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Nokia Siemens Networks

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

## Feature Descriptions for Nokia MetroSite EDGE Base Station

DN04196267

Issue 5-0

MENU





## ⚠ 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.

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# 1 Changes in Feature Descriptions

This section describes changes between releases in the document *Feature Descriptions*.

This document had no updates in releases CXM5 CD1.0, CXM5 CD2.0 and CXM5 CD3.0.

**Changes between CXM5 and CXM6**

The following changes have been made in this version:

- The chapter *Changes in Feature Description* has been added and the change information moved from chapter *General Information* to this new chapter.
- The chapter *New Features in MetroSite EDGE BTS SW CXM6* has been added.
- The following CXM6 features have been added as new sections in the current release. See chapter *New Features in MetroSite EDGE BTS SW CXM6* for more information.
  - BSS20872 Robust AMR Signalling
  - BSS20588 TRAU Bicasting in AMR FR/HR Handover
  - BSS20476 End to End Downlink Abis Performance Monitor
  - BSS20482 BTS ID shown in BTS Manager

# 2 General information

This document describes the features of MetroSite 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.

The BSS13 system features will be available in the following network element releases: BSS13, S13, CXM6, CX6.

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

### Technical Notes

This document does not contain any Technical Notes in CXM6.

### Change Notices

This document does not contain any Change Notices in CXM6.

# 3 New Features in Nokia MetroSite EDGE BTS SW CXM6

## 3.1 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.

## 3.2 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.

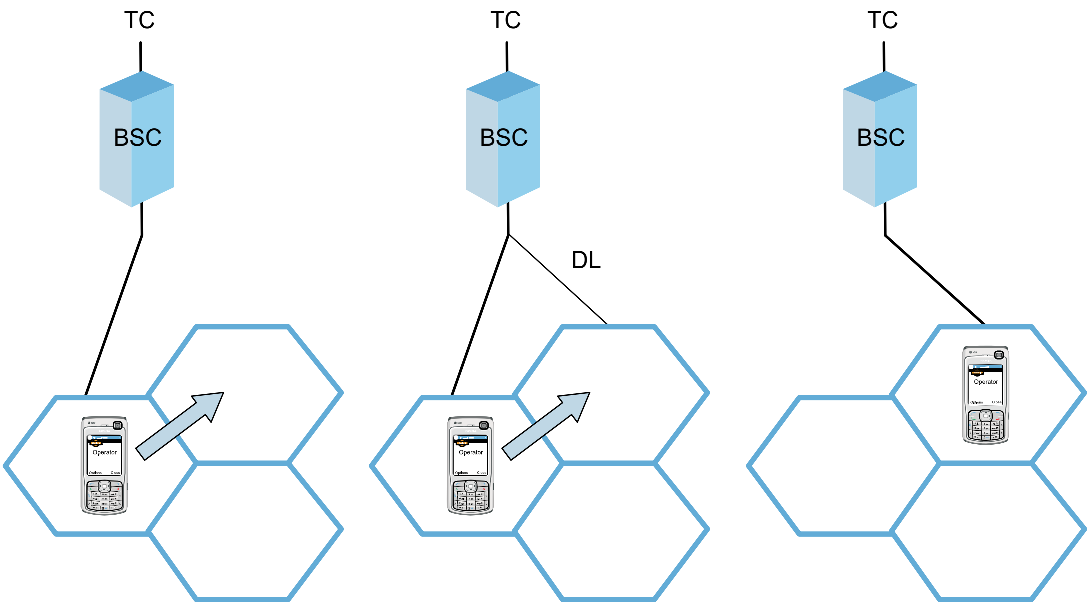


*Figure 1* TRAU bicasting in AMR FR/HR handover

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.

## 3.3 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.

## 3.4 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.

## 3.5 Windows 2003 Server Support

BTS Manager is run by on-site engineers in Windows laptop computers, and by NetAct operators in the NetAct Windows Application Server. With this feature the CXM6 BTS Manager is updated to run on a NetAct server running Windows 2003 Server.

The CXM6 BTS Manager will also run on Windows 2000 and Windows XP computers.

# 4 Features in Nokia MetroSite EDGE BTS SW CXM5

## 4.1 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. 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.

## 4.2 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.

## 4.3 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.

## 4.4 BSS20694, BSS20973 RSSI enhancements

BTS SW CXM5 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. Changing the sample numbers thus does not require S12.
- 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 section BSS11131 Rx Antenna Supervision by comparing RSSI Value for MetroSite.

## 4.5 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**, to better correspond with the actual functionality.

The figure below shows the TRX Test window.

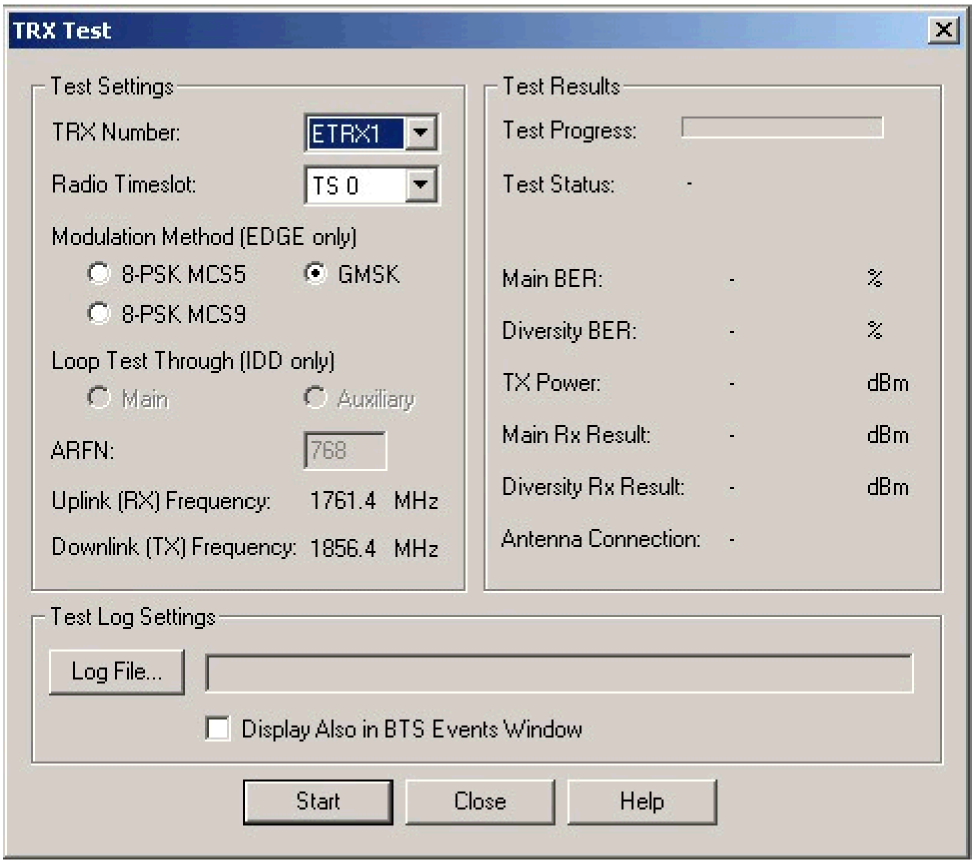


*Figure 2* TRX Test window

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 BSS8142 TRX test.

## 4.6 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.

## 4.7 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.

## 4.8 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.

## 4.9 BSS11131 Rx Antenna Supervision by comparing RSSI Value for MetroSite

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 (Received Signal Strength Indication) and the Div Rx RSSI. This feature provides continuous antenna supervision for the BTSs, which have main and diversity in use.

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 difference is calculated per TRX between received levels on main and diversity antennas. 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 and 64. The functionality of the feature can be disabled by using the maximum value.

**RSSI enhancements**

BTS SW CXM4.1 includes the following enhancements to RSSI:

- 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 section BSS20694, BSS20973 RSSI enhancements.

