Congestion Control

WCDMA RAN

Feature Guide

Congestion Control Feature Guide

Version	Date	Author	Approved By	Remarks
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Figures and Tables

1 Function Attributes

System version: [RNC V3.09, OMMR V3.09, Node B V4.09, OMMB V4.09]

Attribute: [Required]

Involved NE:

UE	Node B	RNC	MSCS	MGW	SGSN	GGSN	HLR
√	√	√	√	-	√	-	-
Note: * -: Not involved * √: Involved							

Dependency: [None]

Mutual exclusion: [None]

Remarks: [None].

2 Overview

2.1 Function Introduction

Congestion control is intended to reallocate radio resources in the case of system congestion and to relieve the congestion by a series of control measures according to service attributes, so as to improve the call successful ratio and enable reasonable utilization of system resources by service priorities.

Congestion occurs when the uplink or downlink load reaches or exceeds the admission threshold and new service requests cannot access the system due to insufficient resources. In this case, the RNC needs to activate the congestion control policy. The service requests include RAB setup, RAB modification or RAB negotiation/re-negotiation, SRNC incoming relocation, inter-Iur RL setup, intra-RNC soft or hard incoming handover, incoming inter-system handover, incoming inter-frequency handover, inter-RNC soft handover, second RAB setup for the same user, and service rate increase triggered by dynamic adjustment of radio bearer.

The above-mentioned resources include: uplink interference, downlink power, data throughput, downlink code resources, uplink and downlink Node B's CE resources, and number of HSPA subscribers.

In the event of congestion, the system should not directly reject the service requests, but release links forcibly, arrange the requests to queue, or decrease the load according to the requirement of service delay and priority to release some resources and improve the call successful ratio.

In the event of system congestion, resource preemption can be triggered to reflect superiority of subscribers with higher priorities and improve call successful ratio. Its main policies consist of two aspects as follows:

- Forced release: The services capable of preemption with higher priorities are allowed to release forcibly those services with lower priorities. That is, the subscribers with higher priorities can implement fast access by preempting the resources of those subscribers who are of lower priorities and subjected to forced release. This is to reflect differentiation of services between subscribers.

- Downgrade: This policy is used to improve call successful ratio by decreasing the data bit rate of online subscribers.

2.1.1 Congestion Control for R99

This function supports congestion control of the R99 cells. That is, the congestion control function is triggered by failure of the R99 services to access for radio resources in the case of tight supply (congestion).

This function consists of queue scheduling and load decrease. When a cell is congested, the queues are maintained according to the congestion causes Load decrease means to make the cells less congested with certain methods. For example, congestion of the R99 services is handled with the methods as follows:

- The calls capable of preemption with higher priorities are provided with top priority to use radio resources by means of forced release of other services and deletion of radio links.

- Some resources are spared for specific congested subscribers by decreasing the data rate of online DCH.

2.1.2 Emergency Call

For emergency calls, the default value of Pre-emption Capability is ‘may trigger pre-emption’, the default value of Pre-emption Vulnerability is ‘not pre-emptable’,Emergency calls require only hard resource (code and CE resources) admission decision instead of soft resource admission decision. If the hard resource congestion occurs, the forced release will be triggered and the online emergency calls can not be forced release.

2.1.3 Directed Retry to GSM

For AMR subscribers, when congestion occurs during their admission due to shortage of resources, if the RAB have no preemption or queuing capacity, directed retry to 2G will be triggered; if the RAB have preemption or queuing capacity, the above forced release/queuing polices will be executed, and directed retry to 2G will be triggered if forced release and queuing fails

2.1.4 Congestion Control Strategy for HSDPA

For the HSDPA cells with limited radio resources, congestion control features will guarantee QoS of subscribers with higher priorities in accordance with service criteria. Resource congestion is most likely to result from limitation of power resources, channelization code resources, the CE resource of A-DPCH and number of HSDPA subscribers. Congestion of services in the HSDPA cells can be cleared by the following means:

- Forced release of resources according to priority
- Adjustment of total HSDPA power (when the total power available to HSDPA is adjusted by RNC dynamically)
- Adjustment of code resources for HSDPA
- DCH downgrade for the Rel99 services
- Channel switch of interactive services and background services over HSDPA to RACH/FACH

2.1.5 Congestion Control Strategy for HSUPA

For the HSUPA cells with limited radio resources, congestion control guarantees QoS of subscribers with higher priorities in accordance with service criteria. HSUPA load decrease is implemented with three congestion control policies as follows:

- Forced release of resources according to priority

If the rejected service is capable of preemption, it is allowed to release forcedly other services with lower priorities.

- Decrease of current load

The load of E-DCH subscribers is mainly controlled by Node B, while the RNC controls only the DCH load. Therefore, DCH downgrade is the only way to decrease the uplink interference without forced release.

- Handover of interactive services and background services over HSUPA to RACH/FACH

3 R99 Congestion Control Algorithm

Congestion control is a process of resource preemption, including forced release, downgrade, and scheduling and admission of queuing subscribers. These policies are described in detail s in the following sections.

3.1 Resource Preemption Policies

In the event of system congestion, resource preemption can be triggered to reflect superiority of subscribers with higher priorities and improve call successful ratio. Its main policies consist of two aspects as follows:

- Forced release: The services capable of preemption with higher priorities are allowed to release forcibly those services with lower priorities. That is, the subscribers with higher priorities can implement fast access by preempting the resources of those subscribers who are of lower priorities and subjected to forced release. This is to reflect differentiation of services between subscribers.

- Downgrade: This policy is used to improve call successful ratio by decreasing the rate of data services for online subscribers.

A complete description of scenarios and application policies for forced release and downgrade will be found in later sections.

First it is necessary to introduce the priority definitions used in congestion control. These definitions will also be referenced in subsequent policy descriptions.

- Basic Priority of RNC-BP: It is determined by two factors: ARP (Allocation/Retention Priority) and Traffic class. ARP is mapped and transferred to the RNC by the core network QoS, while Traffic Class means the type of the originating service. ZTE RNC extends the Traffic Class of protocols. Take the Interactive service for example. Its unique THP (Traffic Handling Priority) is also regarded as a value of Traffic Class for BP mapping. BP can be used for direct mapping of SPI of Node B and Frame Handling Priority, and also plays an important part in priority mapping of AP of RNC and SPI of RNC.

- Application Priority of RNC-AP: It is determined by BP, Radio bearer type (with values of DCH, HSPA, and MBMS), and rate of existing subscribers. In the event of resource congestion or overload, Application Priority of RNC-AP is used to select subscribers/services for load decrease, with consideration to the two factors of bearer type and rate: different bearer types require reflection of priorities, and rate can serve as a key factor to control fast stabilization of load and fast removal of resource congestion for a system. For example, when a service of higher rate is selected for downgrade, the load will decrease faster.

- Scheduling Priority of RNC-SP: The scheduling priority used in the RRM policy of the RNC is determined by BP and radio bearer type, and is used to select subscribers during forced release and admission of queuing subscribers.

- Scheduling Priority of Node B-SPI: SPI of Node B is obtained directly from BP mapping.

Refer to *ZTE UMTS QoS Feature Guide* for more detailed mapping relations and configuration methods and examples of the priorities mentioned above.

The overall process of resource preemption policy is as follows:

1. For a service that fails to be admitted (excluding those admission failures triggered by an online rate increase request), forced release is conducted first (to release RAB) in the case of hard resource congestion if the service has the preemption capability.

   i. If the new service request is capable of queuing, the new service request will be included into the queue to trigger blind downgrade. The blind downgrade means downgrade according to the numbers of DRBC grades of downgrade configured in OMC.

   ii. If the new service request is incapable of queuing, downgrade of existing subscribers will be directly triggered once.

2. For a service that fails to be admitted because of hard resource congestion and it has no preemption capability, or a service that fails to be admitted because of soft resource congestion, the judgment is focused directly on whether it is capable of queuing.

   i. If it is capable of queuing, it will be included into the queue to trigger blind downgrade;

   ii. if it is incapable of queuing, downgrade will be directly triggered once. In the case of soft resource congestion, its handling process is the same as that for “a service with preemption capability during hard resource congestion".

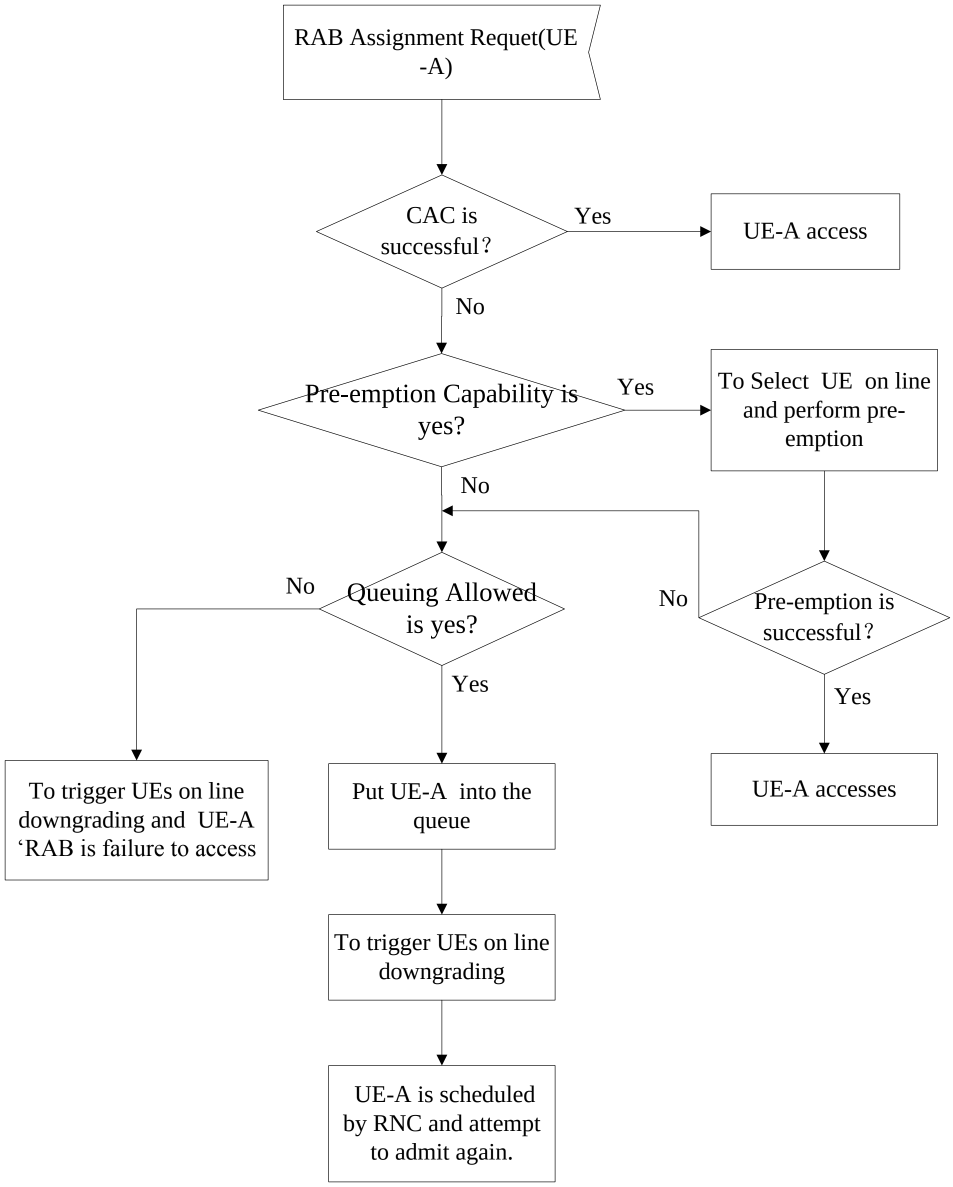
As for an admission failure triggered by an online rate increase request, the affected service will be included into the queue directly. For the subsequent handling, refer to later related sections on 3.1.2 DCH Downgrade and 3.1.3 Congestion Scheduling.

