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| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Services and System Aspects;  Study on Nchf charging services phase 2 improvements and optimizations  (Release 18) | |
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# Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

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In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# Introduction

This report is to study enhancement of the Nchf converged charging service.

# 1 Scope

The present document studies the potential use cases, requirements, and solutions for the enhancements of the Nchf converge charging service.

The study will cover and identify gaps for:

- optimizations regarding amount of information in the request and number of requests;

- enhancement of input to rating;

- cancelling of chargeable events for unsuccessful scenarios;

- enhancement of non-blocking mechanism;

- enhancements of triggers having more consistent triggers and use of NF specific triggers.

Improvements on how to maintain the source code presentations (yaml and ASN.1) the document structure for these will be studied,

# 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, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 32.255: "5G data connectivity domain charging; stage 2".

[3] 3GPP TS 23.503: "Policy and charging control framework for the 5G System (5GS); Stage 2".

[4] 3GPP TS 29.500: "5G System; Technical Realization of Service Based Architecture; Stage 3".

[5] 3GPP TS 32.240: "Telecommunication management; Charging management; Charging architecture and principles".

[6] 3GPP TS 32.291: "Telecommunication management; Charging management; 5G system; Charging service, stage 3".

[7] 3GPP TS 32.298: "Telecommunication management; Charging management; Charging Data Record (CDR) parameter description".

[8] 3GPP TS 32.299: "Telecommunication management; Charging management; Diameter charging application".

[9] 3GPP TS 23.501: "3GPP TS 23.501:"System Architecture for the 5G System".

[10] 3GPP TS 23.203: "Policy and charging control architecture".

[11] 3GPP TS 29.594: "5G System; Spending Limit Control Service; Stage 3".

[12] 3GPP TS 32.290: "Telecommunication management; Charging management; 5G system; Services, operations and procedures of charging using Service Based Interface (SBI)".

[13] IETF RFC 4006 (2005): "Diameter Credit-Control Application".

[14] IETF RFC 8506 (2019): "Diameter Credit-Control Application".

[15] 3GPP TS 29.513: "5G System; Policy and Charging Control signalling flows and QoS parameter mapping; Stage 3".

[16] 3GPP TS 29.594: "5G System; Spending Limit Control Service; Stage 3".

[17] 3GPP TS 32.254: "Telecommunication management; Charging management; Exposure function Northbound Application Program Interfaces (APIs) charging".

[18] 3GPP TS 32.256: "Telecommunication management; Charging management; 5G Data connectivity domain charging; stage 2".

[19] 3GPP TS 29.244: "Technical Specification Group Core Network and Terminals; Interface between the Control Plane and the User Plane Nodes; Stage 3”.

[20] 3GPP TS 29.591: “5G System; Network Exposure Function Southbound Services; Stage 3”.

[21] 3GPP TS 29.541: “5G System; Network Exposure (NE) function services for Non-IP Data Delivery (NIDD) and Short Message Services (SMS); Stage 3”.

[22] 3GPP TS 29.542: “5G System; Session management services for Non-IP Data Delivery (NIDD); Stage 3".

[23] 3GPP TS 38.300: “NR; NR and NG-RAN Overall description; Stage-2".

[24] 3GPP TS 32.251: "Telecommunication management; Charging management; Packet Switched (PS) domain charging".

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

## 3.2 Symbols

Void.

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GP  TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

# 4 Overview

The Nchf converged charging services was first released in Rel-15. This first iteration was to a large extent, with some minor exceptions, copying and combining its predecessors, Ro and Rf, based on Diameter to a service based interface (SBI) supporting converged charging service. The depiction of the internal architecture of the Converged Charging System (CCS) was to a large extent based on the Online Charging System (OCS).

The combination of the Diameter Ro and Rf interfaces into one converged charging service together with the move of the integration point for CDRs have led to that all the information previously reported and transported over two or more interfaces now needs to be transported over a single interface. This makes it essential that the converged charging interface is optimized in regard to the amount of information and number of reports sent, or at least allows for such an optimization if needed.

The information that may be used to assist the determine of reservation in the CCS is not defined except for the rating group. This means that for an immediate event or in an initial request the information about the event or session is limited and lacks accuracy.

Low latency requirements increased by new business cases may need enhancements to the non-blocking mechanism.

Charging of new service together with converged charging have increased the need for more information in the input to rating.

The use of event-based charging has led to a need for cancelling the charging for the chargeable event, e.g. refund, for unsuccessful scenarios or cases not possible to fulfil.

The document structure of the actual service, i.e. yaml, followed the handling of Ro and Rf, based on Diameter, which may need improvements.

# 5 Charging scenarios and key issues

## 5.1 Charging information optimization

### 5.1.1 General

When there is no 5G data connectivity usage, which may be quite frequent in the case of always connected, when a trigger is active and the event occurs, sending a lot of information might be unnecessary. For online the need of getting the trigger even if there is no usage depends on if it requires rating and may impact the granted quota. For the offline it will depend on the use case if the trigger event is needs to be reported in the case of no usage.

The size of a request is only limited by the maximum size of the request in TS 29.500 [4] and controlled by the NF consumer. The CHF may reject the request if the request is over that limit. There is no other way for the CHF to control the size of the message other than controlling or limit the number of charging conditions changes before reporting, this will not state the size or take compression into consideration.

The CDR specification TS 32.298 [7] and the Nchf specification in TS 32.291 [6] may not always be updated to support the same information, this especially applies to attributes that is inherited from other specifications in TS 32.291 [6]. If the attribute or attribute value isn’t supported by the CDR and it is optional the attribute will be discarded. This would mean that even if it is supported in a later stage of the TS 32.298 [7], the value cannot be restored.

The reported charging information accuracy directly impact on the charging accuracy in the CHF. The charging information accuracy of location should be taken into consideration.

When there is the tiered charging per bitrate, for 5G converged charging, the volume aggregation based on the range of bitrate as the charging information should be taken into consideration.

### 5.1.2 Use cases

#### 5.1.2.1 Use Case #1a: Trigger without usage

The operator has an offer for 5G data connectivity, which is volume based and available for both online and offline (in converged charging this means quota and not quota managed) charged subscribers. The offer has different rates depending on the PLMN accessed i.e., if it is roaming and where it is roaming. The operator would also like to get statics on how much the users are using in different PLMNs, as well as for some IoT devices how many times they change PLMN.

A user has a UE that has a PDU session ongoing and is on the border between HPLMN and VPLMN and the UE keeps switching between the networks. The user chooses to only use the UE when it is connected to the HPLMN.

An enterprise has several IoT devices that each have their PDU sessions ongoing.

The operator would like to minimize the number of interrogations and the information sent between the SMF and CHF, this means that this means that for:

- UEs that are online (quota managed) charged and have the offer, a PLMN change should only immediately trigger a CHF when there is usage.

- UEs that are offline (not quota managed) charged and have the offer, a PLMN change should create a container only when there is usage.

- some IoT devices that are offline (not quota managed) charged, a PLMN change should create a container independent of if there is usage or not.

This could be relevant for the following triggers: QoS, GFBR guaranteed status, user location, serving node, Presence Reporting Area(s), 3GPP PS data off status, tariff time, UE time zone, PLMN, RAT type, Session-AMBR, UPF, I-SMF, handover status, access addition/removal and redundant transmission change.

#### 5.1.2.2 Use Case #1b: Size of charging information

An operator has a rating group containing only services charged online and only set immediate for triggers relating to quota management for volume, all other triggers for the rating group are set to deferred. This may in some cases result in a case where a request will be required to be split over several charging data requests e.g., when the payload size of HTTP requests exceeds the recommended values.

The operator may alternatively in this case want to optimize their storage and would therefore like to control the size of the converged charging requests based on the available space in each CHF. It should be noted that there is a trade of between size of the requests and the number of requests.

There are two parts of to the storage in the CHF one is the CDR storage before sending it to the CGF and the allocation of the resource for the SBI. The resource may be stored uncompressed for fast access, whereas the charging information in the converged charging request may be compressed to limit network utilization. This means that the operator would like to control the size of the message both before and after the compression.

When a converged charging request is sent the amount of information included in the intimal is often limited since not much usage can have been done, so it is more important to be able to control the sizes of the update and termination than the initial.

The converged charging request can contain request for units, offline unit reports and online units report for the same rating group.

#### 5.1.2.3 Use Case #1c: Charging Data Request Optimization

The operator has an offer for 5G Data Connectivity, which is volume based, though, this needs to be clearly optimized due to the expected number of IoT devices which an enterprise can have. Each one of the IoT devices may have a PDU session which could lead a major 5GS overload due to burst of Charging Data Requests.

The operator would like to minimize the number of interrogations and the information sent between the SMF and CHF, by:

- Simplify charging for loT devices

- Protect 5GS from charging system overload due to many CDRs

#### 5.1.2.4 Use Case #1d: Undefined CDR attributes and attribute values

An End User (subscriber) uses a service with a RAT type has that isn’t supported by the CDR. The SMF reports the usage with the RAT type. The CHF will not be able to store the RAT type in the CDR and since it is optional it may discard the value. The undefined CDR value refers to the value in a CDR attribute reported by an NF consumer, but cannot be recognized by CHF. The reporting of undefined CDR values might happen to all CDR attributes of integer or enumerated type. CHF should be enhanced to support the handling of undefined CDR values.

#### 5.1.2.5 Use Case #1e: Charging information accuracy of location

The operator has an offering service for subscribers, e.g., 5G data connectivity service specified in the TS 32.255 [2], which is volume based charging. During the 5G data connectivity service consumption, the charging information is collected by the SMF and reported to the CHF when the triggers is encountered. That means whether the CHF can accurately charge for subscribers depends on the received charging information from SMF is correct or not.

#### 5.1.2.6 Use Case #1f: Bitrate charging

The operator has an offer for 5G data connectivity services charged subscribers to provide the tiered charging per bitrate.

The end user subscribes the volume/time based tiered charging based on the averaged bitrate per time interval with special range (High speed/middle or low downlink or uplink). In order to make sure the user experience, the 5G system collects the statistics on traffic volume by averaged bitrate per time interval to implement tiered charging per bitrate.

Account the volume or time based on the range for the averaged bitrate per time interval.

#### 5.1.2.7 Use Case #1g: Charging information for threshold based re-authorization triggers

When received quota threshold based re-authorization triggers (i.e. timeQuotaThreshold, volumeQuotaThreshold, unitQuotaThreshold), the NF consumer shall seek re-authorization for the quota when fall below the supplied threshold. The NF consumer allows the service to continue whilst the re-authorization is progress, until the remaining part had been used up. The description in the TS 32.290 [12] clause 5.4.2 about the Threshold based re-authorization triggers is unclear.

### 5.1.3 Potential charging requirements

**REQ-CH\_INFO-01:** Optimization of charging information may be needed when zero units used.

**REQ-CH\_INFO-02:** Support for control of charging request size.

**REQ-CH\_INFO-03:** Optimization of charging information for small data delivery cases.

**REQ-CH\_INFO-04:** Possibility to support undefined attributes and values, for later usage, in the CDR.

**REQ-CH\_INFO-05:** Support for the optimization of charging information accuracy of location.

**REQ-CH\_INFO-06:** Support for the tiered charging based on averaged bitrate per time interval.

**REQ-CH\_INFO-07:** Support for control of remaining grant quotas during the re-authorization.

### 5.1.4 Key issues

**Key Issue #1a:** Identify the charging scenarios and triggers which can be controlled when there is no usage.

**Key Issue #1b:** How to control if information is sent when there is no usage.

**Key Issue #1c:** How to control if containers are created when these is no usage.

**Key Issue #1d**: How to control the size of the information in the converged charging request, dependent or independent of compression.

**Key Issue #1e:** How to handle when unit request and report for one rating group are split over several requests

**Key Issue #1f:** Identify the charging scenarios for small data delivery

**Key Issue #1g:** How to optimize small data delivery charging requests

**Key Issue #1h:** Where in CDR structure to store undefined values

**Key Issue #1i:** How to determine where the attribute belongs in the CDR structure

**Key Issue #1j:** How to ensure the charging information accuracy of location.

**Key Issue #1k:** How to handle tiered charging based on averaged bitrate per time interval.

**Key Issue #1l:** How to handle the remaining granted quotas during the re-authorization.

### 5.1.5 Solutions

#### 5.1.5.1 Solution #1.1: New immediate trigger variant

A possible solution for key issues #1a, #1b, and #1c covering requirements REQ-CH\_INFO-01, charging information optimization.

This solution adds a variant of the immediate trigger category.

For the current immediate report chargeable events for which, when occurring, charging data generated by the NF consumer and sent to the CHF in a Charging Data Request message. Zero usage may be reported.



Figure 5.1.5.1-1: Message flow for current immediate triggers

**1) Service delivery ongoing:** there is a connection setup for service delivery and a charging session is established between the NF (CTF) and the CHF.

**2) Trigger event:** the NF (CTF) generates charging information related to the service delivered, due to that an immediate trigger for usage reporting or quota request is met.

**3) Charging data request [Update, Unit used, Quota requested]:** the NF (CTF) sends the request to the CHF reporting the used units and if the service is under quota management it includes a quota request for the service to continue.

**4) Account, rating, and reservation control:** The CHF performs the process related to the reported usage and if the service is under quota management it performs processes related to quota requested, it may involve the rating entity and user's account balance.

**5) Update CDR:** based on policies, the CHF updates the CDR with charging data related to the service.

**6) Charging Data Response [Update, Quota granted]:** The CHF responds and if the service is under quota management it includes a quota granted for the service to continue.

**7) Uplink/downlink transmission:** first data or events transmission after the trigger event.

**8) Service delivery continuing** service delivery is continuing and the charging session is continuing between the NF (CTF) and the CHF.

For the deferred report chargeable events for which, when occurring, charging data generated by the NF consumer and stored. Zero usage may be included. The charging data will be sent to the CHF in next a Charging Data Request message.



Figure 5.1.5.1-2: Message flow for deferred triggers

**1) Service delivery ongoing:** there is a connection setup for service delivery and a charging session is established between the NF (CTF) and the CHF.

**2) Trigger event:** the NF (CTF) generates charging information related to the service delivered, deferred trigger for usage reporting is met.

**3) Close counts and start new counts:** the NF (CTF) close all counts related to the service and starts new, keeping the closed counts for reporting when an immediate trigger occurs.

**4) Uplink/downlink transmission:** first data or events transmission after the trigger event.

**5) Service delivery continuing** service delivery is continuing and the charging session is continuing between the NF (CTF) and the CHF.

For the new immediate report chargeable events for which, when occurring and there is usage, charging data generated by the NF consumer and sent to the CHF in a Charging Data Request message.



