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Contents

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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN), and is now submitted for the ETSI standards Membership Approval Procedure.

The present document is part 4 of a multi-part deliverable covering the Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Specification of protocols required to support the NGN Overload Control Architecture, as identified below:

Part 1: "Overview";

Part 2: "Overload and Congestion control; GOCAP";

Part 3: "Overload and Congestion Control for H.248 MG/MGC";

Part 4: "Adaptative Control for the MGC".

1 Scope

The present document describes an extension to H.248.1 gateway protocol to enable a robust overload control mechanism to be implemented between Access Media Gateways (AGWs) and their associated Media Gateway Controllers (MGCs). The control is not dependent on the version of H.248 used.

1.1 Applicability

The Rate Based Access Media Gateway/MGC Overload Control Protocol is **applicable** for:

- analog line interfaces with Analog Line Signalling (ALS), corresponding AGW H.248 Terminations are of type analog line (ALN);
- interfaces with Channel Associated Signalling (CAS).

The Access Media Gateway/MGC Overload Control Protocol is **not applicable** for:

- all interface types with Common Channel Signalling (CCS) for controlling the corresponding bearer connections at the AGW, e.g.:

  a) ISDN B-channels of ISDN BRIs;

  b) ISDN B-channels of ISDN PRIs;

  c) V5.1 B-channels of V5.1 interfaces;

  d) V5.2 B-channels of V5.2 interfaces; or

  e) any narrowband Access Node interface with CCS.

NOTE 1: CCS traffic is relayed in this kind of AGW by embedded SIGTRAN Signalling Gateways (SG). Such a SG type terminates layer 2 of the control plane protocol stack (e.g. Q.921) and passes the layer 3 signalling (e.g. Q.931) transparently to the associated MGC. The AGW therefore has no capability to detect start of call events nor provide address digit analysis.

NOTE 2: Extending the AGW type (of note 1) by an additional capability of "monitoring layer 3 call control signalling" may allow the application of the MGC Overload Control Protocol for CCS interfaces. However, such a concept is for further study.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

[1] ITU-T Recommendation H.248.1: "Gateway control protocol: Version 3".

[2] ITU-T Recommendation Q.543: "Digital exchange performance design objectives".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

call attempt: attempt to setup a path to carry user data between end users

Media Gateway Controller overload: point at which the number of call attempts presented to an MGC exceeds its engineered processing capacity for a significant period of time, excluding momentary peaks

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AGW	Access Media Gateway
BRI	Basic Rate Interface
CAS	Channel Associated Signalling
CCS	Common Channel Signalling
CPU	Central Processor Unit
ISDN	Integrated Services Digital Network
MGC	Media Gateway Controller
NGN	Next Generation Network
PRI	Primary Rate Interface
SNMP	Simple Network Management Protocol

4 AGW – MGC overload control mechanism

The purpose of the present document is to define an overload control mechanism between Access Media Gateways (AGWs) and their associated Media Gateway Controllers (MGCs) in an NGN. This mechanism is concerned solely with MGC overload due to excessive originating call attempts from dependent AGWs. Additional mechanisms (which are outside the scope of the present document) must also be employed to provide an overall overload control solution/strategy in a NGN.

4.1 AGW-MGC overload scenarios

In an NGN there exists the possibility that there will be many thousands of AGWs connected to a single MGC. With such an architecture it is envisaged that it may only require a moderate increase in call attempt levels across all of the AGWs to cause a MGC to become overloaded. In the case of media-stimulated events (e.g. tele-voting) or in the event of a disaster, there is often a large step change in the level of call attempts. In the NGN architecture, such an event is likely to grossly overload the MGCs to a level where service may cease completely.

With such large numbers of AGWs connected to a single MGC it will be necessary to efficiently, and quickly, propagate information relating to the MGC overload back to its dependant AGWs, allowing the AGWs to immediately take preventative action, and thus quickly reduce the level of load that is being offered to the overloaded MGC.

4.2 AGW-MGC overload control mechanism

The high level requirement is to enable the rate of new originating calls that are generated by an AGW to be reduced during conditions of MGC overload, whilst at the same time permitting priority calls to be admitted (e.g. calls to an emergency operator or calls originating from a priority analogue line).

The basic premise of the load control mechanism is that the MGC is able to invoke a regulating capability on the AGW when the MGC is in overload. This is achieved by sending a H.248 MODIFY command request against the ROOT termination with a new package (see clause 5.1) that is recognized by the AGW as being indicative of MGC overload, and contains an indication of the amount of load to be regulated by the AGW. Since the AGW is unaware of the concept of a "call", it is proposed that the AGW shall regulate the level of new off-hook notifications it offers to the overloaded MGC to the level that has been signalled by the MGC. A new off-hook is identified at the AGW via detection of an off-hook event at a termination that is in the NULL context. The proposed mechanism enables the MGC to quickly propagate information relating to its overload, and the allowed admitted rate of off-hooks that its dependant AGWs should be regulating in order to reduce the offered load to the MGC. The purpose of the control mechanism is to maintain high effective throughput at an overloaded MGC subject to bounding MGC response times , i.e. keeping the response times short enough to prevent customer reattempts. The new package would be used by the MGC on the occurrence of either a new originating / terminating a call from/to a dependent AGW to enable regulation of new off-hook notifications.

