to the Base Transceiver Station (BTS) in the channel activation message. The BTS configures the active timeslot according to this information to support either the conventional full rate codec or the EFR. In-band signalling between the transcoder and the BTS is used to control the transcoder codec selection on a call basis.

5.67 BSS6035 Freeform RF hopping

With Freeform RF Hopping it is possible to have more than 2 TRXs per sector in RF-hopping mode and to use up to 64 frequencies per sector.

RF hopping can only be used with WCxx.

The number of frequencies per site is restricted to 192.

UltraSite EDGE BTS supports both Baseband (BB) Hopping and Radio Frequency (RF) Hopping in the different sectors of a base station.

5.68 BSS6025 Short Message Service Cell Broadcast with Discontinuous Receiving (SMS-CB DRX)

SMS-CB DRX enables phase-2 Mobile Stations (MSS) to receive only the needed blocks of the CBCH (Cell Broadcast Channel). This decreases battery consumption.

The BSC has a user interface for SMS-CB (Short Message Services Cell Broadcast) and it stores CB messages in the BSS. After the BTS initialisation, the BTS operates in non-DRX (Discontinuous Receiving) mode until SMS-CB DRX is activated in the BSC. When SMS-CB DRX is employed, the BTS starts transmitting Schedule Messages to the cell area. A Schedule Message includes information about a number of immediately following consecutive CB messages, planned for that cell. The time between two Schedule Messages is called the Schedule Period. The Schedule Period is one minute (see the figure below).

The MS starts operating in DRX mode after the power up when it has received the first Schedule Message. If the MS does not receive a Schedule Message, it has to read at least the first block of each CB message.

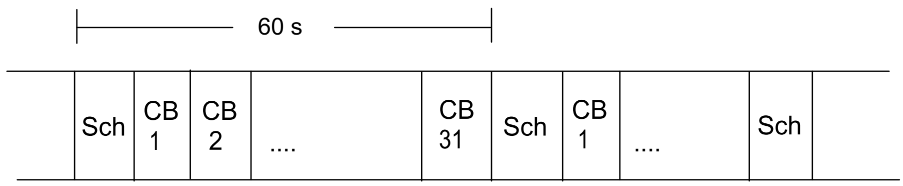


Figure 25 SMS-CB DRX Schedule Period

In DRX mode, in the first block of the Schedule Message, the MS receives information about

- How many CB messages there are
- In which slot they will be transmitted
- Message identifiers (if there are fewer than 6 new messages)

If there are:

- No new CB messages in successive schedule periods, the MS ends up reading only the first block in each Schedule Message.
- 1 to 5 new CB messages, the MS does not need to read other blocks in the Schedule Message, but it still needs to read the new CB messages.
- More than 5 new CB messages, the MS has to read more than one block in the Schedule Message plus all the new CB messages.

5.69 BSS5850 Satellite Abis

This feature allows the use of satellite connections on the Abis. The BTS SW has been modified in such a way that it allows greater delays in transmission between the base station and the rest of the network elements. The maximum allowed one-way transmission delay is 300 ms.

The feature is activated for each BSS individually; that is, all the base stations under a BSC comply with it.

5.70 BSS5730 Remote interrogation of serial and version numbers

The serial numbers and version numbers of BTS units, and their associated software, are stored into each unit by the manufacturer and detected automatically by the BOI/master TRX at start-up and/or adding or replacing units.

The serial numbers and version numbers can be read from the NMS/2000 via the BSC so that the precise type of equipment and configuration is obtained remotely without a site visit.

5.71 BSS5590 C2 cell reselection parameter

The C2 idle-mode reselection parameter allows fast moving MSS to better select a cell where they can receive the best service. The C2 parameter is broadcast in system information messages 3 and 4.

5.72 BSS5072 Better Random Access Channel (RACH) detection

RACH burst detection is based currently on the S/N threshold and 6-bit CRC check. However, a fixed S/N threshold may be unreliable in environments with high co-channel interference levels that cause ghost channel reservations.

The new S/N estimation method with an adaptive threshold overcomes the problem. It provides a more accurate estimate of S/N with the whole 41-bit training sequence of a RACH burst used. In addition, the S/N threshold is now set dynamically for each burst based on the channel conditions.

5.73 BTS2503 Compressed Abis timeslot allocation

Compressed time slot allocation is rarely used and limitations apply (not all BTS families support this feature).

In traditional transmission solutions some capacity is left unused, especially in the case of BTSs with one TRX, because one radio interface time slot is always used for the BCCH. The compressed Abis time slot allocation makes it possible to use this capacity for TRX signalling. It is also possible to use another 16 kbit/s slot to carry the O & M signalling required for the site. This slot can 'steal' the TCH transmission slot thus leaving capacity for six full rate TCHs or twelve half rate TCHs for that TRX.

In environments where it is not necessary to use the full traffic capacity of a TRX, compressed Abis time slot allocation offers an ideal solution for using the transmission medium more efficiently. With this configuration, it is possible to fit 15 TRXs to one 2 Mbit/s PCM.

5.74 BTS2139 Boot software

To provide maximum adaptability, almost all low-level boot software can be downloaded in the same way as the main applications software is downloaded.

The BTS SW can be downloaded and saved in the non-volatile memory of the BOI and each BB2x during normal operation. The BTS SW is activated by resetting the site. This makes it possible to update the BTS SW with minimal downloading time.