Figure 5.1.5.1-3: Message flow for new immediate triggers

**1) Service delivery ongoing:** there is a connection setup for service delivery and a charging session is established between the NF (CTF) and the CHF.

**2) Trigger event:** the NF (CTF) notices that a new immediate trigger with "zero data transmission without reporting" indicator is met. If there is zero usage, NF(CTF) will ignore the reporting for this trigger.

NOTE: which triggers are applicable for the immediate trigger "zero data transmission without reporting" should be specified in the normative work. If the immediate trigger without the "zero data transmission without reporting" indicator, the charging data message should be reported even zero usage for the immediate triggers.

**3) Uplink/downlink transmission:** There are data or events transmission start after the immediate trigger "zero data transmission without reporting ", was met, and the NF (CTF) generates charging information related to the service delivered.

**4) Trigger event:** the NF (CTF) notices that new immediate triggers (e.g. Start of service data flow, in case no valid quota for this rating group) are met, the NF(CTF) generates charging data request message with the new immediate trigger and timestamp, the previous immediate trigger "zero data transmission without reporting" in step 2 is ignored.

**5) Charging data request [Update, Unit used, Quota requested]:** the NF (CTF) sends the request to the CHF reporting the used units with the trigger and if the service is under quota management it includes a quota request for the service to continue.

**6) Account, rating, and reservation control:** The CHF performs the process related to the reported usage and if the service is under quota management it performs processes related to quota requested, it may involve using the reported charging data to rate the usage and deduct the funds corresponding to the usage on the account balance.

**7) Update CDR:** based on policies, the CHF updates the CDR with charging data related to the service.

**8) Charging Data Response [Update, Quota granted]:** The CHF responds and if the service is under quota management it includes a quota granted for the service to continue.

**9) Service delivery continuing** service delivery is continuing and the charging session is continuing between the NF (CTF) and the CHF.

#### 5.1.5.2 Solution #1.2: Keep rating group information together

A possible solution for key issue #1e covering requirements REQ-CH\_INFO-01, charging request optimization.

According to the current charging mechanism specified in TS 32.255 [2] and TS 32.290 [12], the trigger per RG does not distinguish with quota management (online) or without quota management (offline). If the rating group have service with quota management (online), then the charging data request will report all used units for that rating group, including the quota management(online) and without quota management(offline) triggered in the rating group. Only the quota management services reported will be used for quota allocation. This is to ensure that the CHF won’t interpret any reporting of used units for the rating group as a release of all granted service units for the rating group.

#### 5.1.5.3 Solution #1.3: NF consumer ensuring accuracy of location

A possible solution for key issue #1j covering requirements REQ-CH\_INFO-05, charging information accuracy of location.

Add a general description in the TS 32.240 [5] in line with the following:

- the NF (CTF) (e.g., SMF, AMF, NEF) ensures that location reporting in the charging information is accurate for charging purposes.

#### 5.1.5.4 Solution #1.4: Stop and discard the used units during re-authorization

A possible solution for key issue #1l covering requirements REQ-CH\_INFO-07, control of granted quota during re-authorization.

The NF Service Consumer allows the service to continue whilst the re-authorization is progress, using the quota between the threshold and the granted quota. Either until the quota has been consumed or receiving a charging data response from CHF.

If the remaining part is used up before receiving the Charging Data Response:

- NF Service Consumer stops the service delivery and discards the recorded used units.

If the Charging Data Response with new quota is received before the quota is consumed:

- NF Service consumer continues the service delivery, deducting the used units from the new granted quota.

If the Charging Data Response with result code other than success or a final unit action, described in TS 32.290 [12], is received before the quota is consumed:

- the NF Service consumer stops service delivery, discards the recorded used unit, and performs the actions associated with the result code or final unit action.

#### 5.1.5.5 Solution #1.5: Stop and report the used units during re-authorization

A possible solution for key issue #1l covering requirements REQ-CH\_INFO-07, control of granted quota during re-authorization.

Clarify the description in clause 5.4.2 of TS 32.290 [12]. The NF Service Consumer allows the service to continue whilst the re-authorization is progress, until the remaining part had been used up.

The NF Service Consumer allows the service to continue whilst the re-authorization is progress, using the quota between the threshold and the granted quota. Either until the quota has been consumed or receiving the charging data response from CHF.

If the remaining part is used up before receiving a Charging Data Response:

- NF Service Consumer terminates the service date flow and reports the used unit in the next Charging Data Request.

If the Charging Data Response with new quota is received before the quota is consumed:

- NF Service consumer continues the service delivery, deducting the used units from the new granted quota.

If the Charging Data Response with result code other than success or a final unit action, described in TS 32.290 [12], is received before the quota is consumed:

- the NF Service consumer stops service delivery, reports the used unit in a Charging Data Request [Update/Termination], and performs the actions associated with the result code or final unit action.

#### 5.1.5.6 Solution #1.6: CHF control of granted quota during re-authorization

A possible solution for key issue #1l covering requirements REQ-CH\_INFO-07, control of granted quota during re-authorization.

The quota is granted per RG. There may be several RGs in one charging session. The failure of granted quota for one RG will not impact on the quota granted for other RGs. For one special RG, the following mechanism is present.

When received quota threshold based re-authorization triggers (i.e. timeQuotaThreshold, volumeQuotaThreshold, unitQuotaThreshold), the NF consumer shall seek re-authorization for the quota when fall below the supplied threshold.

When the granting new quota is successful from the CHF, the used units during the re-authorization process are treated as the used part of the new granted quota.

When the granting new quota is unsuccessful from the CHF, the CHF may indicate that the remaining quota can be used up, the NF consumer shall allow the service to continue until the remaining part is used up, and then report the usage of remaining quota with the quota management indication. Otherwise, the NF consumer stops the service after receiving failure response if no indication from CHF.

#### 5.1.5.7 Solution #1.7: Continue and report the used units during re-authorization

A possible solution for key issue #1l covering requirements REQ-CH\_INFO-07, control of granted quota during re-authorization.

The NF Service Consumer allows the service to continue whilst the re-authorization is progress, using the quota between the threshold and the granted quota. Either until the quota has been consumed or receiving a Charging Data Response from CHF.

If the remaining part is used up before receiving a Charging Data Response:

- NF Service Consumer stops the service delivery and waits for the Charging Data Response. When the Charging Data Response is received it will follow the same actions as if it was received before the quota was consumed, see next two if-statements.

If the Charging Data Response with new quota is received before the quota is consumed:

- NF Service Consumer continues the service delivery, deducting the used units from the new granted quota.

If the Charging Data Response with result code other than success or a final unit action, described in TS 32.290 [12], is received before the quota is consumed:

- the NF Service Consumer stops service delivery and reports the recorded used unit in a Charging Data Request [Update/Termination], and performs the actions associated with the result code or final unit action.

#### 5.1.5.8 Solution #1.8: CHF control of ChargingInformationData size

A possible solution for key issues 1d covering requirements REQ-CH\_INFO-02, control of charging request size.

CHF can provide the max data of charging information collection in the NF(CTF) to limits the charging information data size that NF(CTF) can use in the charging information reporting, if the corresponding supported feature is supported.

Example of maxzise in the Charging Data Response in the TS 32.291 [6] table 6.1.6.2.1.2:

Table 6.1.6.2.1.2-1: Definition of type ChargingDataResponse

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute name | Data type | P | Cardinality | Description | Applicability |
| invocationTimestamp | DateTime | M | 1 | This field holds the timestamp of the charging service response from the CHF. |  |
| invocationResult | InvocationResult | OC | 0..1 | This field holds the result of charging service invocation by the NF consumer |  |
| invocationSequenceNumber | Uint32 | M | 1 | This field contains the sequence number of the charging service invocation by the NF consumer. The same value of the sequence number received in the request should be used in the response |  |
| sessionFailover | SessionFailover | OC | 0..1 | This field indicates whether alternative CHF is supported for ongoing charging service failover handling by NF consumer. |  |
| supportedFeatures | SupportedFeatures | OC | 0..1 | This IE shall be present if at least one optional feature defined in clause 6.1.8 is supported. |  |
| multipleUnitInformation | array(MultipleUnitInformation) | OC | 0..N | This field holds the parameters for the quota management and/or usage reporting information. It may have multiple occurrences. |  |
| Triggers | array(Trigger) | OC | 0..N | This field identifies the chargeable event(s) supplied by CHF to override/activate the existing chargeable event(s) in NF consumer.  The presence of the triggers attribute without any triggerType is used by CHF to disable all the triggers except rating group level triggers. |  |
| maxChargingData | Uint64 | OC | 0..1 | Maximum payload size if needed by CHF and the supported feature “ MaxChargingData” is applicable.  The fileld will be effective until next resetting of maxChargingData. | MaxChargingData |

#### 5.1.5.9 Solution #1.9: CHF control of chargingdata size

A possible solution for key issues #1d covering requirements REQ-CH\_INFO-02, control of charging request size.

The CHF can today set the following limits for a request to trigger reporting of charging information:

- time: limits the duration the CTF can wait before reporting.

- volume: limits the volume measured by the CTF before reporting.

- event: limits the number of events measured by the CTF before reporting.

- Number Of CCC: limits the number of charging condition changes performed CTF before reporting.

This solution would add two new limits the size of payload (before and after any compression) of the Charging data request:

- charging data: limits the charging data size that CTF can use in the charging data report before compression is applied, if any.

The new attribute e.g., maxChargingData, would be handled in the same way as the current maxNumberOfccc.

Example of how the definition of trigger could look in the TS 32.291 [6] table 6.1.6.2.1.7-1:

Table 5.1.5.9-1: Definition of type Trigger

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Attribute name | | Data type | | P | | Cardinality | | Description | | Applicability | |
| triggerType | | TriggerType | | Oc | | 0..1 | | the events whose occurrence lead to charging event is issued towards the CHF | |  | |
| triggerCategory | | TriggerCategory | | M | | 1 | | This field indicates whether the charging data generated by the NF consumer for the trigger lead to a Charging Event towards the CHF immediately or not. | |  | |
| timeLimit | | DurationSec | | OC | | 0..1 | | Time limit if trigger type is “Expiry of data time limit” | |  | |
| volumeLimit | | Uint32 | | OC | | 0..1 | | Volume limit if trigger type is “Expiry of data volume limit”. This attribute is not valid from Nchf\_ ConvergedCharging API version v2.0.0 | |  | |
| volumeLimit64 | | Uint64 | | OC | | 0..1 | | Volume limit if trigger type is “Expiry of data volume limit”.  This attribute replaces the volumeLimit attribute from Nchf\_ ConvergedCharging API v2.0.0 | |  | |
| eventLimit | | Uint32 | | OC | | 0..1 | | Event limit if trigger type is “Expiry of data event limit”. | |  | |
| maxNumberOfccc | | Uint32 | | OC | | 0..1 | | Maximum number if trigger type is “Max nb of number of charging condition changes” | |  | |
| maxChargingData | | Uint64 | | OC | | 0..1 | | Maximum payload size without any compression, if trigger type is “Max charging data”. | |  | |
| tariffTimeChange | | DateTime | | OC | | 0..1 | | This field contains UTC time indicating the switch time when the tariff will be changed. | |  | |

#### 5.1.5.10 Solution #1.10: Bitrate Charging supported by SMF

A possible solution for key issue #1k and requirement REQ-CH\_INFO-06, Bitrate Charging.

The SMF collects the statistics on traffic volume by averaged bitrate per time interval to implement tiered charging per bitrate.



Figure 5.1.5.10-1: Message flow for SMF solution

**1) Charging Data Request [Initial/update]**: The SMF sends the Charging Data Request [Initial/Update] to CHF.

**2) Open and update CDR:**  CHF generates/updates the CDR based on the charging data request.

3) **Bitrate Charging Determine**: CHF decides to start the tiered bitrate charging and determines the threshold for the tiered charging. Optional, the CHF can decide the time interval for the averaged bitrate accounting.

4) **Charging Data Response [Initial/Update]:** CHF sends Charging Data Response [Initial/Update] to SMF with the threshold, e.g. threshold 1 is the bitrate more than100 M/bps, threshold 2 is bitrate between 100 M/bps and 50 M/bps, threshold 3 is bitrate lesser than 50 M/bps. Optionally, the time interval is 10 seconds if needed.

5) **N4 modification Request:** If the time interval is provided, SMF sends the N4 request to the UPF with the time interval or SMF sends the threshold for the tiered charging.

6) **N4 modification Response:** The UPF reports the traffic volume per time interval to SMF or traffic volume for tiered charging per threshold.

7) **Counts or collection Operation:** SMF starts the new counts for the trigger “tiered charging threshold” and counts the volume based on the corresponding threshold when the deferred trigger “tiered charging threshold” is enable.

8) **Trigger event:** When the immediate trigger is met for reporting, the SMF close the counts for the traffic data volume, including the volume per threshold.

9) **Charging Data Request [Update, Used Units]:** The SMF sends the Charging Data Request [Update, Used Units], e.g., the Used Units for threshold 1, the volume is 5 M, for threshold 2, the volume is10M, for threshold 3, the volume is 20 M, to the CHF. CHF processes the related charging data for CDR generation purpose.

10) **Update CDR:** The CHF stores received charging information for the CDR.

11)  **Charging Data Response [Update]:** The CHF sends the Charging Data Response [Update] the SMF.

#### 5.1.5.11 Solution #1.11 New attribute on all levels of the CDR structure

A possible solution for key issues #1h and #1i covering requirement REQ-CH\_INFO-04, support undefined attributes and values in CDR.

Adding a new attribute for storing undefined attributes and values, to all places in the CDR where an undefined attribute or attribute value could occur. This means that a new attribute would be added to all CDR attributes that is a group of attributes. An example on how this new attribute, undefinedAttribute, could be defined is described in clause 5.1.5.11.1.

##### 5.1.5.11.1 Undefined attribute

This field consists of two parts, the attribute name and value.

The attributeName would contain the name of the attribute e.g., “rATType”

The value would contain the actual the value of the attribute as a string, since all attributes (for openAPI) would be possible to represent as a string e.g., "NR\_GEO".



Figure 5.1.5.11-1: Example of new attribute and usage for solution 1.11

#### 5.1.5.12 Solution #1.12 New attribute in the ChargingRecord, using sequence number for multiple attributes

A possible solution for key issues #1h and #1i covering requirement REQ-CH\_INFO-04, support undefined attributes and values in CDR.

Adding a new attribute or sequence of attributes directly in the ChargingRecord for storing undefined attributes and values. To be able to find in which part of the CDR the attribute belongs both the full resource path as well as a sequence number is needed, the sequence number would refer to which array item the undefined attribute belonged in the case of it being with in an attribute having multiple occurrences e.g., a “SEQUENCE OF”, in the CDR.