Under this proposal, AGWs will, during a MGC overload, regulate any new Off Hook notifications based upon the current level signalled from the MGC and the priority allocated to the Off Hook. Off Hook notifications that are accepted by the regulation mechanism are passed onto the MGC and handled normally. For those calls that are regulated by the filtering mechanism, then the AGW must first determine if the line is initiating a call to a priority destination. The AGW does this by autonomously responding to the Off Hook notification by applying standard dial tone and then, if necessary, collecting and comparing signalled digits with pre-defined simple digit strings. The signalled digits will be sufficient to enable the AGW to establish the priority of the call destination. The priority of the call attempt is reassessed using the digit information, and re-presented to the regulation mechanism. If the call is "rejected" by the regulation mechanism then the AGW applies an autonomous line/port control functionality defined by a pre-configured script/data. In essence, this script defines a sequence of signals that are applied to the line so that the expected behaviour of the calling party is to hang up and re-attempt the o/g call at a later time. The sequence of signals covers the playing of appropriate indications (e.g. network busy tone) together with appropriate line feeds to eventually return the line to an idle state.

5 H.248 package details

A new package is introduced to convey the degree of overload at the (overloaded) MGC to the dependent AGWs. This package is based upon the notification behaviour (nb) package that has been defined in [1] (H.248.1 version 3, annex E.15). The main differences are that this package implements a rate based restriction and may be applied to AGWs that support any version of H.248.

5.1 ETSI Notification Rate Package

Package Name: ETSI Notification Rate Package.

PackageID: etsi_nr (0x00a5)

Version: 1

Description: This package enables the MGC to convey an allowed maximum admitted rate of off-hooks to the AGW.

Extends: None.

5.1.1 Properties

5.1.1.1 Notification Rate

Property Name: Notification Rate.

PropertyID: notrat (0x0001)

Description: This property conveys the maximum allowed admitted rate (per second) of off-hook notifications from terminations in the NULL context that should be regulated by an AGW. The property applies to the ROOT termination.

Type: OctetString, with up to 8 octets.

Valid strings consist of an optional sign character (+, -) followed by 1 to 4 decimal digits, followed by the decimal point "." followed by 1 or 2 decimal digits.

Examples of valid notrat strings are: "10.0", "-0.4", "5.67" and "-1.0". Examples of invalid notrat strings are: "-1, 2" and "1.234E+01".

Possible Values: A value of 0.0 means that no off-hooks shall be admitted on the AGW.

A value > 0.0 is the bucket leak rate applied to off-hooks at the AGW.

A value of < 0.0, received from the MGC, means that leaky bucket restriction shall cease at once.

Default Value: -1.0

Defined In: Termination State.

Characteristics: read/write.

5.1.1.2 Off-Hook Notification

Property Name: Off-Hook Notification.

PropertyID: offHookNot (0x0002)

Description: This property determines whether the off-hook event is reported to the MGC for (priority) o/g calls that are regulated and permitted to proceed by the AGW during periods of MGC overload. The property applies to the ROOT termination.

Type: Enumeration.

Possible Values: "Required" (x0001)

"NotReq" (x0002

"Required" means that the off-hook notification shall be reported to the MGC.

"NotReq" means that the off-hook notification shall not be reported to the MGC.

Default Value: Provisioned on the AGW.

Defined In: Termination State.

Characteristics: read/write.

5.1.2 Events

None.

5.1.3 Signals

None.

5.1.4 Statistics

None.

5.1.5 Error codes

None.

5.1.6 Procedures

The purpose of the mechanism is to enable a MGC, under conditions of overload, to convey this fact to the AGW via a Modify command. The AGW activates a filtering mechanism to limit the admitted rate of off-hook notifications sent through to the MGC. The MGC overload is conveyed in terms of the notrat property(i.e. the maximum rate of new off-hook notifications to sent by the AGW to the MGC). The new property shall be sent/used against the ROOT termination as follows:

```
Transaction = XXX{
    Context=-{
        Modify=ROOT{
            Media{
                TerminationState{etsi_nr/notrat =ZZ.ZZ}
            }
        }
    }
}
```

where XXX = transaction number and ZZ.ZZ = the MGC off-hook admitted rate.

