7 Base Station System

Objectives

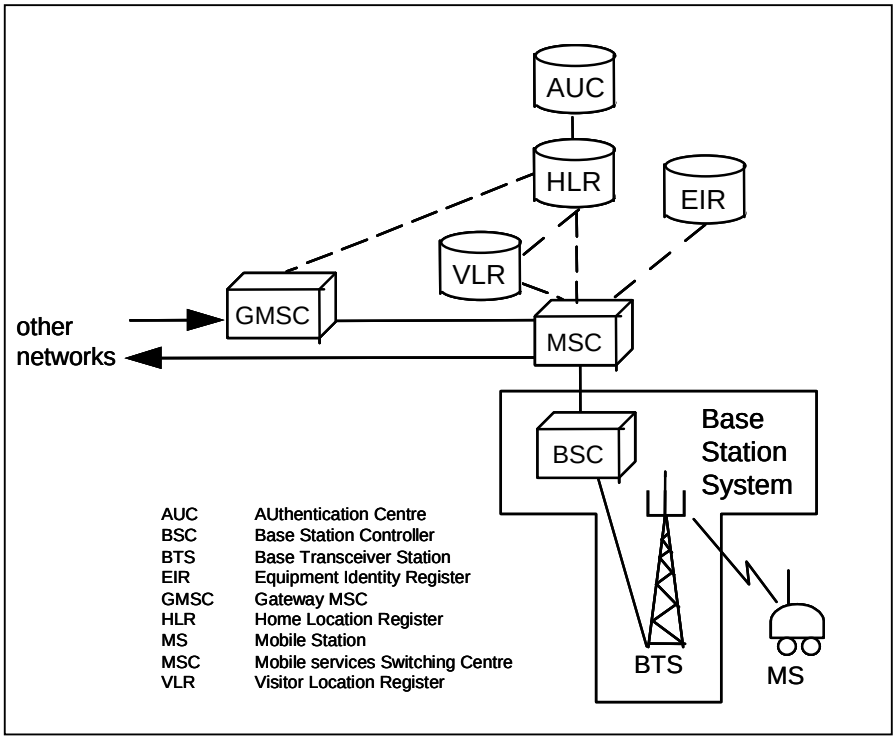
After this chapter the student will:

- be able to describe the functions in BSC and BTS.
- be familiar with the philosophies of the transmission network.

7.1 Introduction

The base station system (BSS) can be seen as a bridge that connects the MS (through the radio interface) to the MSC/VLR and hence other telecommunication users. The BSS is responsible for the radio-related functions to establish and maintain the radio link to the MS. In the BSS there is also a handover preparation function to determine which cell is the best for the connection with the MS to make correct handover decisions. The BSS also manages the radio network resources and cell configuration data.

The functional division of the BSS is basically done between the BTS and the BSC. The BTS comprises the radio transmission and reception equipment for the communication to and from the MS over the air interface. The BSC is in charge of the radio interface management through the control of the BTS and the MS, mainly by handling allocation and release of radio channels.



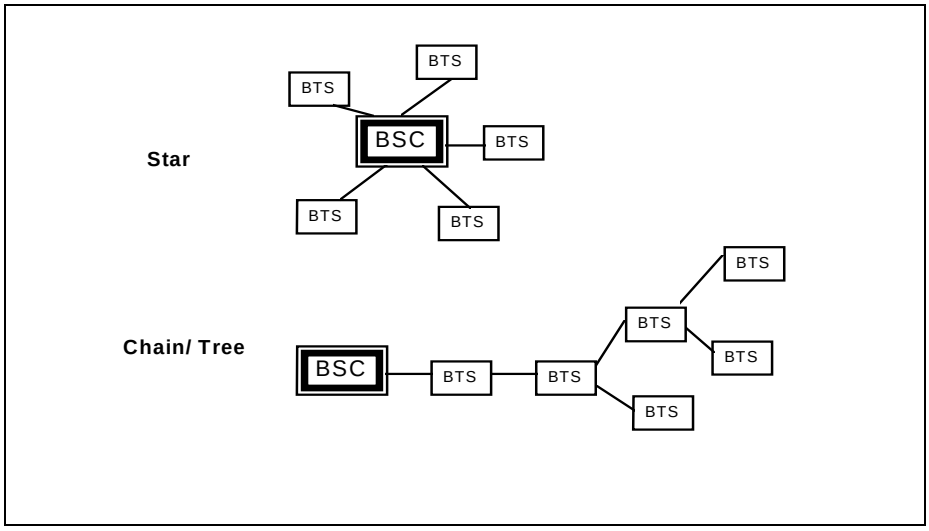
GSM Network

7.2 Transmission network

The GSM recommendations only specifies the fundamental necessities of the BSS. The following is mentioned:

- The BSC is a network component with functions for controlling one or several BTSs.
- The BTS is a network component which serves one cell. It is controlled by a BSC and can consist of one or several TRXs with or without common control equipment.

This makes the interpretation very flexible resulting in a variety of solutions, especially for the transmission network, promoted by different suppliers. Different structures for the transmission network are differently efficient depending on the concentrations and geographical distribution of the subscribers. The star-shaped configuration could be suitable for a city while the chain/tree is better for a widespread area e.g. a coastline or highway.



Transmission network principles

Another issue differentiating the implementations from different suppliers is the Transcoder and Rate Adaptation Unit. The TRAU is the unit that transforms the speech bit rate from 64 kbps (in the form speech is normally coded in telecommunication systems) to 13 kbps (in the form the speech is coded by the GSM-system), or adapts the bit rate in case of data information. The TRAU is considered a part of the BTS, even though GSM specifies that it can be placed remotely. (According to the specification it can not be placed in the MSC. This is to keep the MSC compliant with ISDN, only allowing 64 kbps time slots to be switched.)

