# WCDMA Handover Problem analysis

## ISSUE 1.2
Handover includes soft handover (SHO), hard handover (HHO) and inter-RAT hard handover.

Handover failure is an important factor that influence the network performance. For example:
- Handover failure result in call drop
- Frequent handover waste network resources
- High soft handover ratio waste downlink capacity
Objectives

- Upon completion of this course, you will be able to:
  - Know handover problem analysis flow
  - Know some typical handover problems
Handover problem base on DT optimization flow

- DT (drive test) is important to network evaluation and optimization. The result from DT and KPI can reflect network performance
- Global DT can locate network problems, such as missing neighbor cells, overshoot, pilot pollution and so on
- The following sections describe the DT optimization flow about SHO, HHO, and inter-RAT handover
Handover problem base on DT optimization flow

- Handover performance benchmark

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SHO optimization flow base on DT

1. Inputting Analysis Data
   - Collect DT data, related signaling tracing, RNC CHR, and RNC MML scripts

2. Obtaining When and Where the Problem Occurs
   - In Drive test, record the SHO problem location, time and other related information
SHO optimization flow base on DT

3. Missing neighbor cell

- At the early network stage, usually most call drops are due to missing neighbor cells. To check missing intra-frequency neighbor cells, the following methods can be used:

  - Method 1
    - The Ec/Io recorded by UE is bad
    - The Ec/Io recorded by scanner is good
    - Best cell scramble from scanner is not in the neighbor cell list of measurement control

```
1. Get best Ec/Io from UE in AS
   /|
  /  |\       \ Other analysis flow
2. Compare with best Ec/Io from Scanner
   / |
  /  |\       \ Other analysis flow
3. Check the best cell SC from AS is in Measure control?
   / |
  /  |\       \ Other analysis flow
4. Missing Neighbor cells
```
SHO optimization flow base on DT

- Method 2
  - after call drop, UE set up a new connection with the network immediately in a new cell.
  - If the SC of the new cell is different from the one before call drop, missing neighbor cell could be a reason.
    - Then, check measurement control of source cell to confirm this problem
    - Also, can check the SC in detected set of UE before call drop

[Image: SHO optimization flow base on DT]
SHO optimization flow base on DT

4. Pilot pollution

- Pilot pollution definition: **Excessive strong pilots** exist at a point, but **no one** is strong enough to be a **dominant one**
  - "**Strong pilot**" is defined by RSCP. If $CPICH_{_RSCP} > Th_{RSCP_{AbsMin}}$, this pilot is a strong pilot.
  - "**Excessive**" is defined by the pilot number. If $CPICH_{_Number} > Th_{N}$, the pilots at a point are excessive.
  - "**no one** is strong enough to be a **dominant one**" means $(CPICH_{_RSCP_{ed}} - CPICH_{_RSCP_{Th_{Nyla}}}) < Th_{RSCP_{BasMin}}$. 


SHO optimization flow base on DT

4. Pilot pollution

Based on previous descriptions, pilot pollution exists if all the following conditions are met:

- The number of pilots satisfying $\text{CPICH \_RSCP} > \text{Th}_{\text{RSCP, average}}$ is more than $(\text{CPICH \_RSCP}_{1} - \text{CPICH \_RSCP}_{\text{Th}_{\text{RSCP, average}}}) < \text{Th}_{\text{RSCP, relative}}$

- Set $\text{Th}_{\text{RSCP, average}} = -95\text{dBm}$, $\text{Th}_{\alpha} = 3$, and $\text{Th}_{\text{RSCP, relative}} = 5\text{dB}$, the judgment standards for pilot pollution are:
  - The number of pilots satisfying $\text{CPICH \_RSCP} > -95\text{dBm}$ is larger than 3.
  - $(\text{CPICH \_RSCP}_{1} - \text{CPICH \_RSCP}_{\text{Th}_{\alpha}}) < 5\text{dB}$
SHO optimization flow base on DT

- 5. Improper Configuration of SHO Algorithm Parameters
  - Delayed handover
    - According to the signaling flow, the UE fails to receive “active set update” due to the following cause.
    - After UE reports measurement message, the Ec/Io of source cell signal decrease sharply.
    - When RNC send “active set update", UE already turned off the transmitter due to RL out-synchronization. UE cannot receive “active set update”

**According to the signaling flow, the UE reports the 1A or 1C measurement report of neighbor cells before call drop. After this the RNC receives the event and sends the active set update message, which the UE fails to receive**
SHO optimization flow base on DT