## 4.10 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.

## 4.11 FC STM-1 transmission card HW support in MetroSite EDGE BTS

The FC STM-1 unit enables cross-connection between Plesiochronous Digital Hierarchy (PDH) and Synchronous Digital Hierarchy (SDH) transmission rates. The unit is a complete SDH STM-1 Terminal Multiplexer (TM) or Add/Drop Multiplexer (ADM) inside Base Stations.

The main features of FC STM-1 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 4 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.828.
- 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**

The FC STM unit only fits within the transmission slot of a MetroSite EDGE BTS and cannot be deployed in a MetroHub or UltraSite cabinet.

## 4.12 BSS11118 Multi BCF for MetroSite BTS

Multi BCF Control feature allowed 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 new Multi BCF for MetroSite BTS feature enables up to three MetroSite, or ConnectSite 10 BTS cabinets to be connected to one TalkFamily BTS. The maximum number of TRXs with this combination can be 24 (12 TRXs Talk cabinet and 12 TRXs using three chained Metro cabinets). The Multi BCF for MetroSite BTS enables the Multi BCF to provide a path for site expansion from Talk-family to Nokia Metro and UltraSite EDGE BTSs and thus 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 between the base stations. At the BSC, the operator uses a new SEGMENT (SEG) object to set all BTS objects to share the same BCCH.

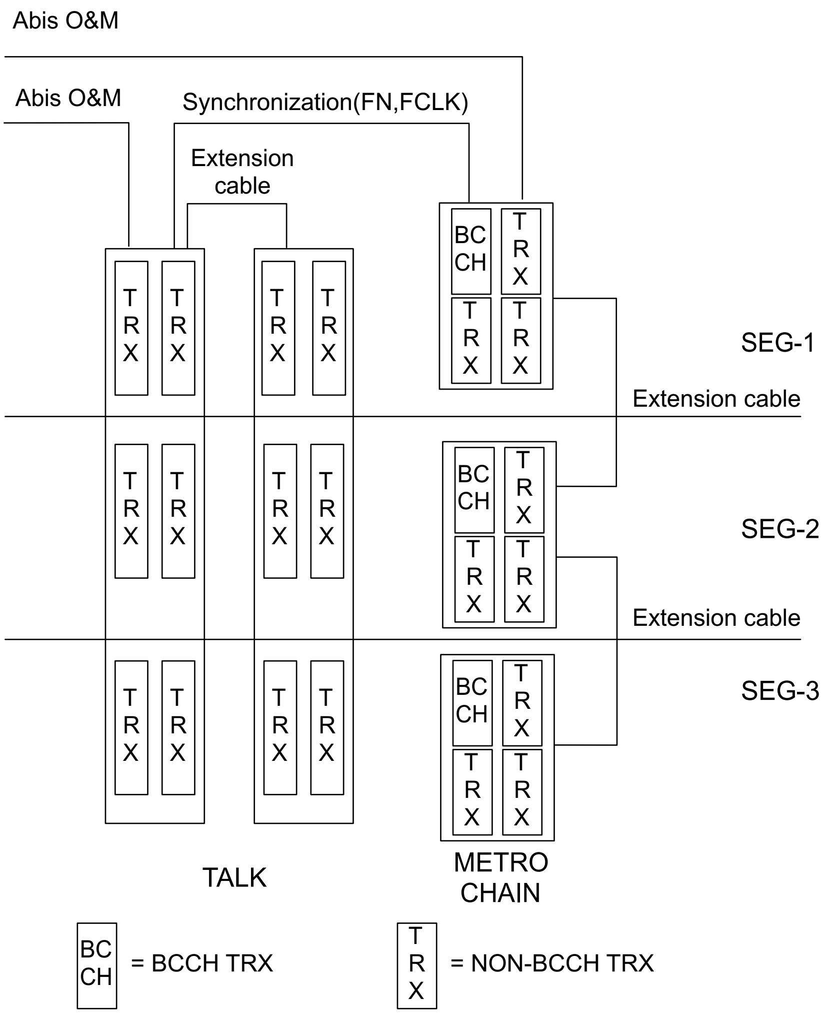


*Figure 3* Multi BCF configuration example

### Segment functionality

The Multi BCF feature introduces a new architecture and radio network object, called the SEGMENT (SEG), which is essentially the same as the telecom cell. The difference between a SEG and a telecom cell is that the SEG may consist of several BTS objects.

A BTS is a group of identical TRXs. A BTS must consist of TRXs of the same frequency band (Common BCCH) and TRXs of the same base station site type (Multi BCF).

The possibility to use the segment structure is not restricted to the Common BCCH Control and Multi BCF Control features, but is an option of its own. An operator can, for example, create multiple hopping groups in a cell by gathering TRXs of one hopping group into one BTS and have several such BTSs in a segment.

Operators can use the new SEG object at the BSC to set all the BTS objects to share the same BCCH. Several BTS objects can belong to one SEG, however, only one BTS object of the SEG can have a BCCH (reconfigurations to the other BTSs are not supported). The SEG can have BTS objects that differ in:

- Frequency band - Primary GSM 900, Extended GSM 900, and GSM 1800 - GSM 800 and GSM 1900 (each band contains only TRXs of the same frequency in one or more BTSs).
- Power levels
    - TalkFamily and UltraSite or ConnectSite 100 BTSs
    - TalkFamily and UltraSite - TalkFamily and MetroSite EDGE BTSs
- Normal and extended cell radius frequencies
- EDGE capability

In its simplest form, a SEG may also consist of only one BTS/TRX.

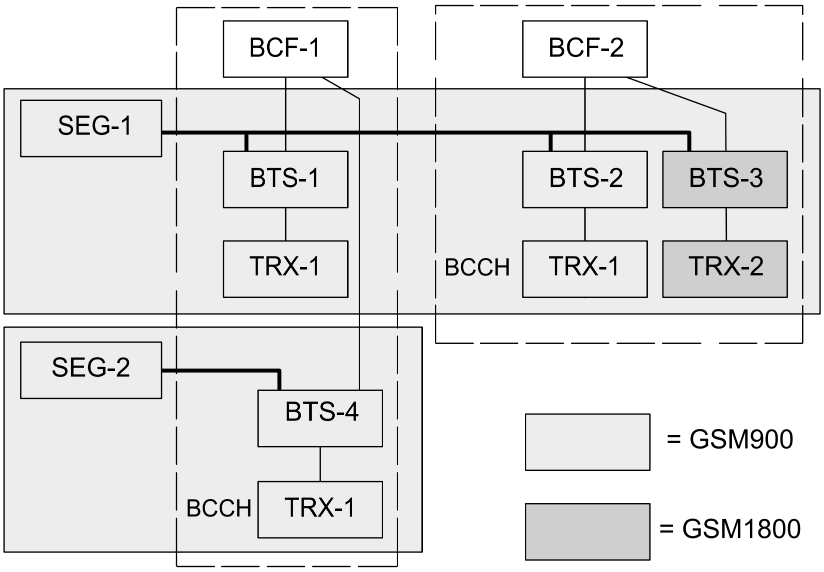


*Figure 4* Example of a SEGMENT radio network object

**Benefits**

Multi BCF for MetroSite BTS feature enhances MetroSite or ConnectSite 10 BTS as part of a Multi BCF concept which allows the combination of several BTSs into one segment. Evolution to EDGE services in TalkFamily BTS sites is enabled in addition to UltraSite, MetroSite and ConnectSite BTSs.

## 4.13 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.

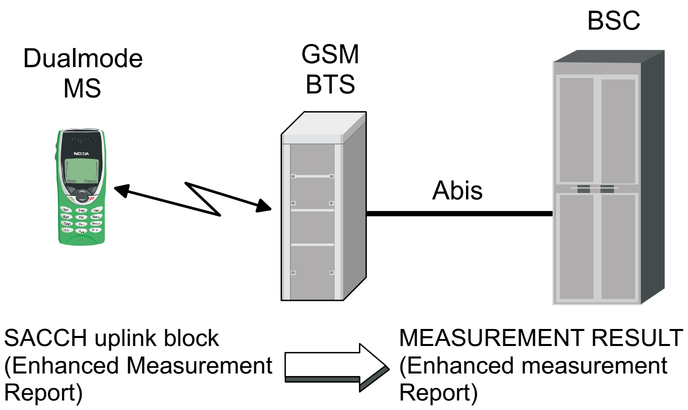


*Figure 5* Enhanced Measurement Reporting

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

## 4.14 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 MetroSite BTS chain a maximum of 9 BTSs. Up to 3 MetroSite EDGE BTS cabinets can be connected to 1 TalkFamily BTS. TalkFamily BTSs cannot be placed after MetroSite in the clock chain. The expansion is always made from Talk to Metro BTS. MetroSite cannot be followed by any other BTS generation in the clock chain.

