Network Working Group
INTERNET-DRAFT
Category: Informational
draft-lior-radius-prepaid-extensions-03.txt
Expires: 16 July, 2004

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February 16, 2003

PrePaid Extensions to Remote Authentication Dial-In User Service (RADIUS)

Status of this Memo

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Abstract

The draft presents an extension to the Remote Authentication Dial-In User Service (RADIUS) protocol to support PrePaid data services for a wide range of deployments such as Dial, Wireless, WLAN. Consideration for roaming using mobile-ip is also given.

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1. Introduction

This draft describes RADIUS protocol extensions supporting PrePaid Data Services.

PrePaid data services are cropping up in many wireless and wireline based networks. A PrePaid Data Service subscriber is one that purchases a contract to deliver a data service for either a period of time, or a quantity of data. Before providing a prepaid data service, the service provider checks that the prepaid subscriber has sufficient funds to cover the particular service request. Only after confirmation that funds are available is the service provided to the user.

The subscriber purchases the Data Service using various means such as buying a PrePaid Card, or online. How the subscriber purchases their PrePaid Data Service depends on the deployment and is not in scope for this document.

In some deployments, the PrePaid data service will be combined with other Prepaid services such as PrePaid voice service. This is not an issue for this document other than the fact that the PrePaid Data Services described in this paper should work with other PrePaid data and or voice services.

The fundamental business driver for a carrier to provide PrePaid data services is to increase participation (subscriber base) and thus to increase revenues. Therefore, it makes sense that PrePaid services meet the following goals:

- Leverage existing infrastructure, hence reducing capital expenditures typically required when rolling a new service;
- Ability to rate service requests in real-time;
- Ability to check that the end userÆs account for coverage for the requested service charge prior to execution of that service;
- Protect against revenue loss, i.e., prevent an end user from generating chargeable events when the credit of that account is exhausted or expired;
- Protect against fraud;
- Be as widely deployable over Dialup, Wireless and WLAN networks.

The protocol described in this document maximizes existing infrastructure as much as possible ¡ hence the use of the RADIUS protocol. The protocol is used in ways to protect against revenue loss or revenue leakage. This is achieved by defining procedures for the real-time delivery of service information to a pre-paid enabled AAA server, to minimize the financial risk, for the pre-paid enabled AAA server to be able to allocate small quotas to each data session and having the ability to update the quotas from a central quota server dynamically during the lifetime of the PrePaid data session. As well, mechanisms have been designed to be able to recover from errors that occur from time to time.

Protection against fraud is provided by recording of accounting records, by providing mechanisms to thwart replay attacks. As well, mechanisms have been provided to terminate data sessions when fraud is detected.

PrePaid System will become more prevalent and sophisticated as the various networks such as Dialup, Wireless and WLAN converge. This protocol extension is designed to meet the challenges of converged networks. The draft mainly addresses how to use the RADIUS protocol to achieve a PrePaid Data Service. The prepaid architecture assumes that rating of chargeable events does not occur in the element providing the service. This rating could be performed in the prepaid enabled AAA server or may exist in an entity behind this AAA server. Business logic and service rules may define that tariffing of events vary in time, e.g., the particular price per megabyte download may be defined to switch at 8pm from a high tariff to a low tariff. The RADIUS extensions for prepaid support scenarios enable scalable implementation of tariff switched prepaid systems.

Furthermore, the prepaid architecture assumes that a quota server is available which, through co-ordination with the rating entity and centralized balance manager is able to provide a quota response in response for prepaid data service. This quota server functionality could be performed in the prepaid enabled AAA server or may exist in an entity behind this AAA server. Finally, the details of the PrePaid System, such as its persistent store, how it maintains its accounts are not covered at all. However, in order to define the RADIUS protocol extensions it is necessary to discuss the functional behavior of the PrePaid System.

1.1 Terminology

Access Device
PrePaid Client
PrePaid Server
Home agent (HA)
Home network
Home AAA (HAAA)
Broker AAA (BAAA)
Visited AAA (VAAA)
Foreign Agent (FA)
WLAN
Service Device

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. Architectural Model

The architectural model supports prepaid clients on either an access device or a service device. An access device (e.g. a NAS) typically provides a single service to end-users, corresponding to network access. The service device enables finer grain services to be defined. For example, a service may be defined for access to a particular destination network, which enables further segmentation of services within the network. An access device and service device may be combined into a single physical entity.

When pre-paid service is used the access or service device collects service event information and reports it while and/or after services are provided to the prepaid user. This event information is sent to a prepaid server by using the prepaid RADIUS extensions.

If real-time credit control is required, the access or service device (prepaid client) contacts the prepaid server with service event information included before the service is provided. The prepaid server, depending on the service event information, performs credit check and allocates a portion of available credit to the

service event. The rating entity converts this credit value into a time and/or volume amount, which is then returned to the requesting device. The rating entity may determine that during the allocated quota, a tariff switch will occur in which case the rating entity will include details of the quota allocated prior to the tariff switch, details of the quota allocated after the tariff switch together with details of when the tariff switch will occur.

The requesting device (either access or service device) then monitors service execution according to the instructions returned by the prepaid server. After service completion or on a subsequent request for service, the prepaid server deducts the reserved allocation of credit from the prepaid userÆs account.

Similarly, when a user terminates an on-going prepaid service, the prepaid client signals the prepaid server with the a value corresponding to the unused portion of the allocated quota. The prepaid server is then able to refund unused allocated funds into a userÆs prepaid account.

There MAY be multiple prepaid servers in the system for reasons of redundancy and load balancing. The system MAY also contain separate rating server(s) and accounts MAY locate in a centralized database. System internal interfaces can exist to relay messages between servers and an account manager. However the detailed architecture of prepaid system and its interfaces are implementation specific and are out of scope of this specification.

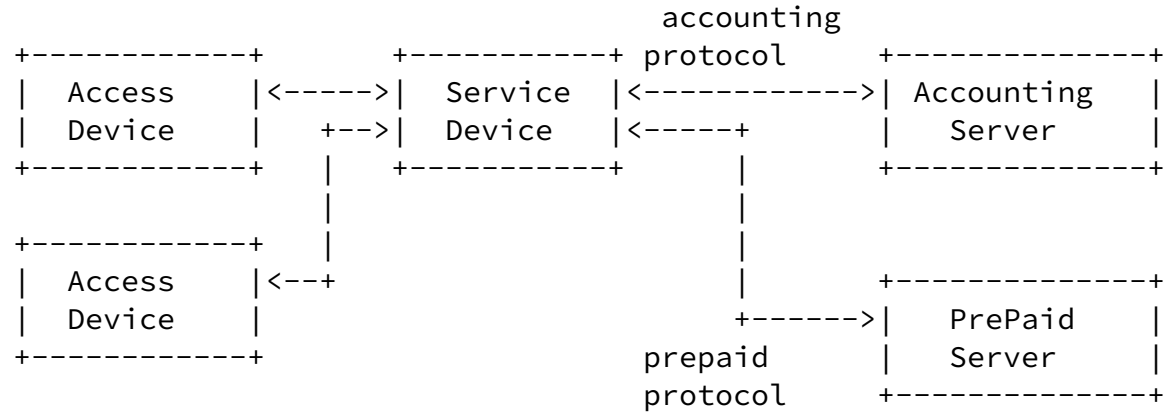


Figure 1 Basic Prepaid Architecture

The prepaid server and accounting server in this architecture model are logical entities. The real configuration MAY combine them into a single host.

There MAY exist protocol transparent RADIUS Proxies between prepaid client and prepaid server. These proxies transparently support the prepaid RADIUS extensions.

In order to generalize the solution, in this paper we generalize the Access Devices, which in reality may be a NAS from in Dialup deployments, PDSN in CDMA2000 deployments,an 802.11 WLAN Access Points or GGSN in GSM deployments. To actively participate in Prepaid procedures outlined here, the Access Device MUST have Prepaid Client capabilities. Prepaid Client Capabilities include the ability to meter the usage for a prepaid data session; this usage includes time or volume usage.

In circumstances when the Access Device does not support the Prepaid client capabilities, prepaid client functionality may be provided using either a stand alone service device or, in the case of roaming scenarios using mobile IP, the prepaid client functionality may be delegated to the Home Agent. It may also be possible to deliver limited prepaid services using RADIUS capabilities specified in RFC2865 and RFC2866.

Furthermore, the device including the prepaid client functionality may also have Dynamic Session Capabilities that include the ability to terminate a data session and/or change the filters associated with a specific data session by processing Disconnect Messages and Change of Filter messages as per [RFC3576].

