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Layer Two Tunnelling Protocol (L2TP): ATM access network extensions

Status of this Memo

This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.

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Abstract

This document augments the procedures described in RFC 2661 to further support ATM SVC (Switched Virtual Circuits) or PVC (Permanent Virtual Circuits) based access networks. L2TP (Layer 2 Tunneling Protocol) specifies a protocol for tunnelling PPP packets over packet based networks and over IP networks in particular. L2TP supports remote access by ISDN and PSTN networks. The extensions defined within this document allow for asymmetric bi-directional call establishment and service selection in the ATM access network.

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1. Introduction

L2TP [RFC2661] defines the procedures for tunneling PPP sessions between a so called L2TP Access Concentrator (LAC) and an L2TP Network Server (LNS). The main focus of [RFC2661] is on supporting HDLC based ISDN/PSTN access networks.

This document augments the procedures described in [RFC2661] to further support ATM SVC or PVC based access networks. Support for ATM access networks requires extensions to the present L2TP procedures so as to cope with :

(a) the traffic management aspects of ATM connections (e.g. asymmetric bandwidth allocation and service category selection capabilities),

(b) the addressing format to be used in switched ATM networks [AESA] and

(c) the limitations imposed on LCP negotiation by transporting PPP over AAL5 over the access network segment of the PPP connection [RFC2364].

Within this document, the necessary extensions to [RFC2661] are defined to cope with issues (a) and (b), issue (c) which is not specific to ATM may be solved as described in [L2TP_link].

1.1 Conventions

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 [RFC2119].

2. Assumptions

In this section we describe some assumptions that have lead to the extensions described in this document.

2.1 Topology

The procedures as defined in [RFC2661] apply mainly to access network technology such as PSTN and ISDN, which may be respectively asynchronous HDLC and synchronous HDLC based. The aim of this document is to extend L2TP support to allow for user / LAC communication based on ATM access network technology.

2.2 Connection Establishment

Due to the wide variety of existing signalling protocols and ATM service categories, and their support or non-support within ATM based access networks, this document takes as approach to provide for a flexible identification of ATM connection characteristics while establishing outgoing and incoming L2TP calls. The procedures as defined within this document allow the allocation of asymmetric bandwidth and service category selection in terms of real or non-real time requirements on the ATM portion of the access network.

As such, the detailed signalling protocol specific information elements that are necessary for switched VC service, are explicitly not negotiated during call establishment over the L2TP tunnel.

In order to identify the endpoint of the ATM connection within the ATM access network, SVCs can be established on the basis of the ATM end system addressing format [AESA]. For PVC based services, the PVC can either be referred to by using the ATM end system addressing procedure (Called/Calling Number), or by making use of a textual name (Service Name). The latter is inspired by the procedures defined within [Auto_PVC].

2.3 LCP negotiation

The procedures described within this document may be combined with the procedures described in [L2TP_link] to limit LCP negotiation between LNS and user, so as to enforce PPP over AAL5 specific LCP negotiation [RFC2364].

3. ATM access enhanced procedures

In order to illustrate the procedures specified within this document, this section will provide an operational description of Virtual dial-up access through an ATM based access network (e.g., ADSL).

Note that the emphasis is on the changes proposed within this document relative to [RFC2661].

3.1 ATM connectivity

Prior to initiating the PPP protocol layer, a Virtual Connection (VC) MUST be established between the user and the Network Access Server (LAC). This virtual connection MAY either be a preconfigured Permanent VC(PVC), where the access network provider, NAS and user agree beforehand on the characteristics of the PVC, or MAY be an on-demand switched VC(SVC), where the negotiation between user, network and NAS takes place by means of an ATM signalling protocol. Note that for establishing PVCs, alternative use may be made of the procedures as described in [Auto_PVC].

In both cases, the user is referred to as the virtual dial-in user.

Prior to accepting the switched connection from the virtual dial-in user, the LAC MAY check with the LNS whether the call should be accepted. In the latter situation, the LAC MAY determine based upon parameters available within the call establishment message that this concerns a virtual dial in user, or MAY undertake a partial authentication of the end system/user, in order to bind the end system/user with a specific LNS.

For PVC based users, the LAC MAY be triggered by the arrival of an LCP Configure Request, or PPP Authentication request message from the virtual dial-in user to initiate conversation with the LNS. Note that the exact timing of triggering communication between LAC and LNS is outside the scope of this document.