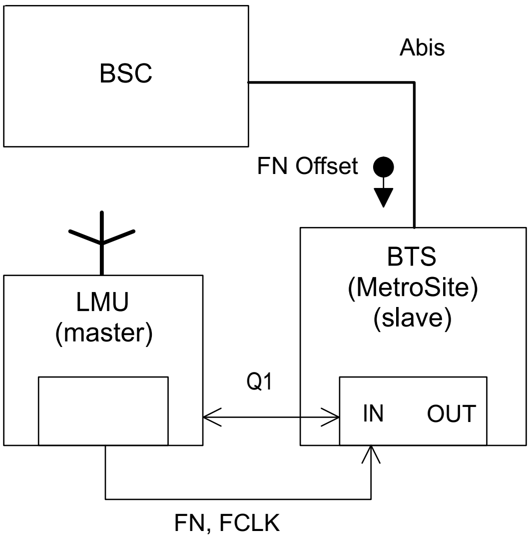


*Figure 6* Synchronised BSS example in MetroSite chain

The BSS is synchronised by a Global Positioning System (GPS). This means that 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

## 4.15 BSS11061 Intelligent shutdown for MetroSite 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 master and 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 MetroSite:

- 3rd Party Battery Backup Solution

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.

The following EAC inputs must be used:

- Input 1: MAINS
- Input 7: Low Battery Warning

BTS shutdown implementation in MetroSite BTS:

- If a transceiver is to be shut down, it can be physically powered off.
- Unless the BTS is part of a larger chained configuration, the transceiver (except for the Master transceiver) is switched off.
- If there is more than one MetroSite cabinet in the site (for example, 2 or 3 MetroSite BTSs are chained together), the Slave cabinets can be powered off (including their master transceivers), as the Master cabinet maintains the transmission chain.

#### 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.

## 4.16 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.

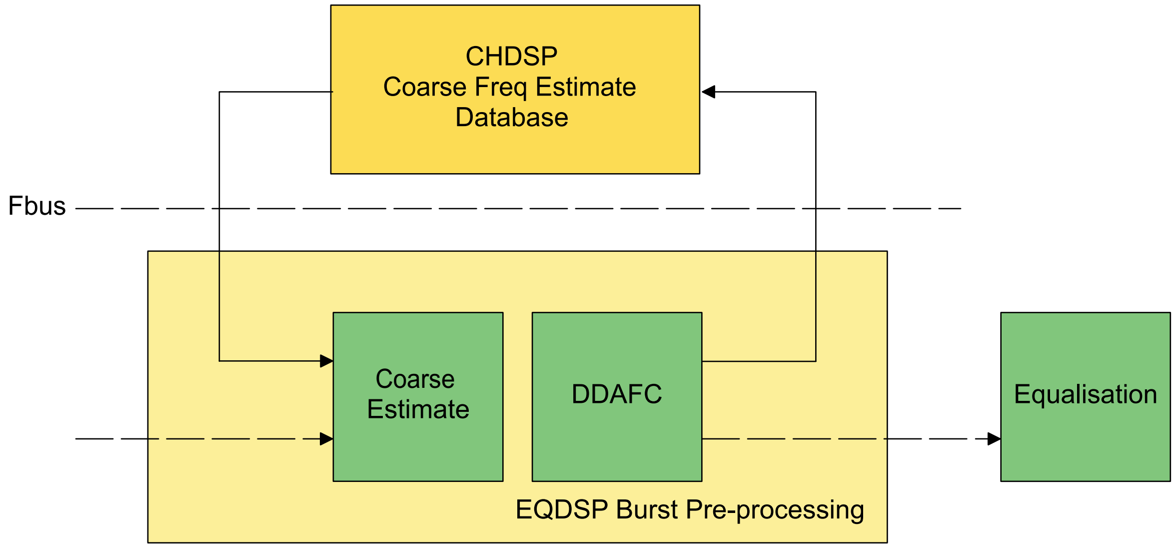


*Figure 7* E-DDAFC interface overview between CHDSP and EQDSP

## 4.17 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.

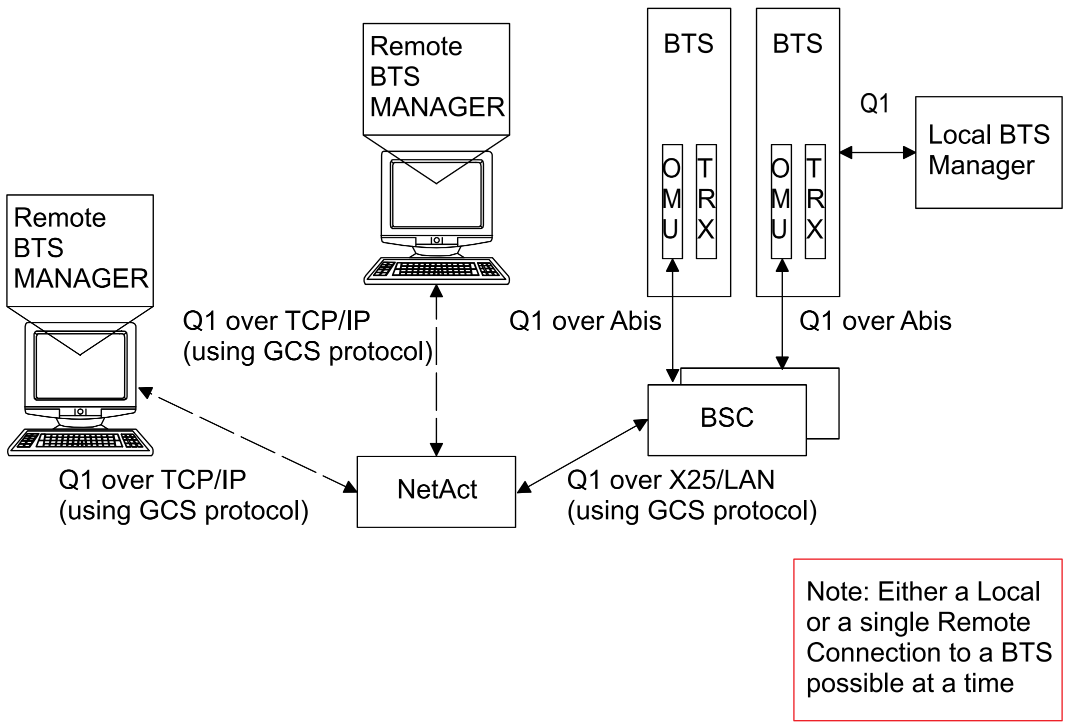


*Figure 8* Remote BTS Manager connection

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.