Note 1: The length of the queue mentioned above is controlled by the OMC parameter *QLength*. When a service in RAB establishment phase is listed in a queue, the duration needed for it to wait for scheduling is controlled by the OMC parameter *TTrueQ*. When a service in incoming relocation phase is listed in a queue, the duration needed for it to wait for scheduling is controlled by the OMC parameter *TTrueQReloc.*

Note 2: For AMR or CS64K services, if RAB assignment message or SRNC relocation request does not carry queue information or indicate the RAB does not have queue ability, whether the RAB is allowed to queue or not is dependent on forced queue switch. Forced queue switch for AMR service is *ForcQueSwiAMR*, forced queue switch for CS 64kbps service is *ForcQueSwiCS64*, maximum time in the queue is *TTrueQForced*；If the RAB assignment message or SRNC relocation request indicate that the RAB has queue ability, the forced queue switch is not taken effect.

For easier understanding of the sequence of resource preemption policies (forced release and downgrade), the following presents an overall flow chart of resource preemption with the process of RAB assignment for a UE as an example.

Figure 1 Flow chart of resource preemption



Note: The cases of downgrade indicated in the figure above all are DCH downgrade.

3.1.1 DCH Forced Release

The purpose of forced release is to ensure immediate access of subscribers with higher priorities whenever possible during congestion.

The following will describe the whole process of forced release from the aspects of the application of interface information during forced release, application scenarios of forced release, selection of subscribers for forced release, and handling of multi-RAB forced release.

Note: All the principles to be described below are universal to both uplink and downlink, so these principles are not differentiated for uplink and downlink.

The mechanism applied to the IE information at the message interface during forced release is as follows:

For a service request originated during system congestion, the system can release an ongoing service forcibly according to service priority and preemption capability. As specified in 3GPP protocols, the preemption capability is determined by the CN in the Allocation/Retention Priority information element (IE) in the RAB assignment message or relocation request message during service setup or in the RL setup message during Iur handover. If the RAB assignment message or relocation request message or RL setup message during Iur handover carries no Allocation/Retention Priority information element, it means this RAB has no preemption capability and can be released forcibly by other RABS for it has the lowest priority. Such an approach is used because this information element is an optional parameter for RAB assignment and relocation request, and the RNC needs to map internally the priority of a message that carries no ARP information for the purpose of complete processing, In ZTE RNC, for a RAB without ARP information, its basic priority (BP) is set to 0, which is the lowest priority. Also as specified in 25.413, if the RAB assignment message carries no ARP, this RAB is regarded by default as incapable of preemption and subjected to forced release.

Table 1 Definition of RAB preemption capability in 3GPP protocols

Cell	**Value**	**Meaning**
Pre-emption Capability	may trigger pre-emption	The RAB has the forced release capability.
	shall not trigger pre-emption	The RAB does not have the forced release capability.
Pre-emption Vulnerability	pre-emptable	The RAB can be released by other RABs forcibly.
	not pre-emptable	The RAB cannot be released by other RABs forcibly.
Priority Level	no priority	The RAB does not have the forced release capability and cannot be released by other RABs forcibly.
	1~14	The resource allocation priority of the RAB. The value "1" stands for the highest priority level.

- Application scenarios of forced release

Forced release can be triggered only for RRC connection establishment of emergency call , the first RAB assignment (including RT and NRT service assignment), not he first RAB assignment of emergency call, CS service combined with PS service, incoming relocation (including 2G-3G handover, and 3G RNC-RNC relocation), CS service calling after PS service online in the case of hard resource being limited.

If hard resource congestion occurs in the RRC signaling phase that establishment cause is not emergency call, an additional attempt of access on FACH will be made instead of triggering forced release.

If hard resource congestion occurs in the RRC signaling phase that establishment cause is emergency call , forced release will be triggered. If force release is failure, an additional attempt of access on FACH will be made. If hard resource congestion occurs in the RAB assignment phase for emergency call again, forced release will be triggered again.

If resource congestion occurs in the high speed RRC signaling phase, an attempt of accessing again in low speed will be conducted. If admission fails again, the congestion control process will be triggered by the low speed RRC establishment. If the hard resource congestion occurs, the corresponding forced release process will be triggered based on the fact the service is emergency cal or not (referring to the description of paragraphs above for details), otherwise the forced release can not be triggered.

The detail description for the congestion method of PS+CS see "The congestion method of PS+CS".

In an R99 cell, hard resources include: downlink channelized resources and uplink and downlink CE resources. These resources are also the hard resources of CS AMR, CS Video, PS RT and PS NRT.

Soft resource (like RTWP and TCP) congestion, transmission resource congestion, and RNC internal congestion will not trigger forced release.

- Mechanism of selecting subscribers for forced release

When a subscriber with preemption capability originates forced release, only those subscribers whose scheduling priorities(SP) are lower than the Scheduling Priority of the subscriber which trigger the forced release of the RAB and whose RAB has pre-emptable PVI (Pre-emption Vulnerability) can be treated as targets of forced release.

If a subscriber meets the forced release conditions above, it is also necessary to calculate whether the resources released from this subscriber can meet the resource requirement of the subscriber who originates this forced release. If yes, this subscriber will be released forcibly. Otherwise, this subscriber cannot be selected as a target for forced release, because even release of this subscriber cannot guarantee access of the originator of forced release. For example, an originator of forced release needs code words with a Spread Factor (SF) of 64, while the online subscribers with the lowest priority use SF of 128, so these subscribers, even with the lowest priorities(SP), cannot be released forcibly.

Moreover, to avoid extensive call drop of online services, there is a limitation to the number of subscribers that can be released forcibly by an originator of forced release. If a subscriber has only one type of hard resource being limited, he/she can release only one subscriber forcibly. If he/she has more than one type of hard resource being limited, at most two subscribers can be released forcibly.

A target subscriber for forced release can be an RT or NRT subscriber.

- Principles of combining preemption capability and scheduling priorities(SP) in the multi-RAB case

If the originator of forced release has more than one RAB, the first step is to combine its preemption capabilities. As long as the originator has one RAB with preemption capability, it will be regarded as capable of preemption. The scheduling priority(SP) used by the originator is the highest scheduling priority(SP) among these RABs, and this priority will be compared with the scheduling priority(SP) of the subscriber to be released forcibly.

If the subscriber to be released forcibly has more than one RAB, the highest RAB scheduling priority(SP) will be used as the scheduling priority(SP) for forced release, and forced release is possible only when all RABs permit forced release (with pre-emptable PVI).

- Execution of forced release

Once the originator of forced release selects a subscriber for forced release, the forced release will be executed on this subscriber, including deletion of the macro diversity link from this subscriber's congested cell and release of the RAB. If this subscriber has more than one link and the congested cell is not the best cell, the link of the congested cell will be deleted. If this subscriber has only one link of the congested cell or the congested cell is this subscriber's best cell, all RABs of this subscriber will be released. Because a subscriber is released at a speed much larger than that of downgrade and conversion to FACH, and with a high success ratio, the originator will not be kept waiting for a long time in the process of access, so as to ensure the access can be completed most quickly. Those subscribers with preemption capability are a minority of subscribers with top priority in the network, while those subscribers to be released forcibly are a minority of subscribers with bottom priorities in the network. The access duration of the subscribers with high priorities is ensured by sacrificing the online qualification of the subscribers with low priorities.

- Handling of failed forced release

If the originator of forced release fails to select a subscriber for forced release (the reason of failing to select a subscriber includes: (i)the online subscribers have higher scheduling priority than originator; (ii) Pre-emption Vulnerability of all online subscribers is not pre-emptable; (iii)the resource released by the online subscribers can not meet the need of originator to be admitted), it indicates the forced release is unsuccessful, and the originator will take different actions depending on whether it has queuing capacity. With queuing capability, the originator will be included into the queue to trigger downgrade and wait for rescheduling and admission. Without queuing capacity, the originator is allowed to trigger downgrade once for later admission or for other subscribers to access directly upon initiating an access request, while the cell is not overloaded at that time.

- Directed retry of AMR subscribers

For AMR subscribers, if congestion occurs during their admission due to shortage of resources, directed retry to 2G will be triggered if they have no preemption or queuing capacity. Otherwise, the above forced release/queuing polices will be executed, but directed retry to 2G will be triggered if forced release and queuing fails.

- Resource preemption policy for handover subscribers

For handover subscribers, if admission fails, neither forced release nor queuing will be conducted, but downgrade can be triggered.

- The congestion method of PS+CS

If PS service is on line that RRC status may be CELL_FACH or CELL_DCH and CS service is calling, PS service will re-allocated minimum DRBC rate and attempt to access with CS in DCH. If access is failure, PS service will re-allocated 0/0kbps and attempt to access with CS in DCH. If access is failure, the CS service is only considered to trigger congestion.

If Pre-emption Capability IE of CS service is 'may trigger pre-emption', pre-emption procedure will be triggered; If pre-emption is failure or Pre-emption Capability IE of CS service is 'shall not trigger pre-emption', and it is allowed to queue, downgrade will be triggered. If it is not allowed to queue, downgrade will be triggered only once.

