Charging for Mobile All-IP Telecommunications

OUTLINES

- Charging in CS Domain
- CAMEL
- Charging in PS Domain
- GTP Protocol
- Online Charging System
- Diameter
CHARGING EVOLUTION IN 3GPP

- **CS Domain**: CDR generated in MSC
  - IN supported → CAMEL
  - Call Details Record (CDR)
- **PS Domain**: GTP’ used in SGSN and GGSN
  - Charging Data Record (CDR)
- **IMS**: Charging convergence
  - IP-Based AAA protocol (Diameter from IETF)
  - Online Charging System (OCS)
EXAMPLE OF MOBILE-TO-MOBILE CS CALL
IN SUPPORTED IN GSM

- In the 3GPP Circuit Switched (CS) service domain, the Mobile Switching Center (MSC) server sends the CDRs to the billing system for offline charging.
- The CS online charging is implemented by two functions through Customized Applications for Mobile network Enhanced Logic (CAMEL)
INTELLIGENT NETWORK

- *Intelligent Network* (IN) allows fixed or mobile operators to offer enhanced telephony services such as number translation and prepaid call.
- As an IN standard, CAMEL provides mobile intelligence across mobile communications network.
- Phase 1 was tailored for the GSM-based core networks.
- Phase 2 extended phase 1 with a greater range of options such as prepaid call charging. In this phase, a pre-recorded announcement can be played to alert the prepaid user of a prepaid call when the user’s credit is depleted.
- Phase 3 supports control capabilities for mobile services including SMS and GPRS.
- Phase 4 is extensible for any enhancements. In particular, it provides control capabilities for the IMS services.
CAMEL FUNCTIONAL ARCHITECTURE (1/2)

- The *GSM Service Switching Function* (gsmSSF) is implemented in a switching node such as *Mobile Switching Center* (MSC).
- The *GSM Service Control Function* (gsmSCF) implements operator specific services through the CAMEL service logic.
- The *GSM Specialized Resource Function* (gsmSRF) provides various resources (such as voice prompt, announcements and DTMF digit collection) that can be allocated to support interaction between users and gsmSRF.
CAMEL FUNCTIONAL ARCHITECTURE (2/2)

CAP: CAMEL Application Part
GMSC: Gateway Mobile Switching Center
gsmSCF: GSM Service Control Function
gsmSSF: GSM Service Switching Function
ISUP: ISDN User Part
HLR: Home Location Register
VLR: Visitor Location Register
MAP: Mobile Application Part
MSC: Mobile Switching Center

CAP: CAMEL Application Part
gsmSCF: GSM Service Control Function
gsmSSF: GSM Service Switching Function
ISUP: ISDN User Part
HLR: Home Location Register
VLR: Visitor Location Register
MAP: Mobile Application Part
PACKET SWITCHED ARCHITECTURE

UTRAN

Node B

RNC

Core Network

GGSN

SGSN

HLR

CG

MS (UE)

Node B

RNC

CG: Charging Gateway
HLR: Home Location Register
Node B: Base Station
RNC: Radio Network Controller
UE: User Equipment

GGSN: Gateway GPRS Support Node
MS: Mobile Station
PDN: Packet Data Network
SGSN: Serving GPRS Support Node
UTRAN: UMTS Terrestrial Radio Access Network
**GPRS Tunneling Protocol Extension**

- When a *Mobile Station* (MS) accesses *General Packet Radio Service* (GPRS), the *Charging Data Records* (CDRs) are generated based on the charging characteristics (data volume limit, duration limit and so on) for that service.

