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Nokia Flexi EDGE Base Station, Rel. EP1, Product Documentation, v.1

Nokia Flexi EDGE BTS Feature Descriptions

Contents

1 Overview of features in Nokia Flexi EDGE BTS SW release EP1

Operating and Application SW

Nokia BSS12 Software consists of Operating Software and Application Software:

- Operating Software refers to basic functionalities of a product.
- Application Software refers to optional features.

The BSS12 system features are available in the following network element releases: S12, EP1.

For more information on the features, see Nokia GSM/EDGE BSS System Documentation and Nokia BSC/TCSM Product Documentation sets.

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

2 Data/Voice

2.1 BSS20088 Dual Transfer Mode

Dual Transfer Mode (DTM) provides mobile users with simultaneous circuit-switched (CS) voice and packet-switched (PS) data services. This means that users can, for example, send and receive e-mail during an ongoing phone call.

In dual transfer mode, the mobile station (MS) is simultaneously in dedicated mode and in packet transfer mode, so that the timeslots allocated for each MS are consecutive and within the same frequency.

Benefits

With DTM, the operator can expand the service portfolio to offer users enhanced services in a GSM/EDGE network. DTM allows the operator to provide a wide range of services that demand a simultaneous CS and PS connection. Mobile users can use data services, such as file transfer, web browsing, video sharing, and mobile netmeeting, during a speech call. This makes it possible to launch services similar to UMTS class A services also in 2G networks. In addition, these services can be used to complement the 3G coverage in places where there is no 3G network coverage.

BTS functionality support

The BTS supports DTM through the normal BTS support of CS and PS services.

Interaction with other features

DTM supports all *full rate* speech codecs. The CS speech codec selection for DTM is similar to the selection mechanism used for a plain CS connection. In addition, the DTM PS channels can be multiplexed in a similar way to normal GPRS/EDGE.

2.2 BSS9006 General Packet Radio Service (GPRS)

General Packet Radio Service GPRS provides packet radio access for GSM mobile stations.

By sharing the channels provided by various network elements and transmission systems, the cellular network resources are used more efficiently for data services than with circuit switched data services.

All mobile stations share the radio resources in a cell, and use the radio resources only when sending or receiving data.

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

- Channel Coding Scheme 1 (CS1) 9.05 kbit/s
- Channel Coding Scheme 2 (CS2) 13.4 kbit/s
- Channel Coding Scheme 3 (CS3) 15.6 kbit/s
- Channel Coding Scheme 4 (CS4) 21.4 kbit/s

In packet transfer mode, the mobile station must use the continuous timing advance procedure. This procedure is carried out on all packet data channels (PDCHs).

Coding Schemes CS3 and CS4 (BSS11088) is an application software product, and it requires a valid licence in the BSC. CS3 and CS4 provide a considerable gain in data rates for GPRS mobile stations not supporting EGPRS (the mandatory RLC header octets are excluded from the data rate values).

Link Adaptation (LA)

Nokia Flexi EDGE BTS supports PCU with GPRS link adaption by providing the measurements for the uplink radio blocks.

Interaction with other features

CS3 and CS4 do not fit to one 16kbit/s Abis/PCU channel and require the use of Dynamic Abis Allocation.

2.3 BSS10083 Enhanced General Packet Radio Service (MCS-1 - MSC-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 the table below shows, EGPRS supports higher data rates compared to the basic GPRS, using several Modulation and Coding Schemes (MCSs). The speed in radio resources is fixed for GMSK and 8PSK, but because the amount of channel coding varies, the user data rate varies depending on the MCS.

Table 1. Peak data rates for single slot EGPRS

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

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.

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.

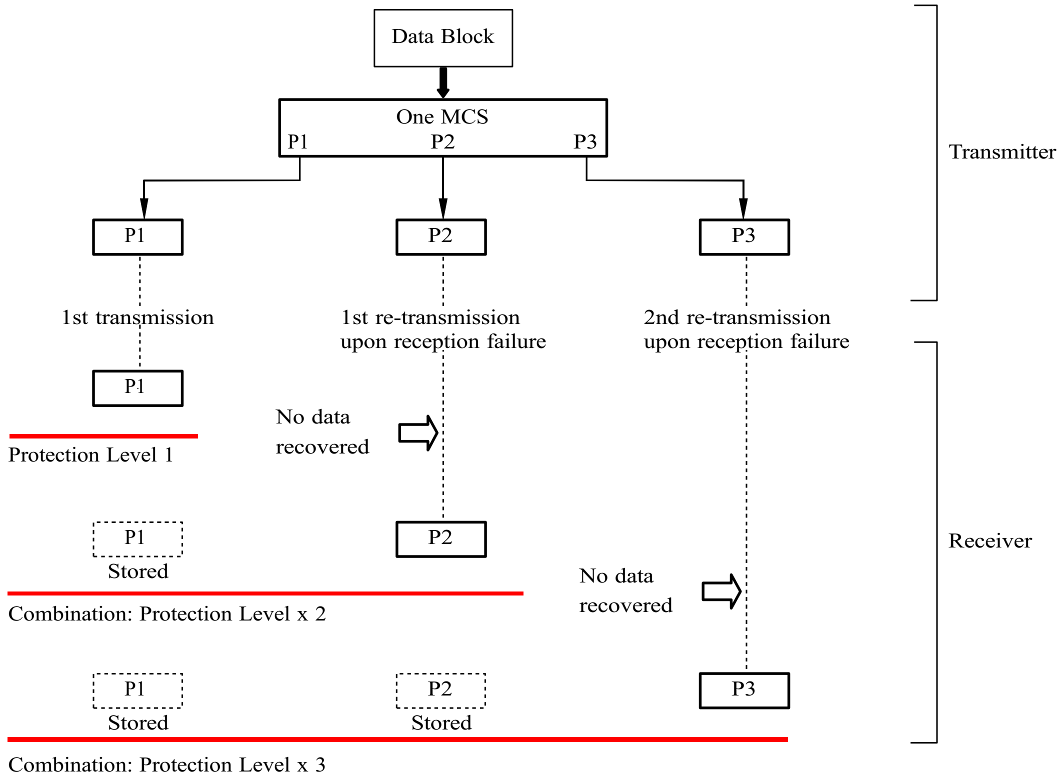

Figure 1. Incremental Redundancy scheme

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

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

Link Adaptation (LA)

Nokia Flexi EDGE BTS supports PCU with EGPRS link adaption by providing the measurements for the uplink radio blocks.

Interaction with other features

EGPRS Modulation and Coding Schemes MCS-1 - MCS-9 require the use of Dynamic Abis Allocation.

2.4 BSS10074 Support of PBCCH/PCCCH

Support of Packet Broadcast Control Channel/Packet Common Control Channel (PBCCH/PCCCH) allows dedicated common control channel (CCCH) capacity for (E)GPRS services.

The BTS transparently supports these channels as packet data channels.

2.5 BSS7003 High Speed Circuit Switched Data and BSS7037 14.4 kbit/s Data Services

High Speed Circuit Switched Data uses multiple parallel channels to provide higher data rates for end-user applications, such as 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 four radio timeslots (RTSLs) per HSCSD call.