## 4.18 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.

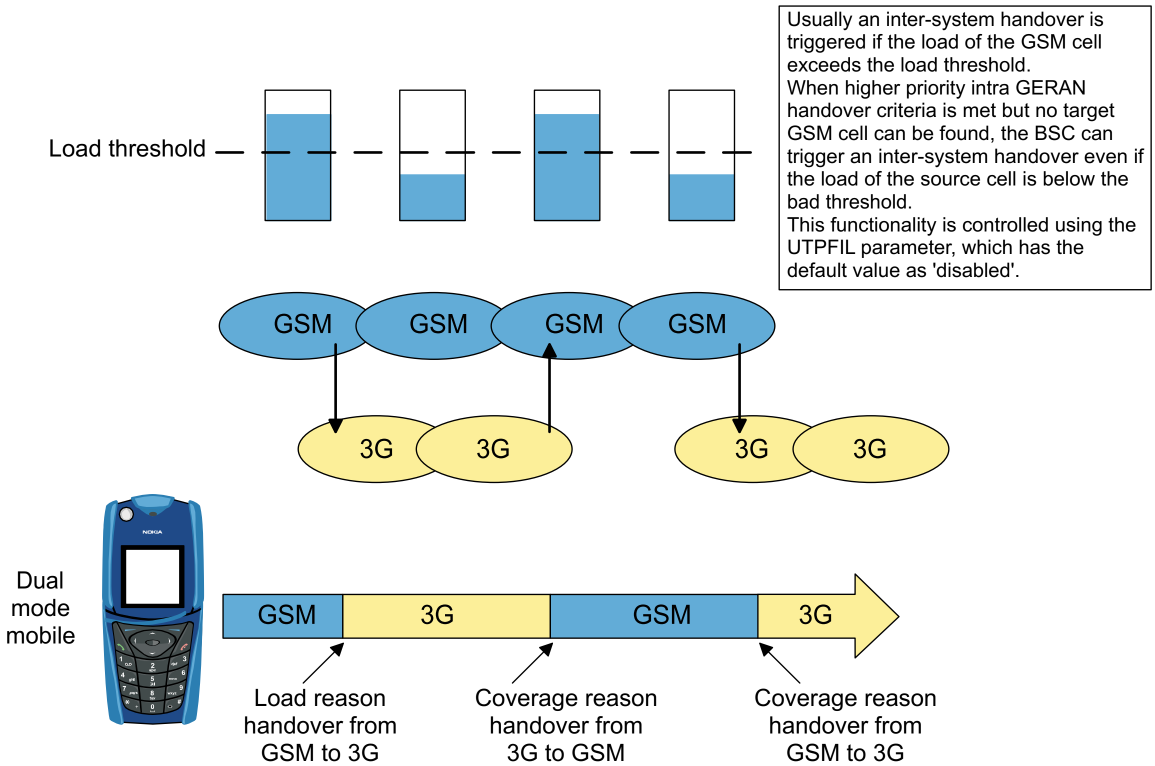


*Figure 9* Load and coverage reason handovers

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.

## 4.19 BSS10091 Enhanced Data Rates for Global Evolution (EDGE)

Enhanced Data Rates for Global Evolution (EDGE) enhances the data capabilities of GSM networks towards 3rd generation services. EDGE increases the air interface data throughput in average three-fold compared to today"s GSM and boosts both circuit and packet switched services. Additionally, EDGE is the 3rd Generation radio technology for the TDMA/EDGE operators. The BSS10.5 EDGE solution includes Enhanced General Packet Radio Service (EGPRS) for the packet switched data.

The EDGE solution is implemented on top of the existing GSM network and requires only minimal hardware and software upgrades to support the new air interface modulation and increased data rates. EDGE transceivers are able to support today"s mobile terminals with GSM modulation as well as enhanced data services on timeslot basis.

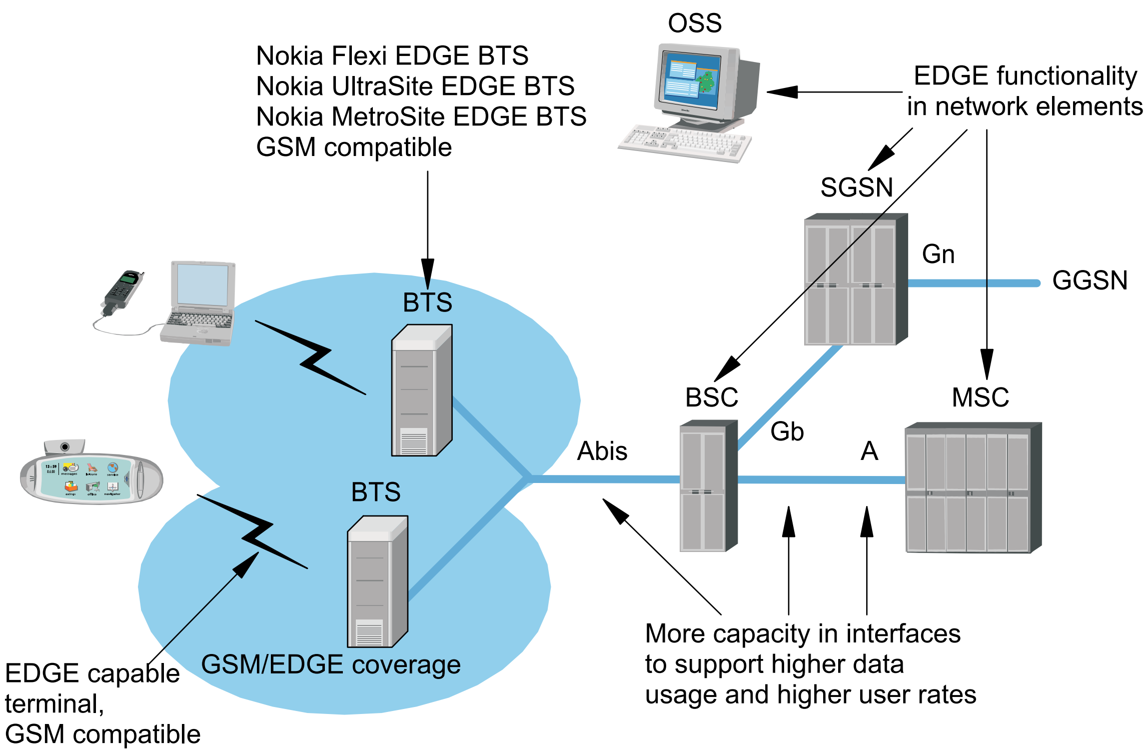


*Figure 10* Impact of EDGE on the mobile network (ETSI release 99 implementation)

Due to the new air interface modulation and much higher data rates, transceiver (TRX) units must be changed to make a base station EDGE capable. The GSM/EDGE capable TRXs for MetroSite EDGE BTS and UltraSite EDGE BTS are compatible with GSM TRXs and fit into the same slot in the BTS cabinets. In addition to providing EDGE services, the GSM/EDGE TRXs are fully GSM compatible and support GSM voice, data, HSCSD, and GPRS plus EGPRS. They are also backward compatible with all legacy GSM terminals.

The EDGE capable base stations also simultaneously support the current GMSK modulation since the modulation choice can be done per timeslot basis.

**Benefits of EDGE**

- Migration to wireless multimedia services

- Improved service quality through increased data capacity and higher data throughput that decrease response time for all data services
- Flexibility in pricing due to lower cost of data capacity for high-speed data applications
- Fast network implementation
- EDGE does not require any new network elements and EDGE capability can be introduced incrementally to the network
- Optimised network investment as GSM enhancement
- Demand-based deployment of data capacity