3.2 Tunnel establishment

If no tunnel connection currently exists to the desired LNS, one is initiated. During the tunnel establishment, LNS and LAC indicate bearer and framing capabilities to each other, according to normal procedures.

The bearer capability is extended to allow the LAC to indicate its support of ATM bearer devices. Positive receipt of this indication, allows both LAC and LNS to use the extensions as defined within this document to support ATM based incoming and outgoing calls.

If no compatibility between LNS and LAC exists according to the extensions defined within this document, no tunnel establishment can take place. This would be because the LAC does not support any bearer capability which is expected by the LNS (e.g., an ATM based LAC, that only signals the "Broadband" Bearer Capability), or vice

versa. It is however encouraged that LAC or LNS implementations would allow for seamless interworking with peer devices which do not implement the extensions defined within this document. This could be implemented by allowing a graceful fallback to digital bearer capability.

3.3 call establishment

During incoming and outgoing broadband call establishment, the following extensions are defined to existing procedures.

3.3.1 Incoming Call Establishment

The ATM connection between the virtual Dial-in user and LAC MAY either be dynamically or statically established. When the VC connection is dynamically established (Switched VC), the LAC will receive a SETUP message over the interface that connects it to the ATM network. This specification does not assume any specific interface type (UNI or NNI). Permanent VC connections MAY either be manually configured, or configured by use of the extensions to the ILMI procedures as defined by [Auto_PVC].

For switched VC connections, the LAC MAY select the peer LNS on the basis of connection establishment information, or by allowing partial PPP authentication of the virtual Dial-in user. The connection establishment information that can be used by the LAC include Called Party AESA, Called Party AESA Subaddress, Calling Party AESA or Calling Party AESA Subaddress.

For Permanent VC connections, the LAC MAY be triggered by (a) the establishment of the PVC, (b) by an LCP configure request, (c) by partially authenticating the virtual Dial-in user, or (d) by means outside the scope of this specification.

Within the ICRQ, the LAC MUST indicate a broadband bearer in the Bearer Type AVP (B bit set to 1), MAY include the Service Category AVP, and MAY include the Service Name AVP. If the LNS would not support the B Bearer bit, it will return an error on the ICRQ message. In such a case, the implementation MAY decide to fall back to digital bearer capability, and SHOULD refrain from using the extensions defined within this document. Further, the ICRQ message MAY contain the VPI/VCI identifier AVP. This identifier can further be used at the LNS for management purposes next to or alternative to the Physical Channel ID AVP.

Within the ICCN, both Tx Connect Speed AVP and Rx Connect Speed SHOULD be used if an asymetric connection has been established.

3.3.2 Outgoing Call Establishment

Within an OCRQ, the LNS MUST indicate to the LAC minimum and maximum speeds for receive and transmit traffic (from the LAC perspective). This is to allow for the bi-directional asymmetric nature of ATM traffic contracts. Note that in order to support UBR connections between LAC and user, the Minimum BPS MUST be set to zero.

Further during OCRQ, the LNS MAY include the required Service Category AVP, i.e., indicating real time (rt) or non-real time (nrt) transport services. The combination of minimum and maximum receive and transmit speed, and the indication of the required service category allows the LAC to establish an ATM connection according to its own capabilities, and the ATM access network capabilities, however within the service requirement for the PPP layer.

Real time connectivity can be provided by either CBR or rt-VBR ATM service categories, non-real time connectivity can be provided by UBR, nrt-VBR, ABR or GFR ATM service categories.

Further the LNS MUST indicate to the LAC in OCRQ message the called number according to the format described in this document (NSAP format). When the called number carries an all zero payload, the LAC SHOULD look at the Service Name AVP to bind the tunnel call to an ATM VC connection.

Next to the normal AVPs, the OCRP message MAY contain the VPI/VCI identifier AVP. This identifier can further be used at the LNS for management purposes next to or alternative to the Physical Channel ID AVP.

3.4 Framing

Within this document the PPP PDU refers to the concatenation of PPP protocol ID, PPP Information and PPP padding fields.

In the direction of user to LNS, the PPP PDU will be carried on top of an AAL5 connection between user and LAC. The LAC MUST strip off the AAL5 specific fields based on the encapsulation mechanism in use on the ATM connection, i.e. VC multiplexed or LLC encapsulated [RFC2364], and MUST encapsulate the PPP PDU with address and control field, as per HDLC procedures, on the L2TP tunnel.

