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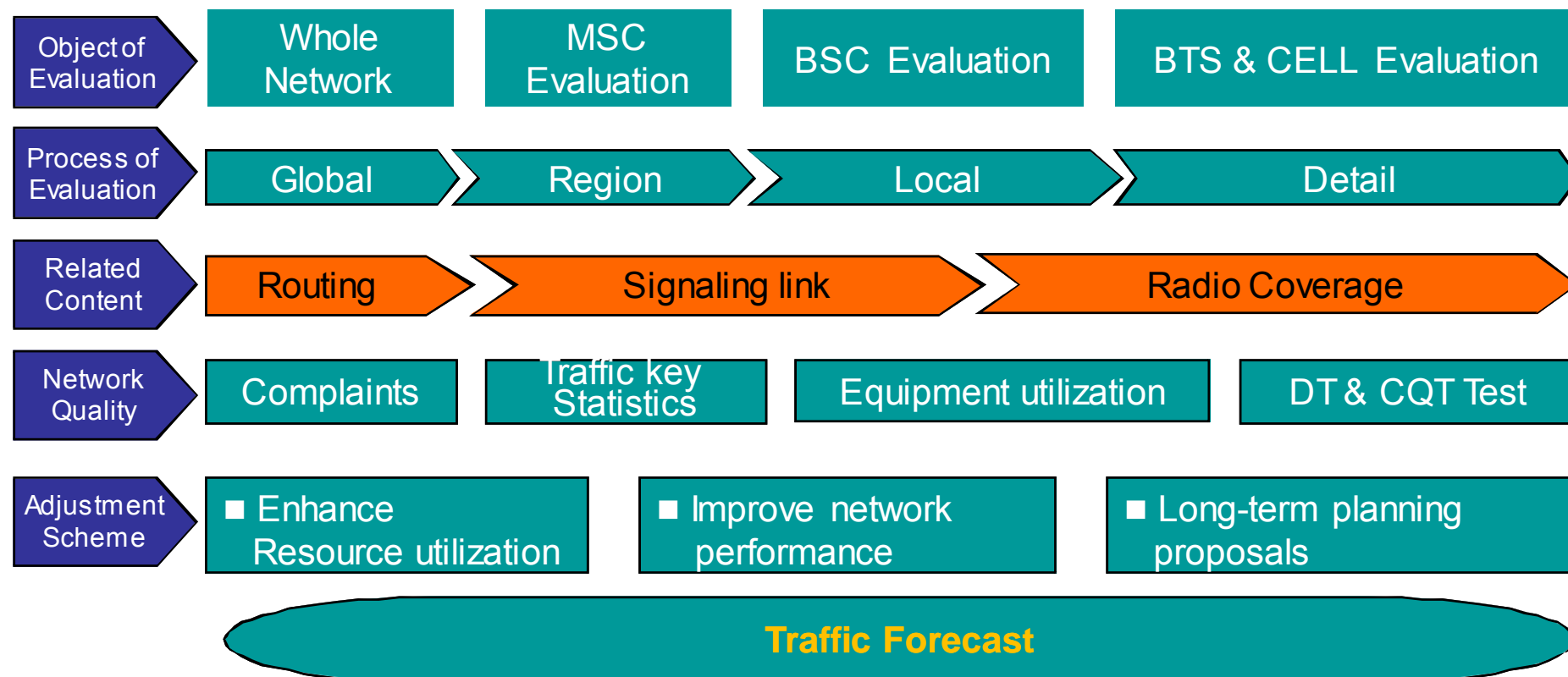
Mobile Network Evaluation

(for China Mobile in XinJiang Province)

Abstract

- Contents of Evaluation
- Evaluation & Consultation of Core Network
- Evaluation & Analysis of Radio Network

Main content of evaluation



- Meanwhile, we also perform some projects named “Audit” in China, as a third party, to examine the completed BTSs as a project supervision for acceptance.

- Contents of Evaluation
- **Evaluation & Consultation of Core Network**
- Evaluation & Analysis of Radio Network

Network structure

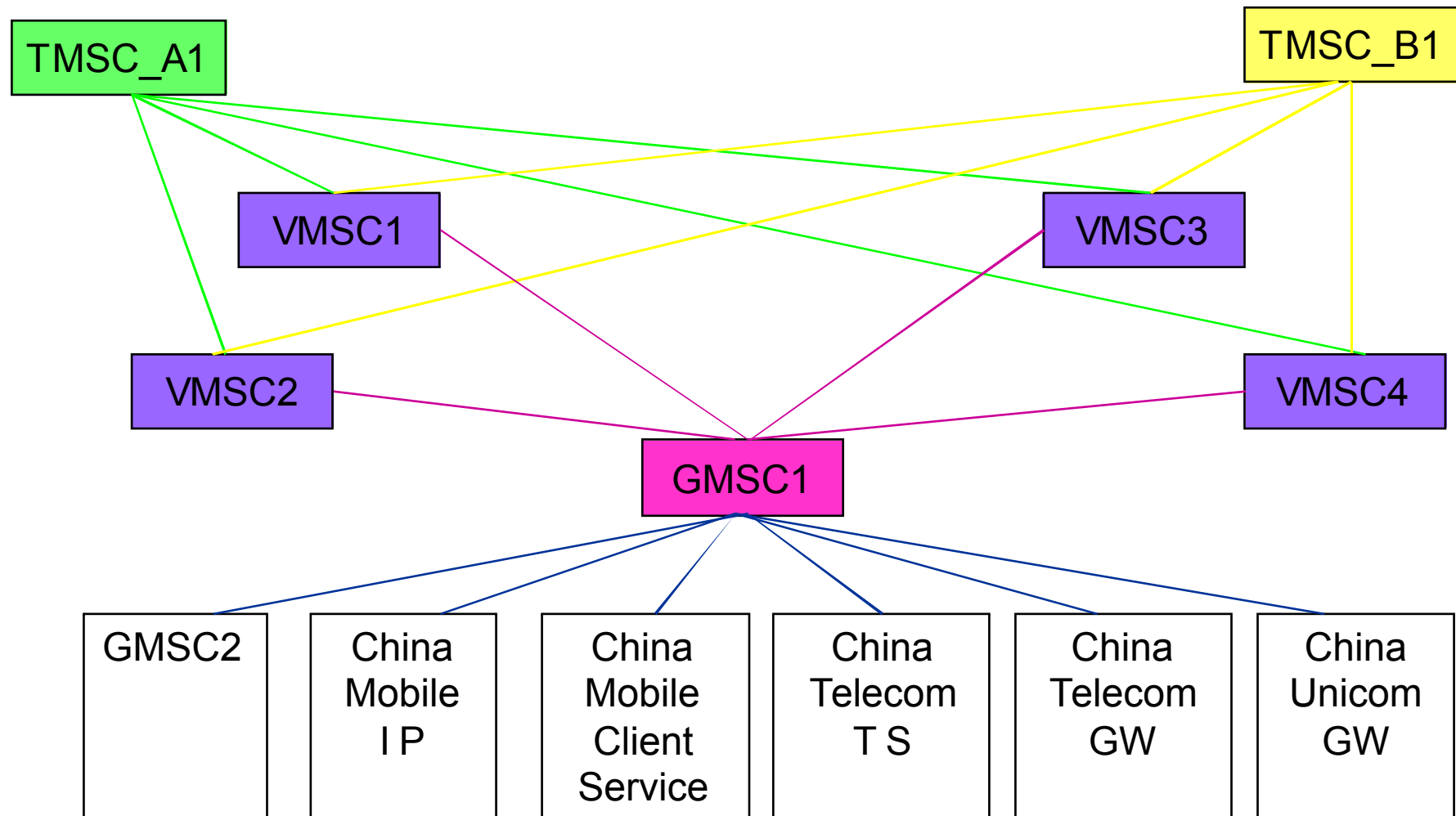
Generally, Voice Network may includes:

- TMSC_A (Inter-province Long-Distance Tandem Office)
- TMSC_B (Intra-province Long-Distance Tandem Office)
- GMSC (Local Gateway)
- VMSC (MSC articulated by BSC)
- Intelligent Network: SSP, SCP, SMP, SMAP , and etc.
- Direct Trunk Group is recommended in Local Network and High Traffic.