⇒ Ping-pong handover
  − Ping-pong handover includes the following two forms
  − The best server changes frequently.
    • Two or more cells alternate to be the best server. The RSCP of the best server is good, but the period for each cell to be the best server is short
  − No dominant cell.
    • All cells RSCP are almost same and good enough, but all cell Ec/Io are bad

According to the signaling flow, when a cell is deleted, the 1A event is immediately reported. Consequently the UE fails because it cannot receive the active set update command
SHO optimization flow base on DT

- 6. Re-performing drive test and locating problems
  - If the problem is not due to previous causes, perform DT again and collect DT data to provide more information
SHO optimization flow base on DT

- Adjustment and Implementation
  - For pilot pollution, the following method can be adopted
    - Adjust engineering parameters of antenna to get a dominant cell or handover problems caused by pilot pollution,
    - adjust engineering parameters of other antennas. So, signals from other antennas become weaker
    - Set up a new site to cover this area if conditions permit.
    - If the interference is from two sectors of the same NodeB, combine the two cells as one
SHO optimization flow base on DT

- Adjustment and Implementation
  - For delayed handover, the following method can be adopted
    - adjust antennas to expand the handover area
    - set the handover parameters of 1A event
    - increase CIO to enable handover to occur in advance
  - For Ping-pong handover, the following method can be adopted
    - Adjust the antenna to form a best server
    - Adjust 1B event parameter to make deleting cell from active set more difficult. For example, increase the 1B event threshold, or 1B hysteresis, or 1B delay trigger time
HHO optimization flow base on DT

1. Collecting analysis data
   - DT data,
   - related signaling tracing

2. Obtaining the call drop time and location information
HHO optimization flow base on DT

- 3. Checking neighbor cell list
  - This optimization flow of HHO is similar with that of SHO
- 4. HHO problems usually refer to delayed handover and Ping-pong handover
  - For Delayed HHO, the following solutions can be adopted
    - Increase the threshold for starting compression mode
    - Increase the CIO of two inter-frequency cells
    - Decrease the target frequency handover trigger threshold of inter-frequency coverage
  - For solving Ping-pong HHO, the method could be
    - Increasing HHO hysteresis and delay trigger time

This optimization flow of HHO is similar with that of SHO and the difference lies in parameter optimization. Confirming inter-frequency missing neighbor cell is similar to that of intra-frequency. When call drop occurs, the UE does not measure or report inter-frequency neighbor cells. After call drop, the UE re-camps on the inter-frequency neighbor cell.
HHO optimization flow based on DT

5. The intra-frequency HHO, the optimization is similar to inter-frequency HHO. The solution could be:

- Decrease the hysteresis and delay trigger time of 1D event to guarantee that the handover can be finished in time
Inter-RAT handover optimization flow based on DT

1. Collecting Analysis Data
   - DT data, related signaling tracing, etc.

2. Obtaining the time and location of call drop
   - record the location and time about the problem occurrence for further investigation

3. Incomplete configuration data?

4. Improper configuration algorithm parameters?

5. Re-perform CQT and find problems

6. Adjustment and implementation

7. Output optimization report
Inter-RAT handover optimization flow based on DT

- Inter-RAT handover problems analysis flow
  - Checking data configuration, especially on the following ones
    - GSM cell information in RNC.
    - GSM cell and LA information in MSC
    - WCDMA cell and LA information in BSS

Add location area cell information near 2G MSC to location area cell list of 3G MSC. The format of location area identity (LAI) is MCC + MNC + LAC. Select LAI as LAI type. Select Near VLR area as LAI class and add the corresponding 2G MSC/VLR number. The cell GCI format is: MCC + MNC + LAC + CI. Select GCI as LAI type. Select Near VLR area as LAI class and add the corresponding 2G MSC/VLR number

Add data of WCDMA neighbor cells on GSM BSS. The data includes:

downlink frequency
Primary scramble
Main indicator
MCC
LAC
RNC ID
CELL ID
Inter-RAT handover optimization flow based on DT

- If the data configuration is complete, the inter-RAT handover problems are due to delayed handover mainly. The following solution can be adopted:
  - Increasing CIO
  - Increasing the threshold for initiating and stopping compression mode
  - Increasing the threshold to hand over to GSM
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Handover problem base on traffic statistic optimization flow

