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***cdma2000 Wireless IP Network Standard;
PrePaid Packet Data Services***

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1 **General Description**

2 Support for PrePaid packet data service is optional in this specification. The PrePaid packet data
3 service allows a user to purchase packet data service in advance based on volume or duration. In
4 order to support PrePaid packet data service the PDSN and/or the HA shall support the PrePaid
5 client (PPC) function and the PrePaid server (PPS) function may be co-located with the Home
6 RADIUS server. In this revision of the specification, the PrePaid packet data service supports a
7 set of capabilities as described in section 1. Additional capabilities may be supported in future
8 revisions of this specification

1 **1 Glossary and Definitions**

2 See X.S0011-001-C.

1 **2 References**

2 See X.S0011-001-C.

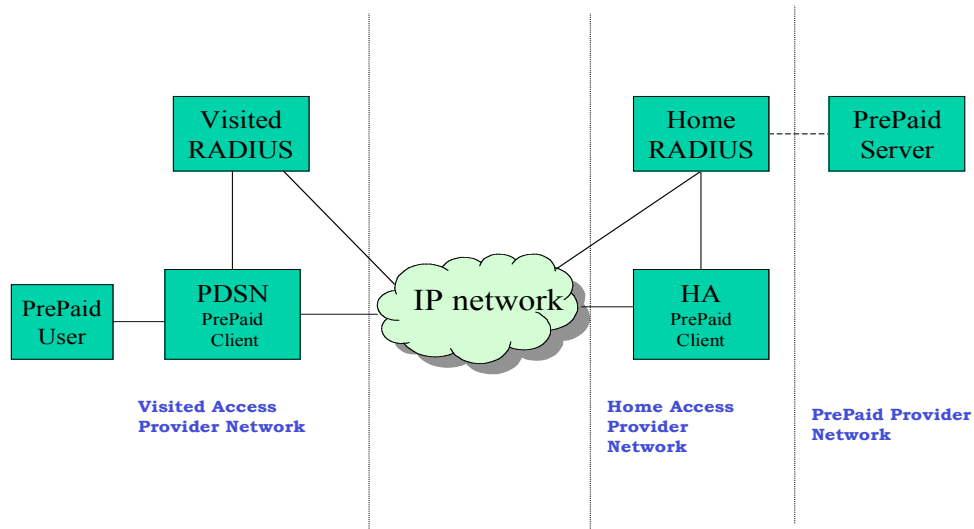
3 PrePaid Packet Data Service Capabilities

In this revision of the specification, the following PrePaid capabilities are supported:

1. Volume based PrePaid, with quota assigned at a service instance level (IP/NAI/SO/SI) if the PPC resides in the PDSN.
2. Volume based PrePaid with quota assigned at the packet data session level (IP/NAI) if the PPC is located in the HA.
3. Duration based PrePaid, with quota assigned at a service instance level (IP/NAI/SO/SI) if the PPC resides in the PDSN.
4. Duration based PrePaid, with quota assigned at the packet data session level (IP/NAI) if the PPC is located in the HA.
5. The capability in the PrePaid client to provide concurrent Volume and Duration based PrePaid when tariff switch is provided. However, the capability of providing concurrent Volume and Duration based PrePaid when tariff switch is not provided is not supported in this version of the specification.
6. PrePaid packet data service applies to both Simple IP and Mobile IP users.
7. Ability for the Home RADIUS/PPS to allow/deny/select a PPC based on the Home RADIUS/PPS policy, user profile, PrePaidAccountingCapability (PPAC) VSA and the Session Termination Capability (STC) VSA of the PDSN and/or the HA.
8. The PrePaid packet data service is based on the RADIUS protocol.
9. Home RADIUS/PPS ability to manage the PrePaid packet data service when the quota allocated to a PPC is consumed or a pre-determined threshold value is reached, through triggers provided to the PPC. A PDSN and an HA that supports PPC also supports the resource management mechanisms as per X.S0011-003-C.
10. PrePaid packet data service inter-working with Remote Address Accounting feature.
11. The capability of the PPC based in the PDSN to support VolumeQuota and a tariff switch time interval concurrently per service instance. The capability of the PPC based in the HA to support VolumeQuota and a tariff switch time interval concurrently per packet data session.
12. The capability in the PPC and the Home RADIUS/PPS to provide tariff switch volume based PrePaid packet data service, with tariff switch trigger controlled at the Home RADIUS/PPS. This capability includes:
 - a) Charged by volume, different tariff for different time of a day.
 - b) Charged by volume, different tariff for different volume consumed, and the PPS shall allocate the quota so that the quota does not overlap the two charging rate.
13. Tariff switching with duration based PrePaid at the Home RADIUS/PPS. This capability include:
 - a) Charged by duration, different tariff for different time of a day.
 - b) Charged by duration, different tariff for different duration consumed, and the PPS shall allocate the quota so that the quota does not overlap the two charging rate.
14. Account balance updated by the Home RADIUS/PPS according to the quota consumed by the user and reported by PPC and the tariff information in the user's profile.
15. The PrePaid Account shall be reconciled at the Home RADIUS/PPS at inter-PDSN handoff.

1 4 Architecture requirements

2 The PrePaid account status shall be stored in a Home RADIUS/PPS that is located in the user's
 3 home network. The PPC shall communicate with the Home RADIUS/PPS via the RADIUS server
 4 infrastructure. To provide PrePaid packet data service, either the serving PDSN or the HA shall
 5 support a PrePaid Client. The proxy RADIUS servers shall forward the PrePaid VSAs
 6 transparently to and from the Home RADIUS server. The Home RADIUS and the PPS may be
 7 collocated functions or separate entities, see Figure 1. From the PDSN or the HA perspective, the
 8 Home RADIUS and the PPS shall be indistinguishable. The interface between the Home RADIUS
 9 and the PPS if they are used as separate entities is outside the scope of this specification.
 10 However the functional behavior of the Home RADIUS/PPS is defined in this specification.



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Figure 1. PrePaid packet data service Architecture

1 **5 PrePaid Client in the PDSN**

2 If the PDSN supports a PPC, it shall also support Dynamic Authorization with RADIUS and
3 Registration Revocation for Mobile IPv4 capabilities (see X.S0011-003-C). The PDSN is referred
4 to as a PrePaid capable PDSN, and the PrePaid capability is based on the following principles:

- 5 • The PDSN includes in the RADIUS Access-Request message to the Home RADIUS
6 server/PPS, the PPAC VSA and the STC VSA with value 3 defined in X.S0011-005-
7 C.
- 8 • Except for quota initialization for the main service instance, which is included in the
9 RADIUS Access-Accept message by the Home RADIUS server/PPS, on-line quota
10 update operation is performed by the PrePaid capable PDSN using on-line RADIUS
11 Access-Request/Accept messages with Service-Type (6) set to "Authorize Only".
12 The on-line RADIUS Access-Request shall contain the PrePaidAccountingQuota
13 (PPAQ) VSA defined in X.S0011-005-C.
- 14 • The Home RADIUS Server/PPS initializes a quota for a user at authentication and
15 authorization if it determines that the user is a PrePaid user with positive PrePaid
16 balance and that the home network policy allows the PDSN to provide PrePaid
17 service. The initialized quota is sent to the PPC in the RADIUS Access-Accept
18 message associated with the creation of the main service instance. The RADIUS
19 Access-Accept message includes the PPAQ and PPAC VSAs.
- 20 • The processing of off-line Accounting Request/Response messages proceeds
21 independent of PrePaid service.
- 22 • RADIUS Accounting (Stop/Start) messages caused by events such as parameter
23 change, time of the day change, inter-PCF handoff do not cause the PrePaid
24 counters (such as VolumeQuota used, DurationQuota used etc.) to be re-set to zero.

25 If the RADIUS Access-Accept message includes the initial quota and contains the Service Option
26 Profile attribute which indicates that the user is allowed to establish multiple service instances,
27 the PrePaid capable PDSN may immediately initiate an on-line RADIUS Access-Request
28 message to request pre-initialization of quota for the auxiliary service instance of SO type 60 or
29 61 that the user may establish.

30 If the user requests establishment of an auxiliary service instance for which quota pre-initialization
31 is not done, the PDSN sends an on-line RADIUS Access-Request message to request
32 initialization of quota.

33 The Home RADIUS/PPS may use the Service Option VSA and other accounting information
34 attributes defined in X.S0011-005-C to determine the correct PPAQ VSA values for the requested
35 service instance.

36 **5.1 Service Description for Volume Based PrePaid at the PDSN**

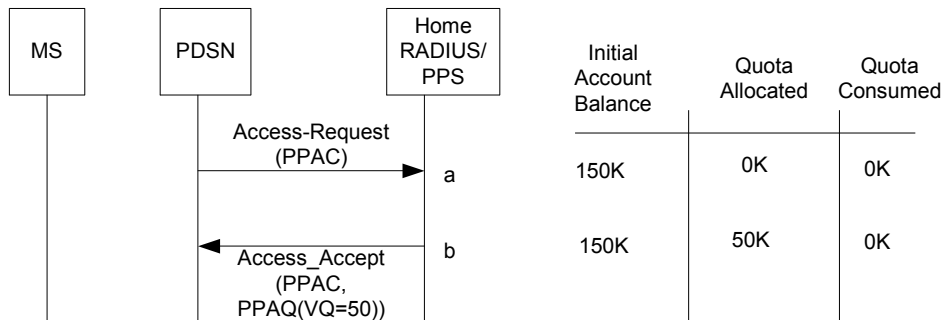
37 **5.1.1 Interaction with Remote IP Address Based Accounting**

38 The PrePaid packet data service interacts with the remote address accounting feature. This
39 specification adds a qualifier to existing attributes for remote address accounting to indicate to the
40 PrePaid Client whether traffic to and from the remote IP addresses is exempt from PrePaid
41 charges. If exempt from PrePaid charge, the PrePaid capable PDSN does not include the octet
42 count from those IP packets in the VolumeQuota within the PPAQ VSA reported to the PrePaid
43 Server. See X.S0011-005-C for updated Remote IPv4/IPv6 Address and Remote Address Table
44 Index VSAs.

45 **5.1.2 Sequence Diagrams**

46 This section describes the flows between the PrePaid capable PDSN and the Home
47 RADIUS/PPS for the PrePaid users.

1 5.1.2.1 Successful PrePaid Authorization



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Figure 2. PrePaid Authorization for a PrePaid capable PDSN

4 **Flow Description:**

- 5 a. The PrePaid capable PDSN determines that Simple IP or Mobile IP setup requires a RADIUS Access-Request message to be sent to the Home RADIUS. The PrePaid capable PDSN includes its own PPAC VSA to inform the Home RADIUS/PPS that it supports PrePaid based on Volume.
- 6
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- 9 b. The Home RADIUS/PPS performs Authentication and Authorization as defined in
- 10 X.S0011-002-C. If the user profile indicates that the user is a PrePaid subscriber, then it
- 11 checks the PPAC VSA received from the PDSN. It also checks that the user has a valid
- 12 balance and account status. The RADIUS Access-Accept message is returned indicating
- 13 in the PPAC VSA that the PrePaid packet data service is based on Volume. The RADIUS
- 14 Access-Accept message includes a PPAQ VSA to initialize the quota to be used on the
- 15 main service instance. The Home RADIUS/PPS assigns a Quota ID to the initialized
- 16 VolumeQuota and a VolumeThreshold.

