User Description, Extended Range

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1 Feature overview

1.1 Introduction

The Extended Range feature provides the Ericsson's GSM system with a possibility of carrying traffic at a larger radius from the base station than the normal GSM range of 35 kilometres. The gain in cell radius with Extended Range is at expense of capacity. Extended range cells are suitable in sparsely populated areas with low transmission loss such as deserts, coastal areas, maritime environments etc.

The Extended Range feature is implemented in the Base Station Controller (BSC).

1.2 Background

Every Slow Associated Control Channel (SACCH) period the mobile station (MS) receives Timing Advance (TA) information from the Base Transceiver Station (BTS). The TA information tells the MS in how much advance successive bursts must be sent in order to reach the BTS at the assigned time slot. The further away the MS is from the base station, the larger is TA.

The GSM specification restricts the TA to maximum 63 bit periods, corresponding to 35 km. In a normal range GSM cell, MSs which are further away than 35 km are not allowed to transmit, since their bursts would be received in the adjacent time slot which may be assigned to another connection. However, by assigning two time slots instead of one for each connection and allowing the BTS to receive the bursts in both time slots, MSs at a larger distance than 35 km can be served by the cell.

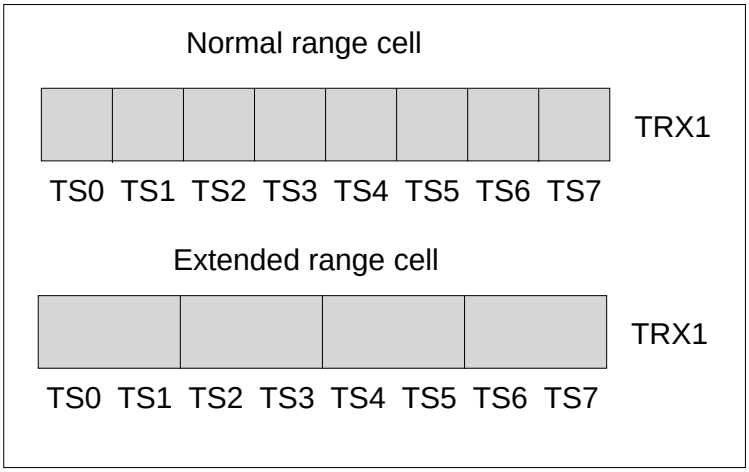

Figure 1 Time slot structure for normal range vs. extended range

1.3 What can be achieved

In a cell configured for extended range the maximum possible cell radius is increased from 35 to approximately 72 km. The Extended Range feature causes a reduction of the number of available channels by 50%.

In an overlaid/underlaid (OL/UL) subcell pair (see ref. 1) it is possible to activate the Extended Range feature in the UL subcell while maintaining the normal GSM range and capacity in the OL subcell. This makes it possible to serve remotely situated areas generating little traffic and nearby areas with high traffic load by building only one site and one antenna system.

Extended Range is supported only by the RBS 200 series using SPP boards, and only applicable for 900 Mhz systems.

Note that Extended Range can not be combined with Half Rate channel coding since both Half Rate and Extended Range are hardware implemented features on different board types. Half Rate requires SPU++ boards and Extended Range requires SPP boards.

2 Technical description

2.1 General

By assigning two time slots instead of one for each connection and allowing the BTS to receive the bursts in both time slots, it is possible to serve MSs with a larger TA than 63. Since two time slots will be assigned to each MS, a trade off between capacity and coverage occurs with the use of Extended Range.

2.2 Algorithm

2.2.1 Virtual TA

When using Extended Range, the BTS is not restricted to handle a maximum TA of 63, although it is not allowed to order the MS a TA greater than 63. When a channel is configured for extended range, the bursts from the MS can be received later than during the assigned time slot. The bursts slide into the next time slot when the MS moves further away from the BTS than allowed by the maximum TA. The TA ordered to the MS is still 63 but the time difference between sending and receiving is now larger than that given by the maximum TA.

In an extended range cell, the TA corresponding to the real signal delay (measured in the BTS) is called Virtual Timing Advance (VTA). Thus VTA is the TA that would have been used if the air interface protocol had allowed a TA larger than 63. When VTA is larger than 63 the time slot next to the one assigned is also needed for reception. At immediate assignment, the BSC extracts the VTA value from the random access delay information it receives from the BTS. When the call is established, VTA is regularly sent from the BTS to the BSC.

2.2.2 TA limits

Parameter **TALIM** is used to specify the TA limit for urgency handover (see ref. 2). If TA, which is continuously monitored, exceeds **TALIM**, an urgency condition is created in Locating. In such a case, it is allowed to make a handover to a worse cell, as well as a better cell. **TALIM** is in a normal cell restricted to the values 0 to 63. For an extended range cell, **TALIM** may be larger and is an urgency handover limit for VTA instead of for TA.

