8. BSS Optimisation Activities

8.1 Introduction

This section of the course provides guidance on how to improve the performance of the network by adjusting performance parameters. The performance monitoring phase will have identified any irregularities in the network by analysing the performance measurement parameters.

8.2 BSS Database Parameter Review

8.2.1 REVIEW DATABASE SETTINGS

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BSS Configuration Parameter Review

- Review current settings as related to performance measurement results
- Recommend changes to improve/optimise performance of specific features.
- Review includes:
  - Handover parameters, timers, thresholds and margins
  - Power control thresholds
  - Averaging mechanisms for handover and power control
  - Call setup parameters to maximise resource utilisation
  - C1/C2 cell reselection parameters
  - Any vendor-specific advance traffic management algorithms

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The BSS database parameter review is intended to review existing BSS database parameter settings in the light of performance measurement results, and recommend changes necessary to improve or optimise the performance of specific features. This review includes the following:

- Handover parameters, timers, thresholds and margins (including inter-layer and inter-band handovers where applicable).
- Power Control thresholds (power window settings, power up/down step size, adaptive power control parameters, and so on).
- Voting and averaging mechanisms for handover and power control decisions.
- Call setup and handover timers to maximise resource utilisation and availability
- C1/C2 cell reselection parameters.
- Advanced traffic management algorithms (Congestion-based handovers, inter-band and inter-layer traffic distribution)

8.2.2 DATABASE CONSISTENCY AND CHANGE CONTROL

Review of all BSS databases to identify inconsistencies and discrepancies, and a review of change control, datafill and database management processes. For example:

- Define pre-configured parameter templates for a variety of site types (micro, highway 2/2, urban 3/3/3, etc.).
- Identify sets of parameters allowed for optimisation on permissions basis (fully configurable permissions per BSC, region, etc).
- Check consistency of live network data against planned configuration.

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BSS Database Parameter Consistency

- Within a network, different site types are defined (e.g. urban micro, rural macro etc) by a standard template
- Each site type database will comprise a default parameter set
- Each site may modify default set to suit local conditions
- Consistency of the default parameter sets should be checked across BSS types
- Change control management processes should be reviewed to ensure procedural consistency

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8.2.3 BSS CONFIGURATION PARAMETER SETS

Each BSS performs in accordance with its software configuration. Generally, there will be a common set of default parameters for each BSS, for example, the handover algorithms. However, each BSS will be programmed with certain parameters which are tailored to suit specific actions, locations and/or applications. Examples of BTS-specific parameters include the cell ID and power output settings.

BSS Configuration Parameter Sets

- Each BSS operates in accordance with its software configuration
- All BSS are configured with certain standard default parameters
- Each BSS will have a subset of BSS-specific parameters
- Parameters defined by:
  - ETSI GSM Recommendations (GSM 12.04)
  - Proprietary Parameter Implementation
- Potentially hundreds of configuration parameters
- Many parameters are inter-dependant
- Often vendor-specific abbreviations/acronyms used for same parameter

The number of configurable BSS parameters run into their hundreds and are defined in two sources:

- ETSI GSM Recommendations. ETSI has defined a primary set of parameters which are listed in the GSM 12.04) document.
- Proprietary Parameters. These are additional parameters created by individual vendors to enhance the capabilities of their equipment when compared that of their competitors.

This multitude of parameters allows for very sophisticated control of the BSS behaviour. However, the complexity can also lead to problems:

- Many parameters are inter-related so changing one can have a corresponding effect on others.
- Many equipment manufacturers use different abbreviations or acronyms for the same GSM-recommended parameter, leading to potential confusion when a network comprises equipment for more than one manufacturer.

8.2.4 BSS PARAMETER TYPES

As mentioned above, the number of performance configuration parameters in a BSS runs into three figures. Within the scope of this overview course, the following provides an overview of the type of parameters stored:

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BSS Configuration Parameter Types

- Identifiers:
  - CI, LAI, GCI, BSIC etc
- Channel Configuration:
  - TCH channels, Signalling channel configuration (e.g. CCCH)
- Timers:
  - Location Updates, C2 calculations etc
- Thresholds:
  - RxLev, RxQual for handover decisions etc
- Offsets:
  - Hysteresis for handovers etc
- Control Features:
  - SFH, DTX, DRX etc

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Identifiers.
This includes such parameters as the Cell Identity (CI), Cell Global Identity (CGI) Location Area Identity (LAI) and Base Station Identity Code (BSIC) etc

Channel Configuration Parameters.
These parameters define the number of traffic channels and control channels. For example, the configuration of CCCH on the signalling channel (i.e. combined/non-combined multiframes).

