2G, 3G Network Planning and Optimization...

Archives

пятница, 4 сентября 2009 г.

2.10 Design of Indoor Coverage System

2.10.1 Characteristics of Indoor coverage

With the rapid development of economy, hotels, commercial centers, large-scale flats, underground railways, and underground parking areas are arising by batch. As a result, mobile stations are more frequently used in indoor environment. Thus, they require better indoor mobile communication services.
Generally, the following problems are present in indoor mobile communication systems:
From the perspective of coverage, the complex indoor structure and the shielding and absorbing effect of the buildings cause great radio wave transmission loss. As a result, the signals in some areas may be weak, especially the signals in the first and second floors in the underground are quite weak, or even there are dead zones. In this case, mobile stations cannot necessarily access the network, there is no paging response, or subscribers are not in service areas.
From the perspective of network quality, the factors interfering radio frequencies are probably present in upper floors of high buildings. In this case, the signals in service areas are not stable, so “ping pong effect” may occur and conversation quality cannot be ensured.
From the perspective of network capacity, if mobile stations are frequently used in buildings, such as large-scale shopping centers, conference halls, some areas in the network cannot meet the requirements of subscribers. In this case, congestion may occur on radio channels.
If the indoor coverage is realized by a repeater, an outdoor high-power base station, or a great-height outdoor antenna, the following problems may arise:
The penetration loss is great, so the indoor coverage is not satisfying. In this case, a large number of dead zones are present, so subscribers cannot keep conversation.
If a repeater is adopted, the level of original signals must be high. In addition, the cross-modulation and intra-frequency interference is great, so the conversation quality is weak and call drop ratio is high.
The network capacity is limited and the call connected ratio is low.
The frequency planning is hard to be performed for the network and the network capacity is hard to be expanded.
The “detached island effect” is great.
The value-added services are restricted for group subscribers due to network quality and capacity.
To enhance the grade of service, we must improve indoor coverage immediately. When designing an indoor coverage system, we must make the following considerations:
A new indoor coverage system cannot affect the existing network.
Enough capacity of an indoor system must be ensured.
An indoor system must support new services and functions.
The chapter analyzes the design of indoor coverage system from the following aspects:
Indoor Antenna System Design
Capacity Analysis and Design
Frequency Planning
Traffic Control

2.10.2 Indoor Antenna System Design

I. RF design
(1) Link budget
In an indoor coverage system, the link budget formula is as follows:
Here,
Pant = antenna input interface power
RFmarg = Raleigh fading margin
IFmarg = access margin (depends on environment)
LNFmarg = design margin (generally, it is 5 dB)
BL = body loss (900MHz: 5 dB; 1800/1900MHz: 3 dB)
MSsens = mobile station sensitivity
Lpath = path loss
Here, Lpath = 20logd (m) + 30logf (MHz) - 28 dB + α. When there no barrier loss, Lp = 20logd (m) + 30logf (MHz) - 28 dB. The “α” indicates the loss caused by other bariers.
Because the penetration in cylindrical tunnels is great, leaky cables are applied in cylindrical tunnels.

When performing link budget, you must consider the followings:
In an indoor multi-antenna system, the link budget for test points must be in accordance with the link with the minimum loss.
Under the same converge area, the EIRP at each antenna interface must be consistent, and the error must be controlled within 10 dB.
The uplink signal must be designed to a high value, so antenna diversity is unnecessary.
To reduce uplink interference, you must properly set the maximum transit power of the mobile station and enable the power control function of the mobile station.
A certain margin must be leaved for error correction and future system expansion.
The estimation and design for interference margin vary with the distance from the outer wall. The smaller the distance, the larger the interference margin is designed.
(2) Service quality design (interference degree)
The actual interference level changes with network layout and frequency re-planning, and it can be tested according to actual situations.
(3) Service quality design (interference margin design)
The greater the interference in an area, the greater the interference margin (IFmarg) is designed, and the

higher the level the mobile station needs to receive.
When a dual-band system is adopted in the indoor environment, the indexes of mobile station receiving level are designed according to the 1800 MHz system standard.