An example on how this new attribute, undefinedInformation, could be defined is described in clause 5.1.5.12.1.

##### 5.1.5.12.1 Undefined Information

This field would be array of the undefined attribute as defined in clause 5.1.5.11.1 with the addition of a sequence number reference.

The reference sequence number would identify the specific occurrence in a sequence that the undefined attribute would belong to e.g., LocalSequenceNumber in the MultipleQFIContainer and UsedUnitContainer. If a sequence number doesn’t exist for a specific attribute that is a sequence of, this would have to be added.



Figure 5.1.5.12-1: Example of new attribute and usage for solution 1.12

#### 5.1.5.13 Solution #1.13 New attribute in the ChargingRecord, using hash value for multiple attributes

A possible solution for key issues #1h and #1i covering requirement REQ-CH\_INFO-04, support undefined attributes and values in CDR.

Adding a new attribute or sequence of attributes directly in in the ChargingRecord for storing undefined attributes and values. To be able to find in which part of the CDR the attribute belongs both the full resource path as well as a hash value for the specific array occurrence, the hash value would be calculated from the attributes and values of a specific array item and thereby uniquely identifying this array item.

The ChargingRecord would contain a new field undefinedInformation defined in clause 5.1.5.13.1.

##### 5.1.5.13.1 Undefined Information

This field would be an array of undefined attribute as defined in clause 5.1.5.11.1 with the addition of a reference hash value reference.

The reference hash value reference would uniquely identify the specific occurrence in a sequence where the undefined attribute would belong. For example, if an attribute could not be added to one item in the sequence of NGRANSecondaryRATUsageReports then the hash value would be created based on the attributes and values that could be stored in that specific occurrence in the sequence.



Figure 5.1.5.13-1: Example of new attribute and usage for solution 1.13

#### 5.1.5.14 Solution #1.14: NF consumer reporting accuracy of location

A possible solution for key issue #1j covering requirements REQ-CH\_INFO-05, charging information accuracy of location.

Add a general description in the TS 32.240[5] in line with the following:

- the NF (CTF) (e.g., SMF, AMF, NEF) includes in the location reporting the accuracy of the location information and time the location was retrieved by the NF (CTF) in the charging information, to be used by the CHF to determine if the accuracy meets current requirements.

#### 5.1.5.15 Solution #1.15: IoT Charging information Optimization

A possible solution for key issues #1f and #1g covering requirements REQ-CH\_INFO-03, optimization of charging information.

Currently, charging for data transfer is based on volume based measurement of the connections in down and uplink directions which has been enhanced to cover big data transfers.

The payload data considered in this is IoT related data (e.g. through Small Data Transmission procedure as referenced in TS 38.300 [22], which can trigger Charging Data Requests messages towards CHF.

This solution would bring the following advantages for IoT Charging:

- Charging for loT subscriptions (which can be devices, group of devices, loT applications, external Identifiers) is simplified.

- Overload of charging system due to many CDRs, one CDR per payload, may be avoided, by reducing the number of requests to Charging, limit down the Charging Data to IoT related one.

- A new option to control loT devices and/or their environment, on this case its considered that each IoT device corresponds to a PDU Session (one UE and one subscriber).

The solution proposes the availability of a new count for the measurement and calculation of NIDD (Non-IP Data Delivery) of the Charging Data Request, and the availability of new default triggers specific to IoT use cases.

The Message Payload is a PFCP session related message (N4 Interface between UPF and SMF) as specified in TS 29.244 [19]. The new attributes Payload-Input-Count and Payload-Output-Count, would be used to indicate the number of times/events each one of an input payload for the subscription and an output payload from the subscription are delivered., it would subsequently generate the respective charging information, once it reaches a threshold leading to a reduction of Charging Requests towards CHF.

A payload can be defined as trigger. The basic trigger mechanism is specified in TS 32.290 [12]

According to TS 32.255 [2], when a PDU session starts, and the converged charging is activated, the SMF invokes a Charging Data Request [Initial] towards the CHF to get authorization to start based on the default triggers. The SMF is optionally provided in a Charging Data Response [Initial] to override the default triggers, with a set of chargeable event triggers to be enabled, and the associated category (on this case deferred report).

The triggers remain active until they are updated or disabled by subsequent Charging Data Response [Update] from the CHF or the PDU session is terminated.

Example of Payload Triggers in TS 32.255[2] table 5.2.1.4.1

Table 5.1.5.15-1: Extension to default trigger conditions in SMF

| Trigger Conditions | Trigger level | Converged Charging default category | Offline only charging default category | CHF allowed to change category | CHF allowed to enable and disable | Message when "immediate reporting" category |
| --- | --- | --- | --- | --- | --- | --- |
| **Limit per PDU session** | | | | | | Charging Data Request [Update] |
| IoT payload threshold reached | PDU session | Immediate | Immediate | No | Yes |

If the IoT Payload Threshold trigger is enabled then a new count in the CDR is started, it only creates a CDR once it reaches the threshold (TS 32.255 [2], step 16ch-a of Figure 5.1.5.15-1)

The triggers remain active until they are updated or disabled by subsequent Charging Data Response [Update] from the CHF or the PDU session is terminated.

Example of Payload-Input-Count and Payload-Output-Count in the Charging Data Request Message in TS 32.290 [12] table 7.1:

Table 5.1.5.15-2: Extension to Common Data structure of Charging Data Request

|  |  |  |
| --- | --- | --- |
| **Information Element** | **Category** | **Description** |
| Payload-Input-Count | OC | This field indicates a number of times the input payload for the subscription is delivered |
| Payload-Output-Count | OC | This field indicates the number of times the output payload from the subscription is delivered |

#### 5.1.5.16 Solution #1.16: Without addition of undefined CDR parameters

A possible solution for key issues #1h and #1i covering requirement REQ-CH\_INFO-04, support undefined attributes and values in CDR.

All attributes (for openAPI reporting) would be possible to represent in the CDR. If the undefined CDR parameters is reported via the Nchf from the NF consumers, just skip the undefined CDR parameters which is not supported in the supportedfeatures.

#### 5.1.5.17 Solution #1.17: Vendor special for undefined CDR parameters

A possible solution for key issues #1h and #1i covering requirement REQ-CH\_INFO-04, support undefined attributes and values in CDR.

All attributes (for openAPI reporting) would be possible to represent in the CDR. If the undefined CDR parameters is reported via the Nchf from the NF consumers, it is up to the vendor private configuration to handle the undefined CDR parameters.

#### 5.1.5.18 Solution #1.18: Introduce a container reference

A possible solution for key issues 1d covering requirement REQ-CH\_INFO-02, control of charging request size.

Introduction of the possibility to refer to another container (PDU or QBC) if they contain the same information.

Table 5.1.5.18-1: Additions to definition of type PDUContainerInformation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute name | Data type | P | Cardinality | Description | Applicability |
| pDUContainerInfoId | String | OC | 0..1 | Uniquely identifies the PDU container information within a charging data request. |  |
| pDUContainerInfoRef | String | OC | 0..1 | Reference to another PDU container information within a charging data request that contains the charging data i.e., this means that no charging data is required to be included in this container |  |
| NOTE 1: Either the pDUContainerInfoId or pDUContainerInfoRef may be included. | | | | | |

Table 5.1.5.18-2: Additions to definition of type QFIContainerInformation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute name | Data type | P | Cardinality | Description | Applicability |
| qFIContainerInfoId | string | OC | 0..1 | Uniquely identifies the QFI container information within a charging data request |  |
| qFIContainerInfoRef | string | OC | 0..1 | Reference to another QFI container information within a charging data request that contains the charging data i.e., this means that no charging data is required to be included in this container |  |
| NOTE 1: Either the qFIContainerInfoId or qFIContainerInfoRef may be included. | | | | | |

#### 5.1.5.19 Solution #1.19: IoT NEF charging information optimization

A possible solution for key issues #1f and #1g covering requirements REQ-CH\_INFO-03, optimization of charging information.

Currently, charging for data transfer is based on volume based measurement of the connections in down and uplink directions which has been enhanced to cover big data transfers.

This solution would bring the following advantages for IoT Charging:

- Charging for loT subscriptions (which can be devices, group of devices, loT applications, external Identifiers) is simplified.

- Overload of charging system due to many CDRs, one CDR per payload, may be avoided, by reducing the number of requests to Charging, limit down the Charging Data to IoT related one.

- A new option to control loT devices and/or their environment, on this case its considered that each IoT device corresponds to a PDU Session (one UE and one subscriber).

The solution proposes the use of the current NIDD (Non-IP Data Delivery) handling as specified in TS 32.254 [17] and adding new trigger for number of API invocations/notifications.

The NIDD delivery uses the following, according to TS 29.591 [20]:

- MO NIDD, the interaction between the SMF and the NEF uses Nnef\_SMContext service, as specified in TS 29.541 [y];

- MT NIDD, the interaction between the SMF and the NEF uses Nsmf\_NIDD service as specified in TS 29.542 [z].

When delivering the message to/from the AF the following can be used:

- NiddDownlinkDataTransfer service, and it can be updated by the NiddDownlinkDataTransferPatch service

- NiddUplinkDataNotification service

To have a trigger each time an uplink message is delivered to the AF or received from the AF may cause a lot of interaction and adding a new limit triggering after a number of events to default trigger conditions in NEF, TS 32.254 [17] table 5.4.1.2.1.1

Table 5.1.5.19-1: Extension to default trigger conditions in NEF

| Trigger Conditions | Trigger level | Default category | CHF allowed to change category | CHF allowed to enable and disable | Message when "immediate reporting" category |
| --- | --- | --- | --- | --- | --- |
| API Invocation/Notification limit | - | Immediate | Not Applicable | Not Applicable | IEC: Charging Data Request [Event]  ECUR: Charging Data Request [Initial] |

Table 5.1.5.19-2: Charging Data Request message content

|  |  |  |
| --- | --- | --- |
| **Information Element** | **Category** | **Description** |
| Session Identifier | OC | Described in TS 32.290 [12]. |
| Subscriber Identifier | OM | Described in TS 32.290 [12], and holds the identifier of the AF |
| NF Consumer Identification | M | Described in TS 32.290 [12]. |
| Invocation Timestamp | M | Described in TS 32.290 [12]. |
| Invocation Sequence Number | M | Described in TS 32.290 [12]. |
| Retransmission Indicator | - | This field is not applicable. |
| One-time Event | OC | This field indicates, if included, that this is a one-time event and that there will be no update or termination. |
| One-time Event Type | OC | Described in TS 32.290 [12]. |
| Notify URI | - | This field is only applicable for the notification of abort charging. |
| Triggers | OC | This field is described in TS 32.290 [12] and holds the NEF specific triggers described in clause 5.4.1.x |
| Multiple Unit Usage | OC | This field contains the parameters for the quota management request and/or usage reporting. |
| Rating Group | M | Described in TS 32.290 [12] |
| Requested Unit | OC | Described in TS 32.290 [12] |
| Used Unit Container | OC | Described in TS 32.290 [12] |
| NEP API Container Information | OC | Used instead of NEF API Charging Information if more than one NEF API Charging Information needs to be reported described in table 5.1.5.19-3. |
| NEF API Charging Information | OM | This field holds the NEF API specific information described in TS 32.254 [17] clause 6.3.1.4 |

Table 5.1.5.19-3: Structure of the NEF API Container Information

|  |  |
| --- | --- |
| Information Element | Description |
| NEP API Container Information | This parameter holds the same information as the NEF API Charging Information. |

Extension of the Triggers information element in the Charging Data Request message contents in TS 32.290 [12] table 6.1.1.2.1:

Table 5.1.5.19-4: Extension of Triggers information element

| **Information Element** | **Converged Charging**  **Category** | **Offline Only Charging Category** | **Description** |
| --- | --- | --- | --- |
| Triggers | OC | OC | This field holds the triggers supplied from the CHF for the charging session that are independent of rating group for quota management and without quota management. |
| Trigger Type | OC | OC | This field holds the events whose occurrence led to charging event is issued towards the CHF |
| Trigger Category | M | M | This field indicates whether the charging data generated by the NF consumer for the trigger lead to a Charging Event towards the CHF immediately or not. |
| Time Limit | OC | OC | This field holds the time limit if trigger type is "Expiry of data time limit" |
| Volume Limit | OC | OC | This field holds the total (uplink and downlink) volume limit if trigger type is "Expiry of data volume limit". |
| Event Limit | OC | OC | This field holds the maximum number of events if trigger type is "Expiry of data event limit". |
| Max Numbers Of Charging Condition Changes | OC | OC | This field holds the maximum number if trigger type is "Max number of charging condition changes". |
| Max Numbers Of Invocations/Notifications | OC | OC | This field indicates the maximum number of invocations accepted and notifications delivered |
| Tariff Time Change | OC | OC | This field contains UTC time indicating the switch time when the tariff will be changed. |

#### 5.1.5.20 Solution #1.20: Reserve a range of special numbers for undefined values

A possible solution for key issues #1h and #1i covering requirement REQ-CH\_INFO-04, support undefined attributes and values in CDR.

If the undefined value(s) in a CDR attribute are reported via the Nchf from an NF consumer, they can be stored in a range of special numbers reserved by the CDR attribute.

NOTE: Which CDR attributes need to reserve a range of special numbers for undefined values should be defined in the normative work.

Take the RAT Type as the example:

*RATType ::= INTEGER*

*--*

*-- This integer is based on the RatType specified in TS 29.571 [249]*

*-- with 3GPP RAT Type specified in TS 29.061 [216] added for backwards compatibility.*

*--*

*{*

*-- 0 reserved*

*uTRAN (1), gERAN (2), wLAN (3),*

*-- 4 reserved for GAN*

*-- 5 reserved for HSPA Evolution*

*eUTRAN (6),*

*virtual (7),*

*-- 8 reserved for nBIoT*

*-- 9 reserved for lTEM*

*nR (51),*

*wIRELINE (55),*

*wIRELINE-CABLE (56),*

*wIRELINE-BBF (57),*

*nR-REDCAP (58),*

*tRUSTED-N3GA (65)*

*-- 101 reserved for IEEE 802.16e*

*-- 102 reserved for 3GPP2 eHRPD*

*-- 103 reserved for 3GPP2 HRPD*

*-- 104 reserved for 3GPP2 1xRTT*

*-- 105 reserved for 3GPP2 UMB*

*-- 90x reserved for undefined CDR parameters*

*}*

#### 5.1.5.21 Solution #1.21: Bitrate charging supported by CHF

A possible solution for key issue #1k and requirement REQ-CH\_INFO-06, Bitrate Charging.