Let us take a look at the capacity demand for the transmission from the BTS, via the BSC and onwards to the MSC, and vice versa. The following number of time slots on a PCM-link is needed:

- for the decoded speech - which is actually PCM-coded - 64 kbps is needed per Traffic Channel (TCH). One time slot on the PCM-link carries one TCH.
- for the speech coded by the GSM-speech codec, four TCHs (13 kbps each) is carried by one time slot in the PCM-link.
- for the control information (channels not carrying traffic) sent between the BTS and BSC even more PCM-capacity is needed. Depending on supplier, control signalling for between one and four carriers can be fitted into a time slot on the PCM-link.

As transmission costs are a considerable part of the total cost for an operator most suppliers have chosen to implement a remote TRAU. Depending on the BSC philosophy of the supplier, the TRAU is either placed at the BSC site or at the MSC site. It is, however always controlled from the BTS.

7.3 BSC functionality

The main roles of the BSC are the management of the radio channels on the air interface, and the management of handovers. In other words, the BSC controls the radio network and ensures best possible utilization of the radio resources. These functions were initially intended to be included in the MSC. However, the complexity of the radio system increased during the initial specification of GSM, which led to a separation of the radio intelligence from the MSC.

General

The BSC must perform the following duties:

- manage the transmission network.
- supply switching for the connection of the MSs to the MSC. The BSC switches 64 kbps time slots to and from different radio links handled by the TRXs in the BTSs.
- manage the stock of radio channels.
- initiate and control the handovers between the different cells.
- manage the radio network and control the BTSs connected to it.

Radio channel management

The configuration of the radio channels is done by assigning logical channels to the available RF resources in the BTSs. The physical channels could be assigned one of seven channel combinations (as listed in the

GSM-specification). The radio channel management also involves establishing and maintaining connections to the MSs.

The BSC is responsible for allocation, assignment, supervision and release of the radio channels. It must also administrate transmission of system information and it must administrate the paging on request from the MSC. Also, the frequency hopping management and the dynamic power control of the MS and BTS is controlled from the BSC. Handover is handled if necessary, according to the outcome from the handover preparation procedure in the BSC.

Radio network management

The BSC administrates the cell description data, such as identities and type of cell, and the configuration of frequencies and output power of the TRXs in the BTSs.

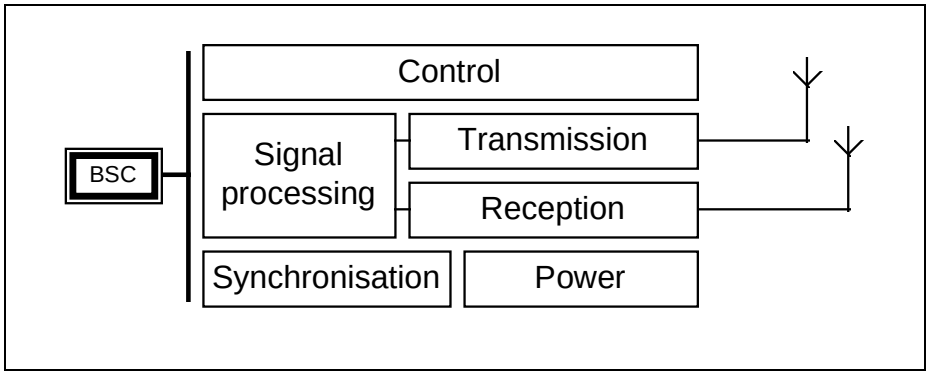
As part of the radio network management the BSC sends cell specific system information to the MS's, containing a list of neighbouring cells on which the MSs should perform measurements. These measurements are used to assist the BSC in evaluating the need for handovers. By evaluating event recordings and statistics those lists and the handover parameters can be revised thus tuning and improving the performance and quality of the radio network.

BTS control

The control, supervision and maintenance of the BTS needed, depends on the equipment used. Loading of software, collecting alarms and statistics could be part of the control. The messages concerning the control are sent on the signalling links between the BSC and the BTSs.

7.4 BTS functionality

The BTS has the equipment needed to transmit and receive on the radio channels allocated to take care of traffic and signalling in one cell. The main responsibility is to provide connections with the MSs over the air interface. The BTS can consist of several TRXs (one per carrier) whose functions can be divided into Control, Signal processing, Transmitting part, Receiving part and Synchronisation. Other functions commonly, but not necessarily, used are combining and dividing the signals to and from the antenna(s), and a battery backup in case of power failure.



BTS structure

Control

All the signalling to the MS as well as to the BSC during different traffic cases is handled from here. Connection to the BSC could also concern the control of a remote TRAU and the associated Discontinuous Transmission (DTX) function. The control function also handles quality measurements with calculation of the Timing Advance value (TA), alarms and other statistics.

Signal processing

The signal processing performed in the TRX is channel coding, interleaving, ciphering, burst formatting and also multiplexing of the logical channels onto the physical channels before transmission. After reception the corresponding channel decoding, de-interleaving and deciphering takes place.

Transmitting part - Tx

The Tx includes functions for GMSK modulation (i.e. transforming bits into radio waves), RF generation and power amplification. A combiner is used in order to combine the signals from several Txs to feed one antenna. If applicable the Txs can also perform frequency hopping.

Receiving part - Rx

Rx has functions for reception and demodulation (transforming the radio waves into bits) of the incoming signal. If antenna diversity is used two signals, one from each antenna, will be fed to the signal processing.

Synchronisation

Due to the TDMA structure synchronisation of the air interface is essential for the reliability of the network. The synchronisation could be retrieved from the PCM link connecting the BTS to the BSC, and is used for two reasons. One is to provide the TRX with a frequency reference but also to increment the TDMA frame counter according to the TDMA structure.