The table below presents the corresponding maximum data rates with different channel coding.

Table 2. Corresponding maximum data rates with different channel coding

Number of RTSLs	9.6 kbit/s	14.4 kbit/s
1	9.6 kbit/s	14.4 kbit/s

Table 2. Corresponding maximum data rates with different channel coding (cont.)

Number of RTSLs	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

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, because of increased traffic for example. 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.

BSS7037 14.4 kbit/s GSM Data Services

With the 14.4 kbit/s GSM Data Services, the speed of one timeslot increases from 9.6 kbit/s to 14.4kbit/s.

The 14.4 kbit/s channel coding has less error correction than 9.6 kbit/s coding. Therefore, there are 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 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.

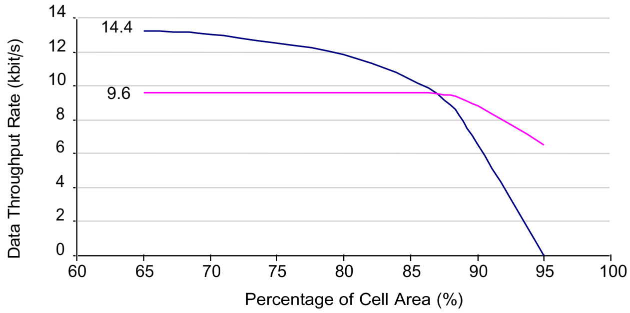

Figure 2. Typical data throughputs for 14.4 kbit/s (non-transparent) and 9.6 kbit/s coding (this depends on the NW radio conditions)

The Automatic Link Adaptation (ALA) optimises the data throughput by automatically choosing the channel coding most suitable to the radio conditions and by control of the power levels.

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

2.6 BSS10004 Adaptive Multi Rate Codec (AMR)

Adaptive Multi Rate Codec provides significantly better speech quality by:

- using better source coding algorithms that give better subjective speech quality for the same link capacity
- adaptively adjusting ratio of bits used for speech coding and channel coding to always provide best subjective speech quality according to current radio conditions.

With AMR it is possible to increase speech capacity by using HR mode and still maintain the quality of current FR calls. It consists of an adaptive algorithm for codec changes and 8 different speech codecs (14 codec modes) listed in the table below.

Table 3. Channel and speech codec modes for AMR

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
(*) Not supported, requires 16 kbit/s TRAU.					

Codec mode adaptation for AMR is based on received channel quality estimation in both the mobile station (MS) and the BTS.

The BTS and MS inform and request of codec used/to be used by in-band signalling.

2.7 BSS7005 Intelligent Frequency Hopping and BSS6114 Intelligent Underlay-Overlay

With Intelligent Frequency Hopping and Intelligent Underlay-Overlay, it is possible to reuse frequencies more intensively, and therefore achieve a higher radio network capacity. With Intelligent Frequency Hopping, it is also possible to avoid frequency dependent fading on the radio path.

When Intelligent Frequency Hopping is in use, the operator can use Intelligent Underlay-Overlay simultaneously with frequency hopping in the same cell. Either baseband (BB) or radio frequency (RF) hopping can be used.

The different interference characteristics of the regular and super-reuse layers in Intelligent Underlay-Overlay require that the network plan for frequency hopping is constructed separately for each layer. Intelligent Frequency Hopping enables the use of separate Mobile Allocation Frequency Lists of radio frequency hopping for the layers of an Intelligent Underlay-Overlay cell. Baseband hopping is implemented by treating the regular layer as a normal cell and the super-reuse layer as a new hopping group.

The operator can set the regular and super-reuse layers in Intelligent Underlay-Overlay individually to hopping.

3 Interworking

3.1 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. When the WCDMA and GSM networks overlap, also an inter-system handover from GSM to WCDMA can be made to release traffic load in the GSM system.

Nokia Flexi EDGE BTS supports this feature as a GSM EDGE Base Station.

3.2 BSS11086 Support for Enhanced Measurement Report

Support for Enhanced Measurement Report (EMR) 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.

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 Nokia features, such as:

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

Interaction with other features:

- The network does not order an MS to use the EMR for reporting when an Idle Broadcast Control Channel (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
- Enables GSM/EDGE/WCDMA interworking
- Improved performance of statistics

4 Operability

4.1 BSS11047 Intelligent shutdown for Flexi EDGE BTS

To provide protection against a mains power break, the operator can equip a BTS with a battery backup system. The purpose of Intelligent Shutdown 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 BSC controls the reduction of the site capacity, which commands individual transceiver units to be shut down or started up.

On a BTS site basis, the user can define the service level of the site to be maintained while the battery backup is in use. Also, two timers can be defined, 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.
- Broadcast control channel (BCCH) backup – The BTS maintains full capacity until the first timer expires. After that, all active calls on non-BCCH transceivers are handed off. The non-BCCH transceivers are blocked from carrying any new calls and the BSC commands the BTS to shut them down. The BCCH TRX(s) are maintained to offer minimum service.
- Transmission backup – The second timer starts after the first one has expired. After the expiry of the second timer, all active calls on BCCH transceivers are handed over. 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 Flexi EDGE BTS:

- Nokia Flexi Support
- Flexi with Integrated Battery Backup Units
- 3rd Party Battery Backup Solution

Nokia Flexi EDGE BTS autodetects the Flexi Support system and the integrated battery backup units. 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 that the BSC sends to the BTS during the initial start-up or reset of the BTS. If the mains power is lost, the battery backup system sends a 'mains breakdown' alarm to the BTS, and further to the BSC, which then triggers the shutdown procedure.

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, the operator 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.

4.2 Remote mode of Nokia Flexi EDGE BTS Manager

The operator can control Nokia Flexi EDGE BTS equipment locally via Nokia Flexi EDGE BTS Manager. To minimise the need for site visits, Nokia Flexi EDGE BTS Manager functions can also be accessed remotely.

The user can monitor and test the BTS remotely, by connecting the Flexi EDGE BTS Manager to the BTS remotely via Nokia NetAct™. A PC with the Flexi EDGE BTS Manager software is used as a user terminal. Nokia General Communication Server (GCS) SW Suite is used for providing both local and remote connections to the BTS.