In the direction of LNS to user, the PPP PDU will be carried on top of an AAL5 connection between LAC and user. The LAC MUST strip the PPP PDU from the address and control field on the L2TP tunnel, and

insert the AAL5 specific fields based on the encapsulation mechanism in use on the ATM connection, i.e. VC multiplexed or LLC encapsulated.

4. Service model issues

4.1 Authentication

In case of ATM switched VC establishment, calling party number information may be used for first level authentication much in the same way as for PSTN or ISDN access. In case of permanent VC establishment, authentication may not be an issue from the LAC side, because of the permanent character of the VC. Bilateral agreement between LAC and LNS providers may eliminate the authentication phase in the latter case.

4.2 Authorization

Because of the flexibility of establishing ATM connections with varying parameters, some authorization may be required prior to accepting the establishment of a switched ATM connection from the user with certain ATM traffic parameters. This authorization may be performed against the ATM specific authentication information (e.g. calling line id), or may be performed after partial authentication of the user at the PPP level. Non authorized access requests result in connection release.

5. New and extended AVPs

5.1 New AVP Summary

The following table lists the extra AVPs that are defined within this document. The "attr" column indicates the integer value assigned to this attribute. Note that the attribute value is relative compared to the vendor ID. The "M" column indicates the setting of the "Mandatory" bit of the AVP header for each attribute. The "LEN" column indicates the size of the AVP including the AVP header. A "+" in this column indicates that the length varies depending upon the length of the actual contents of the value field.

The usage list for each entry indicates the message types that utilize each AVP. An abbreviation shown in mixed or upper case letters indicates that the corresponding AVP MUST be present in this message type. All lower case indicates that the AVP MAY optionally appear in this message type. Some AVPs MAY be present only when a corresponding optional AVP or specific setting within the AVP is present, these AVPs are shown in lower case as well.

Attr	M	Len	Attribute Name (usage)
40	0	10	Rx Minimum BPS (ocrq)

32-bit integer indicating the lowest acceptable line speed for the call in the receive direction. Rx indicates the user to LAC direction.

41	0	10	Rx Maximum BPS (ocrq)

32-bit integer indicating the highest acceptable line speed for call in the receive direction. Rx indicates the user to LAC direction.

42	0	8	Service Category (ocrq, icrq)

The Service Category indicates the service expected for the call, e.g., real time or non-real time.

43	0	6+	Service Name (ocrq, icrq)

The Service Name indicates the service name linked to a preestablished PVC.

44	0	26	Calling Sub-Address(icrq)

20 octet binary encoded NSAP subaddress indicating the Calling Party Sub-Address.

45	0	10	VPI/VCI identifier (icrq, ocrp)

10 octet binary encoded identification of VPI/VCI values used for incoming calls.

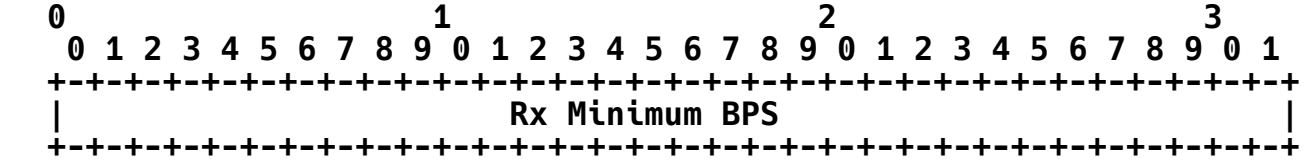
5.2 New AVP definition

The following lists the new AVPs defined within this document, and describes the expected behaviour when this AVP would be present within a message.

Rx Minimum BPS (OCRQ)

The Rx Minimum BPS, Attribute Type 40, encodes the lowest acceptable line speed for this call in the receive direction, for these cases where asymmetric transmission is required.

The Attribute Value field for this AVP has the following format:



The Rx Minimum BPS is a 32 bit value indicating the speed in bits per second.