The CS service include emergency call. For emergency call, the default value of Pre-emption Capability is 'may trigger pre-emption', the default value of Pre-emption Vulnerabilit is 'not pre-emptable',

- Congestion control when cells in different PLMN share the CE resource

Mechanism of selecting subscribers for forced release due to shared CE congestion is similar to the not shared CE congestion. Both select subscribers from low SP to high SP, but the selecting scale will be different in congestion scenery.

1 When only local cell CE resource congestion occurred, it will select subscribers for pre-emption in the local cell.

2 When local cell group CE congestion occurred (including local cell group CE congestion and local cell group PLMN CE congestion both occurred), or only local cell group PLMN CE congestion occurred, it will select subscribers for pre-emption in the local cell group self-PLMN and other PLMNs having more CE resource than (*MinCEPercent[1…PLMNNum]* + CEneed).

3 When (1) and (2) conditions are satisfied together, it will select subscribers for pre-emption in the local cell self-PLMN and other PLMNs having more CE resource than (*MinCEPercent[1…PLMNNum]* + CEneed).

4 When local cell group CE congestion or local cell group self-PLMN CE congestion together with other resource congestion occurred (for example, DL code resource congestion, RTWP congestion, TCP congestion, HSDPA/HUSPA users number congestion, HS-DSCH data throughput congestion), it will select subscribers for pre-emption in the local cell self-PLMN and other PLMNs having more CE resource than (*MinCEPercent[1…PLMNNum]* + CEneed).

Note: *MinCEPercent[1…PLMNNum]* indicates PLMN's minimum proportion of CE resource ; *CEneed* indicates the CE need of the subscriber which trigger the pre-emption.

3.1.2 DCH Downgrade

If the rejected subscribers have no preemption capability or fail to release other subscribers forcibly, as described in the flow chart of figure 1, downgrade will be triggered for online services directly if these subscribers have no queuing capability. If they have queuing capability, they will be included into the queue and trigger downgrade of online services to spare some resources for the services in the queue or the services to be admitted later.

Note: All the principles to be described below are universal to both uplink and downlink, so these principles are not differentiated for uplink and downlink.

The congestion causes that can trigger downgrade include:

- Downlink: limitation of code resources (hard resources), Node B's CE resources (hard resources), power resources (soft resources).

- Uplink: limitation of Node B's CE resources (hard resources), and uplink interference (soft resource).

According to the above descriptions, the following scenarios which trigger congestion could trigger downgrade: RRC setup, RAB setup, RAB modification or RB reconfiguration, Rel99 DCH bit rate upgrade, incoming SRNC relocation, inter-Iur RL setup, intra-RNC soft or hard, incoming ISHO, incoming IFHO, incoming HS-DSCH serving cell change, inter-RNC SHO/HHO, second RAB setup for the same user and so on.

As the services in the queue include newly-admitted services and rate increase service of online services, the policies to trigger downgrade have different considerations. Newly admitted services include first RAB assignment, not first RAB assignment of emergency, CS service in scene of PS service combined CS service and incoming relocated services. For not the first RAB assignment, the forced release and queuing can not be allowed.

If RRC establishment refused to access to the cell for the resource congestion except the cause of User Number, the DCH downgrade will be triggered.

In addition, the services without queuing capability and handover services do not queue, but will also trigger downgrade for the rejecting cell when they are rejected with the same downgrade policies as those for newly-admitted services. Handover services include intra-RNC soft or hard handover, incoming ISHO, incoming IFHO, inter-RNC SHO/HHO.

The services without queuing capacity will still originate downgrade when rejected in an attempt to enable their subscribers to access later or other subscribers to access directly upon initiating an access request, while the cell is not overloaded at that time.

If downgrade is triggered by the service without queuing capacity, congestion_prohibit_timer will be started. The value of congestion_prohibit_timer is 10 seconds. If congestion_prohibit_timer is running, the upgrade request online service will be rejected. The reason is to avoid ping-pong update bit rate of online service.

- Downgrade triggered by newly-admitted services (this policy also applicable to RRC establishment, the services not allowed to queue and handover services)

Unlike forced release, downgrade is specific to individual RABs. That is, when a subscriber has more than one concurrent RAB, these RABs are independent of each other without coupling relationship when they are selected for downgrade.

The time for triggering downgrade: for RRC establishment or handover services or the services not allowed to queue, downgrade will be triggered once upon rejection of admission. For the services in the queue, apart from one time of downgrade triggered respectively when they are included into the queue and when common measurement is reported, in the case of hard resource limitation, multiple times of downgrade can be triggered as long as the queue still contains a service with only hard resources limited. If the queue only contains services with soft resource limited, downgrade can be triggered by common measurement report only.

When a newly-admitted service triggers online service downgrade, the principles for selecting services for downgrade are as follows: the online RABs are sorted according to application priorities(AP), and then are selected for downgrade in the ascending sequence of application priorities(AP). At most *MaxNumUeOfDecRat* RABs can be selected each time when downgrade is triggered, that is multi-RABs which may be own to different UE can be triggered to downgrade by a newly-admitted service simultaneity. If multi-RABs have the same application(AP), the RABs will be selected to downgrade random. As this downgrade is triggered by a newly-admitted service and a handover service, no comparison is made here between the comparative application priorities(AP) of the originator that triggers online service downgrade and the subscriber whose rate is decreased, in order to guarantee call successful ratio and reduce handover subscribers' call drop rate. Application priorities(AP) reflect basic priority(BP), current service rate, and bearer type. Their mapping methods and configuration examples can be found in *ZTE UMTS QoS Feature Guide*. CS AMR, PS RT, and PS NRT can all be treated as the targets of downgrade.

When an online service is selected as an RAB for downgrade, its rate to be decreased can be identified in this way: for PS services, their rate is decreased by several DRBC rate grades each time. The maximum DRBC rate grades (*UlDnMaxStg* in the uplink and *DlDnMaxStg* in the downlink) that can be decreased each time is configurable at the OMC. For I/B services, their rate can be decreased to the minimum DRBC rate. For S services, their rate can be decreased only to a minimum of Guaranteed Bit Rate (GBR).Regarding the CS AMR services, if Iu-up mode version 2 is adopted, downgrade will be conducted according to the types of rate assigned by the Iu interface. If Iu-up mode version 1 is adopted, downgrade will be conducted on the basis of the several rate steps allowed by the RNC. The DRBC rate steps are differentiated for uplink and downlink, and the uplink and downlink DRBC rate steps are defined in *ZTE UMTS DRBC Algorithm Feature Guide*. For detailed applications of the rate steps corresponding to AMR Iu-up mode version 1 and Iu-up mode version 2, refer to ZTE UMTS WB-AMR Feature Guide.

- Downgrade triggered by rate increase request from online services

Downgrade triggered by rate increase request from online services is specific to individual RABs. That is, when a subscriber has more than one concurrent RAB, these RABs are independent of each other without coupling relationship when they are selected for downgrade.

The time of triggering downgrade is the same as that for "Downgrade triggered by newly-admitted services".

When rate increase request from an online service triggers downgrade for another online service, to ensure fairness between two subscribers and prevent ping-pong adjustment between the subscriber who requests downgrade and the subscriber whose rate is decreased, the policies for downgrade triggered by online services take into comprehensive consideration these two factors: comparison between current rate and nominal bit rate (NBR), and application priorities(AP) (based on subscribers' current actual rate mapping assigned). The specific principles are as follows:

1 First all online services (including CS, PS RT and PS NRT) in a cell are divided into three sets according to the comparison between current rate and NBR. Services at a current rate smaller than NBR fall into set1, services at a current rate equal to NBR fall into set2, and services at a current rate larger than NBR fall into set3.

2 The priority relationship between set1, set2 and set3 is: set1>set2>set3. Specifically, rate increase request from set1 can trigger service downgrade of set2 and set3, and rate increase request from set2 can trigger service downgrade of set3. At the same time, the set into which the service whose rate is increased will fall must have an equal or smaller application priority(AP) than the set into which the service whose rate is decreased will fall. For example, service A in set 1 requests rate increase, while service B belongs to set2. If A falls into set2 after its rate is increased to the target rate, while B falls into set1 after its rate is decreased, A is not allowed to trigger downgrade of B. Otherwise, ping-pong adjustment may occur.

3 If the service requesting rate increase and the service available for downgrade belong to the same set, the former must have a higher application priority(AP) than the latter, and the former with its rate increased must have an equal or smaller application priority(AP) than the latter with its downgraded.

NBR is configured separately for uplink and downlink: *UlNormBitRate* and *DlNormBitRate*.

When an online service is selected as an RAB for downgrade, its rate to be decreased can be identified in this way: for all services, their rate is decreased by one step at a time based on the DRBC rates. Specifically, for I/B services, their rate can be decreased to the minimum DRBC rate. For S/C services, their rate can be decreased only to a minimum of Guaranteed Bit Rate (GBR).The DRBC rate steps are differentiated for uplink and downlink, and the uplink and downlink DRBC rate steps are defined in *ZTE UMTS DRBC Algorithm Feature Guide*.

When an online service has its rate being increased, the target rate can be identified as the DRBC rate immediately above the one higher than the current rate (without consideration to the restraint of Max Bit Rate). For details, refer to *ZTE UMTS DRBC Algorithm Feature Guide*.

- Execution of rate increase/decrease

The Iub interface adopts the mode of radio link reconfiguration, while the Uu interface adopts the mode of RB reconfiguration. If UE is in the macro diversity state, the Iub interface will configure more than one link at the same time.

Once congestion occurs to the cell accommodating any one of the macro diversity links, and this UE is selected as the subscriber for downgrade, all the links of this UE must be subjected to downgrade. The reason is that the R99 UE is allowed to have only one type of transmission format and one transmission format set, So it is impossible that different links have different transmission formats or transmission format sets. The macro diversity links mentioned above can be one of the follows: all links under the supervision of SRNC, all links under the supervision of DRNC, and links separated among SRNC and DRNC.

- Congestion control when cells in different PLMN share the CE resource

Because we don't know the CE released by the rate downgrade, so we select the downgrade services without considering the CEneed.

1 When only local cell CE resource congestion occurred, it will select subscribers for downgrade in the local cell.

2 When local cell group CE congestion occurred (including local cell group CE congestion and local cell group PLMN CE congestion both occurred), or only local

cell group PLMN CE congestion occurred, it will select subscribers for downgrade in the local cell group self-PLMN and other PLMNs having more CE resource than (*MinCEPercent[1…PLMNNum]* + CEneed).

3 When (1) and (2) conditions are satisfied together, it will select subscribers for downgrade in the local cell self-PLMN and other PLMNs having more CE resource than (*MinCEPercent[1…PLMNNum]* + CEneed).