The AGW will then invoke/activate a regulation mechanism for off-hooks detected against terminations in the NULL context. Off-hooks that are not subject to regulation will be presented to the MGC in the normal manner. However, off-hooks that are subject to regulating will be given special treatment by the AGW. The special treatment results in the AGW applying appropriate signals to the line to enable sufficient digits to be collected to enable comparison with pre-loaded (priority) digit strings. The result of the comparison will alter the priority of the Off-Hook, and if the call attempt is still not of sufficient priority to be accepted, the AGW will apply appropriate line signals to cause the end user to hang up and return the line to the idle state. If a match occurs, then the dialled digit string is reported to the MGC. The Off-Hook may also be reported in the same message, based on the *offHookNot* property.

The MGC may use an Audit of the Packages Descriptor to determine if an AGW supports the "etsi_nr" package.

5.1.7 Detailed overload control behaviour

5.1.7.1 Control structure

The following clauses describe the functional behaviours required at the AGW and MGC.

5.1.7.1.1 Introduction

A MGC is assumed to have an internal overload control that is able to reject part of the arriving stream of off-hooks in order to bound the response times received by admitted calls. It is also assumed that the internal overload control can represent the internal load state of the system so that it can be used to drive an external control via a feedback loop.

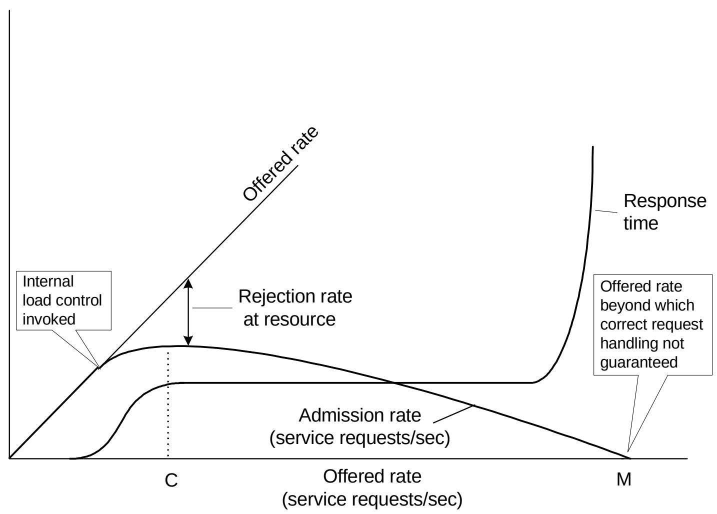

Figure 1: Idealized MGC load response behaviour

It is left to the implementer to decide precisely the way in which this is achieved - different suppliers' MGCs are likely to have different overload control mechanisms. Ideally the MGCs load control mechanism should exhibit the properties outlined in ITU-T Recommendation Q.543 [2], as shown in figure 1. It is the role of the etsi_nr control to attempt adjust the load offered to the MGC such that the internal load control can maintain the system at peak throughput (load "C" in figure 1).

The components of the etsi_nr control are shown in figure 2, each of the components are described in more detail in the following clauses.

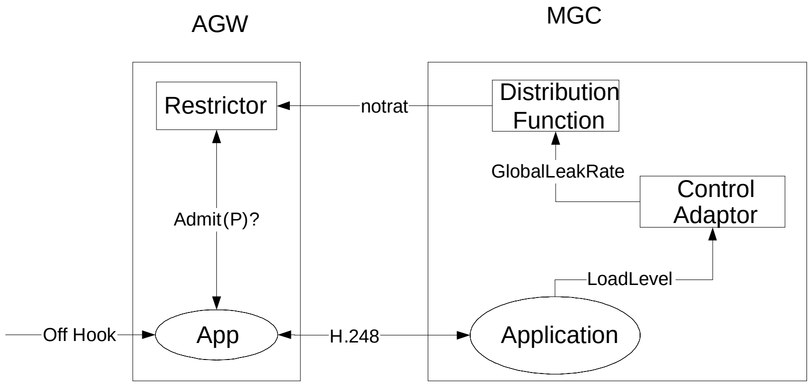

Figure 2: Entities in the etsi_nr control

5.1.7.1.2 Control adaptor

The MGC is assumed to have an internal load monitoring capability – usually associated with the internal load control of the MGC – (not an etsi_nr entity), that periodically measures the MGC load state, generating a system load metric, LoadLevel, which is used by the ControlAdapter. The LoadLevel metric is generated from measurements on the system (e.g. CPU occupancy, buffer lengths, internal reject rates, etc.) and is a continuously increasing function of the system load. (It is *not* simply the CPU occupancy, though that may be one of the measurements used to calculate it.) When the MGC is overloaded, the ControlAdaptor is responsible for mastering the GlobalLeakRate so that the LoadLevel converges to the GoalLoadLevel. The GoalLoadLevel is set at the LoadLevel that corresponds with the highest useful throughput of the system, subject to meeting transaction delay targets, i.e. at point "C" in figure 1.

