Diameter Maintenance and Extensions
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Diameter Specification Recommendations
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Abstract

This document reports on formatting errors, uses cases, and inconsistencies found in various standards specifications related to the Diameter interface requirements. Recommendations are made to reduce errors, support common use cases and build specifications in such a way that programmatic verification of Diameter specifications can be done with minimal to no errors.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on December 31, 2017.

Table of Contents

1. Introduction

This document identifies common errors and uses of Diameter in order to document requirements and possible extensions to the Diameter Command Code Format (CCF) and other formats, e.g. Grouped Attribute Value Pair (AVP) format defined in [RFC6733]. It is by no means an exhaustive analysis of all Diameter specifications but provides a survey of a few dozen RFCs and 3GPP Technical Specifications to determine what improvements can be made in Diameter specifications.

There are no issues with respect to over the wire communication of Diameter as evidenced by the successful implementation of Diameter applications based upon the specifications surveyed in this document. However, the development and implementation time of Diameter applications can be significantly improved when errors and inconsistencies of the message format as documented in the specifications are minimized or non-existent. An automated tool was developed and used to perform the survey analysis of the technical specifications. The tool would perform automated checking, syntax validation, and language generation and was ran against the various specifications to set a benchmark on the current state and quality of

the Diameter specifications. The '.dia' format of a fork of the diafuzzer project (https://github.com/Orange-OpenSource/diafuzzer) was used. It is a simple, deterministic format that provides semantic cross checks of Diameter specifications.

With the goal of automated '.dia' format in mind a survey of various Diameter related RFCs and 3GPP Technical Specifications was executed. During the process several issues, errors, omissions and usage patterns were discovered, and they are outlined in section 4 (Specification Survey) of this document.

Diameter Applications Design Guidelines [RFC7423] does an excellent job of noting common diameter desing use cases but it does not describe how the CCF or related grammers may represent some of these scenarios. To do this the '.dia' format was extended. A few new use cases were also identified that were not covered in [RFC7423].

2. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

3. Survey of Existing Specifications

The tool was ran against the following standards specifications for diameter applications:

RFC 4004 [RFC4004]

RFC 4006 bis [I-D.bertz-dime-rfc4006bis]

RFC 4950 [RFC4950]

RFC 5447 [RFC5447]

RFC 5777 [RFC5777]

RFC 5778 [RFC5778]

Diameter Load (draft) [I-D.ietf-dime-load]

RFC 6733 [RFC6733]

RFC 7155 [RFC7155]

RFC 7683 [RFC7683]

RFC 7944 [RFC7944]

3GPP TS 29.214 [TGPP.29.214]

3GPP TS 29.345 [TGPP.29.345]

3GPP TS 29.344 [TGPP.29.344]

3GPP TS 29.343 [TGPP.29.343]

3GPP TS 29.338 [TGPP.29.338]

3GPP TS 29.337 [TGPP.29.337]

3GPP TS 29.336 [TGPP.29.336]

3GPP TS 29.329 [TGPP.29.329]

3GPP TS 32.299 [TGPP.32.299]

3GPP TS 29.154 [TGPP.29.154]

3GPP TS 29.215 [TGPP.29.215]

3GPP TS 29.368 [TGPP.29.368]

3GPP TS 29.128 [TGPP.29.128]

3GPP TS 29.173 [TGPP.29.173]

3GPP TS 29.217 [TGPP.29.217]

3GPP TS 29.273 [TGPP.29.273]

3GPP TS 29.272 [TGPP.29.272]

3GPP TS 29.061 [TGPP.29.061]

3GPP TS 29.212 [TGPP.29.212]

3GPP TS 32.299 [TGPP.32.299]

3GPP TS 29.229 [TGPP.29.229]

3GPP TS 29.468 [TGPP.29.468]

3.1. Summary of Challenges and Errors

Enumeration issues have their own section below. General issues include but are not limited to:

Spelling and spacing errors.

Inconsistent Table formats over time. Arguably this reflects the changes in Diameter but these inconsistencies occur with documents released in close time frames. There are also too many formats to claim it is a 'change over time' and not just an inconsistency issue.

Missing AVPs and/or AVP Code values.

Case Sensitive inconsistencies.

The wrong name for AVPs in Tables, referenced across specs, etc. that have the same AVP Code.

Claiming an AVP is defined in a spec when in fact it is referenced.

Incorrect references.

Not noting an AVP is referenced at all but including it in a Grouped AVP or Command.