In this document RADIUS is used as the AAA server. There are three kinds or categories of AAA servers. The AAA server in the home network, the HAAA, is responsible for authentication of the subscriber and also authorization of the service. In addition, the HAAA communicates with the Prepaid servers using the RADIUS protocol to authorize prepaid subscribers. In AAA based roaming deployments the AAA server in the visited network, the VAAA, is responsible for forwarding the RADIUS messages to the HAAA. The VAAA may also modify the messages. In roaming deployments, the visited network may be separated from the home network by one or more broker networks. The AAA servers in the broker networks, BAAA are

responsible to route the RADIUS packets and hence donÆt play an active roll in the Prepaid Data Service delivery.

In this document the Prepaid Server is described in functional terms related to their interface with the HAAA. The Prepaid Server interfaces to entities which:

i) Keep the accounting state of the prepaid subscribers (balance manager);
ii) Allow service requests to be rated in real-time (Rating Engine); and
iii) Allow quota to be managed for a particular pre-paid service (Quota Server).

The various deployments for Prepaid are presented in the remainder of this section. The first deployment is the basic Prepaid data service and is depicted in figure 2. Here the Access Device which supports the prepaid client functionality, the HAAA and the Prepaid Server are collocated in the same provider network.

The Subscriber Device establishes a connection with one of several Access Devices in the network. The Access Device communicates with one or more HAAA servers in the network. To provide redundancy more then one HAAA is available to use by an Access Device.

The network will have one or more Prepaid Servers. Multiple Prepaid Servers will be used to provide redundancy and load sharing. The interface between the HAAA and the PPS is the RADIUS protocol in this specification. However, in cases where the PPS does not implement the RADIUS protocol, the implementation would have to map the requirements defined in this document to whatever protocol is used between the HAAA and the PPS.

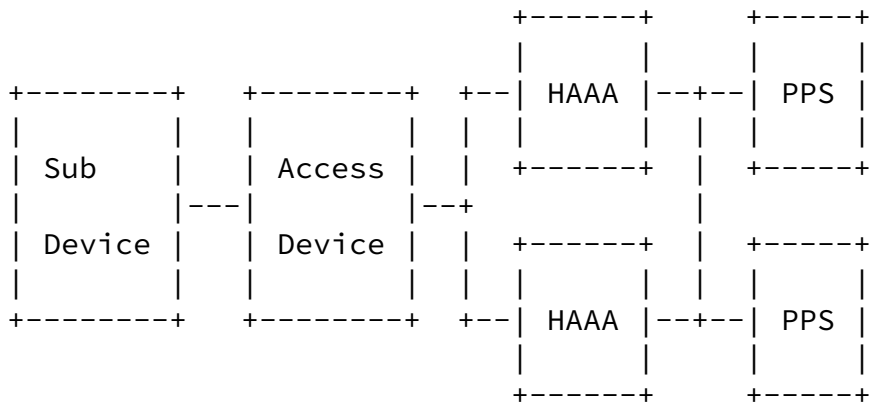


Figure 2 Basic Prepaid Access Architecture

In the second deployment scenario, the Access Device does not support the prepaid client functionality. Instead an independent Service Device provides prepaid client functionality as depicted in figure 3. Here the Access Device which dose not supports the prepaid client functionality is configured as AAA client to the AAA proxy functionality in the Service Device. The Service device, which supports the prepaid client functionality then appends prepaid extensions in the AAA requests proxied to the HAAA.

The Subscriber Device establishes a connection with one of several Access Devices in the network. The Authentication and Authorization requests from the Access Device are proxied through the Service Device which then appends prepaid extensions on to the requests. The Service Device communicates with one or more HAAA servers in the network. The Service Device is responsible for removing prepaid extensions from messages received from the HAAA before proxying them on to the Access Device. To provide redundancy more then one Service Devices are available to use by an Access Device and more than one HAAA is available for use by the Service Device. The Service Device is configured to be default gateway to the Access Device, enabling all traffic to be correctly metered.

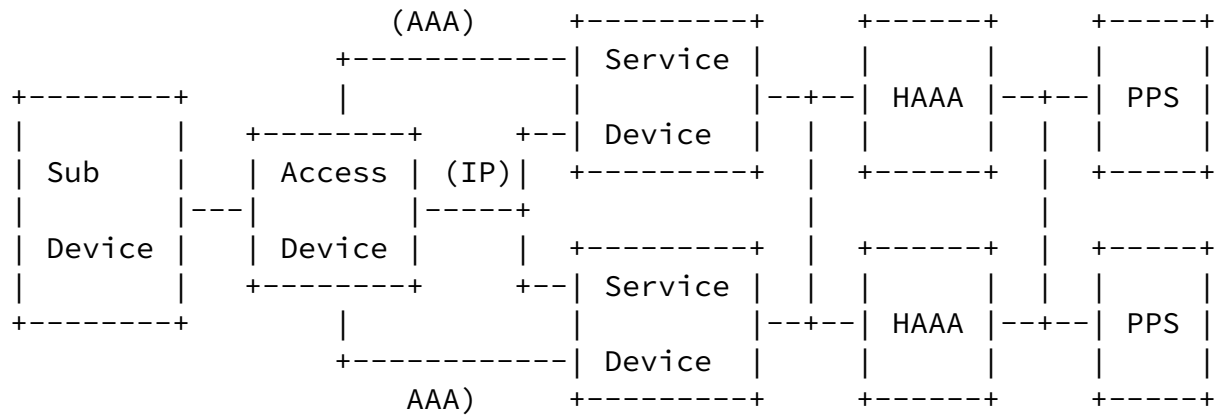


Figure 3 Prepaid Service Architecture

The following figure 4 shows a static roaming prepaid architecture that is typical of a wholesale scenario for Dial-Up users or a broker scenario used in Dial-Up or WLAN roaming scenarios.

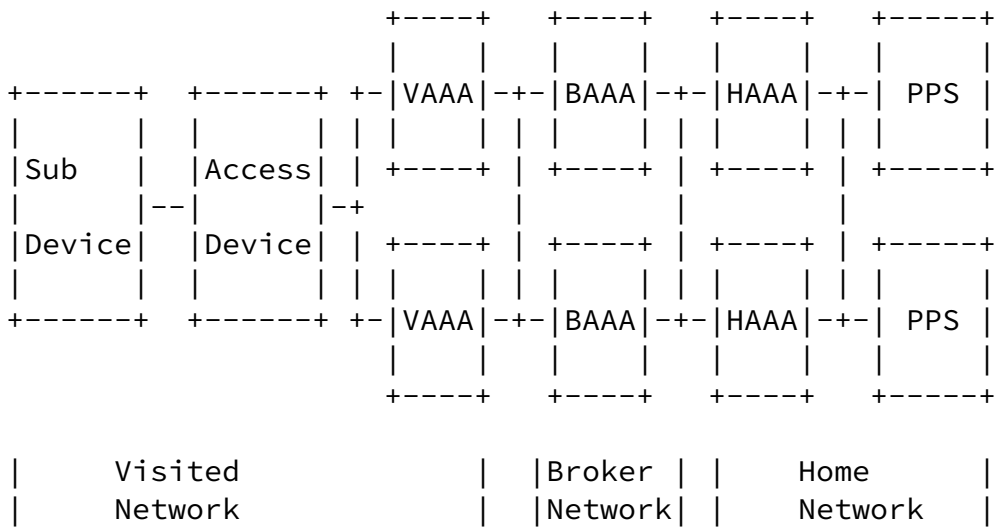


Figure 4 Static Roaming Prepaid Architecture

As in the basic prepaid architecture the subscriberÆs device establishes a connection with the Access Device (NAS, WLAN Access Point). The Access Device communicates with the Visiting AAA server (VAAA) using the RADIUS protocol. Again for redundancy there maybe more then one VAAA. The VAAA communicate using the RADIUS protocol with AAA servers in the broker network (BAAA). There maybe more then one Broker Network between the Visited Network and the Home

Network. The Home Network is the same as in the simple architecture.

To support dynamic roaming the network will utilize mobile-ip. Figure 5 illustrates a typical mobile-ip deployment. Note that typically the mobile device would be moving between networks that use the same technology such as Wireless or WLAN. Increasingly, device will be able to roam between networks that use different technology such as between WLAN and Wireless and Broadband. Fortunately, mobile-ip can address this type of roaming and therefore we need not be concerned with the underlying network technology.