- The traffic statistics is one of the most important data to evaluate a network performance
- The handover traffic statistics data includes RNC-oriented data which reflect the entire network performance, and cell-oriented data which can locate the network problems in cell level
- The analysis flow for SHO, HHO, inter-RAT handover, and HSDPA handover is similar, but the traffic statistics indicators are different
Handover problem base on traffic statistic optimization flow

- Fix handover performance benchmark

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<td>SHO cost</td>
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SHO optimization flow base on traffic statistic

- The SHO success rate is defined as below:

  \[
  \text{SHO success rate} = \frac{\text{SHO successful times}}{\text{SHO request times}}
  \]

- Check the SHO success rate of entire network and cell in busy hour.
- Sort the SHO (or softer handover) failure times of the cell by TOP N and locate the cells with TOP N failure times
- Check the specific causes for these SHO problems
- Perform DT to find the specific causes in the cells

. If they are not qualified, analyze the problematic cells in details
HHO optimization flow base on traffic statistic

- HHO traffic statistics includes outgoing HHO success rate and incoming HHO success rate:
  - **Outgoing HHO Success Rate** = Outgoing HHO Success Times / Outgoing HHO Times
  - **Incoming HHO Success Rate** = Incoming HHO Success Times / Incoming HHO Times
HHO optimization flow base on traffic statistic

- Inter-RAT handover success rate includes voice inter-RAT handover success rate and PS inter-RAT handover success rate

  ⇒ Voice Inter-RAT Outgoing Handover Success Rate = Voice Inter-RAT Outgoing Handover Success Times / Voice Inter-RAT Outgoing Handover Trial Times

  ⇒ PS Inter-RAT Outgoing Handover Success Rate = PS Inter-RAT Outgoing Handover Success Times / PS Inter-RAT Outgoing Handover Trial Times

  ⇒ PS Inter-RAT Terminating Handover Success Rate = PS Inter-RAT Terminating Handover Success Times / PS Inter-RAT Terminating Handover Trial Times
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Chapter 3 Handover problem analysis

3.1 SHO problem analysis

3.2 HHO problem analysis
SHO problem analysis

- Soft handover success rate is low
  - If the soft handover success rate is lower than 98%, it can be defined soft handover success rate is low
  - The reasons could be:
    - Coverage problem
    - Pilot pollution
    - Improper parameter
      - 1A, 1B, 1C, 1D
      - Time to trigger
      - CIO

If the traffic statistics is obviously lower than this value and has statistics significance (the soft handover times exceed certain value), it is judged that the soft handover success rate is low. The causes of low soft handover success rate include

The relative threshold decision algorithm is adopted, namely, the thresholds of 1A and 1B are too big; in this case, even cells with bad signal quality can be allowed to join the active set. RNC delivers the message “ACTIVESET UPDATE COMMAND” to command the UE to join this cell, but because the signals of this cell is too bad and fluctuate, the radio link setup fails, resulting in soft handover failure
SHO problem analysis

- High soft handover percentage
  - SHO percentage should be kept among 30-40%
  - The reasons for high soft handover percentage could be:
    - Coverage problems – overshoot
    - Improper parameters
      - Threshold for 1A, 1B
      - CIO
    - Improper planning method
      - High traffic in soft handover area

Normal soft handover ratio should be kept among 30-40%. If it is bigger than 50%, soft handover will occupy too many system resources, which will result in the reduced capacity and the decreased network performance. The possible causes of the too high soft handover ratio include:

**The overlapped coverage area is too big.**

In areas where NodeBs are in high density and the distances between sites are small, if the coverage range of a cell has not been under good control, the overlapped coverage area will probably be big, which make the handover range very large and the ratio too high. In this case, adjust antenna or power parameter control coverage range, reduce the soft handover ratio; however, caution should be taken to prevent coverage holes during the adjustment.
SHO problem analysis

- Call drop in soft handover
  - RF problem
    - Coverage problem
    - Pilot pollution
  - Missing neighbor cell
  - Improper parameters
    - Threshold for 1A and 1B
    - Time to trigger
    - CIO

SHO failure caused by call drop

The soft handover threshold is too high or the time-to-trigger setting is too big.

Namely, for the relative threshold decision algorithm, relative thresholds for 1A and 1B are too small, which makes it difficult to add the new cell into the active set; or the hysteresis or the time-to-trigger setting is too big – as a result, the soft handover event is not triggered until the UE is at a location in the original cell where the signal quality is very bad, or because the parameter "time-to-trigger" is too long that the soft handover is triggered too late, at that time the received signal quality of service cell becomes so weak that the call might drop before the target cell be added in the active set.