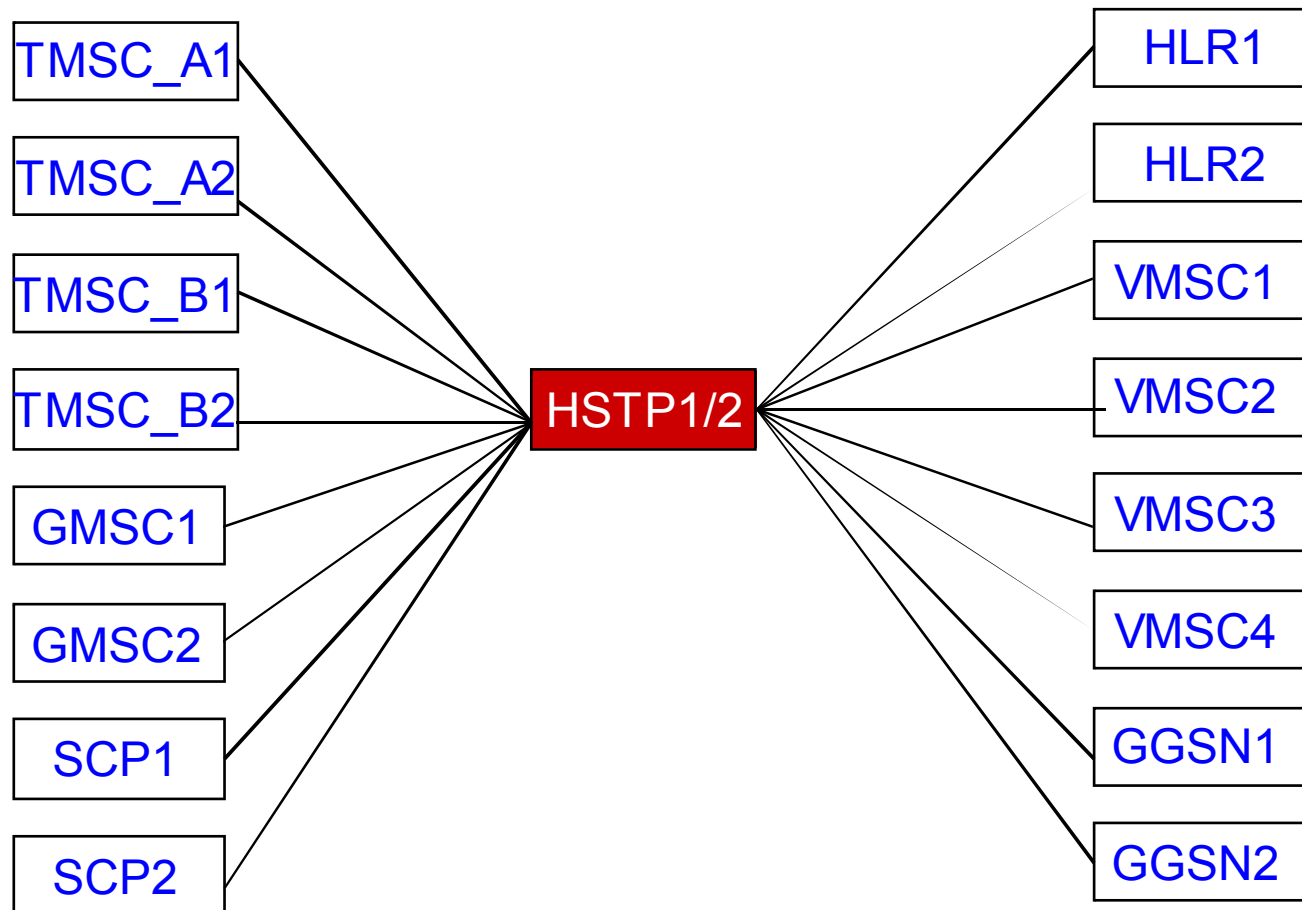
Signaling network may includes:

- HSTP
- LSTP
- Direct Signaling Link is recommended in Local Network and High Load of Signaling.

Schematic diagram of voice network connections



Schematic diagram of signaling network connections



Network element load

- Capacity
- Design Capacity and Present Network Load of HLR/VLR/SSP/STP
- CP Load
- CP Load of HLR/MSC/STP

Route organization

- Traffic Routing / Signaling Routing
- Network structure determines routing planning, and office data testing ensures if routing data is correct.
- Statistic analysis of trunk group, signaling and call setup success rate examine if present routing is smooth and effective.
- Signaling acquisition analysis deeply subdivide the reasons of call setup success rate and call loss among Exchange Offices.
- Whether route organization is reasonable.

Resource allocation

- Whether loads of each Trunk Group are congested, or overtime idle, or balanced.
- Whether loads of each Signaling Links are too high, or balanced.
- Whether loads of each Network Element are sufficient, or balanced.

Network quality of services

- Analysis of Long-distance incoming call setup success rate
- Analysis of Outgoing call setup success rate
- Analysis of Handover success ratio
- Analysis of Complaints
- Comprehensive analysis of radio-related indexes

System information acquisition

- Topology of system voice path
- Topology of system signaling
- Design capacity of HLR/VLR/SSP/MSC/STP
- Routing Planning of Traffic
- Routing Planning of Signaling

Examination of routing data

- Data Examination of Traffic Routing
- Data Examination of Signaling Routing
- Comparison between Present Routing and Routing Planning

Statistic data acquisition

- Statistic of MSC
- Statistic of VLR
- Statistic of CP Load
- Statistic of Trunk Group
- Statistic of Signaling Link
- Statistic of Cell Handover
- Statistic of Recorded Voice Announcement

Statistic data analysis

- Analysis of Network Element Capacity
- Analysis of CP Loads
- Analysis of Trunk Group Loads
- Analysis of Signaling Links Loads
- Analysis of Long-distance Incoming Call Setup Success Rate
- Analysis of Inter-Switch Handover Success Rate during the Busy Hour
- Analysis of Intra-Switch Handover Success Rate during the Busy Hour
- Analysis of Success Rate of Each Trunk Group

Analysis of signaling acquisition

- Acquisition Analysis of ISUP/BSSAP/MAP Signaling
- Analysis of Call Setup Success Rate based on Signaling
- Analysis of Call Loss based on Signaling
- It may subdivide into any Prefix

CDR analysis method based on signaling

- Analysis of statistical data is simple and feasible, but it cannot correspond to the detailed call records. So in depth analysis is not easy.
- CDR analysis based on signaling may remedy the defect.
- Signaling process of a call is similar to a detailed phone call records. The processing of signaling acquisition can gain CDR of some period.
- Based on CDR, we can take the following analysis and correspond to exact call.
- Overall Call Loss Distribution
- Overall Call Loss Distribution
- Timer analysis
- Utilizing the methods such as Call Quality Test to assist problems positioning..

Comprehensive analysis

- Analysis of Network Element Structure
- Analysis of Network Element capability
- Analysis of Route Organization
- Analysis of Resources Allocation
- Analysis of Network Indexes

Control targets

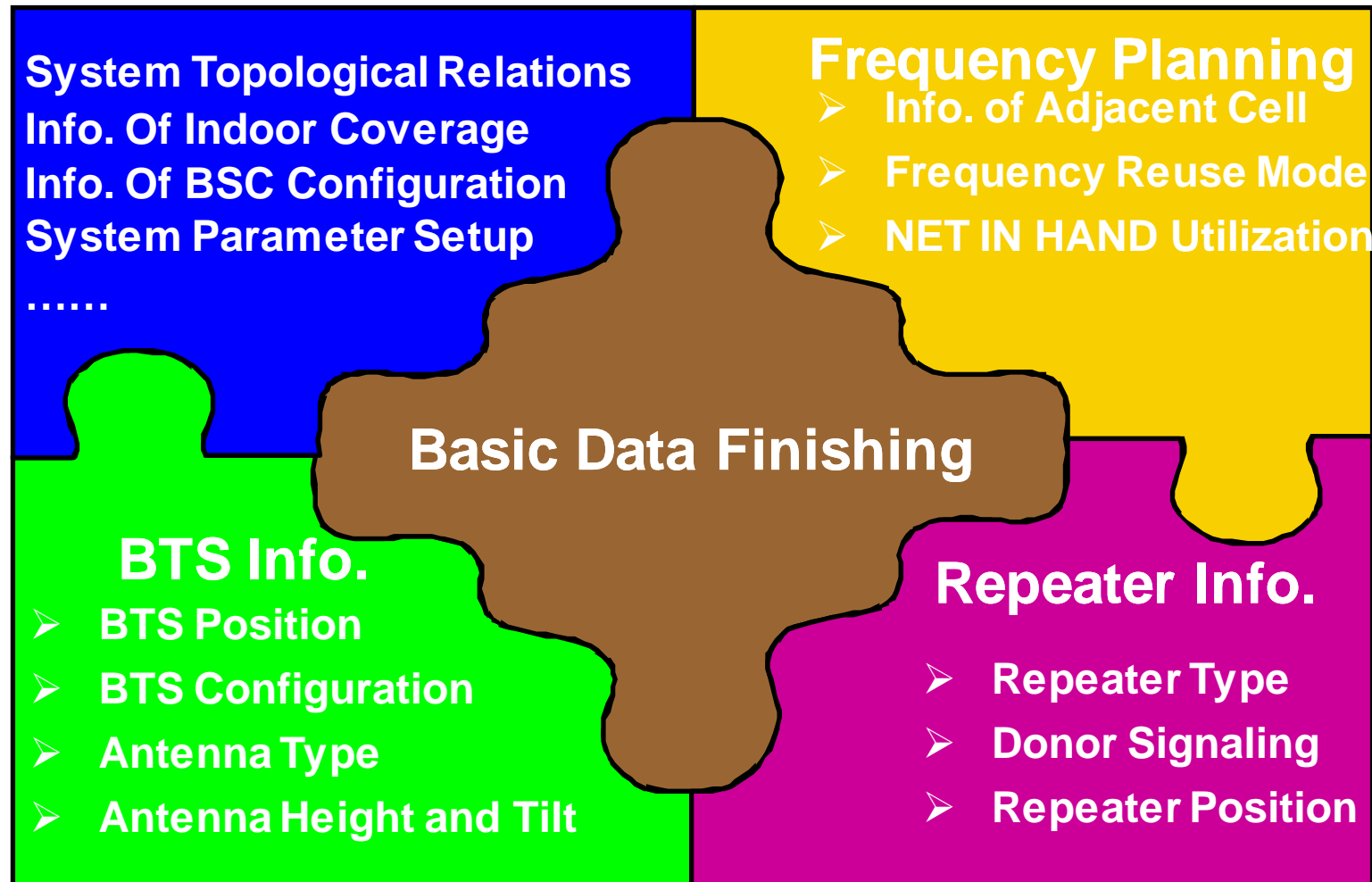
- PDP Context Activation Success Rate : 93%
- GPRS Coverage:
 - It required that most cities should realize GPRS coverage within province in east central region. In western region, it required that key cities should realize GPRS coverage.
 - Complete coverage for airport, high-grade office building and 4-star Hotel or above.
- SGSN expansion in consideration of Threshold: 70%
- Radio Capability :
 - Cell with more than 0.5Erl/channel in urban: 3 dedicated PDCH channels
 - Cell with 0.3—0.5erl/channel : 1 - 2 dedicated PDCH channels
 - The setup of the number of Dynamic PDCH channel and Static PDCH channel : More than 2: 1
- On-site Measured Rate: More than 20kbps
- PCU Congestion Rate : Less than 5%

