Radiator
Policy and charging support

White paper discussing Diameter policy and charging support in Radiator for applications specified by 3GPP and IETF.
For *Radiator policy and charging support* version 1.1

1.0 Introduction

This document describes the Diameter authentication protocol, and outlines the support for 3GPP Gx, Ro, Gy, Wo, Rf, Gz and Wf Diameter applications and their interoperation with RADIUS protocol as implemented by Radiator, the full source Radius server from Open System Consultants (www.open.com.au/radiator).

Diameter is an authentication, authorisation and accounting (AAA) protocol commonly used by, but not limited to, telecommunication systems. Diameter protocols are called applications and use the Diameter base protocol. For example, Diameter Credit-Control Application defines the additional command codes and attributes required for supporting real-time credit-control. See RFC 6733 for the Diameter base protocol. Additional Diameter applications are introduced later in this white paper.

Radius is the de-facto standard protocol for authenticating users and for recording accounting information for wireless and wired LANs. See RFCs 2138, 2139, 2865 and 2866 for more details on the Radius protocol.

Radiator is a highly configurable and extensible Radius server that allows you to easily customise and control how you authenticate users and record accounting information. Radiator supports a wide range of EAP authentication methods, including EAP-MD5, EAP-TLS, EAP-TTLS and EAP-PEAP as part of its standard package.

Support for EAP-SIM, EAP-AKA and EAP-AKA' authentication is available as an add-on package for Radiator. The add-on package is called *Radiator SIM support* later in this white paper.

With *Radiator policy and charging support* operators and carriers are able to construct, develop and create general and special purpose policy, charging and accounting systems that interoperate with 2G, 3G and 4G/LTE systems and provide tools for integration with Wi-Fi networks.

With *Radiator SIM support*, operators and carriers are able to construct complete EAP-SIM and EAP-AKA based wireless authentication and billing systems that interoperate with and utilise the existing worldwide 2G, 3G and 4G/LTE mobile infrastructure, enabling a simple and seamless user experience for roaming wireless LAN users.

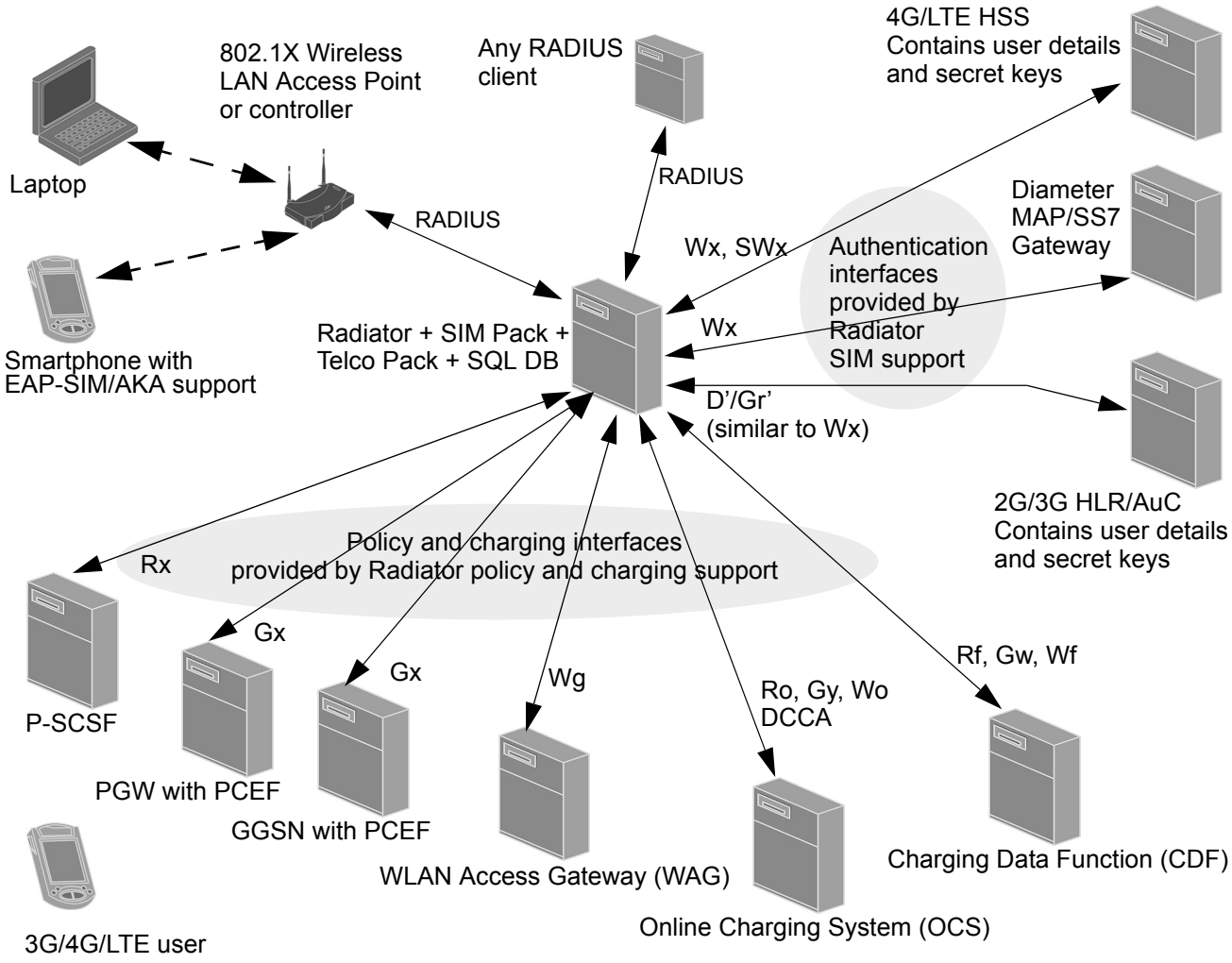
Radiator policy and charging support and *Radiator SIM support* may be used together or separately, depending on the requirements of the operator.

