**Introduction**

A base transceiver station or cell site (BTS) is a piece of equipment that facilitates wireless communication between user equipment (UE) and a network. UEs are devices like mobile phones (handsets), WLL phones, computers with wireless internet connectivity, WiFi and WiMAX gadgets etc. The network can be that of any of the wireless communication technologies like GSM, CDMA, WLL, WAN, WiFi, WiMAX etc. BTS is also referred to as the radio base station (RBS), node B (in 3G Networks) or, simply, the base station (BS). For discussion of the LTE standard the abbreviation eNB for enhanced node B is widely used.So, to understand BTS we have to go through the basics of GSM system because BTS is a part of a GSM system.

**Various Subsystems of GSM**



Figure 1 Subsystems of GSM

**Base Station Subsystem (BSS)**



Figure 2 Subsystems of BSS

From this figure we can say that BTS is a part of BSS(Base station subsystem)

**The Base Station Subsystem (BSS)**

The Base Station Subsystem consists of the following elements:

1. BSC (Base Station Controller)

2. BTS (Base Transceiver Station)

3. TC (Transcoder)

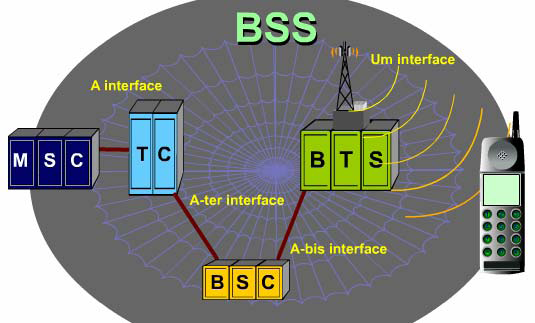


Figure 3 Working of BSS

The **Base Station Controller (BSC)** is the central network element of the BSS and itcontrols the radio network. This means that the main responsibilities of the BSC are: Connection establishment between MS and NSS, Mobility management, Statisticalraw data collection, Air and A interface signalling support.

The **Base Transceiver Station (BTS)** is a network element maintaining the Air

interface. It takes care of Air interface signalling, Air interface ciphering and speechprocessing. In this context, speech processing refers to all the functions the BTSperforms in order to guarantee an error-free connection between the MS and the BTS.The **TransCoder (TC)** is a BSS element taking care of speech transcoding, i.e. it iscapable of converting speech from one digital coding format to another and vice versa.

The BTS, BSC and TC together form the Base Station Subsystem (BSS) which is a

part of the GSM network taking care of the following major functions:

**Radio Path Control**

In the GSM network, the Base Station Subsystem (BSS) is the part of the network

taking care of Radio Resources, i.e. radio channel allocation and quality of the radioconnection. For this purpose, the GSM Technical Specifications define about 120different parameters for each BTS. These parameters define exactly what kind of BTSis in question and how MSs may "see" the network when moving in this BTS area.The BTS parameters handle the following major items: what kind of handovers (whenand why), paging organization, radio power level control and BTS identification.

**BTS and TC Control**

Inside the BSS, all the BTSs and TCs are connected to the BSC(s). The BSCmaintains the BTSs. In other words, the BSC is capable of separating (barring) a BTSfrom the network and collecting alarm information. Transcoders are also maintainedby the BSC, i.e. the BSC collects alarms related to the Transcoders.**Synchronization**The BSS uses hierarchical synchronization which means that the MSC synchronizesthe BSC and the BSC further synchronizes the BTSs associated with that particularBSC. Inside the BSS, synchronization is controlled by the BSC. Synchronization is acritical issue in the GSM network due to the nature of the information transferred. Ifthe synchronization chain is not working correctly, calls may be cut or the call qualitymay not be the best possible. Ultimately, it may even be impossible to establish a call.

