RAN15.0

Capacity Monitoring Guide (BSC6900-Based)

Issue 04

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About This Document

Purpose

Growing traffic in mobile networks, especially in newly deployed networks, requires more and more network resources, such as radio and transmission resources. Lack of network resources will affect user experience. Therefore, monitoring network resources, locating bottlenecks, and performing capacity expansion in real time are critical to the provision of high quality services.

This document describes how to monitor the usage of various network resources and locate network resource bottlenecks.

This document applies to the BSC6900 and 3900 series base stations.

📖 NOTE

- ¬ Radio Network Controllers (RNCs) used in this document refer to Huawei BSC6900 products.
- ¬ For details about the MML commands, parameters, alarms, and performance counters, see section "Operation and Maintenance" in the BSC6900 UMTS Product Documentation or 3900 Series WCDMA NodeB Product Documentation.
- ¬ For details about flow control, see *Flow Control Feature Parameter Description* in the RAN Feature Documentation.

Organization

This document is organized as follows:

Chapter	Description
1. 1 Overview	Introduces network resources and monitoring methods.
2. 2 Network Resource Monitoring	Provides capacity monitoring principles, monitoring methods, and optimization suggestions.
3. 3 Network Resource Troubleshooting	Provides methods for analyzing and locating network congestion and overload problems.
4. 4 Metrics Definitions	Provides a table that includes all metrics currently in use, which facilitates monitoring network resources and analyzing bottleneck dash-board design.

Chapter	Description
5. 5 Reference Documents	Lists the documents referenced within the text and provides the document name, document package, and document package download path at http://support.huawei.com.

Change History

This latest document issue contains all changes made in previous issues.

Issue 04 (2014-01-20)

This is the fourth issue of RAN15.0.

Compared with Issue 03 (2013-11-15), Issue 04 (2014-01-20) includes the following changes:

¬ Correct the counter name in chapter 4 .

Issue 03 (2013-11-15)

This is the third issue of RAN15.0.

Compared with Issue 02 (2013-06-25), Issue 03 (2013-11-15) includes the following changes:

¬ Optimized figures in this document.

Issue 02 (2013-06-25)

This is the second issue of RAN15.0.

Compared with Issue 01 (2013-05-04), Issue 02 (2013-06-25) includes the following changes:

¬ Added section 2.14.
¬ Updated the optimization suggestions in section 2.3.
¬ Updated the monitoring methods and optimization suggestions in sections 2.11 and 2.13.

Issue 01 (2013-05-04)

This is the first issue of RAN15.0.

Compared with Draft A (2013-01-30), Issue 01 (2013-05-04) includes the following changes:

Updated the monitoring principles, monitoring methods, and optimization suggestions in Chapter 2.

Compared with Draft A (2013-01-30), Issue 01 (2013-05-04) deletes the following sections:

¬ Section 2.11

¬ Chapter 3

Draft A (2013-01-30)

This is a draft of RAN15.0.

Contents

1 Overview

This chapter introduces network resources and monitoring methods.

1.1 Network Resources

Figure 1-1 lists the network resources to be monitored.

Figure 1-1 Network resources to be monitored

RNC	NodeB	Cell
SPU	CE	RTWP
MPU	Iub	TCP
DPU	CNBAP	OVSF
INT	HSPA User	PCH
SCU		FACH/RACH

1.1.1 RNC Resources

The RNC resources to be monitored include the following:

- Signaling Processing Unit

  SPU processes UMTS services on the control plane. SPU is most likely to become a resource bottleneck in an RNC.

- Main Processing Unit

  MPU manages control-plane, user-plane, and transmission resources. An MPU overload triggers the flow control mechanism, which then affects the key performance indicators (KPIs) on a network.

- Data Processing Unit

  DPU processes user-plane data. Fast growing mobile broadband (MBB) services require better user experience and larger network throughput any time and any place. The present DPU resources may become a bottleneck in the RNC and fail to meet the service requirements.

- Interface board

RNC interface boards provide transmission ports and resources, process transport network messages, and exchange data between RNC boards and between the RNC and external devices. Resource overload on interface boards increases the packet loss rate, interrupts communications, and affects user experience.

¬ GE Switching network and Control Unit

SCU provides the function of inter-subrack information exchange in the RNC. When the traffic volume of inter-subrack communication approaches the overload threshold, voice service quality, data service quality, and network KPIs deteriorate, causing the system to become unstable.

1.1.2 NodeB Resources

The NodeB resources to be monitored include the following:

¬ Channel element

CEs are baseband processing resources. Generally, CEs are most likely to be congested on a network. In the early phase of network deployment, traffic volume is often small. Operators only need to purchase a small number of CEs to cover the light traffic, which reduces their capital expenditure (CAPEX).

¬ Iub interface bandwidth

The Iub interface exists between the NodeB and RNC. The interface uses asynchronous transfer mode (ATM) or IP transmission depending on the transmission medium. Insufficient Iub interface bandwidth leads to admission failures, transmission KPI deterioration (such as delay, jitter, and packet loss rate), and UMTS service quality degradation.

¬ Common NodeB Application Part

CNBAP load is used to assess the NodeB processing capacity. CNBAP overload lowers the NodeB processing capacity, which then affects KPIs related to the NodeB.

¬ HSPA users

HSPA services are mainly carried on the WBBP boards in a NodeB. Therefore, the number of HSPA users determines WBBP board loads. If WBBP boards are overloaded with HSPA users, new users may fail to access the network.

1.1.3 Cell Resources

The cell resources to be monitored include the following:

¬ Received Total Wideband Power

RTWP includes receiver noise, external radio interference, and uplink power. RTWP is used to monitor uplink load.

¬ Transmitted Carrier Power

TCP refers to the full-carrier power transmitted by a cell. It is used to monitor downlink load. The TCP value is limited by the maximum transmit power of the power amplifier in a NodeB and the maximum transmit power configured for a cell.

¬ Orthogonal Variable Spreading Factor

Insufficient downlink OVSFs affect UEs' access to the network.

¬ Paging channel

PCH usage is affected by the location area and routing area planning. PCH overload decreases the paging success rate.

- Random access channel and forward access channel

  RACH and FACH carry signaling and a small amount of user-plane data. RACH or FACH overload decreases the network access success rate and affects user experience.

1.2 Monitoring Methods

Network resources can be monitored using the following two methods:

- Proactive monitoring: This is a method for monitoring various network resources simultaneously. When resource consumption is consistently greater than its upper threshold, perform capacity expansion to relieve resource congestion. This method is easy to implement and suitable for daily resource monitoring. For details, see Chapter 2.
- Problem-driven analysis: This analysis finds system bottlenecks by locating problems. As an example, capacity analysis is triggered by issues such as call blocks. This method requires higher troubleshooting skills, but it maximizes system capacity and delays network expansion. For details, see Chapter 3.

2

Network Resource Monitoring

2.1 Monitoring Metrics and Procedure

2.1.1 Monitoring Metrics

Metrics are defined to monitor the usage or load of UTRAN resources. Resource thresholds are also recommended based on specific criteria.

Defining peak hours is important for monitoring metrics. There are different ways to define peak hours, but you are advised to simply use the hours during which the corresponding resource usage is the highest as peak hours.

Table 2-1 lists RNC resources, counters, and monitoring thresholds.

Table 2-1 RNC resources, counters, and monitoring thresholds

RNC Resource	Counter	Monitoring Threshold
SPU CPU load	VS.XPU.CPULOAD.MEAN	50%
MPU CPU load	VS.XPU.CPULOAD.MEAN	50%
DPU DSP load	VS.DSP.UsageAvg	60%
SCU CPU load	VS.SCU.CPULOAD.MEAN	60%
Interface board CPU load	VS.INT.CPULOAD.MEAN	50%
Interface board forwarding load	VS.INT.TRANSLOAD.RATIO.MEAN	70%

Table 2-2 lists NodeB resources, counters, and monitoring thresholds.

Table 2-2 NodeB resources, counters, and monitoring thresholds

NodeB Resource	Counter	Monitoring Threshold
CE usage	VS.NodeB.ULCreditUsed.Mean VS.LC.ULCreditUsed.Mean VS.LC.DLCreditUsed.Mean VS.HW.DLCreditAvailable VS.HW.ULCreditAvailable	70%
CNBAP load	VS.RadioLink.Recv.Mean VS.DedicMeaRpt.MEAN	60%
HSPA users	VS.BOARD.UsedHsdpaUserRatio.Mean VS.BOARD.UsedHsupaUserRatio.Mean	60%

For details about other resources, counters, and monitoring thresholds, see the corresponding sections.

2.1.2 Monitoring Procedure

This section discusses the network resource monitoring procedure. It can be easily implemented and works in most scenarios.

The procedure starts with individual resource monitoring. When a resource exceeds a predefined threshold, it should be cross checked against other resources.

For example, if CE usage is higher than 70% but RTWP, TCP, or OVSF resources are normal, this indicates that the cell load is normal, but CEs are insufficient. In this scenario, increase the number of CE licenses or add baseband processing boards rather than expand the NodeB capacity.

Figure 2-1 shows the resource monitoring flowchart.

Figure 2-1 Resource monitoring flowchart
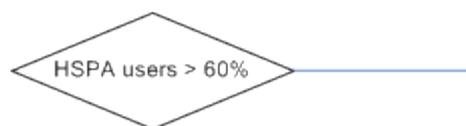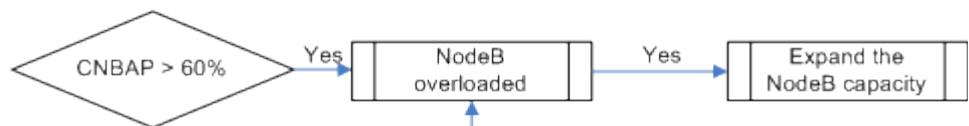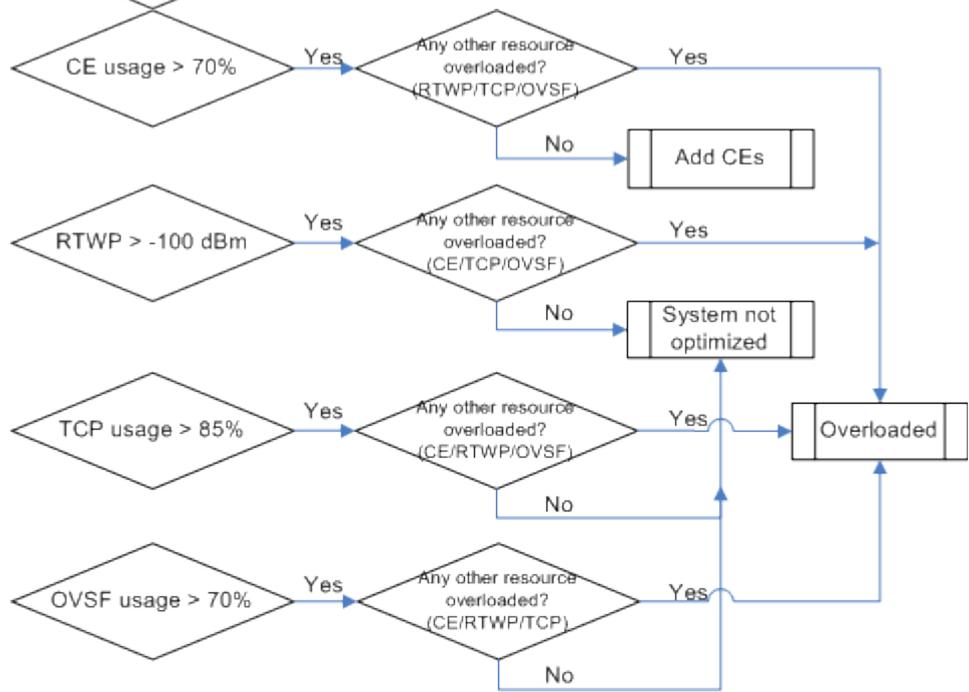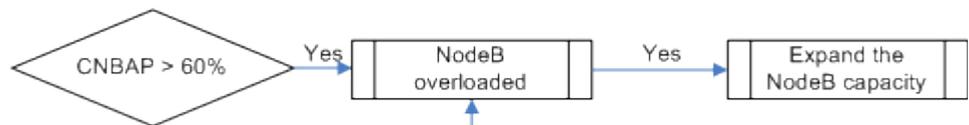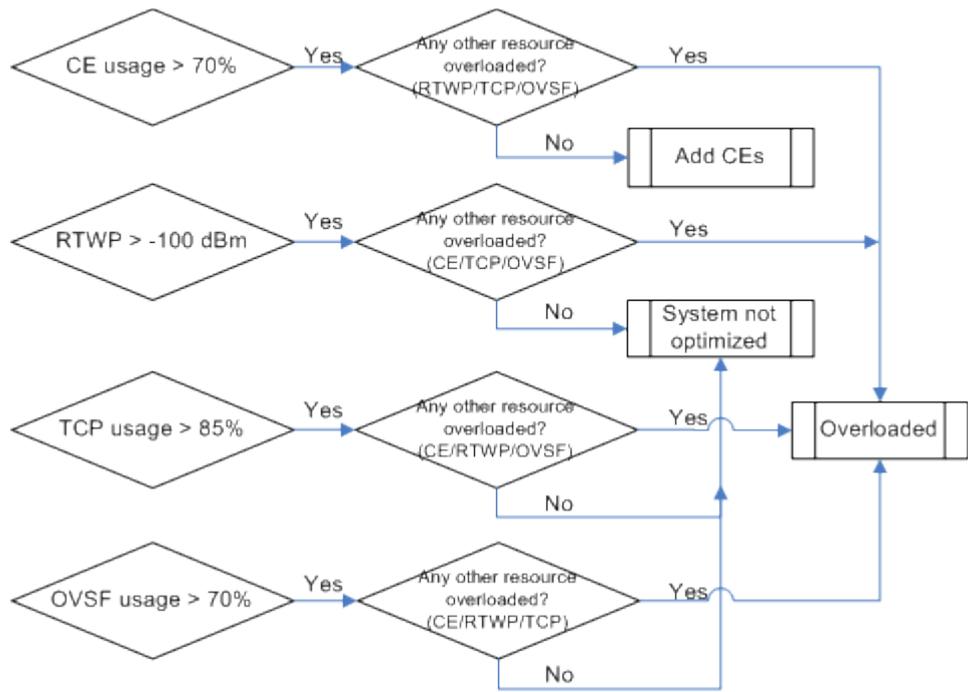
As shown in Figure 2-1, if SPU CPU usage is higher than 50% during peak hours, the SPU is overloaded. In this situation, it is normally unnecessary to continue analysis on other resources.

This procedure applies to most resource monitoring scenarios, but sometimes the system may be overloaded because of other abnormalities instead of traffic increases. Some of these abnormalities can be discovered by resource cross-checking. If more extensive resource cross-checking is unsuccessful, more advanced troubleshooting is required. Chapter 3.

For the sake of simplicity, it is assumed that there are no other abnormalities on the network during the proactive monitoring process described in Chapter 2.

2.2 SPU CPU Load

2.2.1 Monitoring Principles

An RNC can be configured with multiple SPU boards, such as SPUa or SPUb boards. SPU boards are classified into main control SPU boards and non-main control SPU boards, depending on the loaded software. Each SPUa board contains four CPUs and each SPUb board contains eight. Each CPU represents a subsystem. Subsystems can be classified into SPU subsystems and Main Processing Unit (MPU) subsystems.

- Subsystem 0 on the main control SPU board is the MPU subsystem, which manages the user-plane, control-plane, and transmission resources of the RNC.
- Other subsystems on the main control SPU board and all the subsystems on the non-main control SPU board are the SPU subsystems, also called CPU for Service (CPUS) subsystems. They process control-plane services.

To set the logical function type of an SPU board, run the ADD BRD command and set the parameter as follows:

- To add a main control SPU board, set the **Logical function type** parameter to **RUCP**.
- To add a non-main control SPU board, set the **Logical function type** parameter to **UCP**.

📖 NOTE

This section describes SPU subsystems only. For details about the MPU subsystem, see section 2.3.

The functions of SPU subsystems are as follows:

- Processing upper-layer signaling over the Uu, Iu, Iur, and Iub interfaces
- Processing transport layer signaling
- Allocating and managing the various resources that are necessary for service setup, and establishing signaling and service connections
- Processing RNC frame number (RFN) signaling

The SPU CPU load is classified as follows:

- Shareable load caused by call management. When an SPU subsystem is overloaded, the load sharing mechanism works automatically to forward new calls and the loads they caused to lightly loaded subsystems.
- Non-shareable load caused by cell resource management, NodeB resource management, and signaling management at the transport layer. By setting the appropriate parameters, these functions and the loads they caused can be processed by a specific subsystem instead of being forwarded to other subsystems. The non-shareable load on a specific subsystem can be reduced by rehoming NodeBs, reconfiguring the SCTP or SAAL link, or enabling the SSN resource pool feature.

📖 NOTE

For details about load sharing and SSN resource pool, see *Controller Resource Sharing Feature Parameter Description* in the RAN Feature Documentation.

The ratio of shareable load to non-shareable load is approximately 2:1. The ratio varies slightly according to different traffic models but it generally applies to most traffic models. Figure 2-2 shows the CPU load allocation on the SPU.

Figure 2-2 CPU load allocation on the SPU
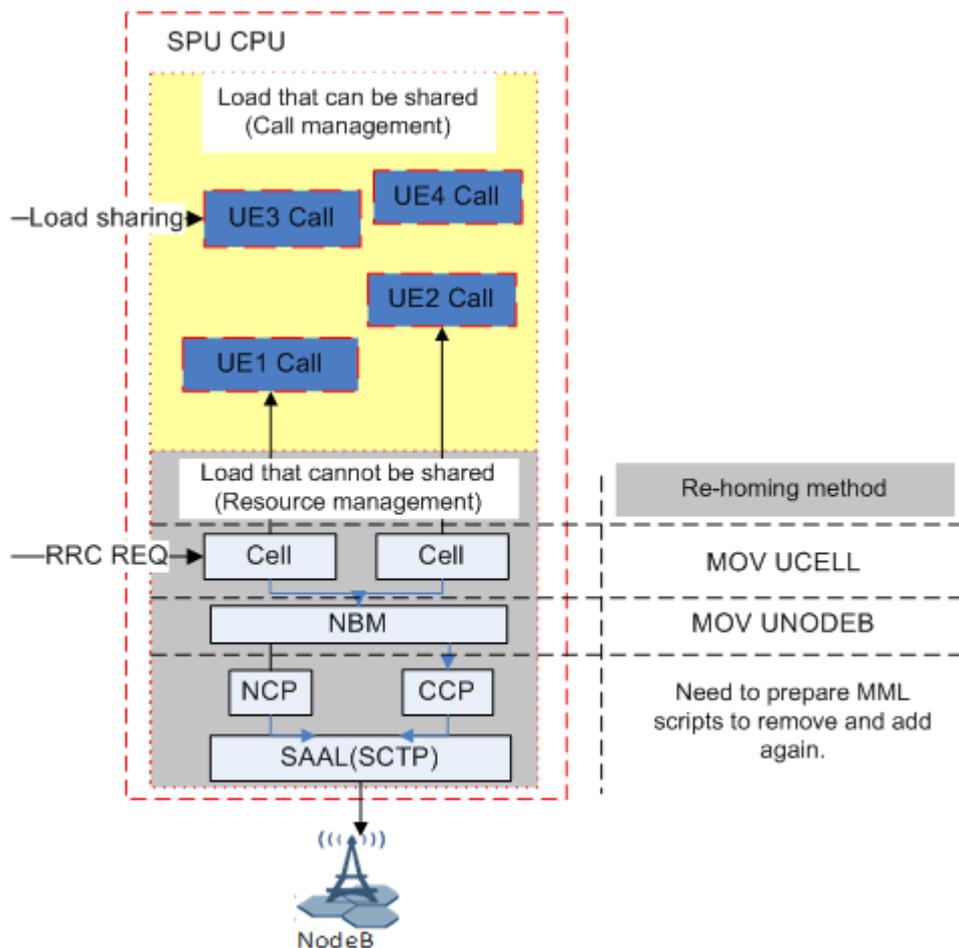
2.2.2 Monitoring Methods

SPU Subsystem-level Monitoring

To obtain the average CPU usage on an SPU subsystem during a traffic measurement period, monitor the VS.XPU.CPULOAD.MEAN counter.

