Optimization of LTE Network Coverage

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Abstract: The trend of mobile, broadband and IP is becoming more and more prominent. Mobile communication technology is now in a critical period in the evolution of network technology. As such, LTE (Long Term Evolution) comes to light. LTE serves as a unified standard for the new generation of mobile communications, equipped with high spectral efficiency, high peak rate, high mobility, flat network architecture and other advantages. Huawei has played a very important role in the commercialization of LTE. As a sponsor of NGMN, Huawei has been actively involved in the research of some key projects of NGMN, such as network self-optimization, system architecture and Network performance evaluation and so on. This paper mainly introduces the problems encountered in the optimization of LTE network coverage, the practical problems encountered by the LTE project team in Qingdao and the analysis and solutions to the problems. At the same time, this paper discusses in detail on the LTE network optimization process.

Key words: LTE; network optimization; 4G; road test coverage

1 Introduction

1.1 Topic background:

With the rapid development of mobile communication technology and the increasing demand for wireless businesses, higher data transmission rate, providing more services and higher system stability have become the direction in the development of mobile communication system. LSTI is the 3GPP LTE / SAE test alliance, which in full known as Long Term Evolution / System Architecture Evolution Trial Initiative. The LSTI Alliance is the most important organization in the LTE industry today. It was established in May 2007 by several telecom equipment manufacturers and telecom operators, which include Alcatel-Lucent, Ericsson, France Telecom / Orange, Nokia, Nokia Siemens Networks, Nortel Networks, T-Mobile and Vodafone, mostly pan-European manufacturers.

The LTE / SAE Test Alliance is committed to validating LTE capabilities to drive the required performance to deliver a true broadband experience on mobile devices. The validation process is divided into three main phases: concept verification, interoperability verification, and testing. Prior to 2010, the alliance will continue to release the results of the joint test results and reports, and plans to deploy the initial LTE system in 2010.

Network optimization targets to resolve issues such as poor coverage, poor voice quality, dropped calls, network congestion, poor switching success rate and low data performance, in order to achieve the best operation conditions. Secondly, it targets to optimize the allocation of resources, to conduct rational deployment and use of the resources to the entire network to meet the needs and development of the situation to maximize its potential, so as to obtain the greatest investment efficiency.

1.2 Research Objectives:

This paper is mainly based on the early stages of LTE network optimization work in Qingdao. It is based on the analysis of PING delay, CSFB, downloading and uploading parameters, to identify the root cause of problems and conducting corresponding measures.

1.3 Research content:

This paper expatiates on the basic principles of the system of LTE network, the advanced technology used in LTE, and introduces the professional software provided by Huawei Company in the network optimization work. Subsequently, from the engineering point of view, expatiates on a pre-commercial network optimization for a 4G network (LTE), the main problems faced in the LTE network optimization process, performance analysis and solutions.

2 Introduction to LTE Principles

2.1 Overview of LTE systems

2.1.1 Overview

LTE design goals:

1. To maintain 3GPP technology and standards advantages in the field of mobile communications

2. To fill the technical gap between the third and fourth generation mobile communication system.
3. To maintain the wireless spectrum resources by using the allocated spectrum in the third generation mobile communication system.

4. To solve excessive concentration of patents in the third generation of mobile communication systems.

2.2 The two standards of LTE:

Frequency division duplex (FDD) and time division duplex (TDD). In FDD mode, the uploading and downloading of data uses two independent 5MHz carrier, while TDD mode only uses one 5MH carrier where the carrier is shared between uploading and downloading data through time. The TDD model is largely based on the concept and idea of the FDD model, which is intended to compensate for the disadvantages of the WCDMA system and for the ability to use those unpaired spectrums allocated by the ITU for IMT-2000.