2.0 Diameter applications in *Radiator policy and charging support* and *Radiator SIM support*

Radiator policy and charging support and *Radiator SIM support* provide a number of different Diameter applications for policy, charging and authentication.

These applications and their respective 3GPP reference points are shown in Figure 1. Diameter Base and EAP application interfaces are also supported by Radiator but not shown in this figure.

FIGURE 1. Diameter authentication, policy and charging interfaces supported by Radiator



3.0 What are policy enforcement reference points and Diameter applications Gx and Wg

3.1 Overview

The 3GPP Gx reference point is located between the Policy and Charging Rules Function (PCRF) and the Policy and Charging Enforcement Function (PCEF). 3GPP Diameter Gx application runs over the reference point. Wg provides similar functionality for 3GPP WLAN interoperability.

Radiator policy and charging support implements the PCRF side of the reference point. The PCEF is located within a GGSN or some other device. When integrating WLANs with mobile operator infrastructure, Radiator can also be used as PCEF.

3.2 Standards

The 3GPP Gx reference point for Release 7 and later is defined in 3GPP TS 29.212. 3GPP TS 29.210 defines Gx with a different Diameter application id for Release 6.

The 3GPP Gx application is based on Diameter Credit-Control Application by IETF and uses the same command codes and attributes with some modifications.

3.3 How Diameter Gx application works

The Policy and Charging Enforcement Function (PCEF) retrieves the policy rules from PCRF as required. These rules instruct PCEF about which traffic should be charged and if the charging is done as online or offline charging. Online charging is done in real-time with Online Charging System (OCS). Offline charging is done by forwarding accounting data to Offline Charging System (OFCS). The rules may also specify filters to block or downgrade certain traffic based on port numbers, Deep Packet Inspection (DPI) or any other criteria.

In mobile networks, such as 3G/4G/LTE, rule retrieval is done when the user starts to browse the network and the PCEF within the GGSN has to create a PDP context for the web traffic. The GGSN sends user's subscriber and other information over Gx with Credit-Control-Request message. PCRF then uses its local information and Subscription Profile Repository (SPR) to return policy rules to PCEF with Credit-Control-Answer message. The GGSN can ask for rule updates any time from the PCRF and when the PDP connection closes, PCEF sends termination request to the PCRF.

The example process can also be triggered when traffic to certain TCP or UDP source ports is detected by the GGSN. This process is called PULL procedure: the GGSN pulls rules from PCRF as required.

Gx also supports unsolicited rule updates. PCRF can send Re-Auth-Request over Gx to GGSN to update GGSN's policy rules. This is called PUSH procedure: PCRF pushes rules to GGSN. The update might be triggered by anything. For example, the operator may offer for each user one time trial for unlimited data speed.

FIGURE 2. Example Diameter Gx request flow. Dashed lines denote optional components and messages.