The soft handover area is too small

If the soft handover area is too small, the static UE is not influenced seriously; however, for the UEs that moves in high speed, call drop may occur because of the untimely handover. This is likely to occur in the freeway scenario. Optimization measures:

- Extend the coverage, and increase soft handover areas
- Increase the relative threshold
- Decrease the time-to-trigger or the hysteresis

Neighbor cells that misses to be configured

In this case, the neighbor cells cannot be added into the active set even if their signals are very strong; so they become the strong downlink interferences which results in call drop. This problem can be located and solved easily, but happens frequently in practice.
**SHO problem analysis**

- Imbalance in uplink and downlink coverage
  - External interference and pilot pollution may influence the planned uplink and downlink coverage
  
  ![Diagram](image)

  - Soft handover decision is based on the downlink CPICH channel quality. In this case, call drop may happen because uplink out of synchronization.

As shown in the figure above, the downlink coverage and uplink coverage of Cell A are not balanced: the downlink coverage (broken line) is larger than the uplink coverage (real line); while in Cell B, the downlink coverage and uplink coverage are balanced. Because the decision in the handover algorithm is carried out according to the downlink link quality, when a UE passes the handover zone from A to B, the downlink quality of the source cell keep good at the verge of uplink coverage, and handover is initiated too late, resulting in uplink link call drop.

If the uplink coverage is larger than the downlink coverage in Cell A, since soft handover has not been initiated in the handover zone, Cell B cannot be added into the active set; so it becomes strong interference which results in downlink call drop.
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Chapter 3 Handover problem analysis

3.1 SHO problem analysis

3.2 HHO problem analysis
HHO problem analysis

- Compress mode failure
  - Inter-frequency handover and inter-RAT handover
  - Without measurement report (2D) from UE
    - Improper threshold for compress mode
      - 2D
      - 2F
  - Without Physical channel reconfiguration complete (Compress mode)
    - Improper compress mode method
      - SF/2
      - Puncture
      - Higher layer scheduling
      - Not all UE can support these three compress modes, but all UE have to support the first one

consider the compressed mode measurement process. Check whether measurement control messages of 2D and 2F events are delivered, if not, check whether the inter-frequency handover algorithm switch is enabled and whether inter-frequency neighborhood is configured.

In case RNC has delivered 2D and 2F measurement controls, but the UE has not reported 2D event measurement yet, the possible reason is that the inter-frequency measurement start threshold is set too low, and the source cell has not triggered 2D event under the condition that the signal quality is bad if 2D and 2F events are frequently reported by turns, it shows that the difference between the start and stop thresholds is too small; because it takes a period of time to start the compressed mode, but the signal of the source cell stops the compressed mode measurement once it ascents a little, this makes that the inter-frequency measurement cannot be carried out timely. In this case, set 2F threshold higher, so as to ensure the implementation and report of the inter-frequency measurement.
HHO problem analysis

- Compress mode failure
  - Inter-frequency handover and inter-RAT handover
  - Ping-pong compress mode
    - Improper parameters
    - The difference between 2D and 2F is too small
HHO problem analysis

- No *Physical Channel Reconfiguration (HHO Indication)*
  - Inter-frequency hard handover and inter-RAT hard handover
    - Without *Physical channel reconfiguration (handover)* or *Handover from UTRAN to GSM*
      - Improper parameter
        - » 2B, 2C
        - » 3A, 3C

Normally, RNC will deliver a *RRC_PH_RECFG message* for the UE to start the compressed mode (Note: for inter-frequency hard handover, the first physical channel reconfiguration message is used to start the compressed mode measurement, not to start hard handover indication.). If the UE supports the compressed mode, it will send back a *RRC_PH_RECFG_CMP message*, and then RNC will deliver the measurement control for the UE’s periodic measurement to report the inter-frequency measurement value.

If the UE has reported numbers of measurement reports, but RNC does not deliver the handover indication “*RRC_PH_RECFG*”, check the inter-frequency measurement value in the report messages. The possible reason is that the inter-frequency hard handover threshold is set too high, but the signal of the target cell does not meet the requirements, which makes the handover decision cannot pass and the handover miss the occasion. In case the distance between sites is big, decrease appropriately the inter-frequency hard handover threshold.
HHO problem analysis

- No **Physical Channel Reconfiguration (HHO Indication)**
  - Intra-frequency hard handover is triggered by 1D event
    - If UE report 1D event
      * Check “intra-frequency hard handover algorithm switch”
      * Iur or lub interface setup link failure
    - If no 1D event report from UE
      * Check neighbor cell list
      * Improper 1D event parameter
      * Check the SC in source RNC and target RNC

In case the target cell did not trigger **1D event**,
check whether the target cell is in the neighbor cell list that is delivered by RNC

If not, the possible reason is that neighborhood has not been configured, check the intra-frequency neighbor cell configuration. If the scrambling code of the target cell is contained, the possible reason is that the signal of the target cell is too bad to trigger **1D event** to start intra-frequency hard handover, resulting in call drop; in this case, improve the coverage.