To query the real-time CPU usage on an SPU subsystem, run the MML command **DSP CPUUSAGE**.

RNC-level Monitoring

RNC-level monitoring covers all SPU subsystems in an RNC. The formulas used to calculate the RNC-level SPU CPU load are as follows:

- If the RNC is configured with only SPUa or SPUb boards, use the following formula:

SPU CPU load = Average of all SPU CPU (VS.XPU.CPULOAD.MEAN)

- If the RNC is configured with both SPUa and SPUb boards, use the following formula:

SPU CPU load = Sum (1.33 x ∑VS.XPU.CPULOAD.MEAN of SPUa + ∑VS.XPU.CPULOAD.MEAN of SPUb)/(1.33 x N + M)

📖 NOTE

- N and M indicate the number of SPU subsystems on SPUa and SPUb boards, respectively.
- The processing capacity of an SPU subsystem on an SPUa board is 1.33 times that on an SPUb board.

When the RNC detects that the CPU load on an SPU subsystem exceeds a specified threshold, ALM-20256 CPU Overload is reported. You can query the overload threshold by running the **LST CPUTHD** command.

2.2.3 Optimization Suggestions

Based on the analysis of RNC-level SPU CPU and SPU subsystem-level CPU loads, optimization suggestions are provided to address problems in scenarios listed in the following table.

No.	Scenario	Optimization Suggestion
1	The RNC-level SPU CPU load is high.	Add SPU boards.
2	The CPU load on an SPU subsystem is much less than the RNC-level SPU CPU load.	Adjust the load sharing threshold.
3	The CPU load on an SPU subsystem is much greater than the RNC-level SPU CPU load.	- Rehome NodeBs. - Enable the SSN resource pool feature. - Reconfigure the SCTP or SAAL link.

Scenario 1: The RNC-level SPU CPU load is high.

Assume that the load sharing threshold is set to 35% and CPU loads on all SPU subsystems are greater than the load sharing threshold, as shown in Figure 2-3.

Figure 2-3 High RNC-level SPU CPU load
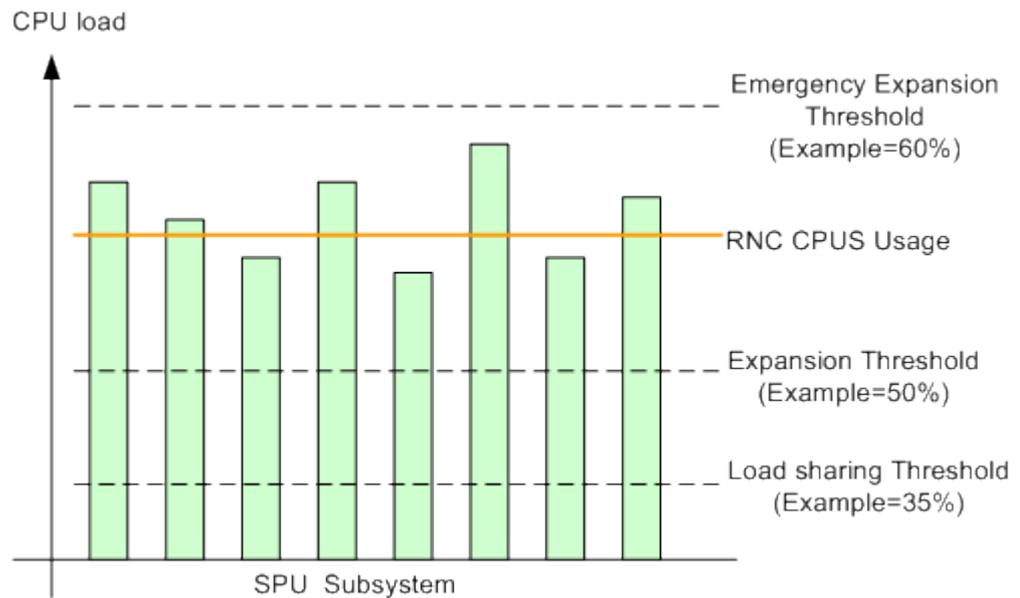
When the RNC-level SPU CPU load exceeds the load sharing threshold, the load sharing mechanism is triggered to balance the loads that can be shared among all SPU subsystems.

Perform capacity expansion in the following scenarios:

- When the RNC-level SPU CPU load during peak hours is greater than the expansion threshold (50%) for three consecutive days in a week:
    - If there are vacant slots, add SPU boards.
    - If there are no vacant slots, add an RNC to configure more SPU boards.
- When the RNC-level SPU CPU load during peak hours is greater than the emergency expansion threshold (60%) for three consecutive days in a week, the RNC may report ALM-20256 CPU Overload and enable the flow control function. In this situation, perform capacity expansion immediately as follows:
    - If there are vacant slots, add SPU boards.
    - Rehome NodeBs to balance loads between RNCs.

Scenario 2: The CPU load on an SPU subsystem is much less than the RNC-level SPU CPU load.

Assume that the load sharing threshold is set to 50% and the CPU load on SPU subsystem A is less than the RNC-level SPU CPU load by more than 10%, as shown in Figure 2-4.

Figure 2-4 CPU load on an SPU subsystem much less than RNC-level SPU CPU load
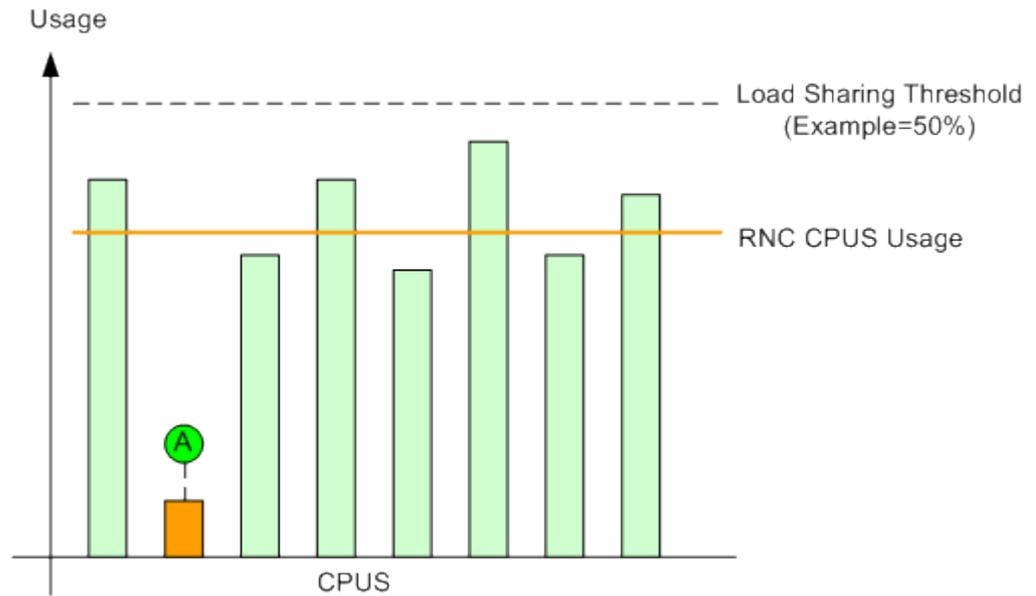
The RNC-level SPU CPU load is less than the load sharing threshold. Therefore, the load sharing mechanism is not triggered, and the shareable load is not allocated to SPU subsystem A. In this situation, run the MML command **SET UCTRLPLNSHAREPARA** with the **Control Plane Sharing Out Threshold** parameter set to a smaller value to trigger the load sharing mechanism.

Scenario 3: The CPU load on an SPU subsystem is much greater than the RNC-level SPU CPU load.

Assume that the load sharing threshold is set to 35%, the CPU load on SPU subsystem B is greater than the load sharing threshold (50%) of a single subsystem and greater than the RNC-level SPU CPU load by 10%, as shown in Figure 2-5.

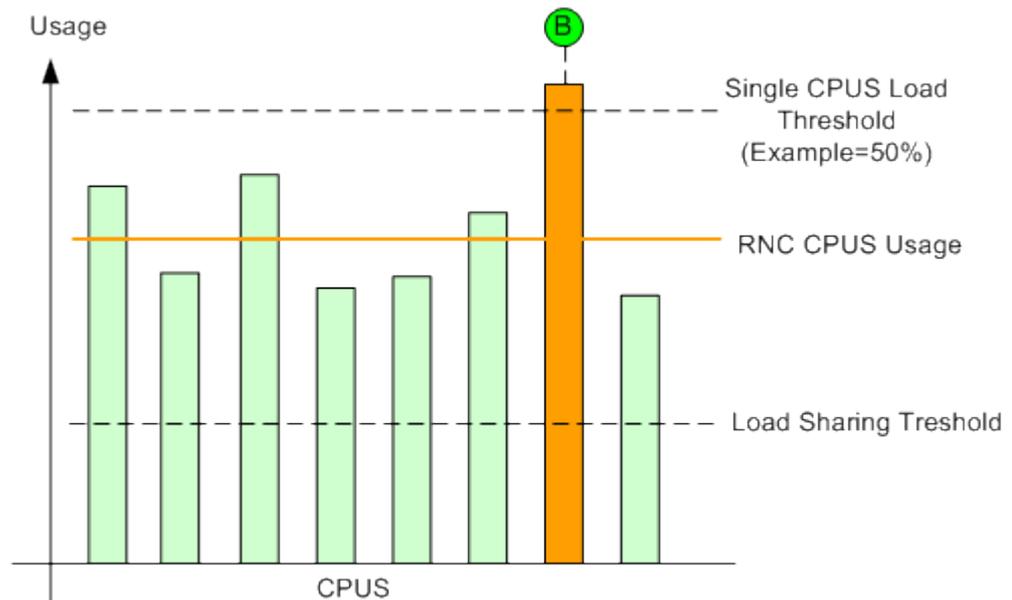**Figure 2-5** CPU load on an SPU subsystem much greater than RNC-level SPU CPU load

As shown in Figure 2-5, the non-shareable load on SPU subsystem B is significantly high and cannot be transferred to other subsystems through load sharing. In this situation, it is recommended that you rehome NodeBs, enable the SSN resource pool feature, or reconfigure the SCTP or SAAL link.

- If there are multiple NodeBs configured on SPU subsystem B, use the CME or run the MML commands **MOV UCELL** and **MOV UNODEB** to rehome NodeBs to other subsystems and ensure that there is only one NodeB on SPU subsystem B.

- If there is only one NodeB configured on SPU subsystem B, transfer the non-shareable load from SPU subsystem B to other SPU subsystems as follows:

    - If the SCTP link is configured over the Iu interface of SPU subsystem B, reconfigure the SCTP link to other SPU subsystems.

    - If the SCTP link is not configured over the Iu interface of SPU subsystem B, enable the SSN resource pool feature.

📖 **NOTE**

- For details about the SCTP or SAAL link, see section "Reconfiguring NodeB Management Distribution" in *RAN Reconfiguration Guide* in the BSC6900 UMTS Product Documentation.

- For details about the SSN resource pool feature, see *Flow Control Feature Parameter Description* in the RAN Feature Documentation.

- For the methods of planning and implementing NodeB and cell rehoming, contact Huawei for technical support.

2.3 MPU CPU Load

2.3.1 Monitoring Principles

The MPU is located in subsystem 0 on the main control SPU board. It manages the user-plane resources, control-plane resources, and transmission

resources in the RNC. The number of MPUs on an SPU board can be configured based on service requirements. The MPU allocates resources such as SPU, DPU, and interface board to each call. More than 60% of the MPU load is used for transmission resource management.

The MPU resource pool function, used to manage transmission resources, is enabled by default. After this function is enabled, all the MPUs work in a resource pool, and the RNC allocates transmission resources based on MPU CPU loads to balance the MPU CPU loads in the RNC.

📖 NOTE

- ¬ In effective mode, run the MML command **DSP BRD** to query the logical function type of an SPUa or SPUb board. If **Logic function type** is set to **RUCP**, subsystem 0 on this SPU is the MPU subsystem.
- ¬ In ineffective mode, find the MML command **ADD BRD** in the RNC configuration file. If the value of **Logic function type** is **RUCP**, subsystem 0 on this SPU is the MPU subsystem.

2.3.2 Monitoring Methods

The RNC counter VS.XPU.CPULOAD.MEAN measures the CPU usage on a single MPU subsystem, which indicates the CPU load on the MPU subsystem.

To query the real-time CPU usage on an MPU subsystem, run the MML command **DSP CPUUSAGE**.

It is recommended that you monitor the RNC-level MPU CPU load, which indicates the average CPU load on all MPU subsystems in an RNC. The formulas used to calculate the RNC-level MPU CPU load are as follows:

- ¬ If the RNC is configured with either SPUa or SPUb boards, use the following formula:

MPU CPU load = Average of all MPU CPU (VS.XPU.CPULOAD.MEAN)

- ¬ If the RNC is configured with both SPUa and SPUb boards, use the following formula:

MPU CPU load = Sum (1.7 x $\sum$VS.XPU.CPULOAD.MEAN of SPUa + $\sum$VS.XPU.CPULOAD.MEAN of SPUb)/(1.7 x N + M)

📖 NOTE

- ¬ N and M indicate the number of MPU subsystems on SPUa and SPUb boards, respectively.
- ¬ The processing capacity of an MPU subsystem on an SPUa board is 1.7 times that on an SPUb board.

When the RNC detects that the CPU load on an MPU subsystem exceeds a specified threshold, ALM-20256 CPU Overload is reported. You can query the overload threshold by running the **LST CPUTHD** command.

2.3.3 Optimization Suggestions

Run the MML command **SET TNLOADBALANCEPARA** with **MPU Load Sharing Threshold** set to **40** and **MPU Load Difference Threshold** set to **10** to adjust the load sharing threshold and offset.

After the load sharing threshold is adjusted, Perform capacity expansion in the following scenarios:

- ¬ The RNC-level MPU CPU load during peak hours is greater than the expansion threshold (50%) for three consecutive days in a week.

¬ When the RNC-level MPU CPU load during peak hours is greater than the emergency expansion threshold (60%) for three consecutive days in a week, the RNC may report ALM-20256 CPU Overload and enable the flow control function. In this situation, perform capacity expansion immediately.

Perform capacity expansion as follows:

¬ If there are vacant slots, add SPU boards.

¬ If there are no vacant slots, perform the following to configure more MPU subsystems:

– Change the logical type from non-main control SPU boards to main control SPU boards when the CPU loads on non-main control SPU boards are less than or equal to 40%.

– Add an RNC when the CPU loads on non-main control SPU boards are greater than 40%.

2.4 DPU DSP Load

2.4.1 Monitoring Principles

The digital signal processing (DSP) subsystems are logical subsystems on the DPUb or DPUe board. A DPUb board contains 22 logical subsystems and a DPUe board contains 28 logical subsystems.

The DPU board processes and distributes UMTS user-plane service data. The main functions of the DPU board are as follows:

¬ Multiplexing and demultiplexing

¬ Processing frame protocols

¬ Selecting and distributing data

¬ Performing the functions of the GTP-U, Iu UP, PDCP, RLC, MAC, and FP protocols

¬ Performing encryption, decryption, and paging

¬ Processing internal communication protocols between the SPU and DPU boards

¬ Processing the Multimedia Broadcast and Multicast Service (MBMS) at the RLC and MAC layers

If a DSP subsystem in the RNC is overloaded, new calls will be transferred to lightly loaded subsystems. It is recommended that you monitor the RNC-level DSP loads.

📖 NOTE

¬ For details about resource sharing on the user plane, see *System Reliability Feature Parameter Description* in the RAN Feature Documentation.

2.4.2 Monitoring Methods

The RNC counter VS.DSP.UsageAvg measures the CPU usage on a single DSP subsystem, which indicates the CPU load on the DSP subsystem.

RNC-level Monitoring

RNC-level monitoring involves all the DSP subsystems in an RNC.

The DSP load on an RNC can be indicated by the average load on all DSP subsystems in the RNC during peak hours. The formulas used to calculate the DSP load on an RNC are as follows:

¬ If the RNC is configured with either DPUb or DPUe boards, use the following formula:

DSP load = Average of all DSP (VS.DSP.UsageAvg)

¬ If the RNC is configured with both DPUb and DPUe boards, use the following formula:

DSP load = Sum (0.5 x $\sum$VS.DSP.UsageAvg of DPUb + $\sum$VS.DSP.UsageAvg of DPUe)/(0.5 x N + M)

📖 NOTE

> ¬ N and M indicate the number of DSP subsystems on DPUb and DPUe boards, respectively.
> ¬ The processing capacity of a DSP subsystem on a DPUb board is half of that on a DPUe board.

When the RNC detects that the CPU load on a DSP subsystem exceeds a specified threshold, ALM-20256 CPU Overload is reported. You can query the overload threshold by running the **LST CPUTHD** command.

If the average load on all DSP subsystems managed by RNC exceeds a specified overload threshold, ALM-22305 Resource overload on the user plane is reported. You can run the **LST UALMTHD** command to query the overload thresholds.

2.4.3 Optimization Suggestions

Based on an analysis of resource pool- and RNC-level DSP loads, optimization suggestions are provided to address problems in scenarios listed in the following table.

No.	Scenario	Optimization Suggestion
1	The RNC-level DSP load is high.	¬ Add DPU boards. ¬ Replace DPUb boards with DPUe boards.
2	The RNC-level DSP load is less than the expansion threshold, and DSP loads are severely unbalanced.	Adjust the load sharing threshold.

Scenario 1: The RNC-level DSP load is high.

Assume that the loads on all DSP subsystems are high, the RNC-level DSP load is greater than the expansion threshold, and loads are balanced among all DSP subsystems, as shown in Figure 2-6.

Figure 2-6 High RNC-level DSP load
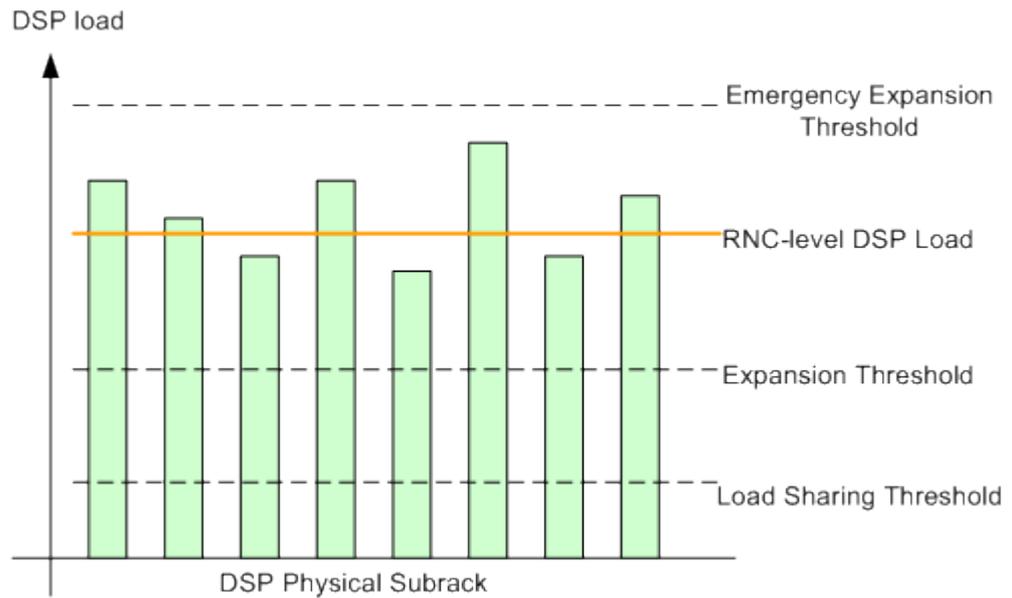
Perform capacity expansion in the following scenarios:

¬ When the RNC-level DSP load during peak hours is greater than the expansion threshold (60%) for three consecutive days in a week, add DPU boards.

