Network Working Group   F. Adrangi, Intel
INTERNET DRAFT   P. Congdon, C. Black, Hewlett Packard
Category: Informational   A. Lior, Bridgewater Systems
Expires: Dec 2004   F. Bari, AT&T Wireless
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Network Bandwidth Parameters
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Abstract

This document describes bandwidth profile parameters and a
protocol framework that enables an AAA server to specify the
parameters that should be allocated by the access network for
duration of an authorized user session.

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1. Introduction

   The bandwidth that a user is authorized within an access network
   can be a result of the access network capabilities based on its
   architecture and access technology, and the type of user
   subscription to the home network (e.g., gold, silver, bronze user
   types).

   This document describes a simple protocol framework that enables
   an access network to advertise its network bandwidth capabilities
   that it can allocate for a given client connection. And, it
   enables the home network to indicate the desired network bandwidth
   capabilities for the user connection within the access network.

   User bandwidth can be determined during initial authentication
   authorization of the session. It is also desirable to change the
   bandwidth mid-session. For example, the user may want to purchase
   additional bandwidth to download a large file. This document
   enables operators to dynamically modify the bandwidth allocation
   for a session.

   This document defines new AAA attributes that can optionally be
   used for the following;

. Conveying bandwidth parameters to the home network that an
  access network can allocate for a given user session

. Conveying the desired bandwidth parameters from the home
  network that should be allocated by the access network for
  the duration of the user session.

These attributes are also used for reporting the allocated
bandwidth in accounting records. The attributes are described for
RADIUS [1], but works as is also in Diameter [RFC 3588], and
through the translation rules defined in [Diameter NASREQ].

1.2 Requirements language

In this document, several words are used to signify the
requirements of the specification. These words are often
capitalized. 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. Overview

This section describes the bandwidth parameters and the protocol
by which these parameters can be exchanged between a NAS and the
AAA server to help the access network determine the bandwidth
parameters that should be allocated for the userÆs connection by
the access.

2.1 Bandwidth Parameters

Bandwidth Profile parameters consists of four parameters: minimum
bandwidth, and maximum bandwidth specified both for ingress and
egress. The following subsections describe these parameters.

2.1.1 Minimum Bandwidth for ingress and egress

It indicates the minimum peak ingress/egress data rate that the
authorized user should get within the access network. This
value is a target, rather than a guarantee.

2.1.2 Maximum Bandwidth for ingress and egress

It indicates the average maximum ingress/egress data rate that
an access network can allow to an authorized user.

2.2 Protocol

Two protocols are described. One protocol is used to allocate
bandwidth when a service is initiated (referred to as Static
Bandwidth Allocation); the other protocol describes how to change

bandwidth attribute dynamically that is, mid-session (also
referred to as Dynamic Bandwidth Allocation).

Both protocols exchange bandwidth parameters using the various
AAA messages, and they are comprised of three phases: bandwidth
Advertisement, Selection, and Confirmation.

Bandwidth Advertisement:

   MAY be sent in Access-Request packet in RADIUS, and the AAR
   and DER commands in Diameter [Diameter NASREQ, Diameter EAP],
   from the NAS to the home AAA server. The attributes convey
   possible/available bandwidth parameters that can be allocated
   for the access network client connection to the AAA server by
   the NAS.

Bandwidth Selection:

   MAY be sent in Access-Accept packet and Change of
   Authorization (COA) messages in RADIUS. MAY also be sent in
   RAR command in Diameter [4]. Selection conveys the desired
   bandwidth parameters for an access network client connection
   to the NAS by the home AAA server.

Bandwidth Confirmation:

   If Bandwidth Selection is received and enforced, the
   attributes MUST be sent in Accounting-Request packets in
   RADIUS and in ACR command in Diameter. Confirmation indicates
   that the desired bandwidth parameters specified by a home
   network are being enforced by the access network.

The Bandwidth Attributes, defined in section 3, are used to carry
the Bandwidth Advertisement, Selection, Confirmation in various
RADIUS packets and Diameter commands.

An Advertisement, Selection, Confirmation is said to be valid if
it contains the four aforementioned bandwidth parameters. For a
valid Advertisement, Selection or Confirmation, the minimum
bandwidth rate values for ingress and egress traffic MUST be
equal or less than their corresponding maximum bandwidth rate
values.