5.1.7.1.3 Distribution function

The Distribution Function receives the GlobalLeakRate from the ControlAdaptor and is responsible for sending out individual leak rates, (notrat) to each AGW. The DistributionFunction is provisioned with a weight for each AGW, w_i, such that the value of notrat sent to the i^{th} AGW is the $w_i \times$ GlobalLeakRate/W, where W is a normalization parameter and is equal to the sum of all the w_i of the AGWs currently registered with the MGC. The scaling factors could be used to send a larger leak rate to an AGW with many line terminations than to one with fewer terminations. The DistributionFunction shall be aware of the previously signalled property value notrat to each of its AGWs. The use of the W factor to normalize the leakrate sent to each AGW means that the notification rate notrat for each AGW is reduced when a new AGW registers with the MGC (see clause 5.1.7.4).

5.1.7.1.4 Restriction

Each AGW has a priority-aware leaky bucket throttle, which can be used to give preference to high priority off-hooks over low priority off-hooks, whilst allowing high priority off-hooks to be throttled if they are causing the MGC overload. This is achieved by equipping the bucket with one threshold per priority level. An off-hook of priority class "*c*" is admitted if and only if the bucket fill + 1 is less than or equal to the priority class "*c*" threshold; in which case the bucket fill is increased by 1; otherwise the priority class "*c*" Off Hook is regulated, and the bucket fill unchanged.

Two priority classes are defined:

- Priority class 0: For emergency Calls, i.e. calls that have been regulated, and the AGW has collected digits autonomously that match the "Priority Digit Map".
- Priority class 1: The default priority class for off-hooks.

Additional priority classes may also be defined, up to priority class MaxClass. MaxClass is an implementation dependant constant.

EXAMPLE 1: It may be that the AGW can dynamically add a high calling rate flag to lines that are originating a large number of Off Hook events. (How the AGW sets and resets that flag is out of scope of the present document). A priority class may be defined for such lines, so an off-hook from a line which has this flag set may use a lower threshold than that used for ordinary lines.

EXAMPLE 2: In some markets there may be a requirement for one or more priority levels associated with line terminations used by civil institutions, such as hospitals, etc. Such lines may be assigned an appropriate priority class to deliver that priority during MGC overload.

The selection of the threshold levels for each priority class will affect the relative rejection probabilities of the different priority levels and it should be noted that although a call attempt may belong to more than one priority (e.g. a call from a line termination marked as high priority with a destination that matches the "Priority Digit Map"), the priorities are applied differently, depending on the phase of call setup, as explained in clause 5.1.7.3.2. For classes 1 to MaxClass, the thresholds are unconstrained and may be larger, smaller or equal to class 0 as required.

5.1.7.2 Actions at an overloaded MGC

Under overload conditions an MGC shall, on receipt of a new originating call attempt from an AGW (i.e. Off-Hook notification), seek to off-load the processing of future calls from the AGW by the sending an H.248 MODIFY command using the new package to convey its notrat. The MGC shall also use terminating call attempts as a trigger to update the notrat on a given AGW. In order avoid extra H.248 messages, the notification may be sent in the first available message to a given AGW. The MGC shall attempt to control its LoadLevel to some goal value, the GoalLoadLevel (set so as to maximize the useful work done by the device, while bounding response times).

The MGC shall be aware of the previously signalled property value notrat to each of its AGWs. On receipt of new originating / terminating call attempts from/to an AGW, the MGC shall update the property notrat if it has increased or decreased from the value previously signalled. An MGC has four states relating to overload:

- Not Overloaded.
- Overloaded.
- TerminationPending.
- ReturningToNotOverloaded.

In the state "Not Overloaded":

- The ControlAdaptor shall monitor the current MGC LoadLevel and if the LoadLevel exceeds the GoalLoadLevel, then the ControlAdaptor shall set the GlobalLeakrate to the InitialLeakRate, pass that value to the DistributionFunction, and change the MGC state to "Overloaded". The DistributionFunction will calculate a notrat value for each of the AGWs.
- If a new terminating or outgoing call attempt is received, then the MGC shall proceed with the call as normal. The DistributionFunction will check the last notrat value sent to the AGW and, if it was positive, send a notrat value of -1.0 using a Modify command against the ROOT termination. In order to minimize the number of H.248 transactions, the Modify command may be nested within the same H.248 transaction as that used to progress the call. The DistributionFunction notes the notrat value sent to that AGW.

In the state "Overloaded":

- In this state, the ControlAdaptor shall monitor the MGC LoadLevel and periodically update the GlobalLeakRate, passing the new value to the DistributionFunction. The GlobalLeakRate is modified in such a way as to cause the MGC LoadLevel to move closer to the GoalLoadLevel. If the LoadLevel falls below the GoalLoadLevel, the MGC shall start the TerminationPending timer, start monitoring the Off Hook arrival rate and change its state to TerminationPending.