Key issues

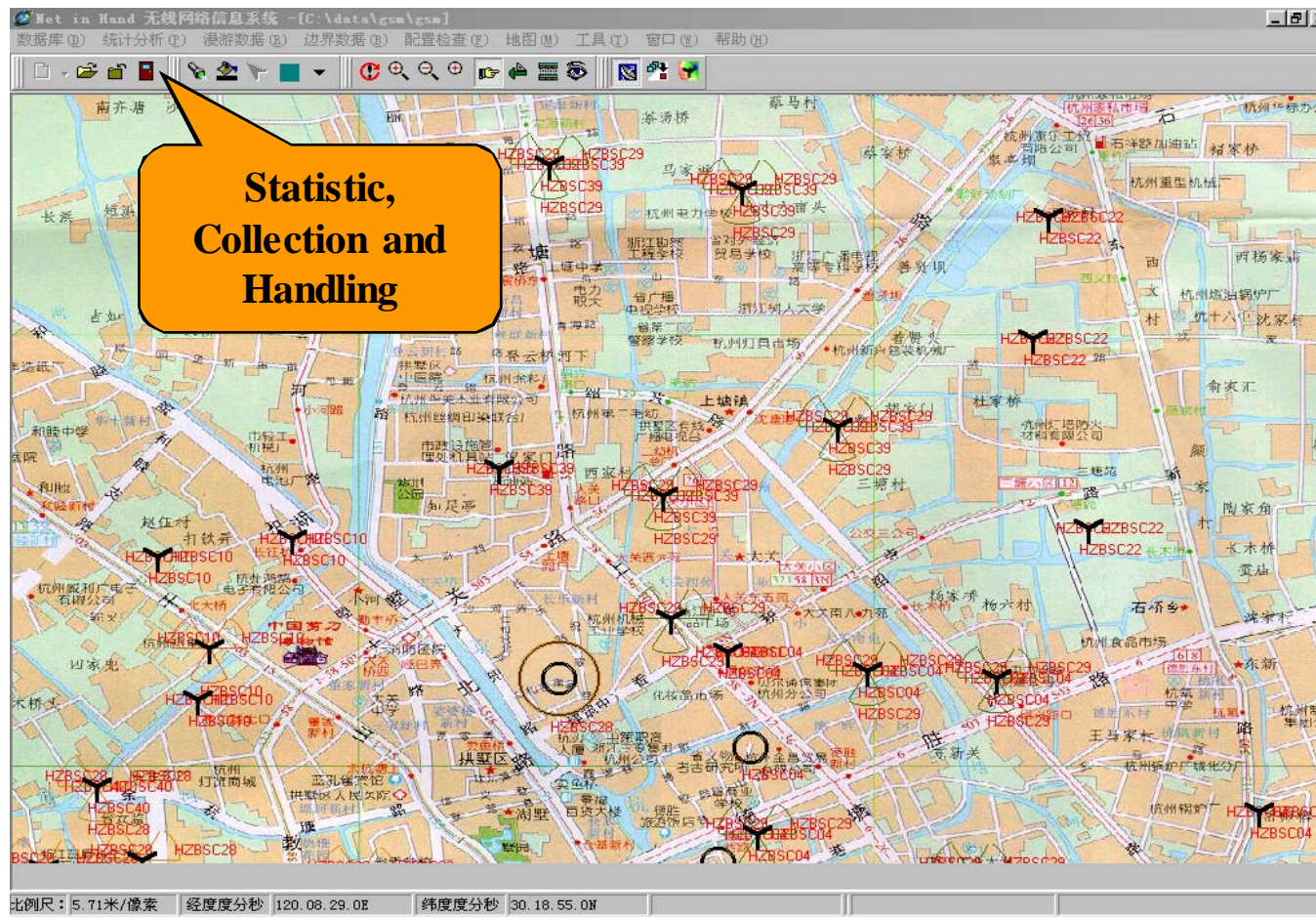
- GPRS Equipment Unstable
- GPRS Network Coverage
- Network Capability

- Contents of Evaluation
- Evaluation & Consultation of Core Network
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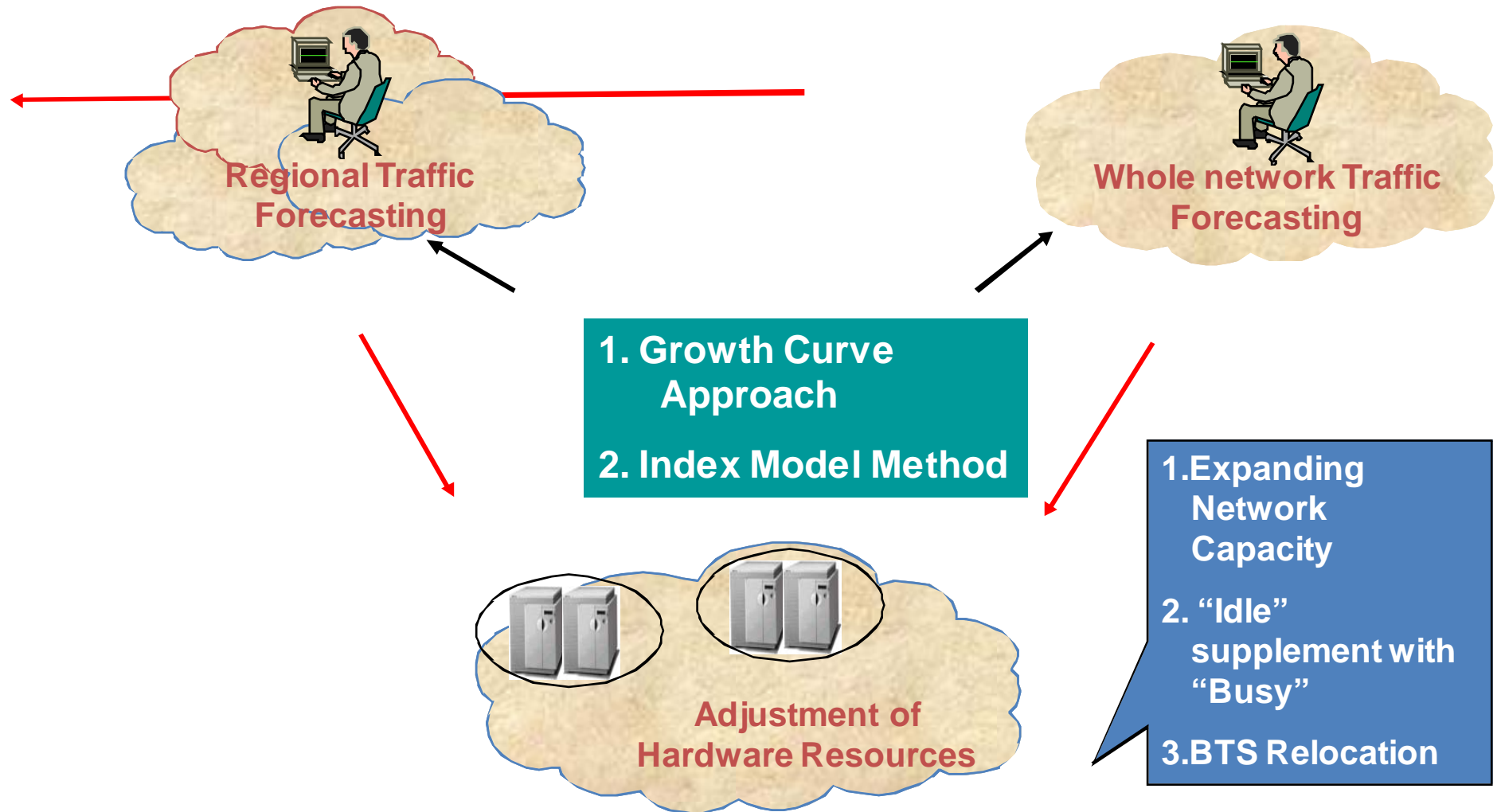
Collection of system basic data