If a Selection is sent in response to an Advertisement, for the
Selection to be considered valid, the bandwidth parameters in the
Selection MUST NOT exceed the corresponding bandwidth parameters
in the Advertisement. A bandwidth rate value of zero in
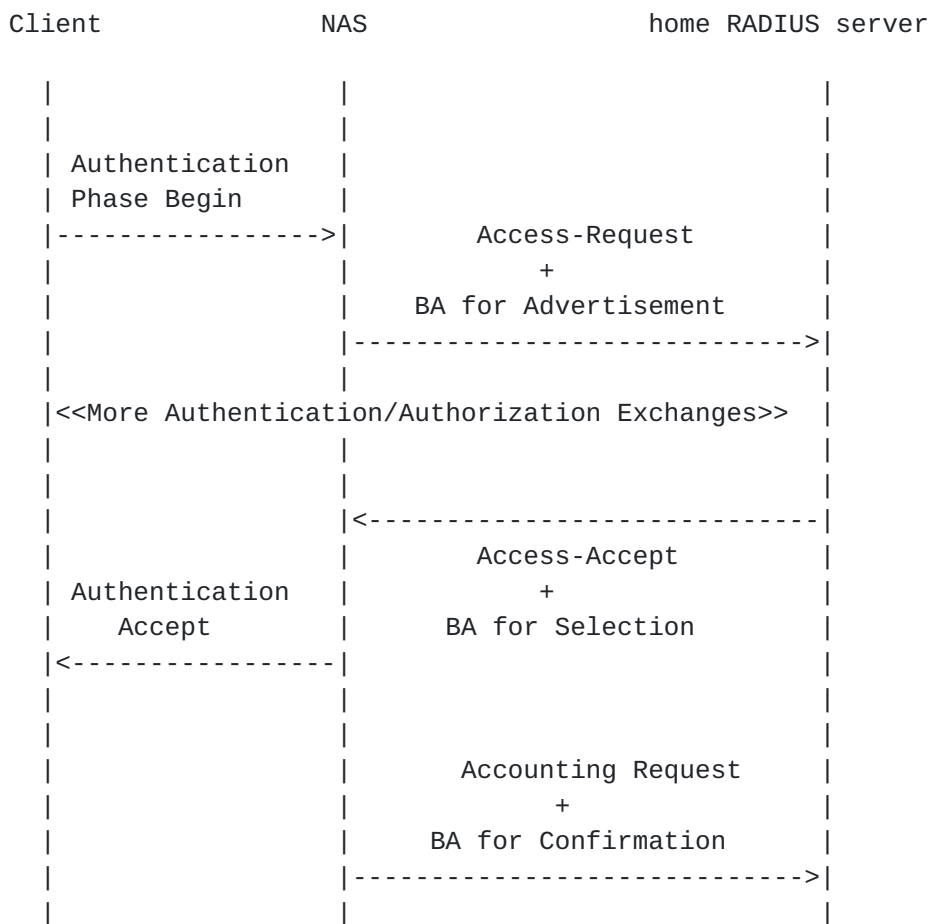
Selection should be interpreted as a ödonÆt careö value.

The following subsections describe static and dynamic bandwidth
allocation.

2.2.1 Static Bandwidth Allocation

Static bandwidth allocation is performed during the initial
session authentication / authorization.

The following diagram shows the protocol interaction between
the NAS and the home RADIUS server for determining network
bandwidth rates that an access network needs to allocate for a
client connection within the access network.

```
   Client                NAS                     home RADIUS server

      |                   |                        |
      |                   |                        |
      | Authentication    |                        |
      | Phase Begin       |                        |
      |----------------->|        Access-Request   |
      |                   |              +          |
      |                   |       BA for Advertisement |
      |                   |------------------------------>|
      |                   |                        |
      |<<More Authentication/Authorization Exchanges>>  |
      |                   |                        |
      |                   |                        |
      |                   |<------------------------------|
      |                   |          Access-Accept  |
      | Authentication    |              +          |
      |    Accept         |       BA for Selection  |
      |<-----------------|                        |
      |                   |                        |
      |                   |                        |
      |                   |        Accounting Request |
      |                   |              +          |
      |                   |       BA for Confirmation |
      |                   |------------------------------>|
      |                   |                        |
```

The NAS MAY send an Advertisement in an Access-Request message.
If the home RADIUS server receives an invalid Advertisement,
then the RADIUS server MUST silently discard the Access-
Request.