4 When local cell group CE congestion or local cell group self-PLMN CE congestion together with other resource congestion occurred (for example, DL code resource congestion, RTWP congestion, TCP congestion, HSDPA/HUSPA users number congestion, HS-DSCH data throughput congestion), it will select subscribers for downgrade in the local cell self-PLMN and other PLMNs having more CE resource than (*MinCEPercent[1…PLMNNum]* + CEneed).

Note: *MinCEPercent[1…PLMNNum]* indicates PLMN's minimum proportion of CE resource ;

Note 1: The transmission resources at the Iub interface and Iu interface are allocated dynamically. Specifically, when transmission resources are congested, bandwidth is allocated to voice services at the Max Bit Rate (MaxBR), to S services at Guarantee Bit Rate (GBR), while to I/B services to a minimum extent. When the resources are not congested, the MaxBR bandwidth assigned by the service is available. That means transmission resources, when allocated, are subjected to dynamic adjustment based on resource occupation, and do not involve bandwidth allocation notification between individual network elements, because judging from message, these two types of resource congestions do not undergo the process of downgrade. Dynamic allocation of the transmission resources at the Iub interface and Iu interface takes into consideration service features and priorities. For mutual influence between the RT and NRT service rates based on transmission resources, refer to *ZTE UMTS RAN Transmission Overview Feature Guide*.

3.1.3 Congestion Scheduling

In the R99, congestion scheduling means to schedule the queuing newly admitted subscribers and online subscribers requesting rate increase for readmission according to scheduling priorities(SP) so that the subscribers with higher scheduling priorities(SP) are scheduled first to use the resources spared from load decrease.

To improve call successful ratio during readmission of the queuing subscribers, the newly admitted services are scheduled for readmission first, and then online services requesting rate increase are admitted. As long as there is a newly admitted service in the queue, no online service requesting rate increase will be scheduled for admission. Newly admitted services include assigned services and incoming relocated services.

Newly admitted services are scheduled in the sequence of scheduling priorities (SP of RNC). A newly admitted service with a higher scheduling priority(SP) will be scheduled prior to another with a lower scheduling priority(SP). For the mapping policies of scheduling priorities(SP), refer to *ZTE UMTS QoS Feature Guide*. When sorting the online services requesting rate increase, the current rates allocated to these services are taken into first consideration for the sake of fairness and priorities. The services with a current rate smaller than the NBR are put into the foremost set (set1), the services with a current rate equal to the NBR are put into set2, and the services with a current rate larger than the

NBR are put into the last set (set3). Then the services in each set are sorted according to their scheduling priorities(SP). The service ranking foremost will be scheduled first.

NBR is configured separately for uplink and downlink: *UlNormBitRate* and *DlNormBitRate*. The time for scheduling queuing services: if the service with the highest scheduling priority(SP) in the queue is suffering soft resource congestion, scheduling for admission cannot be started until the common measurement is reported, because the soft resources are judged on the basis of the common measurement report. If the service with the highest scheduling priority(SP) in the queue is suffering just hard resource congestion, the queue services will be rescheduled for admission whenever other online services undergo release and downgrade. Besides, rescheduling is also triggered when the common measurement is reported. Therefore, for hard resource limitation, there are more chances of rescheduling for admission.

3.1.4 Preemption of Resources at Iur Interface

As resource congestion is a measure judged by the CRNC to trigger load decrease. If the CRNC of an UE is DRNC, the CRNC cannot perform downgrade and RAB release for this UE, but needs to use the Iur interface to notify the SRNC which subscribers are available for downgrade. At present, ZTE's Iur interface congestion mechanism implements the DCH downgrade.

When the CRNC detects resource congestion, it is impartial to the UE linked via the Iur interface and this RNC, namely the UE of SRNC, when selecting subscribers (on the same principles as described in section 3.1.2 DCH Downgrade). However, if a UE linked via the Iur interface is selected as the subscriber for load decrease, only downgrade can be triggered but forced release can not be triggered.

For the UE at the Iur interface, the BP of RNC used by the DRNC is obtained from the Frame Handling Priority (FHP) in the RL setup request. As the Frame Handling Priority is obtained by the SRNC from the BP mapping chart, it reflects completely the ARP and Traffic Class information. However, the Iur interface cannot carry the Traffic Handling Priority, so it is justified to use the FHP for handling.

If the SRNC is not ZTE's RNC, it is also justified that ZTE DRNC uses the Frame Handling Priority directly as BP, because FHP also reflects the data processing priority of one RAB, and can be regarded as equivalent to service priority.

According to the downgrade algorithm provided, the followings gives the summary of handover scenarios which will triggered downgrade or not:

1 For intra-RNC SHO, the RL in non-best cell for a UE can be downgraded by new call admitted in the non-best cell while congestion occurs in the non-best cell.

2 For intra-RNC SHO, the RL in non-best cell for a UE can be downgraded by new call admitted in the best cell while congestion occurs in the best cell.

3 For inter-RNC SHO, the RL in DRNC can be downgraded by new call admitted in the cell under DRNC where congestion occurs in the cell under DRNC.

4 For inter-RNC SHO, the RL in DRNC can be downgraded by new call admitted in SRNC while congestion occurs in the cell under SRNC.

5 For inter-RNC SHO, the RL in DRNC can be downgraded by new SHO request to add the cell under DRNC to the active set while congestion occurs in the cell under DRNC.

3.2 Related Measurement

The common measurement, which is applied to the downgrade and congestion scheduling polices described above, is introduced in detail as follows.

3.2.1 Node B Common Measurement

3.2.1.1 Measurement of Uplink Interference

The uplink interference is measured by the common measurement of received total wideband power (RTWP) through the Iub interface. The Node B reports the measurement result to the RNC periodically. The common measurement period of the RTWP is two seconds.

3.2.1.2 Downlink Power Measurement

The downlink power is measured by the common measurement of downlink transmitted carrier power (TCP) through the Iub interface. The Node B reports the measurement result to the RNC periodically. The common measurement period of the TCP is two seconds.

4 HSDPA Congestion Control Algorithm

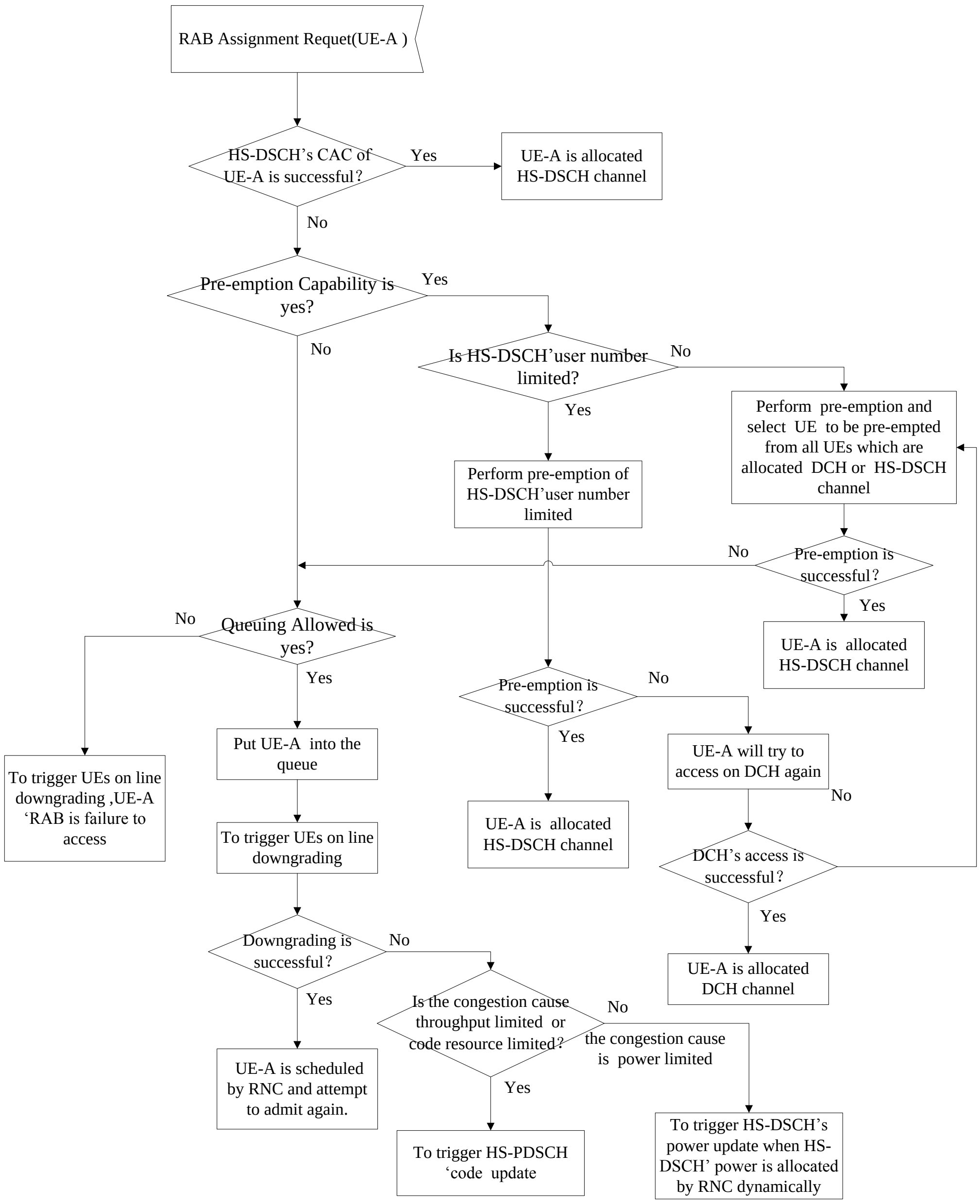
4.1 Resource Preemption Policies

For the HSDPA cells, resource preemption policies include dynamic adjustment of the HSDPA code resources, dynamic adjustment of HSDPA power resources (when the total power available to the HSDPA adopts the RNC Dynamic Assigning Mode - *HsdschTotPwrMeth*), forced release and DCH downgrade.

During resource congestion, the overall process of resource preemption in the HSDPA cells is as follows: upon service admission rejection, forced release will be conducted first depending on the preemption capability of the service. The process of forced release includes the forced release triggered by limitation of the number of HS-DSCH subscribers, and the R99 forced release (triggered by Node B's CE and code resources). If the forced release fails or the service has no preemption capability but queuing capability, the service will be included into the queue, and the DCH downgrade will be triggered first. If the DCH downgrade also fails, a decision must be made on whether to execute the HS-PDSCH code resource adjustment or HSDPA power resource adjustment depending on the causes for congestion. In case of code resource congestion, HS-PDSCH code resource adjustment will be triggered. In case of power resource congestion, the HS power resource adjustment will be triggered.