- If a new terminating or outgoing call attempt is received, then the MGC shall proceed with the call as normal. The DistributionFunction will calculate the notrat value for that AGW (from the GlobalLeakRate) and send the notrat value using a Modify command against the ROOT termination (unless the current notrat has already been sent to that AGW, in which case do not re-send it). In order to minimize the number of H.248 transactions, the MGC may nest the Modify command within the same H.248 transaction as that used to progress the call. The DistributionFunction notes the notrat value sent to that AGW.

In state "TerminationPending":

- If the TerminationPending timer (set when the MGC enters the Termination Pending state) expires, then change state to "ReturningToNotOverloaded", start the ReturningToNotOverloaded timer, set both the LastRTNAttemptCount and the RTNAttemptCount to zero, and monitor Off Hook arrival rate.

- If the TerminationPending timer (set when the MGC enters the Termination Pending state) expires, then change state to "NotOverloaded". (Termination of throttling at an AGW is caused by the receipt of a negative notrat value – see description of "NotOverloaded" state).

- If a new terminating or outgoing call attempt is received, then the MGC shall proceed with the call as normal. The DistributionFunction will calculate the notrat value for that AGW (from the GlobalLeakRate) and send the notrat value using a Modify command against the ROOT termination (unless the current notrat has already been sent to that AGW, in which case do not re-send it). In order to minimize the number of H.248 transactions, the MGC may nest the Modify command within the same H.248 transaction as that used to progress the call. The DistributionFunction notes the notrat value sent to that AGW.

- The ControlAdapter continues to monitor the MGC LoadLevel, the Off Hook arrival rate and periodically updates the GlobalLeakRate, subject to the following two conditions:

  - not exceeding the MaxGlobalLeakRate;

  - if the previous change to the GlobalLeakRate was an increase and if the current Off Hook arrival rate is not greater than the previous Off Hook arrival rate, revert to the GlobalLeakRate in force before the previous change.

  These two restrictions on the growth of the GlobalLeakRate are required in order to prevent the notrat values sent to the restrictors rising to an extent that would be problematic in the event of a sudden increase in the Off Hook rate.

- If the ControlAdapter detects that the LoadLevel exceeds the GoalLoadLevel, the MGC will move to the "Overloaded" state.

In state "ReturningToNotOverloaded":

- If a new terminating or outgoing call attempt is received, then the MGC shall proceed with the call as normal. The DistributionFunction will check the last notrat value sent to the AGW and, if it was positive, send a notrat value of -1.0 using a Modify command against the ROOT termination. In order to minimize the number of H.248 transactions, the Modify command may be nested within the same H.248 transaction as that used to progress the call. The DistributionFunction notes the notrat value sent to that AGW. If the new attempt has originated from a AGW then the MGC shall increment the RTNAttemptCount.

- If the ReturningToNotOverloaded timer expires, then the MGC shall compare the LastRTNAttemptCount and the RTNAttemptCount. If LastRTNAttemptCount < RTNAttemptCount then the MGC shall set the value of LastRTNAttemptCount to RTNAttemptCount, set the value of RTNAttemptCount to zero and restart the ReturningToNotOverloaded timer. Otherwise the MGC shall change state to "NotOverloaded".

- If the ControlAdapter detects that the LoadLevel exceeds the GoalLoadLevel, the MGC will move to the "Overloaded" state, set the GlobalLeakRate to the leak rate that was in use upon entry to the "ReturningToNotOverloaded" state, and cancel the ReturningToNotOverloaded timer.

NOTE: The setting of the MaxGlobalLeakRate parameter is critical. If the value is too small, then the control may fail to converge on a suitable GlobalLeakRate leading to an effect where the control will oscillate. It can be shown that a sufficient condition on the lower bound of MaxGlobalLeakRate is:

$$\frac{maxGlobalLeakRate}{\sum_i w_i} \geq \max\left(\frac{\min(m_0,C)}{w_0},\frac{\min(m_1,C)}{w_1},\ \ldots\ ,\frac{\min(m_i,C)}{w_i},\ \ldots\right)$$

where C is the total MGC capacity w_i is the weight allocated to the i^{th} AGW and m_i is the maximum load that can be generated from the i^{th} AGW.

It should be noted that a new outgoing call attempt is signalled by the AGW via a Notify command containing either just an Off-Hook observed event or an Off-Hook and Digit Completion observed event or a Digit Completion event. The first situation occurs when an Off-Hook is not restricted. The second situation occurs when an Off-Hook is initially restricted but a priority digit string match occurs and the property *offHookNot=Required*. The third situation occurs when an Off-Hook is initially restricted but a priority digit string match occurs and the property *offHookNot=NotReq*. Having sent a MODIFY to increase the notrat value to a given AGW, a MGC shall endeavour to handle any new received Off-Hooks as normal. However, it is recognized that under extreme conditions of overload, a MGC may be driven into a state of high overload whereby all received signalling shall be ignored. This scenario would cause H.248 message retransmission to occur on the AGWs and (in the worst case) may trigger Service Change procedures on the AGW to confirm the availability of the MGC.