17 5.1.2.2 Volume Usage until Account Depletion

18 Once the PrePaid user authentication/authorization is completed and the quota for the main

19 service instance is initialized in the RADIUS Access-Accept message, the PrePaid capable PDSN

20 assumes the role of the PrePaid Client if authorized by the Home RADIUS/PPS. For subsequent

21 on-line quota update request to the Home RADIUS/PPS, the PrePaid capable PDSN uses on-line

22 RADIUS Access-Request messages until the event of termination occurs.

23 On-line RADIUS Access-Request messages are RADIUS Access-Request messages that use

24 the attributes Message Authenticator (80) and Service-Type (6) set to 'Authorize Only' to indicate

25 that the RADIUS Access-Request message is for authorization only, and the PPAQ VSA to

26 indicate that the authorization is for PrePaid quota update.

27 After receiving the RADIUS Access-Accept message indicating that the PrePaid packet data

28 service is allowed and which includes the initial VolumeQuota, Quota ID and the

29 VolumeThreshold for the main service instance in the PPAQ VSA, the PrePaid capable PDSN

30 stores the information and starts metering user's traffic over the specific service instance against

31 the allocated quota at successful PrePaid packet data session establishment (i.e., IP address

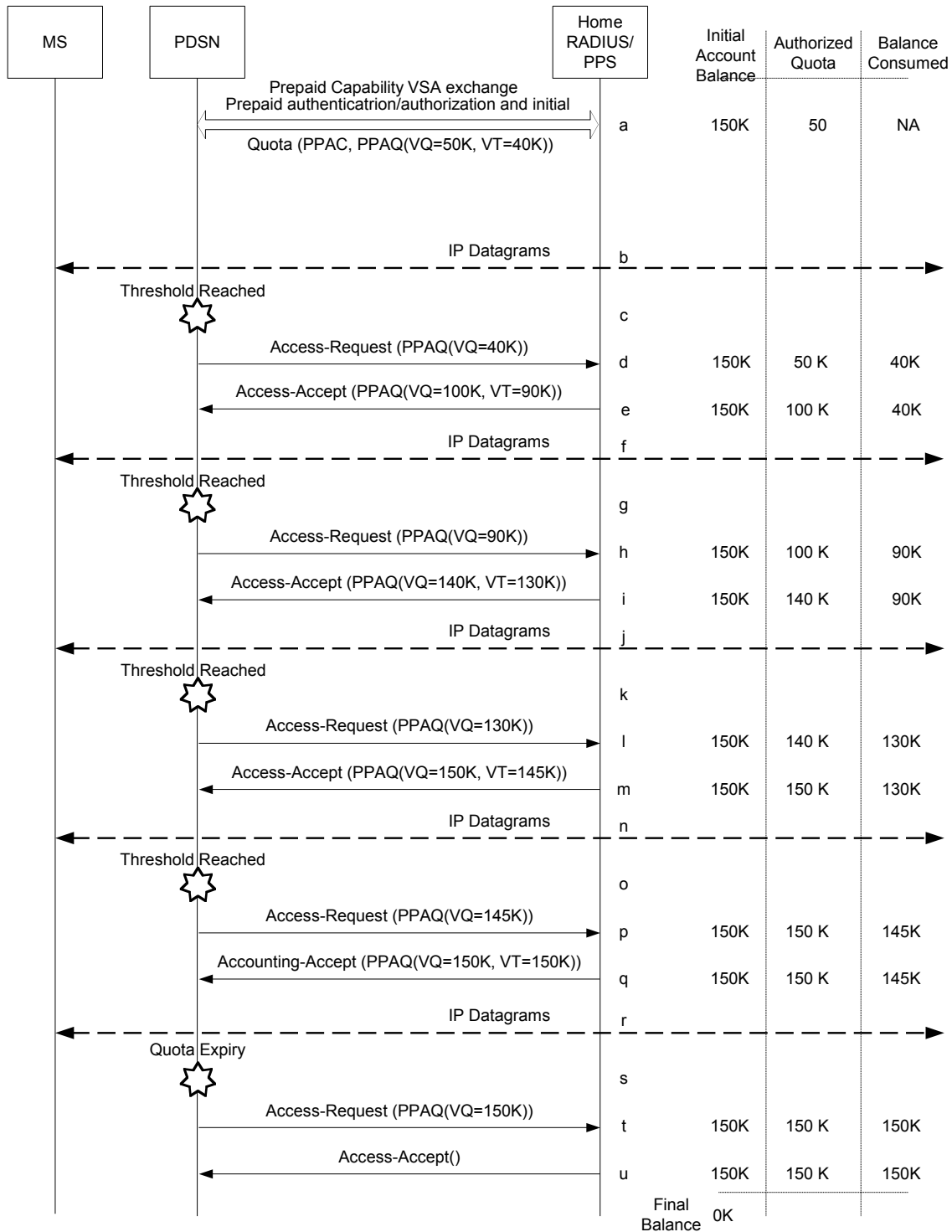
32 assigned for Simple IP or MIP RRP received from the HA and sent to the MS).

33 The PrePaid capable PDSN performs subsequent on-line quota update operation with the Home

34 RADIUS/PPS when the VolumeThreshold value is reached. At subsequent on-line quota update

35 operation, the PDSN sends an on-line RADIUS Access-Request message containing the PPAQ

- 1 VSA which includes the Update-Reason Sub-Type to indicate 'Threshold reached', the Quota ID
2 previously received and the used volume in the VolumeQuota Sub-Type.
- 3 The Home RADIUS/PPS apportions a fraction of the PrePaid account balance into a
4 VolumeQuota and a VolumeThreshold and assigns a Quota ID, all of which are encoded in a
5 PPAQ VSA in the on-line RADIUS Access-Accept message to the PrePaid capable PDSN. The
6 Home RADIUS/PPS assigns a new Quota ID to the allocated VolumeQuota and
7 VolumeThreshold at each quota update operation.
- 8 If the on-line RADIUS Access-Accept message was not received for a previous on-line quota
9 update operation after a configurable time value and the remaining VolumeQuota is consumed or
10 if the quota is consumed when the VolumeQuota value and the VolumeThreshold value are the
11 same, the PrePaid capable PDSN sends an on-line RADIUS Access-Request message
12 containing the PPAQ VSA that includes an Update-Reason Sub-Type to indicate 'Quota reached',
13 and releases the associated service instance.
- 14 As per the usual off-line accounting procedures, the PrePaid capable PDSN sends the RADIUS
15 Accounting-Request message (stop) to indicate the release of the service instance.
- 16 The Home RADIUS/PPS does not allocate a new quota when the on-line RADIUS Access-
17 Request message indicates 'Quota reached' in the Update-Reason Sub-Type in the PPAQ VSA.
- 18 An on-line quota update example is illustrated in the example call flow below describing a
19 successful volume based PrePaid accounting scenario until funds are depleted:



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Figure 3. Volume usage until account depletion

Flow Description:

- a. PrePaid packet data service authentication/authorization is complete. At this step the PrePaid capable PDSN and the Home RADIUS/PPS exchange PPAC VSA to enable PrePaid packet data service. The Home RADIUS/PPS includes a PPAQ to initialize an initial VolumeQuota and a VolumeThreshold value. The Home RADIUS/PPS returns a VQ of 50K, and a VT of 40K. The packet data service instance is authorized for 50K and

- 1 the PrePaid capable PDSN should update the PPS after 40K. 50K is saved as the
2 Authorized Quota value in the Home RADIUS/PPS.
- 3 b. IP data flows. These are counted by the PrePaid capable PDSN.
- 4 c. The 40K threshold is reached.
- 5 d. Triggered by the step c, the PrePaid capable PDSN sends an on-line RADIUS Access-
6 Request message to the PPS with the PPAQ VSA containing the Sub-Type VQ=40K and
7 the Sub-Type Update-Reason set to 3 (i.e., threshold reached).
- 8 e. The Home RADIUS/PPS saves 40K value as Balance Consumed. The Home
9 RADIUS/PPS determines that Initial Account Balance – Authorized Quota = 100K. An
10 additional 50K is authorized at this time. The Authorized Quota is returned in an on-line
11 RADIUS Access-Accept message containing a VQ=100K and VT=90K.
- 12 f. IP data flow continues.
- 13 g. The 90K threshold is reached.
- 14 h. Triggered by step g, the PrePaid capable PDSN sends an on-line RADIUS Access-
15 Request message to the PPS with the PPAQ VSA containing the Sub-Type VQ=90K and
16 the Sub-Type Update-Reason set to 3 (i.e., threshold reached).
- 17 i. The Home RADIUS/PPS saves 90K value as Balance Consumed. The Home
18 RADIUS/PPS determines that Initial Account Balance – Authorized Quota = 50K. An
19 additional 40K is authorized at this time. The Authorized Quota is returned in an on-line
20 RADIUS Access-Accept message containing a VQ=140K and VT=130K.
- 21 j. IP data flow continues.
- 22 k. The 130K threshold is reached.
- 23 l. Triggered by step k, the PrePaid capable PDSN sends an on-line RADIUS Access-
24 Request message to the PPS with the PPAQ VSA containing the Sub-Type VQ=130K
25 and with the Sub-Type Update-Reason set to 3 (i.e., threshold reached).
- 26 m. The Home RADIUS/PPS saves 130K value as Balance Consumed. The Home
27 RADIUS/PPS determines that Initial Account Balance – Authorized Quota = 10K. An
28 additional 10K is authorized at this time. The Authorized Quota is returned in on-line
29 RADIUS Access-Accept message containing a VQ=150K and VT=145K.
- 30 n. IP data flow continues.
- 31 o. The 145K threshold is reached.
- 32 p. Triggered by step o, the PrePaid capable PDSN sends an on-line RADIUS Access-
33 Request message to the PPS with the PPAQ VSA containing the Sub-Type VQ=145K
34 and the Sub-Type Update-Reason set to 3 (i.e., threshold reached).
- 35 q. The Home RADIUS/PPS saves the 145K value as Balance Consumed. The Home
36 RADIUS/PPS determines that Initial Account Balance – Authorized Quota = 0K. No
37 additional Quota Balance is authorized at this time. The previously Authorized Quota
38 returned in the on-line RADIUS Access-Accept message contains a VQ=150K and
39 VT=150K.
- 40 r. IP data flow continues.
- 41 s. The 150K quota is reached.
- 42 t. Since at step q the VQ = VT the PrePaid capable PDSN knows that there is no more
43 balance left for the user. The PrePaid capable PDSN will send an on-line RADIUS
44 Access-Request message to the PPS with the PPAQ VSA containing the Sub-Type
45 VQ=150K, and with the Sub-Type Update-Reason set to 4 (i.e., quota reached), and
46 starts releasing the service instance.