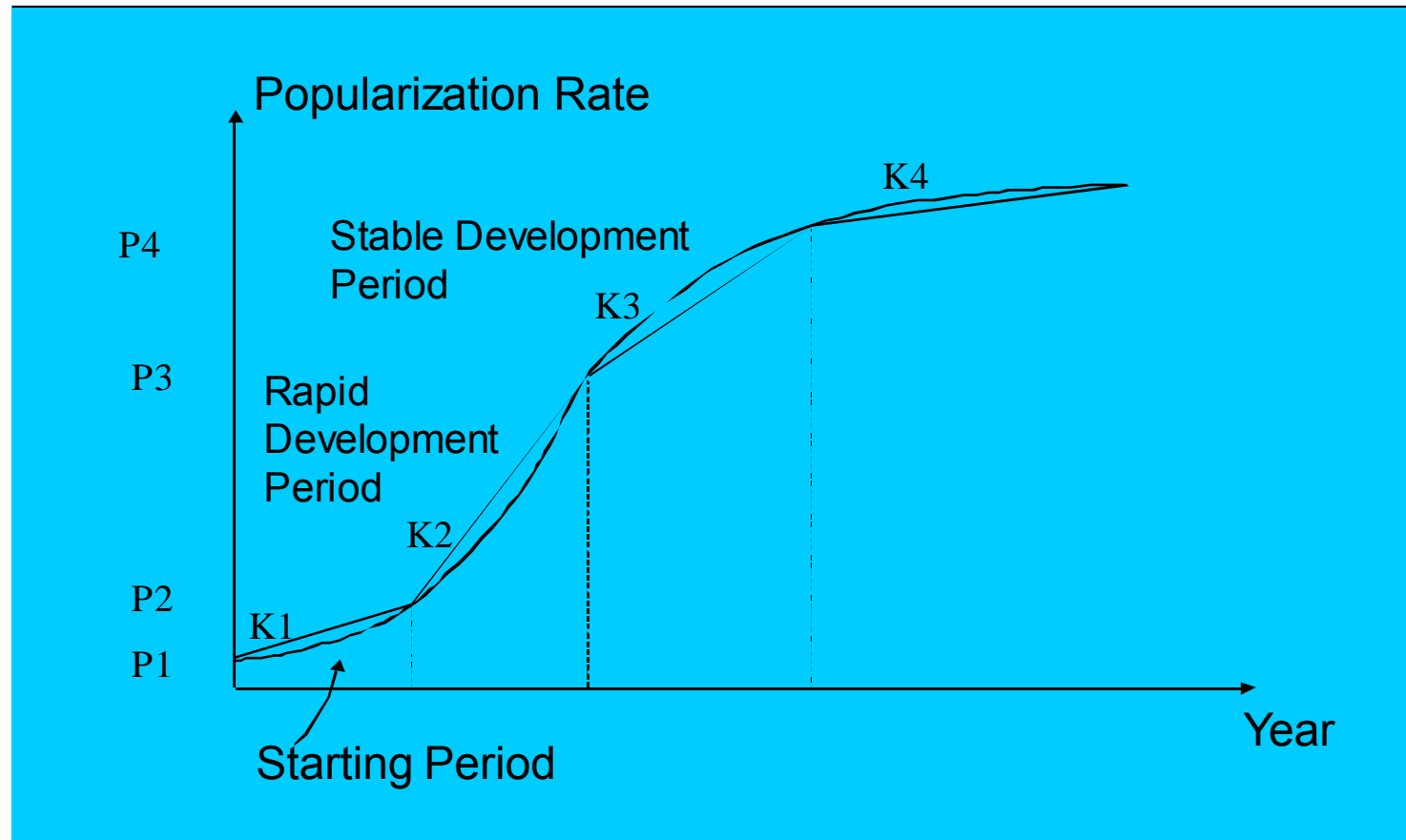
Netinhand maintains network



Two mode of traffic forecasting



Growth curve approach



- Note : $P_i (i=1,2,3,4)$ indicates popularization rate of curve break (Handset/100people)

Growth curve approach

- Growth Curve Approach utilizes the approaches of Principle of Mathematical Statistics and Linear regression analysis to determine the functional relationship between the growth of mobile subscriber number and the growth of year. Regression formula is the following:

$$Y = Le^{-kt}$$

Note: Y : Subscriber number in the tth year (Forecasting)

L : Subscriber number when saturated

b, k : Undetermined coefficient

- Although regression analysis uses more scientific calculation method, it needs a lot of sample size. Meanwhile, the more sample size it provides, the better calculation result and the better precision it will get.

Index model method

- According to previous years basic data of mobile communications market, it obtains the forecasting formula as the following:

$$Y_n = A(1+K)^n$$

Note:

Y_n : Subscriber number in the n^{th} year (Forecasting)

A : subscriber number in the first year.

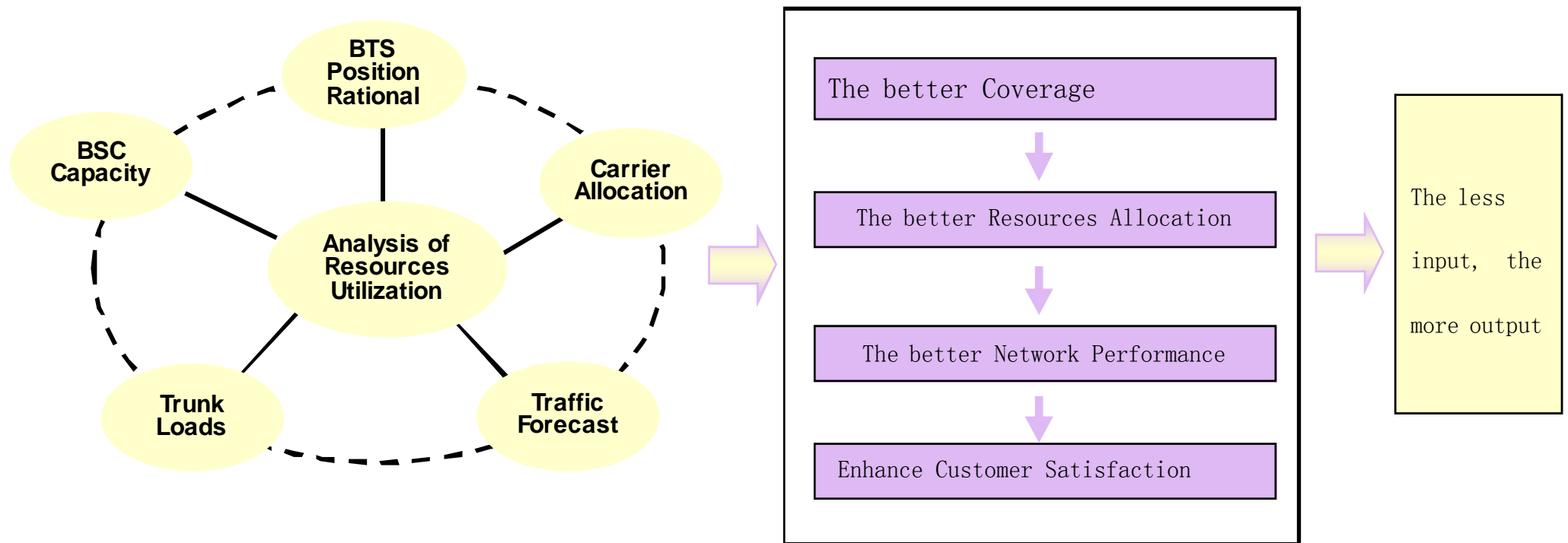
n : year number since the beginning.

K : The average growth rate

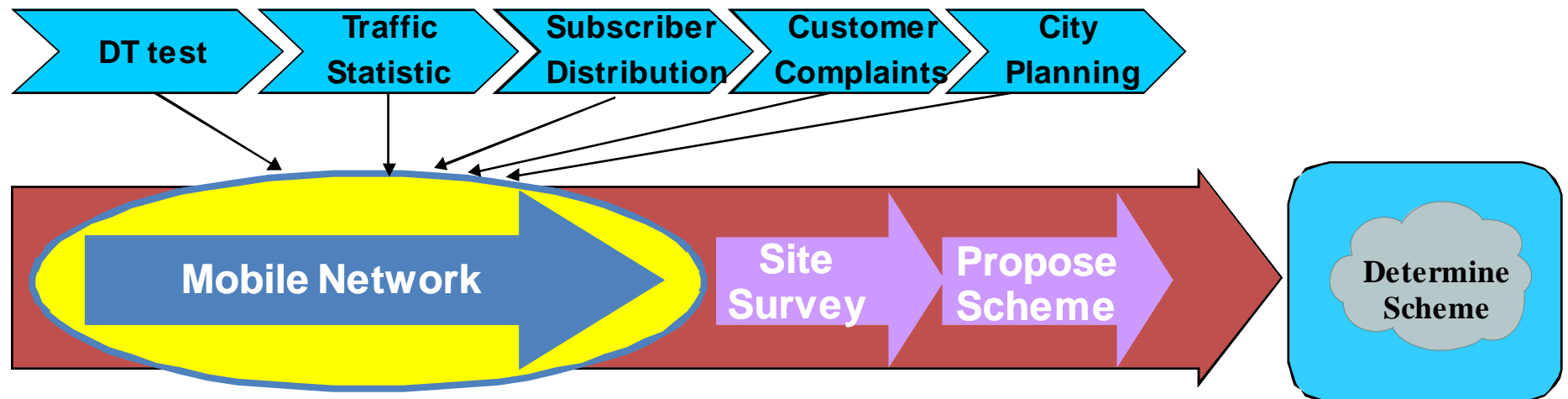
- We may forecast subscriber number for next one year or few years based on subscriber development and growth trends during previous years in combination with development plan of operator and population coverage.

