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A YANG Data Model for Attachment Circuit as a Service with UDP Tunnel Support
draft-jlu-dmm-udp-tunnel-acaas-01

Abstract

Delivery of network services over a Layer 3 tunnel assumes that the appropriate setup is provisioned over links that connect the customer termination points and provider network. The required setup to allow successful data exchange over these links is referred to as an attachment circuit (AC) while the underlying link for carrying network services is referred to as "bearer", in this case a Layer 3 UDP tunnel.

This document specifies an extension for UDP tunnel as Layer 3 bearer to the YANG service data model for AC.

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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1. Introduction

Connectivity services provided by networks to customers ensure the transfer of data between termination points via a provider network. The objectives of the connectivity service can be negotiated and agreed between customers and network providers. To facilitate data transfer within the provider network, it is assumed that the appropriate setup is provisioned over links that connect customer termination points and provider network (usually via Provider Edges (PEs)). This is referred to as attachment circuit (AC) and the underlying link defined in this document is a UDP tunnel as Layer 3 bearer. In general, a bearer can be described as a physical or logical link that connects a customer node (or site) to a provider network. [I-D.ietf-opsawg-teas-attachment-circuit] describes further details of bearers and 'Attachment Circuits'-as-a-service.

[I-D.ietf-opsawg-teas-attachment-circuit] specifies YANG data models for bearers and 'Attachment circuits'-as-a-service ACaaS. Layer 3 UDP tunnel as bearer is not defined in the ACaaS specification and is an extension defined in this document. An example of Layer 3 UDP tunnel as a bearer is in 5G networks where a GTP-U (UDP) bearer is used to transport datagrams of a mobile end-user between 3GPP user plane functions. Section 2 describes the "ietf-ac-udpt" YANG module for Layer 3 UDP tunnel service. Section 3 describes the UDP tunnel

YANG data model. An example of UDP Tunnel with source port number to identify bearers at the transport network Provider Edge (PE) is provided in Appendix B.

2. Attachment Circuit for UDP Tunnel

[I-D.ietf-opsawg-teas-attachment-circuit] defines a YANG service model for AC based on layer 2 bearers. This document extends the YANG service model for AC in [I-D.ietf-opsawg-teas-attachment-circuit] to support UDP tunnels.

The 'l3-service' and 'l3-tunnel-service' in the AC structure in [I-D.ietf-opsawg-teas-attachment-circuit] is used to configure the relevant layer 3 tunnel properties of a UDP tunnel AC. IPv4 and IPv6 properties of the UDP tunnel AC are provided in the "ip-connection" container (Section 5.2.5.2 of [I-D.ietf-opsawg-teas-attachment-circuit]). The extension below adds source port number and range for the UDP tunnel.

The meanings of the symbols in the YANG tree diagram are defined in "YANG Tree Diagrams" [RFC8340].

```
module: ietf-ac-udpt

  augment /ac-svc:attachment-circuits/ac-svc:ac/ac-svc:ip-connection
          /ac-svc:l3-service/ac-svc:l3-tunnel-service
          /ac-svc:l3-tunnel-service:

    +--rw (udp-port)?
       +--:(port-range-or-operator)
          +--rw source-port-range-or-operator
             +--rw (port-range-or-operator)?
                +--:(range)
                |  +--rw lower-port    inet:port-number
                |  +--rw upper-port    inet:port-number
                +--:(operator)
                   +--rw operator?     operator
                   +--rw port          inet:port-number
```

Figure 1: UDP Tunnel Yang Module

'l3-tunnel-service' in Section 5.2.5.2 of [I-D.ietf-opsawg-teas-attachment-circuit] is extended in this document to specify UDP source port number or a range port numbers.

Also, this document defines a new identity (called 'udp') based on the base identity 'l3-tunnel-type' defined in Section 4.2 of [I-D.ietf-opsawg-teas-common-ac].

3. ietf-ac-udp-tunnel YANG Module

The "ietf-ac-udp-tunnel" module uses types and groupings defined in [I-D.ietf-opsawg-teas-common-ac], [I-D.ietf-opsawg-teas-attachment-circuit], and [RFC8519].