Some AVPs mentioned in Grouped AVPs and not defined anywhere. This happened a few times in accounting related 3GPP specifications.

Enumerations do not have a specific format in the base specificaton [RFC6733]. Over the wire the labels themselves are not used as the value is transported in integer formats. When received by a Client or Server the value is checked against a list of valid values. The label only appears in displayed information for errors, logging, etc. However, many of the specifications used varying case, spaces and formats such as parenthesis around numbers, tables, numbers then labels, labels then numbers, etc.

An algorithm keying off of the expression 'is of type Enumerated' was used to figure out the text between enumerations. A function was then used to attempt to parse various label patterns, generate a label that may be acceptable to a coding language and capture the value assigned to the label. This yielded partial success. In some cases, especially billing in 3GPP, hand edits were required to fix

duplicate labels and formats that were inconsistent with the rest of the document's enumerations.

A few cases even referenced their values as coming from other enums or registries associated with the IETF or other standards organizations. These were removed in some cases due to their size while others were copied from the existing enumeration file in the diafuzzer project if it had already been generated.

Although enumerations are now available in the intermediate '.dia' format, many of the labels will not be valid in specific programming languages. More work is required regarding enumerations to accommodate these situations.

3.2. Summary of Indirect Use Cases

Several Use Cases appeared that where the dia format was extended to capture them.

3.2.1. Refinements

Refinement (Extension) of Commands and Grouped AVPs. This is a case where the same AVP/Command is referenced, i.e. same code or vendor/ code combination but the underlying members of the structure are different. Two variants of this were found:

The base (original definition) of the structure was refined. In this case, the 'Refines' Statement in the header may not include the application.

A refinement of a refinement. In this case the specific refinement (AVP + App ID it was specified in) was the part of the refinement clause.

Note: this is not inheritance. In inheritance the children also inherit the attributes (AVPs) of the parent. In many cases the new definition removed some of the parents AVPs or further limited the occurrence amount of the AVPs.

Refinements can only occur if the Command/Grouped AVP is extensible, i.e. it includes *[AVP] in its definition.

The rationale for this can be shown by example. A value of 2[AVP] would not be considered extensible and its behavior is undefined. Can someone limit the number of AVPs present in a Command/Grouped AVP when that value is less than the total sum of the upper bounds of all member AVPs. For example, if a Grouped AVP permits at most 2

occurrences of AVP member "X" and 2 of AVP member "Y", how/why could/ would one limit the Grouped AVP to no more than 3 AVPs?

In the dia format Refinement is captured by adding 'Refines [application id]' at the end of the header/Grouped AVP definition.

3.2.2. Enumerations

Enumeration use cases included definitions that referenced

other Enumerations

registries found on the web

In the second case the Enumeration was typically removed.

In a few cases Enumerations referenced other enumerations and then, in Notes, limited the values (was a proper subset). The opposite case (a proper superset) never presented itself.

Later specifications assigned Unsigned32 as a value in what appears to be an attempt to avoid registries or provide some pseudo extensibility. The exact purpose is actually unclear.

3.3. Summary of Ingestion Barriers

Errors, inconsistencies and Use Cases that could not be easily fulfilled aside. Format differences hampered our ability to quickly ingest Diameter strcutures from specifications. The following is a list of patterns for just AVP header tables:

Pattern 1: Parses the original table format for AVPs defined in an IETF spec.

The header for an RFC is

Attribute Name	AVP Code	Section Defined	Data Type	MUST	MAY	SHLD NOT	MUST NOT	Encr

Pattern 2: Parses the original table format for AVPs defined in a 3GPP spec

Attribute Name	AVP Code	Section defined	Value Type	Must	May	Should not	Must not	May Encr.

Pattern 3: Parses the original table format for AVPs defined for freediameter is BUT some rows define a spec boundary such as the row below the header in this example

```
|Attribute Name|Code|Section|Data|MUST|MAY|SHLD NOT|MUST NOT|Encr|
```

Pattern 4: Parses the original table format for AVPs defined in later IETF specs.

The header for an RFC is

```
  |                | AVP  | Section |            |    |MUST |
  | Attribute Name | Code | Defined | Data Type  |MUST| NOT |
```

An AVP can be 2-line

```
    Accounting-      483  9.8.7   Enumerated | M  |  V  |
      Realtime-Required                      |    |     |
```

Pattern 5: Parses the original table format for AVPs defined in some IETF specs like RFC 7155.