¬ When the RNC-level MPU CPU load during peak hours is greater than the emergency expansion threshold (70%) for three consecutive days in a week, the RNC reports ALM-20256 CPU Overload and enables the flow control function. In this situation, perform capacity expansion immediately.

Perform capacity expansion as follows:

¬ If there are vacant slots, add DPU boards.

¬ If there are no vacant slots and the RNC is configured with DPUb boards, replace the DPUb boards with DPUe boards.

¬ Add an RNC to increase DPU boards.

Scenario 2: The RNC-level DSP load is less than the expansion threshold, and DSP loads are severely unbalanced among physical subrack.

Assume that the expansion threshold is set to 60%, and the DSP load on physical subrack A is less than that on other physical subrack by more than 10%, as shown in Figure 2-7. The DSP load on physical subrack A is low because the RNC-level DSP load is less than the expansion threshold, and DSP loads are severely unbalanced among physical subrack.

Figure 2-7 RNC-level DSP load less than expansion threshold and DSP loads severely unbalanced among physical subrack
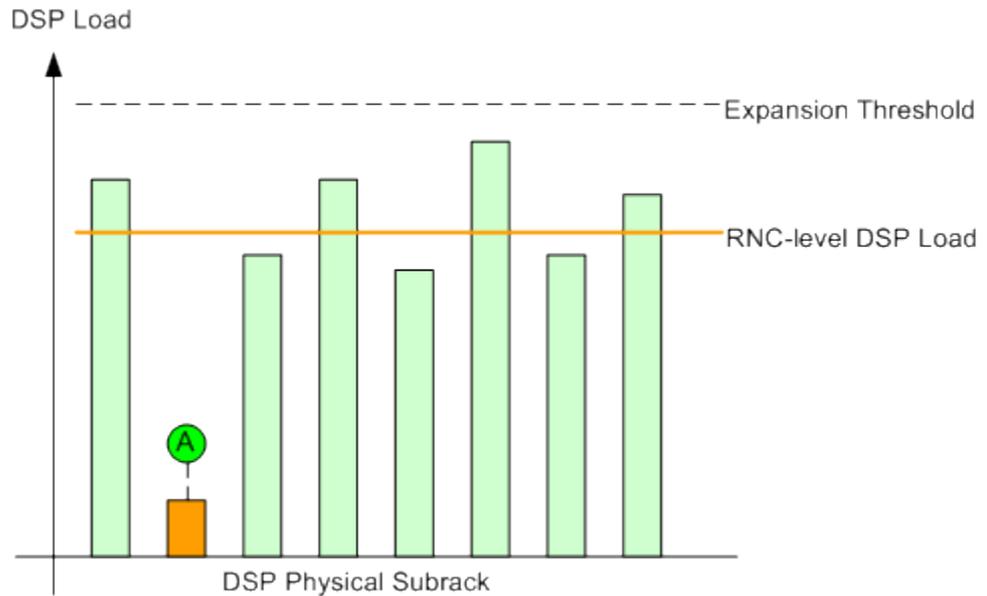
In this situation, run the MML command **SET UUSERPLNSHAREPARA** to set **Percentage of User Plane CPU Usage Sharing Out Threshold(UserPlnCpuSharingOutThd)**.

📖 NOTE

For details about load sharing, see *Controller Resource Sharing Feature Parameter Description* in the RAN Feature Documentation.

2.5 Interface Board Load

2.5.1 Monitoring Principles

RNC interface boards provide transmission ports and resources, process transport network messages, and exchange data between RNC boards and between the RNC and external devices.

These boards forward and process data for the Iub, Iu, and Iur interfaces. If one of the interface boards is overloaded, the packet loss rate increases. This affects communications and deteriorates user experience.

📖 NOTE

- ¬ In effective mode, run the MML command **LST BRD** to query information about a specific board, for example, whether the board is an interface board.
- ¬ In ineffective mode, find the MML command **ADD BRD** in the RNC configuration file. If the value of the **BRDCLASS** parameter is **INT**, the board is an interface board. You can obtain information about this interface board using this command.

2.5.2 Monitoring Methods

To obtain the interface board load, monitor the control-plane CPU load and user-plane forwarding load. The counters used to monitor the interface board load are as follows:

¬ VS.INT.CPULOAD.MEAN: Average CPU Usage of the INT

¬ VS.INT.TRANSLOAD.RATIO.MEAN: Average Forwarding Ratio of Interface Boards

The forwarding load is expressed by the ratio of the actual forwarding data rate to the maximum forwarding data rate configured for the interface board. The forwarding load indicates the operating load and performance of the interface board.

When the RNC detects that the CPU load on an interface board exceeds a specified threshold, ALM-20256 CPU Overload is reported.

2.5.3 Optimization Suggestions

Perform capacity expansion in the following scenarios:

¬ When the average CPU load on interface boards reaches 50%, prepare for capacity expansion. When the average CPU load on interface boards reaches 60%, perform capacity expansion immediately.

¬ When the average forwarding load on interface boards reaches 70%, prepare for capacity expansion. When the average forwarding load on interface boards reaches 80%, perform capacity expansion immediately.

Perform capacity expansion as follows:

¬ In non-transmission resource pool networking scenarios, assess the capacity of each interface board. For loads between interface boards of the same type, adjust the number of links carried on each interface board to balance loads between them. If loads are not balanced after the adjustment, add interface boards of the same type.

¬ In transmission resource pool networking scenarios, if the load on an interface board in the resource pool exceeds the load threshold, add interface boards of the same type.

📖 NOTE

For details about the Transmission Resource Pool in RNC feature, see *Transmission Resource Pool in RNC Feature Parameter Description* in the RAN Feature Documentation.

2.6 SCU Board Load

2.6.1 Monitoring Principles

Two GE Switching network and Control Unit (SCU) boards, such as SCUa or SCUb boards, are installed in slots 6 and 7 of each subrack. Two SCU boards in the same subrack work in active/standby mode.

SCUa and SCUb boards cannot be installed in the same subrack.

📖 **NOTE**

¬ In effective mode, run the MML command **LST SUBRACK** to query the current subrack configuration. In the command output, the values of **SLOT6** and **SLOT7** indicate the SCU board type.

¬ In ineffective mode, find the MML command **ADD SUBRACK** in the RNC configuration file. The value of **SCUTYPE** indicates the SCU board type.

For example, if the **ADD SUBRACK** command in the RNC configuration file is as follows:

ADD SUBRACK: SRN=2, SRName="test2", CONNPWR=NO, SCUTYPE=SCUa;

Then, the SCU board is of the SCUa type.

Ports on an SCU board form a trunk group that connects the MPS to the EPS. Restricted by their switching capacities, SCU boards are likely to be congested when configurations are unbalanced between subracks and when the inter-subrack traffic is heavy. When the traffic volume of inter-subrack communication approaches the overload threshold, voice service quality, data service quality, and network KPIs deteriorate, causing the system to become unstable. Therefore, the SCU CPU load and inter-subrack bandwidth need to be monitored for SCU boards.

2.6.2 Monitoring Methods

Monitoring of SCU CPU Load

The VS.SCU.CPULOAD.MEAN counter monitors the SCU CPU load.

When the RNC detects that the CPU load on an SCU subsystem exceeds a specified overload threshold, ALM-20256 CPU Overload is reported. You can query the overload threshold by running the **LST CPUTHD** command.

Monitoring of Inter-Subrack Bandwidth

The counters used to monitor the inter-subrack bandwidth are as follows:

¬ VS.Frame.Flux.Mean.TxRate: Average Inter-Subrack Transmitting Traffic

¬ Frame Mean Usage: Average utility rate of inter-subrack traffic

The Frame Mean Usage is calculated using the following formula:

Frame Mean Usage = VS.Frame.Flux.Mean.TxRate/Inter-subrack bandwidth x 100%

When a pair of active and standby SCUa boards are configured, the inter-subrack bandwidth is 4 Gbit/s. When a pair of active and standby SCUb boards are configured, the inter-subrack bandwidth is 40 Gbit/s. If either the active or standby SCUa/SCUb board becomes faulty, the inter-subrack bandwidth is reduced by half.

2.6.3 Optimization Suggestions

¬ If the SCU CPU load reaches 60%, contact Huawei for technical support.

¬ If the value of the Frame Mean Usage counter exceeds 40%, contact Huawei for technical support.

2.7 Common Channels

2.7.1 Monitoring Principles

Common channels include paging channels (PCHs), forward access channels (FACHs), and random access channels (RACHs).

PCHs are downlink channels used to transmit paging messages. If the PCH usage is high, paging messages may be lost.

FACHs are downlink transmission channels and RACHs are uplink transmission channels. FACHs and RACHs transmit signaling and a small amount of user data. RACH insufficiency will decrease the network access success rate and deteriorate user experience. FACH insufficiency will cause a large number of state transitions for PS services, occurrence of RRC signaling storms, and loss of signaling messages or user data.

2.7.2 Monitoring Methods

Based on the RNC's default parameter settings, the usages of PCHs, FACHs, and RACHs are calculated using the following formulas:

1. PCH usage

   PCH usage = VS.UTRAN.AttPaging1/(<SP> x 60 x 5/0.01)

2. FACH usage

¬ If a secondary common control physical channel (SCCPCH) carries both a FACH and a PCH, the FACH usage is calculated using the following formula:

   Usage of an FACH carried on a SCCPCH = VS.CRNCIubBytesFACH.Tx x 8/[(60 x <SP> x 168 x 1/0.01) x VS.PCH.Bandwidth.UsageRate x 6/7 + (60 x <SP> x 360 x 1/0.01) x (1 - VS.PCH.Bandwidth.UsageRate x 6/7)]

   where

   VS.PCH.Bandwidth.UsageRate = <VS.CRNCIubBytesPCH.Tx> / (<VS.CRNC.IUB.PCH.Bandwidth> x <SP> x 60.0)

   📖 NOTE

   <SP> indicates the measurement period expressed in minutes.

¬ If an SCCPCH only carries a FACH, the FACH usage is calculated using the following formula:

   FACH usage = ((VS.SRBNum.FACH - VS.OneSRBTTINum.FACH)/2 + VS.OneSRBTTINum.FACH + VS.IndepTRBNum.FACH)/(<SP> x 60.0/0.01)

3. RACH usage

   Each cell has only one RACH. When signaling and user data coexist on the RACH, the RACH usage is calculated using the following formula:

   RACH usage = ((VS.CRNCIubBytesRACH.Rx - VS.TRBNum.RACH x 360/8) x 8/168)/(<SP> x 60 x 4/0.02) + VS.TRBNum.RACH/(<SP> x 60 x 4/0.02)

2.7.3 Optimization Suggestions

It is recommended that you take the following measures to address PCH, FACH, and RACH overload:

¬ PCH overload

Inappropriate LA planning will cause PCH overload because paging messages are broadcast across the entire LA.

- – If paging messages are not retransmitted, the paging message loss rate is 5% when the PCH usage reaches 60%. In this scenario, analyze the cause of paging message loss or replan the LAs.
- – If paging messages are retransmitted once or twice, the paging message loss rate is 1% when the PCH usage reaches 70%. In this scenario, analyze the cause of paging message loss or replan the LAs.

¬ FACH overload

If the FACH usage reaches 70% during peak hours for three consecutive days in a week, the following measures are recommended:

- – If the network is configured with only one SCCPCH, add a second SCCPCH to carry FACHs.
- – If SCCPCHs cannot be added, add carriers, NodeBs, or micro NodeBs.

¬ RACH overload

If the RACH usage reaches 70% during peak hours for three consecutive days in a week, add carriers.

## 2.8 Downlink Load

2.8.1 Monitoring Principles

The downlink capacity of a cell is limited by its total available transmit power, which is determined by the NodeB power amplifier's capability and the power configured for the cell.

The downlink transmit power consists of the following, as shown in Figure 2-8:

¬ Common channel (CCH) power

¬ Non-HSPA power without CCH

¬ HSPA power

¬ Power margin

Figure 2-8 Dynamic power resource allocation
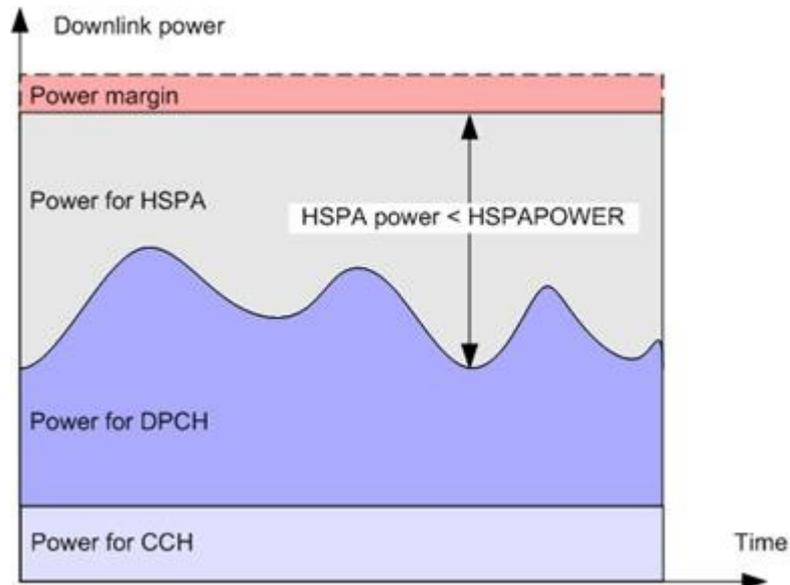
Downlink power resources are allocated as follows:

1.   Downlink power resources are first reserved for common physical channels and allocated to the DPCH. The remaining power resources are available for HSPA, including HSUPA and HSDPA.
2.   The HSPA power resources are first allocated to the HSUPA downlink control channels, including the E-AGCH, E-RGCH, and E-HICH. The remaining power resources are available for HSDPA.
3.   The HSDPA power resources are first allocated to the downlink control channel HS-SCCH. The remaining power resources are available for the traffic channel HS-PDSCH.

Downlink power consumption is related to cell coverage, UE locations, and the traffic load in the cell. Large cell coverage, UEs being physically far away from the cell center, and heavy traffic load all contribute to large downlink power consumption. Therefore, downlink power overload is more likely to occur in hotspots or in cells with large coverage.

When the downlink transmit power is insufficient, the following occurs:

¬ The cell coverage shrinks.
¬ The data throughput decreases.
¬ The service quality declines.
¬ New service requests are likely to be rejected.

2.8.2 Monitoring Methods

The following TCP-associated counters are defined for Huawei RNCs:

¬ VS.MeanTCP: Mean Transmitted Power of Carrier for Cell
¬ VS.MeanTCP.NonHS: Mean Transmitted Power of Carrier for Non-HSDPA Cell
¬ VS.HSDPA.MeanChThroughput: Mean Downlink Throughput of HSDPA MAC-D Flow for Cell

The downlink cell load is indicated by the mean utility ratio of transmitted carrier power in a cell.

- The mean utility ratio of the transmitted carrier power for non-HSPA users in a cell (including non-HSPA users on CCHs) is calculated using the following formula:

MeanTCP (NonHS) Usage = MeanNonHSTCP/MAXTXPOWER x 100%

- The mean utility ratio of the transmitted carrier power for all users in a cell is calculated using the following formula:

MeanTCP Usage = MeanTCP/MAXTXPOWER x 100%

📖 NOTE

- $MeanNonHSTCP = 10^{(VS.MeanTCP.NonHS/10)}/1000$
- $MeanTCP = 10^{(VS.MeanTCP/10)}/1000$
- To obtain MAXTXPOWER, run the **LST UCELL** command to query the value of the **Max Transmit Power of Cell** parameter, and convert the parameter value from the unit "0.1 dBm" to "watt."

2.8.3 Optimization Suggestions

Perform capacity expansion in the following scenarios:

- The **MeanTCP (NonHS) Usage** is greater than 70% during peak hours for three consecutive days in a week.
- The **MeanTCP Usage** is greater than 85% and the value of the VS.HSDPA.MeanChThroughput counter is less than the value required by subscribers during peak hours for three consecutive days in a week (for example, 300 kbit/s).

Perform capacity expansion as follows:

- For cells with heavy traffic, add a carrier for the current sector if possible. If the number of carriers in the sector reaches the maximum, add a NodeB or split the sector.
- For cells with light traffic and poor coverage, add a NodeB.

2.9 Uplink Load

2.9.1 Monitoring Principles

RTWP measures the uplink cell capability on WCDMA networks.

RTWP includes the following:

- Background noise
- Intra-system interference, including uplink signals sent by the UEs in the serving and neighboring cells
- RF interference, including RF interference from an external source (for example, RF interference from another RAT or from equipment other than communication equipment) and intra-system RF interference (for example, intermodulation interference produced by hardware components)

The NodeB measures the RTWP on each receive channel in each cell. The cell RTWP obtained by the RNC is the linear average of the RTWPs measured on all receive channels in a cell under the NodeB. The RTWP indicates the interference to a NodeB and the signal strength on the RX port on the RF module.

The uplink cell capacity is restricted by the rise over thermal (RoT), which equals the RTWP minus the cell's background noise. The formula is as follows:

$$RoT(dB) = RTWP(dBm) - PN(dBm)$$

If there is no RF interference, the RoT is generated by intra-system interference. Under this condition, the RoT is used as a criterion to evaluate the uplink load.

The relationship between the RoT and the uplink load factor η_{UL} is as follows:

$$RoT = 10\log(\frac{1}{1-\eta_{UL}})$$

For example, a 3 dB noise increase corresponds to 50% of the uplink load and a 6 dB noise increase corresponds to 75% of the uplink load.

Figure 2-9 Relationship between RTWP, noise increase, and uplink load
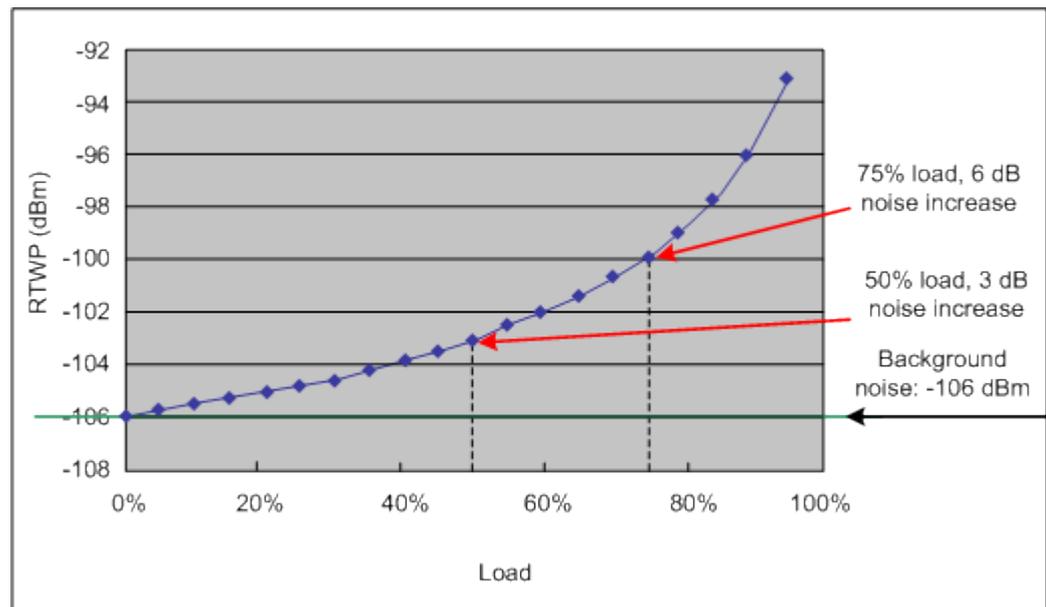
A large RTWP value in a cell is caused by traffic overflow, hardware faults (for example, poor quality of antennas or feeder connectors), or external interference. If the RTWP value is too large, the cell coverage shrinks, the quality of admitted services declines, or new service requests are rejected.