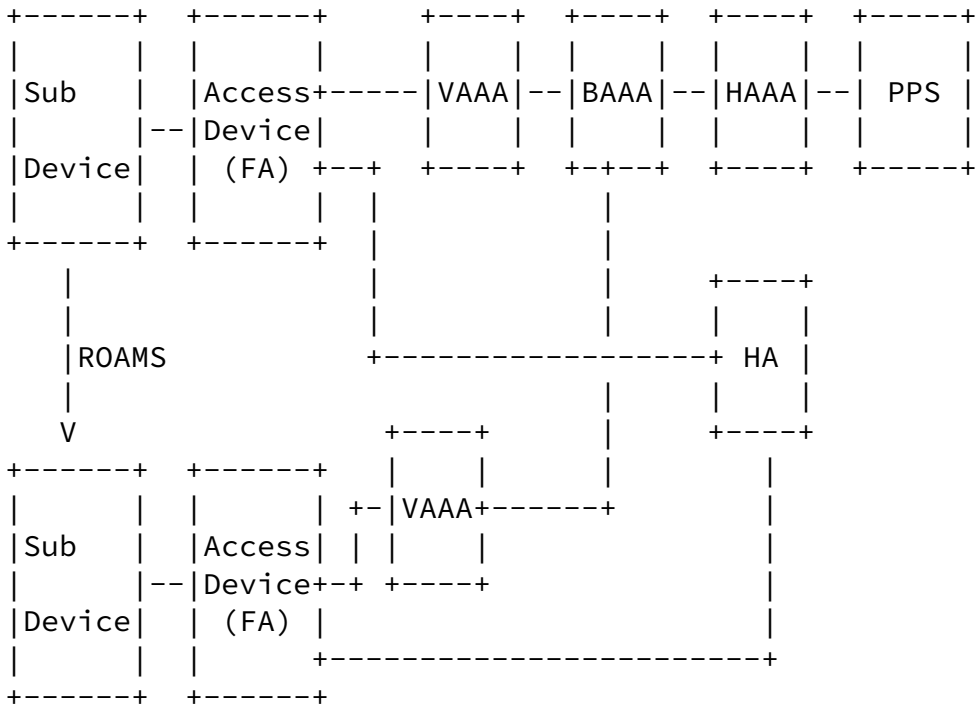


Figure 5 Roaming using mobile-ip and pre-paid enabled Access Devices

In figure 5, the Subscriber device establishes a prepaid session between the Access Device in the foreign network, which has prepaid capabilities and the Home Agent (HA). The setup for this service is identical to the cases covered above. Notice that the Access Device is known as the Foreign Agent (FA). As the subscriber device moves

to another network it establishes a connection with another Access Device in another foreign network. The prepaid data service should continue to be available. When a device associates to another Access Device it MUST re-authenticate at the new Access Device and de-associate or logoff the old Access Device. Furthermore, any unused quota at the old Access Device MUST be promptly credited back to the subscribers account. The reason we say promptly, is because if the subscriber is very low on resources to start with, the subscriber may not have enough resources to log on to the new Access Device. The speed at which resources can be returned depend on the type of handoff procedure that is used: dormant handoff vs. active handoff vs. fast handoff.

As well, notice that if the Access Devices could communicate with each other then there could be a way to accelerate a faster handoff procedure. In particular, it could accelerate the return of the unused portion of the quotas from the old Access Device.

Unfortunately, standards are evolving with each network technology creating their own scheme to make the handoff procedures more efficient.

Finally, pre-paid service may be provided in a roaming scenario where the Access Devices do not support the prepaid client capabilities. In such a scenario, a Service Device is configured as AAA proxy to the Home Agent and also as default gateway for the home agent, see Figure 6.

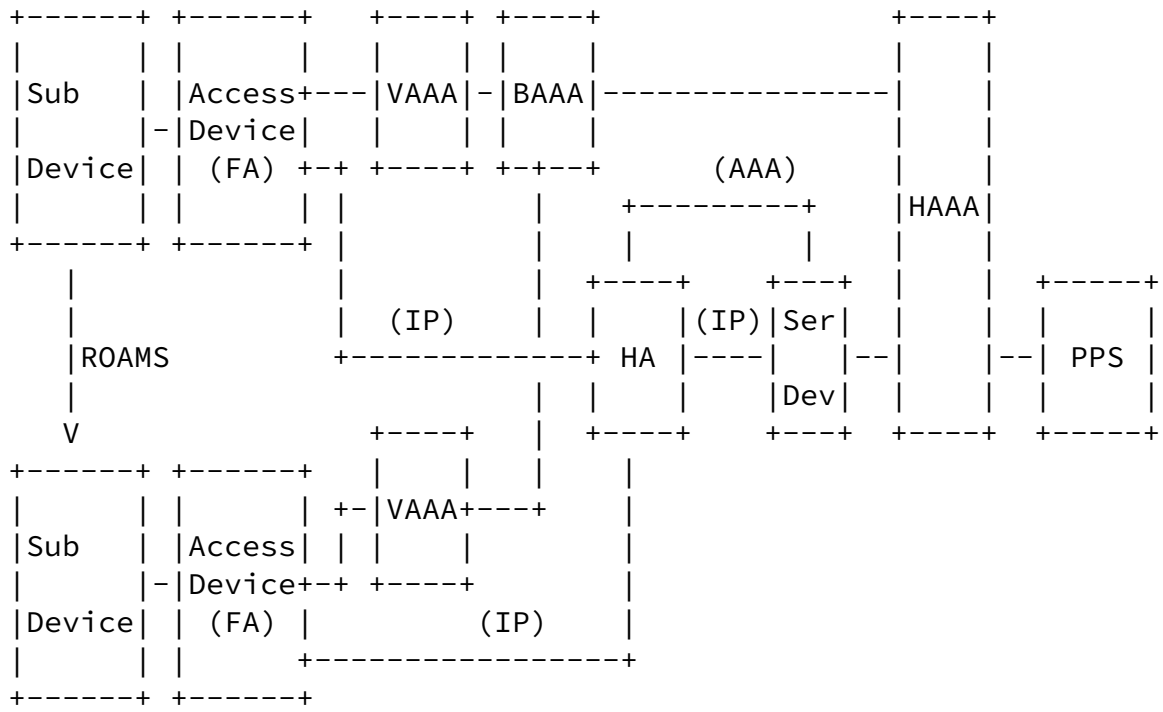


Figure 6 Roaming using mobile-ip and prepaid enabled Service Device behind the Home Agent.

2.1 Why not existing RADIUS attributes?

It has been asked ôWhy not use existing RADIUS attributes to build a prepaid solution? This will allow us to have a solution with existing devices without code modification.ö

It is possible to build a prepaid solution using existing RADIUS attributes. The RADIUS server can simply send an Access-Accept message containing Session-Timeout(27) and set Termination-Action(29) to RADIUS-request. Upon receiving the Access-Accept message, the NAS will time the session and upon termination of the session the NAS generate an Access-Request message again. The RADIUS server would re-authenticate the session and reply with an Access-Accept message with additional time in Session-Timeout(27) or an Access-Reject message if there were no more resources in the userÆs account.

If the user terminates the session before the time expressed in Session-Timeout(27). The NAS will recover any unused time from the accounting stream.

There are several problems with such a solution:

-It only allows for time-based prepaid. The solution presented in this document allows for both time and volume based prepaid. As well as extensibility for other features such as tarified based solutions.

-This solution only allows for prepaid based on Access. The solution presented in this document allows the use of this protocol to support prepaid solutions for other services not just Access.

-Using accounting messages to recoup unused time may be problematic because RADIUS accounting messages are not real-time. A RADIUS server may store-and-forward accounting messages in batches. The solution presented in this paper does not rely on Accounting Packets at all. It uses Access-Request, messages which do flow through any network in real-time. Delaying accounting messages may cause revenue leakage.

-Session-Timeout(27) is not a mandatory attribute. If a prepaid subscriber is being serviced by a NAS that does not adhere to Session-Timeout then that subscriber will obtain unlimited service.

-Termination-Action(29) presents its own issues. First the behaviour of Termination-Action(29) is not mandatory. Second, according to RFC2865 Termination-Action fires when the Service is complete. But we should not be terminating the service we really should only be terminating a session when we are negotiating additional quota. The refreshing of the time quota should be transparent to the user. Because Termination-Action occurs when the Service is complete it is unclear whether or not the user experience would be transparent. For example, will the RADIUS server allocate the subscriber a new IP address? Furthermore, the RADIUS server has no way of telling why the Access-Request message was generated. The RADIUS server will have to wait for the corresponding accounting packet to determine the reason for this Access-Request message. Lastly re-authenticating the subscriber may take far too long. The solution presented in this document allows quota replenishing to occur in an undisruptive manner from the perspective of the user. No re-authentication is required and quotas can be negotiated prior to the quotas running out.

-Prepaid ambiguity. Implementing prepaid using existing RADIUS attributes presents another problem. Due to the fact that the standard RADIUS attributes are not mandatory, then the correct prepaid operation is really an act of faith on the part of the RADIUS server. If Session-Timeout(27) and/or Termination-Action(29) are not supported, the prepaid subscriber will get free access. The solution described in this document, requires that a prepaid capable NAS inform the RADIUS server whether or not it supports prepaid capabilities. The RADIUS server can now determine whether service should be granted or not. For example, if a prepaid subscriber is connected to a NAS that does not support prepaid, the RADIUS server can either instruct the NAS to tunnel the traffic to a gateway that does support prepaid metering, or it may allow the subscriber on but restrict their traffic.