### 4.19.1 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.

### 4.19.2 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.

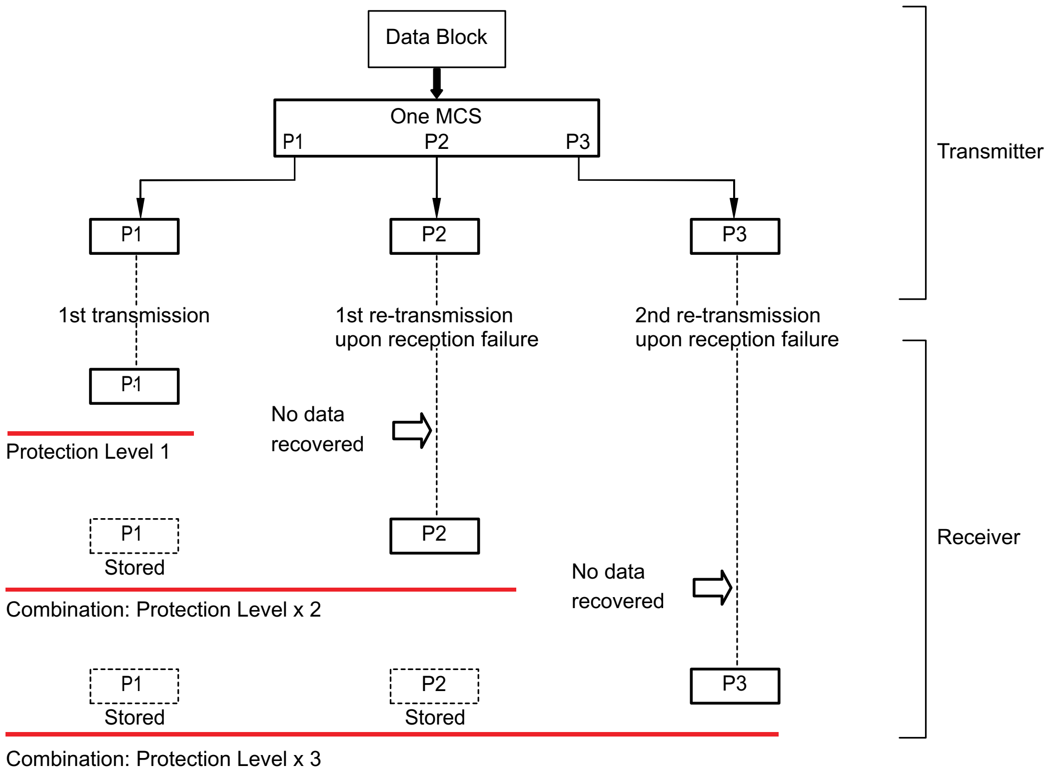


*Figure 11* Incremental Redundancy scheme

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[rsquo ]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.

### 4.19.3 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 | Protection decreases | .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 |

*Figure 12* 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.

## 4.20 BSS10084 Priority Class based Quality of Service (QoS)

At a system level, the concept of "Priority Class" is introduced. This is based on combinations of GPRS Delay class and GPRS Precedence class values. Packets are evenly scattered within an (E)GPRS territory between different timeslots. After that, packets of higher priority are sent before those of lower priority.

Currently, all TBFs (GPRS calls) have the same priority. All users and applications receive the same service level. However, application needs differ and mechanisms for separate service levels are required. GSM specifications define a QoS functionality, which gives a possibility to differentiate TBFs by delay, throughput and priority. With Priority Based Scheduling the operator can give users different priorities.

The scheduling algorithm gives each link a so-called latest service time, before which it should get a chance to use the radio resource. After using the resource the link receives a new latest service time, the current time plus a predefined step. The connection with the smallest latest service time may use the radio resource. The scheduling algorithm checks the queue periodically.

The algorithm is priority-based. It selects the best possible timeslot within a territory and prioritises the TBFs residing in that timeslot, so that the TBF with the highest priority receives most of the air interface.

Each timeslot has a queue, in which the TBFs wait for their turn to use the radio air interface. After that the TBF increases it"s latest service time to the current time plus the scheduling step size. Using the current time is explained by the new TBFs coming into the system. All TBFs must start from the same situation.

The algorithm has a direct impact on the scheduling algorithm. The scheduling step sizes must be set to reflect the allocation of the radio resources, because the time a certain link has control of the resource is decided by the scheduling algorithm. Each service class is given fair amounts of radio time, except for the best effort customers, who receive a small share of the radio interface. Priorities are implemented by giving different operator adjustable scheduling step sizes for different QoS classes. There are 4 QoS classes for uplink, and 3 for downlink.

This algorithm provides priorities between the TBFs in the same timeslot, so that those with the same QoS receive an equal share of air time. However, the equal air time does not provide equal data rates, it only guarantees that the air time inside a QoS group is divided equally and that a higher QoS class receives more air time.

Mobile specific flow control is part of the QoS solution in the Packet Control Unit (PCU). The feature works together with the Serving GPRS Support Node (SGSN) to provide a steady data flow to the mobile station from the network. It is also an effective countermeasure against buffer overflows in the PCU.

Priority Based Scheduling is a standard feature in BSC and the subscriber priority needs to be defined in the DX HLR (HLR) once this feature is taken into use.

## 4.21 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.

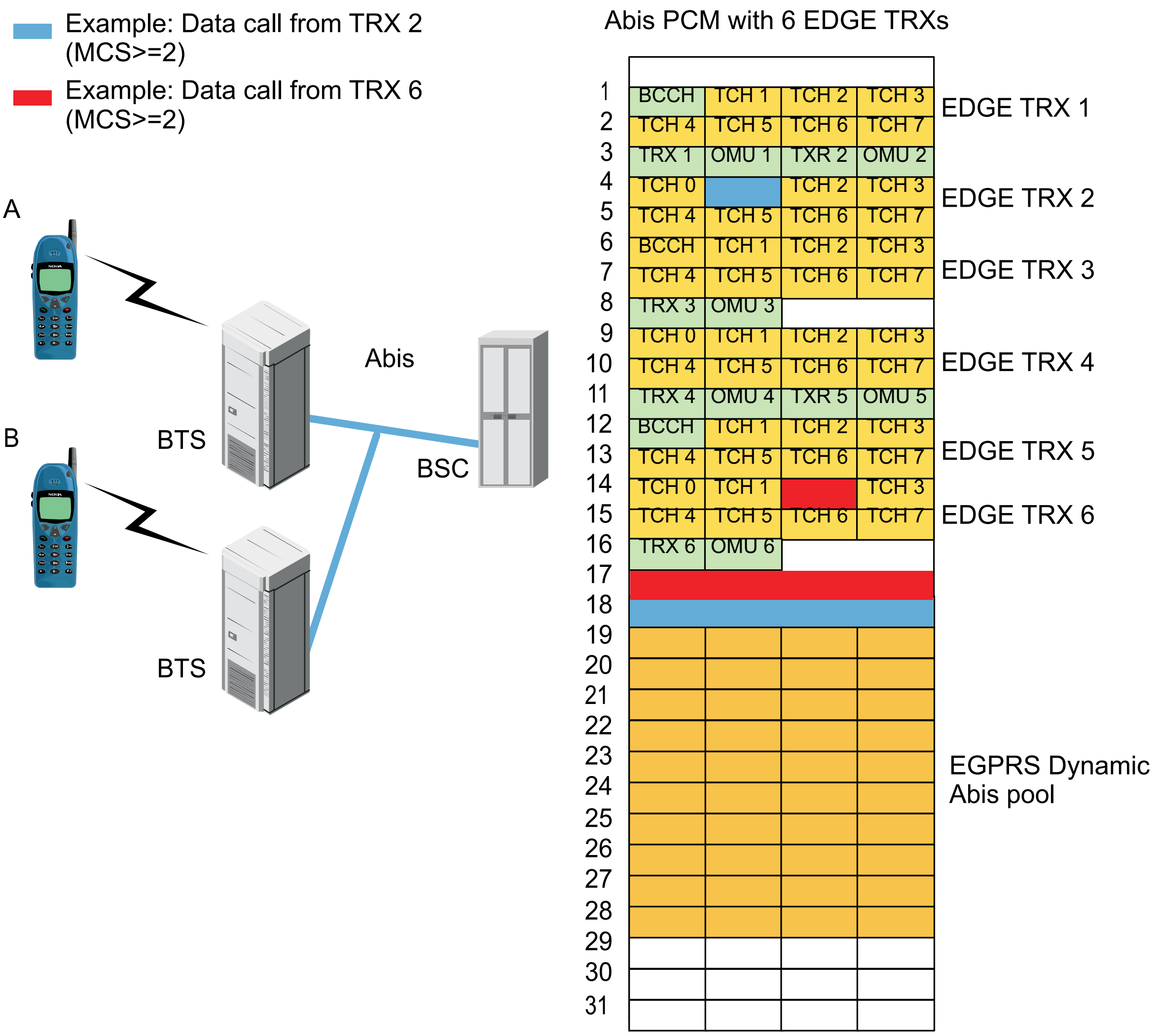


*Figure 13* Dynamic Abis pooling

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).