The header for an RFC is

```
  |                | Section |    |MUST |
  | Attribute Name | Defined |MUST| NOT |
```

Pattern 6: Parses the original table format for AVPs defined in some IETF specs that don't define applications..

The header for an RFC is

```
   |                           | AVP  | Section |                |
   | Attribute Name            | Code | Defined |    Data Type   |
```

Pattern 7: Parses the original table format for AVPs defined in an IETF spec.

The header for an RFC is

```
                 AVP  Section           |    |MUST|
Attribute Name   Code Defined Data Type |MUST| NOT|
```

Pattern 8: Parses the original table format for AVPs defined in later IETF specs.

The header for an RFC is

```
|                | AVP  | Section |            |    | MAY |MUST |
| Attribute Name | Code | Defined | Data Type  |MUST|     | NOT |
```

An AVP can be 2-line

```
Accounting-      483  9.8.7   Enumerated | M  |  V  |
Realtime-Required                       |    |     |
```

Pattern 9: Parses the original table format for AVPs defined in a 3GPP spec

```
Attribute Name|AVP Code|Clause defined|Value Type|Must|May|Should -
```

not|Must not|

Pattern 10: Parses the original table format for AVPs defined in a 3GPP spec

Attribute Name|AVP Code|Value Type|Must|May|Should not|Must not|

Figure 1: Table Patterns

Even with the patterns present some cleanup for "Notes..." was required to get the headers parsable.

Not all specifications used an import table. In fact some inter-mixed the tables used to note AVPs defined in the spec and those that were referenced. Some columns were removed to ensure that they fit within known formats as well. In other words, there are more formats in the specifications than shown here but with some manipulation they can be reduced to this core set.

For AVP imports a 3-column and 4-column format were common. Further they often had references that needed to be removed (an enhancement is planned to overcome this in the test code.

Multiple application specific AVP tables that occurred in a single spec and unified. This was for research convenience but will hamper the generation of small dictionaries.

Command codes have a long name and three letter acronym typically in a table. However, neither of those were used in the definition. For example, it is quite common to see Re-Authorization-Request and RAR but Re-Auth-Request in the command code definition.

There is no easy, programmatic way to identify an application and relations to command codes or result codes.

4. Specification Survey

4.1. Survey Process

The current process for performing validation is to perform the following tasks:

- Separate AVP and AVP import tables. The primary goal of this was to study the table formats to develop code to process them.

Save the file in a text format. This document is then modified to correct the errors.

'Repair' enumerations as required through the use of a separate enum file that is modified as issues are discovered.

Create a filter format file that captured data that was hard to find in the specifcation related to Diameter Applications.

The time spent for each document is the total amount of time from start to finish where the various files were split as described above and the software was then ran. As errors were discovered they were documented and then, as required, repaired. In some cases new software was developed to accommodate new use cases or formats. That was added to the total processing time for the document unless otherwise noted.

4.2. Summary of Errors And Use Cases

4.2.1. RFC 4004

For RFC 4004 [RFC4004], processing took approximately 20 minutes. Defect corrections were approximately an hour.

The AVP Table is a unique format. Line continuations of the table are not consistent.

Enumerations are backwards - # Label

Some issues were noted but not resolved in 4004. See https://www.ietf.org/mail-archive/web/dime/current/msg02053.html

Note that MIP-MN-FA-SPI, MIP-MN-HA-SPI and MIP-HA-to-MN-SPI are missing in the specification. They were removed from their respective Grouped AVPs.

MIP-Nonce is in the AVP definition but MIP-nonce (lowercase 'n' for nonce) in Grouped definitions

4.2.2. RFC 4006 bis (draft 03)

For RFC 4006 bis [I-D.bertz-dime-rfc4006bis], processing took approximately 25 minutes.

The AVP table contains inconsistent continuation lines.

No import tables have been provided and had to be constructed.

Had to change the User-Equipment-Info-Type AVP to the format of 'AVP (AVP Code XXX) is of type Enumerated' to keep the pattern to one type.

Had to stub in TBD values.

Misspelling of IPFiltrRule in table.

Many enums referenced to registry values in the spec.

Section 8.6 removes dashes for Check Balance Result

Redirect-Address-Type Enumerations have spacing so appear as duplicates.

CC-Session-Failover was phrased as 'is type of Enumerated' instead of 'is of type Enumerated'

4.2.3. RFC 4950

For RFC 4950 [RFC4950], processing took approximately 15 minutes. No major issues were found.