Timer Parameters
Timers are counters which are set at the start of a certain time period and count down. If an event has not happened by the time the counter reaches zero, an alternative action may be triggered. For example, the time periods between periodic location updates (T3212) or the penalty timer for C2 calculations (see Cell Reselection in Section 1 for details).

Threshold Parameters
Thresholds are certain values which, when exceeded, trigger a certain event. For example, received signal strength or bit error rate thresholds which may trigger cell handovers.

Offset Parameters
Offsets are fixed values applied for the purposes of applying bias to certain actions. An example is the hysteresis bias value applied to BTS at location area boundaries.

Control Feature Parameters

A number of parameter settings exist to identify the implementation of certain functions and features. Such features include Frequency Hopping, DTX etc

8.2.5 ADJUSTING BSS CONFIGURATION PARAMETERS

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Adjusting BSS Configuration Parameters

- Effected from:
  - PC connected directly to hardware
  - Remotely from OMC/NMC
- Can be individually addressed or broadcast
- May require hardware reset to effect change
- Be aware of hierarchical changes (MSC→BSC→ BTS)
- Only implement during low-traffic periods
- Use test BSS where available
- Avoid simultaneous multiple parameter changes

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It is normally possible to carry out parameter changes from:

- BSS – directly into the BSS database via a PC connected to the BSS.
- OMC/NMC – Many OMC/NMC systems allow parameters to be transmitted to the BSS remotely including a broadcast capability where a specific parameter change needs to be transmitted to several network entities simultaneously.

Adjustment of parameters on live network elements should be deferred until low traffic periods in order to minimise any disruption to existing users. This is particularly important when a configuration change requires a hardware reset to become effective. A change BSC parameter is changes it may affect all BTSs associated with that BSC.

Some network operators reserve a BSS for test purposes. This has the advantage of being able to assess the impact of a parameter change before making the adjustment to a live network. However, it is a non-revenue generating asset.

Making simultaneous multiple parameter changes should also be avoided where possible for two reasons:

- If an unexpected problem arises as a result of a multiple parameter change, it will be difficult to identify the specific parameter or parameter combination causing the problem.
- Similarly if a performance improvement is observed, it may be difficult to identify which of the parameters are causing which part of the performance improvement.

8.3 Identify and Fix Hardware Problems

Identification of BSS hardware problems can be identified though the analysis of OMC statistical data, drive test data, A-Bis and A-Interface logs. 'Worst Performing Cells' can be identified through analysis of established KPI's.

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Identify Hardware Problems

- Problems identified through analysis of performance measurement counters from:
  - OMC Statistics
  - Driver \Test data
  - A-bis and A interface logs
- Identify 'worst performing cells' according to established KPI benchmarks

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Typical examples of hardware problems include:

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Typical Hardware Problems

- Misaligned Antennas
  - Increased interference, coverage degradation
- Wrongly/poorly connected feeders
  - Reduced power output, reduced coverage, cell imbalance, distortion
- Poor transmission line performance (water ingress, corrosion, physical damage etc
  - High VSWR, high Insertion losses, reduced power output, reduced coverage, cell imbalance, distortion
- Poorly calibrated TRXs
  - Inconsistent TRX performance
- Incorrectly configured combiners/duplexers etc
  - Reduced power output, reduced coverage, cell imbalance, distortion

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8.4 Identify and Fix Neighbour Problems

In GSM, several neighbour cells can be defined for a serving cell. Usually, handovers should be made to the strongest neighbour, but in some cases frequent handovers to this best neighbour can result in congestion in the neighbour cell, affecting the users initiating calls from that cell.

The situation can also occur in reverse, when a handover required to the best neighbour can result in a rejection due to unavailability of resources, causing the handover to be attempted to the next best neighbour, which can delay the process and deteriorate the quality further.

Under certain circumstances, it may be necessary to remove a potential neighbour from the neighbour list and provide alternatives. Usually, such decisions are made using demographic considerations.

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Optimising Neighbour Lists

- Effects of poor maintenance:
  - Unwanted legacy neighbours
  - Oversized neighbour lists
  - Co-channel neighbour definitions
  - Missing neighbours
  - Unintentional 1-way neighbour definitions
- Optimise by:
  - Analyse neighbour performance form statistics.
  - Utilise automated neighbour detection
  - Identify inconsistent neighbour profiles
  - Modify appropriate neighbour lists

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The neighbouring BCCH carrier analyser in the GSM receiver makes it easier to determine these alternative neighbours. It can be used to create a list of all the possible BCCH carriers in the nearby vicinity and perform the RxLev measurement (linked to the phone’s RxQual performance) on each of these carriers.