If the signal of the target cell is good enough to set up links, check whether the **hysteresis** value and **time-to-trigger** of **1D event** are set too big, which makes **1D event** cannot be triggered timely before the radio link with the source cell turns bad, resulting in call drop.
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WCDMA Handover Problems Analysis

HHO problem analysis

- Failure of receiving **Physical Channel Reconfiguration**
  - Improper parameters
    - Threshold, hysteresis or time-to-trigger
  - Increase “maximum downlink transmission power”

- Failure of receiving **Physical Channel Reconfiguration Complete**
  - Improve uplink coverage
  - Decrease uplink interference
  - Increase “maximum uplink transmission power” if possible

Through RNC signal tracing, we can find that the **RRC_PH_RECFG message** has been delivered, but in the drive test, we did not find that the UE has received the **RRC_PH_RECFG message**, so hard handover has not been started timely, resulting in call drop. The reason is: the physical channel reconfiguration message, as the hard handover indication, is delivered on the original channel, and when RNC delivers this message after time delay and handover decision, the down link of the source cell will become too bad, so the UE cannot receive the **RRC_PH_RECFG message** to implement handover, resulting in call drop. Here are two solutions:

**Target NodeB Having Not Received Reconfiguration Complete Message**

The physical channel reconfiguration complete message “**RRC_PH_RECFG_CMP**” is transmitted on the target cell channel. It has two cases here:

Through the UE signaling tracing, make sure that the UE has received the **RRC_PH_RECFG message** but did not send the complete message “**RRC_PH_RECFG_CMP**” back to RNC.

- **Reason**: the UE failed to synchronize with the target cell, which led to hard handover failure, resulting in call drop. Try to adjust the antenna or to increase the channel power of the target carrier, so as to enhance coverage; or heighten the hard handover decision threshold to ensure that hard handover is carried out successfully.

  Through signaling tracing, we find that the UE has been handed over and sent the **RRC_PH_RECFG_CMP message**, but RNC side has not received this message. This shows that problems exist in the backward links. Adjust the uplink power control parameter and increase the maximum uplink transmission power of relevant services, so as to increase the UE’s transmission power within the allowed range and improve the quality of the backward links.

consider the parameters, such as hard handover **threshold or hysteresis, time-to-trigger** and so on, and reduce them appropriately. This is equivalent to advancing the hard handover occasion, so that the UE can receive the hard handover indication message in time and complete the handover.

Increase the **downlink transmission power** of the source cell service channel to enhance the downlink coverage of the handover area, so as to ensure the quality of the down link.
HHO problem analysis

- Ping Pong Handover
  - Improper handover parameters
  - Increase handover decision threshold, but need to consider side-effect
  - Adjust transmission environment to decrease the signal fluctuation

In the handover area, because of the signal fluctuation, the UE will probably repeat handovers between the source cell and the target cell. For intra-frequency hard handover, since there are intra-frequency interferences, call drops are likely to occur; for inter-frequency hard handover, since the compressed mode inter-frequency measurement is required, ping pong handover will bring serious influence on the communication quality.

Two solutions can be considered:

- Adjust the parameters, such as **hard handover threshold**, or **hysteresis** and **time-to-trigger**. Heightening the hard handover trigger threshold, ping pong handover can be avoided, but we should be cautious when heightening it. Reason: heightening the parameters, such as the handover threshold, may cause that the handover cannot be implemented in time, resulting in handover failure or call drop.