5.1.7.3 Actions at an AGW

5.1.7.3.1 Activation and deactivation of AGW regulation mechanism

Regulation of new Off-Hook notifications at an AGW shall be activated when the AGW receives a Modify command from the MGC against the ROOT termination with a notrat property which is positive. Such a Modify command may be as a result of an Off Hook sent to the MGC from the AGW, an incoming call, or it may be sent from the MGC without any other stimulus. The AGW shall initialize the bucket fill to be equal to the TesholdVector[1] (i.e. the threshold for calls from ordinary lines). It is recommended that the bucket fill, *f*, is then modified so as to take on a random value uniformly distributed between *f* - 1.0 and *f* + 1.0 (subject to remaining non-negative).

If the AGW receives a Modify command with the notrat property set to a negative value, the AGW shall increase its LeakRate by the proportion indicated in the LeakRateGrowthFactor value and, subject to the new LeakRate not exceeding the MaxLeakRate, the AGW will start the RateIncrementPeriod timer. Upon expiry of the RateIncrementPeriod timer the AGWshall increase its LeakRate by the proportion indicated in the LeakRateGrowthFactor value and, subject to the new LeakRate not exceeding the MaxLeakRate, the AGW will restart the RateIncrementPeriod timer. The AGW will continue to periodically increase its LeakRate in the manner described until the MaxLeakRate is reached. At this point the AGW will cease regulation of new Off-Hooks.

Activation of the regulation shall cause the AGW to start monitoring for new Off-Hook events, and when appropriate (i.e. in the case of a putative call rejection) invoke special treatment for such terminations.

5.1.7.3.2 AGW behaviour when regulation is active

Upon receipt of a new Off-Hook, the AGW shall perform the following actions.

First establish if the off-hook will be regulated:

1) The priority class, *c*, of the off hook is established on the basis of the type of line termination from which it originated.

2) The state (*fill*) of the leaky bucket shall be updated as follows:
   fill = max(0,*fill* - *notrat**Δt)
   where Δt is the elapsed time since the *fill* was last updated.

3) If (1.0 + *fill*) is less than TesholdVector[*c*] the off-hook is not subject to regulation.

If the new Off-Hook is not subject to regulation, then *fill* is incremented by 1.0 and an "Off-Hook" observed event is sent to the MGC, obeying the in hand events descriptor which was previously sent by the MGC. The H.248 Notification command shall contain the in-hand RequestID (as previously sent from the MGC).

Otherwise, the new outgoing call attempt is subject to regulation and the AGW shall apply the special treatment described below.

The AGW connects dial tone and collects sufficient digits to establish whether the dialled string matches a pre-loaded priority digit string or not. If the dialled digits match the priority digit map, then establish if the off-hook will be accepted:

1) The state (*fill*) of the leaky bucket shall be updated as follows:
   $fill = \max(0, fill - notrat^*\Delta t)$
   where Δt is the elapsed time since the *fill* was last updated.

2) If (1.0 + *fill*) is less than the ThresholdVector[0] the off-hook is accepted.

If the off-hook is accepted, then *fill* is incremented by 1.0 and a Notify is reported to the MGC containing an Off-Hook observed event providing the property "offhooknot" is set to required, followed by the digit completion event observed event using a default request ID of FFFFFFFF(hex).

If collected digits do not match the priority digit map or the priority aware leaky bucket rejects the off-hook, then the AGW applies a provisioned sequence of signals to the termination (e.g. an end of call indication such as congestion tone together with any related analogue signals such as end of call/pulsed reduced battery) to encourage the end user to go on-hook. On receipt of the on-hook event for such a regulated call, the AGW shall not notify the MGC of this event, and shall apply appropriate signals (e.g. idle line feed) to return the termination to an idle state.