2.9.2 Monitoring Methods

The RTWP and the Equivalent Number of Users (ENU) are indicated by the following counters:

¬ VS.MeanRTWP: Mean Power of Totally Received Bandwidth for Cell

- ¬ VS.MinRTWP: Minimum Power of Totally Received Bandwidth for Cell
- ¬ VS.RAC.UL.EqvUserNum: Mean Number of UL Equivalent Voice UEs in CEL_DCH State for Cell

The ENU can be specified by the following parameter:

UlTotalEqUserNum: total number of equivalent users in the uplink, which can be queried using the RNC MML command **LST UCELLCAC**.

The UL ENU Ratio is calculated using the following formula:

UL ENU Ratio = VS.RAC.UL.EqvUserNum/UlTotalEqUserNum

In some areas, the background noise increases to -106 dBm or above due to external interference or hardware faults. If this occurs, the value of the VS.MinRTWP counter (the RTWP value obtained when the cell carries no traffic) is considered the background noise.

The RTWP of a cell is considered high when the value of the VS.MeanRTWP counter is greater than -100 dBm during off-peak hours or greater than -90 dBm during peak hours for two or three consecutive days in a week.

A cell is considered heavily loaded if the UL ENU Ratio exceeds 75% during peak hours for two or three consecutive days in a week.

2.9.3 Optimization Suggestions

Perform capacity expansion in the following scenarios:

- ¬ If the value of the VS.MinRTWP counter is greater than -100 dBm or less than -110 dBm during off-peak hours for three consecutive days in a week, there may be hardware faults or external interference. Locate and rectify the faults and attempt to eliminate the interference.

The following table lists the RF alarms reported by the NodeB.

Alarm ID	Alarm Name
ALM-26522	RF Unit RX Channel RTWP/RSSI Unbalanced
ALM-26521	RF Unit RX Channel RTWP/RSSI Too Low
ALM-26532	RF Unit Hardware Fault
ALM-26752	ALD Hardware Fault
ALM-26758	TMA Running Data and Configuration Mismatch
ALM-26755	TMA Bypass
ALM-26757	RET Antenna Running Data and Configuration Mismatch
ALM-26541	ALD Maintenance Link Failure

Alarm ID	Alarm Name
ALM-26529	RF Unit VSWR Threshold Crossed

- ⌐ If the value of the VS.MeanRTWP counter is greater than -90 dBm during peak hours for three consecutive days in a week, there may be hardware faults or external interference. Locate and rectify the faults and attempt to eliminate the interference. If the value of the VS.MeanRTWP counter is still greater than -90 dBm after hardware faults are rectified and external interference is eliminated, enable the following features as required:

    - WRFD-140215 Dynamic Configuration of HSDPA CQI Feedback Period
    - WRFD-010712 Adaptive Configuration of Traffic Channel Power offset for HSUPA

    If the uplink capacity of the cell still does not meet the requirements after the preceding features are enabled, add carriers. If there are no additional UARFCNs available, add NodeBs.

    📖 NOTE

    - ⌐ For details about how to enable the WRFD-140215 Dynamic Configuration of HSDPA CQI Feedback Period feature, see *Dynamic Configuration Based on the Uplink Load Feature Parameter Description* in the RAN Feature Documentation.
    - ⌐ For details about how to enable the WRFD-010712 Adaptive Configuration of Traffic Channel Power offset for HSUPA feature, see *Power Control Feature Parameter Description* in the RAN Feature Documentation.

- ⌐ If the number of uplink ENUs is insufficient and the amount of uplink power is sufficient, run the **MOD UCELLCAC** command with the **UL total equivalent user number** parameter set to a larger value. In addition, run the **SET UADMCTRL** command with the **AF of hsupa interactive service** and **AF of hsupa background service** parameters set to **10**.

## 2.10 OVSF Code Usage

2.10.1 Monitoring Principles

In a WCDMA system, channels are identified by codes. Two types of codes are used for each channel. One is the scrambling code and the other is the Orthogonal Variable Spreading Factor (OVSF) code.

In the uplink, each UE is allocated a unique scrambling code. In the downlink, each cell is allocated a unique scrambling code; all UEs in a cell use the same scrambling code but each of them is allocated a unique OVSF code. Therefore, OVSF codes distinguish the downlink physical channels of different UEs in a cell.

In a WCDMA cell, different user data is distinguished by the CDMA technique, and all user data is transmitted over the same central frequency at almost the same time. OVSF codes provide perfect orthogonality, minimizing interference between different users.

Figure 2-10 illustrates an OVSF code tree.

Figure 2-10 OVSF code tree
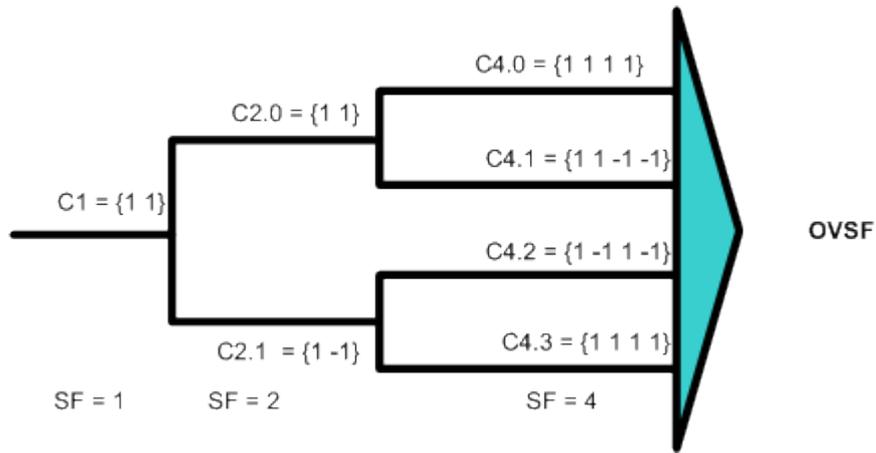
In the downlink, the maximum spreading factor (SF) is 256.

An OVSF code tree can be divided into 4 SF4 codes, 8 SF8 codes, 16 SF16 codes, ..., 256 SF256 codes. Codes with various SFs can be considered equivalent to SF256 codes. For example, a code with SF8 is equivalent to 32 codes with SF256. Using this method, the OVSF code usage can be calculated for a user or a cell.

In a cell, only one OVSF code tree is available. In the OVSF code tree, sibling codes are orthogonal to each other, but are non-orthogonal to their parent or child codes. As a result, once a code is allocated to a user, neither its parent nor child code can be allocated to any other user. Downlink OVSF code resources are limited. If available OVSF codes are insufficient, a new call request is rejected.

After HSDPA is introduced, HSDPA and R99 services share OVSF codes. HS-PDSCH code resource management can be performed at both RNC and NodeB levels. RNC-controlled static or dynamic code allocation is enabled through the **Allocate Code Mode** parameter. NodeB-controlled dynamic code allocation is enabled through the **DynCodeSw** parameter.

Figure 2-11 shows RNC-controlled static code allocation.

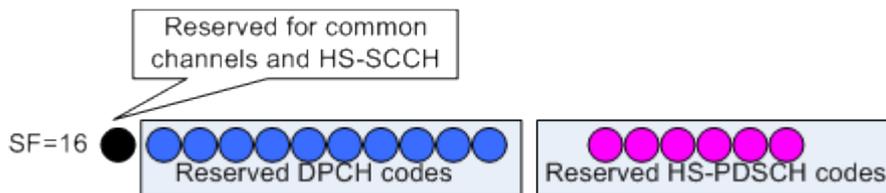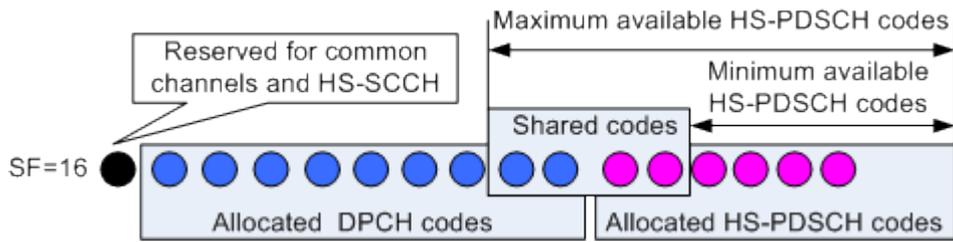**Figure 2-11** RNC-controlled static code allocation

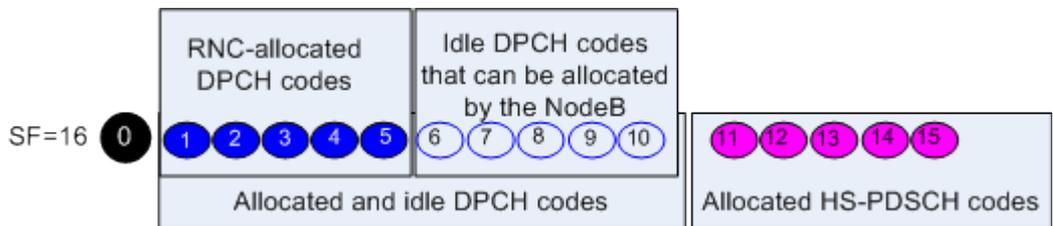Figure 2-12 shows RNC-controlled dynamic code allocation.

Figure 2-12 RNC-controlled dynamic code allocation

The system reserves code resources for HSDPA services, and these code resources can be shared among HSDPA services. Therefore, HSDPA services do not require admission control based on cell code resources.

Figure 2-13 shows NodeB-controlled dynamic code allocation.

Figure 2-13 NodeB-controlled dynamic code allocation

NodeB-controlled dynamic code allocation is more flexible than RNC-controlled dynamic code allocation. It shortens the response time and saves the Iub signaling used for code allocation.

2.10.2 Monitoring Methods

Huawei RNCs monitor the average usage of an OVSF code tree based on the number of equivalent codes with SF256, which is measured by the VS.RAB.SFOccupy counter.

The codes available for the dedicated channel (DCH) can be calculated using the following formula:

DCH_OVSF_CODE = (<VS.SingleRAB.SF4> + <VS.MultRAB.SF4>) x 64 + (<VS.MultRAB.SF8> + <VS.SingleRAB.SF8>) x 32 + (<VS.MultRAB.SF16> + <VS.SingleRAB.SF16>) x 16 + (<VS.SingleRAB.SF32> + <VS.MultRAB.SF32>) x 8 + (<VS.MultRAB.SF64> +< VS.SingleRAB.SF64>) x 4 + (<VS.SingleRAB.SF128> +< VS.MultRAB.SF128>) x 2 + (<VS.SingleRAB.SF256> +< VS.MultRAB.SF256>)

The maximum number of codes available for the DCH can be calculated using the following formula:

DCH_OVSF_CODE_Ava = 256 - (Codes occupied by CCHs + Codes occupied by E-AGCHs + Codes occupied by E-RGCHs and E-HICHs + Codes reserved for HS-PDSCHs + HS-SCCH codes)

For example, if the following conditions are met:

¬ A cell that supports HSPA is configured with one SCCPCH, one E-AGCH, one E-RGCH/E-HICH, and two HS-SCCHs.

- At least one code is reserved for HSDPA services.

Then, DCH_OVSF_CODE_Ava = 256 - (8 + 1 + 2 + 16 + 4) = 225.

OVSF code usages are calculated as follows:

- OVSF Usage = VS.RAB.SFOccupy/256 x 100%
- DCH OVSF Usage = DCH_OVSF_CODE/DCH_OVSF_CODE_Ava

2.10.3 Optimization Suggestions

If the value of a cell's DCH OVSF Usage is greater than 70% during peak hours for three consecutive days in a week, the cell runs out of OVSF codes.

Perform capacity expansion as follows:

- Enable the WRFD-010631 Dynamic Code Allocation Based on NodeB feature if this feature has not been enabled. Preferentially allocate idle codes to HSDPA UEs to improve the HSDPA UE throughput.
- Add carriers or split the sector.
- Enable the WRFD-010653 96 HSDPA Users per Cell feature if it is not enabled.

📖 NOTE

For details about how to enable the WRFD-010631 Dynamic Code Allocation Based on NodeB feature and the WRFD-010653 96 HSDPA Users per Cell feature, see *HSDPA Feature Parameter Description* in the RAN Feature Documentation.

2.11 CE Usage

2.11.1 Monitoring Principles

CE resources are baseband processing resources in a NodeB. The more CEs a NodeB supports, the stronger the NodeB's service processing capability. If a new call arrives but there are not enough CEs (not enough baseband processing resources), the call will be blocked.

Uplink CE resources can be shared in an uplink resource group, but not between uplink resource groups. Downlink CE resources are associated with the baseband processing boards where a cell is set up. CE resources allocated by licenses are shared among services on the NodeB. (CE resources are shared on a per operator basis in MOCN scenarios.)

The NodeB sends the RNC a response message that carries its CE capability. The NodeB's CE capability is limited by both the installed hardware and the configured software licenses.

The methods of calculating the credit resource usage of admitted UEs are different before and after the CE Overbooking feature is enabled. Table 2-3 describes the details.

Table 2-3 Credit resources consumed by admitted UEs before and after CE Overbooking is enabled

Before or After CE Overbooking is Enabled	Credit Resource Consumed by Admitted UEs
Before CE Overbooking is enabled	The RNC calculates the usage of CEs for admitted UEs by adding up credit resources reserved for each UE. – R99 UE: The RNC calculates the usage of credit resources for an R99 UE based on the maximum bit rate (MBR). – HSUPA UE: The RNC calculates the usage of credit resources for an HSUPA UE based on MAX (GBR, $Rate_{one\ RLC\ PDU}$).
After CE Overbooking is enabled	The NodeB calculates the usage of credit resources for all admitted UEs at the cell and NodeB levels and periodically reports the calculation results to the RNC through measure reports (MRs). – R99 UE: The NodeB calculates the usage of credit resources for an R99 UE based on the MBR. – HSUPA UE using a 10 ms transmission time interval (TTI): The NodeB adjusts the credit resource usage on such a UE based on the UE's rate. After the adjustment, the credit resources consumed by such a UE must not exceed the credit resources required by $Rate_{one\ RLC\ PDU}$. – HSUPA UE using a 2 ms TTI: The NodeB adjusts the credit resource usage on such a UE based on the UE's rate and the minimum number of CEs (specified by ***CERSVFOR2MSUSER***) reserved for admitting such a UE. After the adjustment, the credit resources consumed by such a UE must not exceed the credit resources required by $Rate_{one\ RLC\ PDU}$. 📖 NOTE The minimum number of CEs reserved for admitting an HSUPA UE using a 2 ms TTI is 4 by default. The value range is 1 to 8.

📖 NOTE

> For details about CE Overbooking, see *CE Overbooking Feature Parameter Description.*

CCHs do not require extra CE resources because the RNC reserves CE resources for services on these channels. Signaling carried on an associated channel of the DCH does not consume extra CE resources, either. One CE can be consumed by a 12.2 kbit/s voice call.

Table 2-4 to Table 2-9 provide the number of CEs consumed by different services.

Table 2-4 Uplink CEs consumed by an R99 service

Direction	Rate (kbit/s)	SF	2RX: Number of CEs Consumed	2RX: Number of Credit Resources Consumed	4RX: Number of CEs Consumed	4RX: Number of Credit Resources Consumed
UL	3.4	256	1	2	2	4
	13.6	64	1	2	2	4
	8	64	1	2	2	4
	16	64	1	2	2	4
	32	32	1.5	3	2	4
	64	16	3	6	3	6
	128	8	5	10	5	10
	144	8	5	10	5	10
	256	4	10	20	10	20
	384	4	10	20	10	20

Table 2-5 Downlink CEs consumed by an R99 service

Direction	Rate (kbit/s)	SF	Number of CEs Consumed	Number of Credit Resources Consumed
DL	3.4	256	1	1
	13.6	128	1	1
	8	128	1	1
	16	128	1	1
	32	64	1	1
	64	32	2	2
	128	16	4	4
	144	16	4	4
	256	8	8	8
	384	8	8	8

Table 2-6 CEs consumed by an HSUPA service (10 ms TTI, SRB over DCH)

Direction	Rate (kbit/s) SF > minSF	Rate (kbit/s) SF = minSF	SF	2RX: Number of CEs Consumed	2RX: Number of Credit Resources Consumed	4RX: Number of CEs Consumed	4RX: Number of Credit Resources Consumed
UL	32	64	32	1	2	2	4
	64	128	16	2	4	2	4
	128	256	8	4	8	4	8
	608	608	4	8	16	8	16
	1280	1280	2SF4	16	32	16	32
	1800	1800	2SF2	32	64	32	64

Table 2-7 CEs consumed by an HSUPA service (2 ms TTI, SRB over DCH)

Direction	Rate (kbit/s) SF > minSF	Rate (kbit/s) SF = minSF	SF	2RX: Number of CEs Consumed	2RX: Number of Credit Resources Consumed	4RX: Number of CEs Consumed	4RX: Number of Credit Resources Consumed
UL	608	608	4	8	16	8	16
	1280	1280	2SF4	16	32	16	32
	2720	2720	2SF2	32	64	32	64

Table 2-8 CEs consumed by an HSUPA service (10 ms TTI, SRB over HSUPA)

Direction	Rate (kbit/s) SF > minSF	Rate (kbit/s) SF = minSF	SF	2RX: Number of CEs Consumed	2RX: Number of Credit Resources Consumed	4RX: Number of CEs Consumed	4RX: Number of Credit Resources Consumed
UL	16	64	32	1	2	2	4
	32	128	16	2	4	2	4
	128	256	8	4	8	4	8
	608	608	4	8	16	8	16
	1280	1280	2SF4	16	32	16	32
	1800	1800	2SF2	32	64	32	64

Table 2-9 CEs consumed by an HSUPA service (2 ms TTI, SRB over HSUPA)

Direction	Rate (kbit/s) SF > minSF	Rate (kbit/s) SF = minSF	SF	2RX: Number of CEs Consumed	2RX: Number of Credit Resources Consumed	4RX: Number of CEs Consumed	4RX: Number of Credit Resources Consumed
UL	608	608	4	8	16	8	16
	1280	1280	2SF4	16	32	16	32
	2720	2720	2SF2	32	64	32	64
	5760	5760	2SF2+2SF4	48	96	48	96

📖 NOTE

Table 2-4 to Table 2-9 apply only to WBBPb, WBBPd, and WBBPf boards in 3900 series base stations.

HSDPA services do not consume downlink CEs allocated to R99 services. HSUPA and R99 services share uplink CEs.