LTE performance target is: peak rate: downlink peak 100Mbps, uplink peak 50Mbps

Delay: Control face Idle state (IDLE) -> Active state (ACTIVE) : <100ms

User face unidirectional transmission: <5ms

Mobility: 350 km / h (up to 500km / h in certain bands)

Spectrum flexibility: bandwidth from 1.4MHz ~ 20MHz (1.4, 3, 5, 10, 15, 20), support global 2G / 3G mainstream band and some new bands

2.3 LTE key technology: high-order modulation, AMC, HARQ

2.3.1 High-order modulation improves throughput:

PA3 Channel (64QAM vs 16QAM): Cell edge: 0% gain; Cell center: 0% to 10% gain; near base station: 30% to 50% gain.
PB3 Channel (64QAM vs 16QAM): Cell edge: 0% gain; Cell center: 0% gain; near base station: 10% to 20% gain

PA3 or PB3 is a protocol design for certain communication channel. PA is: Pedestrian A; PB is Pedestrian B; 3 refers to UE mobile speed 3km / h. PB3 has a longer delay than PA3 and has more interference.

2.3.2 Adaptive modulation and coding (AMC)

Channel quality information feedback, as known as Channel Quality Indicator (CQI)

The UE measures the channel quality and reports (for every 1 ms or longer) to the eNodeB (evolved from NodeB)

The eNodeB selects the modulation scheme, the size of the data block, and the data rate based on the CQI

2.3.3 HARQ:

HARQ has two operating modes:

(1) Chase or Soft Combining mode - the retransmission data is the same as the initial transmitted data;

(2) Incremental Redundancy mode – the retransmission data is different from the initial transmitted data. This latter mode is better than the first mode, but requires more memory at the receiver terminal. The default memory capacity of the terminal is determined based on the maximum data rate that the terminal can support and soft combination mode, so it is only possible to use a soft combination mode at maximum data rate. While in the use of lower data rates to transfer data, both modes can be used.

2.4 LTE / SAE network overall architecture

Reduced network nodes, reduced system complexity and transmission and wireless access latency; Reduced network deployment and maintenance costs

2.4.1 SAE basic network element:

MME:

Mobility management, session management, user authentication and key management, encryption and integrity protection for NAS
layer signaling, TA LIST management, P-GW, S-GW selection

S-GW:
Packet routing and forwarding functions, IP header compression, IDLE status endpoint, downlink data cache, E-nodeB switchover, user and bearer-based billing, routing optimization, and user roaming QoS and accounting policies

P-GW:
Packet routing and forwarding, ANCHOR function between 3GPP and non-3GPP, UE IP address assignment, gateway function for accessing external PDN

2.4.2 LTE multiple access mode:
LTE multiple access mode
Downlink Multiple Access OFDM:
Advantages of OFDM technology: high spectral efficiency, strong bandwidth expansion, anti-multipath fading, frequency domain scheduling and self-adaptation, relatively simple to achieve MIMO technology
Disadvantages of OFDM technology:
High peak-to-average ratio, sensitive to frequency offset, more multiple access and interference suppression

MIMO technology:
General definition: Multiple-Input Multiple-Output
Multiple inputs and multiple outputs can come from multiple data streams, or from multiple versions of a data stream.
According to this definition, a variety of multi-antenna technology can be counted as MIMO technology
Narrow definition: multi-stream MIMO – increased peak rate
Multiple signal streams are transmitted in parallel in the air
According to this definition, only spatial multiplexing and space division multiple access can be counted as MIM

From the effects of MIMO classification:
Transmit Diversity
The use of large spacing between the antenna elements or the unrelated beamforming to transmit or receive a data stream, to avoid the effects to the entire link when of a single channel breaks down.

Beamforming
Using the correlation between antenna elements of smaller spacing, interference is formed between the waves emitted by the element, concentrating energy in a certain (or some) specific direction to form a beam, resulting in greater coverage and interference suppression.

Spatial Multiplexing
The use of large spacing between the antenna elements or the unrelated beamforming, to transmit multiple data streams to a terminal/base station to increase the link capacity (peak rate).

Space Division Multiple Access (SDMA)
The use of large spacing between the antenna elements or the unrelated beamforming, to transmit multiple data streams to multiple terminal/base station, or receive transmission streams from multiple terminal/base stations, to improve user capacity.