The SMF(CTF) reports the actual duration with the traffic and the volume of used usage during the actual duration for data transmission based on the Quota Consumption Time mechanism.



Figure 5.1.5.21-1: Message flow for bitrate charging supporting from CHF

1) **Charging data request [Initial, Quota Requested]**: The SMF sends the request to CHF for the charging session establishment for the PDU session establishment or start of the service date flow.

2) **Open CDR:**  CHF generates the CDR based on the charging data request.

3) **Bitrate Charging Determine**: CHF decides to start the tiered bitrate charging per time interval.

4) **Charging Data Response [Initial, Quota Granted]:** The CHF responds and if the service is under quota management it includes a quota granted for the service start. In the response, the CHF will include the Quota Consumption Time.

5) **Service delivery start:** there is a connection setup for service delivery start and the uplink or downlink data traffics is transferred.

6) **Trigger event:** the SMF generates charging information related to the service delivered, due to that an immediate trigger for usage reporting,

7) **Charging data request [Update, Unit used]:** the SMF sends the request to the CHF reporting the used units, including both the time for the actual duration with traffic based on the Quota Consumption Time and the volume of the traffic.

8) **Calculate bitrate:** The CHF calculates the mean bitrate, between the initial and update, by taking the volume in bytes times 8 (to get bits) and dividing it with the time in seconds.

9) **Update CDR:** based on policies, the CHF updates the CDR with charging data related to the service.

10) **Charging Data Response [Update]:** The CHF responds the Charging Data request.

NOTE: The Charging Data Request [Update] message in the step 7 may include the requested quota, and if the service is under quota management, the Response in the step 9 includes a quota granted for the service to continue. In order to simplify the message flow, the Update message with the new requested quota is not described.

11) Service delivery is continuing and the charging session is continuing between the SMF and the CHF.

#### 5.1.5.22 Solution #1.22: Bitrate charging using volume and time measurement

A possible solution for key issue #1k and requirement REQ-CH\_INFO-06, Bitrate Charging.

The SMF(CTF) reports the actual duration with the traffic and the volume of used usage during the actual duration for data transmission.



Figure 5.1.5.21-1: Message flow for bitrate charging supporting from CHF

1) **Charging data request [Initial, Quota Requested]**: The SMF sends the request to CHF for the charging session establishment for the PDU session establishment or start of the service date flow.

2) **Open CDR:**  CHF generates the CDR based on the charging data request.

3) **Bitrate Charging Determine**: CHF decides to start the bitrate charging.

4) **Charging Data Response [Initial, Quota Granted]:** The CHF responds and if the service is under quota management it includes a quota granted for the service start.

5) **Service delivery start:** there is a connection setup for service delivery start and the uplink or downlink data traffics is transferred.

6) **Trigger event:** the SMF generates charging information related to the service delivered, due to that an immediate trigger for usage reporting,

7) **Charging data request [Update, Unit used]:** the SMF sends the request to the CHF reporting the used units, including both the time and the volume of the traffic.

8) **Calculate bitrate:** The CHF calculates the mean bitrate, between the initial and update, by taking the volume in bytes times 8 (to get bits) and dividing it with the time in seconds.

9) **Update CDR:** based on policies, the CHF updates the CDR with charging data related to the service.

10) **Charging Data Response [Update]:** The CHF responds the Charging Data request.

11) Service delivery is continuing, and the charging session is continuing between the SMF and the CHF.

### 5.1.6 Evaluation

Solution #1.1 solve key issues #1a, #1b, and #1c.

- Solution #1.1: introduces a new trigger, that will hold the charging data request until there is traffic.

Solution #1.8, #1.9, #1.18 all solves key issue #1d.

- Solution #1.8: requires CTF to control the size of charging information per ChargingDataRequest based on the maxChargingData specified in the ChargingDataResponse. It is an optional attribute in ChargingDataResponse, up to CHF.

- Solution #1.9: requires CTF to keep monitoring the size of charging information based on the maxChargingData specified in the Trigger.

- Solution #1.18: introduce a new attribute in PDUContainerInformation or QFIContainerInformation that can uniquely identify itself. It limits the amount of data sent by allowing the CTF to reference between containers so that information doesn’t have to be repeated.

Solution #1.2 solve key issue #1e.

- Solution #1.2: requires all used units reported for a rating group, both online and offline, to be delivered in the same request.

Solutions #1.15 and #1.19 solve key issues #1f and #1g.

- Solution #1.15: introduces new triggers and information elements for the SMF, that will trigger and report based on payload counts.

- Solution #1.19: introduces new triggers and information elements for the NEF, that will trigger and report based on number of API invocations or notifications.

Solutions #1.11, #1.12, #1.13, #1.16, #1.17, and #1.20 all solve key issue #1h and #1i.

- Solution #1.11: All the information in the Open API can be stored. All levels of the CDR structure should be changed. CHF should deal with the undefined CDR structure parameters.

- Solution #1.12: All the information in the Open API can be stored. Enhance the sequence number for multiple attributes. CHF should deal with the undefined CDR structure parameter.

- Solution #1.13: All the information in the Open API can be stored. The main level of the CDR structure should be changed. CHF should deal with the undefined CDR structure parameter.

- Solution #1.16: CHF can generate the CDRs based on the supported feature negotiation. Unsupported information in the Open API will not be stored in the CDRs.

- Solution #1.17: Depending on the operator’s selection.

- Solution #1.20: Reuse the existing with a reserved range to store undefined value.

Solutions #1.3 and #1.14 solve key issue #1j.

- Solution #1.3: requires that the NF (CTF) provides and ensure the level of accuracy required by the CHF e.g., when a location change is reported, NF(CTF) could indicate the changed location information.

- Solution #1.14: requires the CHF determine if the accuracy meets current requirements based on the reported accuracy level and Location change received time.

Solutions #1.10, #1.21, and #1.22 all solve key issue #1k.

- Solution #1.10: requires that the UPF and SMF enhancement to support mean bitrate reporting.

- Solution #1.20: reuses the mechanism from TS 32.251 [24] to support mean bitrate charging.

- Solution #1.22: reuses existing mechanisms to support mean bitrate charging.

Solutions #1.4, #1.5, #1.6, and #1.7 all solve key issue #1l.

- Solution #1.4: NF (CTF) stops service delivery if no response is received before all the quotas (between the threshold and the granted quota) have been used and discards used units in the case of termination is received.

- Solution #1.5: NF (CTF) terminates the service if no response is received before all the quotas (between the threshold and the granted quota) have been used and reports the used units in a termination request. This means that it will in some cases terminate the service even though there are funds on the account.

- Solution #1.6: NF (CTF) stops or continues service delivery if no response is received all the quotas (between the threshold and the granted quota) have been used depending on CHF indication and reports used units in the next request. This requires new functionality in both CHF and NF (CTF).

- Solution #1.7: NF (CTF) stops service delivery and waits for response when all the quotas (between the threshold and the granted quota) have been used and reports used units in the next request. This is possible even if it is not specified.

### 5.1.7 Conclusions

For key issues #1a, #1b, and #1c, solution #1.1 is recommended into normative work based on requirement.

For key issue #1d, solution #1.8 is recommended into normative work, controlling the charging information size by specifying the data limit in ChargingDataResponse.

For key issues #1e, solution #1.2 doesn’t require any new normative work.

For key issues #1f, and #1g, solutions #1.15, covering PDU sessions, and #1.19, covering exposure, could be introduced in the specification dependent on requirements.

For key issue #1h and #1i, solution #1.17 and #1.20 are recommended into normative work, using vendor specific and a reserved range to store undefined value.

For key issue #1j, solution #1.3, which requires CTF to ensure the accuracy of location, is recommended into normative work.

For key issue #1k, solution #1.22 with possible extension of #1.21 is recommended into normative work depending on requirements.

For key issue #1l, the solution #1.7 is selected for the normative work.

## 5.2 Charging request optimization

### 5.2.1 General

The number of requests from the network function to the CHF is controlled by the number events that require immediate triggering. This means that being able to have less immediate triggers will also minimize the number of requests. There is today a possibility to generate management intervention trigger immediately for events from management requiring reporting of unit usage immediately.

### 5.2.2 Use cases

#### 5.2.2.1 Use Case #2a: Operator defined trigger

An operator has set up some own defined triggers related to events generated by the network or management systems, these events does not require immediate reporting, just that the event is recorded, and the units counted before and after.

#### 5.2.2.2 Use Case #2b: Trigger handling for IEC and PEC

An operator has set up event based charging for 5G connection and mobility domain charging and wants to be able to control the applicable trigger conditions for each functionality (i.e., Registration, N2 connection, Location Reporting) during the UE registration lifetime in the AMF i.e., activate/deactivate charging for any AMF functionality.

### 5.2.3 Potential charging requirements

**REQ-CH\_REQ-01:** Possibility to support other than immediate trigger for own defined management or network triggers.

**REQ-CH\_REQ-02:** Possibility to support trigger setting for event based charging.

### 5.2.4 Key issues

**Key Issue #2a:** What trigger to use.

**Key Issue #2b:** What information to be included with the trigger, if any.

**Key Issue #2c**: Allow the CHF to set triggers for events.

### 5.2.5 Solutions

#### 5.2.5.1 Solution #2.1: Reuse of management intervention trigger

A possible solution for key issues 2a and 2b covering requirements REQ-CH\_REQ-01, charging request optimization.

There is no definition of the management intervention trigger, the only information is that it relates to a management event, it is always immediate, cannot be changed by the CHF and used to trigger an update.

Changing the management intervention trigger to allow the CHF to change the category as well as enable/disable the trigger.

#### 5.2.5.2 Solution #2.2: New operator defined trigger

A possible solution for key issues 2a and 2b covering requirements REQ-CH\_REQ-01, charging request optimization.

Introduce a new trigger e.g., "trigger extension", which then the CHF could change the category as well as enable/disable the trigger. This could be seen as a new management intervention trigger, but would allow the operator to associate it with any type of chargeable event, including management interventions.

#### 5.2.5.3 Solution #2.3: Introduce a trigger profile

A possible solution for key issues 2b and 2c covering requirement REQ-CH\_REQ-02, trigger setting for event based charging.

Introduction of charging trigger profiles in the CTFs (e.g., AMF, SMSF) that can be changed by the CHF could solve this issue. This means that the CTF would inform the CHF which charging trigger profile was used for a specific chargeable event (it could also include the trigger settings) the CHF could then update the trigger settings it would prefer.



Figure 5.2.5.3-1: Post Event Charging

**1. Request for resource usage:** A request for session establishment is received in the NF (CTF).

**2. Content/Service Delivery:** the NF (CTF) delivers the content/service, and determines which charging trigger profile to use based on internal configuration.

**3. Charging Data Request [Event, Units, Charging Trigger Profile]:** The NF (CTF) the CTF generates charging data related to the delivered service with the units used and the charging trigger profile used, and sends the request to the CHF.

**4. Account, rating and trigger control:** The CHF may rate the used units and make a deduction of the calculated amount from user's account balance. It checks the used charging trigger profile to determine if any update to the profile is required.

**5. Create CDR:** the CHF stores received information and creates a CDR related to the service.

**5) Charging Data Response [Event, Charging Trigger Profiles]:** The CHF informs the NF (CTF) on the result of the request, it may include update to one or more charging trigger profiles.

Table 5.2.5.3-1: Additions to definition of type ChargingDataRequest

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute name | Data type | P | Cardinality | Description | Applicability |
| chargingTriggerProfile | TriggerProfileInfo | OC | 0..1 | When the data type is present it is used to report the charging trigger proflie used, including the unique triggerProfileId and a list of triggers..  The "triggerProfileId" attribute within the TriggerProfileInfo data type is used as the key to the map. It uniquely identifies a chargingTriggerProfile in an MNO. |  |

Table 5.2.5.3-2: Additions to definition of type ChargingDataResponse

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute name | Data type | P | Cardinality | Description | Applicability |
| chargingTriggerProfileList | map(TriggerProfileInfo) | OC | 0..N | When the data type is present it includes the charging trigger profile information to be used for any future request.  It may have several occurencies updating several trigger profiles.  The update of any trigger profile will be valid until a new update is sent.  The "triggerProfileId" attribute within the TriggerProfileInfo data type is used as the key to the map. It uniquely identifies a chargingTriggerProfile in an MNO. |  |

### 5.2.6 Evaluation

Solutions #2.1, and #2.2 both solve key issues #2a and #2b.

- Solution #2.1: reuses the current triggers. It has already defined usage for operation management events, the usage of operation management triggers are related to management events and have no more information about why it was triggered therefore it may cause confusion as to why the trigger was considered met.

- Solution #2.2: requires introduction of a new trigger. Separate the trigger from any other types of triggers. It is not necessary to define the extension of private triggers in the standard. No more information about why it was triggered therefore it may cause confusion as to why the trigger was considered met.

Solution #2.3 solves key issue #2b and #2c.

- Solution #2.3: requires introduction of a new trigger profile, that can also solve issues for event based trigger handling. This requires both CTF and CHF maintain a unique and persistent triggerProfileId as the reference key.

### 5.2.7 Conclusions

For key issues #2a and #2b, solution #2.1 is recommended into normative work since this has the most flexibility.

For key issue #2b and #2c, solution #2.3 is recommended to be combined with the solutions for the AMF charging profile.

## 5.3 Rating input enhancement

### 5.3.1 General

A rating group is not defined in the context of SBI, it is however defined in TS 32.299 [8] as the same as the rating group of RFC 4006 [13] obsoleted by RFC 8506 [14] and linked to the charging key defined in TS 23.203 [10], the corresponding spec for SBI is TS 23.503 [3]. In TS 23.503 [3] the charging key is defined as "information used by the CHF for rating purposes".

The rating group gathers a set of services that is subject to the same cost and rates. One rating group can contain several rates if all rates are applicable to all services belonging to the rating group and if quota is granted it can be consumed by all services, belonging to the rating group, equally. How a service is identified is dependent on the network function.

This means that the cost and rates can be determined by the rating group but not the consumption rate of the quota i.e., how fast quota is used by the services belonging to the same rating group, and in the extension how much quota that should be reserved for a specific request.

### 5.3.2 Use cases

#### 5.3.2.1 Use Case #3a: Enhancement of input to CHF rating

A End User (subscriber) has subscribed to a service with multiple QoSs. The PCF dynamically decides to authorize a QoS based on the network information. When granting a quota, the CHF may need additional authorized QoS information corresponding to the Rating Group to assist CHF to grant quota per Rating Group.

As per the present document, the PDU charging information includes the default QoS information (Authorized QoS Information for PDU session and Subscribed QoS Information), which there is not the QoS information corresponding to the Rating Group.