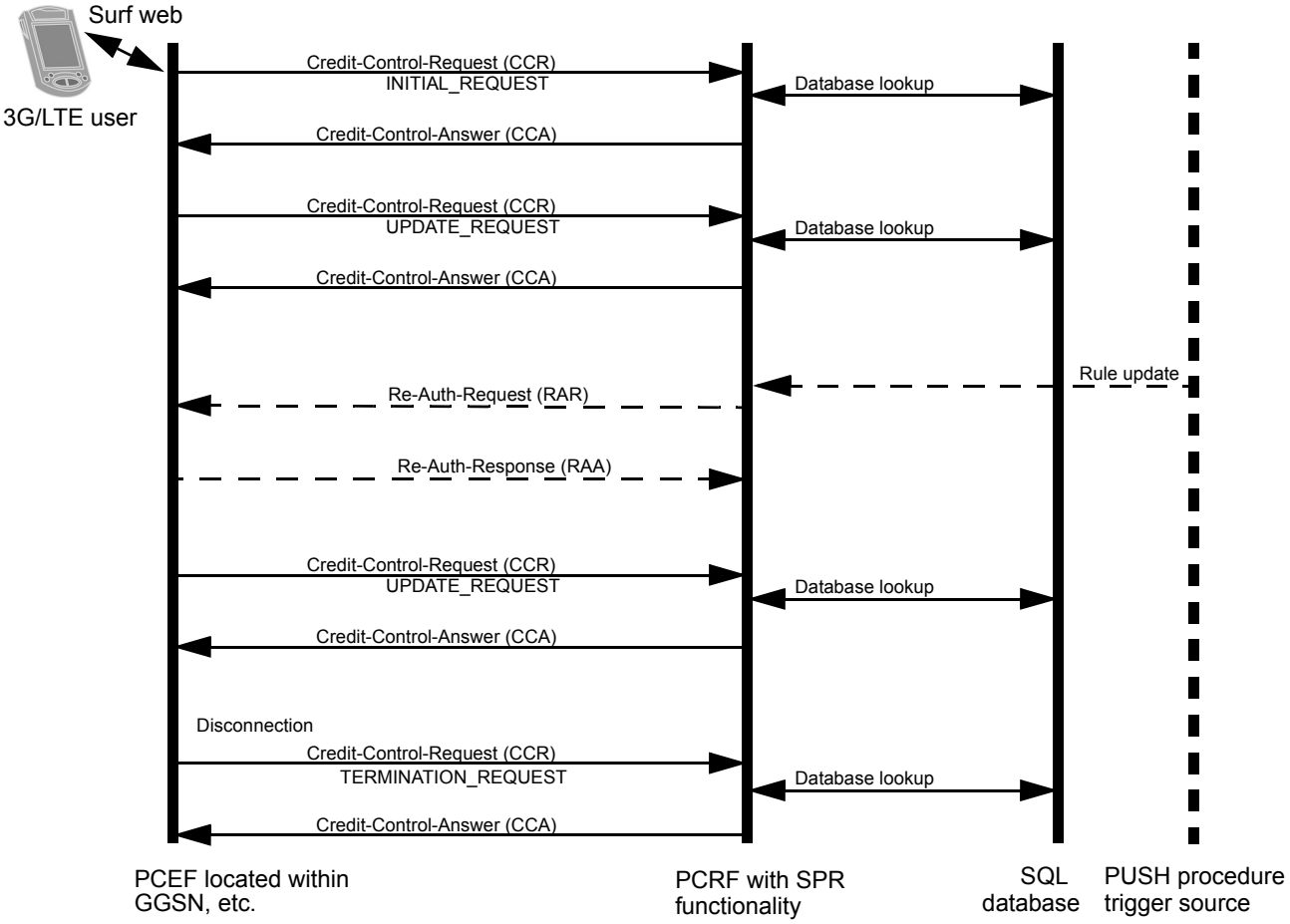


Figure 2 depicts Gx request flow with both PULL and PUSH procedure. SPR functionality is based on SQL backend for example purposes.

3.4 How Gx support in Radiator can be used

Radiator Gx support is designed for both PCRF and PCEF use. The PCRF support provides for more traditional policy configurations while PCEF support provides possibilities for Wi-Fi and 3G integration and specialised applications.

Radiator policy and charging support is a source code product allowing further development to suit operator needs. See Section 6.3 for more about customisation options.

3.4.1 Radiator as Policy Configuration Rules Function

When Radiator is set up as a PCRF, it can be customised and expanded to match the existing customer profile databases. The Gx PCRF component in *Radiator policy and charging support* includes a simple profile database providing basic PCRF functionality.

If the customer profile database already exists, the Gx PCRF component can be customised and expanded to suit the existing database.

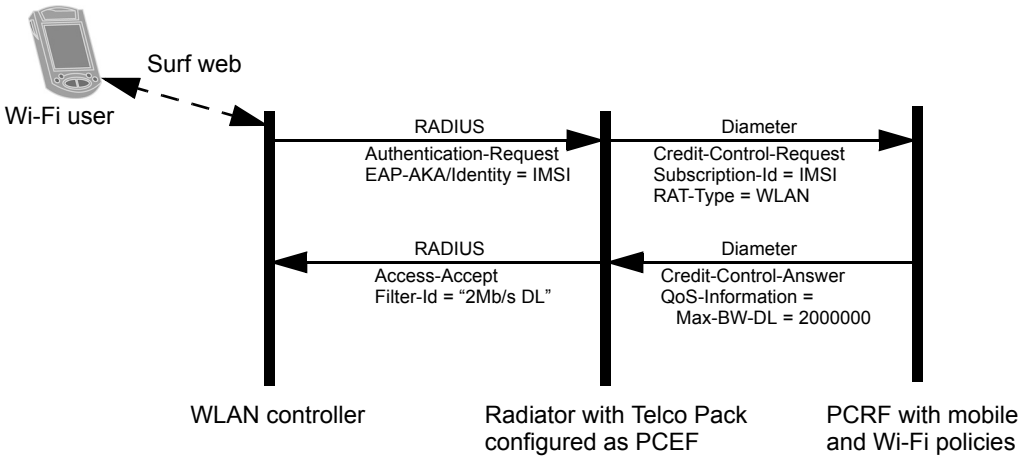
3.4.2 Radiator as Policy Configuration Enforcement Function

When set up as PCEF, Radiator can for example, authenticate EAP-SIM users and pull policies from an existing PCRF with the Wi-Fi user's IMSI. The policies can then be sent back to the WLAN controller with RADIUS Access-Accept message to set session timeout or other policies applicable for Wi-Fi use.

