GSM frequency planning

Band : 890-915 and 935 - 960 MHz

Channel spacing: 200 kHz (but signal bandwidth = 400 kHz)

Absolute Radio Frequency Channel Number (ARFCN)

lower band: $F_l(n) = 890.2 + 0.2\,(n - 1)$ MHz

upper band: $F_u(n) = F_l(n) + 45$ MHz

$n = 1, 2, \ldots\ 124$

Mobile Station

- Vehicular
- Handheld

maximum peak power

class	output power	tolerance
1	20 W (43 dBm)	2 .. 2.5 dB
2	8 W (39 dBm)	2 .. 2.5 dB
3	5 W (37 dBm)	2 .. 2.5 dB
4	2 W (33 dBm)	2 .. 2.5 dB
5	0.8 W (29 dBm)	2 .. 2.5 dB

Adaptive power control in Mobile

- to save power
- to avoid interference
- 15 steps each of 4 dB
- range +43 dBm (20 Watt) ... + 13 dBm (20 mWatt)
- Controlled by base station

Base station

maximum peak power

class	1:	320 Watt
class	2:	160 Watt
	....	
class	8:	2.5 Watt

Adaptive power control: 15 steps

Output spectrum base station

- width 400 kHz (at -30 dB 200 kHz away from carrier)
- -60 .. -70 dB at 400 ... 1800 kHz away from carrier
- Also: spurious emissions and switching transients

Link Budget

- relevant to radio coverage
- relates transmit power, path losses, penetration losses, fade margin etc to received power
- relates noise floor and man-made noise levels to required receive power

	BTS-MS	MS-BS
Transmit power	------------	
Path loss		

Penetration loss		

Fade margin		
Received power	----------	
Minimum required receive power	----------	
Required SNR		
Manmade noise figure		
Noise floor	----------	

Link Budget GSM 03.30 appendix A.1

	M-B	B-M
Noise Figure	8	10 dB
Interference degradation margin	3	3 dB
RX Antenna cable loss	4	0 dB
Lognormal margin	5	5 dB
Fade margin	9 ..	19 dB
TX isolator, combiner, filter	0	3 dB
TX antenna cable	0	4 dB
TX Antenna gain	0	12 dB
Indoor loss	10	10 dB

Equipment with integral antenna:

- Include effect of antenna in link budget

For omnidirectional antenna (0 dBi)

E (dBµV/m) = P (dBm) + 20log F(MHz) + 77.2

For F = 925 MHz

E (dBµV/m) = P (dBm) + 136.5

Receiver Performance

ETSI 05.05 Recommendations

- BER for interference-free operation:

  At -85 dBm (52 dBµV/m)

  - static channel: BER ≤ 10-4 (0.01%)

  - fading channel: BER ≤ 3 10-2 (3 %)

- Receiver sensitivity
  - ■ handheld -102 dBm (35 dBµV/m)
  - ■ other MS and BS -104 dBm (33 dBµV/m)

Discussion:

Compare with Thermal Noise Floor:

kT_0 = 4 10^{-17} watt/Hz (-174 dBm/Hz)

B_N = 400 kHz (+56 dB w.r.t. 1 Hz)

SNR_{BS} = 14 dB

Man-made noise factor at 900 can exceed 14 dB !

Interference rejection

ETSI 05.05 Requirements

cochannel channel interference:	z = 9 dB
200 kHz adjacent channel:	z = -9 dB
400 kHz adjacent channel:	z = -41 dB
600 kHz adjacent channel:	z = -49 dB

Frequency planning

Aspects to be considered

- Propagation Data

  Macroscopic: path loss

  Microscopic: fade margins

  Use terrain heights, building, vegetation from data base

- Demographic data

- Road traffic data

- Logistic data (e.g. in militairy transportable networks)

Different approaches to frequency planning

0) Coarse planning (no terrain data used)

1) coverage limited

step 1: find coverage of base station

step 2: make interference matrix

step 3: find useful map coloring pattern (recursively ?)

recursive approach: change transmit powers

This changes coverage and interference; redo 1-2-3

Example: Broadcasting, Netherlands PTT Ceasar

2) Interference limited

step 1: assign frequencies and powers to base stations

step 2: find coverage and interference zones

recursive approach: modify powers and frequencies

Example: Ericsson plannings tool

3) Dectralized Dynamic Channel Assignments (DCA)

- DECT system, not for GSM

Accuracy of cell planning

Depends on

- accuracy of propagation models
- resolution and accuracy of terrain data

Data bases

- often based on satellite images
- available from several companies

Measurements

When a new planning tool is used for first time in a new country, one needs to adjust propagation models.