- Adjust the coverage. Try the best to make the handover zone evade the environments where the terrains and clutters are complicated, so as to minimize the signal fluctuation.
HNO problem analysis

- Other Problems
  - UE capability
    - For example, some UE can not support intra-frequency hard handover
  - Equipment compatibility.
    - Especially when the hard handover need the corporation among different network element from different manufacture
  - Transmission problem
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Chapter 4 Handover problem cases

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4.2 HHO cases analysis
SHO case 1

- Description

⇒ DT data – signaling trace

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<th>Date/Time</th>
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</thead>
<tbody>
<tr>
<td>4619</td>
<td>2010-08-25 11:13:36:12:126</td>
<td>WCDMA/RRC</td>
<td>DL_DCCH</td>
<td>Activation Update Complete</td>
</tr>
<tr>
<td>4620</td>
<td>2010-08-25 11:13:36:12:256</td>
<td>WCDMA/RRC</td>
<td>DL_DCCH</td>
<td>Activation Update Complete</td>
</tr>
</tbody>
</table>

After call drop, begin to read system information

Call Drop
SHO case1

- Data analysis
  - Check cell information from UE active set and cell information from scanner at call drop points.

From UE

No SC 170 cell!!!
Why?

From Scanner

Data analysis

Active Set

<table>
<thead>
<tr>
<th>SC 170</th>
<th>RSCP</th>
<th>Ec/No</th>
<th>Iq</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-94.18</td>
<td>-11.59</td>
<td>82.87</td>
<td>10995</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SC 130</th>
<th>RSCP</th>
<th>Ec/No</th>
<th>Iq</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>102.13</td>
<td>18.47</td>
<td>82.57</td>
<td>10995</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SC 24</th>
<th>RSCP</th>
<th>Ec/No</th>
<th>Iq</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-93.30</td>
<td>0.43</td>
<td>82.87</td>
<td>10995</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SC 17B</th>
<th>RSCP</th>
<th>Ec/No</th>
<th>Iq</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>66.84</td>
<td>6.05</td>
<td>60.19</td>
<td>10995</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SC 6</th>
<th>RSCP</th>
<th>Ec/No</th>
<th>Iq</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>91.30</td>
<td>-1.02</td>
<td>-40.13</td>
<td>10992</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SC 24</th>
<th>RSCP</th>
<th>Ec/No</th>
<th>Iq</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-92.90</td>
<td>-11.83</td>
<td>80.19</td>
<td>10995</td>
</tr>
</tbody>
</table>
The cause might be missing neighbor cell or delayed handover. Check scrambles in UE active set. Following figure shows the scrambles in UE active set before call drop. No SC 170 cell exists in UE monitor set, because this is possibly due to missing neighbor cell.
SHO case1

- Data analysis

⇒ Check the latest measurement control

<table>
<thead>
<tr>
<th>Index</th>
<th>Case Time</th>
<th>Message Kind</th>
<th>Channel Type</th>
<th>Message Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>4996</td>
<td>2005-10-25 11:06:30</td>
<td>WCDMA BSC</td>
<td>UMTS-U1</td>
<td>Measurement Report</td>
</tr>
</tbody>
</table>

Search for the latest intra-frequency measurement control

Call drop point

Continue to check the neighbor cell list sent by RNC to UE before call drop, as shown in Follow figure. According to the latest measurement control before call drop, no SC 170 exists in the neighbor cell list, because the call drop is due to missing neighbor cell of SC 6 and SC 170.
SHO case1

Measurement ID is 1. It is Intra-frequency measurement control

Check the list of intra-frequency neighbor cell in measurement control and no SC 170

The primary scramble of the cell is 6
SHO case1

- Solution
  - Add neighbor cells in neighbor cell list

Because the RNC updates measurement control according to the best cell which is obtainable by searching for intra-frequency measurement report with 1D event before measurement control is sent. Usually they are configured to bi-directional neighbor cells.
SHO case 1

- If only UE recorded information during test, without scanner information, confirm that call drop is due to missing neighbor cell by using the following method:

  Confirm the scrambles of all cells in **active set** and the scrambles of cells in **monitor set** measured by UE before call drop.

  Compare the scramble information of the cell where the UE camps on after reselection after call drop and the scrambles in UE **active set** and **monitor set** before call drop. If the former scramble is not in the scramble list of active set and monitor set before call drop, the call drop is probably due to missing neighbor cell.

