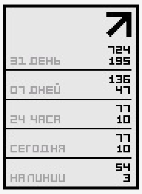
Archives

четверг, 3 сентября 2009 г.

2.7 Design of Base Station Address

2.7.1 Address design

Generally, in GSM radio network planning, the base station address is designed according to the following requirements:
The address must serve to the reasonable cell structure.
Based on the comprehensive analysis of the electronic maps and paper maps, you can select several candidate addresses from the perspective of coverage, anti-interference, and traffic balance.
In actual conditions, carriers are required to discuss the selected addresses with owners. Generally, the addresses must be located within the area 1/4 radius of the cellular base station.
During the early construction stage when only a few base stations are installed, the base stations must be located in the center of the areas where subscribers are densely populated.
For the selection of the base station addresses, the priority must be given to the important areas, such as government offices, airports, train stations, news center, and great hotels so that good conversation quality can be assured. Furthermore, overlapped coverage must be avoided in these areas.
For other coverage areas, the base station addresses are designed according to standard cellular structures. For the suburban areas, highroads, and countryside areas, the design of base station addresses has little relation with cellular structures.
Without affecting the layout of base stations, you can select the telecommunication buildings and post offices as the base station addresses so that the facilities, such as the equipment room, power supplier, and iron tower can be fully utilized.
The direction of antenna major lobe must be in accordance with the area where the traffic intensity is great. In this case, the signal strength of the area can be enhanced, so does the conversation quality. Meanwhile, the direction of the antenna major lobe must be deviated from intra-frequency cells so that the interference can be controlled efficiently.
In urban areas, it is recommended that the overlapped depth of the antennas in adjacent sectors cannot excel 10%. In suburban areas and small towns, the overlapped depth between coverage areas cannot be too great, and the included angle between sectors must be equal to or higher than 90°.
In addition, for actual design, you must consider the mapping relationship between carrier number and cells. Generally, more carriers are configured for the cells with high intensity.
The azimuth angle must be designed according to not only the traffic distribution in the areas around the base stations, but also the performance of the overall network.
Generally, it is recommended to adopt the same azimuth angle for the 3-sector base stations in urban areas so that the complicated network planning can be avoided after cell splitting in the future.
Moreover, the antenna major lobe cannot directly point to the straight streets in populated urban areas, because it can cause cross-coverage.
In the areas connecting urban and suburban areas, and along transport arteries, you must adjust the azimuth angle according to coverage target.
Generally, the base station address is not considered on the high mountains in urban and suburban areas. To be more specifically, the high mountains are those over 200 to 300 meters higher than above the sea-level). Otherwise, not only strong interference and weak signals may be present within the coverage area, but also the base stations are hard to be installed and maintained on high mountains.
New base stations must be installed at the spots where the traffic is convenient, the power supply is available, and the environment is secure. In contrast, new base stations must not be installed at the spots near the radio transmit stations with high power, radar stations, and other equipments which produces great interference, because the interference-field intensity cannot be greater than that defined by the base station.
The base station addresses must be far away from forests or woods to keep the receiving signals from fading.
The transmission between base station controllers must be considered in the design of the base station address.
When selecting a base station address from high buildings in urban areas, you can divide the network into several layers with the help of the building height. The antenna height of major base stations must be a little higher than the average height of buildings. Generally, the antenna height of the base stations in populated urban areas ranges from 25 to 30 meters. In suburban areas (or the antenna points to suburban areas), the antenna height ranges from 40 to 50 meters.
Along highroads or in mountain areas, the base station address is selected based on full survey of the landforms. For example, the address can be determined in an open area or at the turns of the highroads.
When selecting a base station address from the cities characterized by mountains and hills and from the areas where high buildings are constructed with metals, you must consider the effect of time dispersion. In this case, the base station address must near reflected objectives. When the base station is far away from reflected objectives, you must adjust the directional antenna to the reverse direction of the reflected objectives.
Caution:
Time dispersion mainly refers to the intra-frequency interference arising from the time difference between the master signal and other multipath signal arriving at the receiver in terms of space transmission. According to the requirements in GSM protocols, the equalizer of the receiver must carry the time window with 16μs (equivalent to 4.8 km). The multipath signal with time difference greater than 16 μs is regarded as intra-interference signal. In this case, you must consider whether the level difference between the master signal and multipath signal meet the carrier-to-interference ratio (C/I), namely, the master signal is 12 dB greater than the multipath signal at least.