- 1 u. The PPS saves 150K as Balance Consumed. The Balance Consumed = Account
2 Balance at this time. The PPS sends an on-line RADIUS Access-Accept message back
3 to PrePaid capable PDSN to acknowledge the termination of the PrePaid packet data
4 service instance. As part of the usual off-line accounting procedures, the PDSN sends an
5 off-line RADIUS Accounting-Request message (Stop) upon successful release of the
6 appropriate resources (not shown in the diagram).

7 **5.1.2.3 Tariff Switch**

8 The PrePaid capable PDSN and the Home RADIUS/PPS may support tariff switch volume based
9 PrePaid packet data service. The method to synchronize the Home RADIUS/PPS with the PPC is
10 outside the scope of this specification.

11 The tariff switch trigger is controlled at the Home RADIUS/PPS. This capability is provided via
12 both the PPAQ VSA that includes the VolumeQuota (VQ) and VolumeThreshold (VT) Sub-Types,
13 and the PrePaidTariffSwitch (PTS) VSA that includes the VolumeUsedAfterTariffSwitch (VUATS),
14 and TariffSwitchInterval (TSI) and an optional TimeIntervalafterTariffSwitchUpdate (TITSU) Sub-
15 Types.

16 TSI Sub-Type is included in the RADIUS Access-Accept or on-line RADIUS Access-Accept and
17 indicates the interval (in seconds) between the time stamp (G4) of the corresponding on-line
18 RADIUS Access-Request message and the next tariff switch condition. TITSU Sub-Type
19 corresponds to the time after TSI where an on-line RADIUS Access-Request message may be
20 sent by the PrePaid capable PDSN to report VUATS before the next tariff switch condition.

21 If VT is reached prior to expiration of TITSU, the PrePaid capable PDSN sends an on-line
22 RADIUS Access-Request message with the PPAQ VSA that includes the VQ Sub-Type, and the
23 Update-Reason set to 'Threshold Reached" and the PTS VSA that includes the VUATS Sub-
24 Type. The PrePaid capable PDSN then discards TITSU. A new value of TSI and TITSU in a PTS
25 VSA may be received in the on-line RADIUS Access-Accept.

26 If TITSU has expired prior to VT, the PrePaid capable PDSN sends an on-line RADIUS Access-
27 Request message with the PPAQ VSA that includes the VQ Sub-Type, and the Update-Reason
28 set to 'Tariff Switch Update" and the PTS VSA that includes the VUATS Sub-Type.

29 The total volume used before and after the Tariff Switch is reported in an on-line RADIUS
30 Access-Request message which includes the VolumeQuota Sub-Type in the PPAQ VSA, and the
31 volume used after the Tariff Switch is reported in the VolumeUsedAfterTariffSwitch Sub-Type in
32 the PTS VSA.

33 A PrePaid on-line quota update with tariff switch example is illustrated in the call flow below
34 describing a successful volume based PrePaid accounting scenario with Tariff switching point at
35 12:00 and 21:00 until funds are depleted.

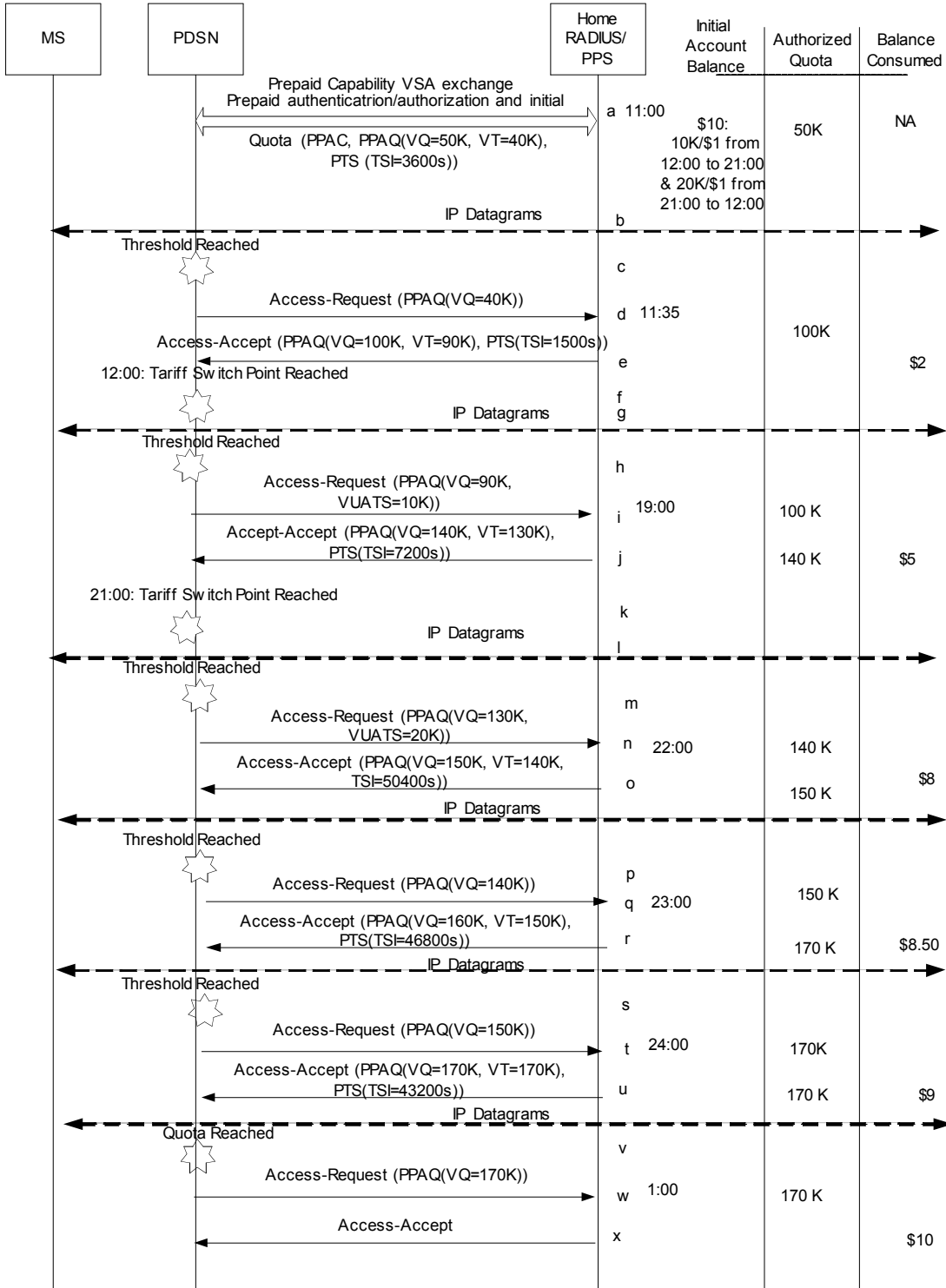


Figure 4. Volume based Tariff Switch until account depletion

Flow Description:

- 1
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- 4 a. PrePaid service authentication/authorization is complete. At this step the PrePaid
- 5 capable PDSN and the Home RADIUS/PPS exchange PPAC VSA to enable PrePaid
- 6 packet data service. Assume that the initial account balance in Home RADIUS/PPS is

- 1 | \$10¹ and PPS provides Tariff Switch capability in this example. The tariff rate is 20K per
 2 | \$1 from 21:00 to 12:00 next day and 10K per \$1 from 12:00 to 21:00. The Home
 3 | RADIUS/PPS includes a PPAQ to initialize an initial VolumeQuota and a
 4 | VolumeThreshold value. The Home RADIUS/PPS returns a VQ of 50K, a VT of 40K, and
 5 | TSI of 3600s. 50K is saved as the Authorized Quota value in the Home RADIUS/PPS.
 6 | Since the request was received at the RADIUS/PPS at 11:00, the conversion from
 7 | account balance to volume was based on 21:00 – 12:00 tariff². After allocation of 50K
 8 | VQ, the Authorized Quota column should show \$2.5 (50K @ \$0.05/K).
- 9 | b. IP data flows. These are counted by the PrePaid capable PDSN.
- 10 | c. The 40K threshold is reached.
- 11 | d. Triggered by the step c, the PrePaid capable PDSN sends an on-line RADIUS Access-
 12 | Request message at 11:35 to the PPS with the PPAQ VSA containing the Sub-Type
 13 | VQ=40K and the Sub-Type Update-Reason set to 3 (i.e., threshold reached).
- 14 | e. The Home RADIUS/PPS saves 40K (after 21:00) value as Balance Consumed (Note
 15 | 21:00 was the Tariff Switching Point). The Home RADIUS/PPS determines that (40K @
 16 | 0.05/K) \$2 is used and \$8 is remaining money in the account. An additional 50K is
 17 | authorized at this time. Since the request was received at the RADIUS/PPS at
 18 | (approximately) 11:35 hours, the conversion from account balance to volume was based
 19 | on 21:00 – 12:00 tariff. After allocation of (50K + 50K) 100K VQ, the Authorized Quota
 20 | column should show \$5 (100K @ \$0.05/K) and the Balance Consumed should show
 21 | \$2. The Authorized Quota is returned in an on-line RADIUS Access-Accept message
 22 | containing a VQ=100K, VT=90K and TSI=1500s.
- 23 | f. At 12:00, Tariff switch point is reached.
- 24 | g. IP data flow continues.
- 25 | h. The 90K threshold is reached.
- 26 | i. Triggered by step h, the PrePaid capable PDSN sends an on-line RADIUS Access-
 27 | Request message at 19:00 to the PPS with the PPAQ VSA containing the Sub-Type
 28 | VQ=90K, and the Sub-Type Update-Reason set to 3 (i.e., threshold reached) and the
 29 | PTS VSA containing the Sub-Type VUATS=10K (Volume used after 12:00)
- 30 | j. The Home RADIUS/PPS saves 80K (after 21:00) and 10K (after 12:00) as Balance
 31 | Consumed. The Home RADIUS/PPS determines that \$5 (80K @ \$0.05/K + 10K @
 32 | \$0.1/K) is used and \$5 is remaining money in the account. An additional 40K is
 33 | authorized at this time. Since the request was received at the Home RADIUS/PPS at
 34 | (approximately) 19:00 hours, the conversion from account balance to volume was based
 35 | on 12:00 – 21:00 tariff. After allocation of (50K + 50K + 40K) 140K VQ, the Authorized
 36 | Quota column should show \$9 (100K @ \$0.05/K + 40K @ \$0.1/K) and the Balance
 37 | Consumed should show \$5. The Authorized Quota is returned in an on-line RADIUS
 38 | Access-Accept message containing a VQ=140K, VT=130K, and TSI=7200s.
- 39 | k. At 21:00, Tariff switch point is reached.
- 40 | l. IP data flow continues.
- 41 | m. The 130K threshold is reached.
- 42 | n. Triggered by step m, the PrePaid capable PDSN sends an on-line RADIUS Access-
 43 | Request message to the PPS at 22:00 hours with the PPAQ VSA containing the Sub-
 44 | Types Update-Reason set to 3 (i.e., threshold reached) and VQ=130K and the PTS VSA
 45 | with Sub-Type VUATS=20K.