<CODE BEGINS> file "ietf-ac-udp-tunnel@2025-09-18.yang"

```
module ietf-ac-udp-tunnel {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-ac-udp-tunnel";
  prefix ac-udpt;

  import ietf-ac-common {
    prefix ac-common;
    reference
      "RFC 9833: A Common YANG Data Model for Attachment Circuits";
  }
  import ietf-ac-svc {
    prefix ac-svc;
    reference
      "RFC 9834: YANG Data Models for Bearers and 'Attachment
                 Circuits'-as-a-Service (ACaaS)";
  }
  import ietf-packet-fields {
    prefix packet-fields;
      reference
        "RFC 8519: YANG Data Model for Network Access
                   Control Lists (ACLs), Section 4.2";
  }

  organization
    "IETF DMM (Distributed Mobility Management)";
  contact
    "WG Web:   <https://datatracker.ietf.org/wg/dmm/>
     WG List:  <mailto:dmm@ietf.org>

     Author:   John Kaippallimalil
               <mailto:john.kaippallimalil@futurewei.com>";
  description
    "This YANG module defines a YANG model for augmenting
     the ACaaS service model with UDP Encapsulation as
     Layer 3 tunnel service.

     Copyright (c) 2025 IETF Trust and the persons identified as
```

```
        authors of the code.  All rights reserved.

        Redistribution and use in source and binary forms, with or
        without modification, is permitted pursuant to, and subject
        to the license terms contained in, the Revised BSD License
        set forth in Section 4.c of the IETF Trust's Legal Provisions
        Relating to IETF Documents
        (https://trustee.ietf.org/license-info).

        All revisions of IETF and IANA published modules can be found
        at the YANG Parameters registry group
        (https://www.iana.org/assignments/yang-parameters).

        This version of this YANG module is part of RFC XXXX; see the
        RFC itself for full legal notices.";

      revision 2025-09-18 {
        description
          "Initial revision.";
        reference
          "RFC XXXX: A YANG Data Model for Attachment Circuit
                     as a Service with UDP Tunnel Support";
      }

      identity udp {
        base ac-common:l3-tunnel-type;
        description
          "UDP Encapsulation.";
        reference
          "RFC 8085: UDP Usage Guidelines, Section 3.1.11";
      }

      augment "/ac-svc:attachment-circuits/ac-svc:ac"
            + "/ac-svc:ip-connection/ac-svc:l3-service"
            + "/ac-svc:l3-tunnel-service/ac-svc:l3-tunnel-service" {
        when "derived-from-or-self(./type, 'ac-udpt:udp')" {
          description
            "Only applicable if l3 service type is UDP encapsulation.";
        }
        description
          "Augments Layer 3 AC service with required data nodes for
           UDP encapsulation support.";
         choice udp-port {
           description
             "Choice of specifying the source port number or referring
              to a group of port numbers.";
           container source-port-range-or-operator {
             description
```

```
                "Indicates a set of source ports numbers.";
              uses packet-fields:port-range-or-operator;
            }
          }
        }
      }
    }
    <CODE ENDS>
```

Figure 2: UDP Tunnel YANG Module

Note to RFC Editor:

Replace "RFC XXXX" with the RFC number to be assigned to this document.

4. Acknowledgements

Thanks to Mohamed Boucadair for the review and comments.

5. Security Considerations

This section is modeled after the template described in Section 3.7 of [I-D.ietf-netmod-rfc8407bis].

The "ietf-ac-udp-tunnel" YANG module defines a data model that is designed to be accessed via YANG-based management protocols, such as NETCONF [RFC6241] and RESTCONF [RFC8040]. These YANG-based management protocols (1) have to use a secure transport layer (e.g., SSH [RFC4252], TLS [RFC8446], and QUIC [RFC9000]) and (2) have to use mutual authentication.