The QoS information is an example as the input to the CHF rating. Any enhancement of input to CHF rating would be introduced case by case.

#### 5.3.2.2 Use Case #3b: Service Charging Enhancement

An End User (subscriber) subscribed to a service, once the service consumption is authorized for the End User, CHF can provide the right Rating Group to be used for service charging whilst the End User consumes it. Furthermore, this can be used for a clear improvement on the charging statistics and reporting.

As per the present document, the Charging Data Request [initial] message has the RequestedUnit Type which will be used by the CHF on the response, though the ServiceID type is not available. Service ID is only available in the UsedUnitContainer type (after initial Chargind Data Request message).

#### 5.3.2.3 Use Case #3c: Switching between online and offline

A UE has four services on going (A, B, C, and D). The NF providing the services (e.g., SMF) determines that these four services belong to three different rating groups (RGs), where service A belongs to RG 1, services B and C belongs to RG 2, and service D belongs to RG 3. It further determines that service A and B are always offline, while C and D are online, but may be set to quota management suspended.



Figure 5.3.2.3-1: Session based charging with suspend and resume of quota management.

**1 Request for resource usage:** A request for session establishment is received in the NF (CTF). The service is configured to be authorized by the CHF to start.

**2 Units Determination:** the NF (CTF)) determines the number of units depending on the service requested by the UE in "Decentralized Units determination" scenario.

**3 Charging Data Request [Initial, Quota request RG2 and RG3]:** The NF (CTF) sends the request to the CHF for the services C and D (i.e., RG 2 and 3), to be granted quota.

**4 Account, rating, and reservation control, and open CDR:** the CHF may open a CDR, rate the request, and check need for quota management. RG 2 will be granted quota while quota management will be suspended for RG 3.

**5 Charging Data Response [Initial, Quota granted RG2, Result code RG3]:** The CHF grants quota for RG 2 and gives a result code for RG 3 to indicating that quota management is suspended.

**6 Service delivery starts and is ongoing:** the NF (CTF) delivers the services.

**7 Usage Reporting Trigger:** the NF (CTF) generates charging data related to the services delivered, based on a trigger for usage reporting is met.

**8 Charging Data Request [Update, Unit used, Quota request RG2 and RG3]:** the NF (CTF) sends the request to the CHF, for quota to be granted for RG 2 and 3. It also reports the used units for services A, B, C, and D. In this case the QMI is reported for: A and B as offline, C as online, and D as suspended.

**9 Account, rating, and reservation control, and update CDR:** the CHF may update the CDR, rate the request, and check need for quota management. RG 3 will be granted quota while quota management will not be applicable for RG 2.

**10 Charging Data Response [Update, Quota granted RG3, Result code RG2]:** The CHF grants quota for RG 3 and gives a result code for RG 2 to indicating that quota management is not applicable.

**11 Service delivery is ongoing:** the NF (CTF) delivers the services.

**12 Usage Reporting Trigger:** the NF (CTF) generates charging data related to the services delivered, based on a trigger for usage reporting is met.

**13 Charging Data Request [Update, Unit used, Quota request RG3]:** the NF (CTF) sends the request to the CHF, for quota to be granted for RG 3. It also reports the used units for services A, B, C, and D. In this case the QMI is reported for: A and B as offline, C as offline, and D as online.

**14 Account, rating, and reservation control, and update CDR:** the CHF may update the CDR, rate the request, and check need for quota management. RG 3.

**15 Charging Data Response [Update, Quota granted RG3]:** The CHF grants quota for RG 3.

**14 Session released:** after some time, the session is released.

**15 Charging Data Request [Termination, Units used]:** the NF (CTF) sends the request to the CHF, for charging data related to the service termination with the final consumed units for services A, B, and D. In this case the QMI is reported for: A and B as offline, C as offline, and D as online.

**9 Account, and rating control, and close CDR:** the CHF may close the CDR, and rate the request.

**18 Charging Data Response [Termination]:** The CHF informs the NF (CTF) on the result of the request.

In this case it is unclear how the quota management indicator (QMI) is influenced by the result code sent by the CHF.

### 5.3.3 Potential charging requirements

**REQ-3GPPCH-ER-01** The 5G system should support the enhancement of input to CHF rating based on the QoS information.

**REQ-3GPPCH-ER-02** The 5G system should support the enhancement of input to CHF rating based on the Service ID information.

**REQ-3GPPCH\_ER-03:** The 5G system should support reporting QMI used for used unit.

### 5.3.4 Key issues

**Key Issue #3a:** Identification and classification of information which can be used as the input to CHF rating.

**Key Issue #3b:** Identify the Network Functions which can provide the input to support the CHF rating.

**Key Issue #3c:** Determine the interaction to support the enhancement of input to CHF rating.

**Key Issue #3d:** How QMI is influenced by the result code.

### 5.3.5 Solutions

#### 5.3.5.1 Solution #3.1: Enhancement of multiple unit usage with service identifier

A possible solution for key issues 3a, 3b, and 3c, enhancement of input to CHF rating.

Any information in the PCC rule could potentially be connected to a specific service identifier, this means that a specific QoS can be identified by the service identifier.

A solution could be to allow the service identifier in the MultipleUnitUsage as well as the rating group in the request for quota, to be able to allocate the right amount of quota needed at that moment for that rating group. The service identifier would in this case only be included as indicative i.e., which services that may be started. This means that both the service identifier(s) that triggered the request (if any) as well as the already started would be included in the request in the case of an update.

Table 5.3.5.1-1: Definition of type MultipleUnitUsage

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute name | Data type | P | Cardinality | Description | Applicability |
| ratingGroup | RatingGroup | M | 1 | The identifier of a rating group. |  |
| serviceIdList | ServiceId | OC | 0..N | This field identity of the used service |  |
|  |  |  |  |  |  |
| requestedUnit | RequestedUnit | OC | 0..1 | This field indicates, if included, that quota management is required. It may additionally contain the amount of requested service units for a particular category. |  |
| usedUnitContainer | array(UsedUnitContainer) | OC | 0..N | This field contains the amount of used non-monetary service units measured. |  |

#### 5.3.5.2 Solution #3.2: Enhancement of requested unit with service identifier

A possible solution for key issues 3a, 3b, and 3c, enhancement of input to CHF rating.

Any information in the PCC rule could potentially be connected to a specific service identifier, this means that a specific QoS can be identified by the service identifier.

A solution could be to allow the service identifier in the requested unit, to be able to allocate the right amount of quota needed at that moment for that rating group. The service identifier would in this case only be included as indicative i.e., which services that may be started. This means that both the service identifier(s) that triggered the request (if any) as well as the already started would be included in the request in the case of an update.

Table 5.3.5.2-1: Definition of type RequestedUnit

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute name | Data type | P | Cardinality | Description | Applicability |
| serviceIdList | ServiceId | OC | 0..N | This field holds the used service identifier(s) linked to the rating group for the input of rating consideration. |  |
| time | Uint32 | OC | 0..1 | This field holds the amount of requested time. |  |
| totalVolume | Uint64 | OC | 0..1 | This field holds the amount of requested volume in both uplink and downlink directions. |  |
| uplinkVolume | Uint64 | OC | 0..1 | This field holds the amount of requested volume in uplink direction. |  |
| downlinkVolume | Uint64 | OC | 0..1 | This field holds the amount of requested volume in downlink direction. |  |
| serviceSpecificUnits | Uint64 | OC | 0..1 | This field holds the amount of requested service specific units. |  |
| NOTE: f none of them is included, "RequestedUnit": {}, the category and amount is determined by CHF for online charging with centralized unit determination and rating scenario. | | | | | |

#### 5.3.5.3 Solution #3.3: The QoS information in RSU as the input for CHF rating

A possible solution for key issues 3a, 3b, and 3c, enhancement of input to CHF rating.

The possible solution supports the potential requirements **REQ-3GPPCH-ER-01** and partial supports **Key Issue #3a, #3b and #3c** to describe the enhancement of input to CHF rating.

The QoS information is the measurement of the overall performance of a service. A solution could be to allow the QoS information in the RequestedUnit as well as the rating group in the request for quota specified in the TS 32.291 [6], as the input for CHF rating consideration, to be able to assist to allocate the right amount of quota needed at that moment for that rating group.

Table 5.3.5.3-1: Definition of type RequestedUnit

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute name | Data type | P | Cardinality | Description | Applicability |
| time | Uint32 | OC | 0..1 | This field holds the amount of requested time. |  |
| totalVolume | Uint64 | OC | 0..1 | This field holds the amount of requested volume in both uplink and downlink directions. |  |
| uplinkVolume | Uint64 | OC | 0..1 | This field holds the amount of requested volume in uplink direction. |  |
| downlinkVolume | Uint64 | OC | 0..1 | This field holds the amount of requested volume in downlink direction. |  |
| serviceSpecificUnits | Uint64 | OC | 0..1 | This field holds the amount of requested service specific units. |  |
| QosInformation | QosData | OC | 0..1 | This field describes the QoS applied for the RG for the input of rating consideration. | CHFRatingInput |
| NOTE: if none of them is included, "RequestedUnit": {}, the category and amount is determined by CHF for online charging with centralized unit determination and rating scenario. | | | | | |

#### 5.3.5.4 Solution #3.4: The Additional Information in RSU as the input for CHF rating

A possible solution for key issues 3a, 3b, and 3c, enhancement of input to CHF rating.

The possible solutions support the potential requirements **REQ-3GPPCH-ER-01** and **REQ-3GPPCH-ER-02** and **Key Issue #3a, #3b and #3c** to describe the enhancement of input to CHF rating.

The QoS information is measurement of the overall performance of a service. The service identifier is the detailed identification of a service data flow. A solution could be to allow the QoS information and service id in the Additional information as well as the rating group in the request for quota specified in the TS 32.291 [6], as the input for CHF rating consideration, to be able to assist to allocate the right amount of quota needed at that moment for that rating group.

Table 5.3.5.4-1: Definition of type RequestedUnit

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute name | Data type | P | Cardinality | Description | Applicability |
| time | Uint32 | OC | 0..1 | This field holds the amount of requested time. |  |
| totalVolume | Uint64 | OC | 0..1 | This field holds the amount of requested volume in both uplink and downlink directions. |  |
| uplinkVolume | Uint64 | OC | 0..1 | This field holds the amount of requested volume in uplink direction. |  |
| downlinkVolume | Uint64 | OC | 0..1 | This field holds the amount of requested volume in downlink direction. |  |
| serviceSpecificUnits | Uint64 | OC | 0..1 | This field holds the amount of requested service specific units. |  |
| additionalInfo | AdditionalInfo | OC | 0..N | This field holds the additional information for the input of CHF rating consideration. | CHFRatingInput |
| NOTE: if none of them is included, "RequestedUnit": {}, the category and amount is determined by CHF for online charging with centralized unit determination and rating scenario. | | | | | |

Table 5.3.5.4-2: Definition of type AdditionalInfo

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute name | Data type | P | Cardinality | Description | Applicability |
| qoSInformation | QosData | OC | 0..1 | This field describes the QoS applied for the requested used unit for the input of rating consideration. |  |
| serviceId | ServiceId | OC | 0..N | This field identity of the used service linked to the rating group for the input of rating consideration. |  |

### 5.3.6 Evaluation

Solution #3.1, #3.2, #3.3, #3.4, and #3.5 all solve key issues #3a, #3b, and #3c.

- Solution #3.1: the new service id list holds the used service ids which can provide the service level information (e.g. video, email, file transfer, VoIP) which will make it easier for the CHF to allocate quota for the rating group. It reuses the current mechanism for MultipleUnitUsage and is backwards compatible. It may cause confusion as to if this is the service id for the requested units or the reported used units.

- Solution #3.2: the new service id list holds the used service ids which can provide the service level information (e.g. video, email, file transfer, VoIP) and is part of the requested units which will make it easier for the CHF to allocate quota for the rating group and is backwards compatible. It is also possible to connect the service id to the QoS.

- Solution #3.3: the new QoS information which can provide the service quality and service experience requirement information (e.g. the authorized bandwidth, latency) holds the currently applied QoS for the rating group and is part of the requested units which will make it easier for the CHF to allocate quota for different service quality requirement of the same rating group.

- Solution #3.4: the new additional information holds both the QoS information and service ids the currently applied for the rating group and is part of the requested units which will make it easier for the CHF to allocate quota for the rating group.

### 5.3.7 Conclusions

For key issues #3a, #3b and #3c, solution #3.2 is recommended into normative work, which can on a case by case be extended to also cover solution #3.4 if the service id solution is deemed insufficient.

## 5.4 Chargeable events and sessions cancelling

### 5.4.1 General

In the present document for the Nchf service there is a possibility charge before the service has been delivered i.e., IEC. This is similar to the DCCA IEC, however in Diameter there is a possibility to do a refund, something similar is missing in Nchf.

### 5.4.2 Use cases

#### 5.4.2.1 Use Case # 4a: Cancel failed event charging

The operator would like to use IEC instead of PEC to catch all service delivery events, even the ones that might be lost or not delivered. When using IEC, the charging request is sent before the service has been deliver, when the service delivery fails, the operator would like to have the possibility to cancel (e.g., by doing a refund) the previous charging request.

### 5.4.3 Potential charging requirements

**REQ-3GPPCH-ESC-01** The 5G system should support to cancelling (e.g., ref und) chargeable service delivery events.

### 5.4.4 Key issues

The following key issues are identified:

- **Key Issue #4a**: How to locate the event that should be cancelled (e.g., refund).

### 5.4.5 Solutions

#### 5.4.5.1 Solutions #4.1: Cancelling using cancel operation and charging session identifier

A possible solution for key issues 4a, covering requirements REQ-3GPPCH-ESC-01, cancelling of event would be to use the charging session identifier, see TS 32.290 [12], which corresponded to ChargingDataRef, TS 32.291 [6]. When a resource is created in the CHF the NF (CTF) will always receive a ChargingDataRef. This ChargingDataRef can be put in a new attribute (e.g., requestToCancel), and used in a new service operation (e.g., cancel) to cancel any previously created resources. After received the new service operation request, the CHF performs the cancel operation, how this is performed will be operator dependent. If CHF cannot handle the cancel request, it will respond and results to indicate the cancel unsuccessfully.



Figure 5.4.5.1-1 Message flow of new service operation (e.g., cancel)

#### 5.4.5.2 Solutions #4.2: Cancelling using a reference identifier for Charging Event

A possible solution for key issues 4a, covering requirements **REQ-3GPPCH-ESC-01**, cancelling of event would be to add a reference identifier (e.g. refundInformation) in Charging Data Response of Nchf\_ConvergedCharging\_Create operation -> multipleUnitInformation for IEC, which can later be sent back in Charging Data Request of Nchf\_ConvergedCharging\_Release operation -> multipleUnitUsage, to identify the event to be cancelled or refunded.



