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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Infrastructure of audiovisual services – Communication procedures

Gateway control protocol: Enhanced analogue lines packages

ITU-T Recommendation H.248.26

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ITU-T Recommendation H.248.26

Gateway control protocol: Enhanced analogue lines packages

Summary

This Recommendation defines several packages that provide support for extended line supervision and metering analogue lines capabilities for ITU-T Rec. H.248. This version adds a phased metering signal suitable for use with complex metering scenarios that are beyond the capability of the metering signals already present in the package. It also introduces a new package to perform metering pulse detection by Media Gateways, and updates all the packages in this Recommendation to conform to the new Packages Template.

Source

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FOREWORD

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Gateway control protocol: Enhanced analogue lines packages

1 Scope

The Analogue Line Supervision package defined in Annex E/H.248.1 supports basic telephony services, using on-hook and off-hook events, and a ringing signal. Some telephony services delivered over analogue line terminations have additional supervisory signalling requirements that are not met by the Analogue Line Supervision package. The packages defined in this Recommendation are intended to meet the needs of the following supervisory signalling functions:

– *Line-side answer supervision*: This function provides a positive notification to a calling line that the called line has answered. This notification may be used by customer premises equipment, for example, to begin timing the call for local billing or charging purposes.

– *Network disconnect*: Many switching systems provide this signal following the termination of an active call if a party remains off-hook for some period of time following the other party going on-hook. The network disconnect notification may be used by customer premises equipment to release resources associated with the call.

– *Metering pulses*: Metering services provide subscribers with real-time information about charging of calls in progress. These services make use of customer premises equipment that shows a count of "units" consumed by chargeable calls, where each unit has a fixed monetary value. To increment the counter in the metering equipment, the switching system sends certain kinds of pulses over the line, either during the call or immediately following termination of the call. These pulses typically consist of short bursts of 12-kHz or 16-kHz tones, although other types of metering pulse such as brief periods of polarity reversal or 50-Hz tones are also seen.

To meet these needs, two supplemental packages are introduced:

– The Extended Analogue Line Supervision package is defined as an extension of the Basic Analogue Line Supervision package, and includes two new signals: Line-Side Answer Supervision and Network Disconnect. This package provides support for all the Loop-Start supervisory signalling requirements identified by Telcordia's GR-506-CORE.

– The Automatic Metering package provides a means to apply metering pulses on an analog line termination. The package includes:

  • signals requesting the automatic application of pulses at fixed intervals as well as the application of pulse bursts;

  • statistics that may be used to track the actual number of pulses applied; and

  • an event that may be used to trigger periodic reporting of the count of pulses applied.

This Recommendation introduces a phased metering signal suitable for use with complex metering scenarios. It also introduces a new metering detection package that can be used to instruct the MG to detect and report metering pulses generated by a network peer.

The support of these packages is optional.

2 References

2.1 Normative reference

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision;

users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

– ITU-T Recommendation H.248.1 (2002), *Gateway Control Protocol: Version 2*, as amended by its Corrigendum 1 (03/2004).

2.2 Informative reference

– Telcordia GR-506-CORE (1996), *LSSGR: Signalling for Analog Interfaces*.

3 Definitions

This Recommendation defines the following terms:

3.1 add-on charge: An optional one-time charge incurred mid-call.

3.2 charge interval: The frequency at which charges are incurred. Some metering models do not accommodate this parameter.

3.3 charge rate: The rate at which currency charges are applied in a call in currency per second.

3.4 phase duration: The length of a phase. Phase duration may be finite or infinite.

3.5 pulse count: The count of the number of pulses which are to be applied.

3.6 pulse count per charge interval: The pulse count for a specific charge interval, calculated as the product of Tariff Pulse Rate and Charge Interval (PCCI = TPR * CI).

3.7 pulse repetition interval: See definition in 6.3.1.1.2.

3.8 set-up charge: An optional one-time charge for call set-up.

3.9 tariff pulse rate: The rate (pulses per second) at which pulses are applied as derived from the tariff rate data and pulse conversion data specified by the service provider.

4 Abbreviations

This Recommendation uses the following abbreviations:

CI Charge Interval

MG Media Gateway

MGC Media Gateway Controller

PC Pulse Count

PCCI Pulse Count per Charge Interval

PD Phase Duration

PRI Pulse Repetition Interval

TPR Tariff Pulse Rate

5 Extended Analogue Line Supervision package

Package name: Extended Analogue Line Supervision package

Package ID: xal (0x0043)

Description: This package defines events and signals necessary to support analogue telephony services where line-side answer supervision and/or network disconnect capabilities are required.

Version: 1

Extends: al (0x0009) version 1

5.1 Properties

None.

5.2 Events

None.

5.3 Signals

5.3.1 Line-side Answer Supervision

Signal name: Line-side Answer Supervision

Signal ID: las (0x0003)

Description: Indicates that the called party has answered. The signal that is sent on the line is provisioned in the MG. Typically this signal involves a reversal of polarity of the current feed on the line.

Signal type: On/Off

Duration: Not applicable

5.3.1.1 Additional parameters

None.

5.3.2 Network Disconnect

Signal name: Network Disconnect

Signal ID: nd (0x0004)

Description: Indicates that the far-end party has disconnected. The signal that is sent on the line is provisioned in the MG. Typically this signal involves a brief removal of the dc voltage on the line.

Signal type: Brief

Duration: Provisioned

5.3.2.1 Additional parameters

None.

5.4 Statistics

None.

5.5 Procedures

The Network Disconnect signal is typically used when a called or calling party remains off-hook after the other party has hung up. In these circumstances, some telephony services provide dial tone to the off-hook phone after a period of several seconds has elapsed. The Network Disconnect signal would normally be applied just prior to the re-application of dial tone on the line.