**Air &A Interface Signalling:**

In order to establish a call, the MS must have a connection through the BSS. This

connection requires several **signalling protocols.**

**Connection Establishment between MS and NSS**

The BSS is located between two interfaces, the Air and the A interface. From the callestablishment point of view, the MS **must** have a connection through these twointerfaces before a call can be established. Generally speaking, this connection may beeither a **signalling**type of connection or a **traffic** (speech, data) type of connection.

**Network Switching Subsystem (NSS)**

The elements of Network Switching Subsystem that have been described so far are:

MSC (Mobile Services Switching Centre)

VLR (Visitor Location Register)

HLR (Home Location Register)

The MSC is responsible for controlling calls in the mobile network. It identifies the

origin and destination of a call (either a mobile station or a fixed telephone in both

cases), as well as the type of a call. An MSC acting as a bridge between a mobile

network and a fixed network is called a Gateway MSC. An MSC is normallyintegrated with a VLR, which maintains information related to the subscribers who arecurrently in the service area of the MSC. The VLR carries out location registrationsand updates. The MSC associated with it initiates thepaging process.

A VLR database is always temporary (in the sense that the data is held as long as thesubscriber is within its service area), whereas the HLR maintains a permanent registerof the subscribers. In addition to the fixed data, the HLR also maintains a temporarydatabase which contains the current location of its customers. This data is required forrouting calls.

In addition, there are two more elements in the NSS: the Authentication Centre (AC)and the Equipment Identity Register (EIR). They are usually implemented as part ofHLR and they deal with the security functions.

**Network Management Subsystem**

The **Network Management Subsystem (NMS)** is the third subsystem of the GSM

network in addition to the Network Switching Subsystem (NSS) and Base Station

Subsystem (BSS). The purpose of the NMS is to monitor various functions andelements of the network. These tasks are carried out by the **NMS/2000** which consistsof a number of Work Stations, Servers and a Router which connects to a DataCommunications Network (DCN).

The operator workstations are connected to the database and communication serversvia a Local Area Network (LAN). The database server stores the managementinformation about the network. The communications server takes care of the datacommunications between the NMS and the equipment in the GSM network known as Network Elements These communications are carried over a Data CommunicationsNetwork (DCN) which connects to the NMS via a router. The DCN is normallyimplemented using an X.25 Packet Switching Network.

The functions of the NMS can be divided into three categories:

**Fault Management**

**Configuration Management**

**Performance Management**

These functions cover the whole of the GSM network elements from the level of

individual BTSs, up to MSCs and HLRs.

**Fault Management**

The purpose of Fault Management is to ensure the smooth operation of the network

and rapid correction of any kind of problems that are detected. Fault management

provides the network operator with information about the current status of alarm

events and maintains a history database of alarms. The alarms are stored in the NMSdatabase and this database can be searched according to criteria specified by thenetwork operator.

**Configuration Management**

The purpose of Configuration Management is to maintain up to date information aboutthe operation and configuration status of network elements. Specific configurationfunctions include the management of the radio network, software and hardwaremanagement of the network elements, time synchronization and security operations.

**Performance Management**

In performance management, the NMS collects measurement data from individual

network elements and stores it in a database. On the basis of these data, the networkoperator is able to compare the actual performance of the network with the plannedperformance and detect both good and bad performance areas within the network.

**Various Interfaces in BTS**

**The Radio Interface( Um)**

Radio interface (between MS and base transceiver stations [BTS]) is the mostimportant in any mobile radio system, in that it addresses the demandingcharacteristics of the radio environment. The physical layer interfaces to the data linklayer and radio resource management sub-layer in the MS and BS and to other

functional units in the MS and network subsystem (which includes the BSS and MSC)for supporting traffic channels. The physical interface comprises a set of physicalchannels accessible through FDMA and TDMA.