2.7.2 Project Parameter Decision

After finishing designing a base station address, you must decide the project parameters needed for the base station installation. These parameters include:

Latitude and longitude of the location of base station antenna
Antenna height
Directions of the antenna
Antenna gain
Azimuth angle
Tilt angle
Feeder specifications
Transmit power for each cell of the base station

And the previous parameters are decided through field survey.

Before beginning field survey, you must familiarize yourself with the overall project and collect the materials and tools relative to the project. They are:

All types of project documents
Background information
Information about the existing network
Local map
Configuration lists required in contracts
Relative tools (including digital camera, GPS, compass, ruler, and laptop computer)

& Note:
Make sure that all the materials and tools are usable before setting out.

The following items must be emphasized before field survey:

The GPS must be placed in an open land to position the latitude and longitude of a base station
Make a detailed record of the surroundings around the base station, such as the distribution of the buildings, facilities with strong interference, and the equipments sharing the same base station address. It is better to record the previous information with a camera.
Prevent the compass from magnetizing, because the magnetization will cause great deviation during the measurement.

Field survey determines the layout of the base station addresses ultimately. The field survey for the base station includes optical measurement, spectrum measurement, and base station address survey. They are specified as follows:

Optical measurement
Measure if a barrier that may reflect electrical waves around the base station, such as high buildings.
Spectrum measurement
Check if the electromagnetic environments around the base stations are normal at present or in recent days.
Base station address survey
Check the installation conditions of antenna and equipments, power supply, and natural environment.

The following sections introduce the design for antenna installation.

I. Environment for antenna installation

The environment for antenna installation can be divided into the environment near the antenna and the base station. For the environment near the antenna, you must consider the isolation between antennas and the effect of iron tower and buildings against the antenna. For the environment near the base station, you must consider the effect the high buildings within 500 meters against the base station. However, if the height of the buildings is properly used, you can obtain the intended coverage area.

If a directional antenna is installed on the wall, the radiation direction of the antenna is perfectly perpendicular to the wall. If its azimuth angle must be adjusted, the included angle between the radiation direction and the wall is required to be greater than 75°. In this case, if the front-to-back ratio of the antenna is greater than 20 dB, the effect of the signals reflected by the wall in reverse direction against the signals in the radiation direction is quite slight.

When installing an antenna, you must consider whether large shadows will be present within the coverage area of the antenna. The shadows are produced mainly because the base station is surrounded by some huge barriers, such as high buildings and great mountains. Therefore, the antenna must be installed in the areas with no such barriers.

When a directional antenna is installed on building roofs, you must prevent the building edges from barring the radiation of antenna beams. Therefore, to reduce or ease the shadow, you can install the antenna near building edges.

Because the building roofs are diversified and complicated, if an antenna must be installed far away from building edges, the antenna must be installed higher than the roof. In this case, the wind load of the antenna must be considered.

II. Antenna isolation in GSM system

To avoid inter-modulation interference, you must leave certain isolation between the receiver and transmitter of the GSM base station, namely, Tx - Rx: 30 dB and Tx -Tx: 30 dB. They are applicable to the situation that a GSM 900MHz base station and a GSM 1800MHz base station share the same address.

The antenna isolation depends on the radiation diagram, space distance, and gain of the antenna. Generally, the attenuation introduced by the voltage standing wave ratio (VSWR) is not considered. The antenna isolation is calculated as follows:

For vertical arrangement, $Lv = 28 + 40lg\ (k/\lambda)$ (dB)
For horizontal arrangement, $Lv = 22 + 20lg\ (d/\lambda) - (G1+G2) - (S1 + S2)$ (dB)

Here,
Lv indicates the required isolation.
λ indicates the length of carrier waves.
k indicates the vertical isolation distance.
d indicates the horizontal isolation distance.
G1 indicates the gains of the transmitter antenna in the maximum radiation direction, in the unit of dBi.
G2 indicates the gains of the receiver antenna in the maximum radiation direction, in the unit of dBi.
S1 indicates the levels of the side lobes of the transmitter antenna in the 90° direction, in the unit of dBp, and it is a negative value relative to the main beam.
S2 indicates the levels of the side lobes of the receiver antenna in the 90° direction, in the unit of dBp, and it is a negative value relative to the main beam.