Servers MUST verify that requesting clients are entitled to access and manipulate a given bearer or AC. For example, a given customer must not have access to bearers (attachment circuits) of other customers. The Network Configuration Access Control Model (NACM) [RFC8341] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

The data nodes in the YANG model in this document inherits from [I-D.ietf-opsawg-teas-attachment-circuit], and the security constraints to the data structures there apply. Data nodes defined in the ietf-ac-udp-tunnel YANG module are writable/creatable/ deletable (i.e., config true, which is the default). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations (e.g., edit-config) and delete operations to these data nodes without proper protection or authentication can have a negative effect on network operations. The

'udp-port' information may be used to track a customer of the slice service and may be considered a violation of the customer-provider trust relationship.

6. IANA Considerations

IANA is requested to register the following URI in the "ns" subregistry within the "IETF XML Registry" [RFC3688]:

URI: urn:ietf:params:xml:ns:yang:ietf-ac-udp-tunnel

Registrant Contact: The IESG.

XML: N/A; the requested URI is an XML namespace.

IANA is requested to register the following YANG module in the "YANG Module Names" subregistry [RFC6020] within the "YANG parameters" registry.

Name: ietf-ac-udp-tunnel

Maintained by IANA? N

Namespace: urn:ietf:params:xml:ns:yang:ietf-ac-udp-tunnel

Prefix: ac-udp-tunnel

Reference: RFC XXXX

7. References

7.1. Normative References

[I-D.ietf-opsawg-teas-attachment-circuit]
Boucadair, M., Roberts, R., de Dios, O. G., Barguil, S., and B. Wu, "YANG Data Models for Bearers and 'Attachment Circuits'-as-a-Service (ACaaS)", Work in Progress, Internet-Draft, draft-ietf-opsawg-teas-attachment-circuit-20, 23 January 2025, <https://datatracker.ietf.org/doc/html/draft-ietf-opsawg-teas-attachment-circuit-20>.

[I-D.ietf-opsawg-teas-common-ac]
Boucadair, M., Roberts, R., de Dios, O. G., Barguil, S., and B. Wu, "A Common YANG Data Model for Attachment Circuits", Work in Progress, Internet-Draft, draft-ietf-opsawg-teas-common-ac-15, 23 January 2025, <https://datatracker.ietf.org/doc/html/draft-ietf-opsawg-teas-common-ac-15>.

[RFC8519] Jethanandani, M., Agarwal, S., Huang, L., and D. Blair, "YANG Data Model for Network Access Control Lists (ACLs)", RFC 8519, DOI 10.17487/RFC8519, March 2019, <https://www.rfc-editor.org/info/rfc8519>.

7.2. Informative References

[I-D.ietf-netmod-rfc8407bis]
Bierman, A., Boucadair, M., and Q. Wu, "Guidelines for Authors and Reviewers of Documents Containing YANG Data Models", Work in Progress, Internet-Draft, draft-ietf-netmod-rfc8407bis-28, 5 June 2025, <https://datatracker.ietf.org/doc/html/draft-ietf-netmod-rfc8407bis-28>.

[RFC3688] Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, DOI 10.17487/RFC3688, January 2004, <https://www.rfc-editor.org/info/rfc3688>.

[RFC4252] Ylonen, T. and C. Lonvick, Ed., "The Secure Shell (SSH) Authentication Protocol", RFC 4252, DOI 10.17487/RFC4252, January 2006, <https://www.rfc-editor.org/info/rfc4252>.

[RFC6020] Bjorklund, M., Ed., "YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF)", RFC 6020, DOI 10.17487/RFC6020, October 2010, <https://www.rfc-editor.org/info/rfc6020>.

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[RFC8040] Bierman, A., Bjorklund, M., and K. Watsen, "RESTCONF Protocol", RFC 8040, DOI 10.17487/RFC8040, January 2017, <https://www.rfc-editor.org/info/rfc8040>.

[RFC8340] Bjorklund, M. and L. Berger, Ed., "YANG Tree Diagrams", BCP 215, RFC 8340, DOI 10.17487/RFC8340, March 2018, <https://www.rfc-editor.org/info/rfc8340>.