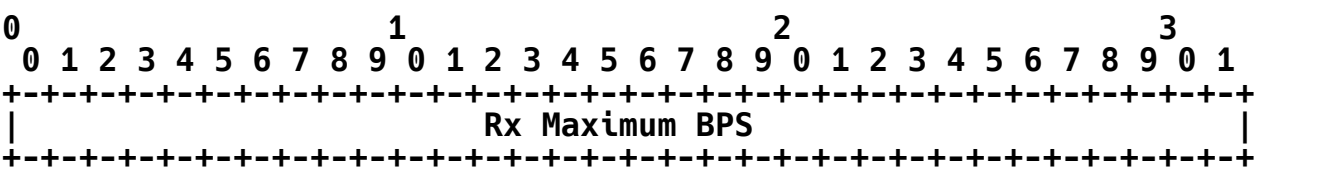
This AVP MAY be included within the OCRQ, and SHOULD only be included when the LAC indicated broadband bearer support in the bearer capabilities AVP during tunnel establishment.

This AVP may be hidden (the H-bit may be set to 0 or 1). The M- bit for this AVP must be set to 0. The Length (before hiding) of this AVP is 10.

Rx Maximum BPS

The Rx Maximum BPS, Attribute Type 41, encodes the highest acceptable line speed for this call in the receive direction, for these cases where asymmetric transmission is required.

The Attribute Value field for this AVP has the following format:



The Rx Maximum BPS is a 32 bit value indicating the speed in bits per second.

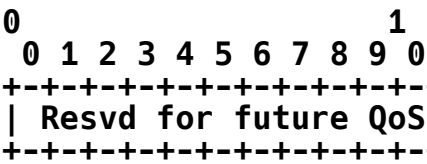
This AVP MAY be included within the OCRQ, and SHOULD only be included when the LAC indicated broadband bearer support in the bearer capabilities AVP during tunnel establishment.

This AVP may be hidden (the H-bit may be set to 0 or 1). The M- bit for this AVP must be set to 0. The Length (before hiding) of this AVP is 10.

Service Category

The Service Category AVP, Attribute type 42, indicates optional extra information on the Quality of Service expected for the call establishment on the broadband bearer medium.

The Attribute Value field for this AVP has the following format:



The Attribute Value field is a 16-bit mask, with one bit defined. The S bit indicates either non real time (S bit set to 0) or real time (S bit set to 1) service requirement. The other bit fields are reserved for future use.

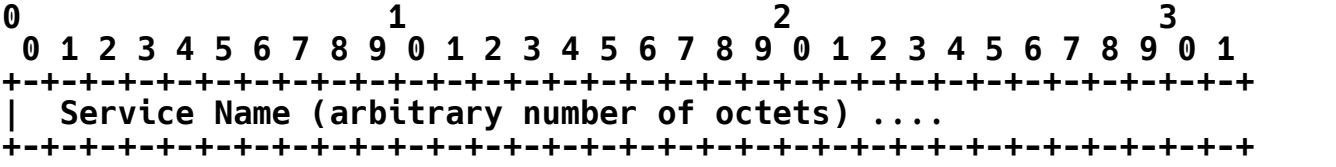
The Service Category AVP MAY be present in OCRQ and ICRQ messages, and SHOULD only be included when the LAC indicated broadband bearer support in the bearer capabilities AVP during tunnel establishment.

This AVP may be hidden (the H-bit may be set to 0 or 1). The M- bit for this AVP must be set to 0. The Length (before hiding) of this AVP is 8.

Service Name

The Service Name AVP, Attribute Type 43, provides the peer with an textual name for referring to an ATM VC connection.

The Attribute Value field for this AVP has the following format:



The Service Name is of arbitrary length, but must be at least 1 octet. The Service Name is UTF-8 encoded. [10646]

The Service Name should be unique at least to the LNS/LAC combination.