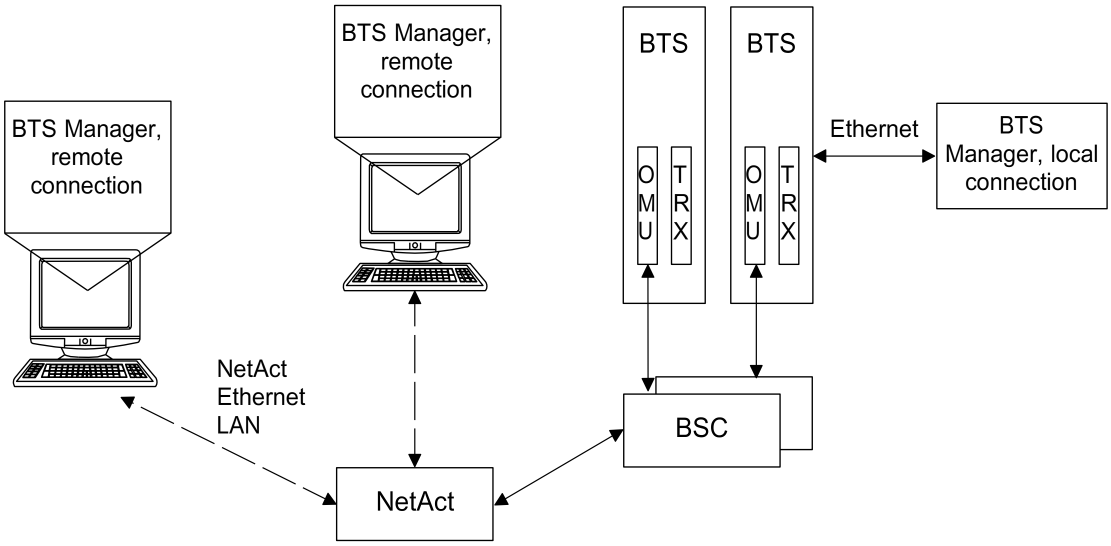

Figure 3. Nokia Flexi EDGE BTS Manager connected in remote mode

The user can connect to a remote BTS using the Flexi EDGE BTS Manager application, via a menu item and/or a toolbar button, or via the command line. The user interface of Flexi EDGE BTS Manager informs the user of the remote connection status when information is being requested from the remote BTS, and when the Flexi EDGE BTS Manager is processing received information from a remote BTS. Nokia Flexi EDGE BTS Manager connected in remote mode supports all other features available via a local connection, except the Control Abis interface (enable/ disable) and the 'block' and 'unblock' commands.

It is not possible to perform the initial BTS commissioning remotely, but it is possible to perform subsequent recommissioning or append commissioning from the Flexi EDGE BTS Manager in remote mode.

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

4.3 BSS10063 Rx Antenna Supervision by Comparing RSSI

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

The monitoring is based on the principle that all received bursts where the Rx level of main or diversity branch is above the defined limit value (-100 dBm), are accepted as samples and used in the averaging process. A minimum of 1.6xE5 samples in one hour must be collected for the BTS to assume that the results are reliable and therefore could be used to raise an alarm.

The differences of the TRXs connected to the same antennas are counted up, and the average difference for main and diversity antennas is calculated. If the difference is above the threshold (default value 10 dB), and the number of samples indicate that the results should be reliable, 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.

It is still possible that both antennas are damaged simultaneously and the difference algorithm cannot detect the fault. For this reason, the BSC also observes the assignment and handover success rate.

Note that the RSSI values observed from Nokia Flexi EDGE BTS Manager may not be the same on both of the carriers of a Dual TRX Module. The difference between carriers can be greater than 10 dB, depending on the Rx level of the calls made on both carriers. If the average uplink Rx level of calls (CS/PS) made on Carrier 1 is high compared to Carrier 2, this difference can be seen and this is not an issue. It implies that calls on Carrier 1 are being made from mobiles that are near to the BTS, while calls on Carrier 2 are being made from mobiles that are relatively far from the BTS. The RSSI difference between two carriers is different from the case where an RSSI alarm is raised. The alarm is due to the difference in the Rx level of the main and diversity paths of a carrier. However, this alarm is not valid for the comparison done across carriers. Moreover, the comparison of RSSI values across carriers is not valid in Nokia UltraSite BTS as a TRX in the UltraSite BTS supports one carrier only, whereas in the Flexi EDGE BTS, a Dual TRX module supports two carriers.

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Benefits

Rx Antenna Supervision by Comparing RSSI can identify antenna problems without the need for active tests.

4.4 BSS9068 BTS SW management

The BTS software can be updated by downloading new BTS software remotely from the BSC. A site visit is not needed. The operator can also download the BTS software with Nokia Flexi EDGE BTS Manager.

The BTS sofware can be downloaded during normal operation. Resetting the site activates the BTS software. This makes it possible to update the BTS software with minimal BTS downtime.

Downloaded BTS software application files are stored in the flash memory of the System Module (ESMA). The flash memory of the System Module can contain two BTS SW versions.

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

Local BTS SW backup minimises BTS boot-up time because there is no need to download the BTS software package from the BSC after each reset.

4.5 BSS9067 Runtime diagnostics and BTS alarms

Alarm diagnostics filters alarms, reporting only those alarms that directly affect the BTS service level, that is, BTS level 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 module has been replaced, the alarm is cancelled either manually or automatically.

When the BSC displays a BTS alarm, the alarm text includes a fault reason describing the cause of the alarm. The operator can use this information in troubleshooting. For more information, see *Trouble Management of Nokia Flexi EDGE BTS*.

4.6 BSS9058 BTS fault recovery

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

For more information on fault recovery and BTS alarms, refer to *Trouble Management of Nokia Flexi EDGE BTS.*

4.7 BSS9063 Abis loop test

The Abis Loop Test verifies the Abis transmission setup and quality.

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

Nokia Flexi EDGE BTS provides a test pattern in uplink for the channels under test. A group switch loop in the BSC loops the uplink data stream back to downlink where the BTS checks the integrity of the downlink pattern. The Abis Loop Test can be run on the fixed channels of a TCH allocation and on the channels of a Dynamic Abis Pool. The BTS provides the related test reports for the BSC.

4.8 BSS9062 BTS supervision

The Nokia Flexi EDGE Base Station monitors and tests itself during operation without a separate command.

Continuous monitoring

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

- Internal buses of the base station
- Transmission equipment and interfaces
- RF parts
- Mast head amplifiers

- Nokia Flexi Support and Nokia Flexi EDGE Base Station Battery Backup (MIBBU)
- Combining units (Remote Tune Combiner Module ECxA, Dual Duplexer Module ERxA and low-noise amplifiers LNA)
- Temperature (heating and cooling) system of the base station
- Power supply voltages
- Reference Oven Oscillator

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

Mains breakdown

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

4.9 BSS9061 Temperature control system

Nokia Flexi EDGE Base Station monitors its temperature continuously with several sensors located in several modules (System Module ESMA, Dual TRX Module EXxA, and Remote Tune Combiner Module ECxA). The BTS controls its temperature with cooling fans to provide as stable operational conditions as possible. Heating and cooling is controlled gradually depending on the ambient temperature to ensure low temperature gradients and noise level.

If the temperature of a module rises too high, a temperature alarm is issued. If the System Module is overheated, the BCF is blocked. If the Dual TRX Module is overheated, the associated TRXs are blocked. Power supply units have their own internal shutdown and recovery in case they are overheated.

No separate heaters are required in Nokia Flexi EDGE BTS. In temperatures below -10º C, the Dual TRX Module heats itself, and the other modules function in the whole operational temperature range.

4.10 BSS9060 TRX Test

The total performance of the TRX is tested with a multi-purpose TRX Test. The test covers:

- Digital and RF parts
- RX operation and TX level
- Both RX branches

The TRX test time is approximately 15 seconds.

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

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

The TRX Test tests both the Tx and Rx RF paths of the selected TRX via an uplooped burst to the Air interface, including the Dual TRX module (EXxx) and Dual Duplexer Module (ERxx) or Remote Tune Combiner Module (ECxx).