The prepaid solution we present is a robust carrier grade prepaid solution. It only requires the support of 2 mandatory attributes and one optional attribute. Furthermore, it does not really require much code support at the NAS. NASes already support measurement of time and volume. This solution requires that they advertise their prepaid capabilities in an Access-Request; that they generate an Access-Request Authorize-Only packet to obtain more quota at or before the quota is used up. It also requires that the NAS send an Access-Request with Authorize-Only when the session terminates to return any unused quota to the prepaid system.

Lastly the solution provided in this document is extensible. This document defines the basic exchanges between a prepaid capable NAS and a RADIUS server. The protocol can easily be extended to support tariff switching and other prepaid business models.

3. Use-cases

In this section we present a set of use cases that will help establish the requirements needed to deliver PrePaid data services. These use cases donÆt address how the PrePaid account is established or maintained. It is assumed that the PrePaid subscriber has obtained a valid account from a service provider such as a wireless operator or a WLAN operator.

To make the document as general as possible, the use cases cover the experience from the Access Device and not from the UserÆs Device. The connection between the UserÆs Device, which typically involves

setting up a layer 2 session, e.g., PPP session or GPRS PDP Context, is specific to a given network technology and the details are not required to deliver a PrePaid service.

3.1 Simple pre-paid access use-case

A PrePaid subscriber connects to his home network. As usual, the Access Device that is servicing the subscriber will use the AAA infrastructure to authenticate and authorize the subscriber.

The Access Device sends a RADIUS Access-Request to the AAA system to authenticate the subscriber, and identify and authorize the service. The Access-Request includes the subscriberÆs credentials and may include the PrePaid capabilities of the Access Device. PrePaid capabilities MUST be included if the Access Device supports PrePaid functionality.

The AAA System proceeds with the authentication procedure. This may involve several transactions such as in EAP. Once the subscriber has been validated, the AAA system determines that the subscriber is a PrePaid subscriber and requests that the PrePaid System authorize the PrePaid subscriber. The request MUST include the PrePaid Capabilities of the serving Access Device. These capabilities will include whether the Access Device support optional granular prepaid service. Granular prepaid service allows an Access Device to offer service differentiation above plain network access, for example discriminating between a prepaid service request for access to the public Internet from access to a particular application server hosted in the private domain of the home provider network. In the simple prepaid access scenario, such capabilities are not required to be supported by the Access Device.

The PrePaid System will validate that the subscriber has a PrePaid Account; it will validate that the account is active; and will validate that the Access Device has the appropriate PrePaid capabilities. If all is in order, the PrePaid System will authorize the subscriber to use the network. Otherwise it will reject the request. The response is sent back to the AAA System. The response includes attributes such as, definition of what services are

authorized. The exact definition of the service may define vanilla network access or more granular service definition. The exact definition of these services is not the focus of this draft. This definition MAY include a ôservice keyö which can be used to correlate prepaid requests for access to a service with the service definition in the prepaid system. Such service key information MUST be included when the prepaid user has subscribed to more than one prepaid service. If a user has subscribed to only a single service, the response MAY also include an allocation of a portion of the subscriberÆs account called the initial quota (in units of time or volume) and optionally a threshold value.

[Editor comments: we should leave tariff switch issues to another document. One way to deal with a tariff switch is to set the threshold or quota such that a new allocation is requested just before or at the tariff switch period.]

When the rating engine has determined that a tariff switch will shortly occur, the initial quota may be segmented into that which SHOULD be used before the tariff switch, that which SHOULD be used after the tariff switch together with details describing the tariff switching instant.

The Access Device is responsible for requesting quota to be allocate for a particular prepaid user.

In order to support concurrent PrePaid sessions, at any time, the PrePaid System allocates a portion of the subscribers account to a given PrePaid session. For example, in a multi-service environment it might happen that an end user with an already ongoing service (e.g., browsing the Internet) issues a new service request (e.g., for downloading a ring-tone) towards the same account. Throughout the lifetime of a session the Access Device will monitor usage according to the quota(s) returned from the prepaid server and will request further quota updates from the PrePaid System as previously allocated quotas are consumed. Conditions may be included with quotas, which indicate when an allocated quota should be returned to the prepaid system. These conditions can include an Idle-Timeout(28) associated with the provided quota. In this case, the Access device monitors the service for activity. When a single inactivity period exceeds that provided in the quota conditions, the unused quota is returned to the prepaid server.

The AAA system incorporates the PrePaid attributes received from the PrePaid System with the service attributes into an Access-Accept message that it sends back to the Access Device. Note the AAA System is responsible for authorizing the service whereas the PrePaid System is responsible for PrePaid authorization.

Upon receiving the Access-Response, the Access Device allows the PrePaid data session to start and it starts to meter the session based on time or volume, as indicated in the returned Quota

Once the usage for the session approaches the allotted quota (as expressed by the threshold), the Access Device will request an additional quota. The re-authorization for additional quota flows through the AAA system to the PrePaid System. The PrePaid System revalidates the subscriberÆs account; it will subtract the previous quota allocation from the userÆs balance and if there is a balance remaining it will reauthorize the request with an additional quota allotment. Otherwise, the PrePaid System will reject the request. Note the replenishing of the quotas is a re-authorization procedure and does not involve re-authentication of the subscriber.

It is important to note that the PrePaid System is maintaining session state for the subscriber. This state includes how much was allocated during the last quota allocation for a particular session and how much is left in the account. Therefore, it is required that all subsequent messages about the PrePaid session reach the correct PrePaid System.

Upon receiving a re-allotment of the quota, the Access Device will, continue the data service session until the new threshold is reached. If the request for additional quota cannot be fulfilled then the Access Device will let the subscriber use up the remaining quota and terminate the session.

Alternatively, instead of terminating the session, the Access Device may restrict the data session such that the subscriber can only reach a particular web server. This web server maybe used to allow the subscriber to replenish their account. This restriction can also be used to allow new subscribers to purchase their initial PrePaid Service.

Should the subscriber terminate the session before the session the quota is used up, the remaining balance allotted to the session must be credited back to the subscriberÆs account.

As well, while the Access Device is waiting for the initial quota, the subscriber may have dropped the session. The initial quota must be credited back to the subscribers account.

3.2 Simple Service Device use-case

When the Access Device does not support the prepaid extensions, an operator may still offer prepaid services to subscribers by using a service device configured as default IP gateway to the Access device.

A Prepaid subscriber connects to his home network in the usual way. The non-prepaid enabled Access Device that is servicing the subscriber will use the AAA infrastructure to authenticate and authorize the subscriber. The Service device will be configured as AAA proxy to the Access Device.

The Access Device sends an Access Request to the Service Device acting as AAA proxy to authenticate the subscriber, and identify and authorize the service. The Service Device will proxy the Access Request and append its own Prepaid capabilities to the Access Request message. These prepaid capabilities are defined identically to the simple access device user-case.

The prepaid system performs functions as with prepaid support in the Access Device, e.g., the AAA system incorporates the prepaid attributes received from the Prepaid System with the service attributes into an Access-Accept message that it sends back to the Service Device. The Service device removes these attributes before forwarding the Access-Accept message to the Access Device.

Upon receiving the Access-Accept with allocated quota, the Service Device allows the prepaid data service session to start and since it is configured as default gateway to the access device, it starts to meter the session based on time and/or volume.

3.3 Support for concurrent PrePaid sessions

Both prepaid support using Access Devices and prepaid support using Service Devices can be configured to support a prepaid multi-service environment. In such circumstances, the prepaid client capabilities will indicate that the Access or Service Device supports a multi-service environment [Editor: need to add this to the PPAC]. [Editor: This needs to be reworked. DonÆt believe that this step is required. The Service Ids should be known a priori ¡ the Access Request should include the Service Key being requested.] In such circumstances, instead of returning a quota, the prepaid service provides a list of authorized services corresponding to a list of service keys to the prepaid client. The Access/Service device then uses these service keys to request prepaid authorization to the corresponding services. The prepaid server responds with an individual quota for the requested service key [Editor: add service key to PPAQ]. The Access/Service Device may in parallel request prepaid authorization to a second service key. In which case a separate authorization exchange is used to provide an independent quota for this second service.

Each session is treated independently.

The method by which a prepaid user activates a service and the method for signaling this information to the Access/Service Device is out of scope of this draft.

The method by which a granular service is defined is out of scope of this draft. Only service key correlation information is required to enable the prepaid server to authorize and rate a particular request.

3.4 Support for Roaming

For some networks it is essential that PrePaid Data Services be offered to roaming subscribers. Support for static and dynamic roaming models are needed. Static roaming is where the subscriber logs onto a foreign network. The foreign network has a roaming agreement directly with the home network or through a broker network or networks. The subscriber remains logged into the network until the subscriber changes location. When changing location a new connection and a new login procedure is required.

Dynamic roaming allows to subscriber to move between foreign networks while maintaining a connection with the home network

seamlessly. As the subscriber moves between networks, the data session is handed off between the networks.