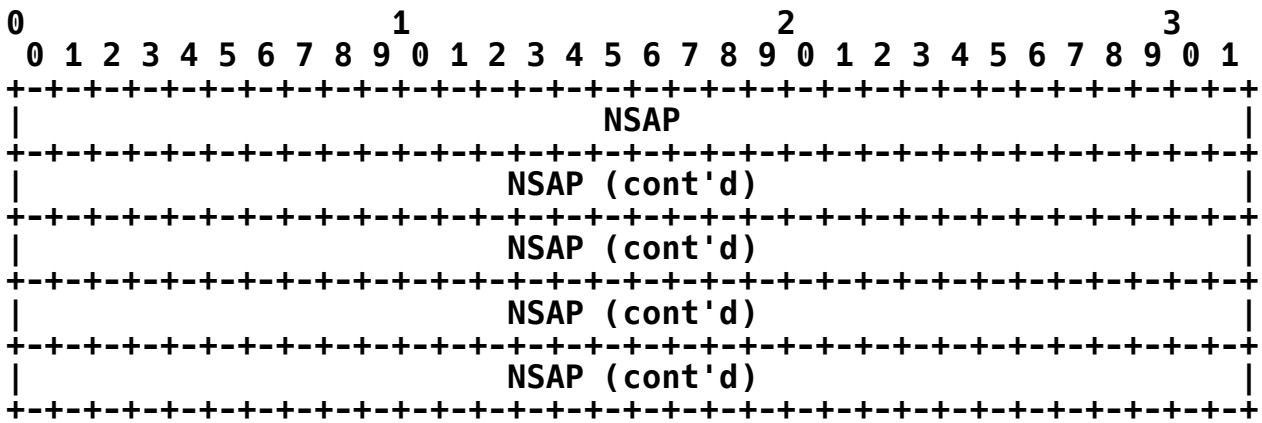
The Service Name AVP MAY only be provided when the Called Number field is encoded as all zeros in OCRQ. The Service Name AVP MAY be present in OCRQ and ICRQ messages, and SHOULD only be included when the LAC indicated broadband bearer support in the bearer capabilities AVP during tunnel establishment.

This AVP may be hidden (the H-bit may be set to 0 or 1). The M- bit for this AVP must be set to 0. The length of this attribute is arbitrary, however at least 7.

Calling Sub-Address (ICRQ)

The Calling Sub-Address AVP, Attribute Type 44, encodes additional Calling Party subaddress information.

The Attribute Value field for this AVP has the following format:



The Calling Sub-Address AVP MUST be encoded as a 20 octet binary encoded NSAP address when the B bit is set in the Bearer Type AVP. The NSAP binary encoded address provides a broader range of address encapsulation methods than an ASCII field. The structure of the NSAP address (e.g., E.164, ICD, DCC) is defined in [AESA].

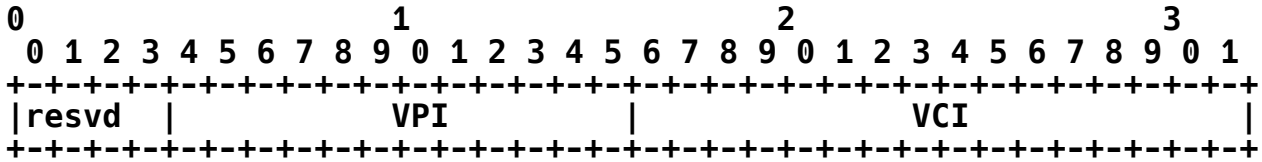
The Calling Sub-Address number AVP MAY be present in ICRQ, and SHOULD only be available if the Calling Party number is also within the message.

This AVP may be hidden (the H-bit may be 0 or 1). The M-bit for this AVP MUST be set to 0. The Length (before hiding) of this AVP is 26.

VPI/VCI identifier(icrq, ocrp)

The VPI/VCI identifier, Attribute Type 45, encodes the VPI/VCI value used at the ATM interface at the LAC.

The Attribute Value field for this AVP has the following format:



The VPI/VCI identifier is a 32 bit value encoding the VPI(12 bits) and VCI (16 bits) value.

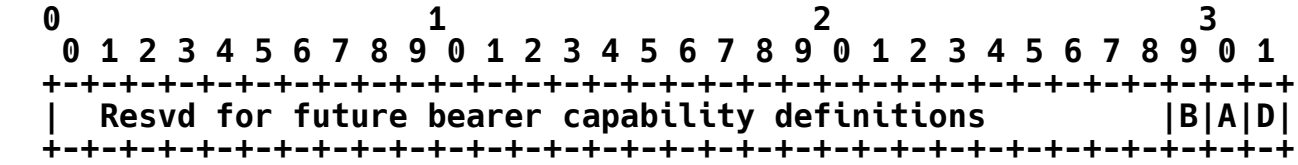
This AVP MAY be included within the ICRQ and OCRP, and SHOULD only be included when the LAC indicated broadband bearer support in the bearer capabilities AVP during tunnel establishment.

This AVP may be hidden (the H-bit may be set to 0 or 1). The M- bit for this AVP must be set to 0. The Length (before hiding) of this AVP is 10.