SON (self-organizing network)
Advantages: to achieve rapid networking, shorten network planning time, simplify network maintenance and adjustment, reduce technical requirements of maintenance personnel
Self-configuring: ANR (Automatic Neighbor Relation), MRO (Mobility Robustness Optimization)
ANR - Automatic Neighbor Relation
The neighbor is automatically configured by the measurement report of the UE. When the network topology changes, the neighbor list is dynamically adjusted.

MRO - Mobility Robustness Optimization

Function: through the identification and statistical analysis of different switching conditions, according to the abnormal switching statistics to optimize the switching parameters to improve network performance

Common exception switches are as follows: ping-pong switch, switch too early, switch too late

2.4.3 LTE physical layer introduction:

Channel bandwidth:

Supported Channel Bandwidth: 1.4MHz, 3.0MHz, 5MHz, 10MHz, 15MHz, and 20MHz

The channel bandwidth of the uplink and downlink of the LTE system may be different, the downlink channel bandwidth is broadcasted by the primary broadcast information (MIB), and the uplink channel bandwidth is broadcasted by the system information (SIB)

Frame structure: FDD frame structure --- Frame structure type 1, suitable for FDD and H-FDD, a length of 10ms wireless frame by 10 length of 1ms sub-frame composition; each sub-frame by two lengths of 0.5ms of the time slot.

TDD frame structure --- frame structure type 2, for TDD

A radio frame with a length of 10 ms consists of two half frames of 5 ms in length, each consisting of five subframes of 1 ms in length

Conventional subframe: consists of two slots with a length of 0.5ms

Special subframe: composed of DwPTS, GP and UpPTS, support 5ms and 10ms DLUL switching point cycle

Physical resource concept

A PRB contains 7 (6) consecutive OFDM symbols in the time domain and contains 12 consecutive subcarriers in the frequency domain.

RE: 1 symbol X1 subcarrier, PRB size and downlink data to match the minimum load. The time domain of the PRB is one slot, which is 0.5 ms

2.4.4 Concept of physical resources

Resource unit group (REG): RE set in the control area for mapping downstream control channels, each REG containing 4 data RE

Control Channel Unit (CCE): 36RE, 9REG

2.4.4.1 Downlink Physical Channel:

Overview of Downlink Physical Channel function

Physical Downlink Control Channel (PDCCH): Use to indicate PDSCH-related transport formats, resource allocation, HARQ information, etc.

Physical Downlink Shared Channel (PDSCH): Transfer data block

Physical Broadcast Channel (PBCH): System information necessary to deliver the UE access system such as bandwidth, number of antennas, etc.

Physical Control Format Indicator Channel (PCFICH): Number of OFDM symbols for PDCCH in one subframe

Physical HARQ indicator channel (PHICH): for NodeB to feed back to the UE and PUSCH related ACK / NACK information

Physical Multicast Channel (PMCH): Passes MBMS-related data

2.4.5 Mobility Management

The Tracking Area is a newly established concept for the location management of the LTE / SAE system for the UE. Multiple TAs form a TA list and are assigned to a UE, and the UE does not need to perform a TA update when moving within the TA list. When the UE
enters a new TA area that is not in its registered TA list and the TA update needs to be performed, the MME reassigns a new TA list to the UE, and the newly assigned TA may also contain some of the TAs in the original TA list. Each cell belongs to only one TA.

2.4.6 LTE measurement

RSRP: Reference Signal Received Power (corresponding to TD-SCDMA / WCDMA of the RSCP), the received power of RS on each RB provides the cell RS signal strength metric. The LTE candidate cell is sorted according to RSRP as an input for switching and cell reselection.

RSSI: Received Signal Strength Indicator, total received bandwidth power observed by the UE for all signal sources.