5.75 BTS2138 Transmission control: alarm handling via Q1 data channel

BTS transmission alarms are sent to the BSC via the Q1 data channel that is placed in PCM timeslot 0 (bits 5 - 8) or in any other PCM timeslot (bits 7 - 8). Centralised transmission O&M management equipment at the BSC is used to manage alarms from Nokia specific transmission equipment.

5.76 BTS2133 Short Message Service (SMS) point-to-point

Base Station supports the short message service (point-to-point) for both mobile originating and mobile terminating calls.

5.77 BTS2067 Fast Associated Control Channel (FACCH) call setup

It is possible to establish a FACCH call without using a Stand-alone Dedicated Control Channel (SDCCH) channel. A Traffic Channel (TCH) is set to 'signalling only' and switched over to normal speech operation when needed. This feature is for emergency calls only.

5.78 BTS2049 Remote transmission control and configuration

The standard control functions of the Nokia Transmission Equipment are supported. This makes it possible to control the transmission equipment remotely from the network via the Abis interface. The BTS provides a transparent two-way path for the remote transmission control commands and responses.

The BTS does not interpret in any way the Nokia Q1 commands given to the transmission units or the responses sent by the transmission units.

5.79 BTS2043 BTS External Alarms and Controls (EAC)

External Alarms and Controls (EAC) signals can be defined to the BTS. Alarms caused on the site, such as the intruder alarm, are sent to the NMS/2000 via the Abis. The outputs are of open-collector type and the inputs are TTL level signals, all referred to 5V.

The EAC settings (name and polarity) are defined at the BSC.

There are 24 user-definable inputs and 6 user-definable outputs. It is possible to label user-definable external alarms and controls in the RNW database at the BSC, or through transmission. The complete EAC names can be seen at the BSC.

The user can define whether an alarm is raised when the External Alarm input is grounded or disconnected from the ground potential. This allows more flexibility for the alarming device.

5.80 BTS2041 BTS local blocking

TRX units can be blocked locally with BTS Manager to enable different operations, such as service operations. The BTS informs the BSC of the blocking by sending a minor alarm. The BSC then clears all calls from the TRX concerned and takes appropriate measures to restore traffic via other TRXs in the BTS, as it would do in the case of a real equipment failure. When the TRX is unblocked with BTS Manager, the BTS cancels the alarm and the TRX is enabled automatically by the BSC. The normal recovery procedure is activated (all calls via the BTS are released).

5.81 BTS2039 BTS SW background downloading

The BTS SW can be updated by downloading new BTS SW remotely from the BSC. The BTS SW can be updated without site visits. The BTS SW can be downloaded also locally with BTS Manager.

The BTS SW can be background downloaded and saved in the master TRX non-volatile memory during normal operation. Resetting the site activates the BTS SW. This makes it possible to update the BTS SW with minimal downloading time.

5.82 BTS2038 Transmission control: alarm handling via LAPD

BTS transmission alarms are sent to the BSC via the O&M LAPD link.

5.83 BTS2037 Air interface measurement pre-processing

The measurement results for the active channels may be averaged for the TRX. This option is useful when 16 kbit/s signalling is used because it reduces the capacity needed on the Abis link. The averaging period may be set to consist of 1 - 4 SACCH multiframes. Both uplink and downlink measurements are averaged. As a result, the BSC receives a measurement report once at the end of the averaging period rather than after every SACCH multiframe.

5.84 BTS2033 Short message cell broadcast

The short message service (cell broadcast) defined in the GSM recommendations is supported.

5.85 BTS2030 BTS Manager local password

Access to the BTS via the BTS Manager port is password protected. The password is stored in the BOI non-volatile memory. It can be changed on-site using BTS Manager.

5.86 BTS2024 Synthesised frequency hopping

Synthesised frequency hopping is available for configurations that have at least two TRXs per sector. Synthesised frequency hopping enables all TRXs to change frequencies in successive timeslots, so that the carriers can hop at many different frequencies in quick succession. Both random and cyclic hopping can be used. The maximum number of frequencies per BTS site is 64. The number of frequencies can be greater than the number of TRXs.

Note that the BCCH carrier must remain at a fixed frequency and at a fixed power level to enable the MS to measure the signal strength.

5.87 BTS2023 Downlink and uplink DTX; TCH/FS, speech

The DTX function (discontinuous transmission activated by speech) is supported as specified in the relevant GSM recommendations.

5.88 BTS2020 RX antenna diversity

Receiver diversity (spatial diversity) is available as an operation SW for all configurations. The two RF signals are demodulated separately and combined by the post detection weighted summing method.

Diversity is defined for every sector separately from the BSC.

5.89 BTS2013 Baseband frequency hopping

Baseband switching is used for frequency hopping. The digital (baseband) and analogue (RF) parts of a TRX are separated from each other. A high-speed time-divided parallel bus is used to cross-connect the baseband part and the radio part of the transceiver. The cross-connection is done on a 'per timeslot' basis. Both random and cyclic hopping can be used.

Baseband hopping is allowed for all BTS configurations. The number of frequencies used in the frequency hopping sequence is the same as the number of TRXs in the sector.

5.90 BTS2012 BTS time base reference from PCM

The PCM clock is used as a reference when tuning the long-term accuracy of the BTS internal clock. The requirement for the accuracy is 0.015 ppm in order to meet the GSM requirement (0.05 ppm) for the clock signal accuracy in the Air interface.