5.3 Changed AVP Definition

The following AVPs see their contents changed relative to [RFC2661] in order to support the procedures described in this document.

Bearer Capabilities



The bearer Capabilities AVP within a SCCRQ or SCCRP indicates the bearer capabilities that the sender of this message can provide for outgoing calls. This document extends the existing AVP with the B bit. If bit B is set, broadband access is supported (ATM).

Attempts to establish an outgoing call with the bearer type set to B, while the bearer capability did not indicate this capability will result in the call being rejected with Result Code 5 'Call failed due to lack of appropriate facilities being available (permanent condition)'.

In these cases where the LAC only supports the B bit, and the LNS would not recognize the B bit, no outgoing calls are possible. Note that when the LAC only has ATM based devices, it may still opt for seamless fall back to digital bearer types.

This specification assumes a non-compliant LNS to categorize a Bearer Capabilities AVP where the B bit is set as unrecognized AVP, upon which the tunnel establishment will fail. This is to be indicated by a Result Code '2-General error - Error Code indicates the problem', Error Code '3- Reserved field was non-zero'.

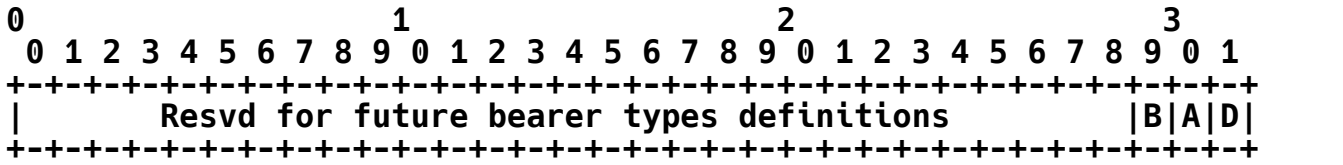
(Tx) Minimum BPS

The (Tx) Minimum BPS AVP encodes the lowest acceptable line speed for this call in the transmit direction. The (Tx) Minimum BPS AVP MAY be used in OCRQ. If the Rx Minimum BPS AVP, as defined within this document, is not available in the message, then symmetric transmission is implied, with both minimum receive and transmit bit-rates equal to Minimum BPS.

(Tx) Maximum BPS

(Tx) Maximum BPS AVP encodes the highest acceptable line speed for this call in the transmit direction. The (Tx) Maximum BPS AVP MAY be used in OCRQ. If the Rx Maximum BPS AVP, as defined within this document, is not available in the message, then symmetric transmission is implied, with both maximum receive and transmit bitrates equal to Maximum BPS.

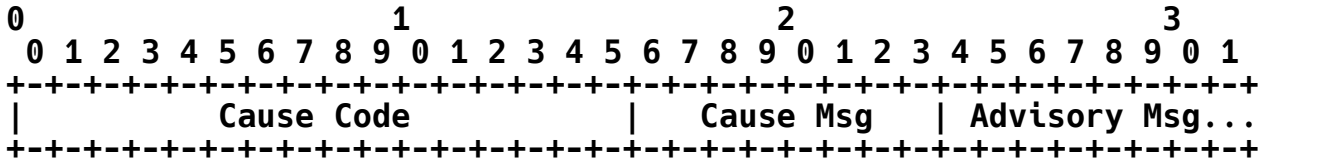
Bearer Type



The bearer type AVP encodes the bearer type for the requested call. This document extends the bearer types with an indication of ATM bearer support (B-bit). If bit B is set, broadband access is requested (ATM). If bit A is set, analogue access is requested. If bit D is set, Digital access is requested.

Note that in the OCRQ all 3 bits (B,A,D) may be set indicating that the call may be of either type. The B bit SHOULD only be set if the Broadband capability was indicated during tunnel establishment.