6 Automatic Metering package

Package name: Automatic Metering package

Package ID: amet (0x0044)

Description: This package supports the automated application of repetitive metering pulses to an analogue line termination. It provides a facility whereby the actual number of metering pulses applied to the termination can be periodically reported to the MGC for verification purposes.

Version: 2

Extends: None

6.1 Properties

None.

6.2 Events

6.2.1 Periodic Report

Event name: Periodic Report

Event ID: pr (0x0001)

Description: This event is used in conjunction with the "enable metering" and "metering pulse burst" signals defined in this package. It is detected when the value of the "pulse count since last report" statistic reaches the value specified in the "report period" parameter.

This event does not have any parameters for the observed event descriptor since it will be reported only when "pulse count since last report" is equal to "report period", which is a value already known to the MGC.

This event is not detected when the application of signals is stopped due to a MG failure, a customer line state event (e.g., on-hook), or by an explicit command from the MGC. The MGC needs to read the value of the statistic "pulse count since last report" in those cases, using an AuditValue command.

6.2.1.1 EventsDescriptor parameters

6.2.1.1.1 Report Period

Parameter name: Report Period

Parameter ID: rp (0x0001)

Description: This parameter specifies the period of metering reports in terms of pulse counts. There is no default value for this parameter, and it must be specified with a non-zero value.

Type: Integer

Optional: No

Possible values: Any positive number of pulses

Default: None

6.2.1.2 ObservedEventsDescriptor parameters

None.

6.3 Signals

6.3.1 Enable Metering

Signal name: Enable Metering

Signal ID: em (0x0001)

Description: This signal starts the automatic generation of metering pulses on the termination. The type and duration of the pulses to be applied are provisioned in the MG.

Signal type: On/Off

Duration: Not applicable

6.3.1.1 Additional parameters

6.3.1.1.1 Pulse Count

Parameter name: Pulse Count

Parameter ID: pc (0x0001)

Description: This parameter specifies the number of metering pulses to be applied to the termination. If the value of this parameter is zero, or if no value is supplied for this parameter, then the repetitive application of metering pulses shall continue until stopped by other mechanisms (for example, the detection of an event, or the replacement of the Signals Descriptor).

Type: Integer

Optional: Yes

Possible values: A non-negative number of pulses

Default: 0

6.3.1.1.2 Pulse Repetition Interval

Parameter name: Pulse Repetition Interval

Parameter ID: pri (0x0002)

Description: This parameter specifies the interval over which the pulses specified in the pulse count should be issued, or, if the pulse count is 0 or not present, the interval between pulses, in milliseconds. For a specified non-zero pulse count, it represents the time over which the pulses should occur. It is up to the MG to perform the appropriate calculations to determine the pulse interval. For a zero or unspecified pulse count, it represents the time that should elapse between the leading edge of a pulse and the leading edge of the succeeding pulse. There is no default value for this parameter, and the MGC should always provide a positive non-zero value.

Type: Integer

Optional: No

Possible values: 1 or more milliseconds

Default: 1

6.3.2 Metering Pulse Burst

Signal name: Metering Pulse Burst

Signal ID: mpb (0x0002)

Description: This signal causes a burst of metering pulses to be applied to the termination.

Signal type: Brief

Duration: Variable

6.3.2.1 Additional parameters

6.3.2.1.1 Burst Pulse Count

Parameter name: Burst Pulse Count

Parameter ID: bpc (0x0001)

Description: This parameter specifies the number of metering pulses to be applied as a burst on the line. The type, duration and pulse repetition interval for the metering pulses comprising the burst are provisioned in the MG.

Type: Integer

Optional: Yes

Possible values: 1 or more pulses

Default: 1

6.3.2.1.2 Pulse Repetition Interval

Parameter name: Pulse Repetition Interval

Parameter ID: pri (0x0002)

Description: Interval from the leading edge of a metering pulse to the leading edge of the next metering pulse.

Type: Integer

Optional: Yes

Possible values: 1 or more milliseconds

Default: 1

6.3.3 Phased Metering

Signal name: Phased Metering

Signal ID: phsm (0x0003)

Description: This signal allows phased metering pulses to be applied by the MG.

Signal type: Brief

Duration: Variable, based on number and length of metering phases specified.

6.3.3.1 Additional parameters

6.3.3.1.1 Pulse Repetition Interval

Parameter name: Pulse Repetition Interval

Parameter ID: pri (0x0001)

Description: Interval from the leading edge of a metering pulse to the leading edge of the next metering pulse.

Type: Sublist of Integer

Optional: No

Possible values: Non-negative number of milliseconds

Default: None

6.3.3.1.2 Maximum Pulse Count per Charge Interval (PCCI)

Parameter name: Max PCCI

Parameter ID: pcx (0x0002)

Description: The maximum number of pulses that will be applied during a given charge interval.

Type: Sublist of Integer

Optional: No

Possible values: Non-negative number of pulses

Default: None

6.3.3.1.3 Repetitions of Max PCCI

Parameter name: Repetitions of Max PCCI

Parameter ID: repx (0x0003)

Description: The number of charge intervals in which to apply the number of pulsesspecified by the pcx parameter.

Type: Sublist of Integer

Optional: No

Possible values: Non-negative number of intervals

Default: None

6.3.3.1.4 Minimum Pulse Count per Charge Interval (PCCI)

Parameter name: Min PCCI

Parameter ID: pcn (0x0004)

Description: The minimum number of pulses that will be applied during a given charge interval.

Type: Sublist of Integer

Optional: No

Possible values: Non-negative number of pulses

Default: None

6.3.3.1.5 Repetitions of Min PCCI

Parameter name: Repetitions of Min PCCI

Parameter ID: repn (0x0005)

Description: The number of charge intervals in which to apply the number of pulses specified by the pcn parameter.