When the RxQual reaches the handover decision threshold, we can determine the potential neighbours at that stage and set one of those as the optimum neighbour. This can also be done by the MS, but in this case the choice is limited to the BA list set in the network, which may not include all good potential neighbours.

Optimisation includes a combined study of neighbour performance statistics and network planning data, using automated neighbour detection techniques via A-Bis traces where supported by the vendor's OMC tool set. The neighbour list is reviewed to identify missing, redundant and 1-way neighbours, and updating of neighbour lists with required changes.

Lack of neighbour maintenance leads to:

- Unwanted legacy neighbours
- Over-sized neighbour lists (impossible to add neighbours for new sites, and reduced handover performance)
- Co-channel neighbour definitions
- Missing neighbours
- Unintentional 1-way neighbour definitions

8.5 Identify and Fix Frequency Plan Problems

8.5.1 FREQUENCY OPTIMISATION ACTIVITIES

Frequency optimisation activities involve identification of interference issues due to a poorly-maintained frequency plan, and rectification through a process of coverage optimisation and frequency plan modifications.

This includes firstly ensuring problem areas have been identified:

- Identify interference issues
- Identify coverage optimisation issues impacting frequency plan quality (excessive coverage overlaps, coverage splashes, etc.)

Having ensured that the issues have been identified correctly, optimisation techniques can be employed to optimise the frequency plan. Such techniques could include:

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Frequency Optimisation Activities

- Identify problem areas:
  - Interference issues (internal and external)
  - Coverage issues (excessive overlaps, coverage gaps, high sites etc)
- Recommend appropriate frequency optimisation techniques
  - BCCH and TCH Frequency Plans
  - Frequency Diversity (space, polarity)
  - Frequency Hopping
  - DTX
  - Antenna Down tilting
  - Advanced Optimisation Techniques

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8.5.2 BCCH AND TCH FREQUENCY PLANS

The Spectrum allocation should be considered to determine if a change to frequency allocation is necessary. The diagram below shows a typical frequency allocation for the 900 band.

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BCCH and TCH Frequency Plans

- BCCH is typically planned with low frequency re-use (long re-use distance) in order to ensure high quality.
- The BCCH plan should take into account: site design, terrain and topography and subscriber distribution. A good BCCH plan can generally be achieved with 14 - 15 carriers.
- The TCH plan requires the same considerations as BCCH, but may also employ:
  - Frequency hopping - synthesiser or baseband
  - Multiple Re-use Patterns - giving tighter re-use on lower TCH layers
  - Concentric multi-layer cell arrangements in which BCCH is only required on one band

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The number of channels required to make a good BCCH plan will vary according to a number of factors:

- Site design (high sites etc.)
- Terrain and topography
- Subscriber distribution
- Regularity of cell plan

In a well optimised network, it is generally possible to produce a high quality BCCH plan within 14-15 channels.

The same issues with the BCCH plan also affect frequency planning of the non-BCCH (TCH) carriers. However there are additional techniques available for the TCH layer to improve re-use efficiency and increase capacity, such as:

- Synthesizer Frequency Hopping
- Baseband Frequency Hopping
- MRP (Multiple Reuse Pattern)
- Concentric Cell

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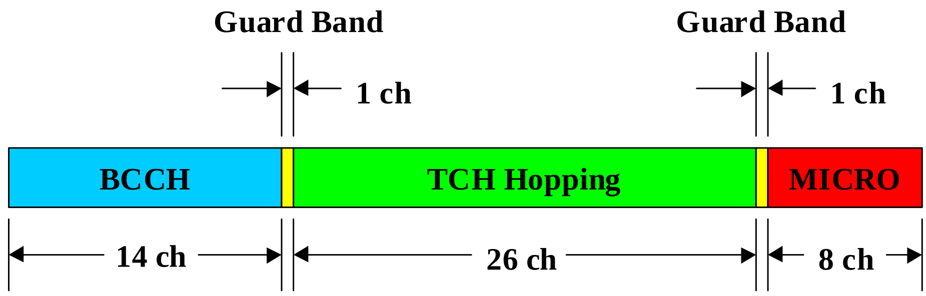
BCCH and TCH Frequency Plans



8.5.3 HIGH SITE REPLACEMENT

In terms of RF design, the problem with this approach is that the legacy sites from the launch rollout phase tend to be high and prominent, and increasingly contribute uplink and downlink interference into the network as the number of lower sites around them increases. The net effect of this is to minimise frequency re-use efficiency and limit the capacity of the network.
Therefore a process is required to identify and eliminate these interferers to allow network growth to continue and high quality to be maintained.

A typical process for replacing or modifying high sites would be as follows:

- From BSS performance statistics and call trace logs, identify those cells which contribute the most interference to the largest number of other cells.