Rationality analysis of resources allocation

- Combined actual traffic data of existing network with overall planning of cities, to adjust the local planning on prior period network. It will be helpful to make full use of existing network resources and gain the greater economic benefits :



BTS position and capacity analysis



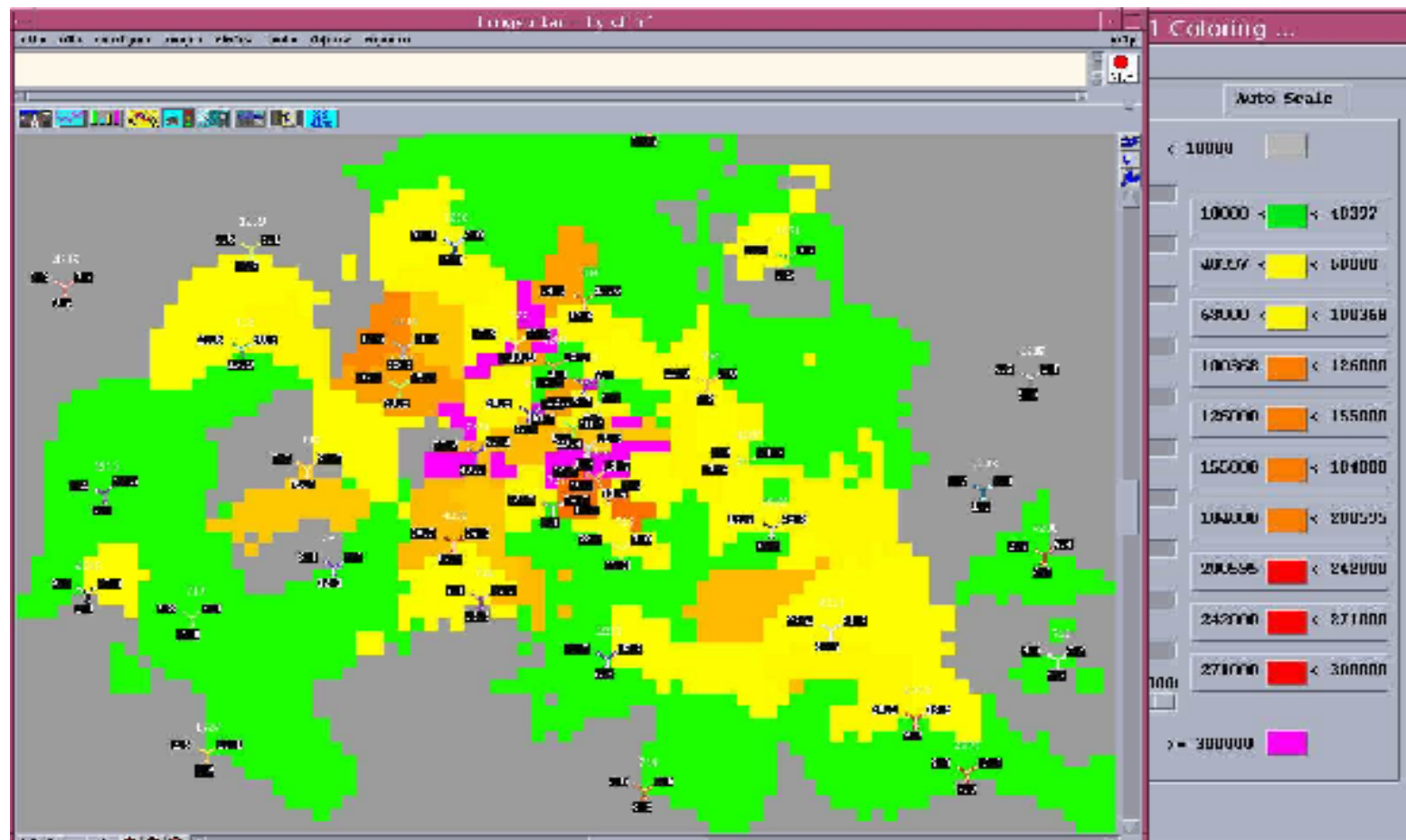
❖ Position Distribution of BTS

- Principle Based On Capacity
- Principle Based On Coverage

❖ Key Issues of Impacting Resources Utilization

- Environment Change of Radio Propagation, such as new high-rise office
- Inaccurate Traffic Distribution Forecasting of Preliminary Planning
- The emergence of new district or community under urban construction.

Simulating traffic distribution by netplan



Rational calculation of BTS number and type

➤ Categories :

- In urban high density traffic areas, according to moderate indoor coverage requirements, 30 meters of antenna height is designed. This type BTS may cover a distance of 0.46Km and cover an area of 0.664 Sq.Km.
- In suburb middle density traffic areas, according to moderate indoor coverage requirements, 30 meters of antenna height is designed. This type BTS may cover a distance of 0.88Km and cover an area of 2.43 Sq.Km.
- In suburb normal density traffic areas, according to vehicle coverage requirements, 40 meters of antenna height is designed. This type BTS may cover a distance of 1.93Km and cover an area of 11.70 Sq.Km.

Rational calculation of BTS number and type

➤ Calculation of Traffic

- It can be obtained by OMC-R statistic of existing network. For example, in a certain place :

In urban high density traffic area, total traffic is 1237.44e,

In suburb middle density traffic areas, total traffic is 390.37e,

In suburb normal density traffic areas, total traffic is 466.54e.

➤ Calculation of BTS Type

- The channel number of each BTS = $\frac{\text{Current Traffic} \times \text{Growth Rate}}{\text{Network Utilization} / \text{number of BTS}}$

Based on calculating the channel number of each BTS, finding out reasonable BTS type.

Rational calculation of BTS number and type

➤ **Area Estimate:**

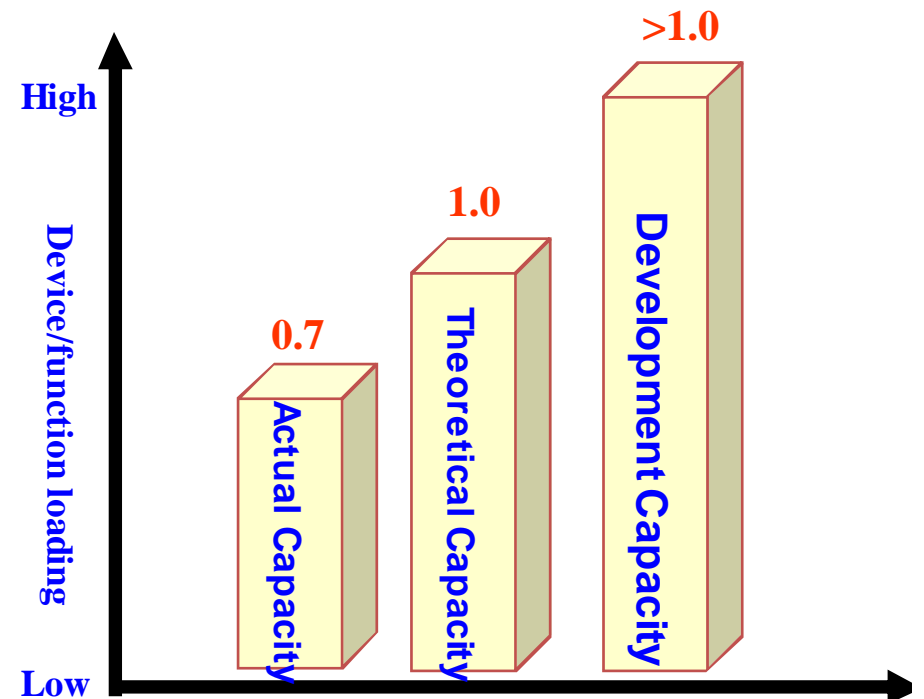
- In urban, high density traffic area is about 10.75 Sq.Km. In suburb, middle density traffic area is about 23.5 Sq.Km.
The rest suburb normal density traffic area is about 365.75 Sq.Km.