RSRQ: Reference Signal Reception Quality (corresponding to Ec / No of WCDMA), RSRQ = N * RSRP / RSSI, N is the number of RBs of the RSSI measurement bandwidth, which reflects the quality of the RS signal. When the RSRP cannot provide enough information to perform reliable mobility management, the LTE candidate cell is sorted according to the RSRQ as an input for switching and cell reselection.

Mobility management

Mobility includes the mobility in the idle state and the mobility in the connected state.

1. Cell selection and reselection is considered the mobility in the idle state. Basically follow the principles of UMTS system, only modify the measurement attributes, cell selection / reselection criteria. The principle of PLMN selection is based on the UMTS PLMN selection principle.

2. Switching is considered the mobility in the connected state. Switching within the LTE system adopts the mode of network control and UE assistance.

3. LTE switching is considered backward switching: initiated by the source base station switching process, which is characterized by the source base station initiative to send the UE context to the target base station.

2.4.7 Cell selection

1. Cell selection time: boot station to the appropriate cell that began cell reselection

UE movement in the RRC_IDLE state

2. The principle of cell reselection: The UE enables the cell reselection process by measuring the attributes of the serving cell and the neighboring cell. The system information of the serving cell instructs the UE to search and measure the information of the neighboring cell.

The cell reselection criteria relate to the measurement of the serving cell and the neighboring cell. The cell reselection parameter can be applied to all UEs in the cell, but it is possible to configure a specific reselection parameter for a UE or UE group.

3. The connected state: connected state refers to ECM-CONNECTED state, its main features are as follows:

- There is a signaling connection between the UE and the network. The signaling connection includes RRC connection and S1-MME connection. The network knows the accuracy of the location of the UE as the cell level. The UE mobility management is controlled by the switching process. The S1 release process will move the UE from the ECM-CONNECTED state to the ECM-IDLE state.

4. The purpose of switching: based on the current network quality of service switching: the basic goal of switching

UE may communicate with a cell that is better in quality than the current serving cell channel and provide a continuous, uninterrupted communication service for the UE.

Switching of same and different frequency: switching based on current network coverage: the UE will lose the coverage of the current RAT, switch on different system, share the resource based on the current network load, the same/different frequency/ Different system switching

3 LTE Network Optimization Tool and Environment

3.1 Introduction to optimization tools

Genex Probe3.6 Series Software (2.3, 3.5, 3.6) Function Overview

GENEX Probe3.6 is an excellent performance of GSM / GPRS / EDGE, WCDMA / HSPA air interface testing tools for collecting wireless network air interface test data, assess network performance, guide the network to optimize the adjustment to help troubleshooting.

GENEX Probe combines the test user equipment (UE), the scanning device (Scanner) and the GPS (Global Positioning System) terminal, collects the wireless network air interface test data, mainly has the following function:

1. Support the mobility test in 4G wireless network environment, collect the wireless parameters of L1, and fully decode the air interface messages of L1, L2, L3 of GSM network (L2, L3), GPRS network, LTE network and HSDPA / HSUPA network.

2. Support CW continuous wave test, the data obtained by the geography of the average operation. Process the dissemination of
derived model data as the network planning software input.

3. Support multi-service concurrent test and set the test items.
4. Can save, export, merge and replay test data, reproduce the test process, and other background or network planning software to provide raw data.
5. Support automatic judgment of critical events, voice prompts, and other graphical interface prompt function.

3.1.2 Genex Assistant3.6 Function overview
Assistant is a good 4G field test background analysis software. By analyzing the field test data collected, users are able to:
1. Understand comprehensive network performance, identify network problems, optimize network quality;
2. Verify wireless network planning and optimize results.

3.1.3 Other auxiliary software: Mapinfo & Googleearth overview role in LTE optimization

<table>
<thead>
<tr>
<th>Np</th>
<th>Software</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mapinfo</td>
<td>digital display of map, making classified maps, regional division, test route description, site distribution production;</td>
</tr>
<tr>
<td>2</td>
<td>Googleearth</td>
<td>display of base station location and related site parameter information, surrounding environment display, altitude display;</td>
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4 Single Station Optimization of the LTE Wireless Network Optimization

China Unicom wireless network optimization work includes three parts, single station verification, cluster optimization and network optimization.