Each physical channel supports a number of logical channels used for user traffic andsignaling. The physical layer supports the functions required for the transmission ofbit streams on the air interface. Layer 1 also provides access capabilities to upperlayers. The physical layer is described in the GSM Recommendation 05 series (part ofthe ETSI documentation for GSM). At the physical level, most signaling messagescarried on the radio path are in 23-octet blocks. The data link layer functions aremultiplexing, error detection and correction, flow control, and segmentation to allowfor long messages on the upper layers.The radio resource layer manages the dialog between the MS and BSS concerning themanagement of the radio connection, including connection establishment, control,release, and changes (e.g., during handover).

**Abis Interface (BTS to BSC)**

The interconnection between the BTS and the BSC is through a standard interface,Abis (most Abis interfaces are vendor specific). The primary functions carried over

this interface are traffic channel transmission, terrestrial channel management, and

radio channel management. This interface supports two types of communications

links: **Traffic channels** at 64 kbps carrying speech or user data for a full- or half-rateradio traffic channel and **Signaling channels** at 16 kbps carrying information forBSC-BTS and BSC-MSC signaling. The BSC handles the LAPD channel signalingfor every BTS carrier. The first three layers are based on the following OSI/ITU-T

recommendations:-

Physical layer: ITU-T Recommendation G.703 and GSM Recommendation 0-8.54

Data link layer: GSM Recommendation 08.56 (LAPD)

Network layer: GSM Recommendation 08.58

There are two types of messages handled by the traffic management procedure part ofthe signaling interface— transparent and nontransparent. Transparent messages arebetween the MS and BSC-MSC and do not require analysis by the BTS.Nontransparent messages do require BTS analysis.The Abis interface lies within the base station subsystem (BSS) and represents thedividing line between the BSC function and the BTS. The BSC and BTS can beconnected using leased lines, radio links or metropolitan area networks (MANs).

Basically, two channel types exist between the BSC and BTS:

Traffic channels (TCH): Can be configured in 8, 16 and 64 kbit/sformats and transport user data

Signaling channels: Can be configured in 16, 32, 56 and 64 kbit/sformats and are used for signaling purposes between the BTS and BSC.Each transceiver (TRX) in a BSC generally requires a signalingchannel on the Abis interface.

**A - Interface (BSC to MSC)**

The A interface allows interconnection between the BSS radio base subsystem and theMSC. The physical layer of the A interface is a 2-Mbps standard Consultative

Committee on Telephone and Telegraph (CCITT) digital connection. The signaling

transport uses Message Transfer Part (MTP) and Signaling Connection Control Part(SCCP) of SS7. Error-free transport is handled by a subset of the MTP, and logicalconnection is handled by a subset of the SCCP. The application parts are dividedbetween the BSS application part (BSSAP) and BSS operation and maintenanceapplication part (BSSOMAP). The BSSAP is further divided into Direct TransferApplication Part (DTAP) and BSS management application part (BSSMAP). TheDTAP is used to transfer layer 3 messages between the MS and the MSC without BSCinvolvement. The BSSMAP is responsible for all aspects of radio resource handling at the BSS. The BSSOMAP supports all the operation and maintenance communicationsof BSS.

The International Telecommunication Union (ITU), which manages the internationalallocation of radio spectrum (among many other functions), allocated the bands 890-915 MHz for the uplink (mobile station to base station) and 935-960 MHz for thedownlink (base station to mobile station) for mobile networks in Europe.

The BTS performs the radio functions of the Base Station Subsystem (BSS). The BTSreceives and sends signals through:

• Air interface — frequencies that connect the BTS to the Mobile Station (MS)

•Abis interface — cable or radio link that connects the BTS to the Base Station

Controller (BSC), which is the central element of the BSS

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•Abis interface — cable or radio link that connects the BTS to the Base Station

Controller (BSC), which is the central element of the BSS.

BTS mainly comprises of 2 components

Antenna system

BTS cabinet

**Antenna System in BTS**

**REQUIREMENTS OF BTS ANTENNA**

1. Strictly defined radiation patterns for accurate network planning.

2. Growing concern for the level of intermodulation due to the radiation of many HF-carriers via one antenna

3. Dual polarization

4. Electrical down-tilting

5. Impeccable design.

**X-POL ANTENNA SYSTEM**

Diversity is used to increase the uplink signal level.