The followings introduce the requirements on the antenna mount in GSM 900MHz and GSM 1800MHz.

(1) Directional antenna

In one system, the following requirements must be met in terms of isolation:
The horizontal distance between two antennas in the same sector must be equal to or greater than 0.4m.
The horizontal distance between two antennas in different sectors must be equal to or greater than 0.5m.
In different systems, the following requirements must be met when two antennas are in the same sector and direction:
The horizontal distance between the two antennas must be equal to or greater than 1m.
The vertical distance between the two antennas must be equal to or greater than 0.5m.
The distance between the bottom of the antennas and the enclosing wall of building roof must be equal to or greater than 0.5m.
The included angle between the line connecting the bottom of the antenna to the antenna-facing roof and the horizontal direction must be greater than 15°.

The bands of the two systems are close to each other, the interference against each other will easily occur. Mostly, the transmission of CDMA2000 1X base station will interfere with the reception of GSM 900MHz base station.
The disclosure signals of the CDMA band falling into the channels of the GSM base station receivers will enhance the noise level of the GSM receivers. In this case, the GSM uplinks become weak, which will reduce the coverage area of the base station and worsen the quality of the network.
If there is not enough isolation between base stations or the transmitting filter interfering base stations does not provide enough out-of-band attenuation, the signals falling into the band of the interfered base station receiver may strong, which will increase the noise level of the receiver.
The deterioration of the system performance is closely related to the strength of interference signals, and the strength of interference signals is determined by the factors, such as the performance of the transmitting elements of the interfering base stations, the performance of the receiving elements of the interfered base stations, the distance between bands, and the distance between antennas.
The signal from the amplifier of the interfering base station is first sent to the transmitting filter, and then it attenuate due to the isolation between the two base stations. Finally, it is received by the receiver of the interfered base station. The power of the spurious interference arriving at the antenna end of the interfered base station can be expressed by the following equation:
Here,
Ib indicates the interference level received at the antenna receiving end of the interfered base station, in the unit of dBm.
PTX-AMP indicates the output power at the amplifier of the interfering base station, in the unit of dBm.
Pattenuation indicates the out-of-band suppression attenuation at the transmitting filer.
Iisolation indicates the isolation between the antennas of the two base stations, in the unit of dB.
WBinterfered indicates the bandwidth of the signals at the interfered base station.
WBinterfering indicates the measurable bandwidth of the interfering signals, or it can be understood as the bandwidth defined by spurious radiation.
Regulate the previous equation and the following equation can be obtained:
Suppose the transmit channel number of CDMA2000 1X is the last one on its working band, that is, 878.49MHz, the spurious signal level on the band of 890-915MHz must be equal to or lower than -13dBm/100kHz. If you intend to put this assumption into practice, you can filter and combine each transmitted channel number by using band-limited filter with a bandwidth of only 1.23MHz. The band-limited filter of this type has great out-of-band attenuation, which can reach 56 dB at 890 MHz and 80 dB at 909 MHz. Here you must consider the worst situation, that is, the frequencies at the highest end of the CDMA system interfere with the frequencies at the lowest end of the GSM system.
In this case, Iisolation = (-13dBm/100kHz) - 56 - Ib + 10lg (200kHz/100kHz)
Here Ib indicates the highest interference level (dBm) allowed by the receiving end of the interfered base station. If the receiving sensitivity of the interfered base station is ensured, the outside interference level are required to be 10 dB lower than the back noise of the receiver. In this case, the sensitivity affected only accounts to about 0.5 dB.
The back noise of the GSM receiver is the sum of the noise intensity, bandwidth, and noise coefficient. If the noise coefficient is 8 dB, the back noise is -174+noise coefficient+10lg (200000) = -174+8+53 = -113 (dBm). Therefore, the maximum spurious interference allowed is -113-10 = -123 (dBm/200kHz).
As a result, the spurious interferences from other systems falling at the GSM receivers are required to be smaller than -123 (dBm/200kHz); otherwise, the spurious interferences will seriously affect the GSM system.
Therefore, Iisolation = (-13dBm/100kHz) – 56 - Ib + 10lg (200kHz/100kHz) = -13- 56- (-123dBm/200kHz) + 10lg (200kHz/100kHz) = 57 dBm/200kHz.
That is, according to the assumption, the isolation between a CDMA antenna and GSM 900MHz antenna must be at least 57dB regardless whether they share the address or not.
Many ways can be used to reduce the interference. For example, you can adopt the following ways:
Design enough distance between antennas
Filter the out-of-band interference of the transmitter
Add different equipments to the filter, such as receiver, duplexer, and divider.
According to the requirements in TIA/EIA-97 protocols, the spurious interference from the CDMA antenna interface falling within the GSM 900MHz receiving bands must be less than -13 dBm/100kHz. Therefore, the problems, such as mutual interference and co-address construction must be considered in the initial design.
To be specific, you can filter and combine each transmitted channel number using a limited-band filter with the bandwidth of only 1.23 MHz. The band-limited filter of this type has great out-of-band attenuation, thus the space distance between the antennas of the CDMA system and GSM system must be shortened.
In addition, to minimize the interference, you must keep suitable isolation between the antennas of the CDMA system and GSM system.
The antenna isolation is calculated according to the following two formulas, which has been introduced earlier:
For vertical arrangement, $Lv = 28 + 40lg (k/\lambda)$ (dB)
For horizontal arrangement, $Lv =22 + 20lg (d/\lambda) – (G1+G2) – (S1 + S2)$ (dB)
According to the two formulas, the requirements on the isolation between the antennas of CDMA system and GSM 900 MHz system are specified in the following three circumstances.
The antennas of the CDAM system and GSM 900MHz system do not share the same address, with the antennas horizontally opposite to each other, or the antennas of the two systems share the same