In both roaming scenarios, the subscriber always authenticates with the home network. PrePaid authorization and quota replenishing for the session need to be received at the home network and more specifically at the PrePaid System where state is being maintained.

Dynamic roaming is particularly challenging. A subscriber that established a PrePaid Data Session may roam to another Access Device that doesnÆt not support PrePaid functionality. The system should be capable to continue the PrePaid session.

3.5 PrePaid termination

When fraud is detected by the PrePaid System, or when an error is detected, it may be beneficial for the PrePaid system to terminate a specific session for the subscriber or all the sessions of a subscriber.

Some errors can occur such that the PrePaid System is in a state where it is not sure whether the session is in progress or not. Under conditions such as this, the PrePaid system may wish to terminate the PrePaid data session to make sure that resources are not being utilized for which it canÆt charge for reliably.

Some handoff procedure used during dynamic roaming may require that the PrePaid system explicitly terminate the subscribers PrePaid data session at an Access Device. For example, if time based PrePaid service is being used and the mobile subscriber performs a dormant handoff, the PrePaid System needs to explicitly terminate the PrePaid session at the old Access Device.

4. Operations

4.1 General Requirements

4.1.1 Broker AAA Requirements

Broker AAA servers MUST support the Message-Authenticator(80) attribute as defined in [RFC2869]. If BAAA servers are used, the

BAAA servers function is to forward the RADIUS packets as usual to the appropriate RADIUS servers.

Accounting messages are not needed to deliver a PrePaid service. However, accounting messages can be used to keep the PrePaid Server current as to what is happening with the PrePaid data session. Therefore, BAAA SHOULD deliver RADIUS Accounting messages using the pass through mode described in [RFC2866].

4.2 Authentication and Authorization for Prepaid Enabled Access Devices

The Access Device initiates the authentication and authorization procedure by sending a RADIUS Access-Request as usual.

If the Access Device has PrePaid Client capabilities, it MUST include the PPAC(TBD) attribute in the RADIUS Access-Request. The PPAC(TBD) attribute indicates to the PrePaid server the PrePaid capabilities possessed by the Access Device. These are required in order to complete the PrePaid authorization procedures.

[Editor: add support for the MultiSession-Capabilities attribute] If the Access Device supports multiple sessions-keys capabilities, then it SHOULD include the MultiSession-Capabilities attribute. The presence of the MultiSession-Capabilities attribute will indicate to the PPS that the Access Device support prepaid service differentiation above simple prepaid access.

If the Access Device supports the Disconnect-Message or the Change-of-Authorization capabilities, then it SHOULD include the Dynamic-Capabilities attribute.

In certain deployments, there may be other ways in which to terminate a data session, or change authorization of an active session. For example, some Access Devices provide a session termination service via Telnet or SNMP. In these cases, the AAA server MAY add the Dynamic-Capabilities message to the Access-Request. Upon receiving the Change-of-Authorization message, the AAA server would then be responsible for terminating the session using whatever means that are supported by the device.

If the authentication procedure involves multiple Access-Requests (as in EAP), the Access Device MUST include the PPAC(TBD) attribute

and the Dynamic-Capabilities attribute (if used) in at least the last Access-Request of the authentication procedure.

The Access-Request will be sent as usual to the HAAA. The packet may be proxied through zero or more BAAA.

Once the Access-Request arrives at the HAAA, the HAAA will authenticate the subscriber. If the subscriber is cannot be authenticated, the HAAA will send an Access-Reject message back to the client. If the subscriber is authenticated, the HAAA will determine whether or not the subscriber is a PrePaid subscriber. The techniques used to determine whether or not a subscriber is a PrePaid subscriber is beyond the scope of this document. If the subscriber is not a PrePaid subscriber, then the HAAA will respond as usual with an Access-Accept or Access-Reject message. If the subscriber is a PrePaid Subscriber the HAAA SHALL forward the Access-Request to a PrePaid server for further authorization.

The Access-Request will contain the PPAC(TBD) attribute, the Dynamic-Capabilities attribute if one was included; and the MultiSession-Capabilities attribute if one was included, the User-Name(1) attribute MAY be set to a value that would represent the SubscriberÆs PrePaid Identity. This attribute is used by the PrePaid server to locate the PrePaid SubscriberÆs account. For added security, the HAAA MAY also set the User-Password(2) attribute to the password used between the HAAA and the PrePaid server.

The PrePaid server lookups the subscriberÆs PrePaid account and will authorize the subscriber taking into consideration the Access Device PrePaid Client Capabilities. The Prepaid Server will decide whether single service prepaid access will be provided or a multiple session pre-paid access will be provided.

4.2.1 Single Service Pre-paid

If a single service prepaid access is provided, upon successful authorization, the PrePaid server will generate an Access-Accept containing the PPAC(TBD) attribute and the PPAQ(TBD) attribute.

The PPAC attribute returned to the client indicates the type of prepaid service to be provided for the session.
which contains the following sub-attributes:

- The QUOTA-Id which is set by the PrePaid server to a unique value that is used to correlate subsequent quota requests;

- Volume and/or Time Quotas, one of which is set to a value representing a portion of the subscribers account;

- MAY contain a Time or Volume Threshold that controls when the Access Device requests additional quota;

- The IP address of the Serving PrePaid Server and one or more alternative PrePaid Servers. This is used by the HAAA to route subsequent quota replenishing messages to the appropriate PrePaid server(s).

Note: Idle-Timeout(28) can be used to trigger the premature termination of a pre-paid service following subscriber inactivity.

Depending on site policies, upon unsuccessful authorization, the PrePaid server will generate an Access-Reject to terminate the session immediately. Alternatively, the PrePaid server may generate an Access-Accept blocking some or all of the traffic and/or redirect some or all of the traffic to a location where the subscriber can replenish their account for a period of time. Blocking of traffic is achieved by either Filter-Id(11) or NAS-Filter-Rule(see Redirect I-d). Redirection is achieved by sending Redirect-Id or Redirect-Rule defined in the Redirect I-d. The period of time before the blocked/redirected session last can be specified by Session-Timeout(27) attribute.

Upon receiving the Access-Accept from the PrePaid Server, the HAAA will append the usual service attributes and forward the packet to the Access Device. The HAAA SHALL NOT append or overwrite any attributes already set by the PrePaid server. If the HAAA, receives an Access-Reject message, it will simply forward the packet to its client. Depending on site policies, if the HAAA fails to receive an Access-Accept or Access-Reject message from the PrePaid server it MAY do nothing or send an Access-Reject or an Access-Accept message back to its client.

4.2.2 Multiple-Session Pre-paid

If the prepaid server decides that multiple-session prepaid service is to be provided, upon successful authorization, the Prepaid server will generate an Access-Accept containing the PPAQ attribute which contains the following sub-attributes:

- a list of the service keys which the Access Device can subsequently use in pre-paid service authorization request.

[Editor: if this stands (see earlier comments) then instead of issuing an access-accept the PPS should issue a Challenge that contains the service-keys]

The first PrepaidServer subtype is set to the IP address of the Serving Prepaid Server, the second one is set to an alternate Prepaid Server if any. This way the HAAA will be able to route subsequent packets to the serving Prepaid Server or its alternate.

[Editor: this should only be done on the Access Accept that deliver the quota for the specific service.]
Additionally, the Prepaid server MAY set the Terminate-Action(29) to RADIUS-Request(1); and MAY set Acct-Interim-Interval(85) to control how often interim Accounting Requests are generated.

Upon receiving the Access-Accept from the Prepaid Server, the HAAA will append the usual service attributes and forward the packet. The HAAA SHALL NOT append any attributes already set by the Prepaid server. If the HAAA, receives an Access-Reject message, it will simply forward the packet to its client. Depending on site policies, if the HAAA fails to receive an Access-Accept message from the Prepaid server it MAY do nothing or send an Access-Reject or an Access-Accept message back to its client.

Upon receiving the Access-Accept with a list of service keys, the Access Device can trigger the authorization request for a particular service corresponding to a service key. The technique for triggering an authorization request for a particular service is out of scope of this draft.

The Access Device initiates authorization for a particular service by sending a RADIUS Access Request including a single service-key reference.

For the specific service-key reference, the prepaid server will check whether funds are available and will, following successful allocation of funds, the Prepaid server will generate an Access-Accept containing the PPQ-Response attribute which contains the following sub-attributes:

- The QUOTA-Id which is set by the Prepaid server to a unique value that is used to correlate subsequent quota updates;

- The ServiceKey-Id which is set by the Prepaid server to the service key requested by the Access Device;

- Volume and Time Quotas, one of which is set to a value representing a portion of the subscribers account;

- The Time of Volume Threshold that the Prepaid server MAY set to control when the Access Device requests additional quota.

Note: Idle-Timeout(28) can be used to trigger the premature termination of a pre-paid service following subscriber inactivity.