2.11.2 Monitoring Methods

The following RNC counters are used to monitor CE usage:

- ¬ VS.NodeB.ULCreditUsed.Mean: Average NodeB Uplink Credit Usage When CE Overbooking Is Enabled for NodeB
- ¬ VS.LC.ULCreditUsed.Mean: Mean Usage of UL Credit for Cell
- ¬ VS.LC.DLCreditUsed.Mean: Mean Usage of DL Credit for Cell

The NodeB uses separate baseband processing units in the uplink and downlink. Therefore, the NodeB manages uplink and downlink CE resources separately. The uplink and downlink CE resource usages are calculated as follows:

- ¬ License-based uplink CE usage

  License-based uplink CE usage = UL NodeB Mean CE Used Number/UL License CE Number

  If the value of the VS.NodeB.ULCreditUsed.Mean counter is greater than 0, the CE Overbooking feature has taken effect, and the following formula is true:

  UL NodeB Mean CE Used Number = VS.NodeB.ULCreditUsed.Mean/2

  Otherwise, the following formula is true:

  UL NodeB Mean CE Used Number = Sum_AllCells_of_NodeB(VS.LC.ULCreditUsed.Mean/2)

  where

  "VS.LC.ULCreditUsed.Mean/2" indicates the number of uplink CEs because the number of uplink credit resources is twice the number of uplink CEs, whereas the number of downlink credit resources is equal to the number of downlink CEs.

  UL License CE Number = UL NodeB License CE Cfg Number

- ¬ License-based downlink CE usage

  License-based downlink CE usage = DL NodeB Mean CE Used Number/DL License CE Number

  DL NodeB Mean CE Used Number = Sum_AllCells_of_NodeB(VS.LC.DLCreditUsed.Mean)

  DL License CE Number = DL NodeB License CE Cfg Number

- ¬ Hardware-based uplink CE usage

  Hardware-based uplink CE usage = UL NodeB Mean CE Used Number/UL CE Capacity Number

  The value of UL NodeB Mean CE Used Number equals that used for calculating the license-based uplink CE usage.

  UL CE Capacity Number = VS.HW.ULCreditAvailable

- ¬ Hardware-based downlink CE usage

  Hardware-based downlink CE usage = DL NodeB Mean CE Used Number/DL CE Capacity Number

  The value of DL NodeB Mean CE Used Number equals that used for calculating the license-based downlink CE usage.

  DL CE Capacity Number = VS.HW.DLCreditAvailable

The CE resource usage can be monitored by alarms. If the CE hardware capacity is exceeded, ALM-28230 Base Station Service Overload is reported.

2.11.3 Optimization Suggestions

If the uplink/downlink license- or hardware-based CE usage is consistently greater than 70% during peak hours for three consecutive days in a week, perform capacity expansion as follows:

- ¬ If the license-based CE usage exceeds the capacity expansion threshold, CE resources are limited by the license. In this situation, upgrade the license file.
- ¬ If the hardware-based CE usage exceeds the capacity expansion threshold, CE resources are limited by the hardware capacity. In this situation, add WBBP boards.

If capacity expansion is inapplicable, perform the following operations:

- ¬ Run the RNC MML command **SET UCORRMALGOSWITCH**. In this step, select the **DRA_DCCC_SWITCH** and **DRA_BASE_ADM_CE_BE_TTI_RECFG_SWITCH** check boxes under the **Dynamic Resource Allocation Switch** parameter to enable the DCCC algorithm and the TTI dynamic adjustment algorithm for admission CE-based BE services, respectively.
- ¬ Run the RNC MML command **SET UUSERGBR** with the **Uplink GBR for BE service** parameter set to **D32**.

Newly added CE resources can share the traffic in hotspots and relieve CE congestion caused by traffic overflow.

2.12 Iub Bandwidth

2.12.1 Monitoring Principles

The Iub interface exists between the NodeB and RNC. The interface uses ATM or IP transmission depending on the transmission medium.

ATM and IP transmission resources can be classified into physical resources, logical port (LP) resources, resource groups, and link resources, as shown in Figure 2-14 and Figure 2-15.

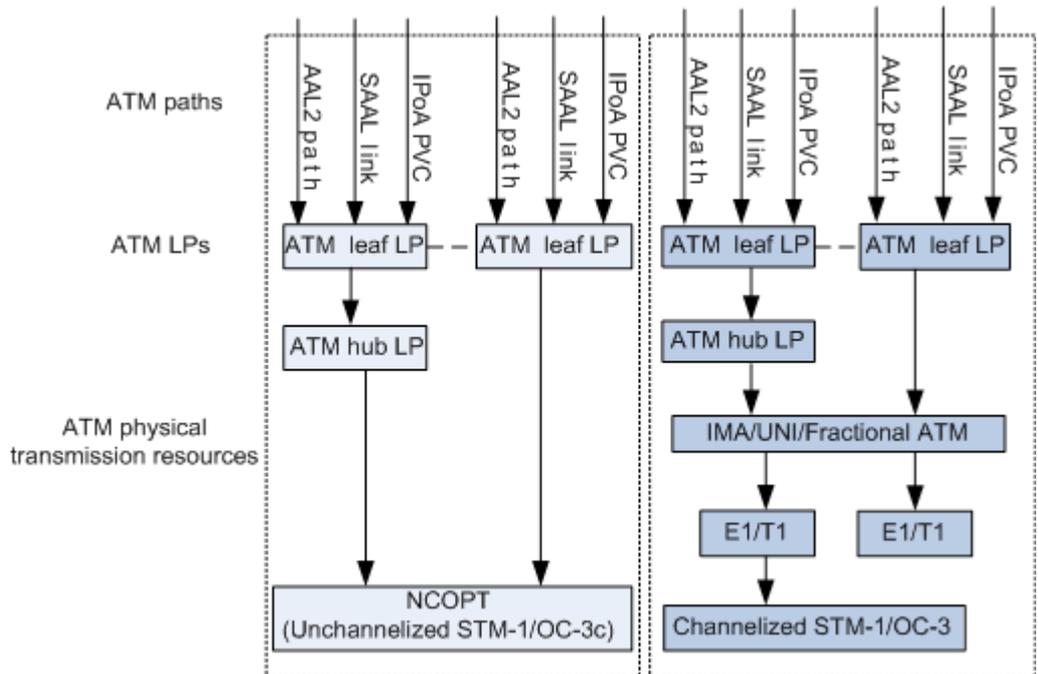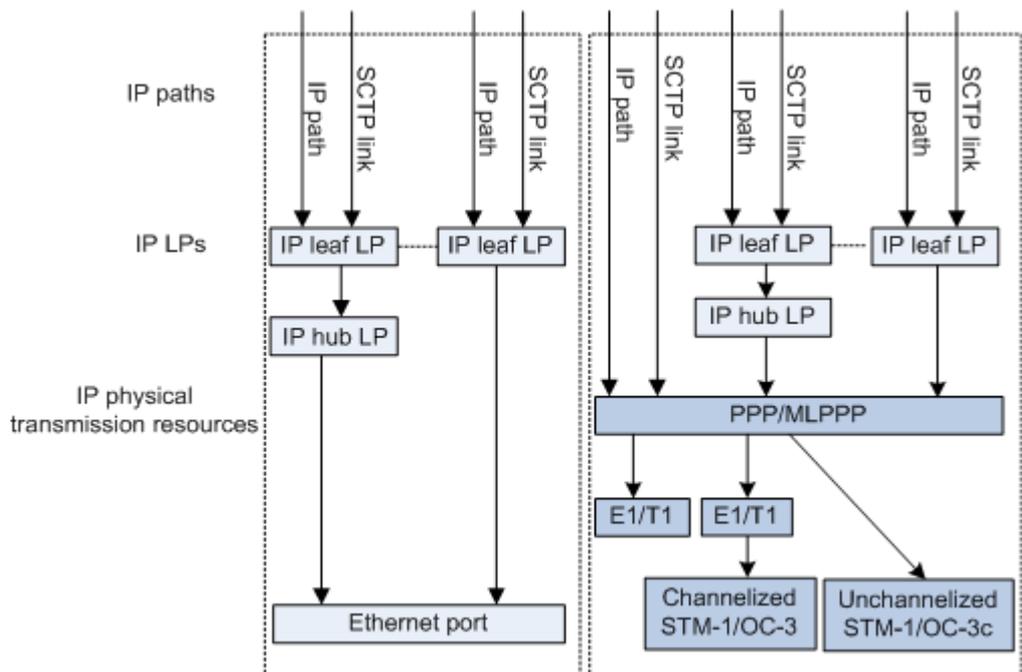**Figure 2-14** ATM transmission resources

Figure 2-15 IP transmission resources

Iub bandwidth congestion will cause RRC connection setup and RAB setup failures. Table 2-10 describes Iub bandwidth congestion scenarios.

Table 2-10 Iub bandwidth congestion scenarios

Scenario	Description
The physical transmission resources are sufficient, but the admission fails.	Admission control is performed based on the sufficiency of transmission resources. If transmission resources are sufficient, the admission succeeds. Otherwise, the transmission fails. Admission control prevents excessive service admission and ensures the quality of admitted services.
The physical transmission bandwidth is insufficient.	The physical transmission bandwidth between the RNC and NodeB is insufficient.

2.12.2 Monitoring Methods

ATM Transmission

On an ATM transmission network, Huawei RNCs and NodeBs can monitor the uplink and downlink loads on their interface boards. The Iub bandwidth usage is indicated by the ratio of the actual uplink or downlink load to the configured Iub bandwidth.

The RNC monitors the bandwidth-based admission success rate for each NodeB.

1. Bandwidth-based admission success rate

The counters for monitoring the bandwidth-based admission success rate are as follows:

¬ VS.AAL2.CAC.Succ: Number of Successful AAL2 Path Admissions

¬ VS.AAL2.CAC.Att: Number of AAL2 Path Resource Admissions

The bandwidth-based admission success rate is calculated using the following formula:

Bandwidth-based admission success rate = VS.AAL2.CAC.Succ/VS.AAL2.CAC.Att

If the bandwidth-based admission success rate is less than 99%, bandwidth congestion has probably occurred on the user plane.

2. Physical bandwidth usage

(1) Control plane

The counters for monitoring the number of bytes transmitted or received on Signaling ATM Layer (SAAL) links (including NCP, CCP and ALCAP links) are as follows:

¬ VS.SAALLNK.PVCLAYER.TXBYTES: Number of bytes transmitted on an SAAL link at the ATM layer

¬ VS.SAALLNK.PVCLAYER.RXBYTES: Number of bytes received on an SAAL link at the ATM layer

The uplink and downlink bandwidth usages of the SAAL links on the control plane over the Iub interface are calculated using the following formulas:

- DL Iub Usage on Control Plane = VS.SAALLNK.PVCLAYER.TXBYTES x 8/1000/SP<Measurement period>/TX BW_CFG

- UL Iub Usage on Control Plane = VS.SAALLNK.PVCLAYER.RXBYTES x 8/1000/SP<Measurement period>/RX BW_CFG

When the uplink or downlink bandwidth usage reaches 70%, bandwidth congestion may have occurred on the control plane. Capacity expansion is then required. In addition, if ALM-21532 SAAL Link Congestion is reported on the Iub interface, bandwidth congestion has occurred on the control plane.

(2) User plane

The counters for monitoring the number of bytes transmitted or received on an AAL2 path at the ATM layer for NodeBs are as follows:

- VS.AAL2PATH.PVCLAYER.TXBYTES: Number of bytes transmitted on an AAL2 path at the ATM layer

- VS.AAL2PATH.PVCLAYER.RXBYTES: Number of bytes received on an AAL2 path at the ATM layer

The uplink and downlink bandwidth usages of the user plane on the Iub interface are calculated using the following formulas:

- DL Iub Usage on User Plane = Sum (VS.AAL2PATH.PVCLAYER.TXBYTES) x 8/SP<Measurement period>/1000/TX BW_CFG

- UL Iub Usage on User Plane = Sum (VS.AAL2PATH.PVCLAYER.RXBYTES) x 8/SP<Measurement period>/1000/RX BW_CFG

When the uplink or downlink bandwidth usage reaches 70%, bandwidth congestion has occurred on the user plane. Capacity expansion is then required.

IP Transmission

On an IP transmission network, the RNC and NodeB can monitor the average uplink and downlink loads on their interface boards. The Iub bandwidth usage is represented by the ratio of the average uplink or downlink load to the configured Iub bandwidth. In addition, the RNC and NodeB can dynamically adjust the bandwidth of a service based on the QoS requirements of the service and user priority and improve the Iub bandwidth usage using the reserve pressure algorithm on their interface boards.

1. Bandwidth-based admission success rate

The counters for monitoring the bandwidth-based admission success rate are as follows:

- VS.ANI.IP.Conn.Estab.Succ: Number of Successful IP Connections for IP Transport Adjacent Node

- VS.ANI.IP.Conn.Estab.Att: Number of IP Connection Setup Requests Received by IP Transport Adjacent Node

¬ VS.ANI.IP.FailResAllocForBwLimit: Number of Failed Resource Allocations Due to Insufficient Bandwidth on the IP Transport Adjacent Node

The IP connection setup success rate is calculated using the following formula:

IP connection setup success rate = VS.ANI.IP.Conn.Estab.Succ/VS.ANI.IP.Conn.Estab.Att

If the IP connection setup success rate is less than 99%, bandwidth congestion has probably occurred on the user plane.

If the value of the VS.ANI.IP.FailResAllocForBwLimit counter is not zero, bandwidth congestion has occurred on the user plane.

2. Physical bandwidth usage

(1) Control plane

The counters for monitoring the number of bytes transmitted or received on Signaling Control Transmission Protocol (SCTP) links (including NCP and CCP links) are as follows:

¬ VS.SCTP.TX.BYTES: Number of IP bytes transmitted on an SCTP link
¬ VS.SCTP.RX.BYTES: Number of IP bytes received on an SCTP link

The uplink and downlink traffic volumes of the SCTP links on the control plane over the Iub interface are calculated using the following formulas:

¬ SCTP DL KBPS = VS.SCTP.TX.BYTES x 8/SP<Measurement period>/1000
¬ SCTP UL KBPS = VS.SCTP.RX.BYTES x 8/SP<Measurement period>/1000

If ALM-21542 SCTP Link Congestion is reported on the Iub interface, bandwidth congestion has occurred on the control plane.

(2) User plane

In transmission resource pool networking, the number of IP bytes transmitted or received on the user plane by each adjacent node is measured by the following counters:

¬ VS.IPPOOL.ANI.IPLAYER.TXBYTES: Number of IP bytes transmitted on the user plane of an adjacent node
¬ VS.IPPOOL.ANI.IPLAYER.RXBYTES: Number of IP bytes received on the user plane of an adjacent node

The Iub bandwidth usage on a transmission resource pool is calculated using the following formulas:

¬ DL Iub Usage on User Plane = VS.IPPOOL.ANI.IPLAYER.TXBYTES x 8/SP<Measurement period>/1000/TX BW_CFG
¬ UL Iub Usage on User Plane = VS.IPPOOL.ANI.IPLAYER.RXBYTES x 8/SP<Measurement period>/1000/RX BW_CFG

If the uplink or downlink bandwidth usage of the user plane on the Iub interface reaches 70%, bandwidth congestion has occurred on the user plane. Capacity expansion is then required.

2.12.3 Optimization Suggestions

If the Iub bandwidth usage exceeds 70% during peak hours for three consecutive days in a week, the Iub bandwidth is insufficient.

No.	Scenario	Optimization Suggestion
1	Bandwidth congestion on the ATM control plane	Increase the bandwidth configured for the SAAL link.
2	Bandwidth congestion on the IP control plane	Increase the transmission bandwidth for the SCTP link.
3	Physical bandwidth congestion on the ATM and IP user planes	Increase the transmission bandwidth.
4	Admission bandwidth congestion on the ATM and IP user planes, not accompanied by physical bandwidth congestion	Decrease the activity factor for PS services.

Scenario 1: Bandwidth Congestion on the ATM Control Plane

If an SAAL link is congested, increase the bandwidth configured for the SAAL link by running the following commands:

ADD ATMTRF: TRFX=NewIndex, ST=NRTVBR, UT=KBIT/S, PCR=NewValue, SCR= NewValue;

MOD SAALLNK: SRN=XXX, SN=XXX, SAALLNKN=XXX, CARRYT=IMA, CARRYSRN=XXX, CARRYSN=NewIndex, CARRYIMAGRPN=NewIndex;

Scenario 2: Bandwidth Congestion on the IP Control Plane

If an SCTP link is congested, check whether the transmission bandwidth between the RNC and NodeB is sufficient and whether the DSCP of the SCTP link is appropriately set. If the transmission bandwidth is sufficient and the DSCP is appropriately set, add an SCTP link by running the following command:

ADD SCTPLNK: SRN=XXX, SN=XXX, SCTPLNKN=XXX, MODE=SERVER, APP=NBAP, DSCP=48, VLANFLAG1=DISABLE, VLANFLAG2=DISABLE, SWITCHBACKFLAG=YES;

Scenario 3: Physical Bandwidth Congestion on the ATM and IP User Planes

Increase the physical bandwidth of the Iub interface as required.

Scenario 4: Admission Bandwidth Congestion on the ATM and IP User Planes, Not Accompanied by Physical Bandwidth Congestion

Step 1 Decrease the activity factor for PS services to enable the system to admit more UEs. Query the activity factor used by the adjacent node by checking the configuration data of the following command:

ADD ADJMAP: ANI=XXX, ITFT=IUB, TRANST=XXX, CNMNGMODE=SHARE, FTI=OldIndex;

Step 2 Run the **ADD TRMFACTOR** command to add an activity factor table. The recommended value for **PSINTERDL**, **PSINTERUL**, **PSBKGDL**, **PSBKGUL**, **HDINTERDL**, and **HDBKGDL** is **10**. The following is an example:

ADD TRMFACTOR:FTI=NewIndex, REMARK="IUB_USER", PSINTERDL=10, PSINTERUL=10, PSBKGDL=10, PSBKGUL=10, HDINTERDL=10, HDBKGDL=10;

Step 3 Run the **MOD ADJMAP** command to use the new activity factor on the adjacent node. The following is an example:

MOD ADJMAP: ANI=XXX, ITFT=IUB, FTI=NewIndex;

📖 **NOTE**

The activity factor equals the ratio of actual bandwidth occupied by a UE to the bandwidth allocated to the UE during its initial access. It is used to predict the bandwidth required by admission. Each NodeB can be configured with its own activity factor. The default activity factor for voice services is 70%, and the default activity factor for PS BE services is 40%.

----End

2.13 NodeB CNBAP Load

2.13.1 Monitoring Principles

CNBAP load is used to assess a NodeB's processing capability. CNBAP overload will cause a radio link setup failure, thereby decreasing the RRC connection setup and RAB setup success rates.

2.13.2 Monitoring Methods

The following NodeB counters are used to monitor the CNBAP load:

¬ VS.RadioLink.Recv.Mean: average number of wireless connection receptions per second

¬ VS.DedicMeaRpt.MEAN: average number of Dedicated Measurement Reporting per second

The CNBAP load on a NodeB is limited by the license and hardware capacity. The license- and hardware-based CNBAP usages are calculated using the following formulas:

¬ License-based CNBAP Usage = (VS.RadioLink.Recv.Mean + VS.DedicMeaRpt.MEAN/12)/License CNBAP

where License CNBAP = NodeB License CNBAP Cfg Number

¬ Hardware-based CNBAP Usage = (VS.RadioLink.Recv.Mean + VS.DedicMeaRpt.MEAN/12)/CNBAP Capacity of NodeB

where the CNBAP capacity of a NodeB depends on the configurations of main control boards, WBBP boards, and UTRP boards. For detailed board specifications, see *3900 Series Base Station Technical Description*.

CNBAP resource usage can be monitored by alarms. If the CNBAP hardware capacity is exceeded, ALM-28230 Base Station Service Overload is reported.

2.13.3 Optimization Suggestions

If the license- or hardware-based CNBAP usage on the NodeB is greater than 60% during peak hours for three consecutive days in a week, the NodeB is considered overloaded.