A home RADIUS server MAY send the Selection after receiving a
valid Advertisement. It MAY also send the Selection in the
absence of an Advertisement, based on local policies such as

the clientÆs subscription profile. When the NAS receives an invalid Selection, it MUST treat the Access-Accept message as an Access Reject.

If the NAS receives a valid Selection in response to an Access-Request that did not contain an Advertisement, then the NAS MAY honor the Selection.

If the NAS receives a valid Selection in response to an Access-Request that contained a valid Advertisement, then the NAS MUST honor the Selection.

In the absence of a Selection after sending a valid Advertisement, in accordance with local policy, the access network MAY enforce its default bandwidth rate values or it MAY use öbest effortö bandwidth for that client connection.

2.2.2 Dynamic Bandwidth Allocation

Dynamic bandwidth allocation uses the Change of Authorization (COA) RADIUS message as defined in [3], and the Diameter RAR message as defined in [4]. These messages are referred to as the re-authorization messages in this specification.

In accordance with [3] there are two methods for dynamically changing authorization attributes of a session. These two methods are described in this section.

At anytime during the session the home AAA server may send the NAS a re-authorization message containing session identification attributes (see [3] for the possible options). The re-authorization message may include authorization attributes in which case it is "pushing" the bandwidth attributes to the NAS. Or, it may instruct the NAS to generate an authorize-only AAA exchange to "pull" the bandwidth attributes. In RADIUS this exchange is an Access-Request with Service-Type set to "Authorize-Only". In Diameter it is the AAR command with the Auth-Request-Type AVP set to AUTHORIZE_ONLY.

In either "push" or "pull" method, upon successful acceptance of the new bandwidth parameters for the session, the NAS MUST generate an Accouting-Stop record that contains the old bandwidth attributes followed by an Accounting-Start message that contains the new bandwidth attributes.

In order to allow for downstream correlation of the accounting records, an NAS that supports dynamic bandwidth allocation MUST

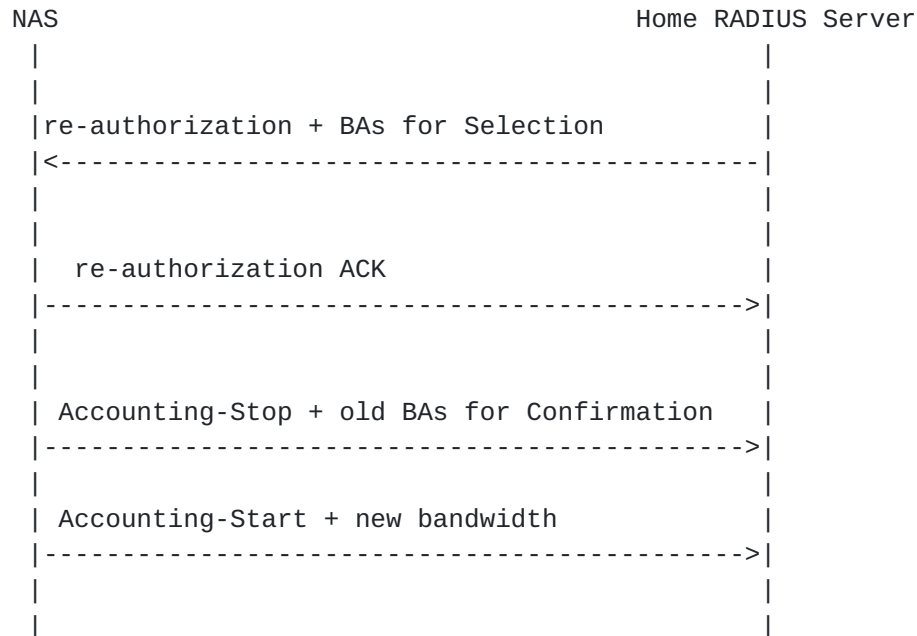include Acct-Multi-Session-Id when writing accounting records.