## 4.22 EDGE HW support

This feature provides SW support for the GSM/EDGE capable MetroSite HW, that is WTxA and CTxA units. Both GSM and GSM/EDGE capable units may co-exist in the same BTS cabinet.

## 4.23 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 2* 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.

## 4.24 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.

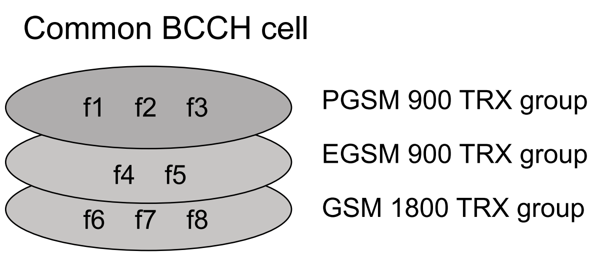


*Figure 14* Common BCCH configuration

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

## 4.25 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.

## 4.26 BSS10102 Chaining of MetroSite BTS

MetroSite GSM and EDGE base stations can be chained in order to build larger configurations for micro cellular environments and still have easy installation and Operation and Maintenance (O&M) functions. The chaining is done by synchronising a frame clock betweeen the base stations and extending the internal D-bus. One transmission unit is saved for each extension cabinet. The O&M functionality is centralised to the master cabinet. Only one extension cable between the cabinets is needed. The maximum number of combined MetroSite base stations is three and the total length of the bus cable is limited to five meters.

If a slave base station looses the chaining interface, the TRX Faulty alarm is activated for each TRX in it. The chaining is arranged so that the centremost cabinet can be depowered without any problem in case of three cabinet configurations.

## 4.27 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).

## 4.28 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).

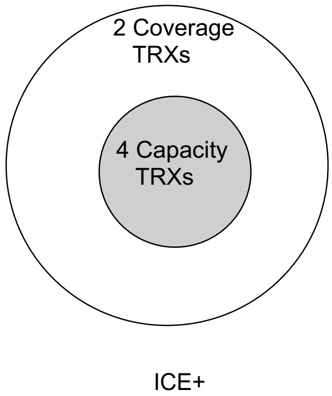


*Figure 15* Intelligent Coverage Enhancement Plus (ICE+)

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.

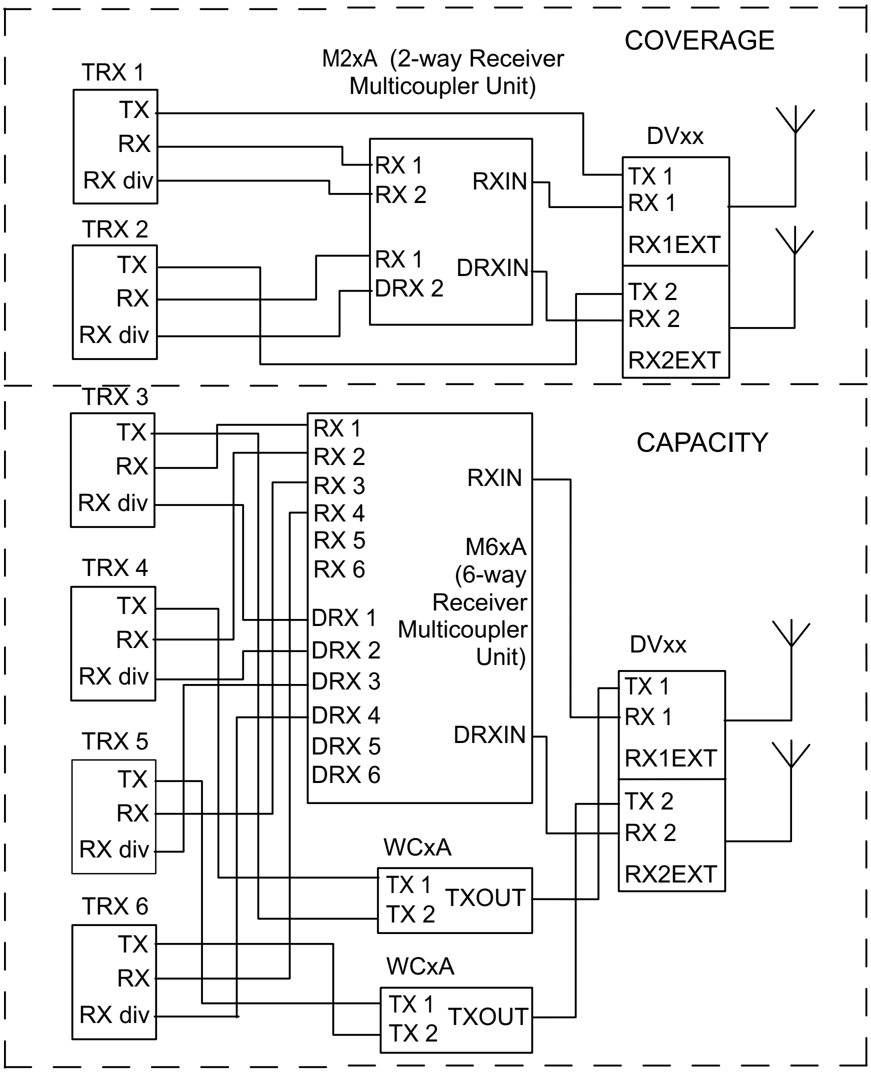


*Figure 16* 2 TRXs using combiner bypass (coverage) and 4 TRXs using 6-way wideband combining (capacity) arranged in an ICE+ configuration

## 4.29 BSS9051 Pseudo baseband frequency hopping for MetroSite BTS

In MetroSite BTS the baseband hopping implementation differs slightly from the earlier BTS products. The baseband hopping in MetroSite BTS is not implemented by switching the baseband data between TRXs. Instead, the RF synthesisers are used to provide frequency hopping that behaves and looks in BTS"s external interfaces like traditional baseband frequency hopping. When the user selects "baseband hopping" mode at the BSC, MetroSite BTS uses pseudo baseband frequency hopping.

With pseudo baseband hopping the number of frequencies in hopping group equals to the number of TRXs in the sector. Each TRX receives the information on the BCCH power level used and uses it when tuned to the BCCH frequency. This ensures the continuous BCCH transmission.

In TRX locking and TRX failure situations MetroSite BTS with pseudo baseband hopping behaves like other BTSs with traditional BB hopping, that is:

- Locking of an individual TRX is not possible.
- If a TRX is blocked by the system, the whole sector needs to be reconfigured.

TRX test can be used normally with pseudo baseband frequency hopping.

## 4.30 BSS8086 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.

## 4.31 BSS8120 Transmission operability

This feature contains the following two sub-features:

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

Several counters are available, which makes it possible to measure MetroSite transmission equipment in two ways:

1. All equipment can be measured within a 24-hour period. This measurement gives 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 MetroSite transmission equipment can be defined. MetroSite 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 will be collected from the equipment (this support is part of the 'Flexible counter collection set' feature). To do this the operator has to know the topology of the transmission network so that the measurement subject can be chosen.

## 4.32 BSS8132 Autodetection of site configuration

MetroSite BTS detects the site configuration automatically, including all unit types and versions, as well as the serial numbers and the GSM band used. This information is stored in the non-volatile memory of the master TRX, and it can be displayed in BTS Manager (see Supervision - Equipment view in the figure below). MetroSite BTS has no HW database file.