If there are no cells suitable for handover there is a risk that a mobile moves far away from the serving cell site even though TA is above **TALIM**. Parameter **MAXTA** specifies at which TA a mobile shall be disconnected (see ref. 2). As for **TALIM**, a new value range is allowed for an extended range cell. For such a cell, **MAXTA** is the disconnection limit for VTA instead of for TA.

The allowed value range for **TALIM** and **MAXTA** for an extended range cell is 0 - 219 (bit periods). During one bit period (3.7 µs) the radio waves propagate approximately 1.1 kilometre. Since VTA is given by the sum of the propagation delay in both directions, VTA equal to 219 corresponds to a distance between the site and the mobile of approximately 120 kilometres.

Due to hardware limitations, RBS 200 only supports a VTA of maximum 133 bit periods, corresponding to 72 km. RBS 2000 does not support Extended Range.

To reconfigure an extended range cell to a normal cell **TALIM** and **MAXTA** must not be greater than 63 bit periods.

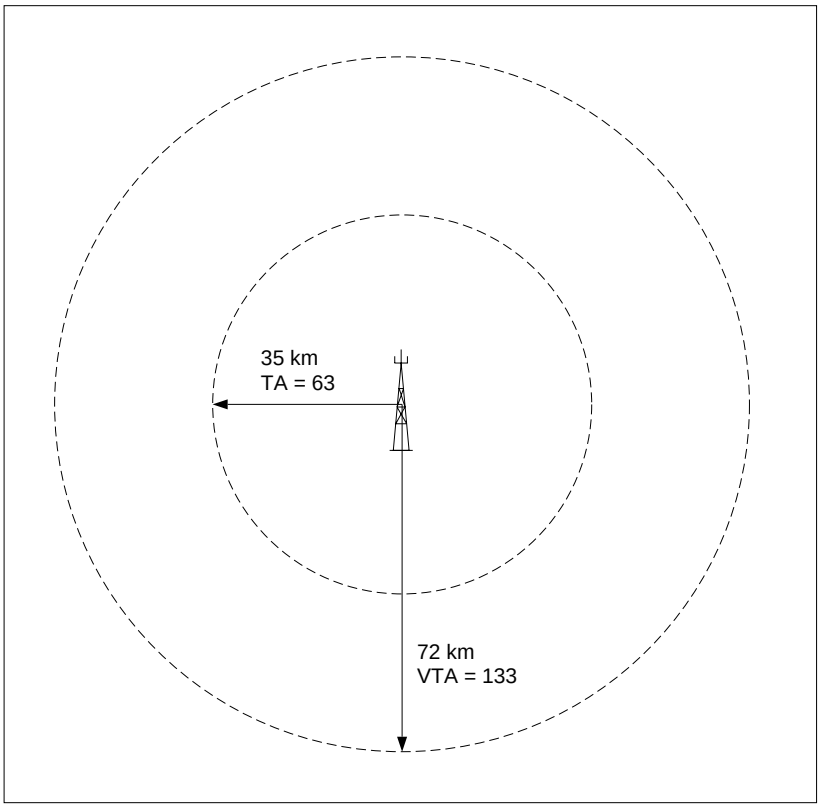

Figure 2 Cell ranges for normal and extended range cells (RBS 200)

2.2.3 Combined normal and extended range cells

To be able to cover a remotely situated area with a low traffic load and still provide the capacity of a normal cell in the area closer to the site, it is possible to configure an UL subcell for extended range while configuring the corresponding OL subcell as a normal range cell. This type of configuration is called a combined normal and extended range cell.

The usual OL subcell functionality is also available in a combined normal and extended range cell. It means that it is still possible to restrict the OL subcell in size using a path loss and TA thresholds, see ref. 1.

In the case of a combined normal and extended range cell the TA limits for urgency handover and disconnection in the OL subcell are not given by **TALIM** and **MAXTA**. Instead they are permanently set to 62 and 63 bit periods respectively and can not be changed by operator's commands.

A combined normal and extended range cell is obtained by setting **XRANGE** = ON in the cell and activate an OL/UL subcell structure.

2.3 Main changes in Ericsson GSM system R7/BSS R7.0

It is possible to combine normal and extended range cells by configuring an UL subcell for extended range and the corresponding OL subcell for normal range.