address, with the antenna type of omni antenna.
Suppose the effective gains of the antennas of the two systems in the maximum radiation direction are 10 dBi (with the feeder loss considered), and the interference signals are 890MHz, according to previous analysis, the isolation between the CDMA system and GSM system is required at least 57dB.
Therefore, the following equation can be obtained according to the previous formula:
$57 = 22 + 20\lg (Dh/\lambda) – (10 + 10)$
The antennas of the CDMA and GSM 900 MHz system share the same address (the antennas are installed on the same platform and horizontally separated), with the antenna type of directional antenna.
Suppose that the two antennas are horizontally placed, and their tilt angle is 65°, and that the effective gains of the two antennas in the radiation direction are 15dBi.
And if the side lobe of the 65°antenna is -18dB in the horizontal plane, the effective gain of the antenna in this direction is (15 – 18) dBi = -3 dBi.
Therefore, $57=222+0\lg (Dh/\lambda) - \{(15+15) + [(-18) + (-18)]\}$.
According to the previous equation, the horizontal distance between the two antennas are d = 9.5m.
The antennas of the CDMA and GSM 900 MHz antennas share the same address (the antennas are not installed on the same platforms of the iron tower and vertically separated), with the antenna types of directional antenna and omni antenna.
In this case, the equation $57=28 + 40 \lg (k/\lambda)$ is present.
According to this equation, the vertical distance between the two antennas is d = 1.8m.
& Note:
The previous descriptions are just theoretical detections. In actual networking, other types of antennas may be installed at the same address. In this case, some equipment indexes must be considered, among which the important ones are spurious radiation, the interference power of the interfering signals to interfered signals, and the antenna isolation.
IV. Installation distance between antennas
Diversity technology is the most anti-fading effective. When two signals are irrelevant to each other, the horizontal distance between the diversity antennas must be 0.11 times that of the valid antenna height. The higher place the antenna is installed, the larger the horizontal distance between diversity antennas is. When the distance between diversity antennas is equal to or greater than 6m, however, the antenna is hard to be installed on an iron tower.
In addition, the distance required by vertical diversity antennas is 5 to 6 times that of the horizontal diversity antennas when the same coverage is ensured. Therefore, the vertical diversity antenna is seldom used in actual projects, but antennas are often vertically installed to meet isolation requirement, especially omni antennas are vertically installed.
In addition, for highroad coverage, the line connecting two receiving antennas must be perpendicular to the highroad. If space diversity is used, the diversity distance is the perpendicular. Isolation requirement: Tx-Tx, Tx - Rx: 30 dB

The installation for GSM 900MHz and GSM 1800MHz antennas is flexible, but no matter what specifications are used, they must meet the requirements on isolation and distance. In addition, in actual projects, barriers are present between antennas. For example, a tower is always present between two omni antennas, so you must shorten the horizontal distance between them.