4.3 Session Start Operation

The real start of the session is indicated by the arrival of Accounting-Request(Start) packet. The Accounting-Request (Start) MAY be routed to the PrePaid Server so that it can confirm the initial quota allocation.

Note that the PrePaid Server role is not to record accounting messages and therefore it SHOULD not respond with an Accounting Response packet.

If the Prepaid server does not receive the Accounting-Request(start) message it will only know that the session has started upon the first reception of a quota replenishment operation.

If the Prepaid server does not receive indication directly (via Accounting-Request(start)) or indirectly, it SHOULD after some configurable time, deduce that the Session has not started. If the Access Device supports termination capabilities, the PPS SHOULD send a Disconnect Message to the Access Device to ensure that the session is indeed dead.

4.4 Mid-Session Operation

During the lifetime of a PrePaid data session the Access Device will request to replenish the quotas using Authorize-Only Access-Request messages.

Once the allocated quota has been reached or the threshold has been reached, the Access Device MUST send an Access-Request with Service-Type(6) set to a value of ôAuthorize Onlyö and the PPAQ(TBD) attribute.

The Access Device MUST also include NAS identifiers, and Session identifier attributes in the Authorize Only Access-Request. The Session Identifier should be the same as those used during the Access-Request. For example, if the User-Name(1) attribute was used in the Access-Request it MUST be included in the Authorize Only Access-Request especially if the User-Name(1) attribute is used to route the Access-Request to the Home AAA server.

The Authorize Only Access-Request MUST not include either User Password or Chap Password. In order to authenticate the message, the Access Device MUST include the Message-Authenticator(80) attribute. The Access Device will compute the value for the Message-Authenticator based on [RFC2869].

When the HAAA receives the Authorize-Only Access-Request that contains a PPAQ(TBD), it SHALL validate the message using the Message-Authenticator(80) as per [RFC2869]. If the HAAA receives an Authorize Only Access-Request that contains a PPAQ(TBD) but not a Message-Authenticator(80) it SHALL silently discard the message. An Authorize Only Access-Request message that does not contain a PPAQ(TBD) is either in error or belongs to another application (for example, a Change of Authorization message [RFC3576]). In this case the Authorize Only Access-Request will either be silently discarded or handled by another application (not in scope of this document).

Once the Authorize Only Access-Request message is validated, the HAAA SHALL forward the Authorize Only Access-Request to the appropriate PrePaid Server. The HAAA MUST forward the Authorize Only Access-Request to the PrePaid server specified in the PPAQ(TBD). The HAAA MUST sign the message using the Message-Authenticator(80) and the procedures in [RFC2869]. As with the

Access-Request message, the HAAA MAY modify the User-Name(1) attribute to a value that represents the userÆs internal PrePaid account in the PrePaid server. Note the PrePaid server could use the Quota-ID sub-attribute contained within the PPAQ(TBD) to locate the user account.

Upon receiving the Authorize Only Access-Request containing a PPAQ(TBD) attribute, the PrePaid server MUST validate the Message-Authenticator(80) as prescribed in [RFC2869]. If the message is invalid, the PrePaid server MUST silently discard the message. If it received an Authorize Only Access-Request message that does not contain a PPAQ(TBD) it MUST silently discard the message.

The PrePaid server will lookup the PrePaid session by using the PrePaid Quota Id contained within the PPAQ(TBD). The PrePaid Server would, take the last allocated quota and subtract that from the UserÆs balance. If there is remaining balance, the PrePaid server re-authorizes the PrePaid session by allocate an additional quota. The PrePaid server may want to calculate a different threshold values as well.

Upon successful re-authorization, the PrePaid server will generate an Access-Accept containing the PPAQ(TBD) attribute. The Access-Accept message MAY contain Service-Type(6) set to Authorize-Only and MAY contain the Message-Authenticator(80).

Depending on site policies, upon unsuccessful authorization, the PrePaid server will generate an Access-Reject or an Access-Accept with Filter-Id(11) or Ascend-Data-Filter (if supported) attribute and the Session-Timeout(27) attribute such that the PrePaid subscriber could get access to a restricted set of locations for a short duration to allow them to replenish their account, or create an account; or to browse free content.

Upon receiving the Access-Accept from the PrePaid server, the HAAA SHALL return the packet to its client. If the HAAA, receives an Access-Reject message, it will forward the packet. Depending on site policies, if the HAAA fails to receive an Access-Accept or an Access-Reject message from the PrePaid server it MAY do nothing or it MAY send an Access-Reject message back to its client.

Upon receiving an Access-Accept, the Access Device SHALL update its quotas and threshold parameters with the values contained in the

PPAQ(TBD) attribute. Note that the PrePaid server MAY update the PrePaidServer attribute(s) and these may have to be saved as well.

Upon receiving an Access-Accept message containing either Filter-Id(11) or Ascend-Data-Filter attributes, and or Session Timeout(27). The Access Device SHALL restrict the subscriber session accordingly.

4.5 Dynamic Operations

The PrePaid server may want to take advantage of the dynamic capabilities that are supported by the Access Device as advertised in the Dynamic-Capabilities attribute during the initial Access-Request.

There are two types of actions that the PrePaid server can perform: it can request that the session be terminated; or it can request that the filters associated with the session be modified.

Both of these actions require that the session be uniquely identified at the Access Device. As a minimum the PrePaid server:

-MUST provide either the NAS-IP-Address(4) or NAS-Identifier(32)
-MUST provide at least one session identifier such as User-Name(1), Framed-IP-Address(), the Accounting-Session-Id(44).

Other attributes could be used to uniquely identify a PrePaid data session.

4.5.1 Unsolicited Session Termination Operation

This capability is described in detail in [RFC3576]. The PrePaid server sends a Disconnect Request packet that MUST contain identifiers that uniquely identify the subscriberÆs data session and the Access Device servicing that session.

Upon receiving the Disconnect Request packet the HAAA will either act on it or will proxy it to another AAA server until it is received by the a AAA that is in the same network as the serving Access Device.

Each AAA MUST route the Disconnect Request packet. How the routing decision is made is an implementation detail.

Once the Disconnect Request packet reaches AAA that is in the same network as the serving Access Device, if the Access Device supports Disconnect-Request (as per [RFC3576]), it sends the message directly to the Access Device; otherwise it uses other mechanisms such as SNMP or Telnet to command the Access Device to terminate the session (this is an implementation detail).

If the Access Device receives a Disconnect-Request packet, it will respond with either a Disconnect-ACK packet if it was able to terminate the session or else it will respond with a Disconnect-NAK packet.

If the AAA server is performing the disconnect operation, it MUST respond with a Disconnect-ACK message if it successfully terminated the session or a Disconnect-NAK message if it failed to terminate the session with the appropriate Error-Cause(101) set.

If any AAA server is unable to route the Disconnect-Request it MUST respond with a Disconnect-NAK packet with Error-Cause(101) set to ôRequest Not Routableö(502).

4.5.2 Unsolicited Change of Authorization Operation

The PrePaid Server MAY send a Change-of-Authorization message as described in [RFC3576] to restrict Internet access when the subscriber has no more balance. The COA packet may contain Filter-Id(11) and or attributes defined in Redirect I-d.

The PrePaid server sends a Change-of-Authorization packet it MUST contain identifiers that will uniquely identify the subscriber session and the Access Device serving that session.

Upon receiving the Change-of-Authorization packet the HAAA will either act on it or proxy it to another AAA server until it is received by a AAA server that is in the same network as the serving Access Device.

Each AAA must route the packet to the serving network. How the routing decision is made is an implementation detail.

Once the Change-of-Authorization packet reaches a AAA that is in the same network as the serving Access Device, if the Access Device supports Change-of-Authorization message, it will forward the

message to the Access Device; otherwise, it will use other mechanisms such as SNMP or Telnet to command the Access Device to change its filters.

If the Access Device receives a Change-of-Authorization packet, it will respond with either a Change-of-Authorization-ACK packet if it was able to change the filter or else it will respond with a Change-of-Authorization-NAK packet.

If the AAA server is performing the change of filter operation, it MUST respond with a Change-of-Authorization-ACK message if it successfully or a Change-of-Authorization-NAK packet if it failed to change the filter.

If a AAA server was unable to route the Change-of-Authorization it MUST respond with a Change-of-Authorization-NAK packet.

4.6 Termination Operation

The termination phase is initiated when either: the Subscriber logs off; the quotas have been consumed, or when the Access Device receives a Disconnect Message. In all of these instances, if the session is a PrePaid data session, the Access Device will send an Authorize-Only Access-Request message with a PPAQ(TBD) Update-Reason attribute set to either ôClient Service terminationö or ôRemote Forced disconnectö and the currently used quota.

The BAAA MUST forward this packet to the next BAAA or the HAAA.

The HAAA MUST validate the Authorize Only Access-Request using the Message-Authenticator(80) as per [RFC2869] and if valid, use the PrePaidServer subtype in the PPAQ(TBD) to forward the Authorize Only Access-Request packet to the serving PrePaid Server or if needed, its alternate.