¹ All dollar amounts referenced in this document are for illustration purposes only.

² Conversion of dollar to quota in the Home RADIUS/PPS for tariff switching may be done using other implementation specific methods.

- 1 o. The Home RADIUS/PPS saves 100K (80K + 20K) (after 21:00) and 30K (10K + 20K)
 2 (after 12:00) value as Balance Consumed. The Home RADIUS/PPS determines that \$8
 3 (100K @ \$0.05/K + 30K @ \$0.1/K) is used and \$2 is remaining money in the account. An
 4 additional 10K is authorized at this time. Since the request was received at the
 5 RADIUS/PPS at (approximately) 22:00 hours, the conversion from account balance to
 6 volume was based on 21:00 – 12:00 tariff. After allocation of (50K + 50K + 40K + 10K)
 7 150K VQ, the Authorized Quota column should show \$9.5 (100K @ \$0.05/K + 40K @
 8 \$0.1/K + 10K @ \$0.05/K) and the Balance Consumed should show \$8. The Authorized
 9 Quota is returned in an on-line RADIUS Access-Accept message containing a VQ=150K,
 10 VT=140K, and TSI=50400s.
- 11 p. IP data flow continues and the 140K threshold is reached.
- 12 q. Triggered by step p, the PrePaid capable PDSN sends an on-line RADIUS Access-
 13 Request message at 23:00 to the PPS with the PPAQ VSA containing the Sub-Type
 14 VQ=140K and the Sub-Type Update-Reason set to 3 (i.e., threshold reached). Since
 15 there was no tariff switched event, the PTS VSA (with Sub-Type VUATS) is not included.
- 16 r. The Home RADIUS/PPS saves 110K (80K + 20K + 10K)(after 21:00) and 30K
 17 (unchanged)(after 12:00) as Balance Consumed. The Home RADIUS/PPS determines
 18 that \$8.50 (110K @ \$0.05/K + 30K @ \$0.1/K) is used and \$1.50 is remaining money in
 19 the account. An additional 10K is authorized at this time. Since the request was received
 20 at the RADIUS/PPS at (approximately) 23:00 hours, the conversion from account balance
 21 to volume was based on 21:00 – 12:00 tariff. After allocation of (50K + 50K + 40K + 10K
 22 + 10K) 160K VQ, the Authorized Quota column should show \$10 (100K @ \$0.05/K + 40K
 23 @ \$0.1/K + 10K @ \$0.05/K + 10K @ \$0.05/K) and the Balance Consumed should show
 24 \$8.5. The Authorized Quota returned in the on-line RADIUS Access-Accept message
 25 contains a VQ=160K, VT=150K, and TSI=46800s.
- 26 s. IP data flow continues and the 150K threshold is reached.
- 27 t. Triggered by step s, the PrePaid capable PDSN sends an on-line RADIUS Access-
 28 Request message at 24:00 to the PPS with the PPAQ VSA containing the Sub-Type
 29 VQ=150K and the Sub-Type Update-Reason set to 3 (i.e., threshold reached).
- 30 u. The Home RADIUS/PPS saves 120K (80K + 20K + 10K + 10K)(after 21:00) and 30K
 31 (unchanged)(after 12:00) as Balance Consumed. The Home RADIUS/PPS determines
 32 that \$9 (120K @ \$0.05/K + 30K @ \$0.1/K) is used and \$1 is remaining money in the
 33 account. An additional 20K is authorized at this time³. Since the request was received at
 34 the RADIUS/PPS at (approximately) 24:00 hours, the conversion from account balance to
 35 volume was based on 21:00 – 12:00 tariff. After allocation of (50K + 50K + 40K + 10K +
 36 10K) 160K VQ, the Authorized Quota column should still show \$10 and the Balance
 37 Consumed should show \$9.0. The authorized additional Quota of 20K is due to the
 38 remaining balance of \$1 in the users account at this time. The Authorized Quota returned
 39 in the on-line RADIUS Access-Accept message contains a VQ=170K, VT=170K, and
 40 TSI=43200s.
- 41 v. IP data flow continues and the 170K quota is reached.
- 42 w. Since at step u the VQ = VT the PrePaid capable PDSN knows that there is no more
 43 balance left for the user. The PrePaid capable PDSN sends an on-line RADIUS Access-
 44 Request message to the PPS at 1:00 with the PPAQ VSA containing the Sub-Type
 45 VQ=170K, and with the Sub-Type Update-Reason set to 4 (i.e., quota reached), and
 46 starts releasing the service instance.

³ Even though the 20K might be used after the next tariff switch interval, which could overflow the user's account, in this example, the Home RADIUS/PPS decides that the possibility of such a small overflow would be acceptable.

- 1 x. The PPS saves the 140K (80K + 20K + 10K + 10K + 20K) (after 21:00) and 30K
 2 (unchanged) (after 12:00) as Balance Consumed. The Balance Consumed (140K @
 3 \$0.05/K + 30K @ \$0.1/K) = Account Balance (\$10) at this time. The PPS sends an
 4 Access Accept back to PrePaid capable PDSN to acknowledge the termination of the
 5 PrePaid packet data session. As part of the usual off-line accounting procedures, the
 6 PDSN sends a RADIUS Accounting-Request message (Stop) upon successful release of
 7 the appropriate resources (not shown in the diagram).

8 **5.2 Service Description for Duration Based PrePaid at the PDSN**

9 As with volume based PrePaid, quota initialization for the main service instance is received in a
 10 RADIUS Access-Accept message during user authentication and authorization. Quota pre-
 11 initialization and initialization for the auxiliary service instances and subsequent quota updates
 12 use on-line RADIUS Access-Accept messages in response to on-line RADIUS Access-Request
 13 messages from the PrePaid capable PDSN.

14 The Event-Timestamp (55) attribute shall be included in the RADIUS Access-Request message
 15 for initial quota allocation and subsequent on-line RADIUS Access-Request messages. For
 16 duration based PrePaid packet data service, the Event-Timestamp attribute (55) is used for
 17 DurationQuota/DurationThreshold allocation by the Home RADIUS/PPS.

18 Upon receipt of the RADIUS Access-Accept message indicating that the PrePaid packet data
 19 service is allowed and which includes the initial DurationQuota, Quota ID and the
 20 DurationThreshold for the main service instance in the PPAQ VSA, the PrePaid capable PDSN
 21 stores the information and starts measuring the duration over the specific service instance
 22 against the allocated quota at successful PrePaid packet data session establishment (i.e., IP
 23 address assigned for Simple IP or MIP RRP received from the HA and sent to the MS).

24 The PrePaid capable PDSN performs subsequent on-line quota update operation with the Home
 25 RADIUS/PPS when the DurationThreshold value is reached. At subsequent on-line quota update
 26 operation, the PDSN sends an on-line RADIUS Access-Request message containing the PPAQ
 27 VSA and which includes the Update-Reason Sub-Type to indicate 'Threshold reached', the Quota
 28 ID previously received and the used Duration in the DurationQuota Sub-Type.

29 The Home RADIUS/PPS apportions a fraction of the PrePaid account balance into a
 30 DurationQuota and a DurationThreshold and assigns a Quota ID, all of which are encoded in a
 31 PPAQ VSA in the on-line RADIUS Access-Accept message to the PrePaid capable PDSN in
 32 response to the on-line RADIUS Access-Request message. The Home RADIUS/PPS assigns a
 33 new Quota ID to the allocated DurationQuota and DurationThreshold at each quota update
 34 operation.

35 If DurationQuota is consumed before the PrePaid capable PDSN receives a response from the
 36 Home RADIUS/PPS for a quota update request or if the quota is consumed when the
 37 DurationQuota value and the DurationThreshold value are the same, the PrePaid capable PDSN
 38 sends an on-line RADIUS Access-Request message containing the PPAQ VSA with the Update
 39 Reason indicating "Quota Reached" and releases the corresponding service instance.

40 The PDSN sends the RADIUS Accounting-Request message (stop) to indicate the release of the
 41 service instance, per the existing off-line accounting procedures.

42 **5.2.1 Interaction with Remote IP Address Based Accounting**

43 Duration based PrePaid has no interaction with remote IP address based accounting as the
 44 duration of the session is not related to the remote destination/source of the packets.

45 **5.2.2 Sequence Diagrams**

46 Similar Sequence Diagrams as in section 5.2.2 apply to Duration based PrePaid.

1 **5.2.2.1 Successful PrePaid Authorization**

2 Similar to 5.1.2.1, but the PrePaidAccountCapability shall indicate duration based PrePaid if
3 supported by the PrePaid capable PDSN.

4 **5.2.2.2 Duration Usage until Account Depletion**

5 Similar to 5.1.2.2, but the duration based PrePaid accounting is accomplished by using the PPAQ
6 VSA with DurationQuota and DurationThreshold Sub-Types.

7 **5.3 PrePaid Capable PDSN Requirements**

8 The PDSN shall assume the role of the PrePaid Client if the PPAC VSA and an initial PPAQ is
9 included in the RADIUS Access-Accept message at packet data session establishment as
10 authorized by the Home RADIUS/PPS.

11 The on-line RADIUS Access-Request/Accept messages are RADIUS Access-Request/Accept
12 messages that are subsequent to the initial RADIUS Access-Request/Accept message and shall
13 be used for PrePaid quota update operations. The PrePaid capable PDSN shall include in the on-
14 line RADIUS Access-Request messages the attributes Message Authenticator and Service-Type
15 (6) set to PrePaid 'Authorize Only' to indicate that the RADIUS Access-Request message is for
16 authorization only, and the PPAQ VSA to indicate that the authorization is for PrePaid quota
17 update. Other attributes shall be included as indicated in Table 2.

18 Only the on-line quota update RADIUS Access-Request/Accept messages and the initial RADIUS
19 Access-Accept message from the Home RADIUS/PPS shall be allowed to include the
20 PrePaidAccountingQuota VSA (PPAQ) as defined in X.S0011-005-C.

21 The on-line RADIUS Access-Request message shall use the same Correlation ID value as used
22 in the RADIUS Access-Request message sent at packet data session establishment.

23 PrePaid service for non-authenticated users (Simple IP users with no CHAP or PAP) is not
24 supported in this specification.