- Develop a plan for de-commissioning the site, or lowering the antennas to a position consistent with surrounding sites if possible. Include the possible requirements for additional in-fill sites due to the loss of coverage from the high site.

- As new low sites are integrated, de-commission or modify the high site in such a way as to cause minimum disruption to coverage. Prioritise the integration of any required new sites to target high sites in order of severity.

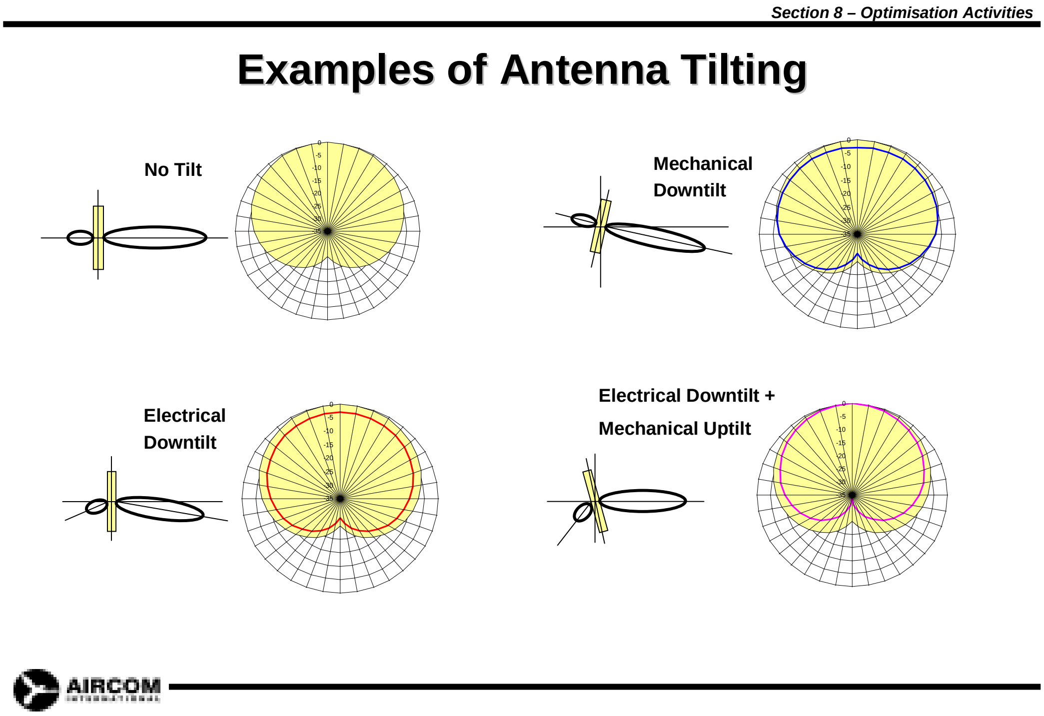
High Site Problems

- Initial roll-out tends to concentrate on higher sites
- High sites potentially cause excessive interference with subsequent lower site roll-out
- A Typical process for replacement could include:
  - From performance parameters, identify those cell interference-contributing the most interference to the most cells
  - Develop plan to lower antennas or decommission these sites. This may require additional lower sites to cover any coverage gaps
  - Prioritise decommissioning and integration of new sites to minimise disruption to services

8.5.4 ANTENNA DOWN-TILTING

Antenna Down-Tilting

- An option for adjusting cell coverage
  - e.g. down tilting may direct coverage deeper into a building
- Antenna tilt may be:
  - mechanical – operator set – affects directional coverage
  - electrical – manufacturer set – affects omni-directional coverage
- Omni antennas may have electrical tilt but not mechanical
- New technologies allow for remote electrical tilting



8.5.5 ANTENNA SELECTION

Antenna specifications have a significant impact on network performance. The suitability of antennas should be reviewed according to the observed performance problems in the network, and recommendations made as necessary, for example:

- Vertical and Horizontal Beamwidth
- Gain
- Front-to-Back Ratio
- Null Fill
- Downtilt (electrical/mechanical)

Antenna Selection

- Factors to consider with Antenna selection:
  - Vertical and Horizontal Beamwidth
  - Gain
  - Front-to-Back Ratio
  - Null Fill
  - Downtilt (electrical/mechanical)

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Antenna positioning is also important with respect to minimising interference and unwanted radiation. This should also be studied in relation to the RF design strategy.

8.5.6 ANTENNA CONFIGURATION OPTIONS

Antenna Configuration Options

- Combining:
  - Economical with antenna elements
  - Reduced coverage due to insertion loss
- Diversity Choice:
  - Horizontal space diversity
  - Vertical space diversity
  - Polarisation diversity

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