The RADIUS accounting messages can be converted to Diameter Gy requests to enforce prepaid data quota with RADIUS Dynamic Authorization Extensions. See Section 4.0 for more details.

Figure 3 shows an example of Radiator authenticating EAP-AKA users and returning special filter to limit traffic sent to Wi-Fi user over the radio network. The returned policy was pulled from PCRF using RAT-Type as a policy hint for PCRF QoS decision making.

FIGURE 3. Radiator Policy Configuration Enforcement Function example



4.0 What are online charging reference points and Diameter applications Ro, Gy and Wo

4.1 Overview

The 3GPP Ro reference point is located between the Online Charging System (OCS) and various 3G network elements. Online charging enables the network to do credit control before authorising initial or subsequent network use.

The 3GPP Gy and Wo applications are based on Diameter Credit-Control Application by IETF and use the same command codes and attributes with some modifications.

Gy is the online charging reference point between PCEF and an OCS. PCEF can be located for example, within a GGSN. Wo is the reference point between WLAN and OCS. Both Gy and Wo are instances of Ro reference point.

Online charging comes in two flavours: **event** based and **session** based charging.

An example of event based charging is the delivery of a SMS or Multimedia (MM) message. Delivery of a message is an event that can be charged. In addition, event based charging might use Direct Debiting or Unit Reservation. The SMS message can be authorised and billed immediately from the user's account while the MM message can be first authorised. The authorisation reserves money from the user's account and the reservation is debited if the MM was successfully delivered.

Session based charging is commonly used for pre-paid plans. When the service is active, online charging can affect it in real-time. OCS can direct the network elements to e.g, disconnect the user or apply traffic shaping on the active service if the user's account balance is exceeded. Session based charging always uses Unit Reservation.

Radiator policy and charging support implements general support for Ro and specific support for Gy and Wo. Ro support is designed to be extended for other Ro instance types. Radiator can also act as a PCEF when used for integrating Wi-Fi or other networks with Gy and Wo supporting charging systems.

4.2 Standards

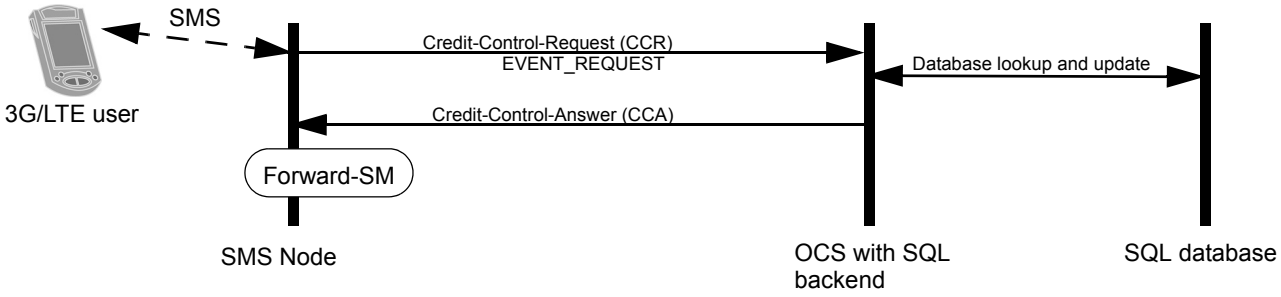
The 3GPP Ro reference point is defined in 3GPP TS 32.299. IETF DCC is defined in RFC 4006. WLAN integration is defined in 3GPP TS 32.252.

4.3 How Diameter Ro applications work

The Policy and Charging Enforcement Function (PCEF) sends a Diameter Credit-Control-Request to OCS when it detects activity that has been configured to trigger charging. Depending on the activity, the Credit-Control-Request asks for Direct Debiting or Unit Reservation.

An example of event based online charging using Direct Debiting is shown in Figure 4. Here authorisation and debiting of a single SMS is requested by a SMS Node. In 3GPP documentation this is called Immediate Event Charging (IEC).