Perform capacity expansion as follows:

- Enable the WRFD-010202 UE State in Connected Mode (CELL_DCH, CELL_PCH, URA_PCH, CELL_FACH) and WRFD-020500 Enhanced Fast Dormancy features.
- If the license-based CNBAP usage exceeds its capacity expansion threshold, CNBAP resources are limited by the license. In this situation, upgrade the license file.
- If the hardware-based CNBAP usage exceeds its capacity expansion threshold, CNBAP resources are limited by the hardware. In this situation, replace the WMPT board with the UMPT board, or add baseband processing boards or replace the WBBPb/WBBPd board with the WBBPf board.
- Split the NodeB or add a NodeB if the CNBAP overload problem cannot be solved by upgrading the license file or by adding or replacing boards.

📖 NOTE

- For details about how to enable the WRFD-010202 UE State in Connected Mode (CELL_DCH, CELL_PCH, URA_PCH, CELL_FACH) feature, see *State Transition Feature Parameter Description* in the RAN Feature Documentation.
- For details about how to enable the WRFD-020500 Enhanced Fast Dormancy feature, see *Enhanced Fast Dormancy Feature Parameter Description* in the RAN Feature Documentation.
- The maximum CNBAP capability of a NodeB is 1500. When the CNBAP capability configured for a NodeB is less than 1500, replace boards to expand the capacity if CNBAP overload occurs. For the CNBAP capabilities of the WBBP boards, see *3900 Series Base Station Technical Description*.

2.14 HSPA Users

2.14.1 Monitoring Principles

HSPA services are mainly carried on the WBBP boards in a NodeB. Therefore, the number of HSPA users determines WBBP board loads. If WBBP boards are overloaded with HSPA users, new users may fail to access the network.

2.14.2 Monitoring Methods

The following NodeB counters are used to monitor the percentage of the number of HSPA users on a WBBP board to the configured number of HSPA users:

- VS.BOARD.UsedHsdpaUserRatio.Mean: average ratio of HSDPA users on a board
- VS.BOARD.UsedHsupaUserRatio.Mean: average ratio of HSUPA users on a board

2.14.3 Optimization Suggestions

If the percentage of the number of HSDPA/HSUPA users on a WBBP board to the configured number of HSDPA/HSUPA users is greater than 60% during peak hours for three consecutive days in a week, perform capacity expansion as follows:

- Enable the WRFD-150242 HSDPA Scheduler Pool feature if VS.BOARD.UsedHsdpaUserRatio.Mean is greater than 60% only on individual WBBP boards.

- Add WBBP boards or replace the existing WBBP boards with those of higher specifications.

- Split the NodeB or add a NodeB if no more WBBP boards can be added.

📖 NOTE

- For details about how to enable the WRFD-150242 HSDPA Scheduler Pool feature, see *HSDPA Scheduler Pool Feature Parameter Description* in the RAN feature documentation.

- The number of HSPA users supported by a WBBP board varies according to board type. For detailed numbers of HSPA users supported by different WBBP boards, see *3900 Series Base Station Technical Description*.

3

Network Resource Troubleshooting

The monitoring method described in Chapter 2 is effective in most scenarios. However, other scenarios may require more detailed troubleshooting to determine if high resource occupancy is caused by traffic increases or other abnormalities.

This chapter describes how to locate network resource problems that require more detailed troubleshooting and is intended for personnel who:

¬ Have a deep understanding of WCDMA networks

¬ Are familiar with the signaling procedure

¬ Are familiar with the operation and maintenance of Huawei products

3.1 Possible Block and Failure Points in the Basic Call Flow

If network resources are insufficient, network access-related KPIs are likely to be affected first.

Figure 3-1 uses a mobile terminated call (MTC) as an example to illustrate the basic call flow, with possible block/failure points indicated. For details about the basic call process, see 3GPP TS 25.931.

Figure 3-1 Basic call flow chart and possible block/failure points
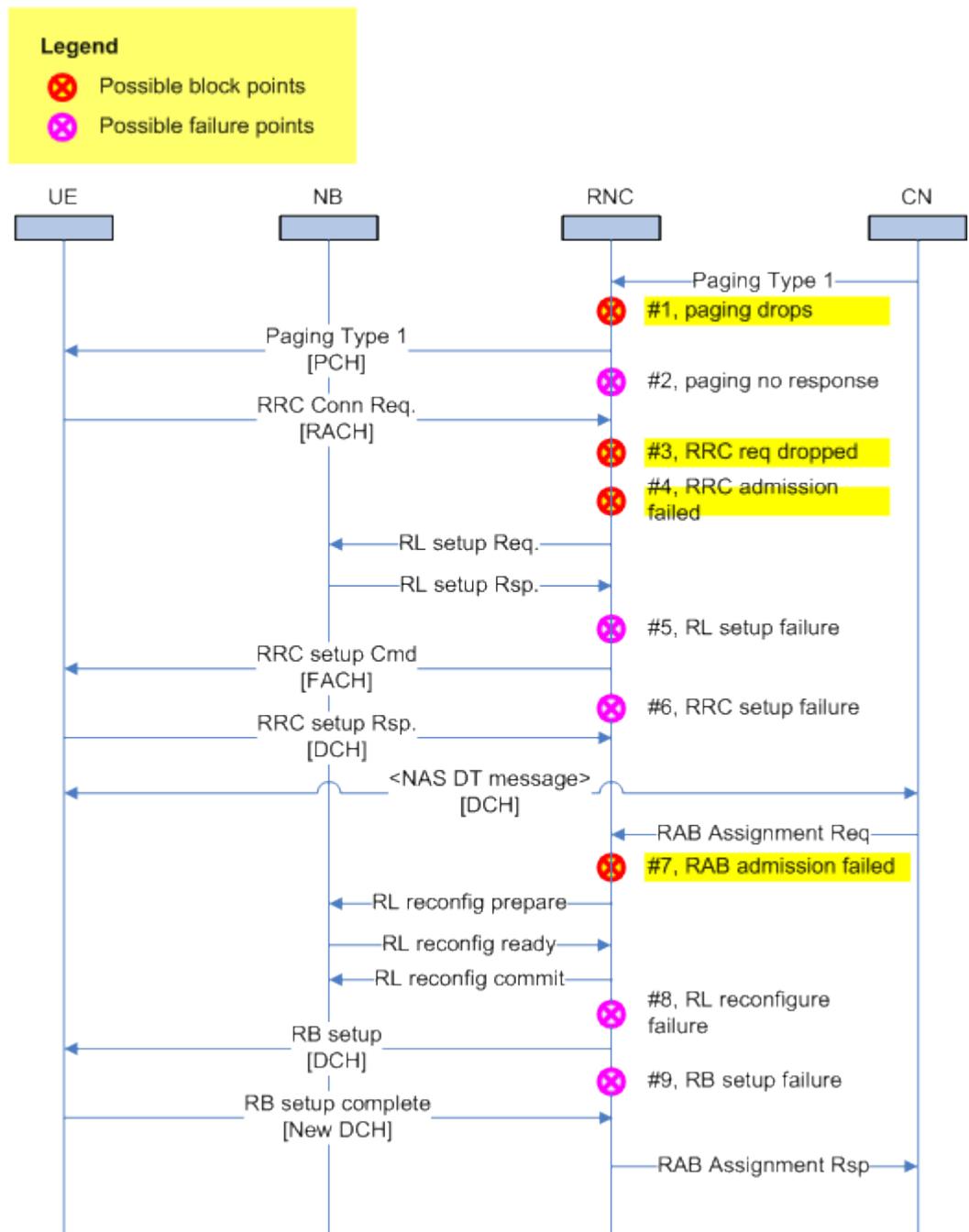
The basic call flow illustrated in Figure 3-1 is described as follows:

Step 1   The CN sends a paging message to the RNC.

Step 2   Upon receiving the paging message, the RNC broadcasts the message on a PCH. If the PCH is congested, the RNC may drop the message at block point #1.

Step 3   The UE may not receive the paging message or access the network, and fails to respond to RNC's paging message. See failure point # 2.

Step 4   If the UE receives the paging message, it sends an RRC connection request to the RNC.

Step 5 If the RNC is congested when receiving the RRC connection request, the RNC may drop the request message. See block point #3.

Step 6 If the RNC receives the RRC connection request and does not discard it, the RNC determines whether to accept or reject the request. The request may be rejected due to insufficient resources, as shown in block point #4.

Step 7 If the RNC accepts the request, the RNC instructs the UE to set up an RRC connection. The UE may not receive RNC's response message or may find that the configuration does not support RRC connection setup. See failure points #5 and #6.

Step 8 After the RRC connection is set up, the UE sends NAS messages to negotiate with the CN about service setup. If the CN determines to set up a service, the CN sends an RAB assignment request to the RNC.

Step 9 The RNC accepts or rejects the RAB assignment request based on the resource usage of RAN. See block point #7.

Step 10 If the RNC accepts the RAB assignment request, it initiates an RB setup process. During the process, the RNC sets up radio links (RLs) to the NodeB over the Iub interface and sends an RB setup message to the UE over the Uu interface. The RL or RB setup process may incur failures. See failure points #8 and #9.

----End

3.2 Counters Related to Call Congestion

As shown in Figure 3-1, call congestion may occur during paging, RRC connection setup, or RAB setup. This section describes counters related to call congestion. For details about these counters, see Chapter 4.

3.2.1 Paging Loss

The counters measuring RNC- and cell-level paging loss are as follows:

¬ RNC-level paging loss

The counters measuring paging loss caused by Iu-interface flow control, CPU overload, or RNC-level PCH congestion are as follows:

– VS.RANAP.CsPaging.Loss: number of failed responses after the RNC receives CS paging messages from the CN

– VS.RANAP.PsPaging.Loss: number of failed responses after the RNC receives PS paging messages from the CN

– VS.RANAP.CsPaging.Att: number of CS paging messages received by the RNC from the CN

– VS.RANAP.PsPaging.Att: number of PS paging messages received by the RNC from the CN

Calculation formula:

Iu-interface paging loss ratio (RNC) = [(VS.RANAP.CsPaging.Loss + VS.RANAP.PsPaging.Loss)/(VS.RANAP.CsPaging.Att + VS.RANAP.PsPaging.Att)] x 100%

¬ Cell-level paging loss

The counters measuring paging loss caused by cell-level PCH congestion are as follows:

- VS.RRC.Paging1.Loss.PCHCong.Cell: number of discarded paging messages due to PCH congestion in a cell
- VS.UTRAN.AttPaging1: number of paging messages of paging type 1 sent by the RNC in a cell

Calculation formula:

Iu-interface paging loss ratio (cell) = (VS.RRC.Paging1.Loss.PCHCong.Cell/VS.UTRAN.AttPaging1) x 100%

3.2.2 RRC Congestion

The following table describes the mapping between reasons of RRC connection setup rejections and corresponding counters.

Rejection Reason	Counter
Uplink power congestion	VS.RRC.Rej.ULPower.Cong
Downlink power congestion	VS.RRC.Rej.DLPower.Cong
Uplink CE congestion	VS.RRC.Rej.ULCE.Cong
Downlink CE congestion	VS.RRC.Rej.DLCE.Cong
Uplink Iub bandwidth congestion	VS.RRC.Rej.ULIUBBand.Cong
Downlink Iub bandwidth congestion	VS.RRC.Rej.DLIUBBand.Cong
Downlink code resource congestion	VS.RRC.Rej.Code.Cong

The RRC block rate is calculated using the following formula:

Vs.RRC.Block.Rate = Total RRC Rej / VS.RRC.AttConnEstab.Sum × 100%

where

- Total RRC Rej = VS.RRC.Rej.ULPower.Cong + VS.RRC.Rej.DLPower.Cong + VS.RRC.Rej.ULCE.Cong + VS.RRC.Rej.DLCE.Cong + VS.RRC.Rej.ULIUBBand.Cong + VS.RRC.Rej.DLIUBBand.Cong + VS.RRC.Rej.Code.Cong
- VS.RRC.AttConnEstab.Sum measures the number of RRC connection setup requests in a cell.

3.2.3 RAB Congestion

The following table describes the mapping between reasons of RAB connection setup rejections and corresponding counters.

Rejection Reason	Counter
Power congestion	¬ VS.RAB.FailEstabCS.ULPower.Cong ¬ VS.RAB.FailEstabCS.DLPower.Cong ¬ VS.RAB.FailEstabPS.ULPower.Cong ¬ VS.RAB.FailEstabPS.DLPower.Cong
Uplink CE congestion	¬ VS.RAB.FailEstabCS.ULCE.Cong ¬ VS.RAB.FailEstabPS.ULCE.Cong
Downlink CE congestion	¬ VS.RAB.FailEstabCs.DLCE.Cong ¬ VS.RAB.FailEstabPs.DLCE.Cong
Downlink code resource congestion	¬ VS.RAB.FailEstabCs.Code.Cong ¬ VS.RAB.FailEstabPs.Code.Cong
Iub bandwidth congestion	¬ VS.RAB.FailEstabCS.DLIUBBand.Cong ¬ VS.RAB.FailEstabCS.ULIUBBand.Cong ¬ VS.RAB.FailEstabPS.DLIUBBand.Cong ¬ VS.RAB.FailEstabPS.ULIUBBand.Cong

The RAB block rate is calculated using the following formula:

VS.RAB.Block.Rate = Total number of failed RAB establishments regardless of the cause of failure/VS.RAB.AttEstab.Cell

where VS.RAB.AttEstab.Cell measures the total number of RAB connection requests in a cell. This counter is calculated as follows:

VS.RAB.AttEstab.Cell = VS.RAB.AttEstabCS.Conv + VS.RAB.AttEstabCS.Str + VS.RAB.AttEstabPS.Conv + VS.RAB.AttEstabPS.Bkg + VS.RAB.AttEstabPS.Int + VS.RAB.AttEstabPS.Str

3.3 Resource Usage Analysis

Figure 3-2 illustrates the general troubleshooting procedure for resource usage issues.

**Figure 3-2** General troubleshooting procedure for resource usage issues
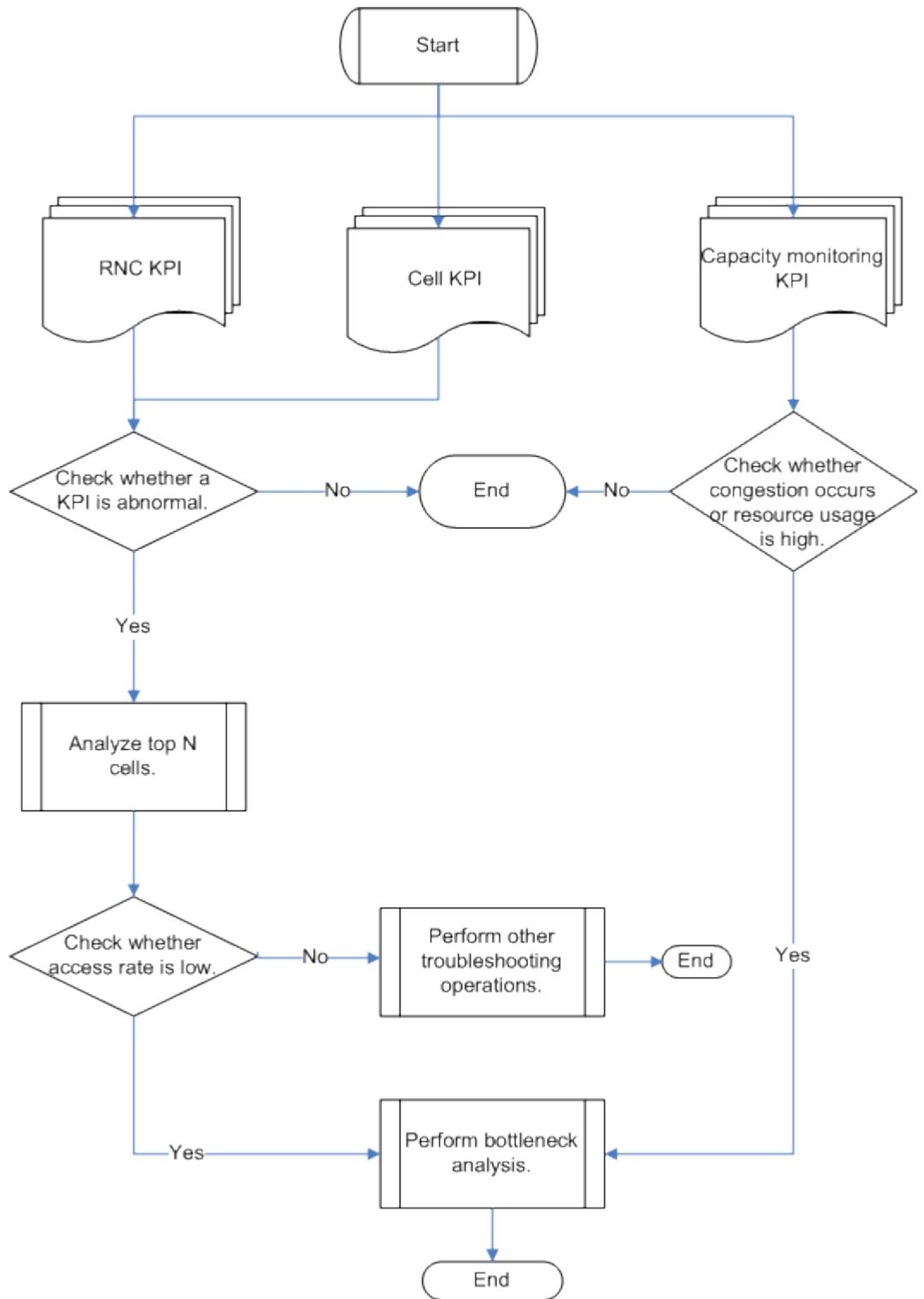
In most cases, the troubleshooting procedure includes detecting abnormal KPIs, selecting top N cells, and analyzing abnormal KPIs.

In the case of system bottlenecks, network access-related KPIs are usually detected first because most of the access congestion issues are caused by insufficient system resources.

Figure 3-3 shows key points for bottleneck analysis. The following sections then describe these key points.

Figure 3-3 Key points for bottleneck analysis
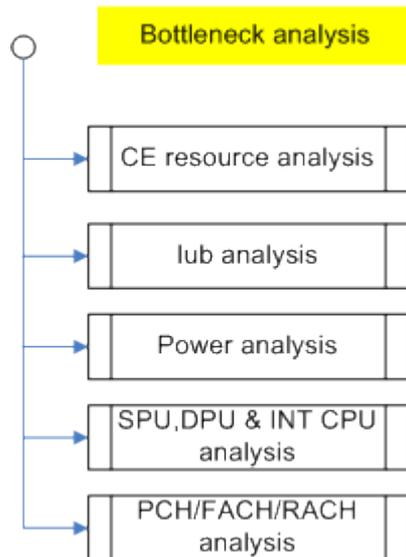
3.3.2 CE Resource Analysis

Both CE congestion and CE resource monitoring require CE resource analysis. If CE usage remains greater than the preset overload threshold or if CE congestion occurs, CE resources are insufficient and must be increased to ensure system stability.

Figure 3-4 illustrates the procedure for analyzing CE congestion.