Type: Sublist of Integer

Optional: No

Possible values: Non-negative number of intervals

Default: None

6.3.3.1.6 Charge Interval

Parameter name: Charge Interval

Parameter ID: ci (0x0006)

Description: The frequency at which charges are incurred, in seconds.

Type: Sublist of Integer

Optional: No

Possible values: Non-negative number of seconds

Default: None

6.3.3.1.7 Phase Duration

Parameter name: Phase Duration

Parameter ID: pd (0x0007)

Description: The duration of the metering phase, in seconds.

Type: Sublist of Integer

Optional: No

Possible values: Non-negative number of seconds

Default: None

6.4 Statistics

6.4.1 Current Pulse Count

Statistic name: Current Pulse Count

Statistic ID: cpc (0x0001)

Description: This statistic represents the total number of metering pulses that have been applied on an analogue line termination since the last time its value was reset to zero by means of the "enable metering" signal defined in this package.

Type: Integer

Possible values: A non-negative number of pulses

Level: Termination

6.4.2 Pulse Count since Last Report

Statistic name: Pulse Count since Last Report

Statistic ID: pcslr (0x0002)

Description: This statistic represents the number of metering pulses that have been applied on an analogue line termination since the last meter report event, or since the last time its value was reset to zero by means of the "enable metering" signal defined in this package. The recognition of the periodic report event and generation of a corresponding notification resets the value of this statistic to zero.

Type: Integer

Possible values: Non-negative number of pulses

Level: Termination

6.5 Procedures

6.5.1 Applying metering pulses

On receiving a SignalsDescriptor containing the signal em, an MG shall set the values of the statistics cpc and pcslr to zero. The MG shall apply the first metering pulse to the termination immediately, and then apply subsequent metering pulses at intervals as determined by the specified value of the pulse repetition interval parameter pri. If the pulse count is greater than 0, then the MG shall determine the appropriate interval between pulses by dividing the pulse repetition interval value by the pulse count. In the event that the interval determined is not integral, then it is the responsibility of the MG to adjust the individual intervals to avoid long-term rounding errors. If the pulse count is zero, or not present, then the MG shall issue a new pulse at intervals equal to the pulse repetition interval.

The MG shall increment by one the values of the pulse count statistics cpc and pcslr for each metering pulse that is applied to the termination, regardless of whether the pulse was generated as a result of the em signal or as a result of the mpb signal.

If the value of the parameter pc associated with the signal em is non-zero, then the repetitive application of metering pulses should be continued until the number of pulses sent, excluding any pulses due to concurrent mpb signals, is equal to the value of the parameter pc. In this case, the MGC should include a SignalType parameter in the Signals Descriptor, specifying the signal type Brief, to override the OnOff signal type for the signal em.

If the value of the parameter pc is zero, or if this parameter is not supplied by the MGC, then the repetitive application of metering pulses should continue until the signal is halted in any of the normal ways. Any pulses applied due to a concurrent mpb signal shall be applied for the em signal in addition to the required repetitive pulses.

If following the application of any metering pulse (regardless of whether it was generated as a result of the signal em or as a result of the signal mbp), the EventsDescriptor contains the event pr, and if the value of pcslr is equal to the value of the EventsDescriptor parameter rp, then the pr event shall be notified, and the value of the statistic pcslr shall be reset to zero. The detection of the event pr shall not cause the termination of the signal em or the signal mbp, even if the KeepActive flag is not set for the pr event.

The repetition rate for the application of metering pulses to the termination may be changed during a call by writing a new SignalsDescriptor containing the signal em, specifying a new value of the pulse repetition interval parameter pri. In this case, the SignalsDescriptor should contain a KeepActive flag for the signal em, and the MG should transition to the new pulse repetition interval after the next metering pulse has been applied.

A metering pulse burst may be applied while a metered call is in progress, for example, to take account of a chargeable mid-call action by the subscriber. In this case, the MGC should send a new SignalsDescriptor that contains the em signal with a KeepActive flag, together with the mpb signal.

The MG should continue to apply metering pulses at the repetition interval specified by the pri parameter of the em signal, while in addition applying the metering pulse burst. The MG should ensure that the pulses comprising the pulse burst are applied in such a manner as not to interfere with the pulses comprising the repetitive background metering, respecting any minimum inter-pulse interval that may be needed to ensure proper recognition of pulses by customer premises equipment.

When an MG is generating metering pulses as a result of an active em signal, and receives a new SignalsDescriptor containing an em signal with a KeepActive flag, it shall not reset the values of the statistics cpc and pcslr to zero.

The detection of an event such as on-hook while a metering pulse is being applied to a termination should not cause truncation of the pulse. Once a pulse has started to be applied, the application of the pulse should continue for the full duration provisioned in the MG.

6.5.2 Specification of full tariff description in a single message

It is important to maximize accuracy of the metering by minimizing messaging and latency in the network. One of the primary ways to achieve this is communication of the entire call tariff model in a single message from the MGC to the MG.

By signalling the key parameters as sub-lists, each phase of the call is represented through a discrete signal element. In order for the MG to be able to determine how to handle each element, the Phase Duration must be included as a parameter.

The mpb signal may be used to describe the one-time set-up charge if applicable. Also, if a one time add-on charge is incurred during the call, a new signal must be sent to the MG to handle the charge. (Set-up and add-on charges are described further in 6.5.3). In this manner, the entire call tariff model can be expressed by a single message as follows:

```
SG{amet/mpb{bpc=Setup Charges,pri=Pulse Interval},
   amet/phsm{pri=[Phase1,Phase2,…,PhaseN],
             pcx=[Phase1,Phase2,…,PhaseN],
             repx=[Phase1,Phase2,…,PhaseN],
             pcn=[Phase1,Phase2,…,PhaseN],
             repn=[Phase1,Phase2,…,PhaseN],
             ci=[Phase1,Phase2,…,PhaseN],
             pd=[Phase1,Phase2,…,PhaseN]}}
```

A tariff rate changeover event can cause the MGC to send a new tariff rate descriptor to the MG, replacing the previous descriptor.