The power level during the TRX test is the same as the power level of the broadcast control channel (BCCH). To avoid unwanted disturbances to the TRXs, the training sequence is not the same as the one normally used.

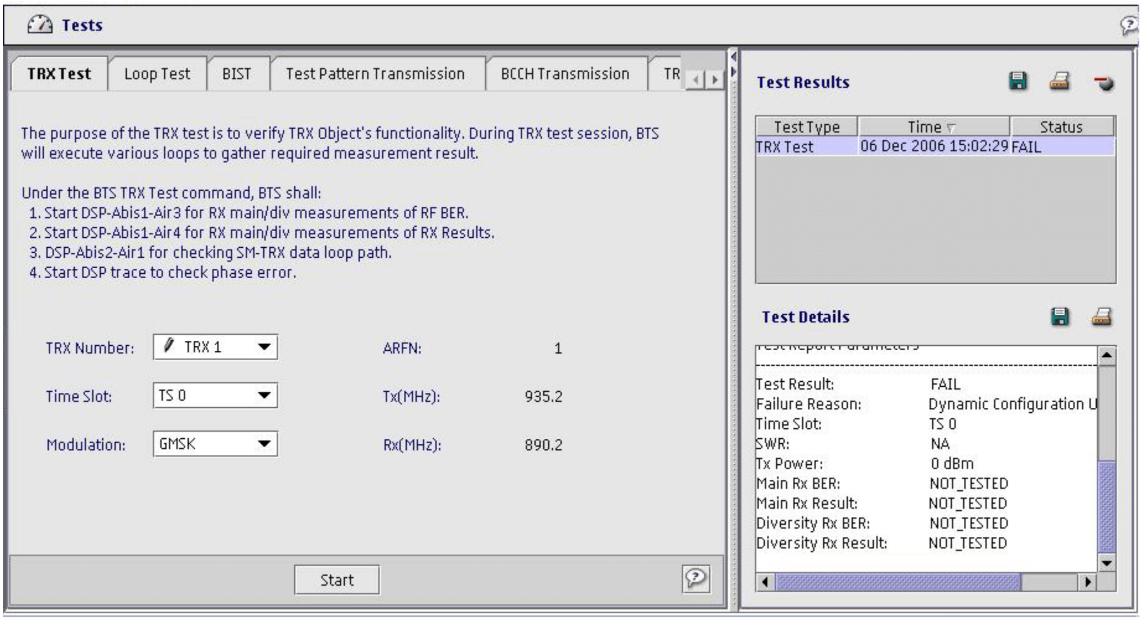

Figure 4. TRX Test window

All TRXs in the BTS can be tested either remotely from the BSC or the NetAct or locally with Nokia Flexi EDGE BTS Manager.

Note that the TRX test can be performed only in traffic channel (TCH) timeslots. Two free timeslots are needed for the test.

The TRX test is not possible when baseband hopping is used.

4.11 TRX Loop Test

Nokia Flexi EDGE BTS provides a TRX Loop Test facility. In a TRX loop test, data generated by SW in digital parts of the TRX is looped from the TX to RX side inside the Dual TRX module (EXxx) and the Dual Duplexer Module (ERxx) or the Remote Tune Combiner Module (ECxx), so that the TX and RX chains excluding antennas and antenna feeder cables are tested. Main or diversity paths can be tested.

The BTS checks the looped test data, and the test result is given as BER values.

The TRX Loop Test can be performed with GMSK TCH/FS or 8PSK PDTCH/MCS-5 test channels.

4.12 BSS9059 Nokia BTS resets

The operator can reset the Nokia Flexi EDGE BTS objects and modules locally with Nokia Flexi EDGE BTS Manager or objects remotely from the BSC or NetAct via Abis.

The reset types are as follows:

- The user can reset the BCF, BTS and TRX separately from the BSC or from Nokia Flexi EDGE BTS Manager. A BCF reset means resetting all units except the Transmission sub-module (FIxA) - in practice, it is a site reset.
- The Transmission sub-modules (FIxA) will remain operational during a BCF reset, to ensure that the transmission cross-connections remain operational.
- Each TRX within the Dual TRX Module (EXxA) is reset separately.
- The user can reset the System Module (ESMA) and Dual TRX Module (EXxA) separately from Nokia Flexi EDGE BTS Manager.
- A System Module (ESMA) reset will reset all units including the Transmission sub-module (FIxA).
- A Dual TRX Module (EXxx) reset will reset the HW and SW for both TRX objects within the Dual TRX Module (EXxA).

4.13 BSS9056 Autodetection of site configuration

Nokia Flexi EDGE Base Station detects the site configuration automatically, including all active modules and versions, their serial numbers and the frequency band used. This information is stored in the flash memory of the System Module (ESMA), and it can be displayed in Nokia Flexi EDGE BTS Manager.

The user needs to set the operator-specific settings, such as external alarm line settings, from the BSC or the NetAct, for example with the Remote MML session.

A possible change in any of the modules or in the configuration causes an automatic system data update in the flash memory of the System Module. The configuration is detected both in normal start-up situations and when extra capacity (more TRXs) is added, modules are removed, or a faulty module is replaced with a new one.

The transmission configuration is also backup-copied to the System Module.

There is no autodetection for the following units: mast head amplifier, power modules, and wide band combiner (WBC).

5 Site solutions

5.1 BSS10046 Multi BCF Control

Multi BCF Control allows the combination of several BTSs into one logical cell, enabling the operator to increase the capacity of a cell while maintaining the maximum spectral efficiency. Multi BCF Control increases the cell capacity for Nokia Flexi EDGE BTSs to 36 TRXs while requiring no extra BCCH. Multi BCF also provides a path for site expansion from Nokia UltraSite EDGE BTS to Nokia Flexi EDGE BTS.

Multi BCF Control requires that BSS9055 Clock Synchronisation between base stations, or BSS10069 Synchronised BSS is used.

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 needs to make some installations, for example synchronisation is needed between the base stations. All the base stations will have a separate O&M link to the BSC. At the BSC, a SEGMENT (SEG) object must be used to set all the BTS objects sharing the same BCCH.

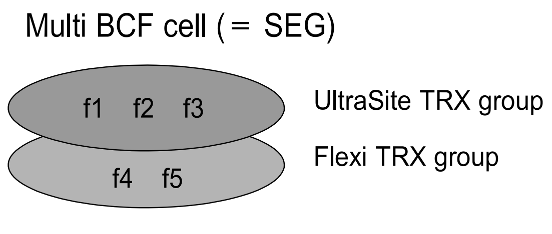

Figure 5. Multi BCF configuration

5.2 BSS9055 Clock Synchronisation between Base Stations

Clock Synchronisation between Base Stations enables synchronous handovers between base stations. The sectors defined to different base stations can use common hopping frequencies with RF hopping, which increases the channel capacity. The maximum site configuration is nine Nokia Flexi EDGE BTSs in a chain.

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

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

It is possible to synchronise a Nokia Flexi EDGE Base Station to a Nokia UltraSite EDGE BTS to serve the adjacent sectors. In this case the clock master is always a Nokia UltraSite EDGE BTS.