Figure 3-4 Procedure for analyzing CE congestion
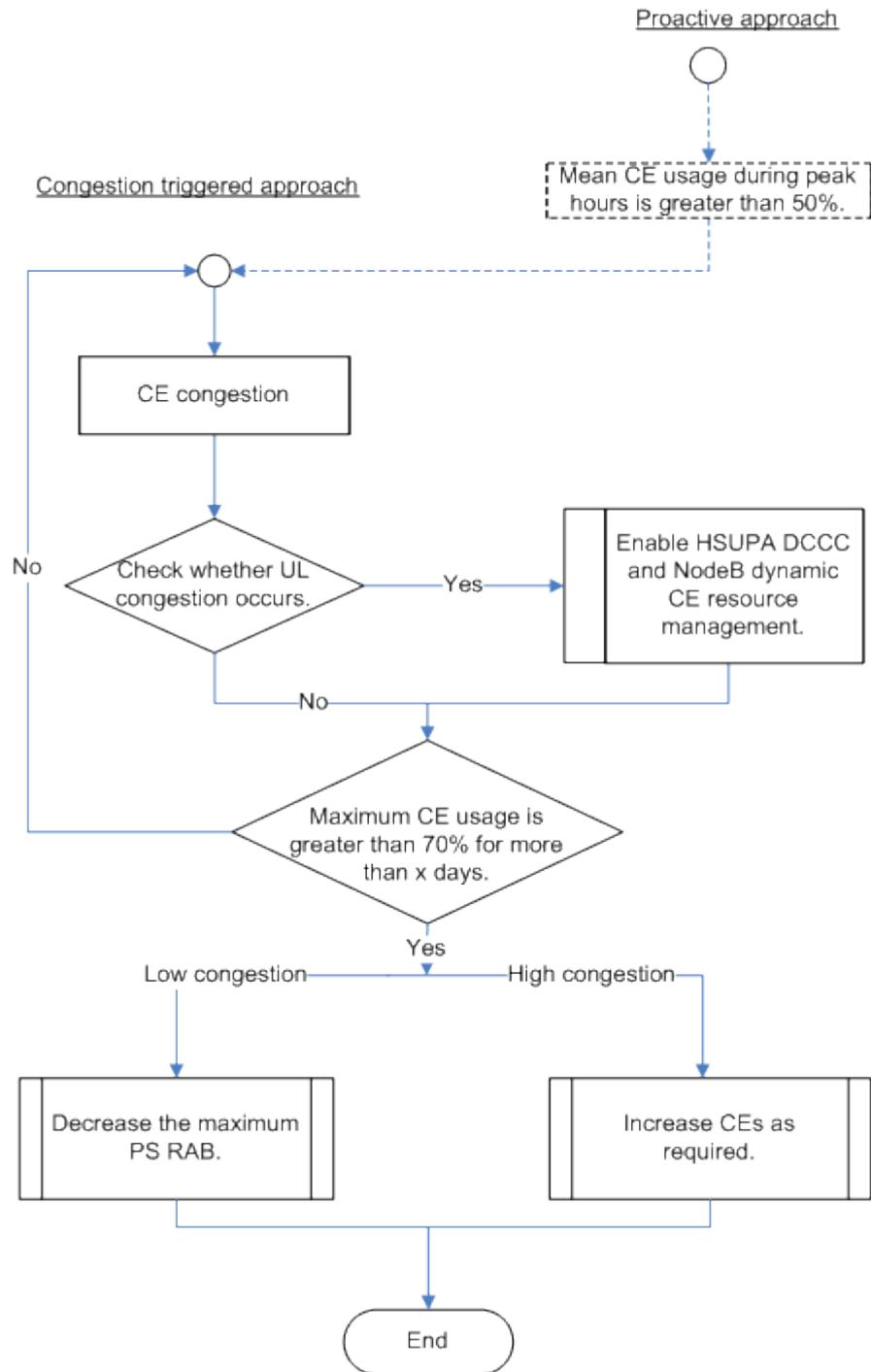
CE resources can be shared within a resource group. Therefore, CE usage on the NodeB must be calculated to determine whether CE congestion occurs in a resource group or the NodeB. If CE congestion occurs in a resource group, reallocate CE resources among resource groups. If CE congestion occurs in the NodeB, perform capacity expansion.

3.3.3 Iub Resource Analysis

Figure 3-5 illustrates the procedure for analyzing Iub bandwidth congestion.

Figure 3-5 Procedure for analyzing lub bandwidth congestion
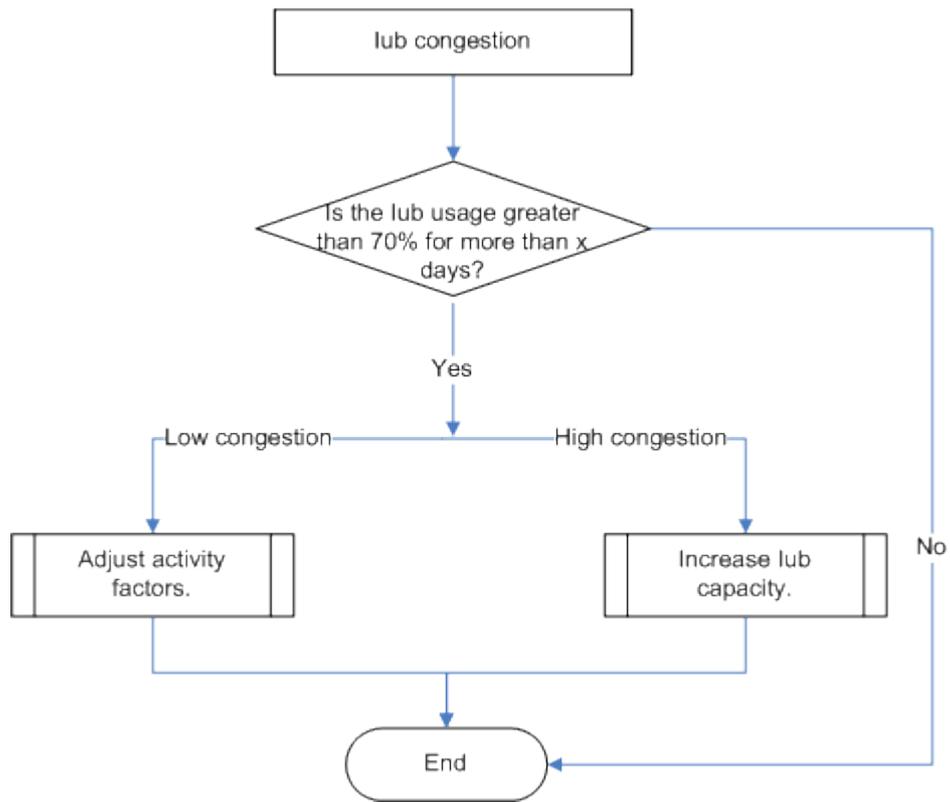
3.3.4 Power Resource Analysis

If the uplink RTWP and downlink TCP values are greater than the preset thresholds, power congestion occurs.

If power congestion occurs in the downlink, enable the load reshuffling (LDR) and overload control (OLC) functions. If power congestion occurs in the uplink, analyze whether the problem is caused by interference or traffic increases.

If the RTWP value remains greater than -97 dBm, identify root causes and troubleshoot the problem.

If the problem is caused by heavy traffic instead of signaling storms, perform the following operations:

¬ Enable LDR and OLC for temporary troubleshooting.
¬ Add carriers or split cells for a long-term solution.

Figure 3-6 illustrates the procedure for analyzing power resource usage.

Figure 3-6 Procedure for analyzing power resource usage
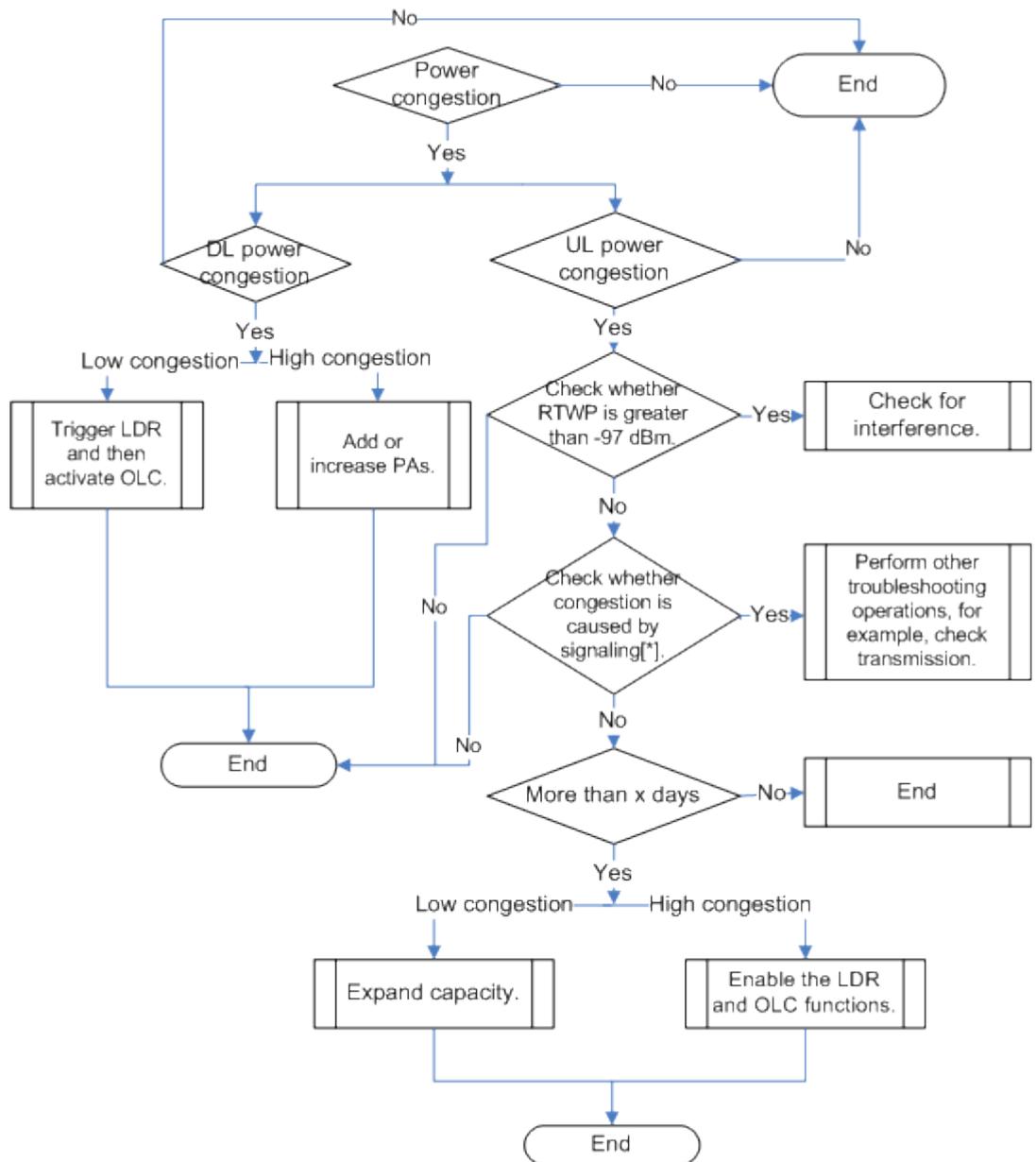
Generally, adding a carrier is the most effective means of relieving uplink power congestion. If no additional carrier is available, add a NodeB or reduce the downtilt of the antenna.

3.3.5 SPU CPU Usage Analysis

Among all RNC CPUs, SPU CPUs are most likely to cause system bottlenecks because smartphones often cause signaling storms on networks.

If the SPU CPU usage exceeds the SPU CPU alarming threshold, RNCs will enable the flow control function to discard some RRC connection setup or paging requests. Therefore, the SPU CPU usage should be less than the SPU CPU alarming threshold.

Figure 3-7 illustrates the procedure for analyzing SPU CPU usage.

**Figure 3-7** Procedure for analyzing SPU CPU usage
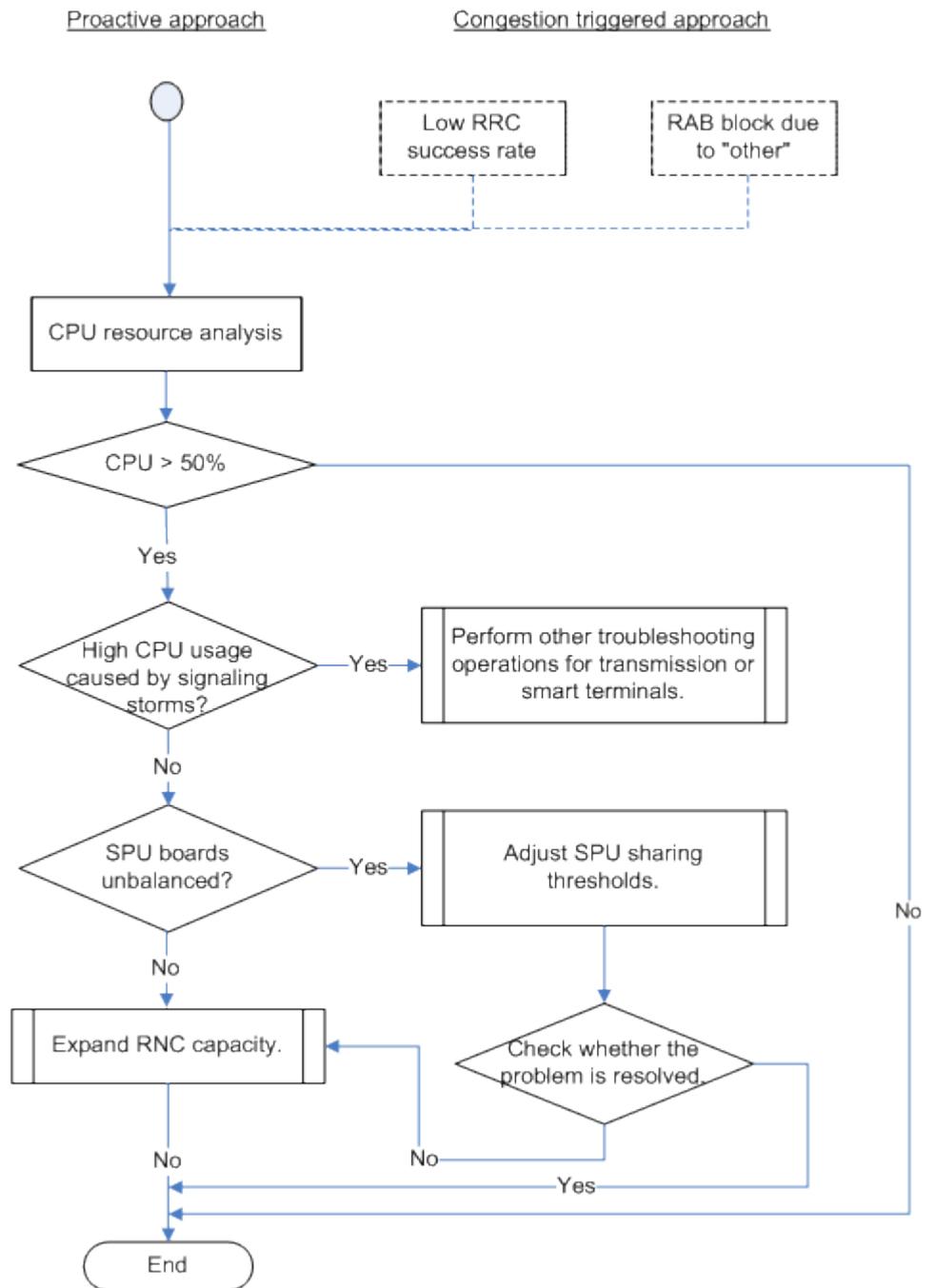
As shown in Figure 3-7, if SPU CPU usage exceeds 50%, analyze the causes to prevent a continuous increment of CPU usage. If this problem is caused by signaling storms, check whether the system configuration is correct and whether the radio link is interrupted. If this problem is caused by traffic increase, add SPU boards.

In addition, check whether SPU subsystem loads are balanced. If they are unbalanced, adjust the load sharing thresholds or evenly allocate NodeBs to SPU subsystems.

3.3.6 DPU DSP Load and Interface Board CPU Usage Analysis

If the DPU DSP or interface board CPUs are overloaded, the RNC discards some user data. Figure 3-8 illustrates the procedure for analyzing DPU DSP load and interface board CPU usage.

**Figure 3-8** Procedure for analyzing DPU DSP load and interface board CPU usage
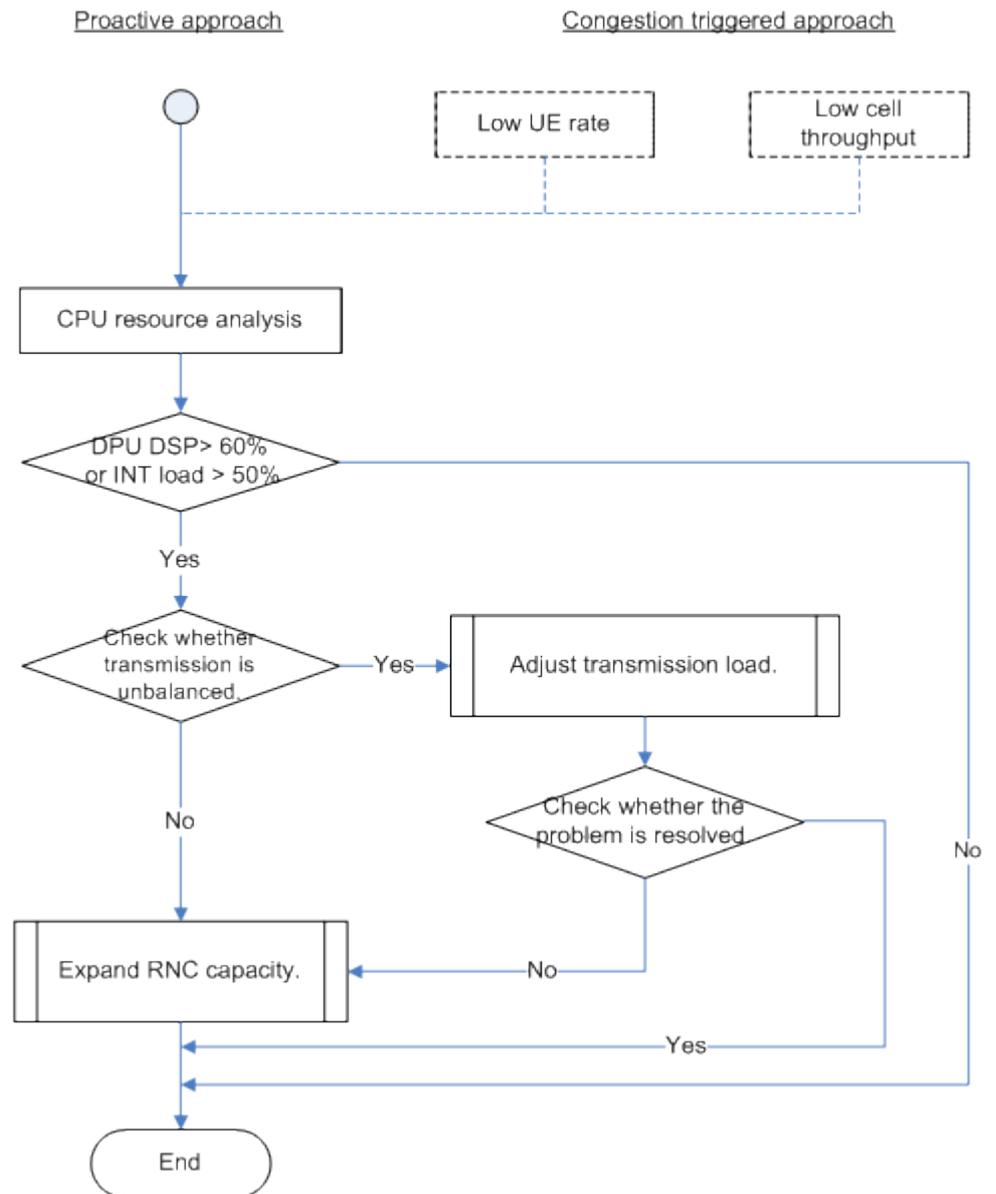
- ¬ If DPU DSP load exceeds 60% or interface board CPU usage exceeds 50%, start the troubleshooting procedure to prevent a continuous increment of load.
- ¬ If traffic increase or unbalanced transmission resources cause the overload, expand hardware capacity.