There are two type of diversities:

* **Space Diversity**
* **Frequency Diversity**

The dipoles are placed at +45°/-45° to handle both horizontally and

vertically polarized components.



Figure 4 Roof Top Antenna Setup

**ADVANTAGES OF X-POL ANTENNAS**

* X-pol antennas reduces interference and improves indoor coverage
* in urban terrain.
* Both antenna systems can be used to transmit.

**GSM BASE PANEL ANTENNA**

* **Specification**
* **Brand: Cushcraft**
* **Model: S8802MP**
* **Frequency:** 880 - 960 MHz
* **Gain:** 2 dBi
* **Type:** Omni



Figure 5 GSM panel Antenna Setup

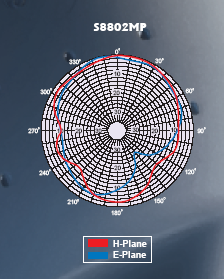


Figure 6 Radiation pattern for GSM panel Antenna

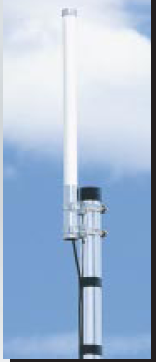


Figure 7 GSM panel antenna

|  |
| --- |
| * Specification |
| * **Brand: Cushcraft** * **Model: S8963B** * **Frequency:** 896 - 960 Mhz * **Gain:** 5 dB * **Type:** Omni |

Figure 8 Radiation pattern for GSM panel antenna

**BTS Cabinet**

**BTS Construction:**

BelowShown in figure is a BTS with 12 TRX and supporting equipments for its optimumperformance.

* **Radio Part**

Transceiver unit is the main part of BTS and the occupancy of a BTS is termed in

number of TRX cards. Each card is responsible for transmitting and receiving the dataand is solely responsible for anything related to radio. It receives the data to

Figure 9 Base Transceiver Station

betransmitted from the baseband card, modulates it and forwards it to respective

Equipment. It receives the data caught by GSM antenna through respectiveequipment, demodulates it and sends it to baseband part for further processing.

Ideally each TRX card needs an antenna for its working. By various techniques likespace diversity or cross polarization, either two or one antenna respectively is requiredfor each TRX for optimum performance and coverage. A BTS can house maximum 12TRX. So ideally we need total 12 or 24 antenna. This will increase the cost by 4 timesplus the proximity of antennas will create tremendous interference.

This leads to employing equipment, which will combine the signals such that less

number of antennas are used as far as possible. Such equipments are combiners,

multicouplers and dual band variable gain duplex filter.Combiners combines the transmit signal of number of TRX and forms one combinesignal. There are two types of combiners: wideband and remote tune. Both differ innumber of TRX it can combine. Wideband can combine 2 while remote tune cancombine 6.

Multicoupler duplicates the received signal and facilitates to provide the received

signal (main and diversity) to each TRX. Here also, it can handle 2 or 6 TRX signals.Dual band variable gain duplex filter combines transmitted and received signals intoone antenna and amplifies received signals with a variable-gain Low Noise Amplifier(LNA). Each unit has two identical parts. Each part has one Tx port and two Rx port,one each for main and diversity. The Tx port is fed by Tx out of the wide bandcombiner. As each unit has two identical parts, effectively Tx of 4 TRX are combinedinto one. Similarly in the receiving part, the Rx main and diversity ports are connectedto the Multicoupler, which in turn duplicates the signal and gives to TRX. Thus evenin the Rx part, four TRX can be handled. DVGA is connected to the antenna throughfeeders. Employing of the above equipments results into combining of Tx and Rx offour TRX into two feeders.

If remote tune combiner is used then DVGA is not used. Also multicoupler which canhandle 6 TRX has to be used.

* **Digital Part**

After the demodulation, the signal is sent to baseband card where the DSP occurs.