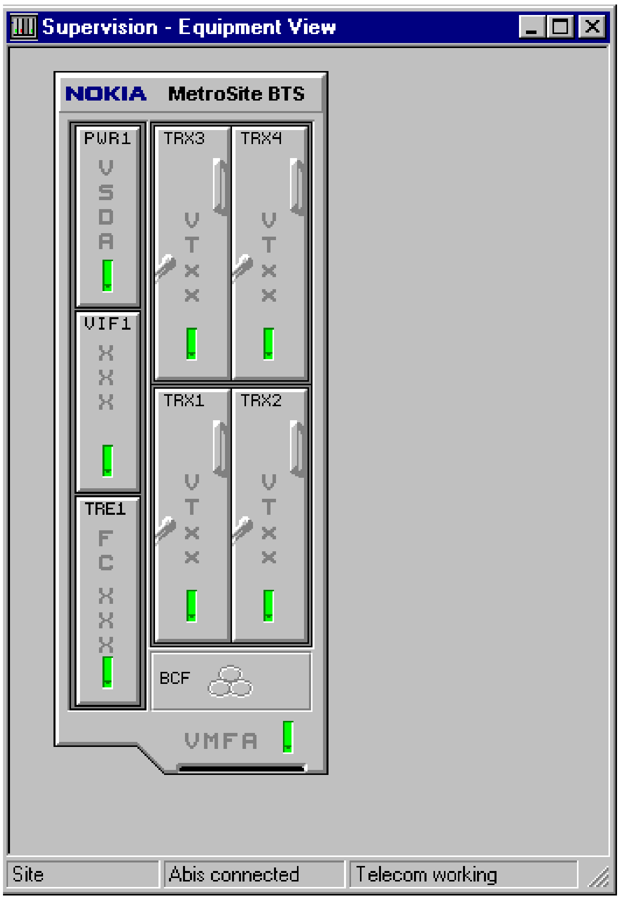


*Figure 17* Autodetected site configuration in the Equipment view in BTS Manager

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

MetroSite BTS system data is backup copied to each slave TRX. This makes it possible to replace the master TRX with a slave TRX without re-commissioning.

## 4.33 BSS8135 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 *MetroSite EDGE BTS, Alarm Descriptions.*

## 4.34 BSS8136 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 site reset by resetting the master TRX and slave TRXs
- Master TRX can be restarted also logically without a site reset (calls via other TRXs are not disturbed)
- Slave TRX can be restarted without disturbing the master TRX.
- Sector reset

Transmission units cannot be reset with BTS SW.

## 4.35 BSS8137 BTS SW management

The non-volatile memory of the master TRX can contain two BTS SW versions.

BTS SW downloading is executed after BCF reset if the BCF does not have correct BTS SW. Downloading the BTS SW can also be performed as a background operation when a BTS SW is being attached to the BCF.

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

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

## 4.36 BSS9066 Supervision of transmission units

MetroSite BTS 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 which further transfers them to the NMS.

**Supervision of transmission units supplied by other manufacturers**

When transmission units supplied by other manufacturers are supervised via External Alarm and Control (EAC) lines, 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 master TRX 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 master TRX 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).

## 4.37 BSS8139 Combined O&M and telecom signalling

This feature makes it possible for both O&M (OMUSIG) and telecom signalling (TRXSIG) links to share the same physical timeslot on the Abis PCM. The combining of the O&M and telecom signalling enables more efficient use of the transmission capacity.

MetroSite BTS TRXs can be configured either as a master TRX or a slave TRX. The master TRX carries out the O&M and telecom functions. This makes it easier to combine the O&M and telecom signalling.

The TRX 1 is the master TRX.

O&M (OMUSIG) and telecom signalling (TRXSIG) links share the same physical timeslot on Abis PCM, but they have their own SAPI values (0 for TRXSIG, 62 for OMUSIG) and polling. Supported bit rates are 16 kbit/s, 32 kbit/s and 64 kbit/s.

## 4.38 BSS8140 Real time update to BTS

The BSC sends the current time (date and time) to MetroSite 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.

## 4.39 BSS8141 BTS supervision

MetroSite BTS is capable of monitoring and testing itself during operation without a separate command as described below.

### Continuous monitoring

Both SW and HW carry out monitoring. The following items are monitored continuously:

- Internal buses of the BTS: Q1-Int, D-bus, F-bus, I2C-bus
- Transmission units and interfaces
- RF parts: synthesisers, output power, power control, reflected power
- Digital parts: processors, ASICs, interfaces
- Temperature and heating or cooling system of the BTS
- Power supply voltages
- Reference Oven Oscillator.

### Mains breakdown

Mains breakdown alarm can be sent via Abis with the help of capacitors in the AC power supply. In case of a short breakdown, which does not affect the BTS operation, the BTS cancels the alarm. A typical voltage drop that lasts less than 20 ms does not cause an alarm.

## 4.40 BSS8142 TRX test

In TRX Test, the total performance of the TRX is tested. The test covers:

- Digital and RF parts
- Antenna connection detection
- RX sensitivity and TX level.
- Both RX branches

TRX test time is about 15 seconds.

The figure below shows the TRX Test window.

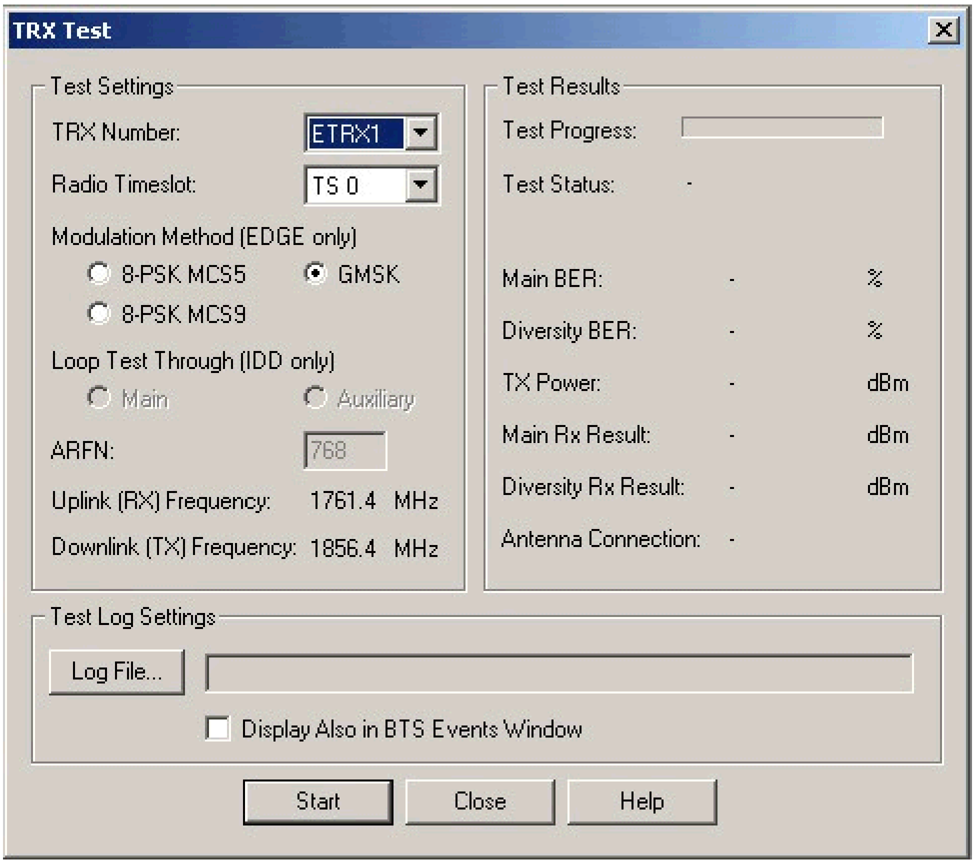


*Figure 18* TRX Test window

The TRX test can be carried out for all TRXs in the base station 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.

## 4.41 BSS8143 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 *MetroSite BTS, Alarm Descriptions*.

## 4.42 BSS8144 BTS temperature control

MetroSite BTS monitors its temperature continuously with several sensors located in the base station units (all TRXs, power supply unit and fan unit). The base station controls its temperature with a cooling fan and heaters to provide as stable operation conditions as possible. Heating and cooling is controlled gradually (the fan speed has 16 steps) depending on the ambient temperature to ensure low temperature gradients and low noise level.

If the temperature of a slave TRX rises too high, a temperature alarm is issued, and the master TRX shuts down the overheated slave TRX. If the base station starts up in an extremely cold environment, power supply to units is prevented and the units are heated to the minimum operating temperature.