- In a GPRS session, the CDRs are generated by the *GPRS Support Nodes* and are sent to the *Charging Gateway* (CG) via the GTPc protocol.
AN OFFLINE CHARGING EXAMPLE OF A GPRS SESSION
CHARGING FOR CS AND PS DOMAINS

CG: Charging Gateway
GGSN: Gateway GPRS Support Node
HSS: Home Subscriber Server
MSC: Mobile Switching Center
PS: Packet Switched
SCF: Service Control Function

CS: Circuit Switched
HLR: Home Location Register
MGW: Media Gateway
PDN: Packet Data Network
SGSN: Serving GPRS Support Node
SSF: Service Switching Function
THE IMS NETWORK ARCHITECTURE

BGCF: Breakout Gateway Control Function
CDF: Charging Data Function
HSS: Home Subscriber Server
MGCF: Media Gateway Control Function
MRF: Media Resource Function
PDN: Packet Data Network
PSTN: Public Switched Telephone Network
T-SGW: Transport Signaling Gateway

CSCF: Call Session Control Function
GGSN: Gateway GPRS Support Node
I-CSCF: Interrogating CSCF
MGW: Media Gateway
MS: Mobile Station
P-CSCF: Proxy CSCF
S-CSCF: Serving CSCF
UE: User Equipment
CHARGING FOR MOBILE ALL-IP NETWORKS

• Advanced mobile telecom incorporates data applications with real-time control and management, which requires a convergent and flexible online charging system. Such convergence is essential to mitigate fraud and credit risks and provide more personalized advice to users about charges and credit limit controls.

• *Online charging* allows simultaneous prepaid and postpaid sessions to be charged in real-time.
The **Remote Access Dial In User Service (RADIUS)** protocol was originally defined by **Internet Engineering Task Force (IETF)** to provide centralized **Authentication, Authorization, and Accounting (AAA)** framework for network access.

- RADIUS is developed based on the client-server architecture, and is commonly used in **Network Access Servers (NASs)** such as wireless access points and VoIP gateways.

![Diagram showing RADIUS client and server with request and answer arrows](image-url)
**Diameter**

- The Diameter protocol was derived from RADIUS with more flexibility, and is generally believed to be the next generation AAA protocol.
- Diameter is an extensible messaging protocol enabling AAA within and across IP multimedia networks that relies on secure and reliable transports.
**Diameter-based Offline Charging**

- Offline charging for both events and sessions are performed between an IMS node and the CDF through the Rf reference point which is designed for non-real-time operations.

Originating network: home1.net.tw

Terminating network: home2.net.hk

```
CDF1: cdf1.home1.net.tw
OCS1: ocs1.home1.net.tw
CSCF1: cscf1.home1.net.tw
MS1: ms1@home1.net.tw

CDF2: cdf1.home2.net.hk
OCS2: ocs2.home2.net.hk
CSCF2: cscf2.home2.net.hk
MS2: ms2@home2.net.hk
```
AN OFFLINE CHARGING EXAMPLE OF IMS CALL

MS1's home IMS

Billing System 1

CCR1

S-CSCF1

ICSCF

HSS

Billing System 2

S-CSCF2

CCF2

Billing System 3

Billing System 4

Originating Visited Network

Visitend Visited Network

GPRS

IMS data path

GPRS

MS1

MS2

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1. ACR (EVENT_RECORD)

2. ACA (EVENT_RECORD)

Produces charging record

1. ACR (START_RECORD)

2. ACA (START_RECORD)

Opens CDR

3. ACR (INTERIM_RECORD)

4. ACA (INTERIM_RECORD)

Updates CDR

5. ACR (STOP_RECORD)

6. ACA (STOP_RECORD)

Closes CDR
UMTS R5 Offline Charging

MMS Service Domain

WAP Gateway

GPRS

CTF
IMS Domain

GGSN

CCF: Charging Collection Function
CTF: Charging Trigger Function
I-CSCF: Interrogating CSCF
MMS: Multimedia Messaging Service
P-CSCF: Proxy CSCF
WAP: Wireless Application Protocol

BGCF: Breakout Gateway Control Function
CSCF: Call Session Control Function
GGSN: Gateway GPRS Support Node
MGCF: Media Gateway Control Function
MRF: Media Resource Function
S-CSCF: Serving CSCF