Each card can handle two TRX. Similarly in the downlink path, the data received fromBSC is digitally processed and sent to TRX for transmission.Once the data is ready after digital processing, each card gives its data to transmissioncard for forwarding the data to BSC. The transmission card collects data and formatsit into one E1 according to G.703 standards. It is sent to BSC via microwave link orfiber link whichever is feasible. Similarly in the downlink path, the transmission card

reframes the E1 and distributes the data to appropriate baseband card.

**Uplink and Downlink Path**

**Uplink path:**

From the MS, the signal is received by the GSM Antenna. The signal is given to

DVGA where it is bifurcated into two combined RXs. This combined Rxs are given toMulticouplers which further divides the signal into individual signal for Receivedmain and diversity. This individual signals are fed to TRX which performs thedemodulation of the signal and gives the information signal to Baseband card. Itperforms the DSP analysis and gives to the transmission unit. It constructs the E1according to the format in BOI and gives it to BSC via transmission link.



Figure 10 The uplink and downlink path

**Downlink path:**

Data from BSC is given to Baseband by transmission unit. DSP analysis is done andthe information signal is given to TRX. The TRX modulates the signal and gives themodulated signal to wideband combiner. The combiner combines two TX

signals intoone and gives it to DVGA. DVGA gets one more combined TX signal from otherwideband combiner. It combines both the signal and gives it to the antenna via thefeeder to be transmitted to the MS.

**Skeleton Of BTS**

The Base transceiver Station contains following Units:

1 Transceiver unit (TSxx)

2 2-way Receiver Multicoupler unit (M2xx)

3 Transceiver Baseband unit (BB2x)

4 BaseOperations and Interfaces unit (BOIx)

5 Transmission unit (VXxx)

6 Wideband Combiner unit (WCxx)

7 Dual Variable Gain Duplex Filter unit

(DVxx)

8 DC/DC Power Supply unit (PWSB)

9 6-way Receiver Multicoupler unit (M6xx)

10 Remote Tune Combiner unit (RTxx)

11 AC/DC Power Supply unit (PWSA)



Figure 11 BTS Cabinet

**Power Supply Unit:**

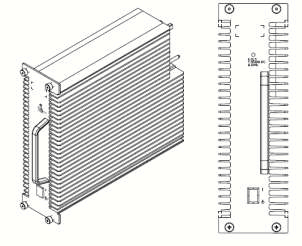


Figure 12 PWSx unit

**Main blocks**

The PWSx unit consists of the following functional blocks:

• Power input

• Power switcher

• Control

**Dual Variable Gain Duplex Filter :**



Figure 13 DVxx Front View Figure 14 Block Diagram

The DVxx performs the following primary functions:

• combines transmitted and received signals into one antenna

• amplifies received signals with a variable-gain Low Noise Amplifier (LNA)

The DVxx unit includes two identical duplex filter sections.Each section comprises a duplexer, a variable-gain LNA, and an I2C-bus I/O bufferblock. Each LNA defaults into the high-gain state at startup and can be switched to thelow-gain state through the I2C-bus using the Site Manager.The gain of the low gain path can also be adjusted. The DVxx unit includesan I2CEEPROM that stores the serial number, information about the insertion loss variationof TX filters, and other data.This information is used to compensate the frequency-dependent power variation ofthe transmitter. The I2C-bus also carries alarm signals to indicate fault conditions foreach LNA branch. The signals are relayed to the Base Operations and Interfaces(BOIx) unit, which generates the alarms and displays them to the user interface.

**Multi coupler**

The M2xx and M6xx are passive units. The units divide Received (RX) and Diversity-Received (DRX) signals and distribute them to the Transceiver (TSxx) units. Afterreceiving RX signals from the Dual Variable Gain Duplex Filter (DVxx) unit, theM2xx and M6xx distributes the RX signals to the TSxx units.