25 **5.3.1 Authorization and Quota Initialization Requirements**

- 26 1. A PrePaid capable PDSN shall measure volume (octets) or total session duration
27 (seconds) per service instance for all PrePaid packet data sessions.
- 28 2. The PrePaid capable PDSN shall indicate to the Home RADIUS/PPS that it
29 supports PrePaid Accounting. The PrePaid capable PDSN shall include the PPAC
30 VSA defined in X.S0011-005-C in the RADIUS Access-Request message at
31 Simple IP or Mobile IP establishment. The PDSN shall also include the
32 SessionTerminationCapability (STC) (see Chapter X.S0011-003-C) with value 3.
- 33 3. If the PPAC VSA is not received from the Home RADIUS/PPS in the initial
34 RADIUS Access-Accept message, or is included but it indicates "PrePaid
35 Accounting not used", the PrePaid capable PDSN shall initiate release of the
36 user's PrePaid packet data session if the RADIUS Access-Accept message from
37 the Home RADIUS/PPS includes a PPAQ VSA.
- 38 4. The PrePaid capable PDSN shall terminate a packet data session when the
39 RADIUS Access-Accept message includes a PPAQ VSA containing the
40 VolumeQuota Sub-Type for a packet data session identified by the PPAC VSA as
41 "Duration" only. The PrePaid capable PDSN shall send an on-line RADIUS
42 Access-Request message with the Update-Reason Sub-Type "Client Service
43 termination" to indicate the release of the packet data session and shall include
44 the Quota ID and the non-used DurationQuota.
- 45 5. The PrePaid capable PDSN shall terminate a packet data session when the
46 RADIUS Access-Accept message includes a PPAQ VSA containing the
47 DurationQuota Sub-Type for a packet data session identified by the PPAC VSA

- 1 as "Volume" only. The PrePaid capable PDSN shall send an on-line RADIUS
2 Access-Request message with the Update-Reason Sub-Type "Client Service
3 termination" to indicate the release of the packet data session and shall include
4 the Quota ID and the non-used VolumeQuota.
- 5 6. If the PDSN receives the RADIUS Access-Accept message containing the PPAC
6 VSA indicating PrePaid, but the initial quota is not included, the PDSN shall
7 release the main service instance, and consequently the packet data session
8 without further notifying the Home RADIUS server/PPS.
- 9 7. If the PDSN is not PrePaid capable, it shall not include the PPAC VSA in the
10 RADIUS Access-Request message to the Home RADIUS server.
- 11 8. The PrePaid capable PDSN shall support PrePaid over a service instance based
12 on either VolumeQuota and VolumeThreshold or a DurationQuota and
13 DurationThreshold. If both VolumeQuota and DurationQuota are received for the
14 same service instance, the PrePaid capable PDSN shall use its local policy to
15 determine which type of PrePaid accounting should be used for that service
16 instance.
- 17 9. If the Class attribute has been received by the PDSN during the RADIUS Access-
18 Accept message, the PDSN shall include the Class attribute as received on all
19 subsequent RADIUS Accounting-Request messages associated with the session.
20 The PDSN shall support one Class attribute per packet data session. If more than
21 one Class attribute is received in the RADIUS Access-Accept message, the
22 PDSN shall accept the first Class attribute that appears in the message.
- 23 10. Upon receiving a RADIUS Access-Accept message indicating that PrePaid packet
24 data service shall be provided, the PrePaid capable PDSN shall store the initial
25 quota, threshold and Quota ID for the main service instance received in the PPAQ
26 VSA, and shall start metering the traffic when the MS has successfully been
27 assigned an IP address (Simple IP) or has successfully registered with the home
28 network (Mobile IP) for the PrePaid packet data session.
- 29 11. If the RADIUS Access-Accept message, in addition to the PPAC VSA, includes
30 the Service Option Profile VSA and indicates that the user is allowed to establish
31 auxiliary service instances of SO type 60 or 61, the PrePaid Capable PDSN may
32 immediately initiate an on-line RADIUS Access-Request message to request pre-
33 initialization of quota for the auxiliary service instance of SO type 60 or 61 that the
34 user may establish. The PPAQ VSA shall include the Update-Reason Sub-Type
35 to indicate "pre-initialization". Note that pre-initialization of quota shall only be
36 applicable for auxiliary service instances of SO type 60 or 61.
- 37 12. If the auxiliary service instance is never requested by the MS, then upon PrePaid
38 packet data session termination, an on-line RADIUS Access-Request message
39 message shall be sent containing the PPAQ VSA with the Update-Reason Sub-
40 Type indicating, "service instance not established". If the user eventually requests
41 establishment of an auxiliary service instance for which quota pre-initialization is
42 not done, the PrePaid capable PDSN shall trigger an on-line RADIUS Access-
43 Request message to request initialization of the quota, as the auxiliary service
44 instance is being setup by the user. The PPAQ VSA shall include the Update-
45 Reason to indicate "initial request".
- 46 13. If the PrePaid user attempts to establish an additional packet data session while a
47 PrePaid packet data session is already active over the same PPP session, the
48 PrePaid capable PDSN shall reject the second packet data session.
- 49 14. If the initial packet data session established by the user is not PrePaid and a
50 subsequent packet data session is requested by the MS, the PDSN shall not
51 include the PPAC VSA in the RADIUS Access-Request message. The home

- 1 network may determine if the HA can provide the PrePaid packet data service for
2 the user.
- 3 15. At Mobile IP re-registration of a PrePaid packet data session, if the PDSN sends a
4 RADIUS Access-Request message to the Home RADIUS/PPS to authenticate the
5 user, it shall include the Session-Continue VSA with the value set to true.
- 6 16. If both DurationQuota and TariffSwitchInterval are received for the same service
7 instance, the PrePaid capable PDSN shall discard the TariffSwitchInterval and
8 shall provide PrePaid based on the DurationQuota only.
- 9 17. If the PTS VSA is received, it shall include the TariffSwitchInterval (TSI) Sub-
10 Type, and may include the TimeIntervalafterTariffSwitchUpdate timer (TITSU)
11 Sub-Type. The TITSU Sub-Type may be included when more than one tariff
12 switch boundary exists, and the user may not reach the VolumeThreshold before
13 the next tariff switch boundary is crossed. The PrePaid capable PDSN shall
14 monitor both the Volume and the Duration concurrently to support tariff switching.

15 5.3.2 On-line Quota Update Procedure Requirements

- 16 1. The PrePaid capable PDSN shall support on-line quota update on a service
17 instance basis as identified by IP/NAI/SO/SI association.
- 18 2. The PrePaid capable PDSN shall include the Service Reference ID VSA defined
19 in X.S0011-005-C in the RADIUS Access-Request message and subsequent on-
20 line RADIUS Access-Request messages. However at quota pre-initialization for
21 auxiliary service instance, its value shall be zero. The main SI indicator in the
22 Service Reference ID VSA shall only be included in the on-line RADIUS Access-
23 Request messages associated with the main service instance.
- 24 3. The PDSN shall include the Message Authenticator (80) in on-line RADIUS
25 Access-Request message and set the value as described in RFC 2869. Upon
26 receiving an on-line RADIUS Access- Accept message, the PDSN shall validate
27 the value of the Message-Authenticator as described in RFC 2869. The PDSN
28 shall silently discard an on-line RADIUS Access-Accept message that does not
29 contain a Message Authenticator Attribute.
- 30 4. The PrePaid capable PDSN shall provide usage of PrePaid resources in new
31 PrePaid counters (i.e., VolumeQuota, VolumeUsedAfterTariffSwitch or
32 DurationQuota) which represent the usage at the service instance level.
- 33 5. For a PrePaid packet data session, the used Volume reported in the
34 VolumeQuota shall be incremented before compression and fragmentation by the
35 number of octets in IP packets sent to the user.
- 36 6. For a PrePaid packet data session, the used Volume reported in the
37 VolumeQuota shall be incremented after decompression by the number of octets
38 in IP packets received from the user.
- 39 7. If the VSAs for Remote IP Address accounting are received and the Qualifier in
40 the VSAs indicate that the IP traffic to and from the remote IP addresses is
41 exempt from PrePaid charges, the PrePaid capable PDSN shall exclude the octet
42 count from those IP packets in the VolumeQuota within the PPAQ VSA reported
43 to the Home RADIUS/PPS.
- 44 8. Upon receiving a RADIUS Disconnect-Request message or Mobile IP
45 Registration Revocation message, the PrePaid capable PDSN shall send an on-
46 line RADIUS Access-Request message containing the used quota and the
47 Update-Reason Sub-Type set to 'Remote forced disconnect', and release the
48 resources that will trigger sending the existing off-line RADIUS Accounting-
49 Request (stop) message.

- 1 9. When a quota (volume or duration) assigned to the main service instance is
2 consumed, the PrePaid capable PDSN shall release the main service instance
3 and send an on-line RADIUS Access-Request message with Update-Reason
4 "Quota reached". Because the main service instance is released, the PrePaid
5 capable PDSN shall release all auxiliary service instances established by the MS.
6 For each service instance, the PrePaid capable PDSN shall send an on-line
7 RADIUS Access-Request message with Update-Reason " Main SI released".
- 8 10. When the Quota for a service instance is consumed, the PrePaid capable PDSN
9 shall release the associated service instance, regardless if other non-PrePaid
10 packet data sessions are active, and shall send an on-line RADIUS Access-
11 Request message to report the used quota with the appropriate Update-Reason
12 value "Quota Reached".
- 13 11. If a threshold (e.g., VT or DT) is provided by the Home RADIUS/PPS, and is
14 reached, the PrePaid capable PDSN shall send an on-line RADIUS Access-
15 Request message to request a quota update. The Update-Reason shall be set to
16 "Threshold reached". The message shall include the VolumeQuota or
17 DurationQuota in the PPAQ VSA and may include the PPAC VSA.
- 18 12. If the MS closes the PPP session or if the PPP session is closed in the PDSN, or
19 if the MIP RRQ Lifetime has expired, the PrePaid capable PDSN shall send an
20 on-line RADIUS Access-Request message with an Update-Reason indicating
21 "Client Service termination". An off-line RADIUS Accounting-Request message
22 (Stop) with the appropriate release indicator shall be sent eventually.
- 23 13. If the PrePaid capable PDSN and the HA successfully negotiated Registration
24 Revocation in Mobile IPv4, the PrePaid capable PDSN shall send a Mobile IP
25 Registration Revocation message to the HA when the user's quota is consumed.
- 26 14. If a TariffSwitchInterval condition is reached during an accounting session, the
27 PrePaid capable PDSN shall accumulate the subsequent volume traffic into the
28 VolumeUsedAfterTariffSwitch counter and shall send an on-line RADIUS Access-
29 Request message to the Home RADIUS/PPS when either VT is reached or when
30 TariffIntervalafterTariffSwitchUpdate (TITSU) has expired, whichever comes first.
31 The on-line RADIUS Access-Request message shall include the VolumeQuota
32 (total quota used) in the PPAQ VSA and the theVolumeUsedAfterTariffSwitch
33 counter in the PTS VSA.
- 34 15. If VT is reached prior to expiration of TITSU, the PrePaid capable PDSN shall
35 send an on-line RADIUS Access-Request message with the PPAQ VSA that
36 includes the VQ Sub-Type, and the Update-Reason set to "Threshold Reached"
37 and the PTS VSA that includes the VUATS Sub-Type. The PrePaid capable
38 PDSN shall then discard TITSU. A new value of TSI and TITSU in a PTS VSA
39 may be received in the on-line RADIUS Access-Accept message.
- 40 16. If TITSU has expired prior to VT, the PrePaid capable PDSN shall send an on-line
41 RADIUS Access-Request message with the PPAQ VSA that includes the VQ
42 Sub-Type, and the Update-Reason set to "Tariff Switch Update" and the PTS VSA
43 that includes the VUATS Sub-Type.
- 44 17. If the Volume Quota is consumed in a middle of a packet, the PrePaid capable
45 PDSN shall send the complete packet, release the resources and report back to
46 the Home RADIUS/PPS with an on-line RADIUS Access-Request containing the
47 PPAQ VSA. It shall return the used VolumeQuota and the Update-Reason Sub-
48 Type set to "Quota Reached".
- 49 18. If the PrePaid capable PDSN receives an on-line RADIUS Access-Reject
50 message as a result of an on-line RADIUS Access-Request message, it shall
51 release the corresponding service instance and send a final on-line RADIUS

- 1 Access-Request message to report the used VolumeQuota and the Update-
- 2 Reason Sub-Type set to 'Remote Forced Disconnect'.