6.5.3 Set-up and add-on charges

6.5.3.1 Using Pulse Burst

The preferred method for handling one time charges (set-up or add-on) is to instruct the MG to apply a pulse burst in conjunction with the existing tariff model. The MG would then pulse at maximum rate until it had recovered the one-time charge and had caught back up with the application of the tariff rate.

For a set-up charge equivalent to five pulses for example, the resulting tariff descriptor would be:

```
SG{amet/mpb{bpc=5,pri=3},
   amet/phsm{pri=[Phase1,Phase2,…,PhaseN],
             pcx=[Phase1,Phase2,…,PhaseN],
             repx=[Phase1,Phase2,…,PhaseN],
             pcn=[Phase1,Phase2,…,PhaseN],
             repn=[Phase1,Phase2,…,PhaseN],
             ci=[Phase1,Phase2,…,PhaseN],
             pd=[Phase1,Phase2,…,PhaseN]}}
```

For add-on charges, a new signal list element is added to the Signals Descriptor and the original tariff model is retained via the use of KeepActive. That is, the MG must be instructed to continue to process the original Tariff Rate Signal List but to also process the add-on charge signal. As with the set-up charge description above, the MG must pulse at maximum rate to recover the add-on charge and "catch up" to the application of the original regular tariff rate.

```
SG{amet/mpb{bpc=8,pri=3},                ;Add-on Charge
   amet/phsm{pri=[Phase1,Phase2,…,PhaseN],  ;Original tariff
             pcx=[Phase1,Phase2,…,PhaseN],
             repx=[Phase1,Phase2,…,PhaseN],
             pcn=[Phase1,Phase2,…,PhaseN],
             repn=[Phase1,Phase2,…,PhaseN],
             ci=[Phase1,Phase2,…,PhaseN],
             pd=[Phase1,Phase2,…,PhaseN],
             KA}}
```

It may be important for the MG to report to the MGC when it has completed pulsing the add-on charges to help the MGC handle any case where additional add-on charges are incurred following the initial add-on charge. This can be accomplished through use of the Signal Completion event in the generic package (see Annex E.1/H.248.1).

6.5.3.2 Combining the extra charge with the regular tariff

An alternative option for handling one-time charges is to combine them with the regular tariff signalling in such a way as to produce a new virtual phase. These virtual phases and regular call phases are generically referred to as Pulse Windows for purpose of describing this mechanism.

Handling a set-up charge in this model for example would produce a tariff descriptor as follows:

```
SG{amet/phsm{pri=[Phase1a,Phase1b,Phase2,…,PhaseN],
             pcx=[Phase1a,Phase1b,Phase2,…,PhaseN],
             repx=[Phase1a,Phase1b,Phase2,…,PhaseN],
             pcn=[Phase1a,Phase1b,Phase2,…,PhaseN],
             repn=[Phase1a,Phase1b,Phase2,…,PhaseN],
             ci=[Phase1a,Phase1b,Phase2,…,PhaseN],
             pd=[Phase1a,Phase1b,Phase2,…,PhaseN]}}
```

Phase 1a is the set-up charge combined with the affected portion of the first phase and phase 1b is the balance of the first phase once the set-up metering has completed.

Add-on Charges are handled similarly. If an one-time add-on charge is required, the MGC will recalculate the remainder of the call tariff, creating additional Pulse Windows as needed.

This alternative option is as accurate as the preferred option for handling set-up charges, but loses accuracy for add-on charges as the MGC is forced to recalculate the tariff descriptor mid-call based upon its view of where the MG has progressed in the current tariff metering.

6.5.4 Handling fractional pulse counts

The tariff pulse rate (TPR), which defines the number of pulses per second required to meet the tariff for a particular call phase, along with the charge interval (CI) is used to calculate the number of pulses required to be signalled during a charge interval (PCCI). In some cases, this can produce a fractional pulse count. Solutions that compensate for this in the MGC result in increased messaging, added latency and consequently reduced accuracy.

Since a fraction of a pulse cannot be signalled by standard metering equipment, the MGC needs to convert each metering phase into discrete components which will describe how many actual pulses to generate across the charge intervals to obtain as much metering accuracy as possible across the phase.

Each component of the metering phase consists of a pulse count for the charge interval (PCCI) and a number of repetitions (Rep), which we will represent as {PCCI Rep}. It can be shown that two discrete components are all that is required to break the PCCI value into parts which will produce the most accurate metering result for the phase. The pulse counts for each component are calculated by multiplying TPR by CI, and then rounding up and truncating the result, respectively. For example, if TPR * CI = 4.3, then the Pulse Count for one of the components will be 5, and the other will be 4. The expression to represent the PCCI value is then:

{PCCImax Repmax}{PCCImin Repmin}

The algorithm for calculating the values of Repmax and Repmin will be discussed in 6.5.4.3.

6.5.4.1 Mapping discrete representations into a pulse map

Having determined the number of pulses for PCCImax and PCCImin for one charge interval in a phase, further consideration must be given to the different permutations for how the charge intervals should be ordered to achieve the pulsing required to meet the tariff.