4.2.4. RFC 5447

For RFC 5447 [RFC5447], processing took approximately 10 minutes. No major issues were found.

4.2.5. RFC 5777

For RFC 5777 [RFC5777], processing took approximately 3 hours.

A unique AVP table format.

Had to hand enter ALL Enum formats.

The approach taken for enum processing is not correct for this document.

Treatment-Action listed as Grouped in AVP table

IP-Bit-Mask-Width not present in table

4.1.7.7 and table are inconsistent with AVP definition used in groups 'IP-Bit-Mask-Width' vs. 'IP-Mask-Bit-Mask-Width'

Filter-Rule's use of ';' for comment is unconventional in parsing

4.2.6. RFC 5778

For RFC 5778 [RFC5778], processing took 24 minutes.

Continuations in AVP tables are inconsistent which required hand editing. The continuation '-' sometimes appears on the first line or not until the second which will require more complex code to deal with the situation.

Imports of AVPs were mixed in with the table definitions specification. This took the most time work out.

Subtype field of the MN-HA and MN-AAA authentication mobility options are not defined in spec and needed to be stitched in (corrected) later.

Although noted properly in text, MIP-Session-Key, MIP-Algorithm-Type, MIP-Replay-Mode was not listed as being imported from an RFC in the AVP table.

4.2.7. Draft Diameter Load

For Diameter Load [I-D.ietf-dime-load], processing completed by hand in 10 minutes. IANA allocations have occurred but the document has not left editors queue which means scripts would not work anyway

4.2.8. RFC 6733

For RFC 6733 [RFC6733], processing took approximately 15 minutes.

Continuations were inconsistent.

The spec does not follow its own CCF.

4.2.9. RFC 7155

For RFC 7155 [RFC7155], processing took several hours. The original RFC was used to fill in many of the gaps in the AVP table code.

AVPs only used for compatibility are in the messages but not mentioned in the document, e.g. NAS-Identifier is still present.

RA-XXX to Re-Auth but Command acronyms, names and custom names are inter-mixed which is a bit confusing and makes it problematic to automate.

Hand stitched the enum values which often pointed to entire registries

4.2.10. RFC 7683

For RFC 7683 [RFC7683], processing took approximately 40 minutes.

The AVP table has a unique format.

Continuations were on the second line requiring look ahead logic.

4.2.11. RFC 7944

For RFC 7944 [RFC7944], processing took approximately 10 minutes. No major issues were found.

4.2.12. 3GPP TS 29.214

For TS 29.214 [TGPP.29.214], processing took approximately 45 minutes.

In the AVP tables a dot is used as a separator instead of a comma.

In the Specific-Action AVP, the Label 'Void' occurs twice. A hand modification was made.

The Service-Info-Status AVP has spaces between the names in the labels. This was corrected.

4.2.13. 3GPP TS 29.229

For TS 29.229 [TGPP.29.229], processing this took 2 hours; 20 minutes.

Many AVPs are listed as being DEFINED in the specification but they are references.

It does not import RFC 4005, 7155 or 4006 despite using their AVPs.

Although restored in Dec 2011 in a change request, Wildcarded-IMPU was not added back to the AVP table Table 6.3.1: Diameter Multimedia Application AVPs

Line-Identifier also does not appear in the Table and this AVP has Vendor Id ETSI (13019)

4.2.14. 3GPP TS 29.468

For TS 29.468 [TGPP.29.468], processing took approximately 60 minutes

Another AVP Table format.

The Commands were abbreviated in a manner not seen elsewhere in the document, e.g. GA-Request is only used in the command definition.

AVP Definitions table removes dashes of the Grouped AVPs.

Duplicate AVP names with different codes for MBMS-GW-SSM-IP-Address and MBMS-GW-SSM-Ipv6-Address.

TMGI-Number in the Grouped AVP but it is defined in the table as TMGINumber.

4.2.15. 3GPP TS 29.345

For TS 29.345 [TGPP.29.345], processing took approximately 70 minutes

AVP Table inter-mixes '.' and ',' separation in the flags fields. Code was finally written to overcome this.

In the AVP Table, App-Identifier was typed as 'Group' and not 'Grouped'.

In the AVP Table, 'Assistance-info' was incorrect case for 'Info'.

Section 6.3.31, WiFi-P2P-Assistance-Iinfo has an extra 'i' in it

User-Identity's, ProSe-Response-Code's and ProSe-Query-Code's origin are unclear. They is not in a reference section but in several groups.