  Check the neighbor cell list

  **This applies for solving call drop due to missing neighbor cell on site**
SHO case2

- Description
  - Following figure shows the pilot pollution point near Yuxing Rd.
  - SC270 cell is suppose to cover the pilot pollution area.
SHO case2

- Data analysis

⇒ Following figure shows Best Service Cell near Yuxing Rd
SHO case 2

- Data analysis

Following figure shows the second best service cell near Yuxing Rd
SHO case2

- Data analysis
  - Analyzing signal distribution of cells near pilot pollution point
  - Following figure shows the third best service cell near Yuxing Rd
SHO case2

- Data analysis

Following figure shows the fourth best service cell near Yuxing Rd
SHO case2

- Data analysis

Composition of pilot pollution near Yuxing Rd

- Though SC270 cell is planned to cover the area, but the best Service Cell is as listed in table

<table>
<thead>
<tr>
<th>Best Service Cell</th>
<th>SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st best Service Cell</td>
<td>SC220</td>
</tr>
<tr>
<td>2nd best Service Cell</td>
<td>SC270</td>
</tr>
<tr>
<td>3rd best Service Cell</td>
<td>SC200</td>
</tr>
<tr>
<td>4th best Service Cell</td>
<td>SC200</td>
</tr>
</tbody>
</table>
SHO case2

- Analyzing RSSI and RSCP distribution near pilot pollution point

- As shown in left figure, the RSSI of the pilot pollution area is not large, about -100dBm to -90dBm.

- As shown in right figure, the RSCP of Best Service Cell is between -105dBm to -100dBm.

- The pilot pollution of the area is caused by no strong pilot signal.
SHO case2

- Following figure shows the RSCP of SC270 cell near Yuxing Rd

- The figure shows RSCP of RSCP distribution of SC270 cell. The signals from SC270 cell is weak in the pilot pollution area
SHO case2

- Solution
  - Adjust the azimuth of SC270 cell from 150° to 130° and the down tilt from 5° to 3°. This enhances the coverage of SC270 cell
- Confirm
  - After analysis of DT data, the area is dominated by SC 270. And the pilot pollution disappear

According to on-site survey, the residential area is densely distributed by 6-floor or 7-floor buildings. The test route fails to cover the major streets, and is performed in narrow streets with buildings around, so the signals are blocked. The suggestion is to adjust the azimuth of SC270 cell from 150° to 130° and the down tilt from 5° to 3° . This enhances the coverage of SC270 cell.

After analysis of DT data, the expected result after adjustment is that the coverage area by SC270 cell increases and the coverage is enhanced.

According to on-site survey, the residential area is densely distributed by 6-floor or 7-floor buildings. The test route fails to cover the major streets, and is performed in narrow streets with buildings around, so the signals are blocked. The suggestion is to adjust the azimuth of SC270 cell from 150° to 130° and the down tilt from 5° to 3° . This enhances the coverage of SC270 cell.

After analysis of DT data, the expected result after adjustment is that the coverage area by SC270 cell increases and the coverage is enhanced.
SHO case2

- Following figure shows the pilot pollution near Yuxing Rd. after optimization
SHO case3

- Description
  - Several call drops happened during RF optimization
  - From figure, the call drop place is at corner
SHO case3

- Data analysis

According to the following figure, the signals of active set scramble 104 and 168 decreased to -17 dB before the corner. But SC208 cell is very good, about -8 dB.
SHO case3

- Data analysis

⇒ the signaling trace from RNC shows that UE report the **1A event** for SC **208**. Then, RNC send **active set update**. But UE can not receive it.
SHO case3

- This is a typical case of corner effect, and the solution could be
  - Adjust 1A event parameter
    - Decrease time to trigger
    - Decrease the threshold
    - Side effect
  - Adjust CIO
    - Increase CIO of best cell
    - Side effect
  - RF optimization
    - Adjust antenna to avoid the signal fluctuation

Configure **1A event** parameter of a cell to enable handover to be triggered more easily.

If you lower the **triggering time** and **hysteresis**, you must configure the triggering time for a specified cell, because the change of the parameter might lead to easily occurrence of handover between the cell and other cells without turning corner effect, or frequent ping-pong handover.

Configure the **CIO** between two cells with turning corner effect to add the target cell more easily. The **CIO** only affects the handover between two cells, with less impact, however, it impacts handover. The configuration leads to an increase of handover ratio.

Adjust antenna to enable the antenna of target cell cover the turning corner. This helps avoid fast variance of signals, and avoid call drop.
SHO case3

- Conclusion
  - From DT, the typical phenomenon for corner effect can be shown as this figure
    ![Graph showing cell56 vs cell1041](image)
    - Source cell signal decrease sharply while target cell increase sharply. Therefore, call drop happens because UE cannot receive **active set update**.
SHO case4

- Needlepoint Effect

⇒ The needlepoint effect phenomenon
  - Best cell signal decrease sharply, then go back very soon
  - From signaling procedure, 1B event happen, then 1A event happen
  - This figure shows the signal fluctuation character of needlepoint effect

The needlepoint effect is that affected by the strong signals of target cell in a short time, the original cell attenuates sharply, and then increase. The variance of $\frac{E_c}{I_0}$ is shown in Following figure (the interval between two points is 0.5s)
SHO case4

- Needlepoint effect and corner effect
  - Needlepoint effect may not cause call drop
    - Needlepoint effect only lasts a very short time, and this duration may not long enough to trigger handover.
    - Cause QoS deteriorate
  - Corner effect cause call drop
    - Source cell signal can not recover

The **needlepoint effect** lasts for a short period, so call drop may not occur if QoS is lowered (for example, configure a greater retransmission times).