6 PrePaid Client in the HA

6.1 Service Description for PrePaid at the HA

If the HA supports a PPC, it shall also support Dynamic Authorization with RADIUS and Registration Revocation for Mobile IPv4 capabilities (see X.S0011-003-C). The HA is referred to as a PrePaid capable HA, and the PrePaid capability is based on the following principles:

- Upon receiving an initial MIP RRQ message, the PrePaid capable HA sends a RADIUS Access-Request message to the Home RADIUS server/PPS, which includes the PPAC VSA, the STC VSA with value 3 and the MIP RRQ Lifetime VSA containing the received RRQ lifetime Sub-Type.
- The PrePaid capable HA accepts an initial quota in the RADIUS Access-Accept message if it contains the PPAC VSA that indicates that PrePaid is allowed for the user.
- Subsequent on-line quota update operation is performed for a packet data session by the PrePaid capable HA using on-line RADIUS Access-Request/Accept messages. The on-line RADIUS Access-Request shall contain at least the attributes Message Authenticator, Service-Type set to 'authorize only' and the PPAQ VSA. The on-line RADIUS Access-Accept message shall contain at least the PPAQ VSA.
- Off-line Accounting is not supported by the HA.

The Home RADIUS/PPS determines whether the HA or the PDSN should provide PrePaid packet data service for the user based on the Session Termination Capability (STC), the PPAC VSAs received from the PDSN and the HA, the user profile and the home network policy.

The STC VSA, if received from the PDSN and the HA⁴, indicates to the Home RADIUS/PPS that the resource management through both Dynamic Authorization with RADIUS and Registration Revocation for Mobile IPv4 are supported (See Resource management section, X.S0011-003-C).

If the PDSN⁵ has not included the STC VSA in the RADIUS Access-Request and if the home network policy and the user profile allow, the Home RADIUS/PPS may allow duration based PrePaid packet data session to be provided by the PrePaid capable HA. In this case, the PrePaid packet data session may be controlled, by using the RRQ lifetime as an allocation unit for the DurationQuota and/or DurationThreshold to synchronize the MIP re-registration operation with the on-line quota update operation. The RRQ Lifetime received in the RRQ message is sent to the Home RADIUS/PPS server as a Sub-Type in the MIP Lifetime VSA. The Home RADIUS/PPS may send a new RRQ Lifetime in the RADIUS Access-Accept message towards the PrePaid capable HA, which the HA forwards to the PDSN in the MIP RRP message.

If the PDSN has included the STC VSA (value 3), the Home RADIUS/PPS may determine based on the home network policy, the user's profile if either volume based or duration based can be provided by the PrePaid capable HA. In this case, duration quota does not require to be synchronized with the RRQ Lifetime received in the MIP Lifetime VSA.

Upon receiving a new MIP registration request, the PrePaid capable HA sends a RADIUS Access-Request message to the Home RADIUS/PPS. The RADIUS Access-Request message includes the PPAC VSA, the MIP RRQ Lifetime VSA containing the RRQ Lifetime Sub-Type (value received in the RRQ message) and a newly generated Correlation ID VSA.

Upon receiving a Mobile IP re-registration request (same CoA) or a Mobile IP registration for the same IP, NAI but different CoA, the PrePaid capable HA sends an on-line RADIUS Access-Request message to the Home RADIUS/PPS. The on-line RADIUS Access-Request message

⁴ A PDSN or the HA supporting previous version of this specification will not include the STC VSA.

⁵ This may be a PDSN supporting previous version of this specification.

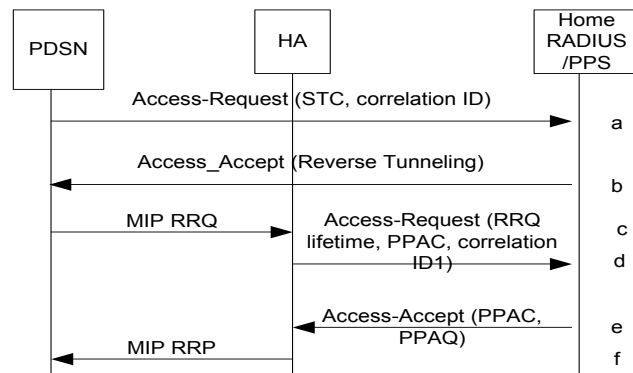
- 1 includes the PPAC VSA, the MIP Lifetime VSA containing the RRQ Lifetime Sub-Type (value
 2 received in the RRQ) and the Used Lifetime From Existing Session Sub-Type (value of used
 3 lifetime of the existing Mobile IP session) and the Correlation ID VSA containing the same
 4 Correlation ID value that is in use at that time.
- 5 If a RADIUS Access-Accept message is received and contains a PPAC VSA indicating PrePaid,
 6 the RADIUS Access-Accept message shall contain an initial quota. Subsequent on-line quota
 7 update operations shall use on-line RADIUS Access-Request messages with the quota allocation
 8 delivered in the on-line RADIUS Access-Accept messages.
- 9 Off-line accounting procedures for the HA are not defined in this specification.

10 **6.2 Interaction with Remote IP Address based Accounting**

11 If attributes for remote address accounting are included in the RADIUS Access-Accept message,
 12 the qualifier Sub-Type is included to indicate to the PrePaid capable HA that the IP traffic to and
 13 from the remote IP addresses is exempt from the PrePaid charges. The PrePaid capable HA
 14 does not include the octet count from those IP packets in the totals reported to the Home
 15 RADIUS/PPS. See X.S0011-005-C for updated Remote IPv4/IPv6 Address and Remote Address
 16 Table Index VSAs.

17 **6.3 Sequence diagrams**

18 **6.3.1 Successful PrePaid Authorization**



19

20 **Figure 5. PrePaid authorization from the PrePaid capable HA**

21 **Flow Description:**

- 22 a. The PDSN is not PrePaid capable. The PDSN receives a MIP RRQ from the MS and
 23 sends a RADIUS Access-Request message to the Home RADIUS/PPS, which includes a
 24 STC VSA indicating to the Home RADIUS/PPS that the PDSN can receive requests to
 25 close user's packet data sessions from authorized remote node.
- 26 b. The Home RADIUS/PPS performs the regular Authentication and Authorization. The
 27 authorization includes the following tasks:
- 28 • the Home RADIUS/PPS verifies the home network policy and the user profile and
 29 determines that the user is a PrePaid user,
 - 30 • checks if the PPAC is sent by the PDSN, in this scenario it is not,
 - 31 • checks if the HA in the home network is configured to provide PrePaid,
 - 32 • checks if the STC VSA is included. [Note: if the STC VSA is not included, the Home
 33 RADIUS/PPS may either reject the RADIUS Access-Request message or limit the
 34 service to duration based PrePaid only at the HA]. In this scenario, the STC VSA is
 35 sent by the PDSN. The Home RADIUS/PPS returns a RADIUS Access-Accept

- 1 indicating that reverse tunneling shall be applied. The PDSN performs regular off-
2 line accounting.
- 3 c. The PDSN forwards the MIP RRQ to the PrePaid capable HA
- 4 d. Upon receiving the MIP RRQ, the PrePaid capable HA sends a RADIUS Access-Request
5 message to the Home RADIUS/PPS. The request shall contain the PPAC VSA, the STC
6 VSA, a generated Correlation ID VSA and the MIP Lifetime VSA containing the RRQ
7 Lifetime.
- 8 e. The Home RADIUS/PPS performs authorization of the request and allows the PrePaid
9 capable HA to provide PrePaid for the user. The Home RADIUS/PPS includes the PPAC
10 VSA along with a PPAQ VSA containing an initial quota. A MIP Lifetime VSA may be
11 included to contain an updated RRQ Lifetime, which is allocated based on the PrePaid
12 user profile (i.e., Duration based PrePaid) and the local policy. However, since the PDSN
13 has indicated support for Session Termination Capability, the MIP Lifetime VSA
14 containing an updated RRQ Lifetime is not required in the RADIUS Access-Accept
15 message.
- 16 f. The PrePaid capable HA sends a successful MIP RRP to the PDSN, which it forwards to
17 the MS. If a MIP Lifetime VSA is received from the Home RADIUS/PPS, the PrePaid
18 capable HA includes the received RRQ Lifetime Sub-Type value in the MIP RRP.

19 **6.3.2 Volume Usage until Account Depletion**

20 Same as 5.1.2.2, with the exception of the off-line accounting messages (start and stop) sent at
21 the beginning and end of the session.

22 **6.3.3 Tariff Switch**

23 Same as 5.1.2.3.

24 **6.3.4 Handoff from a PrePaid Capable PDSN to a Non-PrePaid Capable PDSN**

25 A PrePaid user established a PrePaid packet data session with a PDSN that has PrePaid and
26 session termination capability.

27 The MS performs handoff and moves to a new PDSN that does not have PrePaid and session
28 termination capability. A RADIUS Access-Request message containing the same HA IP address
29 is sent to the Home RADIUS/PPS from the new PDSN. The Home RADIUS/PPS determines that
30 a PrePaid packet data session is ongoing at the previous PDSN. A RADIUS Disconnect-Request
31 message is sent to the previous PDSN. The Home RADIUS/PPS allows the PrePaid Capable HA
32 to provide Duration based PrePaid for the user if the user profile allows it.

33 **6.3.5 Handoff from a Non-PrePaid Capable PDSN to a PrePaid Capable PDSN**

34 This scenario is based on the Home RADIUS/PPS policy that allows the PrePaid capable HA to
35 continue providing PrePaid packet data service for the user, even after the user moves to a new
36 PDSN that has PrePaid capability.