Figure 5.4.5.2-1 Message flow of the Refund for IEC

#### 5.4.5.3 Solutions #4.3: Cancelling CREATE operation and cancal event type and charging session identifier

A possible solution for key issues 4a, covering requirements REQ-3GPPCH-ESC-01, cancelling of event would be to use the charging session identifier, see TS 32.290 [12], which corresponded to ChargingDataRef, TS 32.291 [6]. When a resource is created in the CHF the NF (CTF) will always receive a ChargingDataRef. This ChargingDataRef can be put in a new attribute (e.g., requestToCancel), and used in a new one-time event type (e.g., CANCEL) to cancel any previously created resources. If the ChargingDataRef uniqueness cannot be guaranteed it can be used together with charging id. After received the new service operation request, the CHF performs the cancel operation, how this is performed will be operator dependent. If CHF cannot handle the cancel request it will respond and indicate the cancel unsuccessfully.



Figure 5.4.5.3-1 Message flow of new service operation (e.g., cancel)

The table 5.4.5.3-1 contain additional attributes of the type ChargingDataRequest defined in TS 32.291 [6] clause 6.1.6.2.1.1 for cancel.

Table 5.4.5.3-1: Cancel specified attribute of type ChargingDataRequest

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute name | Data type | P | Cardinality | Description | Applicability |
| requestToCancel | string | OC | 0..1 | This field holds the ChargingDataRef of the event that is to be cancelled. (see NOTE 1) | CANCEL |

NOTE 1: If the value of EventType is CANCEL, the attribute “requestToCancel” must be included in the ChargingDataRequest.

The table 5.4.5.3-2 contains additional values to the EventType for cancel.

**Table 5.4.5.3-2: Enumeration EventType**

|  |  |  |
| --- | --- | --- |
| **Enumeration value** | **Description** | **Applicability** |
| IEC | This value is used to indicate immediate event charging. |  |
| PEC | This value is used to indicate post event charging. |  |
| CANCEL | This value is used to indicate a cancel event | CANCEL |

### 5.4.6 Evaluation

Solutions #4.1, #4.2 and #4.3 solve key issue #4a.

- Solution #4.1: requires an extension to current service operation with a specific service operation (i.e., Nchf\_ConvergedCharging\_Cancel) and uses the current Event type and chargingDataRef. The allocation of ChargingDataRef should be unique to void duplication, otherwise, it may cause an error. The ChargingDataRef can not be recycled for until a cancel is no longer allowed for a charging session or event.

- Solution #4.2: reuses the current event with specific information to determine refund, making the refund implicitly defined. Using a Nchf\_ConvergedCharging Release service operation for events to support carry the previous refundInformation in the case of a cancel, in essence making the event into a session. The negotiation is completed based on the charging data response, if the refundinformation is included in the Charging Data Response, the CHF support the event cancelling.

- Solution #4.3: requires an extension to current service operation with a specific service operation (i.e., Nchf\_ConvergedCharging\_Cancel). Requires an extension to current event type with a specific event type (i.e., Cancel). Uses the current chargingDataRef in a new attribute, charging id or both, the use of both makes it easier to find the Charging Data Request that is to be cancelled.

### 5.4.7 Conclusions

For key issue #4a, solution #4.3 is recommended into normative work.

## 5.5 Non-blocking mechanism enhancement

### 5.5.1 General

The non-blocking mode scenario is introduced for the 5G charging in clause 5.3.2 Charging scenarios of TS 32.290 [12]. The Converged Charging service offers charging with quota management, including the support for both blocking mode and non-blocking mode. The non-blocking charging mode allow the service delivery before sending the request to the CHF for the service to be granted authorization to start. In TS 23.503 [3], the "Service Data flow handling while requesting credit" in clause 6.3 Policy and charging control rule is introduced for indicating whether the service data flow is allowed to start while the SMF is waiting for the response to the credit request (Values: blocking or non-blocking).

In the TS 23.501 [9], when the PCC Rule attribute Service Data flow handling while requesting credit indicates "non-blocking", the SMF requests the report of the relevant usage information for the Charging key and Sponsor Identity (if applicable) and provide a default threshold value to the UPF while waiting for the quota from the CHF.

### 5.5.2 Use cases

#### 5.5.2.1 Use Case # 5a: CHF failed to grant quota

When end user accesses the services and the non-blocking mode is active based on the PCC rule, the quota is not granted from the CHF before the service delivery. The CHF may not grant quota for the service delivery after service delivery have started in e.g., the following cases:

* the end-user service restrictions or limitations;
* the end user's account could not cover the requested service delivery;
* CHF denies the service request for other reasons; etc.

The service delivery will be started and then stopped because of the service start is beyond the control of the CHF.

To avoid the UE frequently initiates service requests and start of service delivery affecting the user's experience, in this case, the non-blocking mode could be disabled temporarily based on the information of CHF and resumed later.

### 5.5.3 Potential charging requirements

**REQ-3GPPCH-NB-01** The 5G system should support to disable temporarily the non-blocking mode.

**REQ-3GPPCH-NB-02** The 5G system should support to resume the non-blocking mode.

### 5.5.4 The key issues

The following key issues are identified:

- **Key Issue #5a**: Non-blocking mode disable/enable affect only specific rating group or all rating groups for a UE.

- **Key Issue #5b**: Identify the Network Functions to disable/enable non-blocking mode.

- **Key Issue #5c**: Determine of the interactions required to disable/enable non-blocking mode for the special user/service.

- **Key Issue #5d**: Determine if non-blocking mode is possible for a rating group.

### 5.5.5 Solutions

#### 5.5.5.1 Solution #5.1: Dedicated non-blocking indicator at service start

The possible solution partially supports the potential requirements **REQ-3GPPCH-NB-01, REQ-3GPPCH-NB-02** and **Key Issue #5d** for the non-blocking mode reporting to CHF.



Figure 5.5.5.1-1: Message flow for dedicated non-blocking indicator

1. PCF sends the PCC rules to SMF with the "Service Data flow handling while requesting credit" to indicate SMF the Non-Blocking mode is adapted.

2. The service data flow are allowed to start while the SMF is waiting for the response to the quota request.

3. SMF sends the Charging Data Request to CHF for the quota request with the non-blocking mode indication when detect the non-blocking mode is usage for the service data flow.

The charging reporting from the SMF with the Non-blocking mode is per Rating Group. After the PDU session establishment, when any service date flow delivery with the non-blocking mode in the RG is detected (may be the first service data flow of the PDU session or the subsequent service data flows of the PDU session), the SMF should immediately report to the CHF with the non-blocking mode indication in the Charging Data Request [Initial] for first service data flow or in the Charging Data Request [Update] for the subsequent service data flow when detected with the non-blocking mode.

#### 5.5.5.2 Solution #5.2: The non-blocking mode change from CHF to SMF

The possible solution supports the potential requirements **REQ-3GPPCH-NB-01, REQ-3GPPCH-NB-02** and **Key Issue #5a, Key Issue #5b, Key Issue #5c** to describe the non-blocking mode change from CHF enhances or extends the Nchf\_Convergedcharging defined in TS 32.255 [3] and SMF operation.



Figure 5.5.5.2-1: Message flow for Non-blocking Change on SMF

1-3. The same steps description with the Figure 5.5.5.1-1.

4. When received the Charging Data Request and Non-Blocking mode, CHF determines to change the Non-Blocking mode based on the user information (e.g. Account Balance and account status) in the charging system. CHF sends the Charging Data Response with the Non-Blocking mode change.

The CHF can change the Non-blocking mode when received the Charging Data Request with the NB mode indication or change it in the any Charging Data Response spontaneously.

The CHF can change the NB mode per UE, per RG or per Service Id.

5. The CHF sends the non-blocking mode in the Charging Data Response to SMF. SMF has the PCC rule about the "service data flow handling while requesting credit" previously and the non-blocking mode change from CHF subsequently, For the subsequent service data flows with the same RG in the PDU session, the SMF will perform the setting from CHF with blocking mode.

The CHF can change the NB mode per UE, per RG, per Service Identifier.

The non-blocking mode set by CHF is only active during the PDU session, When the PDU session is terminated, the non-blocking mode setting by the CHF is inactive. For next PDU session establishment, the SMF will perform the PCC rules from PCF.

#### 5.5.5.3 Solution #5.3: The non-blocking mode change from CHF to PCF via SMF

The possible solutions to support the potential requirements **REQ-3GPPCH-NB-01, REQ-3GPPCH-NB-02** and **Key Issue #5a, Key Issue #5b, Key Issue #5c** could be the following enhancements or extensions to the Nchf\_Convergedcharging defined in TS 32.255 [3] and the interaction between PCF and SMF.



Figure 5.5.5.3-1: Message flow for Non-blocking Change on PCF via SMF

1-4. The same steps description with the Figure 5.5.5.3-1.

5. The CHF sends the non-blocking mode in the charging data response to SMF

6. The SMF transfers the non-blocking mode change to the PCF in the PDU session. The PCF will set the new PCC rules for the "service data flow handling while requesting credit" to SMF.

The CHF can change the NB mode per UE, per RG, per Service Identifier.

When the PDU session is terminated, the PCF still adapts the updated non-blocking mode considering the feedback from CHF.

#### 5.5.5.4 Solution #5.4: The non-blocking mode change per UE from CHF to PCF

The possible solutions to support the potential requirements **REQ-3GPPCH-NB-01, REQ-3GPPCH-NB-02** and **Key Issue #5a, Key Issue #5b, Key Issue #5c** about change the non-blocking mode per UE could be the following enhancements or extensions to the Nchf\_SpendingLimitControldefined in TS 23.503 [3].



Figure 5.5.5.4-1: Message flow for Non-blocking Mode Change on PCF from CHF

0. The CHF subscribes the policy counter status information relating to subscriber spending limits.

1-4. The same steps description with the Figure 5.5.5.1-1.

5. The CHF sent the non-blocking mode change in the spending limit control service to PCF via the Policycounterstatus. According to the TS 23.503 [3] and TS 29.594 [11], The policy counter status is per UE. the policy counter status is a label whose values are not standardized and that is associated with a policy counter's value relative to the spending limit(s) (the number of possible policy counter status values for a policy counter is one greater than the number of thresholds associated with that policy counter, i.e. policy counter status values describe the status around the thresholds). This is used to convey information relating to subscriber spending from CHF to PCF. Specific labels are configured jointly in CHF and PCF.

The specific labels is the non-blocking mode. Configure the special policy counter per UE for the Non-blocking mode, if CHF determines to change the Non-blocking mode (i.e. Enable/disable) for any service data flow, the CHF notifies the PCF to change the policy counter status for UE.

The CHF can change the NB mode per UE.

When the PDU session is terminated, the PCF still adapts the updated non-blocking mode considering the feedback from CHF.

#### 5.5.5.5 Solution #5.5: Dedicated non-blocking indicator before service start

The possible solution partially supports the potential requirements **REQ-3GPPCH-NB-01, REQ-3GPPCH-NB-02** and **Key Issue #5d** for the non-blocking mode reporting to CHF.



Figure 5.5.5.5-1: Message flow for dedicated non-blocking indicator

1. PCF sends the PCC rules to SMF with the sdfHandl set to true, indicating that the service data flow is allowed to start while the SMF is waiting for the response to the credit request i.e., non-blocking mode.

2. SMF sends the Charging Data Request to CHF for the quota request with a non-blocking indication for the rating group with the sdfHandl set to true.

3. The service data flow is allowed to start while the SMF is waiting for the response to the quota request.

The non-blocking charging reporting from the SMF is per rating group. After the PDU session establishment, when any service date flow delivery for a rating group with non-blocking (can be the first or the subsequent service data flows of the PDU session), the SMF should immediately report to the CHF with the non-blocking indication in the Charging Data Request [Initial] if it is the first service data flow or in the Charging Data Request [Update] for the subsequent service data flow.

#### 5.5.5.6 Solution #5.6: The Non-blocking mode change using policy counters from CHF to PCF

A possible solution to support the potential requirements **REQ-3GPPCH-NB-01, REQ-3GPPCH-NB-02** and **Key Issue #5a, Key Issue #5b, Key Issue #5c** reuses the policy and charging control framework defined in TS 23.503 [3], TS 29.513 [15], TS 29.594 [16].

The PCF is configured with PCC Rules that include information for service data flow detection and charging information. The charging information includes Charging Key, Charging method, and Service Data flow handling while requesting credit (see TS 23.503 [3] table 6.3.1).

The CHF is configured with Rating Groups (corresponding to Charging Key) and policy counter information which includes Policy counter identifiers and statuses.

The PCF will use the Nchf\_SpendingLimitControl\_Subscribe for a specific SUPI to retrieve the initial status of the policy counters. Based on these statues, and their configured relationship with the charging keys if any, it may select PCC Rules or even update PCC Rules. It would then provide these to the SMF if requested.

The CHF will, based on Nchf\_ ConvergedCharging requests and account balance changes, check if the status of the policy counters should be updated, if the statuses is changed it will use the Nchf\_SpendingLimitControl\_Notify to send the new status to the PCF, if the PCF have a subscription for the counters.

One policy counter identifier may be connected to one or more Rating Groups in the CHF, this connection is preferably mirrored in the PCF i.e., the policy counter identifier is relevant for one or more Charging Keys. The Charging Keys/Rating Groups, Policy Counter Identifiers, and Policy Counter Statuses need to be synchronized between the PCF and CHF. Since if any of these have different meanings in the PCF and CHF it will lead to issues e.g., if a Charging Key is defined in PCF but there is no rating for the Rating Group this will lead to faulty charging the same is applicable to the Policy counter identifiers and statuses which may lead to faulty PCC Rules being applied.

This means that the PCF can based on the policy counter status set the Service Data flow handling while requesting credit to either blocking or non-blocking in the PCC Rule applicable to a specific Charging Key. The CHF can have policy counter applicable to one or more Rating Groups, and the status can be based on the account balance status e.g., the account balance is near to the limit for a Rating Group.

### 5.5.6 Evaluation

Solution #5.2, #5.3, #5.4 and #5.6 all solve key issue #5a, #5b and #5c.

- Solution #5.2: allows the CHF to directly control the non-blocking mode, by introducing an attribute. This means that both PCF and CHF will control the non-blocking mode. The change of non-blocking mode can be per service data flow or per RG. The Validity Period of non-blocking mode change from CHF is per PDU session. When the new PDU session is established, the non-blocking mode will reuse the PCC rule from PCF which is not able to know the change from the CHF.