FIGURE 4. Event based online charging with Direct Debiting

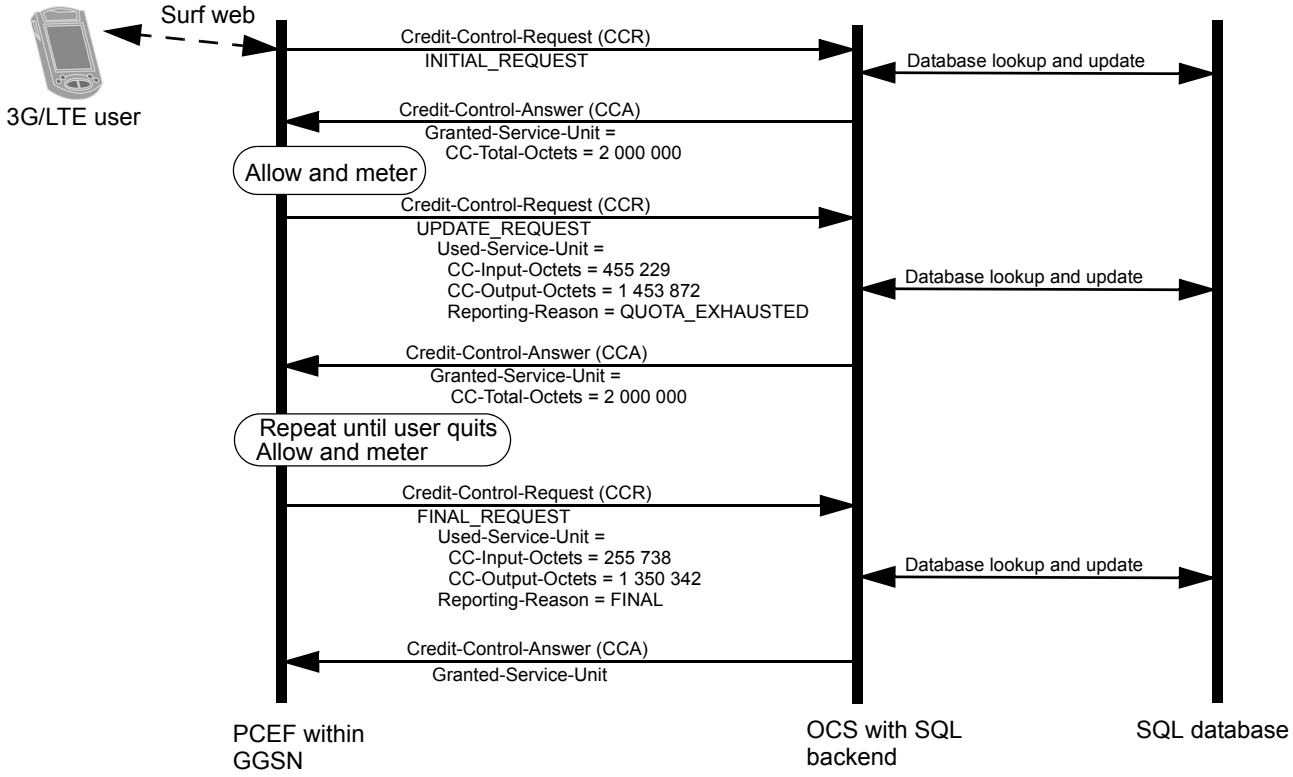


An example of session based online charging using Unit Reservation is shown in Figure 5. Here the user surfs web with prepaid data plan and OCS deducts 3 515 181 bytes from the available data.

In 3GPP documentation this is called Session based Charging with Unit Reservation (SCUR). The units can also be for example, time based in case the user has bought a time based prepaid plan.

Gy interface can also be used for Event Charging with Unit Reservation (ECUR). An SMS Node might anticipate user sending multiple SMSes and asks OCS for authorisation for 5 SMSes. When the user has finished sending, the SMS Node uses Credit-Control-Request to report the number of actual SMSes sent.

FIGURE 5. Session based online charging with Unit Reservation for prepaid data plan