3.3.7 PCH Usage Analysis

In most cases, PCHs are overloaded because an LA covers too many cells. Replan LAs to resolve the PCH overload.

Figure 3-9 illustrates the procedure for analyzing PCH usage.

Figure 3-9 Procedure for analyzing PCH usage
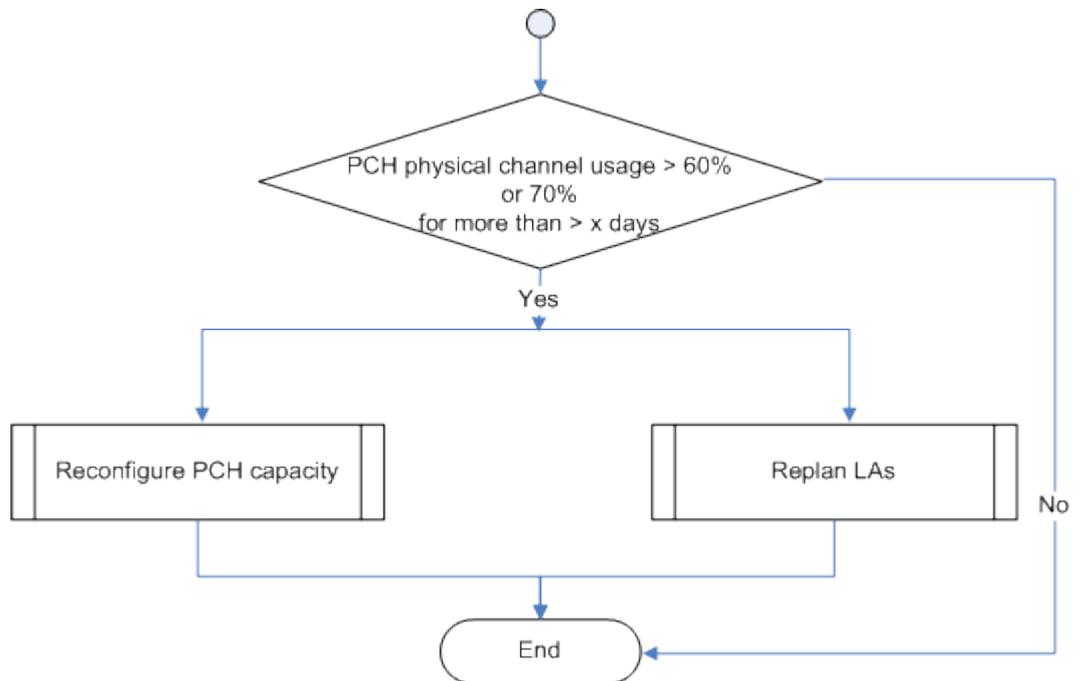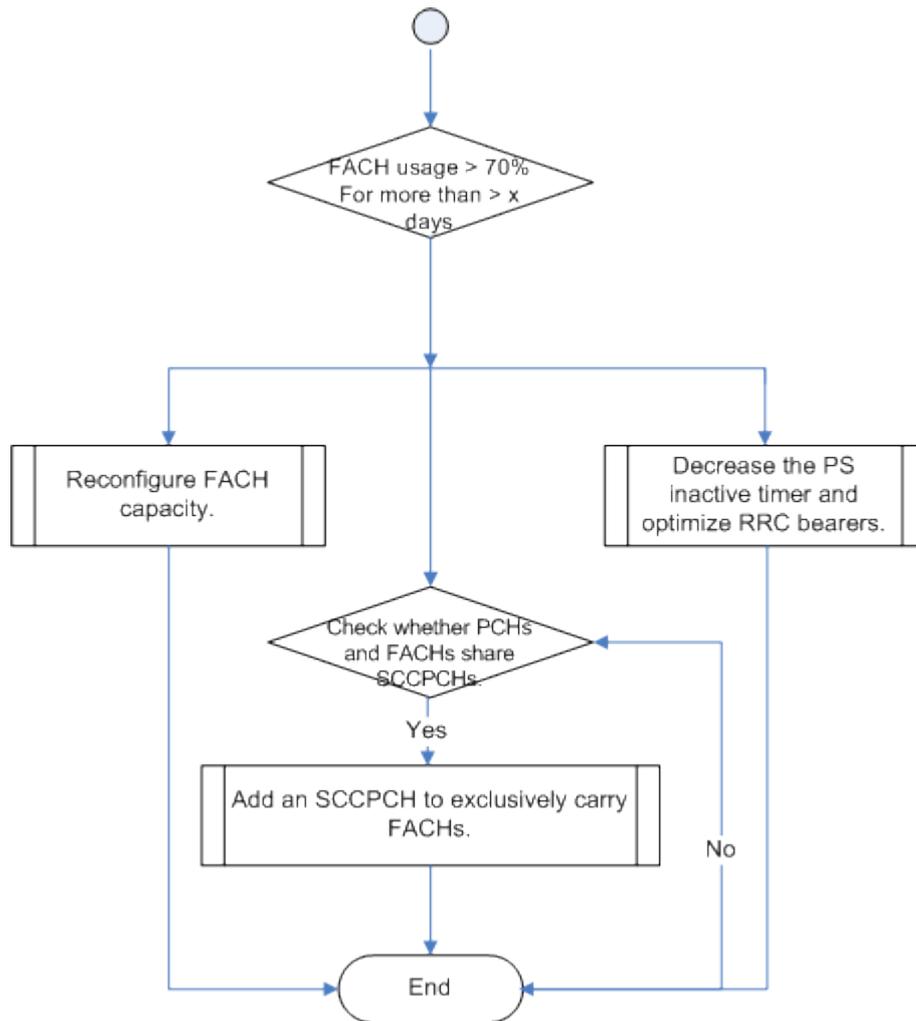

3.3.8 FACH Usage Analysis

FACH congestion is less likely to occur when UE state transition is disabled. However, the RNC usually enables UE state transition to transfer low-traffic services to FACHs. This saves radio resources but increases traffic on FACHs.

Methods of relieving FACH congestion are as follows:

- Shorten the period during which PS services are carried on FACHs to enable fast UE state transition to the CELL_PCH state or idle mode. In addition, set up RRC connections on DCHs if DCH resources are sufficient.
- Add an SCCPCH to carry FACHs.

Figure 3-10 illustrates the procedure for analyzing FACH usage.

Figure 3-10 Procedure for analyzing FACH usage

4

Metrics Definitions

Metric Name	Counter	Description
Congestion-related Metrics		
Call Block Rate	Vs.Call.Block.Rate (customized)	Vs.RRC.Block.Rate + (<RRC.SuccConnEstab.sum>/ (<VS.RRC.AttConnEstab.CellDCH> + <VS.RRC.AttConnEstab.CellFACH>)) x Vs.Rab.Block.Rate
RRC Congesti on Rate	Vs.RRC.Block.Rate (customized)	(<VS.RRC.Rej.ULPower.Cong> + <VS.RRC.Rej.DLPower.Cong> + <VS.RRC.Rej.ULIUBBand.Cong> + <VS.RRC.Rej.DLIUBBand.Cong> + <VS.RRC.Rej.ULCE.Cong> + <VS.RRC.Rej.DLCE.Cong> + <VS.RRC.Rej.Code.Cong>)/<VS.RRC.AttConnEsta b.Sum>
RAB Congesti on Rate	Vs.RAB.Block.Rate (customized)	(<VS.RAB.FailEstabCS.ULPower.Cong> + <VS.RAB.FailEstabCS.DLPower.Cong> +<VS.RAB.FailEstabPS.ULPower.Cong> + <VS.RAB.FailEstabPS.DLPower.Cong> + <VS.RAB.FailEstabCS.ULCE.Cong> + <VS.RAB.FailEstabPS.ULCE.Cong> + <VS.RAB.FailEstabCs.DLCE.Cong> + <VS.RAB.FailEstabPs.DLCE.Cong> + <VS.RAB.FailEstabCs.Code.Cong> + <VS.RAB.FailEstabPs.Code.Cong> + <VS.RAB.FailEstabCS.DLIUBBand.Cong> + <VS.RAB.FailEstabCS.ULIUBBand.Cong> + <VS.RAB.FailEstabPS.DLIUBBand.Cong> + <VS.RAB.FailEstabPS.ULIUBBand.Cong>)/VS.RAB .AttEstab.Cell

Metric Name	Counter	Description
Call Attempts	VS.RAB.AttEstab.Cell (customized)	(<VS.RAB.AttEstabCS.Conv> + <VS.RAB.AttEstab.CS.Str> + <VS.RAB.AttEstabPS.Conv> + <VS.RAB.AttEstabPS.Str> + <VS.RAB.AttEstabPS.Int> + <VS.RAB.AttEstabPS.Bkg>)
Power Usage-related Metrics		
MeanTCP (NonHS) Usage	VS.MeanTCP.NonHS	$$\dfrac{10^{\frac{VS.MeanTCP.NonHS}{10}}}{MAXTXPOWER * 1000}$$ where MAXTXPOWER is the maximum power configured for a cell. Measured in watts.
MeanTCP Usage	VS.MeanTCP	$$\dfrac{10^{\frac{VS.MeanTCP}{10}}}{MAXTXPOWER * 1000}$$ where MAXTXPOWER is the maximum power configured for a cell. Measured in watts.
Mean UL RTWP	VS.MeanRTWP	VS.MeanRTWP
Min UL RTWP	VS.MinRTWP	VS.MinRTWP
UL ENU Rate	VS.RAC.UL.EqvUserNum	VS.RAC.UL.EqvUserNum/UlTotalEqUserNum
Iub Interface Resource Usage-related Metrics		
Bandwidth-based Admission Success Rate	VS.AAL2.CAC.Succ VS.AAL2.CAC.Att	VS.AAL2.CAC.Succ/VS.AAL2.CAC.Att
DL Iub Usage on Control Plane	VS.SAALLNK.PVCLAYER.TXBYTES VS.SAALLNK.PVCLAYER.RXBYTES	DL Iub Usage on Control Plane = VS.SAALLNK.PVCLAYER.TXBYTES x 8/1000/<SP>/TX BW_CFG
UL Iub Usage on Control Plane		UL Iub Usage on Control Plane = VS.SAALLNK.PVCLAYER.RXBYTES x 8/1000/<SP>/RX BW_CFG

Metric Name	Counter	Description
DL Iub Usage on User Plane	ATM transmission: VS.AAL2PATH.PVCLAYER.TX BYTES VS.AAL2PATH.PVCLAYER.RX BYTES IP transmission in non-pooled networking: VS.IPPATH.IPLAYER.TXBYTE S VS.IPPATH.IPLAYER.RXBYTE S IP transmission in resource pool networking: VS.IPPOOL.ANI.IPLAYER.TXB YTES VS.IPPOOL.ANI.IPLAYER.RXB YTES	ATM transmission: DL Iub Usage on User Plane = Sum(VS.AAL2PATH.PVCLAYER.TXBYTES) x 8/<SP>/1000/TX BW_CFG IP transmission in non-pooled networking: DL Iub Usage on User Plane = Sum(VS.IPPATH.IPLAYER.TXBYTES) x 8/<SP>/1000/TX BW_CFG IP transmission in resource pool networking: DL Iub Usage on User Plane = VS.IPPOOL.ANI.IPLAYER.TXBYTES x 8/<SP>/1000/TX BW_CFG
UL Iub Usage on User Plane		ATM transmission: UL Iub Usage on User Plane = sum(VS.AAL2PATH.PVCLAYER.RXBYTES) x 8/<SP>/1000/RX BW_CFG IP transmission in non-pooled networking: UL Iub Usage on User Plane = sum(VS.IPPATH.IPLAYER.RXBYTES) x 8/<SP>/1000/RX BW_CFG IP transmission in resource pool networking: UL Iub Usage on User Plane = VS.IPPOOL.ANI.IPLAYER.RXBYTES x 8/<SP>/1000/RX BW_CFG
IP Connecti on Setup Success Rate	VS.ANI.IP.Conn.Estab.Succ VS.ANI.IP.Conn.Estab.Att	VS.ANI.IP.Conn.Estab.Succ/ VS.ANI.IP.Conn.Estab.Att
PCH/FACH Usage-related Metrics		
PCH Usage	VS.UTRAN.AttPaging1	VS.UTRAN.AttPaging1/(<SP> x 60 x 5/0.01)

Metric Name	Counter	Description
FACH Usage	VS.CRNCIubBytesFACH.Tx VS.PCH.Bandwidth.UsageRate VS.SRBNum.FACH VS.OneSRBTTINum.FACH VS.IndepTRBNum.FACH	¬ If only one SCCPCH is configured, the following formula is true: FACH Usage = VS.CRNCIubBytesFACH.Tx x 8/((60 x \<SP\> x 168 x 1/0.01) x VS.PCH.Bandwidth.UsageRate x 6/7 + (60 x \<SP\> x 360 x 1/0.01) x (1- VS.PCH.Bandwidth.UsageRate x 6/7)) where VS.PCH.Bandwidth.UsageRate = \<VS.CRNCIubBytesPCH.Tx\> / (\<VS.CRNC.IUB.PCH.Bandwidth\> x \<SP\> x 60.0) ¬ If two SCCPCHs are configured, the following formula is true: FACH Usage = ((VS.SRBNum.FACH-VS.OneSRBTTINum.FACH)/2 + VS.OneSRBTTINum.FACH + VS.IndepTRBNum.FACH)/(\<SP\> x 60/0.01)
RACH Usage	VS.CRNCIubBytesRACH.Rx VS.TRBNum.RACH VS.TRBNum.RACH	RACH Usage = ((VS.CRNCIubBytesRACH.Rx - VS.TRBNum.RACH x 360/8) x 8/168)/(\<SP\> x 60 x 4/0.02) + VS.TRBNum.RACH/(\<SP\> x 60 x 4/0.02)
OVSF Usage-related Metrics		
OVSF Quantity	VS.RAB.SFOccupy	VS.RAB.SFOccupy
OVSF Usage	VS.RAB.SFOccupy.Ratio	VS.RAB.SFOccupy/256 x 100%
DCH OVSF Usage	VS.SingleRAB.SF VS.MultRAB.SF4 VS.MultRAB.SF8 VS.SingleRAB.SF8 VS.MultRAB.SF16 VS.SingleRAB.SF16 VS.SingleRAB.SF32 VS.MultRAB.SF32 VS.MultRAB.SF64 VS.SingleRAB.SF64 VS.SingleRAB.SF128 VS.MultRAB.SF128 VS.SingleRAB.SF256 VS.MultRAB.SF256	DCH OVSF Usage = DCH_OVSF_CODE/DCH_OVSF_CODE_Ava where DCH_OVSF_CODE = (\<VS.SingleRAB.SF4\> + \<VS.MultRAB.SF4\>) x 64 + (\<VS.MultRAB.SF8\> + \<VS.SingleRAB.SF8\>) x 32 + (\<VS.MultRAB.SF16\> + \<VS.SingleRAB.SF16\>) x 16 + (\<VS.SingleRAB.SF32\> + \<VS.MultRAB.SF32\>) x 8 + (\<VS.MultRAB.SF64\> + \<VS.SingleRAB.SF64\>) x 4 + (\<VS.SingleRAB.SF128\> + \<VS.MultRAB.SF128\>) x 2 + (\<VS.SingleRAB.SF256\> + \<VS.MultRAB.SF256\>)
CPU Usage-related Metrics		

Metric Name	Counter	Description
SPU CPU Load	VS.XPU.CPULOAD.MEAN	VS.XPU.CPULOAD.MEAN
MPU CPU Load	VS.XPU.CPULOAD.MEAN	VS.XPU.CPULOAD.MEAN
DSP Load	VS.DSP.UsageAvg	VS.DSP.UsageAvg
INT Load	VS.INT.CPULOAD.MEAN VS.INT.TRANSLOAD.RATIO.MEAN	￢ VS.INT.CPULOAD.MEAN ￢ VS.INT.TRANSLOAD.RATIO.MEAN
Credit Resource Usage-related Metrics		
License-based Downlink CE Usage	VS.NodeB.ULCreditUsed.Mean VS.LC.ULCreditUsed.Mean VS.LC.DLCreditUsed.Mean VS.HW.DLCreditAvailable VS.HW.ULCreditAvailable	Sum_AllCells_of_NodeB(VS.LC.DLCreditUsed.Mean) /DL NodeB License CE Cfg Number
License-based Uplink CE Usage		If the value of VS.NodeB.ULCreditUsed.Mean is greater than 0, the following formula is true: (VS.NodeB.ULCreditUsed.Mean /2)/UL NodeB License CE Cfg Number Otherwise, the following formula is true: Sum_AllCells_of_NodeB(VS.LC.ULCreditUsed.Mean/2)/UL NodeB License CE Cfg Number
Hardware-based Downlink CE		Sum_AllCells_of_NodeB(VS.LC.DLCreditUsed.Mean) / VS.HW.DLCreditAvailable
Hardware-based Uplink CE Usage		If the value of VS.NodeB.ULCreditUsed.Mean is greater than 0, the following formula is true: (VS.NodeB.ULCreditUsed.Mean /2) / VS.HW.ULCreditAvailable Otherwise, the following formula is true: Sum_AllCells_of_NodeB(VS.LC.ULCreditUsed.Mean/2) / VS.HW.ULCreditAvailable
NodeB CNBAP Load-related Metrics		
License-based CNBAP Usage	VS.RadioLink.Recv.Mean VS.DedicMeaRpt.MEAN	License-based CNBAP Usage = (VS.RadioLink.Recv.Mean + VS.DedicMeaRpt.MEAN/12)/License CNBAP

Metric Name	Counter	Description
Hardware-based CNBAP Usage		Hardware-based CNBAP Usage = (VS.RadioLink.Recv.Mean + VS.DedicMeaRpt.MEAN/12)/CNBAP Capacity of NodeB
SCU Board Load-related Metrics		
SCU CPU Load	VS.SCU.CPULOAD.MEAN	VS.SCU.CPULOAD.MEAN
Frame Mean Usage	VS.Frame.Flux. Mean.TxRate	Frame Mean Usage = VS.Frame.Flux.Mean.TxRate/Inter-subrack bandwidth x 100%
HSPA User-related Metrics		
Average HSPA User Ratio	VS.BOARD.UsedHsdpaUserRatio.Mean VS.BOARD.UsedHsupaUserRatio.Mean	VS.BOARD.UsedHsdpaUserRatio.Mean VS.BOARD.UsedHsupaUserRatio.Mean

5 Reference Documents

This chapter lists the documents referenced within the text and provides the document name, document package, and document package download path at http://support.huawei.com.

Document Name	Document Package	Document Package Download Path at http://support.huawei.com
RAN Reconfiguration Guide	BSC6900 UMTS Product Documentation	Wireless -> WCDMA-RAN -> WCDMA-RNC
3900 Series Base Station Technical Description	3900 Series Base Station Product Documentation	Wireless -> WCDMA-RAN -> WCDMA-NodeB
Flow Control Feature Parameter Description	RAN Feature Documentation	Wireless -> WCDMA-RAN -> WCDMA-RAN Public
Controller Resource Sharing Feature Parameter Description		
System Reliability Feature Parameter Description		
Transmission Resource Pool in RNC Feature Parameter Description		
Dynamic Configuration Based on the Uplink Load Feature Parameter Description		
Power Control Feature Parameter Description		
HSDPA Feature Parameter Description		
CE Overbooking Feature Parameter Description		

Document Name	Document Package	Document Package Download Path at http://support.huawei.com
State Transition Feature Parameter Description		
HSDPA Scheduler Pool Feature Parameter Description		