Discovery-Auth-Request and Match-Report-Info use incorrect case - ProSe-App-ID.

ProSe-Query-Code and ProSe-Response-Code are noted in Grouped AVPs but do not exist elsewhere in the spec.

4.2.16. 3GPP TS 29.344

For TS 29.344 [TGPP.29.344], processing took approximately 50 minutes

ProSe-Subscriber-Information-Request is the name for ProSe-Initial-Location-Information-Request.

Authorized-Discovery-Range was not listed as a defined AVP and has no values assigned. Filled in as 3708 but these sections are not present in 29.230 at all

4.2.17. 3GPP TS 29.343

For TS 29.343 [TGPP.29.343], processing took approximately 10 minutes

No issues.

4.2.18. 3GPP TS 29.338

For TS 29.338 [TGPP.29.338], processing took approximately 55 minutes

Table 6.3.2.2/1: Command-Code values for SGd/Gdd has spaces in the command names.

Send-Routing-info-for-SM-Answer in the command definition is lowercase and can't be linked to the command table.

Not an issue but an observation. There is no Load Control draft reference.

SGSN-Absent-User-Diagnostic SM has a space in it in the AVP table

SM-Delivery- Failure-Cause has spacing issue in table.

SMSMI-Correlation-ID has dash issues in its definition..

SM-Delivery-Not-Intended has values as a list with ending of ',' and period. Similar issues for SM-RP-MTI

MME-SM-Delivery-Outcome- There is an extra > at the end of the header definition

SM-Enumerated-Delivery-Failure-Cause used ',' and '.' for the list. Also the data type 'Enumerated' was not capitalized causing a miss in the system.

MSISDN import is from 29.329 and not 23.329

4.2.19. 3GPP TS 29.337

For TS 29.337 [TGPP.29.337], processing took approximately 20 minutes

No issues.

4.2.20. 3GPP TS 29.336

For TS 29.336 [TGPP.29.336], processing took approximately 9 hours as it was used for testing.

Spacing issues in AVP tables for Maximum Latency, Maximum Response Time

Scheduled-communication-time definition is lower case.

Periodic-Time is lowercase in the AVP Table.

Found a '/' in the Flags portion of the AVP Table.

eNodeB-ID and Extended-eNodeB-ID in this spec but 'Id' in defining spec .217

4.2.21. 3GPP TS 29.329

For TS 29.329 [TGPP.29.329], processing took approximately a billion minutes

Spacing issues in AVP User-Data-Request command.

Does not specify the Supported-Features, Feature-List, Feature-List-ID, Supported-Applications, Server-Name, Public-Identity from another app in the AVP table.

4.2.22. 3GPP TS 32.299

For TS 32.399 [TGPP.32.299], processing took approximately 9 hours

Unique Table format.

Required to remove imported AVPs and create a new table.

UTF8string case incorrect in AVP table for a number of entries.

ProSe-Direct-Communication- Transmission-Data-Container and Status- AS-Code have spaces.

LCS-Client-ID changed to LCS-Client-Id.

ProSe-Direct-Communication- Transmission-Data-Container

Related- Change-Condition- Information

Trunk-Group-ID was Trunk-Group-Id in AVP table.

Wrote more software to deal with the values flipped in enums (int first then label)

Enums were a large issue so hand editing had to take place to clean up the values.

'is of type of Enumerated' and 'is of type enumerated' were present in the document

AoC-Service-Type had to be repaired by hand as the algorithm picked up the overloaded Change-Condition values

MBMS-User-Service-Type

Node-Functionality needs fixing

Online-Charging-Flag had to be corrected

Originator had missing elements

Void numbers get caught in enums

PoC-Event-Type used semicolons

ProSe-Direst-Discovery-Mode spelling issue

ProSe- Role-Of-UE spacing issue

Participant-Access-Priority uses colons in enum labels and mixed descriptions

Changed Type-Number Unsigned32 as the registry is too difficult to code

Submission-Timestamp not defined

PoC-User-Role-Ids instead of PoC-User-Role-IDs

Removed [Monitored-HPLMN-Identifier] as it made no sense and was not defined

[Prose-Function-PLMN-Identifier] removed

[VASP-Id] & [VAS-Id] removed from MMS-Information

Service-Generic-Information removed from Service-Information defined in OMA-DDS-Charging_Data [223].