As shown in 6.5.4.2, a PCCI value of 2.3333 for 10 charge intervals in a phase can be represented by the expression {3 3} {2 7}. This means that the MG must send three pulses for three charge intervals during the phase and two pulses for seven charge intervals during the phase. Many permutations exist for this scenario. Examples include:

{3, 3, 3, 2, 2, 2, 2, 2, 2, 2}

{3, 2, 3, 2, 3, 2, 2, 2, 2, 2}

{2, 2, 2, 2, 2, 2, 2, 3, 3, 3}

{3, 3, 2, 3, 2, 2, 2, 2, 2, 2}

An almost infinite number of pulse map patterns could be defined. Three examples of pre-defined pulse map patterns are as described in Table 1.

Table 1/H.248.26 – Pre-defined pulse map patterns

Pulse map pattern name	Pulse map example	Comment
Max Loaded	{X, X, X, N, N, N, …}	Pulse at the PCCImax rate until the Repmax count is met, and then pulse at PCCImin to the end of the phase. For very high fractions this option reduces the likelihood of underpulsing. As the fraction decreases, however, this method may overpulse.
Interleaved	{X, N, X, N, X, …}	For fractions of 0.5 this is the most accurate pulse map possible.
Min Loaded	{N, N, N, X, X, X, …}	Pulse at the PCCImin rate until Repmin count is met, and then pulse at PCCImax to the end of the phase. For very low fractions, this option reduces the likelihood of overpulsing. As the fraction increases, however, this method may underpulse.

The most accurate model for the map is to dynamically define it in such a way as to interleave PCCImax and PCCImin using the ratio of Repmax to Repmin as a template. PCCImax should always be chosen as the lead value as it is in the best interest of the service provider to slightly over-pulse as opposed to under-pulse.

Example 1: {3 7} {2 3}

Repmax/Repmin = 2.333. Rounding, we get two PCCImax for every one PCCImin, leading to this pulse map pattern:

{3 3 2 3 3 2 3 3 2 3}

Example 2: {3 3} {2 7}

In this case, since Repmin > Repmax, we get two PCCImin for every one PCCImax:

{3 2 2 3 2 2 3 2 2 3}

Example 3: {24 2} {23 5}

Repmin/Repmax = 2.5. Since the MG should err on the side of PCCImax, truncate to two PCCImin for every PCCImax rather than rounding to three PCCImin for each PCCImax:

{24 23 23 24 23 23 23}

As discussed in 6.5.4.2 below, the actual pulse map may contain a variable number of elements. In some cases, the pulse map will contain fewer elements than the number of charge intervals in the phase. In this case, the MG shall repeatedly iterate over the pulse map for the duration of the phase.

6.5.4.2 Determining the number of elements in the pulse map

The determined value of the number of elements in the map, NumElementsPerPulseMap, is a function of the number of charge intervals in the phase and the phase duration. If the phase duration is finite, the number of charge intervals that make up the phase determines the parameter sublist length. In the case where the phase is of infinite duration however, the number of elements in the pulse map is set to a value which can most accurately compensate for a fractional PCCI value.

Consider a PCCI value of 8.3333. This results in a pulse map that will produce nine pulses in some charge intervals and eight pulses in other charge intervals.

A pulse map with ten elements, which is repeated indefinitely, will produce very accurate results throughout the phase. The PCCI expression becomes {9 3} {8 7} with a resultant pulse map pattern of:

{9 8 8 9 8 8 9 8 8 8}

A pulse map with 100 elements will produce:

{9 33} {8 67} or {9 8 8 9 8 8 9 8 8 9 8 8 9 8 8 . . .}

This is only slightly more accurate than the ten element pulse map.

As the PCCI value decreases, a map with 100 elements becomes significantly more accurate than a map with ten elements. For most reasonable tariffs, however, modelling shows that using ten elements will produce very accurate results.

Consider a scenario where the MG must send one pulse in twenty minutes. Assume also that CI equals 60. The TPR for one pulse in 20 minutes is 0.00083333. The resulting PCCI is 0.05.

If the map were to use ten elements, there would result a repeated pattern of:

{1 1} {0 9} = {1 0 0 0 0 0 0 0 0 0}

There would be one pulse every time the list was repeated. Since CI equals 60 s, this means one pulse in every 60 * 10 = 10 minutes which is a rate of two pulses in 20 minutes or double the TPR of one pulse in 20 minutes.

If on the other hand the map used 100 elements, the resultant pattern would be:

{1 5} {0 95} = {1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 …}

This produces the expected result of one pulse in 20 minutes.

6.5.4.2.1 The reciprocal model for handling low TPR

A very low PCCI/TPR is only really possible for very long phases or charge intervals – most likely the final phase of a call. An alternative method for dealing with this scenario is to define a pseudo charge interval which is merely the reciprocal of the TPR. That is, if there is a very small pulse/second value, the reciprocal will tell us how often we should generate one pulse. For the case described above where TPR equals 0.00083333 pulses/second, 1/TPR equals 6000 seconds/pulse, the reciprocal model will produce:

{1 1} {0 0} CI = 6000, PD = infinite

This would produce one pulse every 20 minutes.

Unfortunately, it is difficult to select the value of PCCI at which point to switch from the pulse map method to the reciprocal method. The MGC should use the pulse map method with the number of elements set to 100 for infinite phase durations.

6.5.4.3 Calculating Repmax and Repmin

The number of elements in the pulse map, NumElementsPerPulseMap is determined as described above.