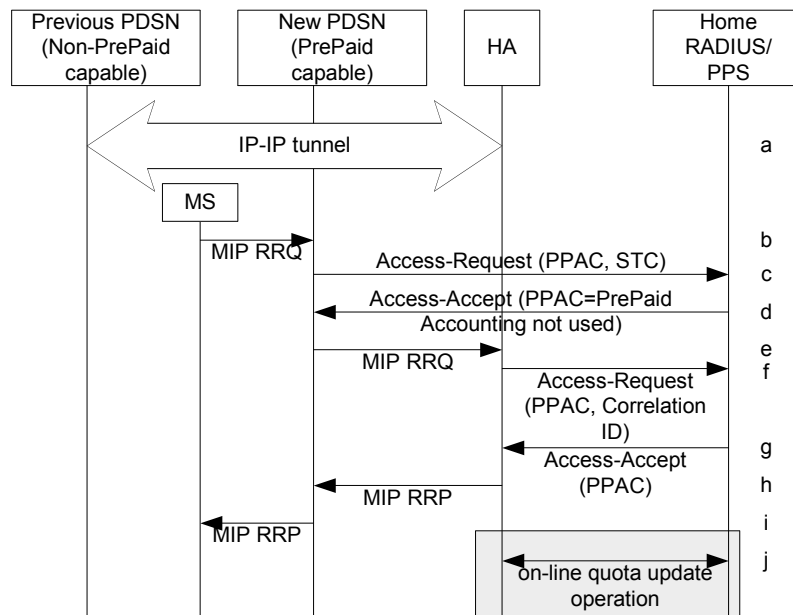


Figure 6. Handoff from a Non-PrePaid to a PrePaid Capable PDSN

Flow Description:

- 1
- 2
- 3
- 4 a. A PrePaid user establishes a packet data session through a non-PrePaid capable PDSN
- 5 with session termination capabilities. In this scenario, ~~we assume it is assumed~~ that the
- 6 HA was allowed by the Home RADIUS/PPS to provide PrePaid packet data service for
- 7 the user.
- 8 b. The user moves to the coverage area of a PrePaid capable PDSN and send a MIP
- 9 Registration Request through the PDSN.
- 10 c. A RADIUS Access-Request message containing the same HA IP address used prior to
- 11 handoff, the PPAC VSA and the STC VSA is sent to the Home RADIUS/PPS.
- 12 d. The Home RADIUS/PPS sends a RADIUS Access-Accept message to the new PrePaid
- 13 capable PDSN, and which may contain the PPAC VSA set to 'PrePaid Accounting not
- 14 used' or the PPAC VSA may be omitted.
- 15 e. The New PDSN forwards the Mobile IP RRQ to the HA
- 16 f. The HA sends an RADIUS Access-Request message to the Home RADIUS/PPS. The
- 17 request shall contain the PPAC, the Session Continue VSA, the same Correlation ID in
- 18 use before the handoff and the MIP Lifetime VSA containing both the RRQ Lifetime Sub-
- 19 Type (lifetime value received in the RRQ) and the Used Lifetime From Existing Session
- 20 Sub-Type (value of used lifetime of the existing Mobile IP session) if duration based
- 21 PrePaid is being provided for the session.
- 22 g. The Home RADIUS/PPS performs authorization of the request and based on the home
- 23 policy allows the PrePaid capable HA to continue PrePaid packet data service for the
- 24 user. The PPAC VSA is included in the response back to the HA. The HA continues to
- 25 use the allocated quota.
- 26 h. The HA returns the MobileIP Registration Reply to the PDSN.
- 27 i. The PDSN send the MobileIP Registration Reply to the MS.

- 1 j. Not immediately following step i, the HA will subsequently use on-line RADIUS Access-
2 Request messages during the lifetime of the MIP session to update the quota allocation
3 which may be initiated by trigger conditions such as reaching a given threshold.

4 **6.4 PrePaid Capable HA Requirements**

5 **6.4.1 Authorization and Initialization Requirements**

- 6 1. The PrePaid capable HA shall support PrePaid for packet data sessions identified
7 by IP/NAI.
- 8 2. The PrePaid capable HA shall enforce Reverse tunneling for all the authorized
9 volume based PrePaid packet data sessions.
- 10 3. The PrePaid capable HA shall send a RADIUS Access-Request message to the
11 Home RADIUS/PPS upon receiving the initial RRQ, re-registration and updated
12 (new CoA) RRQ. The RADIUS Access-Request message shall include the
13 additional VSAs: PPAC, STC and a Correlation ID generated by the HA. For the
14 initial RRQ, the HA shall include in the RADIUS Access-Request the MIP Lifetime
15 VSA containing the RRQ Lifetime Sub-Type with the value corresponding to the
16 lifetime received from the RRQ message. For the re-registration or the updated
17 RRQ (new CoA) for the user, the HA shall include the Session Continue VSA set
18 to TRUE, the Correlation ID VSA with the same Correlation ID value that is in use
19 and the MIP Lifetime VSA containing both the RRQ Lifetime Sub-Type (lifetime
20 value received in the RRQ) and the Used Lifetime From Existing Session Sub-
21 Type (value of used lifetime of the existing Mobile IP session) if duration based
22 PrePaid is being provided for the session.
- 23 4. If the RADIUS Access-Accept message from the Home RADIUS/PPS contains
24 the PPAC VSA indicating that PrePaid accounting should be provided for the
25 user, the RADIUS Access-Accept message shall include a PPAQ VSA with an
26 initial quota unless the Correlation ID sent in the RADIUS Access-Request is the
27 same as an existing PrePaid session for which there exists an outstanding quota.
- 28 5. The PrePaid capable HA should not allow any traffic (e.g., if on-line PrePaid quota
29 purchase service at MIP session establishment is provided) and shall not update
30 the DNS server until an initial quota is received from the Home RADIUS/PPS.
- 31 6. If a new MIP Lifetime VSA is included in the RADIUS Access-Accept message
32 from the Home RADIUS/PPS, the PrePaid capable HA shall include the value in
33 the MIP RRP back to the PDSN.
- 34 7. If both DurationQuota and TariffSwitchInterval are received for the same PrePaid
35 packet data session, the PrePaid capable HA shall discard the TariffSwitchInterval
36 and shall provide PrePaid based on the DurationQuota only.
- 37 8. If the PTS VSA is received, it shall include the TariffSwitchInterval (TSI) Sub-
38 Type, and may include the TimeIntervalafterTariffSwitchUpdate timer (TITSU)
39 Sub-Type. TITSU Sub-Type may be included when more than one tariff switch
40 boundary exists, and the user may not reach the VolumeThreshold before the
41 next tariff switch boundary is crossed. The PrePaid capable HA shall monitor both
42 the Volume and the Duration concurrently to support tariff switching.

43 **6.4.2 On-line Quota Update Procedure Requirements**

- 44 1. If the PPAC VSA is not included in the RADIUS Access-Accept message or if it
45 indicates 'PrePaid accounting not used', the HA shall send a MIP RRP back to the
46 PDSN and shall not send any further on-line RADIUS Access-Request messages
47 to the Home RADIUS/PPS.
- 48 2. The PrePaid capable HA shall support PrePaid for a PrePaid packet data session
49 based on either VolumeQuota and VolumeThreshold or a DurationQuota and

- 1 DurationThreshold. If both VolumeQuota and DurationQuota are received from
2 the Home RADIUS/PPS, the PrePaid capable HA shall use its local policy to
3 determine which type of PrePaid accounting should be used for that packet data
4 session.
- 5 3. The PrePaid capable HA shall store and process the PPAQ VSA that is included
6 in the initial or on-line RADIUS Access-Accept message from the Home
7 RADIUS/PPS. When the Threshold (VT or DT) value is reached, the PrePaid
8 capable HA shall trigger an on-line RADIUS Access-Request message with the
9 Update Reason set to "Threshold Reached".
- 10 4. If the VolumeQuota or the DurationQuota is reached for the PrePaid packet data
11 session, the PrePaid capable HA shall close the PrePaid packet data session,
12 clear the associated MIP binding and shall send an on-line RADIUS Access-
13 Request message with the Update Reason 'Quota Reached'.
- 14 5. During an on-line quota update operation triggered by a "threshold Reached"
15 reason, while waiting for a new quota allocation, the HA shall allow the session to
16 continue until the remaining quota is consumed at which point if a quota is not
17 received, the PrePaid client shall close the PrePaid packet data session and send
18 an on-line RADIUS Access-Request message containing the Update-Reason
19 value "Quota Reached".
- 20 6. If the PDSN and the PrePaid capable HA successfully negotiated Registration
21 Revocation for Mobile IPv4, the PrePaid capable HA shall send a MIP Revocation
22 message to the PDSN, when the PrePaid capable HA determines that the quota
23 is reached and consequently closes the the PrePaid packet data session. The HA
24 shall send an on-line RADIUS Access-Request message to the Home
25 RADIUS/PPS containing the PPAQ VSA which shall include the used quota and
26 the Update-Reason value "Quota Reached".
- 27 7. If attributes for remote address accounting are received, and indicate that the IP
28 traffic to and from the remote IP addresses is exempt from PrePaid charges, the
29 PrePaid capable HA shall exclude the octet count from those IP packets in the
30 VolumeQuota within the PPAQ VSA reported to the Home RADIUS/PPS.
- 31 8. If a TariffSwitchInterval condition is reached during an accounting session, the
32 PrePaid capable HA shall accumulate the subsequent volume traffic into the
33 VolumeUsedAfterTariffSwitch counter and shall send an on-line RADIUS Access-
34 Request message to the Home RADIUS/PPS when either VT is reached or when
35 TariffIntervalafterTariffSwitchUpdate (TITSU) has expired, whichever comes first.
36 The on-line RADIUS Access-Request message shall include the VolumeQuota
37 (total quota used) in the PPAQ VSA and the theVolumeUsedAfterTariffSwitch
38 counter in the PTS VSA.
- 39 9. If VT is reached prior to expiration of TITSU, the PrePaid capable HA shall send
40 an on-line RADIUS Access-Request message with the PPAQ VSA that includes
41 the VQ Sub-Type, and the Update-Reason set to "Threshold Reached" and the
42 PTS VSA that includes the VUATS Sub-Type. The PrePaid capable PDSN shall
43 then discard TITSU. A new value of TSI and TITSU in a PTS VSA may be
44 received in the on-line RADIUS Access-Accept.
- 45 10. If TITSU has expired prior to VT, the PrePaid capable HA shall send an on-line
46 RADIUS Access-Request message with the PPAQ VSA that includes the VQ
47 Sub-Type, and the Update-Reason set to "Tariff Switch Update" and the PTS VSA
48 that includes the VUATS Sub-Type.