## 4.43 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.

## 4.44 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.

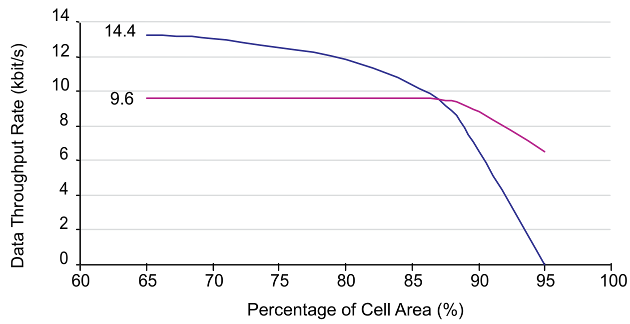


*Figure 19* Typical data throughputs for 14.4 kbit/s (non-transparent) and 9.6 kbit/s coding (Note: this will depend on the NW radio conditions)

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.

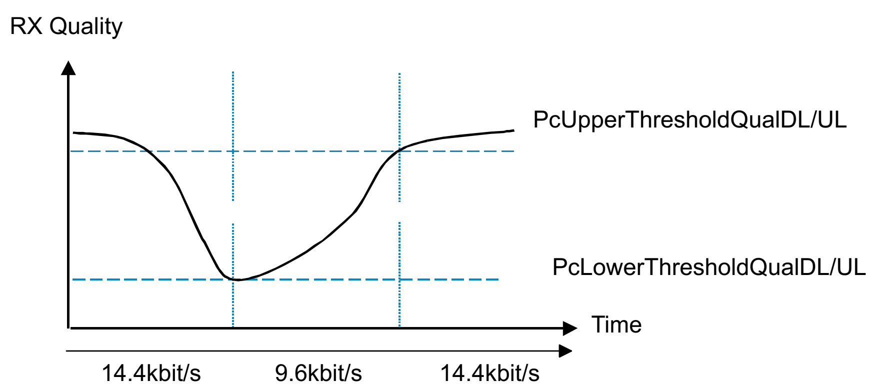


*Figure 20* Nokia Automatic Link Adaptation

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

## 4.45 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.

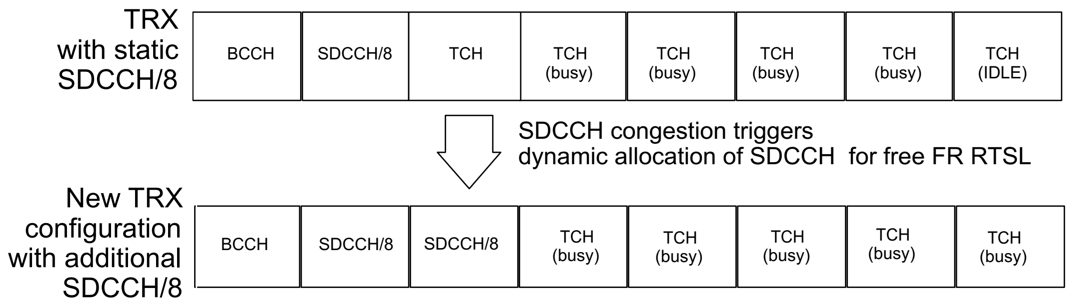


*Figure 21* Dynamic SDCCH allocation

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.

## 4.46 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 3* 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.

## 4.47 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).

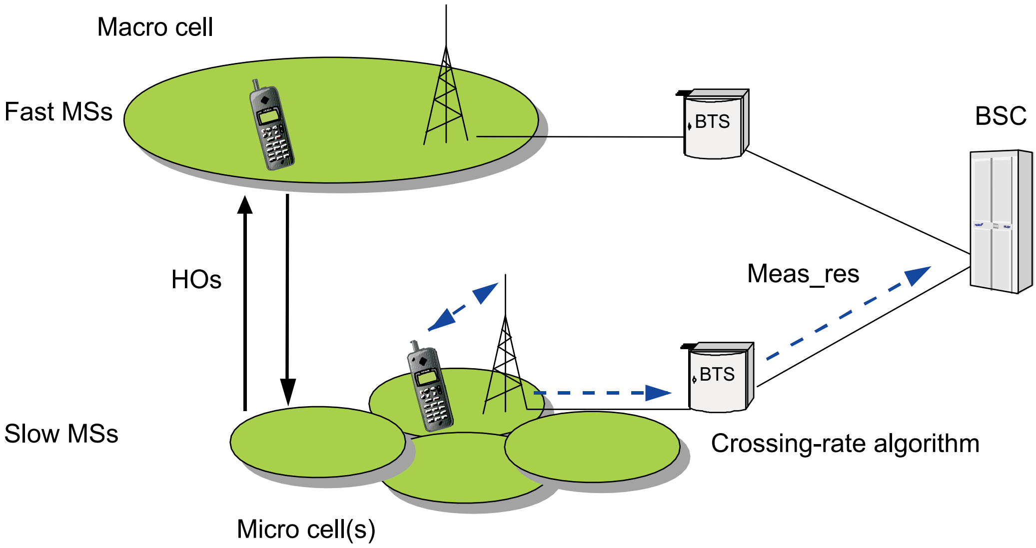


*Figure 22* MS speed detection used for handover decision

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.

## 4.48 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.

## 4.49 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.

## 4.50 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.

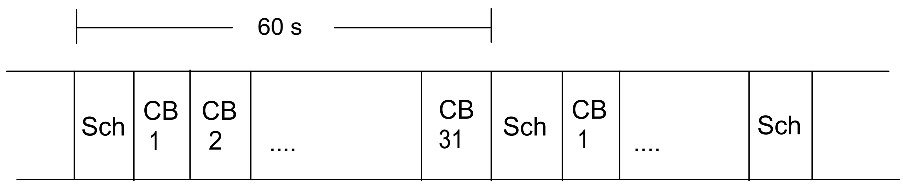


*Figure 23* SMS-CB DRX Schedule Period

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.

## 4.51 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.

## 4.52 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.

## 4.53 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.

## 4.54 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.

## 4.55 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.

## 4.56 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 each TRX during normal operation. The BTS SW is activated by resetting the site. This makes it possible to update the software with minimal downloading time.

## 4.57 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.

## 4.58 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.

## 4.59 BTS2092 Oven oscillator adjustment alarm

If the 13 MHz output is not correctly adjusted and set, an alarm is sent to the BSC. This alarm is usually active after the BTS start-up. If this alarm remains active, it may indicate that either the oven oscillator is degrading rapidly or the 2M PCM frequency is not correct.

## 4.60 BTS2089 BTS power backup

In the case of a mains power loss, the external Battery Backup can supply operating power for the BTS.

## 4.61 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.

## 4.62 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.

## 4.63 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 10 user-definable inputs and 4 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.

## 4.64 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).

## 4.65 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.

## 4.66 BTS2038 Transmission control: alarm handling via LAPD

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

## 4.67 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.

## 4.68 BTS2036 Antenna supervision

The antenna connection is supervised continuously by the HW when high transmitter power is used. If the reflected power exceeds the alarm threshold, an alarm is issued.

The transmitted power level and the power level reflected from the antenna are measured, and their signal ratio is compared to the defined threshold to issue an alarm.

## 4.69 BTS2033 Short message cell broadcast

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

MENU



## 4.70 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.

## 4.71 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.

## 4.72 BTS2022 Logical channel configurations

The following logical channel configurations are supported as specified in the GSM recommendations:

TCH/F (SPEECH or DATA) + FACCH/F + SACCH/TF

FCCH + SCH + BCCH + CCCH

FCCH + SCH + BCCH + CCCH + SDCCH/4 + SACCH/C4

SDCCH/8 + SACCH/C8

SDCCH/8 + SACCH/8 + CBCH

FCCH + SCH + BCCH + CCCH + SDCCH/4 + SACCH/C4 + CBCH

There can be up to 12 SDCCH channels per TRX. The number of these channels is limited by the transmission capacity per TRX via the Abis interface.

## 4.73 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.

At least two TRXs per sector are required to support the RX diversity.

## 4.74 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.