NumElementsPerPulseMap = f(NumChgIntPerPhase, PhaseDuration)

Repmax is then calculated using the fractional part of PCCI and the NumElementsPerPulseMap as follows:

Repmax = ROUND(NumElementsPerPulseMap * FractionalPart(PCCI)

and:

Repmin = NumElementsPerPulseMap – Repmax

For example, if PCCI equals 2.33333, and there are 10 elements in the pulse map, then PCCImax equals 3, PCCImin equals 2 and:

$$\text{Repmax} = \text{ROUND}(10 * 0.33333) = \text{ROUND}(3.33) = 3$$

Thus, the discrete expression representing PCCI equals 2.333 and NumElementsPerPulseMap equals 10 is:

{3 3} {2 7}

Using the Interleaved method for expressing the pulse map means that the MG should pulse the following:

{3 2 2 3 2 2 3 2 2 2}

As an additional example, consider the case where PCCI equals 2.3333 and there are seven charge intervals in the phase. This means that NumElementsPerPulseMap equals seven. The resultant discrete expression is:

{3 2} {2 5}

and the pulse map is:

{3 2 2 3 2 2 2}

As another example, PCCI = 4.3 and the Phase Duration is infinite. In this case, the NumElementsPerPulseMap equals 10. This is expressed as {5 3} {4 7} which results in a pulse map of:

{5 4 4 5 4 4 5 4 4 4}

If the subscriber disconnects after 17 charge intervals have passed, the MG will have begun repeating the pattern and will have pulsed a map of:

{5 4 4 5 4 4 5 4 4 4 5 4 4 5 4 4 5}

6.5.4.4 Handling odd charge interval values

The previous clause assumed that a phase is evenly divided into a number of charge intervals. That is, the phase duration is evenly divisible by the number of charge intervals. It is possible that a provider may define tariff models where the phase duration is not evenly divided into charge intervals as illustrated in Figure 1.

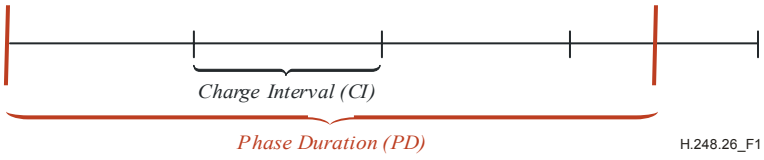

Figure 1/H.248.26 – Phase duration not evenly divided in charge intervals

There are two possible methods for handling this case, each producing very different results. The preferable method is dependent upon the best interpretation of the service provider's intentions.

6.5.4.4.1 Phase pulse count priority metering

The MGC should use this method if it is most important to accurately pulse the total number of pulses expected to be produced over the entire phase as calculated by TPR * PD, regardless of the number of charge intervals which may be encountered.

First, the phase will be broken into two pulse windows as illustrated in Figure 2. The first pulse window will consist of the set of whole charge intervals which can fit within the phase duration. The second pulse window will deal with the remainder.

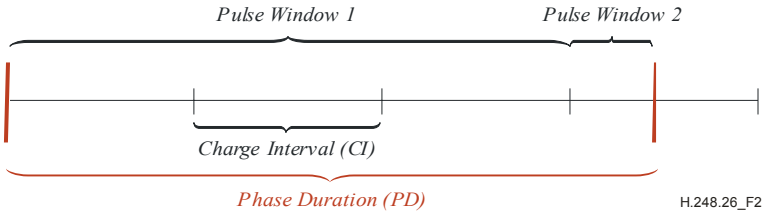

Figure 2/H.248.26 – Dividing the phase into pulse windows

Using the formulae defined in 6.5.4.3, a pulse map for the first pulse window is easily created by merely truncating the value of NumElementsPerPulseMap. That is, NumElementsPerPulseMap equals TRUNC(MIN(10, NumChgIntPerPhase)).

The pulses to be sent during the second pulse window are determined by rounding up the difference between the number of pulses required to be sent over the entire phase and the number sent in the first pulse window.

Consider for example, a tariff model with a Phase Duration equal to 180, a Charge Interval equal to 25 and a Tariff Pulse Rate equal to 0.093333. In this case we have:

PCCI = TPR * CI

= 0.093333 * 25

= 2.333333

PCCImax = 3, PCCImin = 2

NumChgIntPerPhase = PhaseDuration/ChargeInterval

= 180/25

= 7.2

NumElementsPerPulseMap = TRUNC(MIN(10, NumChgIntPerPhase))

= 7

Repmax = ROUND(NumElementsPerPulseMap * FractionalPart(PCCI)

= ROUND(7 * FractionalPart(.3))

= ROUND(2.1)

= 2

Repmin = NumElementsPerPulseMap – Repmax

= 5

Pulse Map for Pulse Window 1 = {3 2} {2 5}

Total Pulses in Pulse Window 1 = (PCCImax * Repmax) + (PCCImin * Repmin)

= (3 * 2) + (2 * 5)

= **16**

Total Pulses Required in Phase = NumChgIntPerPhase * PCCI

= 7.2 * 2.333333

= **16.8**

Total Pulses for Pulse Window 2 = ROUND(16.8 – 16)

= **1**

Pulse Map for Pulse Window 2 = {1 1} {0 0}

Total Pulses Sent for Entire Phase = 17

In this example, the phase was over-pulsed by 0.2 pulses. This is as accurate as the metering application can possibly be made. This example is illustrated in Figure 3:

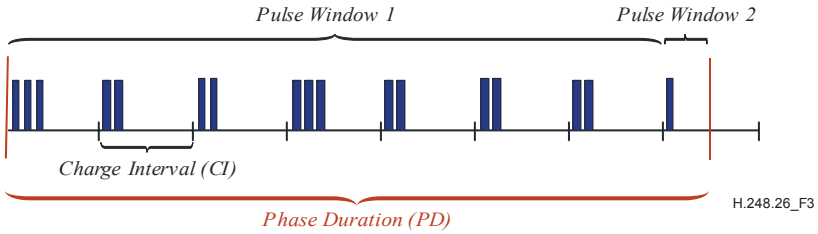

Figure 3/H.248.26 – Phase pulse count priority metering

6.5.4.4.2 Charge interval priority metering

The MGC should use this method if the objective is to always apply charges at the beginning of a charge interval regardless as to how much of the actual interval can fit within the remainder of the phase.