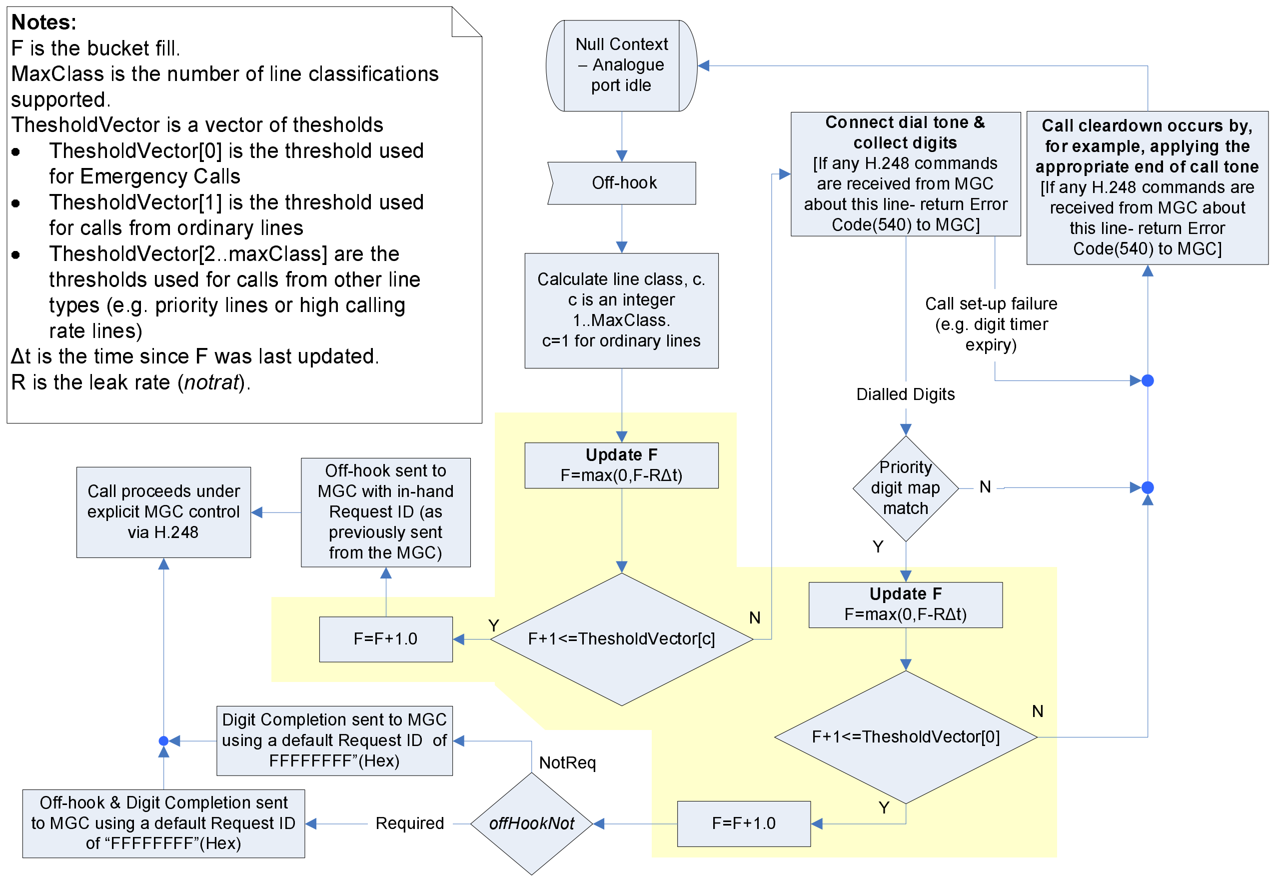

Figure 3: Behaviour at an AGW when the restriction is active.
The yellow area denotes a region that must be entered by only one thread of execution at a time.

The behaviour of the AGW when the etsi_nr control is active is summarized in figure 3. In figure 3 those areas shaded in light yellow denote where, in order to protect the integrity of the bucket state, only a single thread of execution may be active at any one time.

The special treatment logic applied by an AGW to regulated calls may be pre-defined or controlled via a configurable script. This is an AGW implementation decision. Moreover, the script defines the special line treatment logic described above, including the packages/events used for reporting the observed events, the request id to be used for reporting the observed events and the end of call tone, etc.

On receipt of a new notrat value, the fill, *f*, of the leaky bucket is brought up to date using the previous value of notrat. The signalled notrat is then used as the leak-rate for subsequent bucket operations. Whenever notrat is updated, it is recommended that the bucket fill is then randomized between (*f*-1,*f*+1), where *f* is the current bucket fill. This randomization of the bucket state is to ensure that the restrictors at different AGWs do not get synchronized. As a result, the bucket fill may exceed the largest priority threshold, but shall not be permitted to exceed a value of twice the largest priority threshold nor shall it be allowed to drop below zero.

NOTE: The preceding text assumes the use of a continuously leaking bucket. Other leaky bucket implementations are acceptable, e.g. a bucket that leaks 1.0 every 1/notrat seconds.

5.1.7.3.3 Receipt of H.248 signalling on a termination during regulating mechanism

During periods of AGW regulation, it is possible for a new terminating call to be offered to the AGW whilst it is in the process of regulating an outgoing seizure on a termination (e.g. dial tone connected or partial digit match to priority digit string). Under these circumstances an incoming H.248 command from the MGC shall be rejected with error code 540 ("Unexpected Initial Hook State"). The MGC shall, on receipt of this error code, provide appropriate call handling (e.g. reject the incoming call attempt with reason "subscriber busy").