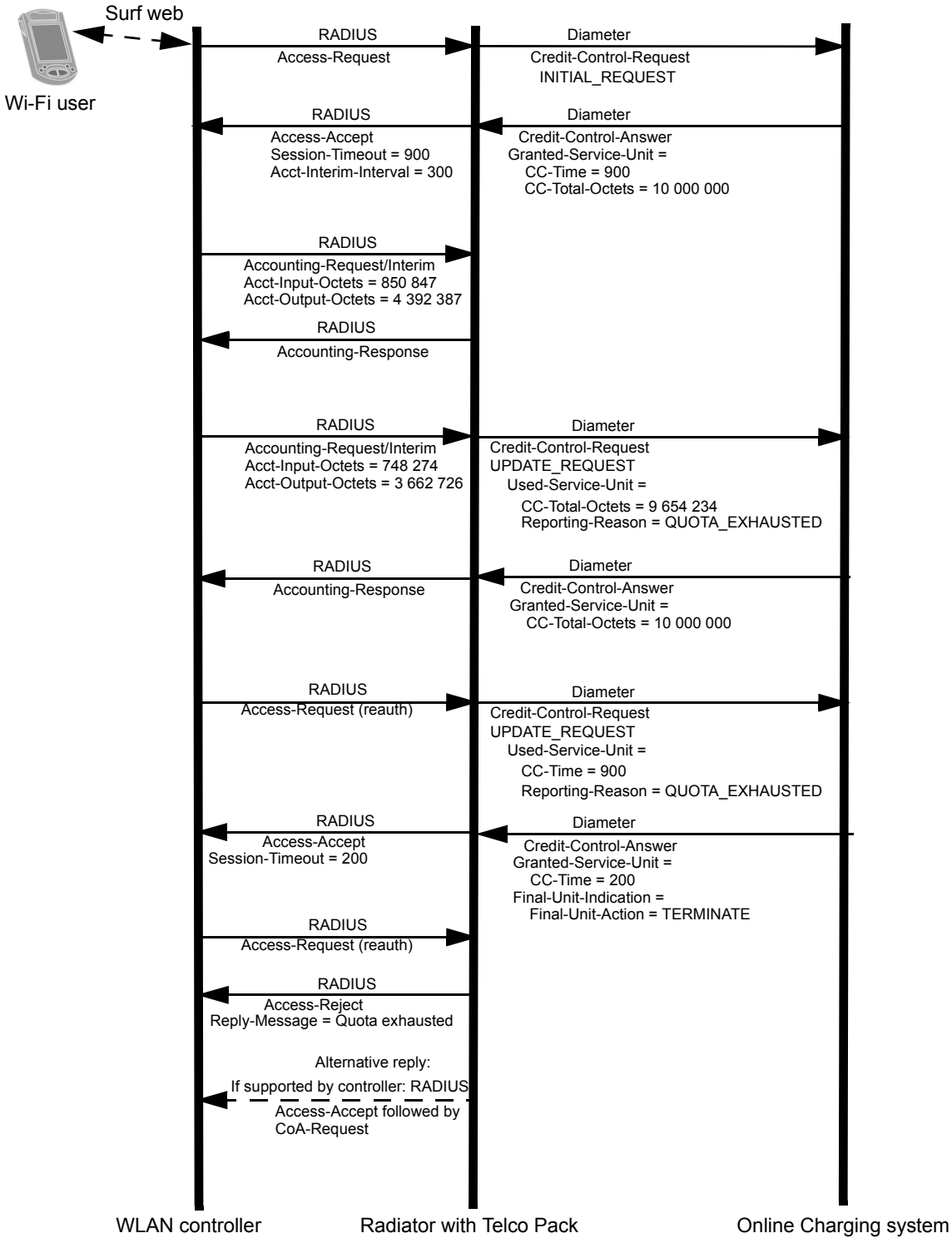
4.4 How Ro support in Radiator can be used

Ro and IETF DCC support in Radiator are designed to be used for both event and session based charging.

The flexibility provided by Radiator allows setting up specialised OCSs. Examples are: integrating WLAN access billing, implementing data roaming bill shock prevention safeguards as required by regulators, rapid development of new charging methods and other services which can be hard to implement with other OCSs.

An example of WLAN access billing is shown in Figure 6. Online credit control based on time will be more accurate than volume based credit control since octets are only reported after they have been used. The example also shows an alternative to connection termination: the user might be directed to a payment page for a quota top-up.

FIGURE 6. Integrating WLAN access with online credit control



4.4.1 Case study: Using Radiator to respond to regulatory requirements

Data roaming bill shock prevention is a common example of OCS specialisation. Bill shock prevention regulation typically requires notifying the users about the activation of the prevention system and approaching of billing limit. The system must also provide the means to enable and disable the safeguard and change the limit value. Customers have different plans and specialised requirements which affect the metering and alerting.

These requirements demand flexibility from OCS integration with the operator's customer database, SMS notification service and operations management systems. For example, because the bill shock prevention system affects the service in real time, it must be able to push information about its actions in the help desk view. When billing limit is reached, the customers may contact the operator's help desk about the loss of service they interpret as a problem. At this point the information about reached limit needs to be available for the help desk staff to correctly diagnose the perceived problem.

In addition to the special demands regulation creates, the regulation tends to change. For example, bill shock regulation may grow beyond its initial application area. The OCS must be future proof to adapt to future regulatory changes or any changes the operator wishes to implement outside regulation.

The Radiator licensing model and source code availability provide the solution for avoiding the customer lock-in often encountered with bespoke systems. The flexibility of Radiator provides the solution for any new and future requirements OCS must support.

5.0 What are offline charging reference points and Diameter applications Rf, Gz and Wf

5.1 Overview

The 3GPP Rf reference point is located between the Charging Data Function (CDF) and various network elements that implement Charging Trigger Function (CTF). Offline charging can **not** affect the active service in real-time like online charging can.

The Rf applications are based on Diameter Base Accounting Application by IETF and use the same command codes and attributes with some modifications.

Both Gz and Wf are instances of Rf reference point. Gz is the reference point between PCEF and an Offline Charging System (OFCS). PCEF can be located for example, within a GGSN. Wf is the reference point between WLAN and CDF.