The **turning corner effect** causes an absolute call drop because the signals of original cell will not recover after turning corner.
SHO case4

- The needlepoint effect cause call drop in the following situations:
  - If needlepoint can not satisfy handover
    - call drop may not happen, but QoS deteriorate, like high BLER
    - High BLER cause TRB reset, then call drop
  - If needlepoint can satisfy handover
    - Source cell signal deteriorate, and UE can not receive active set update, then call drop
    - Second handover in needlepoint may cause call drop
      - After first handover, the source cell is deleted from active set. But, it will be add into active set immediately.

If the needlepoint lasts for a short period, unable to meet the handover conditions and to affect call drop, it will lead to deterioration of quality of service (QoS), such as over great BLER exists in downlink.

If handover occurs in the target cell, and the signals of the original cell is over weak, so the UE cannot receive active set update messages, and consequently call drop occurs.

If the needlepoint lasts for a short period, and the handover conditions are difficult to meet, so the signaling RB (SRB) or traffic RB (TRB) reset occurs due to weak downlink signals before handover. Finally, call drop occurs.

If the target cell completes handover, and becomes a cell in the active set, call drop occurs because the cell can exit the active set before completing a handover with the needlepoint disappearing quickly.
SHO case4

- Solution
  - RF optimization
    - Avoid source cell signal deteriorate sharply
  - Increase RLC retransmission time

Observe the **needlepoint effect** by scramble distribution diagram of the best cell recorded by Scanner. If two antennas cover two streets respectively, at the crossing point, needlepoint effect occurs easily.
4.1 SHO cases analysis
4.2 HHO cases analysis
HHO case1

- Description
  - When the UE moves to an inter-frequency cell, it fails to handover.
  - It camps on the inter-frequency cell after disconnection

- Analysis
  - From signaling procedure, it happened in compress mode.
  - UE did not trigger compress mode
  - Check [Measurement report](#).
  - 2D event and 2F event reporting indicator is Ec/Io
HHO case 1

- Pilot Ec/Io depends on:
  - CPICH RSCP strength
  - Downlink interference
  - The relation between Ec/Io can be represented as following figure:

![Graph showing the relation between Ec/Io and RSCP](image)

At the coverage edge of a carrier, when UE moves from the current cell to another cell, the CPICH RSCP attenuates at the same speed as the attenuation of interference (the background noise is not impacted by path loss, so the CPICH RSCP attenuates a little faster than interference attenuates. However, the difference between the two speeds is close (depending on the strength of background noise). Therefore the UE receives the signals the CPICH Ec/Io of which changes slowly. According to the simulation and on-site test, When the CPICH RSCP is about -110 dBm, the CPICH Ec/Io can reach about -12 dB.
HHO case1

- Solution
  - Change 2D and 2F event reporting indicators to RSCP
- Confirm
  - After adjustment, UE initiate compress mode successfully
- Conclusion
  - At center of carrier coverage, 2D and 2F event reporting indicators is Ec/Io
  - At edge of carrier coverage, 2D and 2F event reporting indicators is RSCP

If you take Ec/Io as the measurement quantity for 2D event, the 2D event will be triggered before call drop. Therefore adopting Ec/Io as the measurement quantity for 2D event will not trigger 2D event upon call drop of UE, so the inter-frequency measurement will not be started.

In this case, configure the cell to carrier coverage edge cell and take RSCP as the measurement quantity for 2D/2F event so that inter-frequency measurement is originated in time.
HHO case2

- Problem description
  - In an area between WCDMA network and GSM network, a CS inter-system handover can be done successfully, but a PS inter-system handover is failed.
  - The corresponding signaling procedure is given as below.
HHO case2

- CS handover procedure:
HHO case2

- PS handover procedure:
HHO case2

- Analysis
- Result
- Conclusion
Summary

- Handover problems analysis flow
- Typical handover problem case analysis
Thank You

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