Physical properties

The maximum cable length for the total system is 100 metres. The synchronisation chain between the BTSs is made using RS-485 connection for the transferred clock signals.

Synchronisation recovery

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

Fast tuning

- If the clock reference is taken from Abis:

If the BTS is being commissioned, the fast oven-controlled crystal oscillator (OCXO) tuning is executed for the maximum duration of 8.6 seconds. The target accuracy is 0.02 ppm. The adjustments can be 10 times larger than in normal tuning. After fast tuning, the BTS starts normal tuning, and allows the BTS configuration to be completed.

- If the clock reference is taken from an external synchronisation source (other BTS or LMU):

If the BTS is being commissioned, the fast OCXO tuning is executed for an indefinite duration until the target accuracy of 0.02 ppm is met. Typically, the external clock reference is stable, therefore the fast tuning is completed in 4.6 seconds (two rounds). The first round is for getting the reading and for adjustments, and the second round is for validating that the required accuracy is met. The adjustments can be much larger than in normal tuning. After fast tuning, the BTS starts normal tuning, and allows the BTS configuration to be completed.

Normal tuning

With Abis as reference, the digital-to-analogue converter (DAC) word adjustment may occur every 20 minutes. The purity of Abis is monitored continuously, and the adjustment is only performed if the purity is good enough.

With an external clock as reference, the DAC word adjustment may occur every 20 minutes. The presence of the external clock source is monitored, the purity is not. When the external clock is present, the adjustment is made.

With both clock sources, the current DAC word is written as a new calibrated DAC word, if the current DAC word eventually drifts far enough from the calibrated DAC word. This ensures that in later start-ups (in any environmental conditions), the BTS starts immediately with a value as accurate as possible, and the C-plane and U-plane signalling and traffic remain undisturbed.

5.3 BSS10069 Synchronised BSS

With Synchronised BSS, all the clocks of the different sites in the network are synchronised, so that the GSM frame timing is aligned between all sites.

This is done by using a Location Masurement Unit (LMU), which gets a GPS time reference, and uses this to generate clock signals for the BTSs.

Syncronising all BTS sites in the network minimises timing differences between TDMA bursts of different sites. That significantly improves performance of Interference Rejection Combining and DFCA. The benefits are:

- Improved quality (higher data throughput, lower frame error rate (FER))
- Possibility of tighter frequency reuse
- More effective cell re-selection and handover processes
- More accurate MS locationing functionality

5.3.1 BSS20371 BSS Site Synchronisation Recovery Improvement

BSS Site Synchronisation Recovery Improvement is an enhancement to BSS11073 Recovery for BSS and Site Synchronisation. With BSS Synchronisation Recovery Improvement, the BTS site continues in the BSS synchronised service even if the GPS coverage is lost for up to 24 hours. The BTS site also continues in the BSS synchronised service throughout an LMU software update.

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

Interaction with other features

Improved BSS Synchronisation Recovery is used in any networks which use BSS Synchronisation.

5.3.2 BSS11073 Recovery for BSS and Site Synchronisation

The main purpose of Recovery for BSS and Site Synchronisation is to give automatic recovery for BSS Synchronised sites (sites with LMU) if the BSS 20371 Site Synchronisation recovery improvement is not used.

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

Recovery for BSS and Site Synchronisation also offers synchronisation recovery for a Multi BCF site using BSS9055 Clock Synchronisation.

When the BTS chain is defined in the BSS radio network database, Recovery for BSS and Site Synchronisation 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 sites need to be locked and unlocked in the correct order to enable system synchronisation. The BSC receives the information for recovery from Q1 and BTS alarms.

Recovery for BSS and Site Synchronisation 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 synchronised mode, and with the Multi BCF configuration, provided that all the unlocked BCFs are defined to the same chain operating in synchronised mode.

For a Flexi EDGE BTS chain, the maximum number of BTSs is nine.

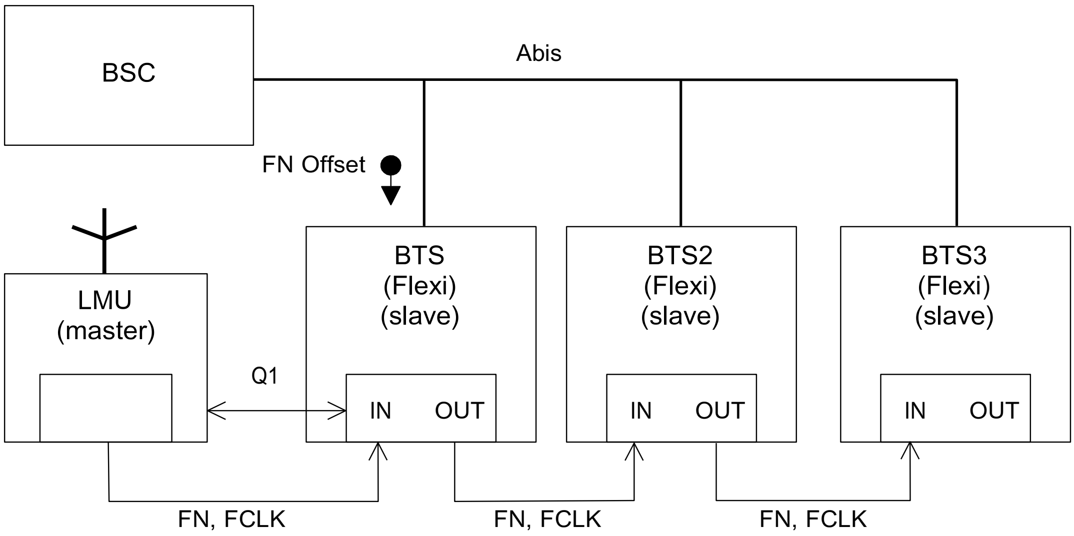

Figure 6. Synchronised BSS example in Flexi EDGE BTS chain

The BSS is synchronised by a Global Positioning System (GPS), that is, LMUs are installed to every site with GPS antennas. The clock source is a GPS satellite via the LMU. When the 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 the BSC is changed to 'unsynchronised'. When the LMU clock is recovered, the BTS becomes synchronised again.

Recovery for BSS and Site Synchronisation supports the following BTS generations and SW, when the chain is defined:

- Flexi EDGE BTS with EP1.0
- UltraSite EDGE BTS with CX4
- When BSS synchronisation configuration is used, LMU SW 4.3 or LMUB SW 1.0 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 to synchronised operation
- Timeslot offset parameter sending to LMU
- BTS synchronisation configuration and mode information available from the BSC by MML and NetAct

5.4 Operating bands

Nokia Flexi EDGE BTS supports the following operating bands:

- GSM 800
- GSM 900 (including E-GSM and P-GSM)
- GSM 1800
- GSM 1900

Dual and Tri Band Common BCCH

Common BCCH allows the combination of two or more sectors into a single logical cell, with a single BCCH carrier. With common BCCH sectors in different frequency bands such as 900/1800 MHz (or 800/1900 MHz, or 800/1800 MHz) can be configured with a common BCCH carrier.