In this case, the pulse map is allowed to repeat such that as many pulses as possible are sent for the start of the new charge interval. Using the example of the previous clause, sixteen pulses are still pulsed for the first seven charge intervals:

Pulse Map = {3 2} {2 5}

Total Pulses in first 7 charge intervals = (PCCImax * Repmax) + (PCCImin * Repmin)

= (3 * 2) + (2 * 5)

= 16

An eighth charge interval will begin and the MG shall move back to the beginning of the pulse map and send an additional 3 pulses. The phase will then complete in 5 seconds and a total of 19 pulses will have been sent across the phase despite the fact that TPR * PD = 16.8 pulses were calculated for this phase. This example is illustrated in Figure 4.

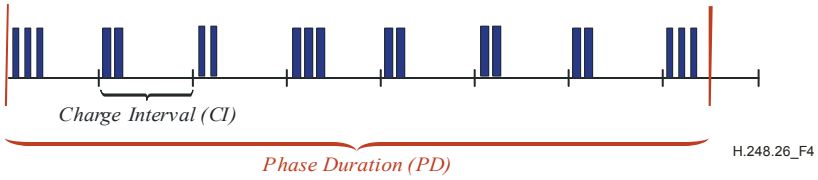

Figure 4/H.248.26 – Charge interval loaded metering

7 Metering Pulse Detection package

Package name: Metering Pulse Detection package

Package ID: metd (0x0096)

Description: This package supports detection of metering pulses on analogue or digital line terminations. It provides a facility whereby the actual number of metering pulses detected on the termination can be periodically reported to the MGC.

Version: 1

Extends: None

7.1 Properties

7.1.1 Last Repetition Interval

Property Name: Last Repetition Interval

Property ID: lri (0x0001)

Description: Contains the time interval between the last two pulses detected.

Type: Integer

Possible values: A positive integer number specifies the interval in milliseconds between the last two detected metering pulses. –1 specifies that no pulses have been detected. 0 specifies that the interval-recording mechanism is armed. That is, a pulse was detected and the timestamp of the last pulse was recorded, but a subsequent pulse has not been detected.

Default: –1

Defined in: TerminationState Descriptor

Characteristics: Read only

7.2 Events

7.2.1 Periodic Report

Event name: Periodic Report

Event ID: pr (0x0001)

Description: This event is detected when the value of the "Pulse Count since Last Report" statistic reaches the value specified in the "Report Period" parameter. This event is not detected while the incoming metering pulses are stopped. The MGC may audit the Statistics Descriptor in order to read the value of the statistic "Pulse Count since Last Report".

Requesting this event enables metering pulse detection.

7.2.1.1 EventsDescriptor parameters

7.2.1.1.1 Report Period

Parameter name: Report Period

Parameter ID: rp (0x0001)

Description: This parameter specifies the period of metering reports in terms of pulse counts.

Type: Integer

Optional: Yes

Possible values: 1 or more pulses

Default: 1

7.2.1.2 ObservedEventsDescriptor parameters

None.

7.2.2 Repetition Interval Changed

Event name: Repetition Interval Changed

EventID: ric (0x0002)

Description: This event is generated when MG changes the "Last Repetition Interval" property value. Requesting this event enables metering pulse detection.

7.2.2.1 EventsDescriptor parameters

7.2.2.1.1 Repetition Interval Threshold

Parameter name: Repetition Interval Threshold

Parameter ID: rit (0x0001)

Description: This parameter sets the time deviation threshold from the current value of the "Last Repetition Interval" property in order to trigger the event. That is, if the time between two consecutive metering pulses changes more than the value specified in this parameter, the event will be detected.

Type: Integer

Optional: Yes

Possible values: Any non-negative integer in milliseconds

Default: Provisioned

7.2.2.2 ObservedEventsDescriptor parameters

7.2.2.2.1 New Repetition Interval

Parameter name: New Repetition Interval

Parameter ID: nri (0x0002)

Description: This parameter reports the new value of the "Last Repetition Interval" property.

Type: Integer

Optional: No

Possible values: A positive integer number specifies interval in milliseconds between last two detected metering pulses. 0 specifies that interval-recording mechanism is armed, that is first metering pulse is detected, or metering pulse was not detected within previous "Last Repetition Interval" value. –1 specifies that no pulses have been detected.

Default: None

7.2.2.2.2 Pulse Count since Last Repetition Interval Changed

Parameter name: Pulse Count since Last Repetition Interval Changed

Parameter ID: pcslric (0x0003)

Type: Integer

Optional: Yes

Possible values: Any non-negative integer

Description: This parameter reports the number of metering pulses that have been detected on a termination since the last "Repetition Interval Changed" event. 0 specifies that no metering pulse was detected within previous "Last Repetition Interval"" value.

Default: 0

7.3 Signals

None.

7.4 Statistics

7.4.1 Current Pulse Count

Statistic name: Current Pulse Count

Statistic ID: cpc (0x0001)

Description: This statistic represents the total number of metering pulses that have been detected on a termination since the last time its value was reset to zero by means of "enabling "metering pulse detection" defined in this package.

Type: Integer

Possible values: Non-negative number of pulses

Level: Termination

7.4.2 Pulse Count since Last Report

Statistic name: Pulse Count since Last Report

Statistic ID: pcslr (0x0002)

Description: This statistic represents the number of metering pulses that have been detected on a termination since the last "Periodic Report", or "Repetition Interval Changed" events, or since the last time its value was reset to zero by means of enabling metering pulse detection as stated in this package. The recognition of the "Periodic Report", or "Repetition Interval Changed" events and generation of a corresponding notification resets the value of this statistic to zero.