Engineering optimization content: Engineering optimization mainly conduct base station site verification, single station verification, cluster optimization and network optimization.

Grand station verification mainly consider the base station hardware equipment verification, specific verification including BBU installation verification, RRU installation verification, cable installation verification, lightning protection box / power box installation verification. Surface verification will be a main verification.

Grand station and single station optimization

Single cell performance test items are as follows:

<table>
<thead>
<tr>
<th>Test Item</th>
<th>Test Content</th>
<th>Test Description</th>
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<tbody>
<tr>
<td>Single-user multi-point throughput and cell average throughput</td>
<td>Single-user multi-point throughput</td>
<td>Test Single-user multi-point throughput</td>
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<tr>
<td>Cell average throughput</td>
<td>Test cell average throughput</td>
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<tr>
<td>Single User Peak Throughput</td>
<td>Single User Peak Throughput</td>
<td>Test Single User Peak Throughput</td>
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<td>Single-user Ping packet delay</td>
<td>Single-user Ping packet delay</td>
<td>Test single-user in the good / medium / poor the ping packet delay</td>
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<tr>
<td>Single-user ping packet success rate</td>
<td>Test users in the good / medium / poor Ping packet success rate</td>
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<tr>
<td>Control plane delay</td>
<td>Access delay</td>
<td>Test user in the good / medium / poor the control surface access delay</td>
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<tr>
<td></td>
<td>Paging delay</td>
<td>Test user in good / medium / poor control plane paging delay</td>
</tr>
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</table>

Outdoor grand station coverage optimization goals:
RSRP: In the coverage area, the probability of TD-LTE wireless network coverage of RSRP > -105dBm should be greater than 95%
RSRQ: In the coverage area, the probability of TD-LTE wireless network coverage of RSRQ > -13.8dB should be greater than 95%
RS-CINR: In the coverage area, the probability of TD-LTE wireless network coverage of RSRQ > 0dB should be greater than 95%;
PDCCH SINR> -1.6dB, sampling probability greater than 95%
When the test antenna is placed on a car roof, the probability of RSRP> -95dBm should be greater than 95%
Other indicators regardless of the antenna being placed inside or outside the car is required to fulfill the above requirements
Coverage optimization tools are divided into coverage testing tools, analysis tools, and optimization tuning tools
Coverage test tool
In a single station or during cluster coverage optimization, CNT + LMT + UE is used in a IDLE or business status coverage test
In the development of area coverage optimization, a reverse coverage testing system is preferred, followed by the use of scanner, where the antenna is placed inside the car
To solve the four coverage problems
Coverage voids, weak coverage, cross-coverage, pilot pollution (or weak coverage and cross-coverage) have the following means:

1. Adjust the antenna down tilt angle; adjust the RS power; increase or decrease the antenna high; site relocation; add new site or RRU
2. Principle 1: First optimize RSRP, then optimize PDCCH SINR;
3. Principle 2: The two key tasks of coverage optimization: Eliminate weak coverage (to ensure RSRP coverage); Purify the switching tape to eliminate cross-coverage (to ensure PDCCH SINR coverage, switching tape to be as clear as possible, ensure as far as possible two adjacent cells to only switch once);
4. Principle 3: Prioritize the optimization of weak coverage, cross-coverage, then optimize pilot pollution;
5. Principle 4: Prioritize to adjustment of antenna down tilt angle, position, antenna height and moving stations, and finally consider adjusting the RS transmit power and lobe width;

Coverage optimization process:

1. Coverage road test preparation
   - Determine the test route, prepare the site information, prepare the required electronic map, determine the road test equipment and ensure software running normally
   - Confirm that there is no faulty site in the coverage test area
   - Conduct background verification test and ensure site neighborhood configuration, power parameters, switching parameters, reassignment parameters are correct, include all possible neighborhood area

2. Coverage road test
   - Possibly conduct both UE (UE can be in voice maintaining state) and scanner at the same time, to identify missing neighborhood area and analyze position problems to determine test routes, traverse all road that can be traveled by car, possibly place the antenna inside the car.