The following provides detailed descriptions of the flow chart with the RAB assignment as an example:

Figure 2 Flow chart of resource preemption in the HSDPA cell



Note: The cases of downgrade indicated in the figure above are all DCH downgrade cases.

The following describes specific resource preemption policies.

4.1.1 Forced Release

For the HSDPA cells, the basic principles of forced release are the same as those for the R99 forced release.

Compared with the R99 cell, the HSDPA cell has several increments changed as follows:

The causes for resource congestion are extended:

1. Hard resources: There is additional limitation to the number of HSDPA subscribers, that is, an additional scenario where forced release is triggered by limitation of the number of HSDPA subscribers. The hard resources that can trigger forced release include: downlink channelized code resources, uplink and downlink Node B's CE resources, and limitation of number of HS-DSCH services. The principles for forced release of downlink channelized code resources, and uplink and downlink CE resources are the same as those described in section 3.1.1 "DCH Forced Release". All online subscribers (including the DCH and HS-DSCH subscribers) in the cell are all subjected to forced release. Pre-emption triggered by the shared CE resource congestion in HSDPA cell refers to the "3.1.1 DCH Forced Release".

2. Soft resources: There is additional limitation to the HS-DSCH data throughput, and the other soft resources are the same as those of the R99, including power and RTWP.

3. The HS-DSCH data throughput congestion triggers only dynamic adjustment of HS-PDSCH code codes, while congestion of the other resources can trigger DCH downgrade.

4. When a streaming service over the HS-DSCH in a cell cannot meet its QoS (that is, when the HS-DSCH Required Power reported by Node B indicates that the power needed is smaller than the power available to this streaming service), forced release will be triggered for those HS-DSCH services with a low scheduling priority(SP) (the specific principles are described below in detail.)

5. For the HSDPA cells, HS-DSCH and DCH channels exist on the downlink. When there are coexisting services over the HS-DSCH and DCH bearers in a subscriber cell, it is necessary to consider priorities of the bearer channels. Therefore, the application priorities(AP) used for forced release need to be mapped, according to the channel types allocated to the services, from the mapping chart of the application priorities(AP) configured by the OMC.

6. Execution of forced release: If a subscriber allocated HS-DSCH channel is selected to be released forcibly and if the congested cell is HS-DSCH serving cell of the subscriber, the RAB will be released;If a subscriber allocated HS-DSCH channel is selected to be released forcibly and if the congested cell is not HS-DSCH serving cell of the subscriber, the radio link will be deleted. If a subscriber allocated DCH channel is selected to be released forcibly, the execution of forced release is the same as that described in section 3.1.1 "DCH Forced Release".

The following provides a detailed description of the forced release policies specific to change of these increments:

7. Policies for forced release triggered by limitation of the number of HS-DSCH subscribers

As the HS-DSCH usually has a high data rate, ZTE considers that the subscribers with higher priorities should be admitted to the HS-DSCH first. Therefore, if the HS-DSCH cannot be allocated due to limitation of the number of HS-DSCH subscribers, the first step is to sort the online subscribers already with the HS-DSCH channel allocated. If there is a subscriber with a lower scheduling priority(SP) than the HS-DSCH requesting subscriber, this lower-priority HS-DSCH subscriber will be triggered to migrate to the CELL_FACH. If there is no subscriber with a lower scheduling priority(SP) than the HS-DSCH requesting subscriber, it is suggested to attempt admission on the DCH again. If the admission of DCH also fails, the resource preemption should be executed, but the targets for forced release are all online subscribes in the cell (including the DCH and HS-DSCH subscribers).

The scenarios where forced release is triggered by limitation of the HS-DSCH subscribers include: first RAB assignment, not first RAB assignment of emergency call and incoming relocation.

The originator of forced release defined in the policies for forced release triggered by limitation of the number of HS-DSCH subscribers must have preemption capability, and the scarified subscriber must allow forced release too.

The contractual policies for the originator of forced release with more than one RAB and the subscriber released forcedly are the same as the multi-RAB combining policies in section 3.1.1 "DCH Forced Release“.

8 Forced release triggered by failure of the streaming service on the HS-DSCH to meet QoS

When the HSDPA Total Power is allocated dynamically by the RNC, on the conditions that the HS-DSCH Required Power is larger than the HS-PDSCH and HS-SCCH Total Power, or the HS-DSCH Required Power is larger than the Node B safety threshold (*Node BSafeThr)* – NoHsdschTcp, the following load decrease measures will be executed in sequence: first the DCH subscriber downgrade is triggered. When the downgrade is completed, if the conditions above are still satisfied, a subscriber suitable for switch to the DCH or forced release will be selected for DCH channel switch (since this is a service with guaranteed rate, it is switched only to the DCH). If the DCH succeeds in admission, channel switch will be executed. If the channel switch fails, forced handover will start. If forced handover fails, the related RABs will be released. In the procedure above, the HS-DSCH Required Power is reported by Node B through the common measurement.

In the Node B Assigning Mode, on the condition that the HS-DSCH Required Power is larger than the Node B safety threshold (*Node BSafeThr)* – NoHsdschTcp, the following load decrease measures will be executed in sequence: first the DCH subscriber downgrade is triggered. When the downgrade is completed, if the condition above is still satisfied, a subscriber suitable for switch to the DCH or forced release will be selected for DCH channel switch (since this is a service with guaranteed rate, it is switched only to the DCH). If the DCH succeeds in admission, channel switch will be executed. If channel switch fails, forced handover will start. If the forced handover fails, the related RABs will be released.

The principles to select target subscribers of channel switch, forced handover, or RAB release: sort the HS-DSCH Required Power of RABs with guaranteed rate based on the Node B report in the descending sequence, and start ergodic process from the beginning. Then calculate whether the HS-DSCH Required Power is smaller than or equal to the HSDPA Total Power after deletion of all RABs corresponding to one priority(SP) of the UE.

If yes, stop selection, and the selected subscribers will undergo subsequent operations. If not, continue selection.

Upon completion of selecting subscribers, the selected subscribers will be switched to the DCH one by one. If channel switch fails (DCH admission rejected), inter-frequency handover will be executed. If inter-frequency handover is impossible to be executed, the related RAB will be released.

The subscriber selection that triggers DCH downgrade and the downgrade principles are the same as those in section 3.1.2 "DCH ".

Note: The Node B reports the HS-DSCH Required Power of each UE with different Scheduling priorities(SP). If a UE has several RABs with guaranteed rate and the same scheduling priority(SP), the system cannot differentiate them. In this case, the system migrates the channels or releases the related radio links or RABs of all. If the RABs of a UE are of different priorities(SP), the system can differentiate them and sequence them separately.

4.1.2 DCH Downgrade

If the rejected subscribers have no preemption capability or fail to release other subscribers forcibly, as described in the flow chart of figure 2, downgrade will be triggered for online services directly if these subscribers have no queuing capability. If they have queuing capability, they will be included into the queue and trigger downgrade of online services to spare some resources for the services in the queue or the services to be admitted later.

All the principles for DCH downgrade in the HSDPA cell are the same as those for DCH downgrade in the R99 cell (refer to 3.1.2 "DCH ").

DCH downgrade triggered by the shared CE resource congestion in HSDPA cell refers to 3.1.2 "DCH ".

Note: The differences involved below are effective only to the downlink. As the uplink in the HSDPA cell is supported to use the DCH, the principles for the uplink are totally the same as those for the DCH downgrade.

The HSDPA cell is different from the R99 cell as follows:

- For the HSDPA cell, the downlink needs to initiate the two common measurements of NoHsdschTCP and HS-DSCH Required Power.
- There is an additional scenario where the DCH downgrade is triggered.

1 When the HSDPA Total Power is allocated dynamically by the RNC, on the conditions that the HS-DSCH Required Power is larger than the HS-PDSCH and HS-SCCH Total Power, or the HS-DSCH Required Power is larger than the Node B safety threshold (*Node BSafeThr)* – NoHsdschTcp, the following load decrease methods will be executed in sequence: first the DCH subscriber downgrade is triggered. When downgrade is completed, if the conditions above are still satisfied, a subscriber suitable for switch to the DCH or forced release will be selected for DCH channel switch (since this is a service with guaranteed rate, it is swtiched only to the DCH). If

the DCH succeeds in admission, channel switch will be executed. If channel switch fails, forced handover will start. If forced handover fails, the related RABs will be released.

2 In the Node B Assigning Mode, DCH downgrade will be triggered when any of the following conditions is satisfied:

i If HS-DSCH Required Power is larger than the Node B safety threshold (*Node BSafeThr)* – NoHsdschTcp, the following load decrease measures will be executed in sequence: first the DCH subscriber downgrade is triggered. When the downgrade is completed, if the condition above is still satisfied, a subscriber suitable for switch to the DCH or forced release will be selected for DCH channel switch (since this is a service with guaranteed rate, it is switched only to the DCH). If the DCH succeeds in admission, channel switch will be executed. If channel switch fails, forced handover will start. If forced handover fails, the related RABs will be released.

ii When the NoHsdschTCP common measurement is reported, and there is any HS-DSCH subscriber, the downlink downgrade algorithm will be started (to decrease the downlink DCH rate) if MinHsdpaPower (*MinHspaPwrRto)* + NoHsPower is larger than the Node B safety threshold. Where, MinHsdpaPower is the minimum power reserved for the HSDPA subscriber and configured by the background. NoHsPower is the result of the common measurement reported by Node B.

NoHsdschTcp is obtained from the common measurement (Transmitted carrier power of all codes not used for HS-PDSCH or HS-SCCH transmission) reported by Node B.

4.1.3 Dynamic Adjustment of HS-PDSCH Code Resource

When DCH downgrade fails, the HS-PDSCH code resource adjustment will be triggered in the event of code resource congestion.

The HS-PDSCH code resource adjustment includes HS-PDSCH code resource extension and reduction.

- If the HS-DSCH admission is rejected due to limitation of data throughput, it indicates the code resource currently allocated to the HS-PDSCH are insufficient, and dynamic increase of the number of HS-PDSCH will be triggered (for detailed policies, refer to *ZTE UMTS Code Resource Feature Guide*.)

- In the case of DPCH resource congestion, it indicates there are insufficient DPCH resources, and decrease of the number of HS-PDSCH will be triggered while guaranteeing the basic data rate of HSDPA (note: basic rate refers to a sum of the guaranteed bit rates of the services with guaranteed bit rates over the HS-DSCH). For detailed adjustment policies, refer to *ZTE UMTS Code Resource Feature Guide*.