➤ **Calculation of BTS Number:**

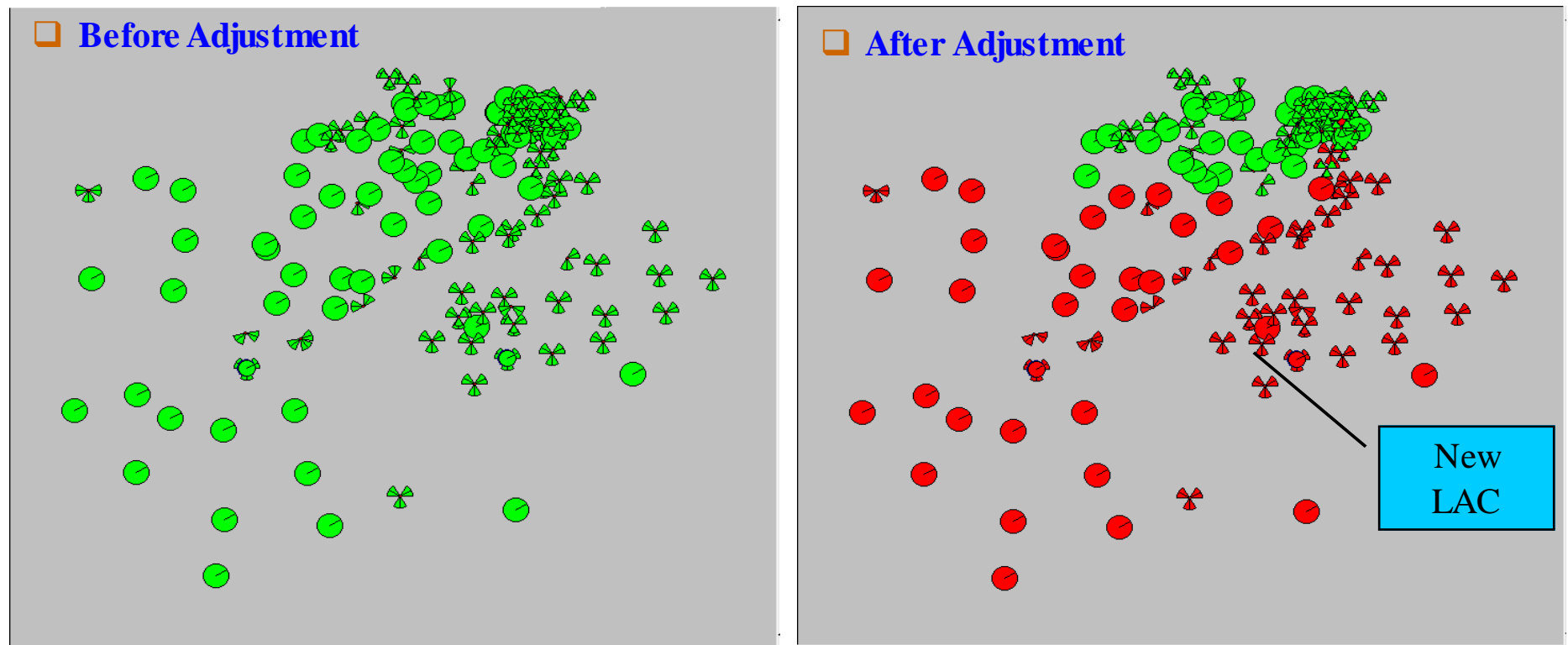
- The BTS number = [region area/Coverage area of each BTS*0.9]

Capacity analysis of system BSC and LAC

- With the growth of traffic, the capacity of some BSCs and LACs is close to or even exceeding the design capacity. So it brings some hidden troubles to sustained stable development of the network.
- With years' rich experience of GSM network planning and optimization, our company can evaluate NE load and propose corresponding scheme by utilizing the relationship among design capacity, current network capacity and forecasting capacity. On the basis of ensuring the sustained development of the network, we can improve Resources Utilization.

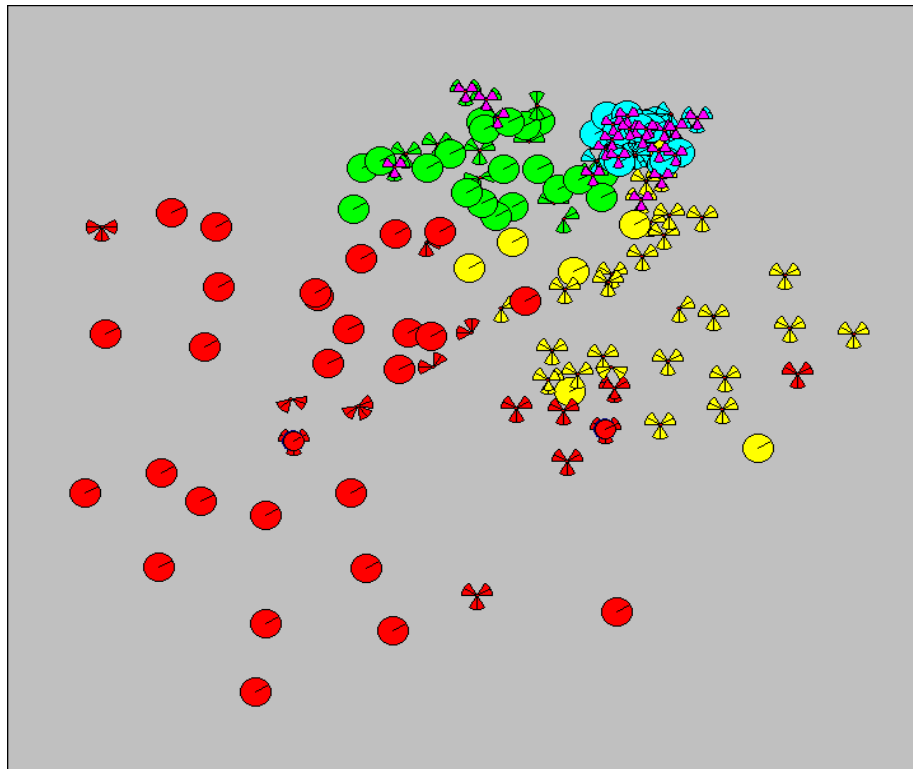


Case study : LAC capacity

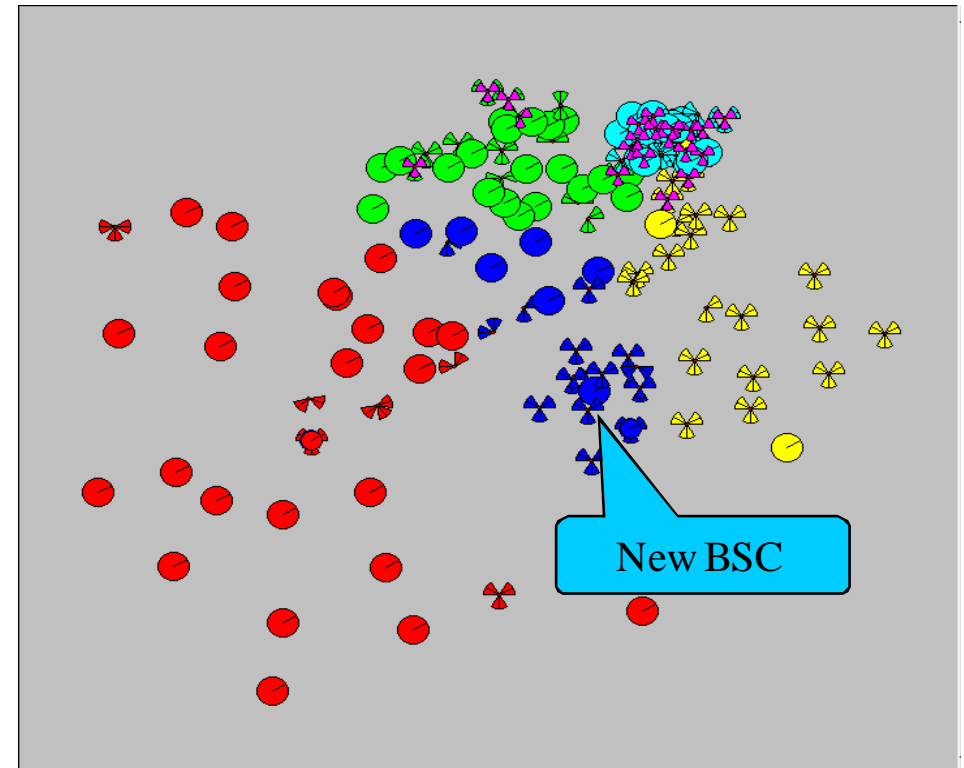


Case study : BSC split (in a certain place)

Before Adjustment



After Adjustment



Case study : BSC split (in a certain place)

❑ After Adjustment, Paging Load Forecasting

	LAC	Pages Per Second	assoc BSC
Before	LAC 22300	51.14	B03 B15 B26 B33 B36
	LAC 22300	19.47	B03 B15 B26
After	LAC 22301	31.67	B33 B36 NEW BSC

❑ After Adjustment, BSC Load Forecasting

Item		BTS sites	Active RF carriers	traffic(max)
Theoretical Value		100	384	2400
BEFORE	BSC33	34	356	746.23
	BSC36	45	302	705.26
AFTER	NEW	24	221	446.28
	BSS33	22	247	550.76
	BSS36	31	182	439.89

3 BTSs are partitioned into BSC15, and BSC15 will balance with BSC03.

Case study : BSC capacity checking (in a certain place)

The Result of BSC Capacity Checking

BSC	Need MTL	existing MTL	Need LCFS	existing LCFS	Existing BSP	existing CSFP
61	8	8	10	10	2	1
62	8	6	8	9	2	N/A
63	8	5	7	10	2	N/A
64	4	8	5	11	2	N/A
65	8	8	9	9	2	N/A
66	8	7	8	9	2	N/A

Frequency planning

➤ Targets:

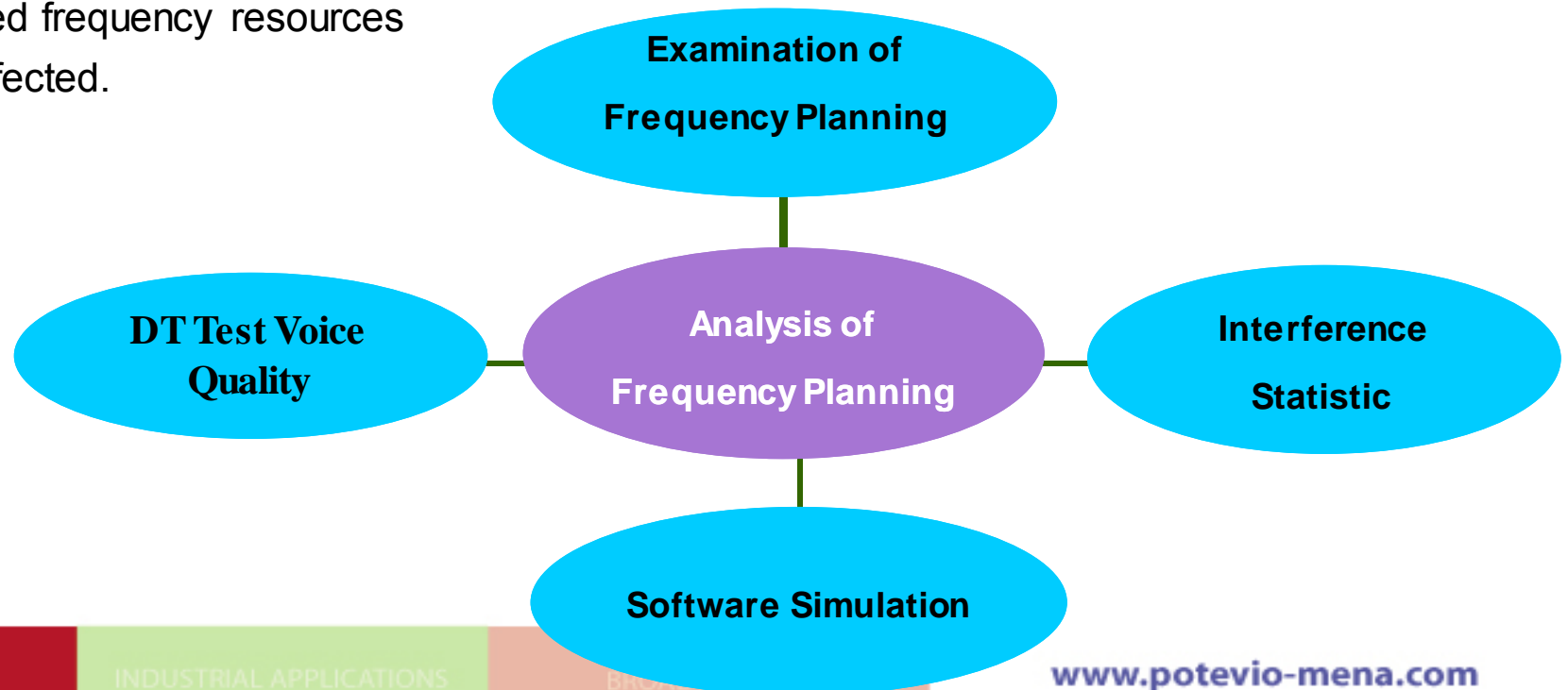
- GSM is an interference-limited system, and frequency resources are limited.
- To maintain acceptable service level and maximize the frequency utilization to meet demand.

➤ Principles:

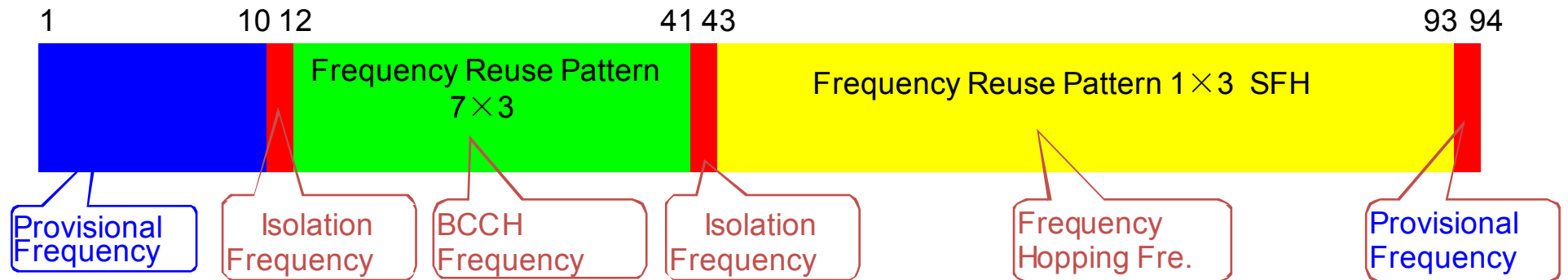
- GSM requires:
Co-frequency $C/I \geq 12\text{dB}$ (Lower Limit 9dB)
Adjacent frequency $C/I \geq -6\text{dB}$ (Lower Limit -9dB)
- Same adjacent frequency is not allowed within a BTS
- Adjacent cells cannot have Co-frequency and should avoid adjacent frequency as possible.
- The distance of Cells with Co-frequency or same BSIC should be as far as possible.

Analysis of frequency planning

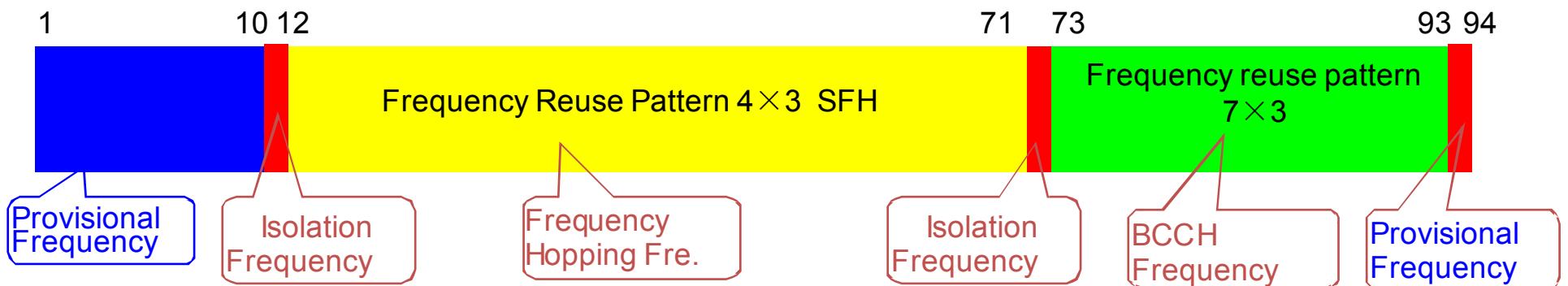
- Due to some temporary expansion and new BTS, some temporary frequencies have to be introduced. Repeaters introduced for improving local coverage and local frequency adjustment for some new indoor distribution system will disrupt the relationship of original frequency planning. The conflict probability of Co-frequency and adjacent frequency will be increased inside system and network interference will be increased as well. Then the effective use of the limited frequency resources will be affected.



Case Study: Frequency planning



(A place, GSM900) Schematic Diagram of Frequency Allocation Before and After Adjustment



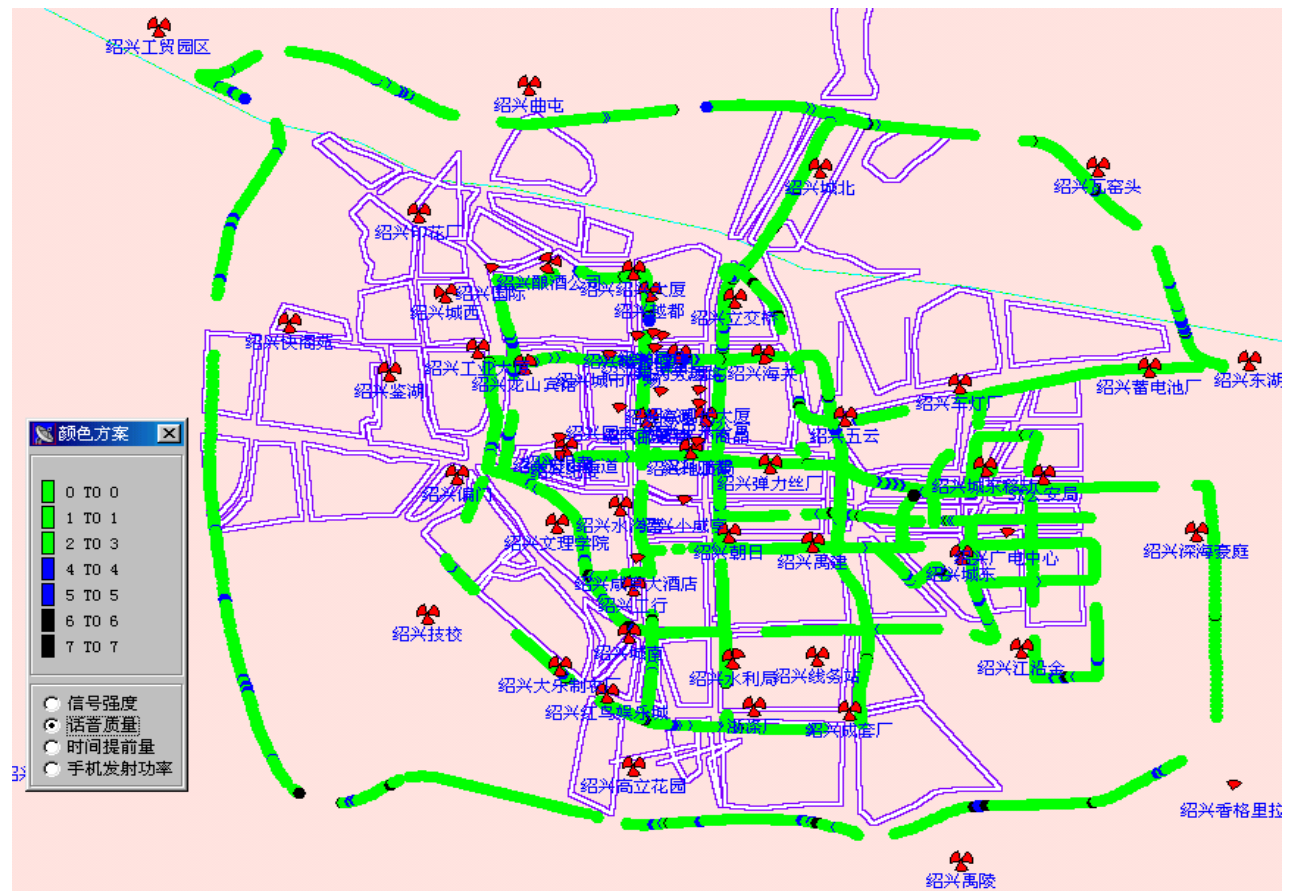
(A place, GSM900) Schematic Diagram of Frequency Allocation Before and After Adjustment