The PrePaid Server MUST validate the Authorize Only Access Request and use the information contained in the PPAQ(TBD) attribute to adjust the subscriberÆs balance and to close the session. The PrePaid Server SHALL respond back with an Access-Accept message.

4.7 Mobile IP Operations

In roaming scenarios using mobile-ip, as the mobile subscriber roams between networks, or between different types of networks such as between WLAN and CDMA2000 networks, the PrePaid data session is maintained transparently.

As the subscriber device associates with the new Access Device, the Access Device sends a RADIUS Access-Request and the subscriber is re-authenticated and reauthorized. If the Access Device has PrePaid Client capabilities, it MUST include the PPAC(TBD) attribute in the RADIUS Access-Request. In this manner the procedure follows the Authentication and Authorization procedure described earlier.

The Access-Request message is routed to the home network and MUST reach the PrePaid System that is serving the PrePaid session. The PrePaid system will then correlate the new authorization request with the existing active session and will assign a quota to the new request. Any outstanding quota at the old Access Device will be returned to the PrePaid system due to the usual mobile-ip handoff procedures. Specifically, the quota will be returned when the Access Device sends the Authorize Only Access-Request with PPAQ(TBD) Update-Reason subtype set to either ôRemote Forced disconnectö or ôClient Service terminationö. In order to trigger the sending of this last Authorize Only Access-Request, the PrePaid system may issue a Disconnect Message [CHIBA] to the Access Device.

If the subscriber has roamed to an Access Device that does not have any PrePaid Capabilities, PrePaid data service may still be possible by requesting the Home Agent (providing it has PrePaid Capabilities) to assume responsibilities for metering the service. The procedure for this scenario will be given in the next release of this draft.

4.8 Accounting Considerations

Accounting messages are not required to deliver PrePaid Data Service. Accounting message will typically be generated for PrePaid Data Service. This because accounting message are used for auditing purposes as well as for bill generation.

Accounting messages associated with PrePaid Data Sessions should include the PPAQ(TBD) attribute.

4.9 Service Device Operation

To be completed

4.10 Interoperability with Diameter Credit Control Application

RADIUS PrePaid solutions need to interoperate with Diameter protocol. Two possibilities exist: The AAA infrastructure is Diameter based and the Access Device are RADIUS based; or the Access Device is Diameter based and the AAA infrastructure is RADIUS based.

The Diameter Credit Control Application [DIAMETERCC] describes how to implement a PrePaid using an all Diameter based infrastructure.

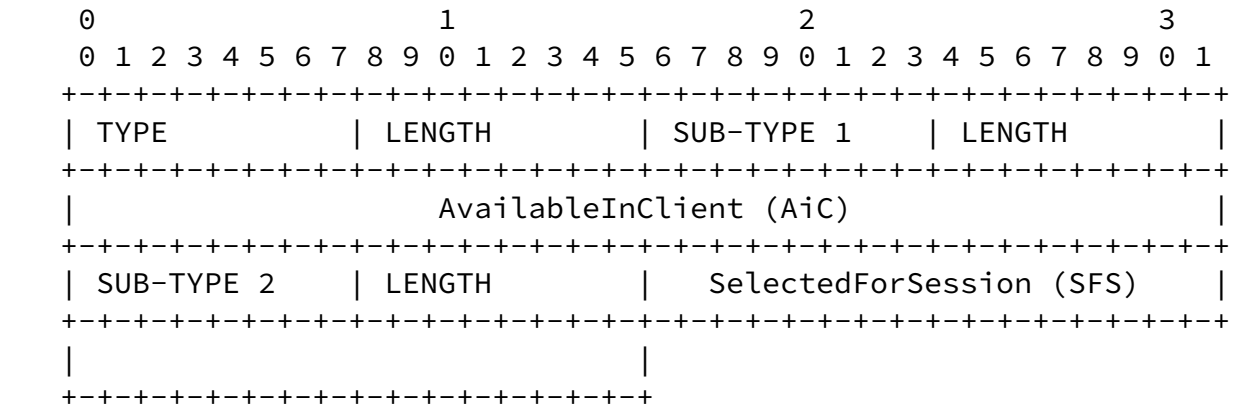
<This section to be completed.>

5. Attributes

This draft is using the RADIUS [RFC2865] namespace.

5.1 PPAC Attribute

The PrepaidAccountingCapability (PPAC) attribute is sent in the Access-Request message by a Prepaid Capable NAS and is used to describe the PrePaid capabilities of the NAS. The PPAC is available to be sent in an Access-Accept message by the Prepaid server to indicate the type of prepaid metering that is to be applied to this session.



TYPE : value of PPAC

LENGTH: 14
VALUE : String

The value MUST be encoded as follows:

```
Sub-Type (=1)          : Sub-Type for AvailableInClient attribute
Length                 : Length of AvailableInClient attribute
                         (= 6 octets)
AvailableInClient (AiC):
```

The optional AvailableInClient Sub-Type, generated by the PrePaid client, indicates the PrePaid Accounting capabilities of the NAS and shall be bitmap encoded. The possible values are:

0x00000001	PrePaid Accounting for Volume supported
0x00000010	PrePaid Accounting for Duration supported
0x00000011	PrePaid Accounting for Volume and Duration supported (non concurrently)
Others	Reserved, treat like Not Capable of PrePaid Accounting (=0).

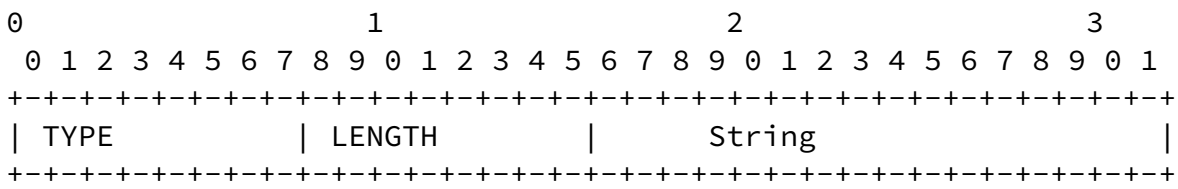
```
Sub-Type (=2)          : Sub-Type for SelectedForSession attribute
Length                 : Length of SelectedForSession attribute
                         (= 6 octets)
SelectedForSession (SfS):
```

The optional SelectedForSession Sub-Type, generated by the PrePaid server, indicates the PrePaid Accounting capability to be used for a given session. The possible values are:

0x00000000	PrePaid Accounting not used
0x00000001	Usage of PrePaid Accounting for Volume. (only possible if the AvailableInClient supports PrePaid Accounting for Volume)
0x00000010	Usage of PrePaid Accounting for Duration. (only possible if the AvailableInClient supports PrePaid Accounting for Duration)
0x00000011	Usage of PrePaid Accounting for Volume and Duration (non concurrent) (only possible if the AvailableInClient supports PrePaid Accounting for Volume and duration)
Others	Reserved, treat like PrePaid Accounting not used(=0).

5.2 Session Termination Capability

The value shall be bitmap encoded rather than a raw integer. This attribute shall be included RADIUS Access-Request message to the RADIUS server and indicates whether or not the NAS supports Dynamic Authorization.