V. Design of base station parameters in residential areas
A large number of residential areas are distributed in urban areas, so this section introduces the design of base station parameters in these areas.
(1) Features of residential areas

Building intensity
Great-intensity residential areas: the distance between buildings is within 10 meters.
Middle-intensity residential areas: the distance between buildings ranges from 10 to 20 meters.
Low-intensity residential areas: the distance between buildings is larger than 20 meters.
Construction material
The walls of the residential areas are constructed with concretes.
The walls of the residential areas are constructed with bricks and concretes.
The walls of the residential areas are constructed with hollow blocks.
Notes:
The thickness of the buildings varies with the regions and climates. Three specifications are available, namely, 24m, 47m, and 49m. Generally, the walls are thicker in southern parts and thinner in northern parts.

(2) Antenna installation in residential areas
The address where the antenna should be installed in residential areas is hard to be determined. Generally, when adopting micro cells, you can install the antenna within a residential area near to the target coverage area.
In this case, the antenna can be installed in the following spots:
On outer walls (not roofs) of a building
On pillars
Install a micro cell in underground garages
If the antenna is installed at a wall corner, the major lobe of the antenna can radiate the space between buildings. Generally, the major lobe of the antenna cannot face the walls of the buildings nearby directly.
If frequencies are reusable among these micro cells, the directions of antennas must be consistent with each other. In addition, you can also use the cell splitter to enable a cell to coverage the areas in two directions. In this case, however, the frequency utilization ratio may decrease and extra power splitter will introduce loss of 3 dB.
For the residential areas with regular arrangement, the directional antennas whose horizontal beam width is 90° to 120° and vertical beam width is greater than 30° are recommended.
Under certain conditions, the micro cell antenna can be installed on the pillars within a residential area.
For the residential areas with irregular arrangement, the antenna can be installed on the walls of a building, so the reflected waves can coverage the walls of opposite buildings. In this case, the antennas whose horizontal beam width is greater than 120°and vertical beam width is greater than 30°are recommended.
(3) Antenna selection
When the walls of a building is selected as an installed position, you can use the build-in antenna of

the micro cell directly, or other antennas with small size. According to coverage features of residential areas, when selecting the specifications for the micro cell antennas to be used, you must consider the following factors:
Antenna gain
Horizontal beam width
Vertical beam width
Polarization mode
Visual effect (antenna size, shape, and weight)
The antenna gain is recommended less than 9 dBi for micro cell antennas. Because the coverage area of a micro cell antenna is small and the installed position is near to the coverage area, the antenna gain can be adjusted to a smaller value, especially if the gain of an antenna is greater than 10dBi, its size is large, which may cause opposition from residents.
The selection of the horizontal and vertical beam width for an antenna is related to radio environment. If a micro cell antenna is installed on a wall, the antenna height is lower than the average height of surrounded buildings. In this case, if both the indoor coverage of lower floors and higher floors can be assured, you must select the antennas with greater vertical beam width. According to the height of buildings, you can select the directional antennas whose vertical beam width ranges from 35°to 80°.
The selection of the horizontal beam width of the micro cell antenna and the installed position of the antenna are related to coverage target. In this case, you can select the directional antennas whose beam width ranges from 60° to 150°, or you can choose omni antennas or bi-directional antennas (8-shaped antennas).
Both vertical polarization antennas and dual polarization antennas can be selected for a micro cell. The coverage area of a micro cell in urban areas is small, so the diversity reception is unnecessary. In this case, a vertical polarization antenna can meet the coverage requirements in residential areas. As for the dual polarization antenna, however, it is expensive and large in size, so it is not recommended.
The visual effect must be emphasized for the micro cell antennas installed in residential areas. They must be small and moderate. In addition, they must be light for installation convenience. If the contract between the color of the antenna and that of the surrounded buildings is great, you must color the antenna with the same color of the buildings.

In some cases, you should consider adopting dual-band antennas. When selecting a small-sized antenna, you should consider whether its maximum output power can bear the micro cell output power. When adopting short jumpers instead of 7/8 feeders, you should consider whether the antenna connector (N-shaped male/female, 7/16 DIN header) matches the jumper connector.
Автор: ourdot на 23:22

0 коммент.:

Отправить комментарий

Подпись комментария: Выбрать профиль...

Отправить комментарий Просмотр