II. Antenna system design
When designing an indoor distribution system, you must first survey the building type, structure, interference environment, customers, and then analyze the path loss. Finally, decide the antenna type, number, and installation location according to the requirements of an area.
This section introduces the antenna design guidelines in some typical cases.
(1) Single cell
If the indoor coverage is realized by a signal cell, each antenna must be designed to ensure that signals are evenly distributed in the coverage area. Generally, it is recommended to install the antenna in a zigzag way.
(2) Multi-cells
If the indoor coverage is realized by multiple cells, a certain distance must be leaved between intra-frequency reuse cells. Each antenna must also be designed to ensure that signals are evenly distributed in the coverage area of each cell. If the frequencies are reused frequently, it is recommended to install the antennas on different layers at the same position of the layer.(3) Closed building
A closed building has the characteristics, such as thick outer wall, great signal attenuation, and little leakage. In addition, it is little affected by outdoor intra-frequency cells. Therefore, the frequency between floors is easily to be planned. For the antenna design guideline in a closed environment.
(4) Half-open environment
For a half-open building, the outer wall is made of glasses, so the signal attenuation is small. Within the building are the open conference halls, which are greatly affected by outdoor intra-frequency cells, so you must plan dedicated frequencies or adopt the multi-antenna system with low output power to limit the edges of the indoor cells within the building.
(5) Frame-structure building
For a frame-structure building, the number of internal walls is large and they are thick. Therefore, if the antenna is installed at the corridors, the antenna output power must be high so that good coverage can be ensured. In this case, signals will leak at the windows near the corridor, so you must plan dedicated frequencies for the building. The distance of the intra-frequency cells between floors is larger than that in other environments. For the antenna design guideline in frame-structure building.
(6) Office building
The indoor environment of office buildings requires high grade of services, so its coverage is realized by several directional and omni antennas. You can control the coverage area easily through properly designing the effective radiation power in the cell. For design guideline, see (7) Parking area
Parking area has no special requirement on capacity and mobile station receiving level (-90 dBm). For a parking area, the elevator, escalator, entrance and exit are key coverage areas.
(8) Supermarket
Supermarkets have certain requirements on coverage and capacity. The antennas can be designed according to actual structure of the buildings.
III. Survey
The antenna design and installation is finally decided according to the survey, which includes the following aspects:
Detailed coverage area and signal quality and converge requirements
Distribution of the signals in coverage areas
Composition of buildings in coverage areas
Signal access location and mode
Installation position
According to the survey, you must output the final topological structure diagram, antenna cabling scheme, and list of materials. Generally, the omni antenna is installed at the ceiling center. The small directional antenna is hung on the inner side of the outer wall, with the radiation directed to indoor part. In this case, the effect of the antenna against the outdoor system can be reduced to the minimum, so the C/I requirement of the outdoor system can be met.
If possible, you can test the coverage and adjust the antenna design according to the test result, or re-plan the frequency to ensure the voice quality. Generally, if the radiation power at the antenna interface is 10 dBm, the 2 dBi small indoor omni antenna is used. In this case, if the walls are densely distributed in the areas within 30 meters from the antenna, the coverage level can reach -70 dBm.

2.10.3 Capacity Analysis and Design

Before analyzing the capacity, you must define the type of the indoor service area.

Definition of indoor service area type

Indoor service area type
Characteristic
Example
Public service area
The traffic is hard to be predicted.
The population number varies with day and night.
The capacity characteristics, such as uneven distribution and bursting must be considered.
The grade of service and the traffic of each subscriber are similar to that for outdoor cells.
Airport, shopping center, and play ground.
Commercial service area
The existed fixed networks are frequently used.
The traffic is relatively fixed and easy to be calculated.
High service quality is required.
Generally, the grade of service (GoS) is 1%, the traffic of each subscriber can reach 0.1 Erl.
Office building and commercial hotels of high ranks.

There are two cell organization modes of distributed antenna system, namely, single cell and multiple vertical split cells. The single cell is applied to the indoor environment which requires smell coverage area. The multiple vertical split cells are applied to the indoor environment with dense traffic.
Likewise, a single cell will split when the capacity does not meet the requirement, with vertical splitting the splitting mode. Generally, a cell will vertically split into at least three cells so that frequency reuse can be ensured. Four layers must be present between two intra-frequency cells . To avoid interference between frequencies, you must take measures to prevent a cell from horizontally splitting.

2.10.4 Frequency Planning

If the dedicated frequency is adopted in indoors, the frequency planning is relatively simple. Generally, the frequency reuse mode in business service areas is almost the same as that in pubic service areas. If the frequency resource is adequate, you must try best to use dedicated band for indoor coverage. If not, you can search the available channel numbers with relatively small interference through scanning the channel numbers. If the frequency resources of the 900 MHz cannot meet requirements, you can introduce the 1800 MHz frequency; namely, use a dual-band system.
If you steal frequency resource for indoor system due to no available dedicated frequency, you must pay attention to the followings:
Do not select the frequencies of the neighbor cells.
Ensure that the BCCH frequencies are not interfered.
The interference on the TCH frequencies can be reduced with the help of radio frequency hopping.
Search the available uplink frequencies through using BTS equipments to scanning the uplink channel numbers.
Search the available downlink frequencies through using drive test equipment to scanning the downlink channel numbers.
If the hierarchical cell structure is not used, the cell with the strongest signal level is the service cell, and the interference from neighbor frequencies can be neglected.
If the hierarchical cell structure is used, the cell with the strongest signal level cannot necessarily be the service cell, so you must take measures to reduce the interference from neighbor frequencies.
Because the environment is urban areas is quite complicated, especially the effect of the antenna back lobe is present, the service areas for high buildings are greatly interfered, so you must carefully plan the frequencies for the indoor coverage of high buildings. Generally, for the lower floors, you can plan the frequencies according to general method. For the higher floors where the interference is strong, you can use dedicated channel numbers. However, the final frequency planning must be based on practical tests.

2.10.5 Traffic Control

The indoor coverage system for high buildings can be taken as a system independent of outdoor systems if the coverage of the indoor system is good. Theoretically, you can only consider the cell selection and reselection, handover relationship, and the compact on outdoor networks at the entrances and exits of the building.
However, the actual conditions are quite complicated. For example, the signals outside of the building may be strong. In this case, if a mobile station is powered off, it may camp on an outside cell. Therefore, when optimizing the network, you must set the one-way adjacent cell and two-way adjacent cell according to actual conditions and set the parameters, such as CRO and TO to a proper value according to the regularity of cell selection and reselection. In addition, you can set the indoor cells to a high priority so as to reserve more traffic. And the inter-layer handover threshold and hysteresis are defined and adjusted according to actual conditions.
Автор: ourdot на 0:03

0 коммент.:

Отправить комментарий

Подпись комментария: Выбрать профиль...

Отправить комментарий Просмотр