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 because of decreased number of handovers

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

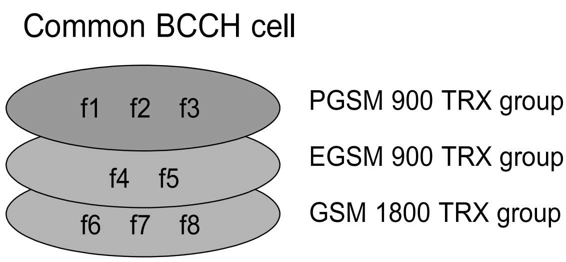

Figure 7. Common BCCH configuration

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

5.5 BTS2043 BTS External Alarms and Controls (EAC)

External Alarms and Controls (EAC) signals can be defined to the BTS.

Benefits

The external alarms and controls allow alarms to be sent from external equipment attached to the BTS, and allow control of external equipment attached to the BTS.

External Alarms caused on the site, such as the intruder alarm, are sent to the NetAct via the Abis. The alarms are TTL level signals, all referred to 5 V. The operator can define whether an alarm is raised when the alarm input line is grounded or disconnected from the ground potential (this is known as alarm polarity). This allows more flexibility for the alarming device.

The External Controls allow the user to control external equipment remotely from the BSC. The External Controls are of open-collector type.

The EAC settings (such as name, alarm polarity, control state) are defined at the BSC. The EAC names can be viewed at the BSC.

Restrictions

There are 24 user-definable external alarms and 6 user-definable external controls. The System Module (ESMA) provides 12 alarm inputs and 6 control outputs. Another 12 alarm inputs are available with the optional Flexi System External Alarm Module (FSEB).

5.6 BTS2020 RX antenna diversity

Receiver diversity (spatial diversity) dramatically improves the uplink performance. It is available as operation software for all configurations having at least one antenna in sector. Two RF signals are demodulated jointly using an interference rejection combining algorithm, thus significantly increasing tolerance to interference. Sensitivity is improved, especially in fading scenarios.

Diversity is defined for every sector separately from the BSC.

6 Basic GSM operation

6.1 Basic GSM features

Nokia Flexi EDGE BTS supports the following basic GSM channel combinations:

- Combined Broadcast Control Channel including Frequency Control Channel (FCCH), Synchronisation Channel (SCH), Common Control Channel (CCCH), Standalone Dedicated Control Channel (SDCCH/4), Slow Associated Control Channel (SACCH/C), and Random Access Channel (RACH)
- Non-combined Broadcast Control Channel including Frequency Control Channel (FCCH), Synchronisation Channel (SCH), Common Control Channel (CCCH), and Random Access Channel (RACH)
- Standalone Dedicated Control Channel including Standalone Dedicated Control Channel (SDCCH/8) and Slow Associated Control Channel (SACCH/C)
- Full Rate Speech (TCH/FS, TCH/EFS, TCH/AFS) with Slow Associated Control Channel (SACCH/T) and Fast Associated Control Channel (FACCH)
- Half Rate Speech (TCH/HS, TCH/AHS) with Slow Associated Control Channel (SACCH/T) and Fast Associated Control Channel (FACCH)
- Full Rate Circuit Switched Data (TCH/F24, TCH/F48, TCH/F96, TCH/F144) with Slow Associated Control Channel (SACCH/T) and Fast Associated Control Channel (FACCH)

6.2 BSS6071 Enhanced Full Rate Codec

Enhanced Full Rate Codec (EFR) 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 better quality than Adaptive Differential Pulse Code Modulation (ADPCM).

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

6.3 BTS2023 Downlink and uplink DTX

Discontinuous transmission (DTX) is a mechanism allowing the radio transmitter to be switched off during speech pauses. This feature reduces the power consumption of the transmitter, which is important for mobile phones, and decreases the overall interference level on the radio channels affecting the capacity of the network.

The DTX function is supported both in downlink and uplink for the following speech channels: TCH/FS, TCH/EFS, TCH/AFS, TCH/HS, and TCH/AHS.

6.4 BTS2503 Compressed Abis timeslot allocation

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.

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6.5 BTS2067 Fast Associated Control Channel (FACCH) Call Setup

With Fast Associated Control Channel (FACCH) Call Setup, it is possible to establish a call without using a stand-alone dedicated control channel (SDCCH). A traffic channel (TCH) is set to 'signalling only' and switched over to normal speech operation when needed. FACCH Call Setup is for emergency calls only.

6.6 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 BSC configures the idle traffic channel (TCH) resources for SDCCH use. For an example of this, see 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. Dynamic SDCCH Allocation can be used with both combined and non-combined Broadcast Control Channel (BCCH).

The BTS only needs to be configured to the minimum static SDCCH capacity sufficient to handle the normal SDCCH traffic.

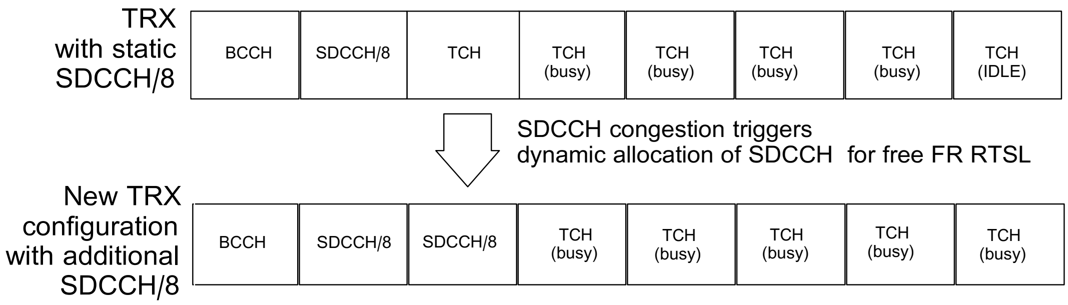

Figure 8. Dynamic SDCCH allocation

An 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.

Dynamic SDCCH Allocation 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. With Dynamic SDCCH Allocation, this can be handled without any need to configure extra permanent SDCCH capacity.

6.7 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.

6.8 BTS2013 Baseband Frequency Hopping

In Nokia Flexi EDGE BTS, the Dual TRX Modules are interconnected through a Gigabit Ethernet L2 switch to facilitate baseband hopping. Both random and cyclic hopping can be used for baseband hopping. The number of frequencies used in the baseband hopping frequency hopping sequence is the same as the number of carriers in the sector. Baseband hopping is allowed for all BTS configurations.

6.9 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.

6.10 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.

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

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

6.12 BTS2033 Short message cell broadcast

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

6.13 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.

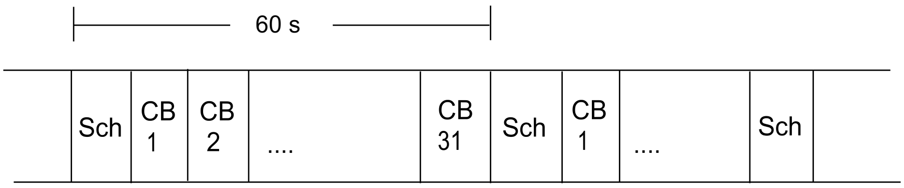

Figure 9. SMS-CB DRX Schedule Period

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.