Radiator policy and charging support implements general support for Rf and specific support for Gz and Wf. Rf support is designed to be extended for other Rf instances. Radiator can also act as a CDF when used for integrating Wi-Fi or other networks with Gz and Wf based interfaces.

5.2 Standards

The 3GPP Rf reference point is defined in 3GPP TS 32.299. The Gz reference point is defined in 3GPP TS 32.251. The Wf reference point is functionally equivalent to Rf.

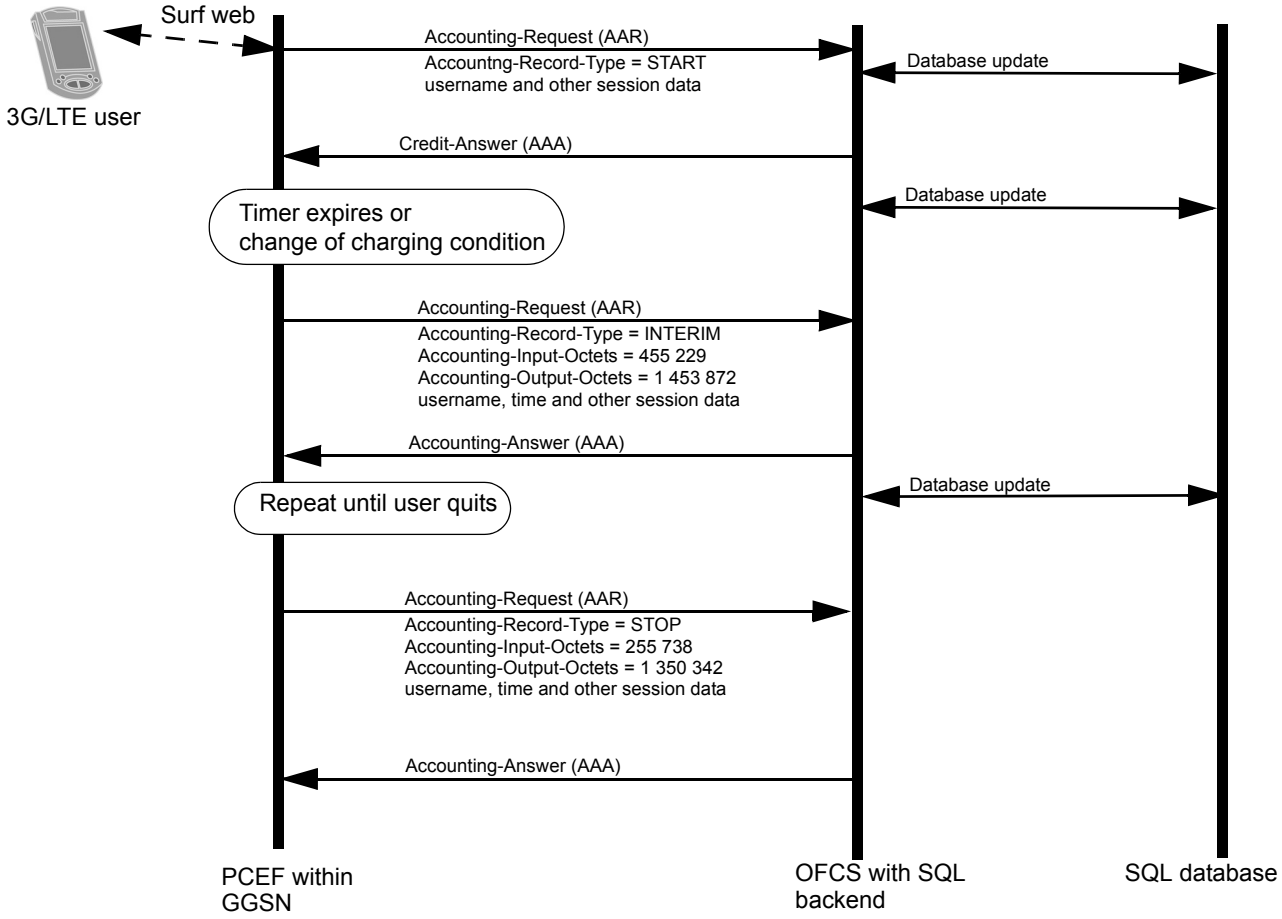
5.3 How Diameter Rf application works

The Charging Trigger Function sends a Diameter Accounting-Request to Charging Data Function over Diameter when it detects activity that has been configured to trigger charging.

An example of session based offline charging is shown in Figure 7. Here the user surfs web with postpaid data plan. The OSFC will record 3 515 181 bytes used for this session. The Policy and Charging Enforcement Function (PCEF) within the GGSN acts as CTF and the CDF is part of Offline Charging Server (OFCS).

Rf interface also supports event based offline charging. For each delivered event, CTF sends one Accounting-Request with Accounting-Record-Type set to EVENT_REQUEST. There is no need to use start, interim or stop record types.