[RFC8341] Bierman, A. and M. Bjorklund, "Network Configuration Access Control Model", STD 91, RFC 8341, DOI 10.17487/RFC8341, March 2018, <https://www.rfc-editor.org/info/rfc8341>.

[RFC8446] Rescorla, E., "The Transport Layer Security (TLS) Protocol Version 1.3", RFC 8446, DOI 10.17487/RFC8446, August 2018, <https://www.rfc-editor.org/info/rfc8446>.

[RFC8972] Mirsky, G., Min, X., Nydell, H., Foote, R., Masputra, A., and E. Ruffini, "Simple Two-Way Active Measurement Protocol Optional Extensions", RFC 8972, DOI 10.17487/RFC8972, January 2021, <https://www.rfc-editor.org/info/rfc8972>.

[RFC9000] Iyengar, J., Ed. and M. Thomson, Ed., "QUIC: A UDP-Based Multiplexed and Secure Transport", RFC 9000, DOI 10.17487/RFC9000, May 2021, <https://www.rfc-editor.org/info/rfc9000>.

[RFC9543] Farrel, A., Ed., Drake, J., Ed., Rokui, R., Homma, S., Makhijani, K., Contreras, L., and J. Tantsura, "A Framework for Network Slices in Networks Built from IETF Technologies", RFC 9543, DOI 10.17487/RFC9543, March 2024, <https://www.rfc-editor.org/info/rfc9543>.

Appendix A. Abbreviations

AC	Attachment Circuit
CE	Customer Edge
GTP-U	General Packet Radio Service (GPRS) Tunneling Protocol - User plane (3GPP)
GW	Gateway
NSC	Network Slice Controller
PE	Service Function
SF	Provider Edge
SMO	Service Management and Orchestration
TN	Transport Network
UDP	User Datagram Protocol

Appendix B. Example

This example is adapted from Appendix A.7 of [I-D.ietf-opsawg-teas-attachment-circuit] where details of the topology and service are described. Figure 3 describes the end-to-end network topology as well as orchestration scope:

* The topology is made up of two sites ("site1" and "site2"), interconnected via a Transport Network (e.g., IP/MPLS network). An SF is deployed within each site in a dedicated IP subnet.

* A 5G Service Management and Orchestration (SMO) is responsible for the deployment of SFs and the indirect management of a local Gateway (i.e., CE).

* An IETF Network Slice Controller (NSC) [RFC9543] is responsible for the deployment of IETF Network Slices across the Transport Network.

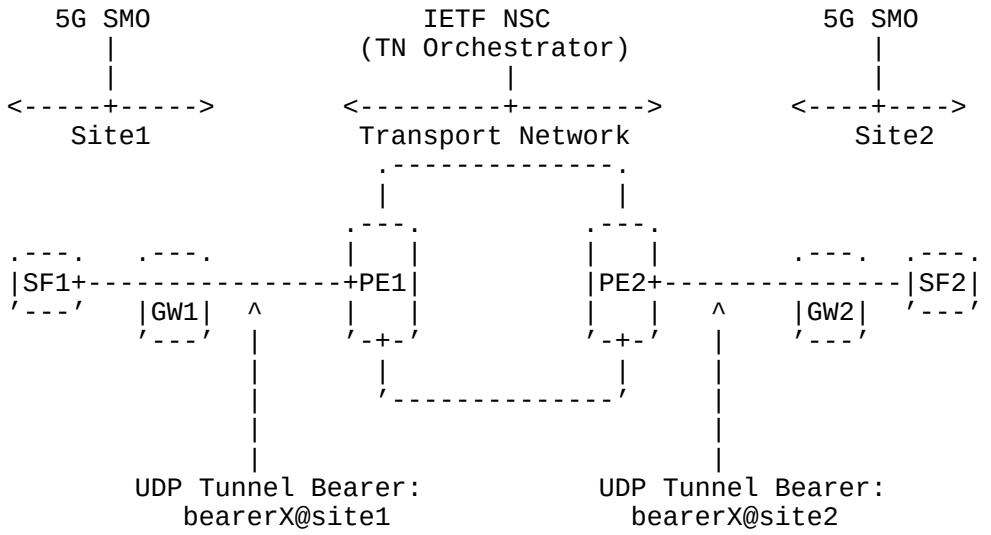
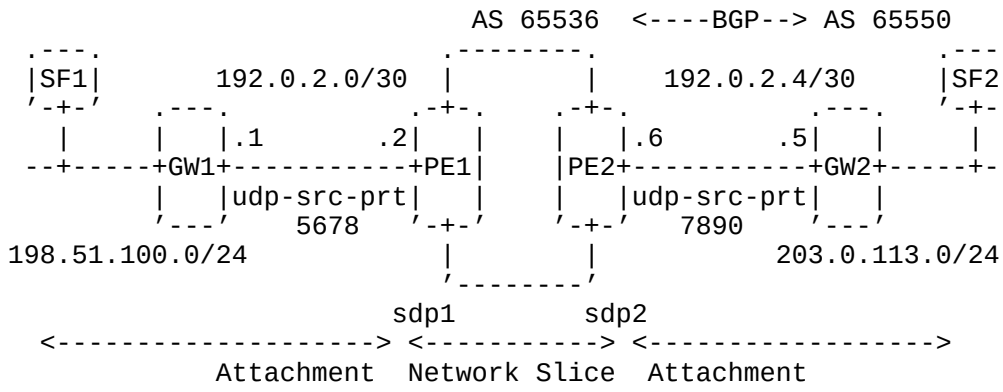