- Solution #5.3: allows the CHF to indirectly control the non-blocking mode, by using the current policy counters. This means that only PCF will control the non-blocking mode, with input from CHF. The change of non-blocking mode can be per service data flow or per RG. The PCF can be able to know the change of non-blocking mode from the CHF dynamically.

- Solution #5.4: the granularity of the control of non-blocking mode is per UE, not for special service data flow or per RG. The new type of Nchf\_ SpendlingLimitControl service for spending limit should be supported. the controlling on the non-blocking mode need to add the new value of currentStatus to present that the non-blocking mode is the changing value (disable or enable) which is not specified in the standard.

- Solution #5.6: reuses the current mechanism and by that the start of the service delivery does not need to wait the Charging Data Response from CHF. Keep alignment with the common service flow about non-blocking specified in the TS 32.290 [12]. No impact on the charging data request. A policy counter for spending limit may be connected to one or more Rating Groups in the CHF to support the control of non-blocking mode per service data flow or per RG. If control of the non-blocking mode from CHF is required a specific value of currentStatus to present the non-blocking mode is required. The currentStatus values is currently not specified. The CHF cannot be aware of the non-blocking mode, CHF provides the notification about the policy counter status for the PCF, which controls the non-blocking policy.

Solution #5.1and #5.5 both solve key issue #5d.

- Solution #5.1: keeps alignment with the Figure 5.3.2.3.2: SCUR - Session based charging with Decentralized and Centralized Unit Determination, Centralized Rating, immediate start of service delivery (non-blocking mode) specified in TS 32.290 [12], before sent the charging data request, the service delivery starts. A new indication is added in the charging data request. CHF may instruct to stop the service delivery based on the non-blocking mode awareness, not only for the disable/enable the non-blocking mode.

- Solution #5.5: the start of the service delivery does not need to wait the Charging Data Response from CHF. Keep alignment with the common service flow about non-blocking specified in the TS 32.290 [12]. Needs to be combined with solution #5.1. New indication should be added in the charging data request. CHF may instruct to stop the service delivery based on the non-blocking mode awareness, not only for the disable/enable the non-blocking mode.

### 5.5.7 Conclusions

For key issues #5a, #5b and #5c, solution #5.6 with possible extension of #5.1 solution could be taken into normative work based requirements.

For key issue #5d, solution #5.6 doesn’t require any support, and solution #5.4 is outside the current scope of SA5.

# 6 Documentation improvements

## 6.1 General

The charging management documentation is today organized according to TS 32.240 [5] with a set of domain/subsystem/service specific TSs covers the domains (CS, PS, 5GS), subsystem (IMS) and service (SMS, MMTel etc.) levels, respectively, in the TS 32.25x, TS 32.26x and TS 32.27x TS number ranges. Network Slicing is covered under TS 28-series. These TSs describe the mapping of the common architecture specified onto the specific domain/subsystem/service as well as the scenarios and information for converged charging that are specific to the domain/subsystem/service. They are commonly referred to as the middle tier charging TSs.

A set of TSs in the TS 32.28x range covers common services, such as the Announcement service.

A set of TSs in the TS 32.29x range covers common aspects, such as CDR parameter and syntax descriptions, converged charging applications, and the charging interactions between the network and the Billing Domain (CDR file transfer).

The complete document structure for these TSs is outlined in the following figure 6.1-1:



Figure 6.1-1: Charging specifications structure

This means that all information elements are first specified in the middle tier charging TSs and then converted into the OpenAPI in TS 32.291 [6], ASN.1 in TS 32.298 [7] and Diameter in TS 32.299 [8]. In some case there are mapping between the middle tier charging TSs information element and one or more of the protocols.

## 6.2 Use cases

### 6.2.1 Use Case # 6a: The binding description

Currently the Information Elements are described in the 5G service charging specifications (e.g., TS 32.254 [17], TS 32.255 [2], and TS 32.256 [18]), the CDR parameters in TS 32.298 [7] (ASN.1), and the resource attributes in the TS 32.291 [6] (OpenAPI). 3GPP The TS 32.291 [6] clause 7 "Bindings of CDR field, Information Element and Resource Attribute" contains the binding between the Information Element, Resource Attribute and CDR fields for 5G charging.

The Information Elements, CDR Fields and Resource Attributes are specified in the TS 32.291 [6] clause 7.

The CDR parameters (ASN.1) are specified in theTS 32.298 [7].

The data model and yaml are specified in the TS 32.291 [6].

This means that the link between 5G service charging specifications, CDR and OpenAPI is unclear.

### 6.2.2 Use Case # 6b: The simplification of CDR records

The TS 32.298 [7] provide the charging data record (CDR) parameters for GPRS charging, EPC charging and 5G charging, this means that it includes generic bearer level, subsystem level and CHF level CDR parameters.

The CHF CDR will contain service and the subsystem level CDR parameters in the same record type, and should be considered for optimization.

### 6.2.3 Use Case # 6c: Common IEs applied in the service charging specifications

TS 32.290 [12] clause 7 "Message contents" specifies the common information element structure specified. The 5G services charging specifications (e.g., TS 32.254 [17], TS 32.255 [2], and TS 32.256 [18]), references to the common information elements and provide the information about how these common information element are used and might extend or limit the use of these. The way these are reference and updated are today handled differently in the different 5G services charging specifications.

## 6.3 Key issues

**Key Issue #6a**: clarify the binding for the CDR fields, CDR parameter, Information Elements and Resource Attributes

**Key Issue #6b**: optimize the CHF CDR representation.

**Key Issue #6c**: how to reference to the common information elements in the 5G service charging specifications

## 6.4 Solutions

### 6.4.1 Solution #6.1: Binding in stage2 documents

A possible solution for key issues 6a, clarification of binding.

Currently the Information Elements are described in the 5G service charging specifications (e.g., TS 32.254 [17], TS 32.255 [2], and TS 32.256 [18]), the CDR parameters in TS 32.298 [7] (ASN.1), and the Nchf attributes in the TS 32.291 [6] (OpenAPI).

5G service charging specifications could provide binding between Information Elements, and both CDR parameters (ASN.1) and Nchf attributes and removing the binding from TS 32.291 [6].

### 6.4.2 Solution #6.2: Binding in TS 32.298

A possible solution for key issues 6a, clarification of binding.

The TS 32.298 [7] provides binding between Information Elements, and CDR parameters (ASN.1).

### 6.4.3 Solution #6.3: Binding in TS 32.291 and TS 32.298

A possible solution for key issues 6a, organization of OpenAPI and ASN.1.

Currently the Information Elements are described in the 5G service charging specifications (e.g., TS 32.254 [17], TS 32.255 [2], and TS 32.256 [18]) and the CDR parameters in TS 32.298 [7] (ASN.1), the Nchf attributes in the TS 32.291 [6] (OpenAPI).

The TS 32.298 [7] could provide binding between Information Elements and the CDR parameters (ASN.1), while the TS 32.291 [6] could provide binding between Information Elements and Nchf attributes (OpenAPI).

### 6.4.4 Solution #6.4: Separate the CHF CDR record in new TS

A possible solution for key issues 6c, optimizing CHF CDR representation.

Separate the CHF CDR in TS 32.298 [7] into a new TS (e.g., TS 32.298-01 or new 32-series number), with a new top level structure for the ASN.1. The top level will be defined in work item.

### 6.4.5 Solution #6.5: Complete the Common IE applied

A possible solution for key issue #6c.

In the service charging specifications, it copies all the common IEs specified in TS 32.290 [57] and describes whether to use (Described in TS 32.290 [57]) or not use (This field is not applicable.) in the service charging.

Table 6.4.5-1: Message content structure

| **Information Element** | **Converged Charging**  **Category** | **Offline Only Charging Category** | **Description** |
| --- | --- | --- | --- |
| Session Identifier | OC | OC | Described in TS 32.290 [57]. |
| Subscriber Identifier | OM | OM | Described in TS 32.290 [57]. |
| NF Consumer Identification | M | M | Described in TS 32.290 [57]. |
| NF Functionality | M | M | Described in TS 32.290 [57]. |
| NF Name | OC | OC | This field is not applicable. |
| NF Address | OC | OC | This field is not applicable. |
| NF PLMN ID | OC | OC | Described in TS 32.290 [57]. |
| Charging Identifier | OM | - | Described in TS 32.290 [57]. |
| Invocation Timestamp | M | M | Described in TS 32.290 [57]. |
| Invocation Sequence Number | M | M | Described in TS 32.290 [57]. |
| Retransmission Indicator | OC | OC | Described in TS 32.290 [57]. |
| One-time Event | OC | - | Described in TS 32.290 [57]. |
| One-time Event Type | OC | - | Described in TS 32.290 [57]. |
| Notify URI | OC | - | Described in TS 32.290 [57]. |
| Supported Features | OC | - | Described in TS 32.290 [57]. |
| Service Specification Information | OC | - | Described in TS 32.290 [57]. |
| Triggers | OC | OC | Described in TS 32.290 [57]. |
| Multiple Unit Usage | - | - | Described in TS 32.290 [57] |
| Rating Group | - | - | Described in TS 32.290 [57] |
| Requested Unit | - | - | This field is not applicable. |
| Time | - | - | This field is not applicable. |
| Total Volume | - | - | This field is not applicable. |
| Uplink Volume | - | - | This field is not applicable. |
| Downlink Volume | - | - | This field is not applicable. |
| Service Specific Units | - | - | This field is not applicable. |
| Used Unit Container | - | - | Described in TS 32.290 [57] |
| Service Identifier | - | - | Described in TS 32.290 [57] |
| Quota management Indicator | - | - | Described in TS 32.290 [57] |
| Triggers | - | - | Described in TS 32.290 [57] |
| Trigger Timestamp | - | - | Described in TS 32.290 [57] |
| Time | - | - | Described in TS 32.290 [57] |
| Total Volume | - | - | Described in TS 32.290 [57] |
| Uplink Volume | - | - | Described in TS 32.290 [57] |
| Downlink Volume | - | - | Described in TS 32.290 [57] |
| Service Specific Unit | - | - | Described in TS 32.290 [57] |
| Event Time Stamps | - | - | Described in TS 32.290 [57] |
| Local Sequence Number | - | - | Described in TS 32.290 [57] |

For example, expands all the sub-IEs in the second Layer and third layer which are used for the service charging.

Add the general principle in to the TS 32.290 [57] clause 7.

### 6.4.6 Solution #6.6: Partial the Common IE applied

A possible solution for key issue #6c.

In the service charging specifications, only expand the required layers of common IEs and describe whether to use (Described in TS 32.290 [57]) or not use (This field is not applicable.) in the service charging.

Table 6.4.6-1: Message content structure

| **Information Element** | **Converged Charging**  **Category** | **Offline Only Charging Category** | **Description** |
| --- | --- | --- | --- |
| Session Identifier | OC | OC | Described in TS 32.290 [57]. |
| Subscriber Identifier | OM | OM | Described in TS 32.290 [57]. |
| NF Consumer Identification | M | M | Described in TS 32.290 [57]. |
| NF Functionality | M | M | Described in TS 32.290 [57]. |
| NF Name | OC | OC | This field is not applicable. |
| NF Address | OC | OC | This field is not applicable. |
| NF PLMN ID | OC | OC | Described in TS 32.290 [57]. |
| Charging Identifier | OM | - | Described in TS 32.290 [57]. |
| Invocation Timestamp | M | M | Described in TS 32.290 [57]. |
| Invocation Sequence Number | M | M | Described in TS 32.290 [57]. |
| Retransmission Indicator | OC | OC | Described in TS 32.290 [57]. |
| One-time Event | OC | - | Described in TS 32.290 [57]. |
| One-time Event Type | OC | - | Described in TS 32.290 [57]. |
| Notify URI | OC | - | Described in TS 32.290 [57]. |
| Supported Features | OC | - | Described in TS 32.290 [57]. |
| Service Specification Information | OC | - | Described in TS 32.290 [57]. |
| Triggers | OC | OC | Described in TS 32.290 [57]. |
| Multiple Unit Usage | - | - | Described in TS 32.290 [57] |
| Rating Group | - | - | Described in TS 32.290 [57] |
| Requested Unit | - | - | This field is not applicable. |
| Used Unit Container | - | - | Described in TS 32.290 [57] |
| XXX | - | - | This field indicated the special service. |

If all the sub-IEs compared to the upper level are the same (i.e. This field is not applicable or Described in TS 32.290 [57]) for the service charging, only show and refer to the upper level

- Take the "Requested Unit" as the example, the sub-IEs (i.e. time, totalVolume, uplinkVolume, downlinkVolume and serviceSpecificUnits) are not applicable. In the table, only "Requested Unit" is described "This field is not applicable", without expand and show the sub-IEs, please see Table 6.4.6-1: Message content structure.

If partial sub-IEs compared to the upper level is different (even, only one sub-IEs), expand the upper layer, show and refer to the all sub-IEs and upper level.

- Take the "Requested Unit" as the example, the sub-IEs (i.e. totalVolume, uplinkVolume, downlinkVolume and serviceSpecificUnits) are not applicable and the sub-IEs (i.e. time) refer to the TS 32.290 [57]. In the table, the"Requested Unit" includes all the sub-IEs should be described.

Table 6.4.6-2: Example of Requested Unit

|  |  |  |  |
| --- | --- | --- | --- |
| Requested Unit | OC | OC | Described in TS 32.290 [57]. |
| Time | OC | OC | Described in TS 32.290 [57]. |
| Total Volume | - | - | This field is not applicable. |
| Uplink Volume | - | - | This field is not applicable. |
| Downlink Volume | - | - | This field is not applicable. |
| Service Specific Units | - | - | This field is not applicable. |

If special sub-IEs for the service charging should be added in the upper layer and partial sub-IEs compared to the upper level is different, refer to the upper layer with the need to expand the upper layer.

- Take the "Requested Unit" as the example, the new sub-IEs (i.e. New xxx) are added and the all the sub-IEs are showed in the table to present its own description.

Table 6.4.6-4: Example of Requested Unit for addition

|  |  |  |  |
| --- | --- | --- | --- |
| Requested Unit | OC | OC | Described in TS 32.290 [57]. |
| Time | OC | OC | Described in TS 32.290 [57]. |
| Total Volume | - | - | This field is not applicable. |
| Uplink Volume | - | - | This field is not applicable. |
| Downlink Volume | - | - | This field is not applicable. |
| Service Specific Units | - | - | This field is not applicable. |
| New xxx | OC | OC | This field is used for the ….. |

### 6.4.7 Solution #6.7: Binding in TS 32.291

A possible solution for key issues 6a, clarification of binding.

The TS 32.291 [6] provides binding between Information Elements, and both CDR parameters (ASN.1) and Nchf attributes. The use of CDR filed would be discontinued.