The HS-PDSCH code resource reduction refers to the HSDPA downgrade of the whole cell, without involving selection of a single subscriber for downgrade from the RNC angle. After reduction, the HS-PDSCH code resource ultimately has an influence on the code resource allocation to the HSDPA subscribers of Node B. That means there are fewer code resources available for scheduling by Node B. As a result, the total HSDPA throughput is decreased. The influence of reducing code resource on each UE certainly takes into consideration the SPI of Node B. For more details, refer to *ZTE UMTS HSDPA Introduction Feature Guide*.

The process of dynamic adjustment of the HS-PDSCH code resources takes into overall consideration the needs for both HSDPA and R99 services. That means when the HSDPA code channels can only satisfy the GBR needs for the HSDPA service, the R99 service is not allowed to trigger reduction of the HSDPA code channel. When the HSDPA service triggers downgrade of the R99 service, the ultimate rate of the R99 service can only be decreased to its minimum rate (refer to 3.1.2 "DCH ".)Refer to *ZTE UMTS Code Resource Feature Guide* for more detailed policies for code resource adjustment performed for the sake of subscribers' QoS when the code resource between the R99 and HSDPA are shared.

4.1.4 Dynamic Adjustment of HSDPA Power Resource

When DCH downgrade fails, the HSDPA power resource adjustment will be triggered in the event of power resource congestion.

The HS-PDSCH power resource adjustment triggered by the RNC is effective only when the HSDPA power allocation method (*HsdschTotPwrMeth*) adopts the RNC dynamic allocation mode, which is reflected in two aspects as follows:

- When the HS-DSCH admission is rejected due to limitation of power resource, it indicates the power needed by the HSDPA is congested, and dynamic increase of the HSDPA power resources will be triggered (for detailed policies, refer to *ZTE UMTS Power Control Feature Guide*.)

- When the DPCH subscribers are limited due to power resource, dynamic decrease of the quantity of available HSDPA power resources will be triggered (for detailed policies, refer to *ZTE UMTS Power Control Feature Guide*.)

The following scenarios may cause congestion because of limitation of power resource: RRC setup, RAB setup, RAB modification or RB reconfiguration, Rel99 DCH bit rate upgrade, incoming SRNC relocation, inter-Iur RL setup, intra-RNC soft or hard, incoming ISHO, incoming IFHO, incoming HS-DSCH serving cell change, inter-RNC SHO/HHO, second RAB setup for the same user and so on.

The mechanism for handling the mutual influence between the HSDPA and non-HSDPA services is reflected on two aspects as follows:

- For the HSDPA services with GBR, if the power available to the HSDPA cannot meet the minimum requirement (common measurement report of HS-DSCH Required Power) of the GBR service, the downgrade of the R99 PS services will be triggered (both the NRT and RT PS are subjected to downgrade, but the R99 RT service must guarantee its GBR.)

- In case of co-carrier support of HSDPA, available minimum power (*MinHspaPwrRto*) should be reserved for the HSDPA service. If the actual power available to the HSDPA is smaller than the minimum power that should be reserved, it is also necessary to trigger the R99 PS service for downgrade. That means it is also allowed to reserve a part of power for a service without GBR.

4.1.5 Congestion Scheduling

For the cells that support HSDPA, the congestion scheduling policies are the same as those in 3.1.3 "Congestion Scheduling“.

4.1.6 Congestion Control for Dual-Cell HSDPA

Services number based congestion control:

- For single carrier HS-DSCH subscriber, if the services number congestion in target carrier, it will execute pre-emption triggered by the HS-DSCH service number limitation, referring to “4.1.1 Forced Release”.
- For double carriers HS-DSCH subscriber, it will execute pre-emption triggered by the HS-DSCH service number limitation in the congestion carrier, referring to “4.1.1 Forced Release”.

HS-DSCH data throughput based congestion control:

- For single carrier HS-DSCH subscriber, if HS-DSCH data throughput congestion in target carrier, it will execute dynamic adjustment of HS-PDSCH code resource procedure in target carrier, referring to “ 4.1.3 Dynamic Adjustment of HS-PDSCH Code Resource “. If HS-DSCH data throughput congestion in double carriers, it will execute dynamic adjustment of HS-PDSCH code resource procedure in double carriers, referring to “ 4.1.3 Dynamic Adjustment of HS-PDSCH Code Resource “.
- For double carrier HS-DSCH subscriber, if HS-DSCH data throughput congestion in double carriers, it will execute dynamic adjustment of HS-PDSCH code resource procedure in double carriers, referring to “ 4.1.3 Dynamic Adjustment of HS-PDSCH Code Resource “.

TCP based congestion control:

- For single carrier HS-DSCH subscriber, if TCP congestion in target carrier, it will execute DCH downgrade procedure in target carrier, referring to “4.1.2 DCH Downgrade”. If TCP congestion in double carriers, it will execute DCH downgrade procedure in double carriers, referring to “4.1.2 DCH Downgrade”.
- For double carrier HS-DSCH subscriber, if TCP congestion in double carriers, it will execute DCH downgrade procedure in double carriers, referring to “4.1.2 DCH Downgrade”.

4.2 Related Measurement

4.2.1 Node B Common Measurement

4.2.1.1 Downlink Power Measurement

The HS-DSCH congestion control needs the common measurement information of HSDPA related Node B, including HS-DSCH Required Power and Transmitted carrier power of all codes not used for HS-PDSCH or HS-SCCH transmission (NoHsdschTcp). Therefore, these common measurements must be enabled in the cells that support HSDPA.

All the common measurements above are reported at the intervals of two seconds.

5 HSUPA Congestion Control Algorithm

5.1 Resource Preemption Policies

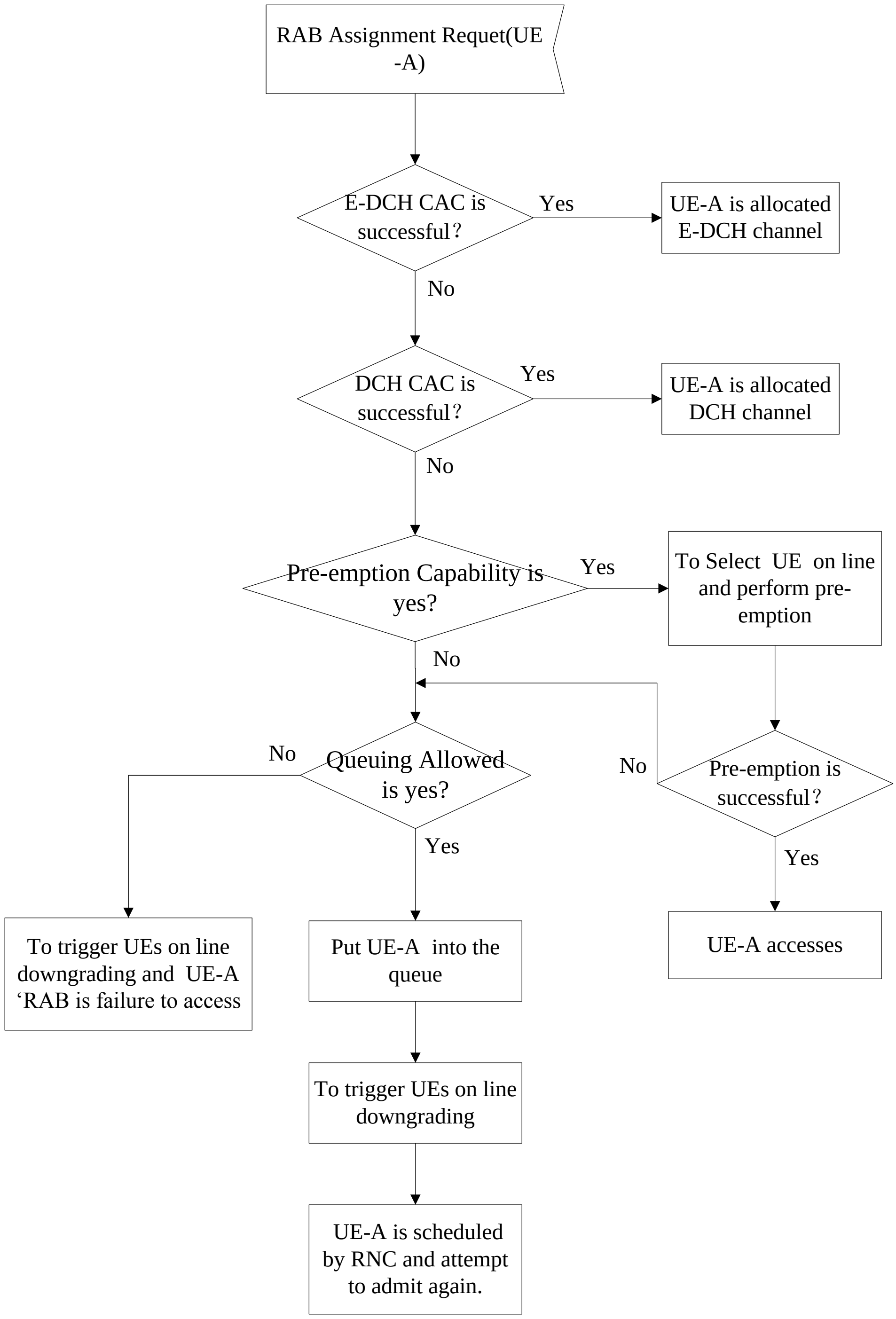
For the HSUPA cells, the resource preemption policies consist of forced release and DCH rate increase.

During resource congestion, the overall process of resource preemption in the HSDPA cells is as follows: for a service that fails to be admitted (excluding those admission failures triggered by an online rate increase request), forced release is conducted first (to release RAB) in the case of hard resource congestion if this is a service with preemption capability. If the forced release fails, the service will be included into the queue to trigger blind downgrade if it is capable of queuing. If it is incapable of queuing, downgrade will be directly triggered once. For a service that fails to be admitted because of hard resource congestion and it has no preemption capability, or a service that fails to be admitted because of soft resource congestion,, the judgment is focused directly on whether it is capable of queuing. If it is capable of queuing, it will be included into the queue to trigger blind downgrade; if it is incapable of queuing, downgrade will be directly triggered once. In the case of soft resource congestion, its handling process is the same as that for “a service without preemption capability during hard resource congestion".

For the HSUPA cells, as the E-DCH resources are scheduled at Node B,and DCH resources are scheduled at the RNC, the current policy is that E-DCH uses remaining DCH resources.