Figure 3: An example of a Network Topology to Deploy Slices with UDP Tunnel Bearer

Figure 4 describes the logical connectivity enforced with IETF Network slice and ACaaS models with UDP tunnel bearer identified by the UDP source port number.



* "ac1" properties:
- bearer-reference: bearerX@site1
- udp-src-prt: 5678
- CE address (SF1): 198.51.100.0/24
- PE address: 192.0.2.2/30
- Routing: static 198.51.100.0/24 via
  192.0.2.1 tag primary_UP_slice

* "ac2" properties:
- bearer-reference: bearerY@site2
- udp-src-prt: 7890
- CE address (SF2): 203.0.113.0/24
- PE address: 192.0.2.6/30
- Routing: BGP local-as: 65536 (Provider ASN)
  peer-as: 65550 (customer ASN)
  remote-address: 192.0.2.5 (Customer address)

Figure 4: Logical Overview

Figure 5 is an adaptation of A.7, Figure 41 in [I-D.ietf-opsawg-teas-attachment-circuit] with a UDP Tunnel bearer identified by the source port number.

=============== NOTE: '\' line wrapping per RFC 8792 ================

```
{
  "ietf-ac-svc:attachment-circuits": {
    "ac": [
      {
        "name": "ac1",
        "description": "Connection to site1 on vlan 100",
```

```
          "requested-start": "2023-12-12T05:00:00.00Z",
          "l2-connection": {
            "bearer-reference": "bearerX@site1"
          },
          "ip-connection": {
            "ipv4": {
              "address-allocation-type": "ietf-ac-common:static-\
                                                              address"
            },
            "l3-service" {
              "l3-tunnel-service": "ietf-ac-udpt:udp"
            }
          },
          "routing-protocols": {
            "routing-protocol": [
              {
                "id": "1",
                "type": "ietf-vpn-common:static-routing",
                "static": {
                  "cascaded-lan-prefixes": {
                    "ipv4-lan-prefix": [
                      {
                        "lan": "198.51.100.0/24",
                        "next-hop": "192.0.2.1",
                        "lan-tag": "primary_UP_slice"
                      }
                    ]
                  }
                }
              }
            ]
          }
        },
        {
          "name": "ac2",
          "description": "Connection to site2 on vlan 200",
          "requested-start": "2023-12-12T05:00:00.00Z",
          "l2-connection": {

            "bearer-reference": "bearerY@site2"
          },
          "ip-connection": {
            "ipv4": {
              "address-allocation-type": "ietf-ac-common:static-\
                                                              address"
            },
            "l3-service" {
              "l3-tunnel-service": "ietf-ac-udpt:udp"
```

```
            }
          },
          "routing-protocols": {
            "routing-protocol": [
              {
                "id": "1",
                "type": "ietf-vpn-common:bgp-routing",
                "bgp": {
                  "neighbor": [
                    {
                      "id": "1",
                      "peer-as": 65550
                    }
                  ]
                }
              }
            ]
          }
        }
      ]
    }
  }
```