7 Transmission

7.1 Basic transmission

7.1.1 Abis Trunk Transmission for E1 (ETSI) interface

Up to four full rate (FR) or Enhanced Full Rate (EFR) speech channels, or up to eight Half Rate (HR) speech channels, are multiplexed on a single PCM timeslot. It is possible to create point-to-point star, multidrop chain or remote star transmission connections between BSC and BTS sites. This flexibility ensures that all kinds of transmission needs are fulfilled: traditional star configuration, economical multidrop chains, and reliable multidrop loops are all possible.

Up to 12 TRXs are supported on a single 2 Mbit/s PCM line. See also *BTS2503 Compressed Abis timeslot allocation*.

Abis Trunk Transmission Allocation is implemented using the standard G.703 2 Mbit/s PCM frame structure.

For more information, see *Nokia BSS Transmission Configuration* in BSC/TCSM Product Documentation.

Interaction with other features

BSS30285 Activation of additional two E1/T1 interfaces

7.1.2 Abis Trunk Transmission Allocation for T1 (ANSI) Interface

Up to four full rate/enhanced full rate (FR/EFR), and eight with Half Rate (HR) speech channels are multiplexed on a single PCM timeslot. It is possible to create point-to-point star, multidrop chain or remote star transmission connections between BSC and BTS sites. With this flexibility, all kinds of transmission needs can be satisfied: traditional star configuration, economical multidrop chains, and reliable multidrop loops are all possible.

Up to 10 TRXs are supported on a single 1.5 Mbit/s PCM line. See also *BTS2503 Compressed Abis timeslot allocation*. This feature is implemented using the standard T1.403 PCM frame structure.

The T1 TRAU supports Extended Super Frame (ESF) and SF/D4 framing. ESF supports CRC-6 checks and 4 kbit/s datalink for performance management

Interaction with other features

BSS30285 Activation of additional two E1/T1 interfaces

7.1.3 Abis Trunk Signalling

Radio Signalling Link is a logical link between the BSC and the BTS in Layer 2. The RSL is identified by a functional address known as Service Access Point, SAPI=0. Radio signalling links over the Abis interface are addressed to different units by Terminal Endpoint Identifiers, TEI. The TEI values are fixed and correspond to the TRX-id. The TEI management is not used.

One signalling channel is used for each transceiver (TRX) and one for each BTS base control function (BCF). Alternative signalling speeds are available: 16 kbit/s, 32 kbit/s, or 64 kbit/s. The selection of the signalling speed is done in the commissioning phase on BTS basis. The same selection is also done on the BSC site when channel configuration is defined.

Normally, 16 kbit/s TRX signalling speed is recommended for the FR operation. 32 kbit/s TRX signalling rate is recommended for the HR use.

At the BCF signalling rate of 64 kbit/s, the SW downloading time needed is approximately four times shorter than with 16 kbit/s signalling.

7.1.4 Network Synchronisation

In normal network conditions, synchronisation information is carried by selected 2 Mbit paths from upper to lower hierarchical levels according to the synchronisation plan, from the MSC down to the BTSs.

Nokia Flexi EDGE BTS selects the 2 Mbit signal that has the highest priority from a group of pre-selected digital paths as the active synchronisation signal. The operator can change the group of signals using the Nokia Flexi EDGE BTS Manager application. Selection of a new signal is automatic in case of input failure and input recovery.

In addition to using 2 Mbit signals for synchronisation, it is possible to synchronise with an external clock signal, such as the LMU clock signal.

Network Synchronisation can be protected via PDH Loop Protection. See *BSS30280 Abis loop protection* for more details.

7.1.5 Support for Nokia Microwave Radio Links

The FlexBus transmission sub-module (FIFA) forms the integrated microwave unit support with Nokia Flexi EDGE BTS.

One FIFA transmission sub-module is used per Nokia Flexi EDGE BTS with two FlexBus interfaces, allowing for microwave radio tail and chain site topologies using Nokia FlexiHopper and MetroHopper.

The FIFA sub-module offers E1 bypass cross-connections from one FlexBus interface to the other, and up to 16xE1 add/drop capability to Nokia Flexi EDGE BTS and sub 2M cross-connect function of which up to 8xE1 can be dropped to the BTS itself.

The FIFA sub-module is visible as a separate managed element at Nokia NetAct. The operator can manage the FIFA sub-module locally and remotely using Nokia FlexiHub manager. Nokia Flexi EDGE BTS provides functions for alarm, performance data polling and forwarding to the BSC.

Some features related to Nokia Microwave Radio require an application SW licence, for example the L55341.05 licence for an additional FlexBus interface.

7.1.6 BSS9065 Transmission Operability

Nokia Flexi transmission equipment is measured with several counters:

- All equipment can be measured within 15-minute/24-hour periods. This measurement gives a fixed set of counters, which are near-end G.826 signal quality counters. These counters are:
    - Total time
    - Available time
    - Errored seconds
    - Severely errored seconds
    - Background block errors
    - Errored block
- A certain set of Nokia Flexi transmission equipment can be defined. Nokia Flexi transmission equipment refers either to the whole equipment or part of it (functional entity and supervision block). It is also possible to define the counters that are collected from the equipment. To do this, the topology of the transmission network must be known so that the measurement subject can be chosen.

7.2 Transmission solutions

7.2.1 Q1 Interface Between the BSC and Transmission Equipment

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

With the Q1 Interface Handling MML, the user creates the service channels used in communication between the BSC and the transmission equipment. The Q1 service channels are asynchronous serial communications channels. The protocol used is Nokia's own Transmission Management System Protocols.

The default maximum number of Q1 service channels in the BSC is 18.

The user also defines the supervised equipment. Altogether 512 pieces of equipment can be defined into Q1 service channels under the BSC. All the equipment in the same channel has a unique address (polling address).

To succesfully access the equipment assigned to the service channels, the equipment must be configured with its Q1 address locally, with a hand-held service terminal or the equipment's manager application.

Note that, for proper working of Q1 BSC polling over Timeslot 0, the BTS must be commissioned with TCH or cross-connected traffic.

Supervision of transmission units supplied by other manufacturers

When transmission units supplied by other manufacturers are supervised via External Alarm and Control (EAC) lines, the alarms can be sent to the BSC and NetAct. When the alarms are sent to the BSC and NetAct, the System Module (ESMA) supervises the alarm handling and alarms are reported as normal external alarms.

7.2.2 PDH traffic routing

Cross-connections define how signals are routed from a transmission interface to another transmission interface. They are the basic building blocks for creating the path for transmitting the Abis capacity from the Nokia BSC to the Nokia BTS via interconnecting nodes.

Cross-connection granularities

There are several types of cross-connections available, and each has a different granularity. Granularity means the bit rate at which a cross-connection is made, that is, the number of bits connected into a specific direction in a cross-connection. In 2 Mbit/s mode, the available granularities are:

- 8k (1 bit)
- 16k (2 bits)
- 32k (4 bits)
- 64k (all 8 bits in a time slot)
- n x 64k (where n = 1 - 31)

BSS21129 Grooming

The cross-connection feature of the transmission units makes traffic grooming possible.

Nokia Flexi EDGE BTS is capable of grooming traffic at for example 8 kbit/s granularity, which enables fully optimised and flexible use of the available transmission resources. This ensures that the path used for transmitting Abis capacity can be used efficiently.