Type: Integer

Possible values: Non-negative number of pulses

Level: Termination

7.5 Error code

7.5.1 Invalid Combination of Metering Detection Events

Error code #: 459

Name: Invalid Combination of Metering Detection Events

Definition: The command was disregarded because the Events Descriptor contained more than one metering detection event.

Error Text in the error Descriptor: –

Comment: –

7.6 Procedures

7.6.1 General procedures

The setting of an Events Descriptor containing either event in this package on a termination enables "metering pulse detection". An Events Descriptor without one of the events defined in this package disables "metering pulse detection".

Because a new Events Descriptor completely replaces a previously set descriptor, in order not to disrupt currently enabled "metering pulse detection" on a termination, the MG must act according to the following procedure:

If metering pulse detection is enabled on a termination and the MG receives a new Events Descriptor with exactly the same request (e.g., both events and parameters) to enable metering pulse detection, it must not disrupt the current metering pulse detection. If the MGC needs to restart metering pulse detection with the same event and parameters as are currently active on a termination, it first has to disable metering pulse detection by sending an Events Descriptor which either does not contain any events from this package, or contains an event or event parameters which differ from currently active metering pulse detection event and parameters.

7.6.2 KeepActive and EventBufferControl procedures

Care should be taken to specify the KeepActive flag when necessary to ensure that notification of metering pulse detection event does not interrupt currently active signals. EventBufferControl should be set to off, as metering pulse detection events are periodic in nature (that is once set, they potentially result in multiple notifications).

7.6.3 Timestamp procedures

Because the time detected and/or the time interval between pulses are potential attributes of incoming metering pulses, inclusion of a timestamp in the ObservedEvents Descriptor is mandatory for metering pulse detection events.

7.6.4 Properties procedures

When placing terminations in-service, or when enabling metering pulse detection on a termination using the "Repetition Interval Changed" (ric) event or when disabling currently active "metering pulse detection" which was enabled using ric event, the MG shall reset value of the "Last Repetition Interval" (lri) property to –1. This indicates that no pulses were detected, or metering pulse detection is not enabled. Furthermore, the MG only updates the value of the lri property to values other than –1 if metering pulse detection is enabled using the ric event.

7.6.5 Statistics procedures

When enabling metering pulse detection on a termination, the MG shall reset the values of the statistics "Current Pulse Count" (cpc) and "Pulse Count since Last Report" (pcslr) to zero.

Once metering pulse detection is enabled on a termination, the MG shall increment by one the values of the cpc and pcslr statistics for each metering pulse that is detected on the termination, regardless of the metering pulse detection method used.

On each metering pulse detection notification event the MG sends, it shall reset the value of the pcslr statistic to zero.

7.6.6 Metering pulse detection methods and procedures

The "Periodic Report" (pr) event is used in networks where metering pulses are expected to come irregularly, or only a number of metering pulses is required to be detected. In most network configurations, a MGC controlling a MG which receives metering pulses is the "end receiver" of metering pulses. In these networks, the MGC only needs to know the number of metering pulses received by the MG and thus the MGC might choose to use the pr event for metering pulse detection.

The "Repetition Interval Changed" (ric) event is used in networks where metering pulses are expected to come on a regular basis with roughly the same periodic interval between metering pulses. Typically in this case, the controlling MGC is not the "end receiver" of the metering pulses but rather a metering pulse "proxy". An example of one such configuration would be a R2 to R2 gateway where the incoming R2 exchange MGC has to proxy the metering pulses to the outgoing R2 exchange MGC. Usage of the ric event provides an optimized metering pulse detection method for such configurations. This method minimizes signalling traffic between the MG and MGC associated with metering pulse detection.

It is up to the MGC to choose either metering method. The MGC shall not activate both the tpr and ric events at the same time on a single termination. If the MG receives an Events Descriptor which contains both the pr and ric events, it shall fail the command with error code 459.

7.6.6.1 Usage of "Repetition Interval Changed" (ric) event

Upon receipt of an Events Descriptor which contains the ric event, the MG shall enable metering pulse detection.

7.6.6.1.1 Incoming metering pulses start

When the first metering pulse is detected, the MG shall set the value of the "Last Repetition Interval" (lri) property to 0. At the same time, the ric event shall be notified with nri set to 0 and pcslric set to 1 to indicate that the first metering pulse is detected and the interval-recording mechanism is armed (e.g., the time stamp of first pulse is recorded).

Upon detection of the second metering pulse, the MG shall calculate the repetition interval value, update the lri property with that value and send the ric event notification with nri set to the new value of the lri property, and pcslric set to 1.

The MG shall monitor the termination for metering pulse repetition interval changes. If a change occurs and it does not fall within the current value of the "Repetition Interval Threshold" (rit), the lri property shall be updated with the new value and the ric event shall be notified with the appropriate parameters as indicated in 7.6.6.1.2 and 7.6.6.1.3.

7.6.6.1.2 Incoming metering pulse repetition interval decreased

If the next metering pulse is detected before the minimum expected timeout period has expired (e.g., lri – rit), the MG shall update the lri property value to the new value and send the ric event notification, with nri set to the new lri value and pcslric set to the current value of the pcslr statistic, to indicate that the repetition interval just decreased.

7.6.6.1.3 Incoming metering pulses stop, or repetition interval increased

If the next metering pulse is not detected within the maximum expected timeout (e.g., lri + rit), the MG shall set the lri property value to 0 and send the ric event notification with nri set to 0 and pcslric set to the current value of the pcslr statistic, to indicate that the interval-recording mechanism is re-armed due to the stoppage of incoming metering pulses or the increase of the repetition interval. The MG shall retain the timestamp of the last detected incoming metering pulse and then follow the procedures as described in 7.6.6.1.1.

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