7 RADIUS Server Requirements

1. The PrePaid users shall be authenticated by their home RADIUS server and authorized for pre-paid service by the Home RADIUS/PPS-. The PrePaid server function and the Home RADIUS may be co-located and if they are separate entities, the interface is outside the scope of this specification.
2. If the authorization is rejected by the PrePaid server function, the Home RADIUS shall send an Access-Reject to the PDSN or the HA.
3. If a Home RADIUS/PPS receives a RADIUS Access-Request message without the PPAC VSA it shall not include the PPAQ VSA in the RADIUS Access-Accept message even if the user's profile indicate PrePaid is allowed for the user.
4. Upon receiving an on-line RADIUS Access-Request message the Home RADIUS/PPS server shall validate the message against the Message-Authenticator (80) (by using the procedures outlined in RFC 2869). If the on-line RADIUS Access-Request message does not contain the Message Authenticator, then, the Home RADIUS/PPS shall silently discard the message.
5. The Home RADIUS/PPS shall enforce reverse tunneling on volume based PrePaid packet data service if the home network policies determined that the HA shall provide the PrePaid packet data service.
6. The Home RADIUS/PPS shall be able to allow/deny/select a PPC in the PDSN or the HA based on the Home RADIUS/PPS policy, user profile, PrePaidAccountingCapability (PPAC) and Session Termination Capability (STC) of the PDSN and/or HA.
7. If the Home RADIUS/PPS determines that PrePaid packet data service is authorized for the user, it shall return in a RADIUS Access-Accept message both the PPAC VSA to indicate the PrePaid capability selected for the session and the PPAQ VSA to indicate the initial Quota and Threshold and the corresponding QuotaID.
8. At subsequent on-line quota update using on-line RADIUS Access-Request message, the Home RADIUS server shall update the user account and shall determine if an updated quota should be returned to the PPC. If quota update is required, the Home RADIUS/PPS shall return the PPAQ VSA with the updated Quota, Threshold and QuotaID in the on-line RADIUS Access-Accept message.
9. If the Home RADIUS/PPS receives a RADIUS Access-Request message for a PrePaid packet data session containing the Session Continue VSA (set TRUE or FALSE), it shall not return an updated quota in the RADIUS Access-Accept message.
10. Upon receiving a valid on-line RADIUS Access-Request message with Update-Reason (Sub-Type = 8) indicating that the associated resources are released at the PPC (Quota reached (4), Remote Forced disconnect (5), Client Service termination (6), Main Service Instance released (7), Service Instance not established (8)), the Home RADIUS/PPS shall respond with an on-line RADIUS Access-Accept message that shall not include the PPAQ VSA.
11. If there is any error processing the RADIUS Access-Request message, the Home RADIUS/PPS shall send a RADIUS Access-Reject message.
12. The RADIUS server shall support Dynamic Authorization procedure as defined in X.S0011-003-C.
13. To request support from the PrePaid client for Tariff Switching based on volume, the Home RADIUS/PPS server shall include both the PPAQ and the PTS VSAs in

- 1 the RADIUS Access-Accept message or on-line RADIUS Access-Accept
2 message.
- 3 14. If the Home RADIUS/PPS determines that a PPC with an outstanding quota is no
4 longer functioning (such as lack of update messages for long periods of time⁶ or
5 after tariff switch intervals), the Home RADIUS/PPS shall terminate the PrePaid
6 session by sending a RADIUS Disconnect-Request message to the PPC. If the
7 Home RADIUS/PPS does not receive an on-line RADIUS Access-Request
8 message containing the used quota as a result of sending the RADIUS
9 Disconnect Request message, the Home RADIUS/PPS shall restore the quota
10 allocated to that PPC to the user's unused account balance.

⁶ This period is pre-configured in both the Home RADIUS/PPS and the PPC through Service Level Agreements

1 **8 PrePaid VSAs**

2 To provide PrePaid Packet Data service, the PrePaid capable PDSN, the PrePaid capable HA
3 and the Home RADIUS/PPS shall support the PrePaid VSAs defined in X.S0011-005-C. The
4 VSAs involved in supporting the PrePaid packet data service capabilities include:

- 5 • PrePaidAccountingQuota (PPAQ)
- 6 • PrePaidAccountingCapability (PPAC)
- 7 • ReleaseIndicator (F13)
- 8 • Remote IPv4 Address
- 9 • Remote IPv6 Address
- 10 • Remote AddressTable Index
- 11 • SessionTerminationCapability (STC)
- 12 • MIP RRQ Lifetime
- 13 • Service Option
- 14 • Service Reference ID
- 15 • Session Continue
- 16 • PrePaidTariffSwitch (PTS)

1 9 PrePaid: Attributes Table

2 RADIUS Access-Request and RADIUS Access-Accept messages contain attributes as described
3 in X.S0011-005-C. The following tables list the occurrence of the PrePaid specific attributes in the
4 RADIUS Access-Request and RADIUS Access-Accept messages when PrePaid packet data
5 service is provided.

6 The following notation is used in the attribute tables in this section:

7

0	This attribute shall not be present.
0+	Zero or more instances of this attribute may be present.
0-1	Zero or one instance of this attribute may be present.
1	Exactly one instance of this attribute shall be present.

8

Attribute	Type	Access-Request	Access-Accept
PrePaidAccountingQuota (PPAQ)	26/90	0	0-1
PrePaidAccountingCapability (PPAC)	26/91	1	0-1
PrePaidTariffSwitch (PTS)	26/98	0	0-1
Class [Note 1]	25	0	0-1
MIP Lifetime [Note 2]	26/92	0-1	0-1
SessionTerminationCapability (STC) [Note 3]	26/88	1	1
Session Continue [Note 4]	26/48	0-1	0
Remote IPv4 Address	26/59	0	0+
Remote IPv6 Address	26/70	0	0+
Remote Table Index	26/71	0	0+
Event-Timestamp [Note 5]	55	0-1	0-1
Carrier-ID	26/142	0-1	0

9 [Note 1] A RADIUS Access-Accept or on-line RADIUS Access-Accept messages may contain a
10 single instance of the Class (25) attribute. If received, the PDSN shall include the same Class
11 attribute for each off-line Accounting-Request messages associated with that session. The PDSN
12 shall not modify the contents of the Class (25) attribute. A RADIUS server that receives a Class
13 (25) attribute that has been modified should silently discard the Accounting-Request message.

14 [Note 2] MIP Lifetime shall be included in the RADIUS Access-Request message from the HA to
15 the Home RADIUS/PPS if the HA is PrePaid capable. It may be included in the RADIUS Access-
16 Accept message from the Home RADIUS/PPS to HA, in which case, the HA shall include the
17 received value in the MIP RRP sent to the PDSN.

18 [Note 3] The PDSN shall include the SessionTerminationCapability Attribute to indicate that it
19 supports Dynamic Authorization Extensions to RADIUS and Registration Revocation in Mobile
20 IPv4.

21 [Note 4] At Mobile IP re-registration of a PrePaid packet data session, if the PDSN sends a
22 RADIUS Access-Request message to the Home RADIUS/PPS to authenticate the user, it shall
23 include the Session-Continue VSA with the value set to true.

24 [Note 5] Event-Timestamp is used for Duration based and Tariff Switch PrePaid and it may be
25 used to prevent replay attacks over and above the mechanism provided by RADIUS. When this
26 attribute is present, both the PDSN/HA and the RADIUS server shall check that the Event-
27 Timestamp Attribute is current within an acceptable time window. If the Event-Timestamp
28 Attribute is not current, then the message shall be silently discarded. A default time window of
29 300 seconds is recommended.

30 **Table 1. PrePaid Attributes in RADIUS Access-Request and RADIUS Access-Accept**
31 **messages**

1 On-line RADIUS Access-Request messages are based on Authorize-Only RADIUS Access-
 2 Request messages, which is distinguished from other RADIUS Access-Request messages by the
 3 presence of the Service-Type (6) Attribute with a value of "Authorize Only". As per the RADIUS
 4 standards, Authorize-Only RADIUS Access-Request messages include other RADIUS attributes
 5 such as the Message Authenticator (80) Attribute. The on-line RADIUS Access-Request message
 6 introduced by this specification is distinguished from other Authorize-Only RADIUS Access-
 7 Request messages by the inclusion of the PPAQ Attribute. That is, a RADIUS server could use
 8 the presence of Service-Type (6) with a value of "Authorize Only" with a PPAQ to detect an on-
 9 line RADIUS Access-Request message.

10 On-line RADIUS Access-Request contains one or more attributes that identify the mobile station,
 11 the access device (PDSN or HA) and one or more session identifiers.

12 Attributes that identify the mobile station:

- 13 ▪ User-Name (1)
- 14 ▪ Calling-Station-ID (31)

15 Attributes that identify the sending Access Device (PDSN or Home Agent):

- 16 ▪ NAS-IP-Address (4)
- 17 ▪ NAS-Identifier (32)

18 Attributes that identify the session:

- 19 ▪ Framed-IP-Address (8)
- 20 ▪ Correlation ID (26/44)
- 21 ▪ Home Agent (26/7)
- 22 ▪ Foreign Agent Address (26/79)

23 The following table lists the occurrence of attributes specific to the on-line RADIUS Access-
 24 Request messages and on-line RADIUS Access-Accept messages.

25

Attribute	Type	On-line Access-Request	On-line Access-Accept
User-Name	1	1	0-1
User-Password [Note 1]	2	0	0
CHAP-Password [Note 1]	3	0	0
NAS-IP-Address [Note 5]	4	0-1	0
Service-Type [Note 2]	6	1	0
Framed-IP-Address [Note 6]	8	0-1	0-1
Home Agent	26/07	0-1	0-1
Service Option	26/16	0-1	0
Correlation ID	26/44	1	0-1
Foreign Agent Address	26/79	0-1	0
PrePaidAccountingQuota (PPAQ)	26/90	1	0-1
PrePaidAccountingCapability (PPAC)	26/91	0	0
PrePaidTariffSwitch (PTS)	26/98	0-1	0-1
Service Reference ID	26/94	1	0
Calling-Station-ID	31	0-1	0
NAS-Identifier [Note 5]	32	0-1	0
Event-Timestamp [Note 3]	55	0-1	0-1
Message-Authenticator [Note 4]	80	1	1
NAS-IPv6-Address [Note 5]	95	0-1	0
Frame-IPv6-Prefix [Note 6]	97	0-1	0-1

Framed-Interface-ID	96	0-1	0-1
Carrier-ID	26/142	0-1	0
GMT-Time-Zone-Offset	26/143	0-1	0

1 [Note 1] These attributes shall not be specified in an on-line RADIUS Access-Request or on-line
2 RADIUS Access-Accept messages for security reasons.

3 [Note 2] Service-Type shall be is set to “Authorize Only”.

4 [Note 3] Event-Timestamp is used for Duration based and Tariff Switch PrePaid and it may be
5 used to prevent replay attacks over and above the mechanism provided by RADIUS. When this
6 attribute is present, both the PDSN/HA and the RADIUS server shall check that the Event-
7 Timestamp Attribute is current within an acceptable time window. If the Event-Timestamp
8 Attribute is not current, then the message shall be silently discarded. A default time window of
9 300 seconds is recommended.

10 [Note 4] On-line RADIUS Access-Request messages and on-line RADIUS Access Accept
11 messages that are received without a Message-Authenticator shall be silently discarded.
12 Receivers of the Message-Authenticator shall calculate the correct value of the Message-
13 Authenticator and silently discard the packet if it does not match the value sent. The algorithm for
14 computing the Message Authenticator is presented in RFC 2869.

15 [Note 5] An on-line RADIUS Access Request message shall contain either NAS-Identifier (32)
16 and/or either a NAS-IP-Address (4) or a NAS-IPv6-Address (95).

17 [Note 6] Either Framed-IP-Address (8) or Framed-IPv6-Address (97) shall be provided in an on-
18 line RADIUS Access-Request.

19 **Table 2. PrePaid Attributes in on-line RADIUS Access-Request and on-line RADIUS**
20 **Access-Accept messages**