2.2.2.1 Push Method

In the Push Method, to effect a dynamic bandwidth change the home RADIUS server sends a re-authorization message and includes a valid Selection. The RADIUS server MAY also include other attributes in the re-authorization message.

```
    NAS                                       Home RADIUS Server
     |                                                |
     |                                                |
     |re-authorization + BAs for Selection            |
     |<-----------------------------------------------|
     |                                                |
     |                                                |
     |   re-authorization ACK                         |
     |----------------------------------------------->|
     |                                                |
     |                                                |
     | Accounting-Stop + old BAs for Confirmation     |
     |----------------------------------------------->|
     |                                                |
     | Accounting-Start + new bandwidth               |
     |----------------------------------------------->|
     |                                                |
     |                                                |
```

Upon the successful reception of the re-authorization message (see [3] for details) by the NAS, if the re-authorization message contains an invalid Selection, the NAS MUST respond with a re-authorization NAK with Error Cause (101) set to öInvalid Requestö (404).

If the NAS is able to offer the requested bandwidth to the specified session, the NAS MUST reply with a re-authorization ACK and it MUST generate an Accounting-Stop record containing the old bandwidth attributes followed by an Accounting-Start record containing the new bandwidth attributes. If the NAS can not comply with the request for new bandwidth it MUST reply with re-authorization NAK with Error Cause (101) set to "Resources Unavailable"(506).

If the NAS receives a re-authorization message that does not include Bandwidth attributes then the NAS must not alter the bandwidth already allocated to the session.

   2.2.2.2 Pull Method

        Alternatively, in the pull method, to effect a dynamic
        bandwidth change, as per [3], the home network sends a re-
        authorization message to instruct the AN to generate an
        Authorize-Only request (Access-Request with Service-Type set
        to Authorize-Only).

   NAS   Home RADIUS server
       | |
       | re-authorization + Service-Type = öAuthorize Onlyö |
       |<--|
       | |
       |re-authorization NAK + Service-Type = öAuthorize Onlyö|
       | + Error-Cause "Request Initiated" |
       |-->|
       | |
       | Access-Request + Service-Type öAuthorize Onlyö |
       | + BAs for Advertisement |
       |-->|
       | |
       | Access-Accept + BAs for Selection |
       |<--|
       | |
       | Accounting-Stop + old BAs for Confirmation |
       |-->|
       | |
       | Accounting-Start + new BAs for Confirmation |
       |-->|
       | |
       | |

        As with the static bandwidth allocation (described earlier),
        the AN MAY Advertise the currently available bandwidth in the
        Authorize-Only message.

        Upon receiving the Authorize-Only message from the AN, the
        RADIUS server MUST respond with either an Access-Accept
        message or an Access-Reject message.

        When responding with an Access-Accept message, the RADIUS
        server MAY include the BAs for Selection. If the Authorize-
        Only message included an Advertisement, the bandwidth
        parameters in Selection MUST be within the bounds of
        bandwidth parameters in the Advertisement received in the
        Authorize-Only message.

Upon receiving an Access-Reject in response to the Authorize-Only, the AN will terminate the session and send an Accounting-Stop record.

Upon receiving an Access-Accept in response to an Authorize-Only request that does not contain bandwidth Selection, the access network MUST allocate its default bandwidth rate values, and then the NAS MUST generate an Accouting-Stop record that contains the old bandwidth attributes followed by an Accounting-Start message that contains the new bandwidth attributes.

Upon receiving an Access-Accept packet that contains an invalid Bandwidth Selection, the AN MUST treat the response as an Access-Reject and immediately terminate the session.

Upon receiving an Access-Accept message in response to an Authorize-Only message that contained the Bandwidth Advertisement, then providing the bandwidth selections are within the bounds of the Advertisement, then AN MUST honor the requested bandwidth and generate an Accounting-Stop message that contains the old bandwidth attributes followed by an Account-Start message that contains the new bandwidth attributes. If the bandwidth Selection were outside the bounds of the Advertisement, then the AN MUST treat the Access-Accept as an Access-Reject and immediately terminate the session.

Upon receiving an Access-Accept message that contains a valid Selection in response to an Authorize-Only that did not contain the Advertisement, the AN MAY honor the Selection or it MAY continue to honor the previously agreed to bandwidth. In the former case, the AN must generate an Accounting Stop message containing the old bandwidth attributes followed by an Accounting-Start message containing the current bandwidth attributes.

2.3 Diameter RADIUS Interoperability

   In deployments where both RADIUS clients talking with Diameter
   Servers or Diameter Client talking with RADIUS server then a
   translation agent will be deployed and operate in accordance to
   the NASREQ specification.

3. Attribute Format/Syntax

   This section describes format and syntax for the attributes that
   carry the network bandwidth parameters. The attributes are used

for bandwidth parameters Advertisement, Selection, and
Confirmation.