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3 Engineering guidelines

3.1 Capacity

In order to increase the traffic capacity in an extended range cell a TRX may be configured for combined control signalling. With this TRX configuration the same channel is used for both broadcast and dedicated signalling. The remaining channels are all available for traffic. An extended range cell with one TRX and configured for combined control signalling thus holds three traffic channels. Only two channels are available for traffic if the TRX is not configured for combined control signalling.

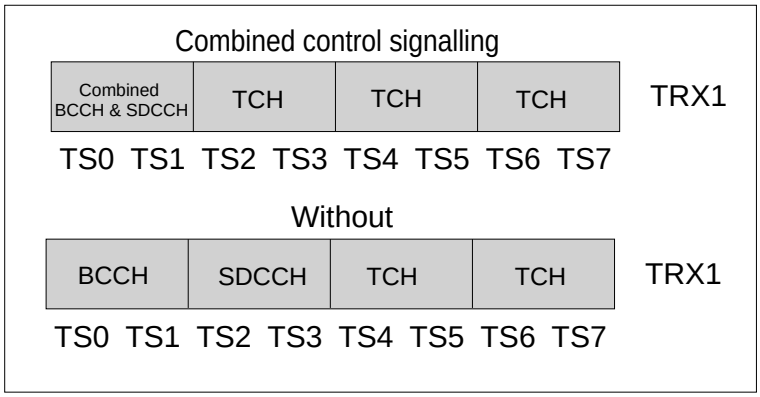

Figure 3 Extended range cell with and without combined control signalling

It is recommended to configure the cell for combined BCCH and SDCCH to increase TCH capacity unless the paging capacity is a limiting factor. The parameter **BCCHTYPE** has to be set to COMB or COMBC depending on whether the function Short Messages Service Cell Broadcast is activated or not in the cell, see also ref. 2 and ref. 3. If paging capacity is a limiting factor the feature Adaptive Configuration of Logical Channels can be used to minimise the risk of SDCCH congestion (see ref. 4).

3.2 Power balance

The maximum cell range should be calculated for a system in power balance. When using the feature extended range it is important to look at the power balance calculations and try to minimize the losses in the system in order to have enough signal strength at desired cell range. Introduction of an LNA (Low Noise Amplifier) is recommended to increase the uplink sensitivity. The BTS output power balance is calculated as follows (see also ref. 2).

$$P_b(\text{after combiner}) = P_m + D_s + G_d + LNA_{corr}$$

when downlink attenuation is equal to uplink attenuation, where:

- P_b is the BTS output power after combiner.
- P_m is the MS output power.
- D_s is the sensitivity difference between MS and BS.

- G_d is the diversity gain, typically 3.5 dB in GSM.
- LNA_{corr} is the LNA correction factor.

It is assumed that the antenna gain is the same for the base station transmitter and receiver. The log-normal fading and interference margins are equal for up- and downlink.

To take advantage of the range of up to 72 km, high antennas with high antenna gain and high output power are necessary. It is also possible to get good coverage if the antenna is placed on mountains or hills and the antenna is pointing over open land or water where good conditions for wave propagation exist.

Blocking can be a problem if some mobiles get too close to the base station, especially if the mobiles are using some kind of booster to improve the uplink or when an LNA is used. Thus, it is important to use the feature MS power control in order to minimize the transmitted power from the mobiles in this situation.

3.3 Recommendations

The feature extended range should be used only in areas where the traffic demands are low and in environments where propagation conditions of very low path loss exist. **MAXTA** should be set to 133. **TALIM** should be used to limit the range of the cell, e.g. where the cell otherwise would take traffic from undesirable areas. A recommended value on **TALIM**, when using the extended range feature, is 132.

4 Parameters

4.1 Main controlling parameters

XRANGE switches the Extended Range feature on/off. It is defined per cell.

TALIM is the TA threshold for excessive TA (or VTA) urgency. It applies for all subcells except for the OL subcell in a combined normal and extended range cell. It is defined per cell.

MAXTA is the TA threshold for call disconnection caused by excessive TA (or VTA). It applies for all subcells except for the OL subcell in a combined normal and extended range cell. It is defined per cell.

4.2 Value ranges and default values

Table 1

Parameter name	Default value	Recommended value	Value range	Unit
XRANGE	OFF		ON, OFF	
MAXTA	62	133	0-219(1) for extended range 0-63 for normal range.	bit periods
TALIM	61	132	0 -219 (1) for extended range 0-63 for normal range	bit periods

(1) For RBS 200 the useful value range is 0 to 133. RBS 2000 does not support Extended Range.

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5 References

1 User Description, Overlaid/Underlaid Subcells.

2 User Description, Locating.

3 User Description, Idle Mode Behaviour.

4 User Description, Adaptive Configuration of Logical Channels.