5.1.7.4 MGC failure

Following a restart, the MGC shall set the GloalLeakRate to the RecoveryGlobalLeakrate. The value of RecoveryGlobalLeakRate shall be operator configurable. It is recommended that it be low enough to compensate for the extra work needed to be done by a MGC in the initial period following a restart. After the MGC has recovered, it shall enter the "TerminationPending" state (see clause 5.1.7.2).

5.1.7.5 AGW failure

In the event of a AGW failure, the in-hand notrat value may be lost. Under these circumstances, an AGW shall assume an initial value of notrat of -1.0. (Leaky bucket operation is ceased; none of the Off Hooks will be regulated). and then register with an MGC.

After the successful registration, the MGC, if it supports the "etsi_nr" package, shall determine if this package is supported by the AGW. This can be achieved by the issuing of an AuditValue command against the ROOT termination to audit the packages supported. Alternatively the MGC may determine this from the profile identifier specified in the ServiceChange parameter ServiceChangeProfile or by any other priori knowledge.

If the AGW does support the "etsi_nr" package, then the MGC can send a MODIFY command against the ROOT termination to update the notrat value. This Modify command does not have to be in response to an Off Hook notification or a new terminating call, but may be sent without any other stimulus.

The above procedures ensure MGC and AGW interoperability for the cases where the AGW supports the "etsi_nr" package and the MGC does not, where the MGC supports the "etsi_nr" package and the AGW does not and finally where both the AGW and the MGC support the "etsi_nr" package.

5.1.7.6 AGW re-registration

In the event of an AGW losing communication with its MGC or MGC initiated handover, the AGW will re-register with a secondary MGC. It is possible that the secondary MGC may not support this package, so the AGW shall set initial value of notrat -1.0. (Leaky bucket operation is ceased; none of the Off Hooks will be regulated.) After the ServiceChange procedures are completed successfully, it is recommended that the secondary MGC follow the same procedures and guidelines as described in clause 5.1.7.5.

In the event of an AGW losing communication with its primary MGC, if it reattempts to establish connection with the same primary MGC, it shall retain the previous notrat value.

6 Management requirements

6.1 Configuration management

The implementer shall ensure that the following parameter are operator configurable (by means of a proprietary management interface, or the use of SNMP) and that their range and granularity are sufficient so as to work over a wide range of scenarios.

6.1.1 Parameters defined at each AGW

- ThresholdVector[0 to MaxClass].
- Priority digit map string.
- LeakRateGrowthFactor (integer in the range 1 to 100).
- RateIncrementPeriod (seconds).
- MaxLeakRate (Off-hooks per second).

NOTE: The LeakRateGrowthFactor defines a percentage increase expressed as an integer between 1 and 100. A value of n would imply that the new leak rate is set to the old leak rate multiplied by:

$$\left(1.0 + \frac{n}{100.0}\right).$$

6.1.2 Parameters defined at the MGC

- GoalLoadLevel.
- InitialGlobalLeakRate.
- RecoveryGlobalLeakRate.
- MaxGlobalLeakRate.
- The weight for each AGW as used by the distribution function.
- TerminationPendingPeriod (seconds) used to set the TerminationPending timer.
- ReturningToNotOverloadedPeriod (seconds) used to set the ReturningToNotOverloaded timer.

NOTE 1: The GoalLoadLevel is a place-holder for an implementation-dependent parameter or parameters.

NOTE 2: It is possible that a MGC may implement a function to optionally generate the AGW eights autonomously, on the basis of the number of access lines supported by each AGW.

6.2 Performance management

When an MGC initiates this type of overload control towards an AGW, then the following information shall be recorded by the AGW for subsequent retrieval via a proprietary interface, or the use of SNMP:

- Date.
- Time.
- AGW identity.
- MGC identity.

When an AGW terminates this type of overload control towards an MGC, then the following information shall be recorded by the AGW for subsequent retrieval via a proprietary interface, or the use of SNMP:

- Date.
- Time.
- AGW identity.
- MGC identity.
- For each of the priority classes from class 1 to class MaxClass (i.e. not class 0):
    - The number of outgoing call attempts offered to the restrictor (at first pass).
    - The number of outgoing call attempts accepted by the restrictor at first pass (ie did not exceed their priority class's Threshold).
    - The number of outgoing call attempts that were rejected by the restrictor either, because they were non-emergency calls or terminated during call set up (e.g. digit timer expiry).
    - The number of outgoing emergency calls that were admitted by the restrictor as a result of the dialled digits matching the priority digit map.
    - The number of emergency calls that were rejected by the restrictor as a result of the ThresholdVector[0] being exceeded.

6.3 Alarm management

When the MGC initiates etsi_nr overload control then an alarm shall be raised with the following parameters via the NM interface:

- Date.
- Time.
- MGC identity (e.g. H.248 MID).

When the MGC terminates etsi_nr overload control then the alarm shall be cleared with the following parameters via the NM interface:

- Date.
- Time.
- MGC identity (e.g. H.248 MID).

History

Document history		
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