   A summary of the AN Bandwidth Parameter Attributes is shown below.


```
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Type      |     Length    |      Value                   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Value              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```


   Type

       TBD - Ingress Average Minimum Bandwidth Rate

   Length

      6

   Value

   An integer value representing the ingress average minimum
   bandwidth rate in bytes per second.


```
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Type      |     Length    |      Value                   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |            Value              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```


   Type

       TBD - Ingress Average Maximum Bandwidth Rate

   Length

      6

   Value

   An integer value representing the egress average minimum

bandwidth rate in bytes per second

```
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Type       |     Length      |      Value                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             Value           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Type

    TBD Egress Average Minimum Bandwidth Rate

Length

    6

Value

An integer value representing the ingress average maximum
bandwidth rate in bytes per second


```
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Type       |     Length      |      Value                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             Value           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Type

    TBD Egress Average Maximum Bandwidth Rate

Length

    6

Value

An integer value representing the egress average maximum
bandwidth Rate in bytes per second

4. Table of Attribute(s)

The following table provides a guide to which attribute(s) may be
found in which kinds of packets, and in what quantity.

Request	Accept	Reject	Challenge	Accounting Request	#	Attribute
0-1	0-1	0	0	0-1	TBD	Ingress Minimum Band.
0-1	0-1	0	0	0-1	TBD	Ingress Maximum Band.
0-1	0-1	0	0	0-1	TBD	Egress Minimum Band.
0-1	0-1	0	0	0-1	TBD	Egress Minimum Band.

For Change-of-Authorization Messages

Request	ACK	NAK	#	Attribute
0-1	0	0	TBD	Ingress Minimum Bandwidth
0-1	0	0	TBD	Ingress Maximum Bandwidth
0-1	0	0	TBD	Egress Minimum Bandwidth
0-1	0	0	TBD	Egress Maximum Bandwidth

Note 1 : if the Change-of-Authorization message contains any
bandwidth attributes then all the bandwidth attributes received for
this session are overwritten. If the Change-of-Authorization
message does not contain any bandwidth attributes then, the
previously received bandwidth attributes remain in effect.

Note 2: if one of the attribute is included in a qualified RADIUS
packet, then all the three attributes MUST be included.

5. IANA Considerations

   This document requires the assignment of four new RADIUS attribute
   numbers for the following attribute(s):

      1) Ingress Average Minimum Bandwidth Rate
      2) Ingress Average Maximum Bandwidth Rate
      3) Egress Average Minimum Bandwidth Rate
      4) Egress Average Maximum Bandwidth Rate

   Please See section 3 for the registered list of numbers.

6. Security Considerations

The attributes in this document have no additional security
considerations beyond those already identified in [1].

7. Acknowledgements

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feedback and guidance.

8. References

[1] Rigney, C., Rubens, A., Simpson, W. and S. Willens, "Remote
    Authentication Dial In User Server (RADIUS)", RFC 2865, June
    2000.

[2] Rigney, C., "RADIUS Accounting", RFC 2866, June 2000.

[3] Chiba, M., Dommety, G., Eklud, M., Mitton, D., Aboba, B.,
    öDynamic Authorization Extensions to Remote Authentication
    Dial In User Service (RADIUS)ö, RFC 3576, July 2003.

[4] Calhoun, et al., ö Diameter Base Protocolö, RFC 3588,
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AuthorsÆ Addresses

  Farid Adrangi
  Intel Corporation
  2111 N.E. 25th Avenue
  Hillsboro OR
  USA

  Chuck Black
  ProCurve Networking Business
  Hewlett-Packard Company
  8000 Foothills Blvd
  Roseville, CA 95747

  Phone: +1 916 785 9713
  Fax: +1 916 785 1199
  Email: chuck.black@hp.com

Paul Congdon
        ProCurve Networking Business

Hewlett-Packard Company
8000 Foothills Blvd - MS 5662
Roseville, CA 95747

Phone: +1 916 785 5753
Fax: +1 916 785 8478
Email: paul.congdon@hp.com

Avi Lior
Bridgewater Systems Corporation
303 Terry Fox Drive
Suite 100
Ottawa, Ontario K2K 3J1
Canada

Farooq Bari
AT&T Wireless
7277 164th Avenue N.E.
Redmond WA
USA

Phone: +1 425-580-5526
EMail: farooq.bari@attws.com

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