[3GPP-Session-Stop-Indicator] removed

IM-Information DCD-Information removed from Service-Information defined in OMA-DDS-Charging_Data [223]

ePDG-Address vs EPDG-Address

M2M-Information removed from Service-Information as it was missing

SM-Device-Trigger-Information's Reference-Number removed since it was missing

Incoming-Trunk-Group-ID removed

4.2.23. 3GPP TS 29.154

For TS 29.154 [TGPP.29.154], processing took approximately 10 minutes

Variance of a later Table format.

Command Codes were abbreviated in such a way that they had to be changed so the software could match them up properly

Time-window grouped AVP definition corrected to Time-Window

4.2.24. 3GPP TS 29.215

For TS 29.215 [TGPP.29.215], processing took approximately 60 minutes

S9a* reference table has a TS reference instead of 3GPP TS.

UE-Local-IPv6-Prefix type in AVP table is all lower case.

Note that ' is of type of Enumerated" was corrected to allow the software to catch the Subsession-Operation and DRA-Binding.

Imports are missing.

Change Framed-Ipv6-Prefix to Framed-IPv6-Prefix.

Logical-Access-ID to Logical-Access-Id

Physical-Access-ID to Physical-Access-Id

4.2.25. 3GPP TS 29.368

For TS 29.368 [TGPP.29.368], processing took approximately 20 minutes

TS used in imported AVP tables.

Command Codes were abbreviated in such a way that they had to be changed so the software could match them up properly.

'Feature-Supported-In-Final-Target AVP' in the AVP definitions table.

External-Id used instead of External-Identifier.

4.2.26. 3GPP TS 29.128

For TS 29.128 [TGPP.29.128], processing took approximately 30 minutes

Result Codes were not found

DRMP definitions are not handled.

Non-IP-Data had type of OctetString

4.2.27. 3GPP TS 29.173

For TS 29.173 [TGPP.29.173], processing took approximately 25 minutes

4.2.28. 3GPP TS 29.217

Processing took approximately 43 minutes.

The Modify-Uecontext-Request / Answer command definitions did not match anything in the Command Table.

4.2.29. 3GPP TS 29.273

For TS 29.273 [TGPP.29.273], processing took 60 minutes.

The AN-Trusted enum wasn't picked up by the code.

Transport-Acess-Type - misspelling resulting in loss in the document.

Case issue - Subscription-ID vs Subscription-Id

MIP6-Feature-Vector shows as 64 bit in the document but 32 in RFC 5447.

4.2.30. 3GPP TS 29.272

For TS 29.272 [TGPP.29.272], processing took approximately 3 hours. Multiple issues were found but this document was used as a reference for development and not considered in processing efficiencies calculations.

Table 7.3.1/1: S6a/S6d, S7a/S7d and S13/S13' specific Diameter AVPs Alert-Reason has type of 'Enumerate'

ProSe-Subscription-Data Grouped AVP has a type ID of 'xxx'

Supported-Services AVP has a type of 'zzzz'

'Subscriber Status' AVP needs a dash

'Notification- To-UE-User' has a space.

'IDR- Flags' has a space.

'Monitoring Event Report' has multiple spaces.

'eNodeB-ID' and 'Extended-eNodeB-ID' in this spec but 'Id' in defining spec .217

Claims QoS-Capability as a defined AVP but it is part of RFC 5777

Trace-Depth is an enum in 32.422 and had to be manually added.

Job-Type reference vague. From the specification, 'The possible values are those defined in 3GPP TS 32.422 [23] for Job-Type.'

'Report Interval' has a space.

Preferred-Data-Mode was listed as a Grouped type but is Unsigned32.

4.2.31. 3GPP TS 29.061

For TS 29.2061 [TGPP.29.061], processing took approximately 2 hours.

Enums use 'AVP code' vs. 'AVP Code'

3 AVP tables created for 4 of the apps

Enums have to be added by hand as they are not tied by application ID

Messages did not have App IDs in the CCF headers as they are extensions

MBMS-Session-Repetition-Number has 'M.V' ('.' instead of comma)

MBMS-User-Data-Mode-Indication Enumeration uses spaces for its label values

3BPP-PDP-Type - Enum defined as RADIUS; not available to parser in Diameter

4.2.32. 3GPP TS 29.212

For TS 29.212 [TGPP.29.212], processing took approximately 7 hours.

Logical-Access-ID and Physical-Access-ID have case inconsistencies with other specifications.