Figure 16 Block Diagram

Figure 15 M2xx Unit

**Wideband Combiner**:

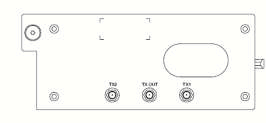
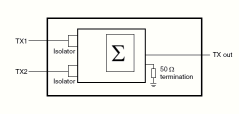


Figure 17 Front view of WCxx Figure 18 Block Diagram

The WCxx unit consists of the following components:

• one 2-way combiner

•two isolators

• one heatsink for thermal dissipation

The WCxx unit combines transmit (TX) signals from two Transceiver (TSxx)

unitsand feeds the combined signal to the TX port of the Dual Variable Gain

Duplex filter unit.

**Transceiver Card**



Figure 19 Left Isometric View of TRX Figure 20 Block Diagram of TRX

Transceiver unit is the main part of BTS and the occupancy of a BTS is termed in

number of TRX cards. Each card is responsible for transmitting and receiving the dataand is solely responsible for anything related to radio. It receives the data to betransmitted from the baseband card, modulates it and forwards it to respective

equipment. It receives the data caught by GSM antenna through respectiveequipments, demodulates it and sends it to baseband part for further processing.

The TSxx unit of the Nokia UltraSite EDGE BTS performs RF modulation/demodulation and amplification for one RF carrier. The TSxx unit handles uplink

signals from the Mobile Station (MS) to the BTS and downlink signals from the BTSto the MS.

The TSxx unit consists of the following modules:

• Transceiver (T R X )

• Frequency Hopping Synthesizer (F H S )

• Power Amplifier (PA )

• Power Supply (PSU )

**Baseband Card:**





Figure 21 BB2x Card Figure 22 Block Diagram of Base Band Card

The BB2x unit of the BTS has the following mainfunctions:

• perform s digital signal processing for speech and data channels

• manages signaling for speech functions

The BB2x alsouses software downloaded from the Base Operations and

Interfaces(BOIx)unit

• sets its timing according to references from the BOIx unit

•supports synthesized (RF ) and Baseband (BB ) frequency hoppingThe BB2x unit has two independent BB sections. Each section communicates with the

TRX module of one TSxx unit. Therefore, one BB2x unit can process two TSxxunits,each with eight received and transmitted logical channels.

**Base operations and Interface unit (BOIx)**

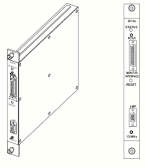


Figure 23 BOIx Unit

The BOIx unit handles the control functions that are common to all other units in

BTS.

These functions include:

BTS initialisation and self-testing

Configuration

Operations and Maintenance (O&M) functions

Software downloads

Main clock functions

Timing functions

Collection and management of external and internal alarms

Delivery of messages to the Base Station Controller (BSC) through the

Transmission (VXxx) unit

**Operation**

The BSC or Nokia BTS Manager downloads software to the FLASH memory of theBOIx unit. (During download, an LED on the BOIx unit indicates the status of theboard.) The BOIx unit downloads BTS software and configuration data to other BTSunits.The BOIx unit collects alarms from other active units and saves configurationinformation into non-volatile memory. The BOIx unit also controls the uplink anddownlink cross-connection between the Transceiver Baseband unit (BB2x) and theTransceiver (TSxx) unit.

The BOIx unit detects unit alarms and performs recovery actions. In certain situations,the BOIx unit resets itself. The BOIx unit generates an accurate reference clock signalfor the TSxx unit, BB2x unit, and Remote Tune Combiner (RTxx) unit. The BTS cansynchronize its frame clock and number with another BTS unit(with Talk as the clock master) or to another BTS unit. Themechanics of the BOIx unit provide EMI/EMC shielding for internal electricalcomponents.

**Conclusion**

After the understanding of the BTS system we can conclude that BTS will be very helpful for wireless communication. In the BSS most of the task will be done by the BTS. Most of the operations will be done by the BTS cards and it is the base of the wireless system. It is very helpful to the mobile communication field. It is a combined unit made up of several cards, antenna and towers (for support the antenna).

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