The following provides detailed descriptions of the flow chart with the RAB assignment as an example:

Figure 3 Flow chart of HSUPA resource preemption(kyz)



Note: The cases of downgrade indicated in the figure above all mean DCH downgrade.

The following describes specific resource preemption policies.

5.1.1 Forced Release

For a cell that supports HSUPA, its downlink supports HSDPA, and HSUPA is introduced onto its uplink, so the principles for the downlink forced release policies are the same as the force policies in section 4.1.1 "Forced Release."

The basic forced release principles on the uplink are all the same as the R99 forced release principles, so this section describes only the uplink differences compared with the R99.

The causes for resource congestion are extended:

- Hard resources: There is an additional limitation of number of HSUPA subscribers, so the hard resources that can trigger force release include: downlink channelized code resources, uplink and downlink Node B's CE resources, and limitation of number of E-DCH services. The principles for forced release of limitation of number of E-DCH services, downlink channelized code resources, and uplink and downlink CE resources are the same as those described in section 3.1.1 "DCH Forced Release". All online subscribers (including the DCH and E-DCH subscribers) in the cell are all subjected to forced release.

- Soft resources: Limitation of uplink interference based on the RSEPS measurement

DCH downgrade is likely to be triggered by congestion of both hard and soft congestion.

Pre-emption triggered by the shared CE resource congestion in HSUPA cell refers to the "3.1.1 DCH Forced Release".

5.1.2 Downgrade for DCH Subscribers

The load of E-DCH subscribers is mainly controlled by the Node B, while the RNC controls only the DCH load. Therefore, to decrease the uplink interference without forced release, the algorithm has no alternative but to deal with the DCH. The policy is the same as that of DCH downgrade described in *3.1.2 DCH* ".

DCH downgrade triggered by the shared CE resource congestion in HSUPA cell refers to 3.1.2 "DCH ".

5.1.3 Congestion Scheduling

For the cells that support HSUPA, the congestion scheduling policies are the same as those in 3.1.3"Congestion Scheduling".

5.2 Related Measurement

5.2.1 Node B Common Measurement

5.2.1.1 Measurement of Received Scheduled E-DCH Power Share (RSEPS)

For the HSUPA cell, if the services are rejected for the reason of uplink interference limited, there are two possible factors: 1. the sum of all scheduled E-DCH power generated by the GBR part is too high; 2. the sum of all DCH power and no scheduled E-DCH power is too high. The RTWP of the cell and the RTWP of the scheduled E-DCH can be measured through the Node B common measurement of RSEPS.

For the cells that support HSUPA, the power limit based E-DCH congestion control requires that the Node B periodically reports the HSUPA power related Node B common measurement information of RSEPS. The common measurement of the uplink RTWP is reported at the intervals of two seconds.

6 MBMS Congestion Control Algorithm

Refer to ZTE UMTS MBMS Feature Guide.

7 Configuration of Parameters

7.1 Parameter List

Abbreviated name	Parameter name
MaxNumUeOfDecRat	Maximum Number of UE Decreasing Rate When Congestion
UlNormBitRate	DCH Uplink Nominal Bit Rate(kbps)
DlNormBitRate	DCH Downlink Nominal Bit Rate(kbps)
HsdschTotPwrMeth	HSPA Total Downlink Power Allocation Method
MinHspaPwrRto	Minimum HSPA Total Downlink Power
Node BSafeThr	Safe Threshold for Node B
TTrueQ	Time of True Queue for Congested Service in RAB Setup Process
TTrueQReloc	Time of True Queue for Congested Service Relocating into UTRAN
QLength	True Queue Length
UlDnMaxStg	Maximum Number of Degraded Uplink Load Steps Every Time
DlDnMaxStg	Maximum Number of Degraded Downlink Load Steps Every Time

MinCEPercent	Minimal percent of CE can be used by the PLMN
ForcQueSwiAMR	Forced Queue Switch for AMR Service
ForcQueSwiCS64	Forced Queue Switch for CS 64kbps service
TTrueQForced	Maximum Time in the True Queue when Service be Forced into Queue

7.1.1 Parameter Configuration

7.1.1.1 Maximum Number of UE Decreasing Rate When Congestion

- OMC Path

Path: View->Configuration Management->RNC NE->RNC Radio Resource Management->Utran Cell->Utran Cell XXX->Modify Advanced Parameter->Load Control Relationship -> Maximum Number of UE Decreasing Rate When Congestion

- Parameter configuration

This parameter is used when load decrease is triggered. It is used to select the number of subscribers over the uplink/downlink DCH according to the current congestion status.

Increasing this parameter for load decrease can increase the number of DCH subscribers who can be selected each time for downgrade and accordingly increase the quantities of resources to be released.

Decreasing this parameter may decrease the number of DCH subscribers who can be selected each time for downgrade and accordingly decrease the quantities of resources to be released.

The default value is "3".

7.1.1.2 DCH Uplink Nominal Bit Rate(kbps)

- OMC Path

Path: View->Configuration Management->RNC NE->Qos Configuration->Priority and Rate Segment Related Qos Advanced Parameter->Check and Modify ->DCH Uplink Nominal Bit Rate

- Parameter configuration

This parameter is mainly used for DRBC queue scheduling, congestion control and load control. During downgrade by load decrease, DRBC queue scheduling, and load control, calculation of the priority of the UE whose rate is decreased is related to nominal bit rate. This parameter indicates the nominal bit rate for uplink interactive/background services, and is related to basic priority. Each type of basic priority corresponds to associated nominal bit rate.

Default configuration is [8, 8, 8, 8, 8, 16, 16, 16, 16, 16, 16, 64, 64, 64, 64, 64] kbps.

Increasing the nominal bit rate of a basic priority tends to increase the downgrade selection priority of the UE whose rate is decreased during downgrade by load decrease, DRBC queue scheduling, and load control.

Decreasing the nominal bit rate of a basic priority tends to decrease the downgrade selection priority of the UE whose rate is decreased during downgrade by load decrease, DRBC queue scheduling, and load control.

7.1.1.3 DCH Downlink Nominal Bit Rate(kbps)

- OMC Path

Path: View->Configuration Management->RNC NE->Qos Configuration->Priority and Rate Segment Related Qos Advanced Parameter->Check and Modify-> DCH Downlink Nominal Bit Rate

- Parameter configuration

This parameter is mainly used for DRBC queue scheduling, congestion control and load control. During downgrade by load decrease, DRBC queue scheduling, and load control, calculation of the priority of the UE whose rate is decreased is related to nominal bit rate. This parameter indicates the nominal bit rate for downlink interactive/background services, and is related to basic priority. Each type of basic priority corresponds to associated nominal bit rate.

Default configuration is [8, 8, 8, 8, 8, 16, 16, 16, 16, 16, 16, 64, 64, 64, 64, 64] kbps.

Increasing the nominal bit rate of a basic priority tends to increase the downgrade selection priority of the UE whose rate is decreased during downgrade by load decrease, DRBC queue scheduling, and load control.

Decreasing the nominal bit rate of a basic priority tends to decrease the downgrade selection priority of the UE whose rate is decreased during downgrade by load decrease, DRBC queue scheduling, and load control.

7.1.1.4 HSPA Total Downlink Power Allocation Method

- OMC Path

Path: View->Configuration Management->RNC NE-> RNC Radio Resource Management-> Advanced Parameter Manager->Hspa Configuration information -> HSPA Total Downlink Power Allocation Method

- Parameter configuration

This parameter indicates the allocation method for total power on the HSPA downlink. There are three methods:

If this parameter is configured to “0”, it means the RNC Static Assigning Mode;

If this parameter is configured to “1”, it means the RNC Dynamic Assigning Mode;

If this parameter is configured to “2”, it means the Node B Assigning Mode.

The default value is “2”.

7.1.1.5 Minimum HSPA Total Downlink Power

- OMC Path

Path: RNC Radio Resource Management->UltranCell->UltranCellXXX-> Modify Advanced Parameter->Hspa Configuration Information In A Cell-> Minimum HSPA Total Downlink Power(%)

- Parameter configuration

This parameter indicates the minimum value of the total transmission power allocated to HS-PDSCH, HS-SCCH, E-AGCH, E-RGCH and E-HICH code resource. It is effective only in the RNC Dynamic Assigning Mode, and its default is 20% of the downlink transmission power of the cell.

Increasing this parameter can increase the total transmission power available to HS-PDSCH, HS-SCCH, E-AGCH, E-RGCH and E-HICH codes.

Decreasing this parameter can decrease the total transmission power available to HS-PDSCH, HS-SCCH, E-AGCH, E-RGCH and E-HICH codes.

7.1.1.6 Safe Threshold for Node B

- OMC Path

Path: Path: View->Configuration Management->RNC NE->RNC Radio Resource Management->UltranCell->UltranCellXXX-> Modify Advanced Parameter->Load Control Relationship-> Safe Threshold for Node B(%)

- Parameter configuration

This parameter indicates the threshold for safe use of the HSDPA power in the Node B Assigning Mode, namely the permissible maximum value set by the system. The power used by HSDPA should be under instead of above this threshold at any time.

Decreasing this parameter will decrease the maximum HSDPA power available to Node B.

At present, this parameter has been up to the maximum value of the Node B side, so it is meaningless to increase it.

7.1.1.7 Time of True Queue for Congested Service in RAB Setup Process

- OMC Path

Path: View->Configuration Management->RNC NE->RNC Radio Resource Management-> Advanced Parameter Manager->Global Access Control->Time of True Queue Congested Service in RAB Setup Process

- Parameter configuration

This parameter indicates the maximum time length that a call can stay in the true queue in RAB setup process. When queuing longer than this parameter, the subscriber will fall out of the true queue. Ranging from 0~60s, it is configured to 10s by default.

Decreasing this parameter will shorten the maximum queuing time of a call in the true queue, making it more likely to fall out of the queue.

This parameter must be smaller than or equal to the timer duration of the RAB response of CN. At present, the CN default value is 10s, so this parameter is effective when it is smaller than or equal to 10s. It is inadvisable to increase this configuration.

7.1.1.8 Time of True Queue for Congested Service Relocating into UTRAN

- OMC Path

Path: View->Configuration Management->RNC NE->RNC Radio Resource Management-> Advanced Parameter Manager -> Global Access Control->Time of True Queue for Congested Service Relocating into UTRAN

- Parameter configuration

This parameter indicates the maximum time length that a call can stay in the true queue when relocation into UTRAN. When queuing longer than this parameter, the subscriber will fall out of the true queue. Ranging from 0~60s, it is configured to 4s by default.

Decreasing this parameter will shorten the maximum queuing time of a call in the true queue, making it more likely to fall out of the queue.