Acronyms in the command code lines but they do not correlate to previously described acronyms in the document.

Table 5c.6.1.1 is incomplete.

Periods, '.', were used as separators in AVP tables, e.g.'M.V'.

Sd and St use TS-Request and TS-Answer but they are don't have application assigned codes.

'Enumerated' appears in a type definition

Incorrect reference of 7863 vs 7683

Manual correction was required in the document. Somehow PCC-Rule-Status did not got the enums it needed. It appears no spacing created an error. Hopefully software can be updated to overcome this.

Pre-emption Vulnerability (in the Section's first line) spacing kills the correct name identification.

In many Enumerations there is an extra space between 'of type' and 'Enumerated'

PCC-Rule-Status has a label of 'TEMPORARILY INACTIVE'

Bearer-Control-Mode 'is of type of Enumerated' issue

Network-Request-Support Label spaces

For the Default-Access AVP - 'The values defined in the Default-Access AVP are the same as the ones defined in IP-CAN-Type AVP.'

Also, mentions '3GPP-EPS IP-CAN' as an option but it is not an option in the referenced type.

CS-Service-QoS-Request-Operation 'is type of Enumerated,

CS-Service-Resource-Failure-Cause AVP (AVP code2814) has a spacing issue

'Logical-Access-ID to 'Logical-Access-Id'

CS-Service-QoS-Request-Identifier is in table as CS-Service-Qos-Request-Identifier

Some enumerations with duplicate labels, e.g. Specific-Action

5. Recommendations for Specification Improvement and Automation

5.1. Error Reduction

The overall recommendations are as follows:

The name of all AVPs, Commands and Grouped AVPs appear consistently throughout the document.

The letter case MUST be consistent for all names.

No spaces should appear in the names.

Use of underscores is discouraged except for line continuations in tables.

5.1.1. Defined AVPs

This section addresses AVPs defined in the specification. The following recommendations are made:

Tables MUST include the following columns:

- Attribute Name
- AVP Code
- Section Defined
- Data Type

AVP Flag Rules for MUST and MUST NOT

Tables MAY include Notes and other notations in the column headers but MUST NOT exceed more than 8 lines of text to describe the header.

The columns may be separated by space, '|' or both when in text format that follows one of the following styles.

- All columns except AVP Flags are separated by whitespace and Flag column boundaries are pipe delimited.

- Pipe delimited columns with the exception of the first column.

AVP Names MUST NOT have spaces or underscores.

Use '.' or ',' as Flag separators. Although no space is also acceptable.

Use of two lines for an AVP is permitted. The following conditions apply.

- An underscore MUST be used at the end of the first line or at the beginning of the second (not both).

- An underscore is not a part of the AVP name

- All other columns except the Name MUST appear on the same line.

All Defined AVP Tables in the specification MUST use the same header format.

Imported or Re-used AVPs MUST NOT be present in defined AVP tables.

Example One

Attribute Name	AVP Code	Section Defined	Data Type	MUST	MUST NOT
AVP-Name	85	9.8.2	Unsigned32	M	V

Example Two

Attribute Name	AVP Code	Section Defined	Data Type	MUST	MUST NOT
AVP-Name	85	9.8.2	Unsigned32	M	V

Figure 2: Accepted Table Patterns

An open question exists when multiple AVPs tables are present and associated with a specific application within the specification. How the application can be associated to the table is an open question.

5.1.2. Imported AVPs

Imported or Re-used AVPs MUST be included in the specification. A table MUST be present if AVPs are re-used/imported.

The table MUST include the AVP and Source document columns.

The table MAY include a Comment column.

An M-bit column MAY be present as required.

The table MUST be pipe delimited when in text format.

5.1.3. Grouped AVPs

When a Grouped AVP is refined a Refine keyword is appended to the end of the header. It MUST include an application identifier of the Grouped AVP it refines if that application was not the original specification or 'version' of the Grouped AVP. When the Grouped AVP refines the original definition of the Gropued AVP it SHOULD include the referenced application identifier.

The refined Grouped AVP MUST be included in the AVP Import table and NOT in the defined AVPs table.

Open question, should the vendor and application identifiers of the application that created be in the Grouped AVP header?

When refining a Grouped AVP the following conditions apply:

The original AVP MUST be extensible, i.e. it MUST have the '*[AVP]' member.