Case Study: Frequency planning

On 3rd of June

DT :

Voice Quality Testing

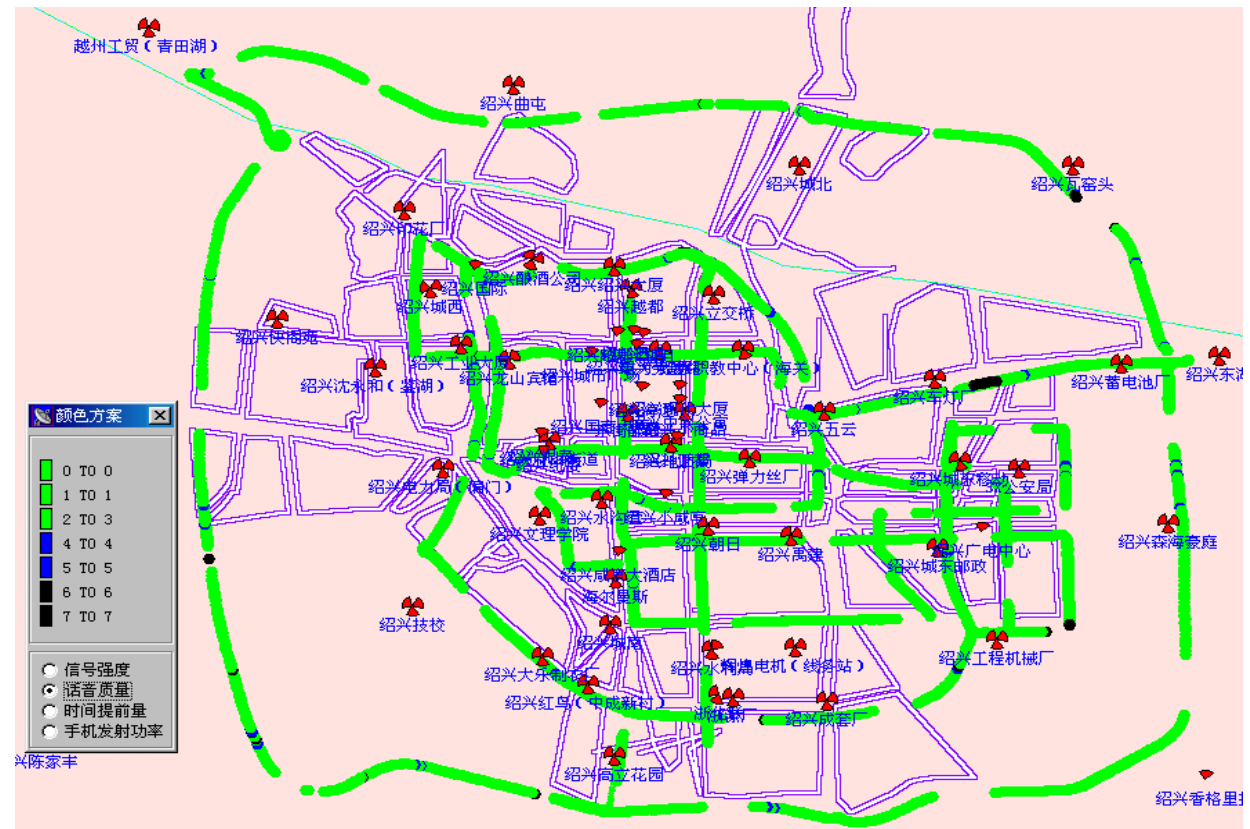


Case Study: Frequency planning

On 7th of June

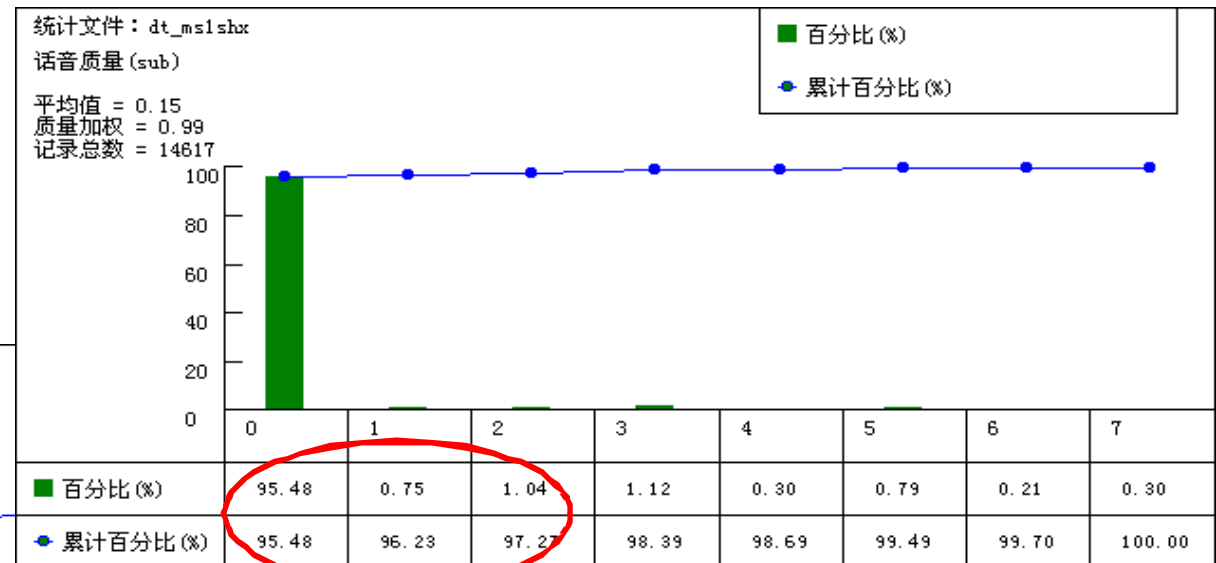
DT :

Voice Quality Testing

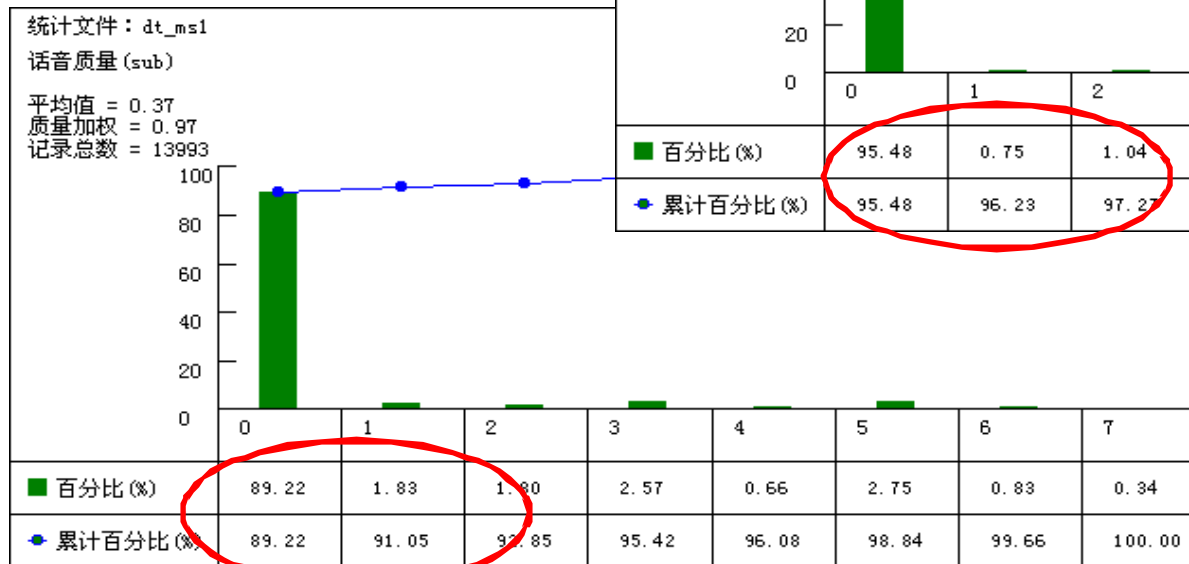


Case Study: Frequency planning

7th June DT Testing Statistic



3rd June DT Testing Statistic



Thanks for your attention !



Panorama of our company, it occupies over 300,000 square meters

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