   Analysis of road test data
   - Analyze whether the RSRP and PDCCH SINR meet the requirements of the indicator. If it does not meet the requirement, identify the areas of the weak coverage (coverage voids and weak coverage), cross-coverage (cross area coverage and pilot pollution) according to the definition of previous coverage problems and judgment method to conduct preliminary solution and record into ‘Road Test Log and Parameter Adjustment Record’
     - Solve problems according to the prepared solution
     - After the problem is solved, conduct the coverage test. If the KPI is not satisfied, continue to analyze the problem and conduct road test adjustments until the coverage indicators meet the requirements before entering the business test optimization

   Road test optimization
   - In the road test optimization, focus on the coverage service area (PCI display map and the service area of the whole network cable map), prioritize to solve the problem of weak coverage area
     - For areas with pilot pollution, cross-coverage, and poor SINR, plan the coverage area of each cell, control and eliminate cross-coverage
     - After the weak coverage and cross coverage areas are resolved, return to the optimization process Step 1, follow the same steps for test comparison

3. Coverage problem and judgment method:
   - Coverage void
     - Coverage void is the area where there is no TD-LTE signal in the site.
     - UE terminal sensitivity is generally at -124dBm. Considering the sensitivity difference of the commercial and test terminal, set aside a margin of 5dB and the coverage void is defined as RSRP <= -119dBm
     - Using the UE test data: UE shows in areas where there is no network or RSRP less than -119dBm, the call rate is almost 0. From the RSRP data acquired from EU, in the CNT navigation Map, geographically display of RSRP road field strength distribution, according to RSRP color list to view the coverage void
     - Using reverse coverage test data: select NES in the CNA navigation bar Menu list and view the coverage void area covered by the PCCPCH RSCP color list
     - Using the scanner test data: select Scanner1 in the CNA navigation Menu list, according to RSRP colour list to view the coverage void, weak coverage and cross-coverage. Then return to optimization process Step 1, follow the same steps for test comparison.
     - Generally, coverage void is due to the planned site is yet to open, unreasonable site layout or new building construction. The best
solution is to increase the site or use RRU, followed by adjusting the surrounding base station's engineering parameters and power to solve the coverage void.

Weak coverage

Weak coverage generally refers that there is a signal, but the signal strength can not ensure that the network can be stable to meet the requirements of the KPI situation.

The area of RSRP <= 95dBm measured by the antenna outside the vehicle is defined as a weak coverage area. The region of RSRP <= 105dBm measured by the antenna in the vehicle is defined as a weak coverage area.

Using UE test data: the UE shows the network RSRP <=105dBm, but the fixed call rate is less than 90%. In the CNT, the area covered by the weak field is viewed according to the RSRP icon. The weak coverage area is generally accompanied by UE call failure, dropped calls, ping-pong switching and switching failures.

Using reverse coverage test data: select NES in the CNA navigation bar Menu list and view the area covered by the PCCPCH RSCP color list.

Using scanner test data: select Scanner1 in the CNA navigation bar Menu list and view the area covered by the weak field according to the RSRP color list.

Priority is given to reducing the antenna down tilt angle at the nearest base station in the weak coverage area, adjusting the antenna position, increasing the station or RRU, increasing the transmit power of the RS.

For tunnel areas, consider using RRU first.

Cross-coverage

When a cell signal appears in one or more areas, and the signal can become the main service provider, then it is known as the cross-coverage.

Using reverse coverage test data, road test data, scanner test data, in the CNA navigation bar Menu list select Scanner1, according to the RSRP color list to view weak coverage area.

First consider the signal strength to reduce the cross-signal, you can increase the tilt angle, adjust the position, reduce the transmission power and other means. When reducing the cross signal, it is necessary to pay attention to the change of the switching zone and coverage of the cell with other cells and avoid the switching and coverage performance of other areas.