Figure 5: Message Body of a Request to Create AC with UDP Tunnel

Figure 6 is an adaptation of A.7, Figure 42 in [I-D.ietf-opsawg-teas-attachment-circuit] that shows the message body of that response to a GET request received from the controller.

```
    {
     "ietf-ac-svc:attachment-circuits": {
       "ac": [
         {
           "name": "ac1",
           "description": "Connection to site1 on vlan 100",
           "actual-start": "2023-12-12T05:00:00.00Z",
           "l2-connection": {
             "bearer-reference": "bearerX@site1"
           },
           "ip-connection": {
             "ipv4": {
               "local-address": "192.0.2.2",
               "prefix-length": 30,
               "address": [
                 {
                   "address-id": "1",
```

```
                    "customer-address": "192.0.2.1"
                  }
                ]
              },
              "l3-service" {
                "l3-tunnel-service": "ietf-udpt:udp",
                "ietf-ac-udpt:source-port-range-or-operator" {
                    "port": 5678
                }
              }
            }
          },
          "routing-protocols": {
            "routing-protocol": [
              {
                "id": "1",
                "type": "ietf-vpn-common:static-routing",
                "static": {
                  "cascaded-lan-prefixes": {
                    "ipv4-lan-prefix": [
                      {
                        "lan": "198.51.100.0/24",
                        "next-hop": "192.0.2.1",
                        "lan-tag": "primary_UP_slice"
                      }
                    ]
                  }
                }
              }
            ]
          }
        },
        {
          "name": "ac2",
          "description": "Connection to site2 on vlan 200",
          "actual-start": "2023-12-12T05:00:00.00Z",
          "l2-connection": {
            "bearer-reference": "beareY@site2"
          },
          "ip-connection": {
            "ipv4": {
              "local-address": "192.0.2.6",
              "prefix-length": 30,
              "address": [
                {
                  "address-id": "1",
                  "customer-address": "192.0.2.5"
                }
```

```
                ]
              },
              "l3-service" {
                "l3-tunnel-service": "ietf-udpt:udp",
                  "ietf-ac-udpt:source-port-range-or-operator" {
                      "port": 7890
                  }
                }
              }
            },
            "routing-protocols": {
              "routing-protocol": [
                {
                  "id": "1",
                  "type": "ietf-vpn-common:bgp-routing",
                  "bgp": {
                    "neighbor": [
                      {
                        "id": "1",
                        "peer-as": 65550,
                        "local-as": 65536
                      }
                    ]
                  }
                }
              ]
            }
          }
        ]
      }
```


Figure 6: Example of a Message Body of a Response Indicating Creation of the ACs

Figure 7 is derived from A.7, Figure 43 in [I-D.ietf-opsawg-teas-attachment-circuit]. Figure 7 shows the message body of the request to create a Slice Service bound to the ACs created using Figure 5. Only references to these ACs are included in the Slice Service request.

```
{
  "ietf-network-slice-service:network-slice-services": {
    "slo-sle-templates": {
      "slo-sle-template": [
        {
          "id": "low-latency-template",
          "description": "Lowest latency forwarding behavior"
        }
      ]
    },
    "slice-service": [
      {
        "id": "Slice URLLC_UP",
        "description": "Dedicated TN Slice for URLLC-UP",
        "slo-sle-template": "low-latency-template",
        "status": {},
        "sdps": {
          "sdp": [
            {
              "id": "sdp1",
              "ac-svc-name": [
                "ac1"
              ]
            },
            {
              "id": "sdp2",
              "ac-svc-name": [
                "ac2"
              ]
            }
          ]
        }
      }
    ]
  }
}
```


Figure 7: Example of a Message Body of a Response Indicating Creation of the ACs

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