Any refinement of an AVP present in the refined Group MUST adhere to the restrictions, if any, that were defined by inherited Groups. For example, if a Grouped AVP refines an attribute 'Foo' to the range X*Y and 'Foo'x is defined in the original AVP with a range of A*B then X >= A and Y <= B.

AVPs retained without further restriction of the number of occurrences MUST be kept in the Refining AVP's definition otherwise they are assumed to be dropped from the new AVP definition. Otherwise, it is impossible to determine the Author's intent.

Open question, can a Grouped AVP have a range limited [AVP] member, e.g. *5[AVP]?

Figure Figure 3 shows an example refinement. In it all but the User-Name AVP are dropped in the new definition.

```
From TS 29.336
User-Identifier ::= <AVP-Header: 3102, 10415>
  [User-Name]
  [MSISDN]
  [External-Identifier]
  [LMSI]
  *[AVP]

From TS 29.128
User-Identifier ::= <AVP-Header: 3102, 10415, Refines>
  [User-Name]
  *[AVP]
```

Figure 3: Refined AVP from TS 29.128 and TS 29.336

5.1.4. Command Errors

The largest issue with Commands is the inconsistent values between the name, three letter acronym defined in the table and the actual name used in the command definition. Maintaining consistency will resolve this issue.

Like Grouped AVP refinement, a Refine keyword is appended to the end of the header. It MUST include an application identifier of the Command it refines if that application was not the original

specification or 'version' of the Command. When the Command refines the original definition of the Command it SHOULD include its application identifier.

When refining a Command the following conditions apply:

The original Command MUST be extensible, i.e. it MUST have the '*[AVP]' member.

Any refinement of an AVP present in the refined Command MUST adhere to the restrictions, if any, that were defined by inherited Commands. For example, if a Command refines an attribute 'Foo' to the range X*Y and 'Foo' is defined in the original Command with a range of A*B then X >= A and Y <= B.

Commands retained without further restriction of the number of occurrences MUST be kept in the Refining Command's definition otherwise they are assumed to be dropped from the new Commands definition. Otherwise, it is impossible to determine the Author's intent.

5.1.5. Enumeration Errors

Enumeration Value Names MUST adhere to alphanumeric and underscore characters.

Enumeration Value Names MUST not begin with an underscore.

When being defined the format MUST include the label and the value assigned with the label enclosed in parenthesis on a single. Otherwise, this will confusion when the label values end in integers and are close to the numeric value. For example, 'speed_10 10' is okay, 'speed_1010' is a error. This can be avoided by requiring the enclosure of the values in parenthesis, e.g. 'speed_10 (10)' and 'speed_10(10)'. The last example may not be as readable as desired but it can be understood.

5.2. Formats for automated validation

This section discusses ways by which further clarity can be defined in a specification and automated validation can occur for a diameter application.

Following the recommendations in the previous section will reduce errors but there are still many pieces of information that cannot be programmatically validated. This includes the following:

GAP 1: The application identifier and name of an application.

GAP 2: The application and vendor identifiers associated with a defined AVP table.

GAP 3: The application and vendor identifiers associated with Commands.

GAP 4: Reused and newly defined result codes for an application.

GAP 5: Easily parsed enumerations that cover all use cases.

The following formats show an example of how information could be added to an Appendix to close these gaps.

```
1: AppFoo ::= <Diameter Application: 10415 101010>
2: Command1-Name-Request C1R
3:  Command1-Name-Answer C1A
4:
5: Result-Codes ::= <Diameter Result-Codes: 101010>
6:  NEW_RESULT (4999)
7:  IMPORTED_RESULT IMPORT (4010)
```

Figure 4: Example Application and Result Code Formats

GAP 1 is closed in line 1. GAP 3 is closed in lines 1 through 3 while GAP 4 is closed by lines 5 through 7.

GAP 2 can be closed by using a common discernable Table Name format, e.g. AppFoo defined AVPs. In this case the Application Name can be looked up and associated to the defined AVP table.

Gap 5 can be partially closed by following a pattern similar to Result-Codes but this does not resolve all uses cases.

```
Result-Codes ::= <Diameter Enumeration: 123, 45678>
  Label_1 (0)
  LABEL_Two (2)
```

Figure 5: Example Enumeration AVP

Further work is required to comprehensively cover all Enumeration Use Cases.

6. IANA Considerations

7. Security Considerations

This document is informational and provides some guidance on issues related to formatting and possible extensions of the Diameter CCF to improve understanding and code generation capabilities. It has no impact to the Security of Diameter or Diameter applications.

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