### 6.4.8 Solution #6.8: Binding in new TS

A possible solution for key issues 6a, clarification of binding.

Introduce a new TS only handling binding of the Information Elements to any other parameter, attribute, or field.

### 6.4.9 Solution #6.9: Separate the CHF CDR record in TS 32.298

A possible solution for key issues 6c, optimizing CHF CDR representation.

Separate the CHF CDR information belonging to different 5G service charging specifications (e.g., TS 32.254 [17], TS 32.255 [2], and TS 32.256 [18]) into their own sections in TS 32.298 [7] e.g., PDU Session Charging Information could be in clause 5.2.5.2.2 in clause 5.2.5.2 “CHF CDRs”.

### 6.4.10 Solution #6.10: Only Applicable Common IEs

A possible solution for key issue #6c.

Only the common IEs specified in TS 32.290 [57] which are applicable to this particular service charging TS are present the service charging specification table. The full sub-IEs layers are expanded to include the applicable sub-IEs.The table 6.4.10-1 is an example based on Table 6.4.5-1 applied with this solution:

Table 6.4.10-1: Message content structure

| **Information Element** | **Converged Charging**  **Category** | **Description** |
| --- | --- | --- |
| Session Identifier | OC | Described in TS 32.290 [57]. |
| Subscriber Identifier | OM | Described in TS 32.290 [57]. |
| NF Consumer Identification | M | Described in TS 32.290 [57]. |
| NF Functionality | M | Described in TS 32.290 [57]. |
| NF Name | OC | This field is not applicable. |
| NF Address | OC | This field is not applicable. |
| NF PLMN ID | OC | Described in TS 32.290 [57]. |
| Charging Identifier | OM | Described in TS 32.290 [57]. |
| Invocation Timestamp | M | Described in TS 32.290 [57]. |
| Invocation Sequence Number | M | Described in TS 32.290 [57]. |
| Retransmission Indicator | OC | Described in TS 32.290 [57]. |
| One-time Event | OC | Described in TS 32.290 [57]. |
| One-time Event Type | OC | Described in TS 32.290 [57]. |
| Notify URI | OC | Described in TS 32.290 [57]. |
| Supported Features | OC | Described in TS 32.290 [57]. |
| Service Specification Information | OC | Described in TS 32.290 [57]. |
| Triggers | OC | Described in TS 32.290 [57]. |

The table 6.4.10-2 is an example based on Table 6.4.6-2 applied with this solution:

Table 6.4.10-2: Requested Unit with only "Time" applicable

|  |  |  |
| --- | --- | --- |
| Requested Unit | OC | Described in TS 32.290 [57]. |
| Time | Oc | Described in TS 32.290 [57]. |

The table 6.4.10-3 is similar to Table 6.4.6-4 with a new common IE applicable to the service-specific TS, applied with this solution:

Table 6.4.x-2: Requested Unit with addition

|  |  |  |  |
| --- | --- | --- | --- |
| Requested Unit | OC | OC | Described in TS 32.290 [57]. |
| Time | OC | OC | Described in TS 32.290 [57]. |
| New xxx | OC | OC | This field is used for the ….. |

## 6.5 Evaluation

Solution #6.1, #6.2, #6.3, #6.7, and #6.8 all solve the key issue #6a:

- Solution #6.1: adds the binding of the information to the stage 2 specifications and removing it from TS 32.291.

- Solution #6.2: adds the binding of the CDR information to the TS 32.298.

- Solution #6.3: adds the binding of the CDR information to the TS 32.298 and keeping it in TS 32.291, like solution #6.2.

- Solution #6.7: requires enhancement to TS 32.291, by providing the binding between information elements, and both CDR parameters in ASN.1 and Nchf attributes in OpenAPI and removing the use of CDR field.

- Solution #6.8: introduce a new TS to present the binding of information elements to any other parameter, attribute or field.

Solution #6.4 and #6.9 solves the key issue #6b:

- Solution #6.4: introduces a new TS for the CHF CDR information.

- Solution #6.9 requires enhancement to TS 32.298, by providing sub-clauses for each 5G service level CDR information under the clause of CHF CDRs.

Solution #6.5, #6.6 and #6.10 solve the key issue #6c:

- Solution #6.5: propose the complete the common IE which specified in the TS 32.290 is applied in all service specifications. This will allow to clearly describe which IE is used or not used, as well as which IE is added for the special service. Requires that all service TSs must be updated if there is a change to any IEs in TS 32.290

- Solution #6.6: only top-level the common IE, specified in the TS 32.290, is repeated in all service specifications. This requires rules for which IEs to add or not and it cannot clearly describe which IE is used or not used, as well as which IE is added for the special service. Requires that all service TSs must updated only if there is a change on the only top-level IEs TS 32.290 is updated.

- Solution #6.x: in each service TS, only common IEs specified in the TS 32.290 which are applicable are present in the service TS table. Only service TSs impacted by change to IEs in TS 32.290 (i.e., new common IEs or removed common IEs which are applicable to the service) are affected.

## 6.6 Conclusion

For key issue #6a, solution #6.3 is recommended into normative work, it has the least impact while still showing the mapping to ASN.1.

For key issue #6b, solution #6.4 is recommended into normative work, if there is a requirement to do a major change in the ASN.1 for other reasons then solution #6.9 should be considered.

For key issue #6c, solution#6.x is recommended for normative work, with the clarification in TS 32.290 [12] "only common IEs which are applicable to the service middle tier TSs are present in the definition of Charging Data Request message contents of the middle tier TSs. Common IEs not present in this definition imply they are not applicable to the middle tier TS."

# 7 Conclusions and recommendations

At this time it is not recommended to introduce any of the conclusions outside the requirement from charging for a specific service i.e., the conclusions should only be used when action taken for other reason. The conclusions may be re-evaluated based on the specific service requirements.

Annex A (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2021-09 | SA5#138e | S5-214430 |  |  |  | Initial skeleton (v0.0.0) of TR 28.826 | 0.0.0 |
| 2021-10 | SA5#139e | S5-215241 |  |  |  | Study document structure | 0.1.0 |
| S5-215469 |  |  |  | Addition of introduction and scope |
| S5-215470 |  |  |  | Addition of overview |
| S5-215590 |  |  |  | Add the topic for Non-blocking Mode Enhancement |
| S5-215591 |  |  |  | Add the topic for Enhancement of input to CHF Rating |
| 2021-11 | SA5#140e | S5-216523 |  |  |  | Use case trigger without usage | 0.2.0 |
| S5-216525 |  |  |  | Use case size of charging information |
| 2022-02 | SA5#141e | S5-221120 |  |  |  | Update the References | 0.3.0 |
| S5-221682 |  |  |  | Restructuring clauses 5.3 to 5.5 |
| S5-221726 |  |  |  | Adding use case for operator defined trigger |
| S5-221736 |  |  |  | Adding use case for cancel failed event |
| 2022-04 | SA5#142e | S5-222450 |  |  |  | Adding general clause for documentation | 0.4.0 |
| S5-222773 |  |  |  | Add the solution for NB Enhancement |
| 2022-05 | SA5#143e | S5-223700 |  |  |  | Adding trigger solutions to clause 5.2 | 0.5.0 |
| S5-223716 |  |  |  | ServiceID in Charging Data Request |
| 2022-07 | SA5#144e | S5-224138 |  |  |  | Update the Reference | 0.6.0 |
| S5-224194 |  |  |  | Correcting clause 5.5.5 |
| S5‑224464 |  |  |  | Add the QoS solution for CHF Rating |
| S5‑224465 |  |  |  | Add the General for NB mechanism enhancement |
| S5‑224466 |  |  |  | Add the Additional Information for CHF Rating |
| S5-224467 |  |  |  | Adding issue and solution to identifying non-blocking mode |
| S5-224468 |  |  |  | Adding solution for cancel failed event |
| S5-224481 |  |  |  | Correcting clause 5.2.5 |
| 2022-08 | SA5#145e | S5-225754 |  |  |  | Adding potential solution for locating cancel failed event | 0.7.0 |
| S5-225777 |  |  |  | Adding solution for non-blocking mode change using PCF |
| 2022-09 | SA#97e | SP-220845 |  |  |  | Edithelp review and presented for information | 1.0.0 |
| 2022-11 | SA5#146 | S5-226136 |  |  |  | Adding new use case for IoT Devices | 1.1.0 |
| S5-226433 |  |  |  | Adding key issues for documentation structure |
| S5-226855 |  |  |  | Undefined attribute handling in CDR |
| S5-226856 |  |  |  | Adding solution in clause 5.1 using new trigger category |
| S5-226857 |  |  |  | Adding solution in clause 5.1 not splitting rating group |
| S5-226858 |  |  |  | Addition of optimization on charging information accuracy |
| S5-226859 |  |  |  | Addition of Bitrate charging |
| S5-226860 |  |  |  | Addition of Threshold based re-authorization triggers optimization |
| S5-226861 |  |  |  | Clarifiy the Cancel Operation |
| S5-226862 |  |  |  | Clarify the Non-Blocking solution |
| S5-226863 |  |  |  | Optimization of the Binding |
| S5-226864 |  |  |  | Simplify the structure of CDR record |
| 2023-01 | SA5#146Bis-e | S5-231057 |  |  |  | Add the max size solution | 1.2.0  1.2.0 |
| S5-231250 |  |  |  | Adding solution for size of charging information |
| S5-231251 |  |  |  | Correcting solutions in clause 5.1 |
| S5-231254 |  |  |  | Common IEs applied in the service charging specifications |
| S5-231276 |  |  |  | Adding solution for key issue #1l in clause 5.1 |
| S5-231286 |  |  |  | Correction on the key issues in the topic 5.5 |
| S5-231288 |  |  |  | Evaluation and Conclusion for Topic 5.5 |
| S5-231289 |  |  |  | Evaluation and Conclusion for Topic 5.4 |
| S5-231290 |  |  |  | Evaluation and Conclusion for Topic 5.3 |
| S5-231291 |  |  |  | Evaluation and Conclusion for threshold |
| S5-231292 |  |  |  | Add the solution for keeping reporting based on the triggers |
| 2023-03 | SA5#147 | S5-232584 |  |  |  | Add the potential solution for Common IEs applied | 1.3.0 |
| S5-232747 |  |  |  | Clarify the solution 1.1 |
| S5-232749 |  |  |  | Correction on the potential solutions for key issue #1l |
| S5-232750 |  |  |  | Solving termination action issue |
| S5-232797 |  |  |  | Add the solution for Bitrate charging |
| S5-232798 |  |  |  | Adding solutions to undefined attribute handling in CDR |
| S5-232801 |  |  |  | Adding use case requested units and quota management indication |
| S5-232802 |  |  |  | Adding solution to clause 5.1 on location accuracy |
| S5-232803 |  |  |  | Updating solution in clause 5.4 |
| S5-232804 |  |  |  | Additional evaluation to clause 5.1 |
| S5-232805 |  |  |  | Adding evaluation to clause 5.2 |
| S5-232806 |  |  |  | Additional evaluation to clause 5.3 |
| S5-232816 |  |  |  | Additional evaluation in clause 5.4 |
| S5-232817 |  |  |  | Add evaluation to clause 5.5 of solution #5.6 |
| S5-232818 |  |  |  | Evaluation and Conclusion |
| S5-232819 |  |  |  | Solution for Key issue#1f and #1g |
| S5-232820 |  |  |  | Add the potential solution for Common IEs applied |
| 2023-04 | SA5#148e | S5-233418 |  |  |  | Update the evaluation for the charging accuracy | 1.4.0 |
| S5-233666 |  |  |  | Correcting use cases and key issues in clause 6.2 |
| S5-233681 |  |  |  | New solutions for documenting binding in clause 6.3 |
| S5-233691 |  |  |  | Updating cancelling using charging session identifier clause 5.4 |
| S5-233699 |  |  |  | Update the evaluation for the cancelling |
| S5-233701 |  |  |  | Add the solution for the undefined CDR |
| S5-233702 |  |  |  | Update the key issue, evaluation and conclusion in the clause 6 |
| S5-233715 |  |  |  | New solutions for CDR handling in clause 6.3 |
| 2023-05 | SA5#149 | S5-234476 |  |  |  | Solution #1.15 Trigger | 1.5.0 |
| S5-234478 |  |  |  | Update the solution evaluation |
| S5-234480 |  |  |  | Used unit containers for one rating group split over messages |
| S5-234481 |  |  |  | Adding use case and key issue on handling of event charging triggers |
| S5-234482 |  |  |  | Adding solution using charging trigger profile |
| S5-234483 |  |  |  | Adding solution using container reference for message size |
| 2023-08 | SA5#150 | S5-235466 |  |  |  | Correction to solution #1.1 on zero data transmission | 1.6.0 |
| S5-235625 |  |  |  | Corrections to clause 6.5 |
| S5-235626 |  |  |  | Update of evaluation and conclusions clause 6.5 |
| S5-235875 |  |  |  | IoT Solution |
| S5-235876 |  |  |  | New solution for IoT Charging information Optimization |
| S5-235877 |  |  |  | Clarify solution #1.2 on the reporting per RG |
| S5-235878 |  |  |  | Clarify use case #1d and add solution for the handling of undefined CDR values with reserved numbers |
| S5-235879 |  |  |  | Add the solution for bitrate charging supported by CHF |
| S5-235880 |  |  |  | Correction to solution #3.2, #3.3 and #3.4 on CHF rating enhancement |
| S5-235881 |  |  |  | Correction to #4.3 on event cancelling |
| S5-235882 |  |  |  | Clarify solution #2.3 about the scope of trigger profile update |
| S5-235883 |  |  |  | Update the solution evaluation and conclusion in clauses 5.1, 5.2, 5.3, 5.4, 5.5 |
| 2023-10 | SA5#151 | S5-237013 |  |  |  | Payload Data reference | 1.7.0 |
| S5-237014 |  |  |  | Evaluation and clarification charging information optimization solutions |
| S5-237015 |  |  |  | Evaluation and conclusion for rating input enhancement |
| S5-237016 |  |  |  | Correction of solution 4.1 and evaluation |
| S5-237018 |  |  |  | Correction to reference in clause 6 |
| 2023-11 | SA5#151 | S5-238038 |  |  |  | Removal of editor's note solution 1.21 | 1.8.0 |
| S5-238039 |  |  |  | Introduce one Solution for common IEs with clause 6 evaluation and conclusion |
| S5-238040 |  |  |  | Study conclusion and recommendations |
| 2023-12 | SA#102 | SP-231522 |  |  |  | Presented for approval | 2.0.0 |
| 2023-12 | SA#102 |  |  |  |  | Upgrade to change control version | 18.0.0 |