FIGURE 7. Session based offline charging over Gz interface



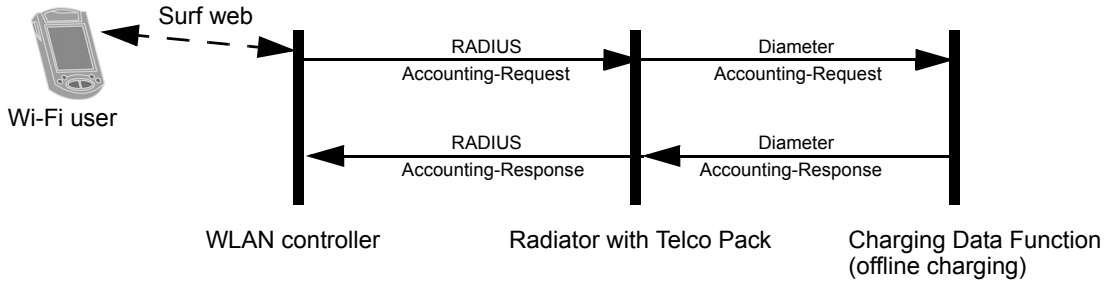
5.4 How Rf support in Radiator can be used

Radiator supports both session and event based offline charging over Rf interface.

Radiator can be configured to handle Diameter Rf Accounting-Requests in multiple ways. They can be stored in a SQL database, written to a file, proxied or any combination of the previous.

In addition, Radiator can be configured to convert RADIUS based accounting requests to Diameter accounting requests which can then be sent over the Ro interface. An example of converting accounting requests from a RADIUS based WLAN controller is shown in Figure 8.

FIGURE 8. Radiator as accounting proxy and Rf Charging Data Trigger



6.0 Customisation and testing

6.1 Supported Diameter peers

Cisco ASR 5000, NSN HSS, Huawei HSS, Juniper GGSN, Nokia Flexi ISN and Ulticom D7G MAP gateway are used by Open System Consultants' clients. Additional testing has been done with FreeDiameter

6.2 Configuration examples

Radiator policy and charging support includes sample implementations showing how to use Radiator with different Diameter interfaces.

These samples can be used together with *Radiator SIM support* showing how to achieve complete EAP-SIM and EAP-AKA authentication with Diameter Wx or SWx interface integrating Wi-Fi authentication with Public Land Mobile Network (PLMN) infrastructure backed authentication.

6.3 Customising

Radiator policy and charging support is a source code product allowing further development to suit operator needs.

Operators that do not wish to use the provided Diameter interfaces can write and test custom modules according to their own unique requirements. Open System Consultants can provide contract assistance with this task. The operator-specific custom modules are typically written entirely in Perl, but portions can be written in C or C++, and possibly other languages if necessary.

Radiator policy and charging support comes with an example Diameter server and client module. These example modules show how to interface to SQL databases, handle attributes and requests and can serve as a starting points for developing operator-specific modules.

6.4 Creating new Diameter applications

Radiator Radius server is developed in a modular way to permit easy extension and enhancement. It is delivered with support for a wide range of EAP methods, internal and external authentication protocols and user databases.

In Radiator, it is simple to add support for new Diameter, EAP and other protocols as they are developed, and it is simple to add new authentication modules (AuthBy modules) to interface with new external authentication methods. *Radiator policy and charging support* uses these extension methods to add support for the different Diameter interfaces and for generic interfaces to the external systems such as SQL databases.

6.5 Other Diameter applications supported by Radiator

Diameter based accounting support is supported by Radiator 4.12 and later. AuthBy DIAMETER does RFC 4005 based conversion of RADIUS Accounting requests to Diameter Accounting messages.

Radiator SIM support includes Diameter Wx and SWx clients.

Diameter EAP conversion and application is currently under development.

6.6 Testing

Prior to deploying a complete system, operators may wish to test the Radiator Diameter modules for compliance and performance.

The *Radiator policy and charging support* comes with a number of tools to facilitate testing, even in an environment where there is no access to a real Diameter servers or clients.

Evaluation versions of the *Radiator policy and charging support* and Radiator are available to suitably qualified organisations.

6.7 Licensing

Radiator policy and charging support is available as an optional add-on product for Radiator. In order to use *Radiator policy and charging support*, operators are required to purchase a license. Annual maintenance for Radiator *Radiator policy and charging support* is also available.

7.0 Further information

Open System Consultants can provide a range of design, installation, configuration, testing, commissioning and support services. Contact info@open.com.au.

Open System Consultants can also put operators in contact with suitable prime contractors for deployment of complete Diameter policing, charging, EAP-SIM/EAP-AKA/ EAP-AKA', Wi-Fi integration and offloading and other AAA solutions. Contact info@open.com.au.

Various levels of pre-paid support are available from Open System Consultants, ranging from limited volume email support contracts through to 24x7 telephone support. Contact info@open.com.au for more details.

For pricing on Radiator and *Radiator policy and charging support* and *Radiator SIM support*, contact info@open.com.au.

http://www.open.com.au