Q.931 Cause Code



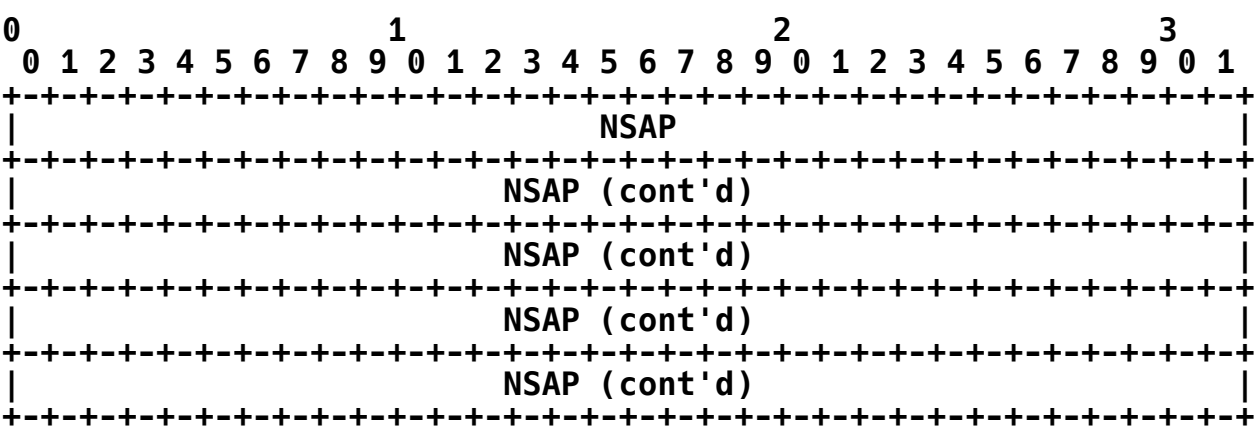
The Cause code is not changed from [RFC2661], except for the fact that it can also carry Cause Codes specific to ATM signalling messages, these cause codes can be found in ATM

Forum UNI 4.0 [UNI] and the references thereof. The Cause code should be interpreted relative to the Bearer Type in use for the specific call.

Called Number

The Called Number AVP, Attribute Type 21, encodes the AESA number to be called for an OCRQ, and the Called number at the LAC for an ICRQ.

The Attribute Value field for this AVP has a changed encoding from [RFC2661]:



The Called Number AVP MUST be encoded as a 20 octet binary encoded NSAP address when the B bit is set in the Bearer Type AVP. The NSAP binary encoded address provides a broader range of address encapsulation methods than an ASCII field. The structure of the NSAP address (e.g., E.164, ICD, DCC) is defined in [AESA].

The Called number AVP MUST be present in OCRQ, and MAY be present in ICRQ.

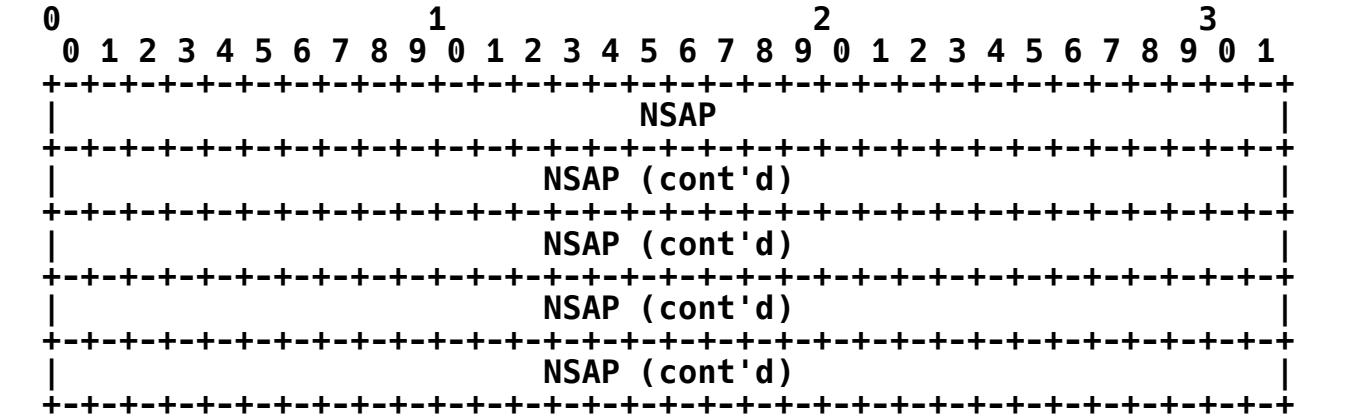
If the Called Number AVP in an OCRQ carries an all zero NSAP address, the Service Name AVP SHOULD provide further information to bind the L2TP call to a specific VC connection. See also [Auto_PVC].

This AVP may be hidden (the H-bit may be 0 or 1). The M-bit for this AVP MUST be set to 0. The Length (before hiding) of this AVP is 26.