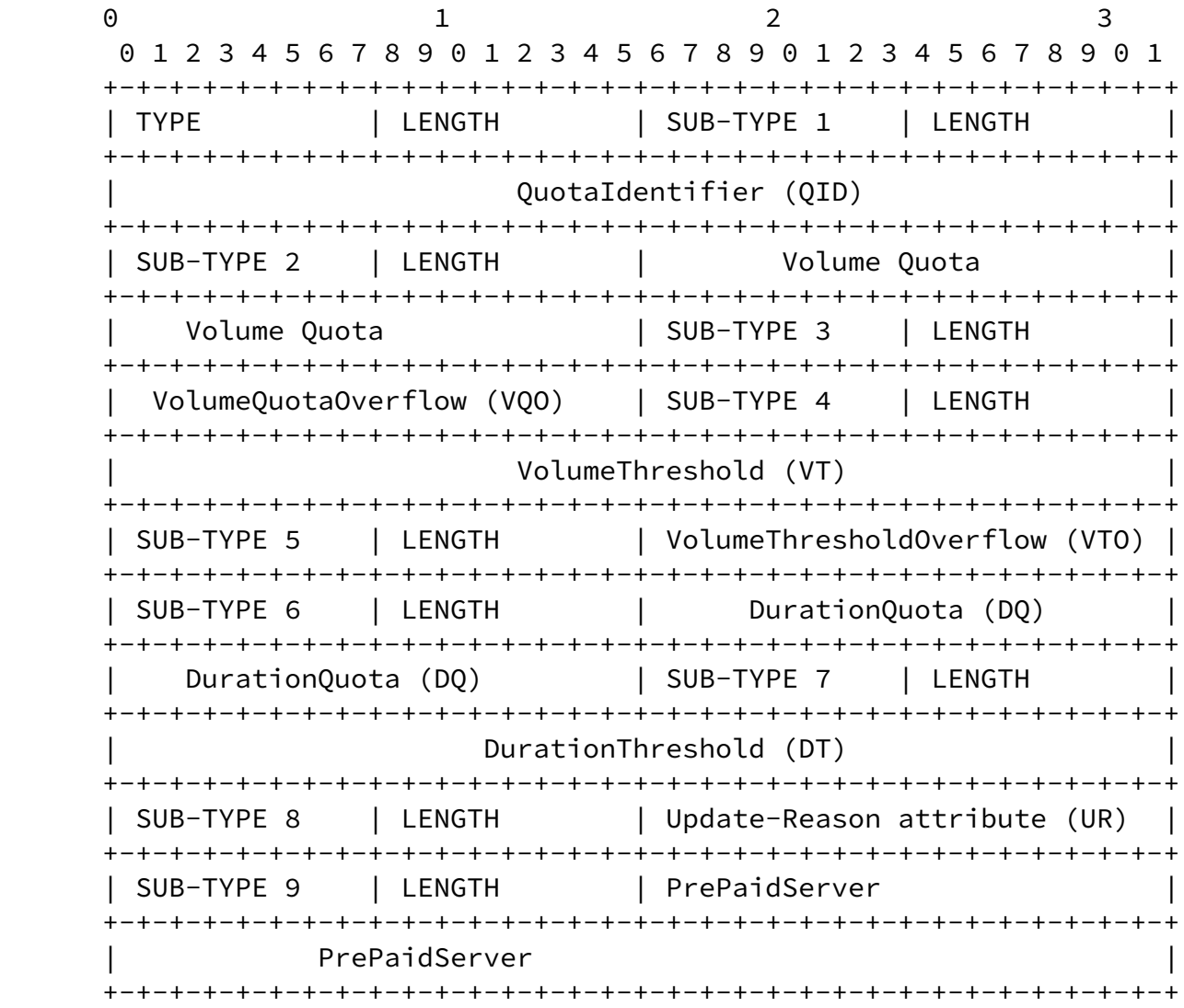
Type : value of Session Termination Capability
Length: = 4
String encoded as follows:

0x00000001 Dynamic Authorization Extensions (rrfc3576) is supported.

5.3 PPAQ Attribute

The PPAQ(TBD) attribute is sent in Authorize Only Access-Request and Access-Accept messages. In Authorize Only Access-Request messages it is used to report usage and request further quota; in an Access-Accept message it is used to allocate the quota (initial quota and subsequent quotas).

The attribute consists of a number of subtypes. Subtypes not used are omitted in the message.



Type : Value of PPAQ
Length: variable, greater than 8

String: The String value MUST be encoded as follows:

Sub-Type (=1): Sub-Type for QuotaIDentifier attribute
Length : Length of QuotaIDentifier attribute (= 6 octets)

QuotaIDentifier (QID):

The QuotaIDentifier Sub-Type is generated by the PrePaid server at allocation of a Volume and/or Duration Quota. The on-line

quota update RADIUS Access-Request message sent from the Access Device to the PPS shall include a previously received QuotaIDentifier.

Sub-Type (=2): Sub-Type for VolumeQuota attribute
Length : length of VolumeQuota attribute (= 6 octets)

VolumeQuota (VQ):

The optional VolumeQuota Sub-Type is only present if Volume Based charging is used. In RADIUS Access-Accept message (PPS to Access Device direction), it indicates the Volume (in octets) allocated for the session by the PrePaid server. In RADIUS Authorize Only Access-Request message (Access Device to PPS direction), it indicates the total used volume (in octets) for both forward and reverse traffic applicable to PrePaid accounting.

Sub-Type (=3): Sub-Type for VolumeQuotaOverflow
Length : length of VolumeQuotaOverflow attribute (= 4 octets)

VolumeQuotaOverflow (VQO):

The optional VolumeQuotaOverflow Sub-Type is used to indicate how many times the VolumeQuota counter has wrapped around 2^32 over the course of the service being provided.

Sub-Type (=4): Sub-Type for VolumeThreshold attribute
Length : length of VolumeThreshold attribute (= 6 octets)

VolumeThreshold (VT):

The VolumeThreshold Sub-Type shall always be present if VolumeQuota is present in a RADIUS Access-Accept message (PPS to Access Device direction). It is generated by the PrePaid server and indicates the volume (in octets) that shall be used before requesting quota update. This threshold should not be larger than the VolumeQuota.

Sub-Type (=5): Sub-Type for VolumeThresholdOverflow
Length : Length of VolumeThresholdOverflow attribute
(= 4 octets)

VolumeThresholdOverflow (VTO):

The optional VolumeThresholdOverflow Sub-Type is used to indicate how many times the VolumeThreshold counter has wrapped around 2^32 over the course of the service being provided.

Sub-Type (=6): Sub-Type for DurationQuota attribute
Length : length of DurationQuota attribute (= 6 octets)

DurationQuota (DQ):

The optional DurationQuota Sub-Type is only present if Duration Based charging is used. In RADIUS Access-Accept message (PPS to Access Device direction), it indicates the Duration (in seconds) allocated for the session by the PrePaid server. In on-line RADIUS Access-Accept message (PPC to PPS direction), it indicates the total Duration (in seconds) since the start of the accounting session related to the QuotaID.

Sub-Type (=7): Sub-Type for DurationThreshold attribute
Length : length of DurationThreshold attribute (= 6 octets)

DurationThreshold (DT):

The DurationThreshold Sub-Type shall always be present if DurationQuota is present in a RADIUS Access-Accept message (PPS to Access Device direction). It represents the duration (in seconds) that shall be used by the session before requesting quota update. This threshold should not be larger than the DurationQuota and shall always be sent with the DurationQuota.

Sub-Type (=8): Sub-Type for Update-Reason attribute
Length : length of Update-Reason attribute (= 4 octets)

Update-Reason attribute (UR):

The Update-Reason Sub-Type shall be present in the on-line RADIUS Access-Request message (Access Device to PPS direction). It indicates the reason for initiating the on-line quota update operation. Update reasons 4, 5, 6, 7 and 8 indicate that the associated resources are released at the client side, and therefore the PPS shall not allocate a new quota in the RADIUS Access_Accept message.

1. Pre-initialization
2. Initial request
3. Threshold reached
4. Quota reached
5. Remote Forced disconnect
6. Client Service termination
7. Main SI released
8. Service Instance not established

Sub-Type (=9) : Sub-Type for PrePaidServer attribute
Length : Length of PrePaidServer
(IPv4 = 6 octets, IPv6= 18 octets

PrePaidServer:

The optional, multi-value PrePaidServer indicates the address of the serving PrePaid System. If present, the Home RADIUS server uses this address to route the message to the serving PrePaid Server. The attribute may be sent by the Home RADIUS server. If present in the incoming RADIUS Access-Accept message, the PDSN shall send this attribute back without modifying it in the subsequent RADIUS Access-Request message, except for the first one. If multiple values are present, the PDSN shall not change the order of the attributes.

NOTES:

Either Volume-Quota or Time-Quota MUST appear in the attribute.
Volume Threshold may only appear if Volume Quota appears
If the Access Device can measure time, and if Time-Threshold appears with Volume Quota, then the Access device should trigger a quota replenishment when the Current Time >= Time-Threshold.

5.4 Table of Attributes

TO BE COMPLETED.

Request	Accept	Reject	Challenge	#	Attribute
Authorize_Only	Request	Accept	Reject		

6. Security Considerations

The protocol exchanges described are susceptible to the same vulnerabilities as RADIUS and it is recommended that IPsec be employed to afford better security.

If IPsec is not available the protocol in this draft improves the security of RADIUS. The various security enhancements are explained in the following sections.

6.1 Authentication and Authorization

RADIUS is susceptible to replay attacks during the Authentication and Authorization procedures. A successful replay of the initial Access-Request could result in an allocation of an initial quota.

To thwart such an attack...

6.2 Replenishing Procedure

A successful replay attacks of the Authorize Only Access-Request could deplete the subscribers prepaid account.

To be completed.

7. IANA Considerations

To be completed.

This draft does create RADIUS attributes. However, the authors recognize that it may not be possible to obtain such attributes. Therefore, in subsequent drafts it will be proposed to use a Vendor space as an Application Space.

8. Normative References

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[DIAMETERCC] Work in Progress.

[REDIRECT] RADIUS Redirection Internet Draft. Work in progress.

Acknowledgments

The authors would like to thank Mark Grayson (Cisco) and Nagi Jonnala for their contribution to this draft.

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Intellectual Property Statement

Full Copyright Statement

Expiration Date

This memo is filed as draft-lior-radius-extensions-for-prepaid-03.txt, and will expire 16th July, 2004.