7.2.3 BSS 30280 Abis loop protection

Nokia PDH loop protection is considered an efficient way to protect traffic in a transmission network such as a base station subsystem (BSS). In a live telecommunications network it is important to secure, in addition to the actual payload traffic, the network synchronisation and the centralised network management during any period of abnormal circumstances.

For these reasons, Nokia PDH loop protection protects:

- payload traffic
- network synchronisation
- network management connections

A transmission loop formed with Nokia elements consists of a loop master and one or more loop slaves. Usually the loop master is a transmission node, whereas the loop slaves can be either transmission nodes, BTSs or a combination of both inside one loop.

The loop principle is that the transmitted signal is always sent in both directions, but the received signal is selected from one direction only. The loop master sends pilot bits on the basis of which the switching decision is made. Each individually protected slave station needs one pilot bit.

Network synchronisation must also be ensured in a loop network and it follows the loop principle in a similar way. The synchronisation switching takes place independently from the pilot bits by having master clock bit (MCB) and loop control bit (LCB).

Based on the configured priorities, each network element decides individually from which direction the signal and the synchronisation will be received, and, thus, it does not require any external or additional supervision for its decision.

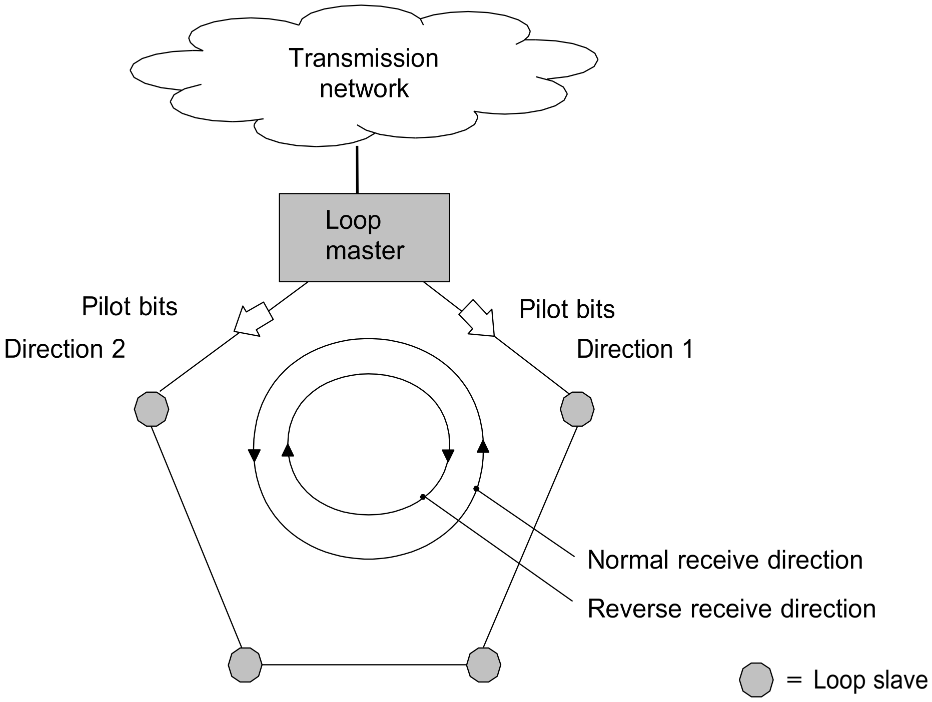

Figure 10. Loop principle

Nokia's way of implementing loop protection is ultimately secure, providing very fast route switching that recovers the transmission connections instantly. Nokia loop protection is embedded and thus very fast. The loop protection protects against failures, such as cable-cuts, equipment failures, heavy rain and multipath fading, and against obstacles in the line-of-sight, such as cranes and growing trees.

Compared to an unprotected wireless network, Nokia PDH loop protection increases site availability at least tenfold and prevents end-of-chain availability degradation.

The protection functionality is compatible with the existing Nokia BSS transmission.

Nokia Flexi EDGE BTS can only act as a slave node in a Nokia PDH Loop protected network.

For more information refer to the Nokia PDH Loop Protection in GSM Networks document that can be obtained upon request.

7.2.4 Redundant Abis Trunk

If a failure or a problem in the transmission connection occurs between the BSC and the BTS sites, an alternative transmission route (redundancy) is desirable.

Two alternative strategies are available for redundancy:

- a duplicated point-to-point type connection
- a redundant multi-drop loop connection

These two alternatives provide solutions for different transmission needs: either the traditional redundant point-to-point configuration or the economical multidrop loop configuration.

Redundant Abis Trunk for E1 interface (ETSI) is implemented by using the standard G.703 2 Mbit/s PCM frame structure.

Redundant Abis Trunk for T1 interface (ANSI) is implemented by using the standard T1.403 1.5 Mbit/s PCM frame structure.

For more information, see *Nokia BSS Transmission Configuration* in BSC/ TCSM Product Documentation.

7.3 BSS10045 Dynamic Abis allocation

Dynamic Abis provides an efficient transport mechanism for GPRS and EGPRS to use more than one 16 kbps subchannel on the Abis interface for each packet data channel (PDCH) on the Air interface. The continuous areas of PCM timeslots on PCM links are configured as Dynamic Abis pools (DAPs) to provide the needed capacity.

The dual TRX modules support two carriers, each of which belongs to one logical TRX. Each logical TRX utilising Dynamic Abis is associated with a DAP in addition to the standard fixed traffic channel (TCH) area. Any packet data channel would be continuously using a master PCU channel located on a fixed area. Depending on the traffic load on each Air interface channel, more capacity would be allocated from the DAP. See the table below for the number of 16 kbps DAP subchannels used with each CS and MCS.

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Table 4. Number of 16 kbps DAP subchannels used with each CS and MCS

CS/MCS	Number of DAP subchannels
CS1	0
CS2	1
CS3	1
CS4	1
MCS-1	0
MCS-2	1
MCS-3	1
MCS-4	1
MCS-5	1
MCS-6	2
MCS-7	3
MCS-8	4
MCS-9	4

The PCU controls the downlink and uplink slave allocation on a radio block basis. Any 20 ms period on Abis is controlled based on real traffic demand. Downlink and uplink allocations are controlled separately. The slave allocation is informed to the BTS by in-band signalling on the corresponding downlink master channel.

Multiple logical TRXs can share a DAP. Multiple DAPs can be configured for each BTS and for each physical Abis link.

O&M signalling, TRX signalling, and circuit-switched channels are used with Dynamic Abis in the same way as they are used with the Nokia conventional Abis solution.

Appendix A Other features

A.1 Other features

Nokia Flexi EDGE BTS also supports the following feature enhancements made in Nokia UltraSite EDGE BTS:

- Enhanced Automatic Frequency Correction (E-AFC)
- BSS10022 Frame Erasure Rate (FER) Measurement
- BSS9064 Real Time Update to BTS
- BSS7048 CCCH Improvements
- BSS6074 Active Channel Interference Estimation
- BSS5072 Better Random Access Channel Detection
- BTS2041 BTS Local Blocking