Calling Number

The Calling Number AVP, Attribute Type 22, encodes the Calling Party AESA as received from the Virtual Dial-in User.

The Attribute Value field for this AVP has a changed encoding from [RFC2661]:



The Calling Number AVP MUST be encoded as a 20 octet binary encoded NSAP address when the B bit is set in the Bearer Type AVP. The NSAP binary encoded address provides a broader range of address encapsulation methods than an ASCII field. The structure of the NSAP address (e.g., E.164, ICD, DCC) is defined in [AESA].

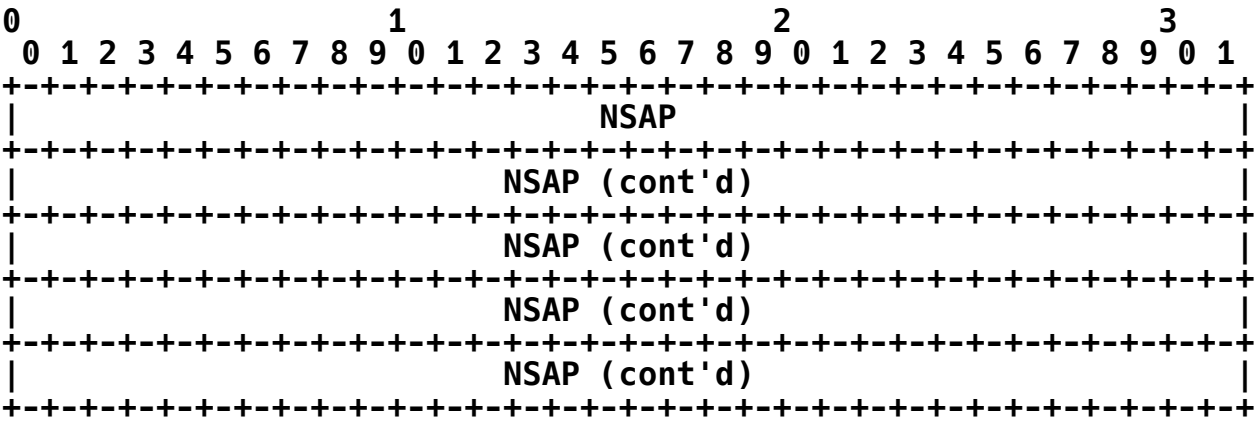
The Calling number AVP MAY be present in ICRQ.

This AVP may be hidden (the H-bit may be 0 or 1). The M-bit for this AVP MUST be set to 0. The Length (before hiding) of this AVP is 26.

Sub-Address

The Sub-Address AVP, Attribute Type 23, encodes additional Called Party subaddress information.

The Attribute Value field for this AVP has a changed encoding from [RFC2661]:



The Sub-Address AVP MUST be encoded as a 20 octet binary encoded NSAP address when the B bit is set in the Bearer Type AVP. The NSAP binary encoded address provides a broader range of address encapsulation methods than an ASCII field. The structure of the NSAP address (e.g., E.164, ICD, DCC) is defined in [AESA].

The Sub-Address number AVP MAY be present in ICRQ and OCRQ, and SHOULD only be available if the Called Party number is also within the message.

This AVP may be hidden (the H-bit may be 0 or 1). The M-bit for this AVP MUST be set to 0. The Length (before hiding) of this AVP is 26.

6. IANA Considerations

This document requires IANA to allocate 6 new type values for the following AVPs (see section 5.2) :

- Rx Minimum BPS
- Rx Maximum BPS
- Service Category
- Service Name
- Calling Sub-Address
- VPI/VCI Identifier

This document further defines a new bit (B) in the bearer capabilities and bearer type AVPs (section 5.3).

This document defines a flag field in the Service Category AVP, only one bit in this flag has been assigned within this document (S). Further assignments fall under the rule of "Specification Required", i.e. Values and their meaning must be documented in an RFC or other permanent and readily available reference, in sufficient detail so that interoperability between independent implementations is possible.

7. Security Considerations

No extra security risk outside these specified by [RFC2661] are foreseen.

8. Acknowledgements

The authors would like to thank Laurent Hermans for his work on earlier versions of this document, Juha Heinanen (Telia) and David Allen (Nortel Networks) for their constructive discussion on the document during the Minneapolis IETF meeting, Mark Townsley (cisco) for his hint on the use of the VPI/VCI identifier AVP.

9. References

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11. Full Copyright Statement

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