Increasing this parameter will increase the maximum queuing time of a call in the true queue, making it difficult to fall out of the queue.

7.1.1.9 True Queue Length

- OMC Path

Path: View->Configuration Management->RNC NE->RNC Radio Resource Management-> Advanced Parameter Manager->Global Access Control->True Queue Length

- Parameter configuration

This parameter indicates the length of the true queue. If the true queue is longer than this parameter, the congested subscribers cannot enter the true queue. Ranging from 0~32, it is configured to 16 by default.

Increasing this parameter can increase the length of the true queue.

Decreasing this parameter can decrease the length of the true queue.

7.1.1.10 Maximum Number of Degraded Uplink Load Steps Every Time

- OMC Path

Path: View->Configuration Management->RNC NE->RNC Radio Resource Management->Utran Cell->Utran Cell XXX->Modify Advanced Parameter->Load Control Relationship ->Maximum Number of Degraded Uplink Load Steps Every Time

- Parameter configuration

This parameter specifies the maximum number of DRBC rate steps that can be decreased at a time during the implementation of the load decrease measures in the uplink. You can configure the parameter in reference to the configuration of DRBC uplink rate steps.

Provided that the number of uplink DRBC rate grades is set to 2 grades [64 384], the current bit rate is 384kbit/s and the parameter is set to 1. If the uplink rate is decreased by 1 step, the rate is decreased to 64kbit/s. Provided that the number of uplink DRBC rate grades is set to 3 grades [64 128 384], the current bit rate is 384kbit/s, and the parameter is set to 1. If the uplink rate is decreased by 1 step, the rate is decreased to 128kbit/s. if the parameter is set to 2, the rate is decreased by 2 steps to 64kbit/s. By default, the settings is 1 step

7.1.1.11 Maximum Number of Degraded Downlink Load Steps Every Time

- OMC Path

Path: View->Configuration Management->RNC NE->RNC Radio Resource Management->Utran Cell->Utran Cell XXX->Modify Advanced Parameter->Load Control Relationship -> Maximum Number of Degraded Downlink Load Steps Every Time

- Parameter configuration

This parameter specifies the maximum number of degraded downlink load steps at a time during the implementation of the load decrease measures in the downlink. You can configure the parameter in reference to the configuration of DRBC downlink rate grades.

Provided that the number of downlink DRBC rate grades is set to 4 [8 64 128 384], and the current bit rate is 384kbit/s. If the parameter is set to 1 step, the downlink rate is decreased by 1 grade to 128kbit/s. If the parameter is set to 2 steps, the rate is decreased by 2 steps to 64kbit/s. If the parameter is set to 3 steps, the rate is decreased by 3 steps to 8kbit/s. By default, the setting is 1 step.

7.1.1.12 Minimal percent of CE can be used by the PLMN

- OMCR

Path: View->Configuration Management->RNC NE->RNC Radio Resource Management->NodeB Configuration Information->NodeB Configuration Information

XXX->Number of PLMN for RAN Sharing: Mininal percent of CE can be used by the PLMN

- Parameter configuration

This parameter indicates the minimal percent of CE of the PLMN. Increasing this parameter, the PLMN will occupy more CE resource and the congestion will occur less possibly. Decreasing this parameter, the PLMN will occupy less CE resource and the congestion will occur more possibly.

7.1.1.13 Forced Queue Switch for AMR Service

- OMCR

Path ： View->Configuration Management->RNC NE->RNC Radio Resource Management-> Advanced Parameter Manager->Global Access Control->Forced Queue Switch for AMR Service

- Parameter configuration

This parameter indicates the forced queue switch for AMR service. In the condition that there is no queue information or the RAB be assigned has no queue ability in the AMR RAB assignment information, if the forced queue switch is opened, then this AMR RAB has the queue ability.

If RAB assignment message or SRNC relocation request does not carry queue information or indicate the RAB does not have queue ability. Operator can open the switch to improve the KPI.

7.1.1.14 Forced Queue Switch for CS 64kbps service

- OMCR

Path ： View->Configuration Management->RNC NE->RNC Radio Resource Management-> Advanced Parameter Manager->Global Access Control->Forced Queue Switch for CS 64kpbs service

- Parameter configuration

This parameter indicates the forced queue switch for CS 64kbps service. In the condition that there is no queue information or the RAB be assigned has no queue ability in the CS 64kbps service RAB assignment information, if the forced queue switch is opened, then this CS 64kbps service has the queue ability.

If RAB assignment message or SRNC relocation request does not carry queue information or indicate the RAB does not have queue ability. Operator can open the switch to improve the KPI.

7.1.1.15 Maximum Time in the True Queue when Service be Forced into Queue

- OMCR

Path ： View->Configuration Management->RNC NE->RNC Radio Resource Management-> Advanced Parameter Manager->Global Access Control->Maximum Time in the True Queue when Service be Forced into Queue

- Parameter configuration

This parameter indicates the maximum time in the true queue when service is forced into queue. The default value is 6s, value scale is 0~60s. This parameter value should be smaller than or equate to the timer duration of the RAB response of CN.

Decreasing this parameter will shorten the maximum queuing time of a call be forced in the true queue, making it more likely to fall out of the queue.

Increasing this parameter will increase the maximum queuing time of a call be forced in the true queue, making it difficult to fall out of the queue.

8 Counter And Alarm

8.1 Counter List

Counter No.	Description
C310504764	Number of rejected services, DCH uplink user limit
C310504765	Number of rejected services, DCH uplink_RTWP limit
C310504766	Number of rejected services, DCH uplink CREDIT_LIMIT
C310504767	Number of rejected services, DCH uplink OVERLOAD
C310504768	Number of rejected services, DCH downlink USER limit
C310504769	Number of rejected services, DCH downlink TCP limit
C310504770	Number of rejected services, DCH downlink CREDIT limit
C310504771	Number of rejected services, DCH downlink OVERLOAD
C310504772	Number of rejected services, DCH no code
C310504774	Number of rejected services, HS user limit
C310504775	Number of rejected services, HS cell total pwr limit
C310504776	Number of rejected services, HS traffic volume limit
C310504778	Number of rejected services, HS total power limit
C310504785	Number of rejected services,HSDPA conversation class services
C310504786	Number of rejected services, HSDPA Interactive class services
C310504787	Number of rejected services, HSDPA Background class services
C310504788	Number of rejected services, HSDPA Streaming class services
C310504793	Number of rejected services,HSUPA conversation class services
C310504794	Number of rejected services,HSUPA Interactive class services
C310504795	Number of rejected services,HSUPA Background class services
C310504796	Number of rejected services,HSUPA Streaming class services
C310504801	Number of rejected services, Setup

C310504802	Number of rejected services, Handover
C310504803	Number of rejected services, DRBC
C310504804	Number of rejected services, non-DRBC Reconfig
C310494628	Number of Resource requisition attempt
C310494629	Number of Resource requisition failure
C310271696	Number of RNC initiate release by Rab Release Request for CS-speech by RAB pre-empty
C310271715	Number of RAB release by Iu release request for CS-speech by RAB pre-empty
C310271729	Number of RAB release by RAB release request for CS by RAB pre-empty
C310271748	Number of RNC initiate RAB release by Iu release request for CS by RAB pre-empty
C310271767	Number of RNC initiate RAB release by for CS-Speech by RAB pre-empty
C310271786	Number of RNC initiate RAB release by for CS-Videophone by RAB pre-empty
C310275904	Number of RNC initiate RAB release by release request for CS-HSDPA by RAB pre-empty
C310275923	Number of RNC initiate RAB release by release request for CS-HSUPA by RAB pre-empty
C310281800	Number of RAB release by RAB release request for PS by RAB pre-empty
C310281819	Number of RNC initiate RAB release by Iu release request for PS by RAB pre-empty
C310281833	Number of RNC initiate RAB release by RAB release request for PS-HSDPA by RAB pre-empty
C310281852	Number of RNC initiate RAB release by Iu release request for PS-HSDPA by RAB pre-empty
C310281866	Number of RNC initiate RAB release by RAB release request for PS-HSUPA by RAB pre-empty
C310281885	Number of RNC initiate RAB release by Iu release request for PS-HSUPA by RAB pre-empty
C310281904	Number of RNC initiate RAB release by release request for PS-HSDPA by RAB pre-empty
C310281923	Number of RNC initiate RAB release by release request for PS-HSUPA by RAB pre-empty
C311774805	Number of PS Downgrade due to UL CE Congestion
C311774806	Number of PS Downgrade due to DL CE Congestion
C311774807	Number of PS Downgrade due to Code Congestion
C311774808	Number of PS Downgrade due to UL Power Congestion
C311774809	Number of PS Downgrade due to DL Power Congestion

C310200611	Total queue time of SPEECH RAB assignment setup
C310200612	Total queue time of CS64 RAB assignment setup
C310200613	Total queue time of Streaming class RAB assignment setup
C310200614	Total queue time of Interactive class RAB assignment setup
C310200615	Total queue time of Background class RAB assignment setup
C310200616	Number of queue SPEECH RAB assignment setup
C310200617	Number of queue CS64 RAB assignment setup
C310200618	Number of queue Streaming class RAB assignment setup
C310200619	Number of queue Interactive class RAB assignment setup
C310200620	Number of queue Background class RAB assignment setup
C310100890	Total number of successful Multi RAB assignment setup with queuing
C310110542	Total number of failed Multi RAB assignment setup with queuing
C310383642	Failed RAB modification number with queuing for CS domain,TQUEUING Expiry
C310383789	Failed RAB modification number with queuing for PS domain,TQUEUING Expiry
C310110329	Number of failed RAB assignment setup in cell for CS domain,TQUEUING Expiry
C310110386	Number of failed RAB assignment setup in cell for PS domain,TQUEUING Expiry
C310175765	Number of failed HSDPA RAB assignment setup in cell for CS domain,TQUEUING Expiry
C310175810	Number of failed HSUPA RAB assignment setup in cell for CS domain,TQUEUING Expiry
C310170625	Number of failed HSDPA RAB assignment setup in cell for PS domain,TQUEUING Expiry
C310170670	Number of failed HSUPA RAB assignment setup in cell for PS domain,TQUEUING Expiry

8.2 Alarm List

This feature has no related alarm.

9 Glossary

A

ARP Allocation/Retention Priority

D

DRBC	Dynamic Radio Bearer Control
G	
GBR	Guarantee bit rate
M	
MBMS	Multimedia Broadcast Multicast Service
N	
NRT	Non-real Time Traffic
R	
RT	Real Time Traffic
RTWP	Received Total Wide Band Power
T	
TCP	Transmitted Carrier Power