When the coverage cannot be reduced, consider increasing the signal from the nearest cell and making it the dominant cell.

When above two methods failed, then consider the method of circumvention: single neighbors, adjacent neighbors.

5 Qingdao Unicom LTE Coverage Optimization

Qingdao Jimo Trade and Industry Bureau grand station coverage data analysis:

1. Jimo Trade and Industry Bureau grand station LTE test indicators

1 Download foreground test
Upload:

Background data:

Ping delay:

DT road map:
From the figure we can see the problems and solutions of the LTE optimization process:

1. As 3G network signal overlap and interact and before commercialization of LTE, 3G, 2G and 4G network switching will not cause a great impact to the users. However, upon our actual measurements, we are concern on the CSFB single-station verification process. We are required to focus on the UE receiving terminal delay time, record it and use as a preparation for later KPI optimization.

2. On the signal test process of the three LTE sectors, the interference between the sectors for the single station verification has brought a lot of difficulties especially on downloading. Other than locating good basis and trying to eliminating stations one by one, although it presents difficulty to the work, but it can guarantee the work quality and avoid repeated tests.

Case 2: Weak coverage & lack of neighboring relationship leading to dropped calls

This case occurs in Qingdao City Southern District. The situation is similar to that in case 2 and is due to the fact that the surrounding area is yet to open.

*Note: The red area in the figure is the area where the signal is poor. In the CQT test, the green area is the point with good signal.*
Red frames depict the sites which are yet to open in the region caused a relatively large coverage void. Figure 1 shows the poor coverage area which caused dropped calls. This region mainly uses communication terminal Wu Brigade-2 (PCI151), Chamshan road Fusin building-3 (PCI139), Huaiquan dynasty-3 (PCI134) and Tiantai Stadium-3 (PCI134) for network coverage. It is recommended to adjust the Chamshan road Fusin building 3 district to 290 degrees; Communication terminal Wu Brigade 2 district adjusted to 190 degrees; also to enhance the neighboring relation between the communication terminal of Chamshan road Fusin building-3 district, Wu Brigade 2 district and Tiantai stadium-2 district;

Case 3: Weak coverage lead to dropped calls

This case occurs in Qingdao City Southern District. Due to the unreasonable position of the original base station of the surrounding areas and taking into account the terrain and blockage of surrounding buildings, resulting in weak coverage and cause dropped calls.
signals; the signal quality is poor, resulting in dropped calls. The building density in this region is large, individual cell signal is blocked significantly. Taking into account that the south side of the area is the sea, non-targeted coverage area, antenna adjustment will not affect the quality of the surrounding network. To sum it up, it is recommended to adjust the position of People’s Liberation Army 91379 Force-2 (PCI206) and the Badaxia Police Station-3 (PCI356) to be covered along the road, and adjust the angle of the Post Office Equipment Station-2 (PCI161) to 180 degree, and adjust the down tilt angle by to 2 degrees;

Adjustment plan as shown:

Case 3 Antenna Adjustment Plan

Conclusion

This paper mainly introduces the principle of LTE and the problems and solutions in the optimization stage, and combines the progress of Qingdao Unicom LTE to carry on the detailed analysis to this research topic.

To sum it up, the main work and research of this paper are as follows: The first half of the paper describes the main principles of the LTE network. As it is an emerging new technology, the principles are introduced a little more in order to better understand the 4G technology. The second half of the paper describes in detail on the optimization of LTE coverage, weak coverage problems, single-station test problems, antenna adjustment plan, etc., combined with specific cases in Qingdao.

This article is based on my own ideas, improvement solutions, and has also received some good results. However, given my limited capability, I am unable to provide a comprehensive explanation of the optimization of the entire network which I hope to do so in the future. I have only participated in the early stages of coverage optimization, and have not participated in the later 3G and 4G switching optimization which therefore is not included in this article. I hope to have the opportunity of improve in the future. Hope to receive your comments, thank you.

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