(a) CCF

(b) Application Server

(i) Billing System

(j) MMS Relay Server
Diameter-based Online Charging

- All-IP mobile network utilizes the *Diameter Credit Control* (DCC) application to communicate with the *Online Charging System* (OCS) through the Ro interface.
We introduced the UMTS R6 *Online Charging System* (OCS). Specifically, we described the functionalities of the OCS components including the session-based charging function, the event-based charging function, the rating function and the account balance management function. We also elaborated on the contents of the rating messages exchanged between the charging functions and the rating function within the OCS.
**UMTS CHARGING ARCHITECTURE (RELEASE 6)**

- Offline Charging Trigger Function
- Online Charging Trigger Function

**Billing System**

- Bx
- (l) CGF
- Ga
- Rf
- (m) CDF
- (c) CRF
- Gz
- Rf
- (h) WLAN
- (i) SGSN
- Gz
- (j) GGSN
- (b) TPF
- Wo
- ISC
- (n) IMS-GWF
- Ro
- Bo
- (a) Online Charging System

**Offline Charging**

**Online Charging**

- BGCF: Breakout Gateway Control Function
- CDF: Charging Data Function
- CRF: Charging Rule Function
- GGSN: Gateway GPRS Support Node
- IMS: IP Multimedia core network Subsystem
- MGCF: Media Gateway Control Function
- OCS: Online Charging System
- TPF: Traffic Plane Function
- CAP: CAMEL Application Part
- CGF: Charging Gateway Function
- CSCF: Call Session Control Function
- IMS-GWF: IMS Gateway Function
- ISC: IMS Service Control
- MRFC: Media Resource Function Controller
- SGSN: Serving GPRS Support Node
- WLAN: Wireless LAN
THE OCS ARCHITECTURE

Online Charging System

a. Session Based Charging Function (SBCF)
b. Event Based Charging Function (EBCF)
c. Account Balance Management Function (ABMF)
d. Charging Gateway Function (CGF)
e. Rating Function (RF)
f. Recharge Server
g. Billing System

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Immediate Event Charging

1. MESSAGE
2. CCR
3. Price Request
4. CCA
5. 200 OK
6. 200 OK
7. 200 OK
8. Message Delivery

UE1  P-CSCF  S-CSCF  Messaging Application Server  Online Charging System

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Event Charging with Unit Reservation
SESSION CHARGING WITH UNIT RESERVATION

1. INVITE
2. CCR (INITIAL_REQUEST)
3. Tariff Request
4. CCA (INITIAL_REQUEST)
5. 200 OK
6. CCR (UPDATE_REQUEST)
7. CCR (TERMINATE_REQUEST)

IMS signaling for call establishment with UE2
IMS call connection to UE2
IMS call release

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SERVICE DATA FLOW-BASED CHARGING

- In this chapter, we introduced the service data flow-based charging (FBC) architecture consists of the Charging Rule Function (CRF), the Traffic Plane Function (TPF) and the Application Function (AF).
- The FBC allows breaking down of a PDP context into individual service data flows determined by the IP addresses and the port numbers. Therefore, the mobile operators can meter data usage for individual service flows.
- The FBC solution is used to accurately classify and charge the data packets by their content types through static and dynamic policies.
FBC Architecture for IMS/GPRS Services

AF: Application Function
CRF: Charging Rules Function
GGSN: Gateway GPRS Support Node
SGSN: Serving GPRS Support Node
UE: User Equipment

CDF: Charging Data Function
CSCF: Call Session Control Function
OCS: Online Charging System
TPF: Traffic Plane Function
**AN EXAMPLE OF SERVICE DATA FLOWS**

**Service Flow 1 (WAP)**
- PDP Context (Bearer Session)
- Packets to/from IP 192.168.1.1 and Port 3000
- Access Gateway (WAP)
- IP Filter 1
- Charging Rule 1
- OCS
- CRF
- crf.home.net.tw

**Service Flow 2 (Streaming)**
- Packets to/from IP 192.168.1.2 and Port 5000
- Streaming Server
- IP Filter 2
- Charging Rule 2
- TPF
- GGSN
- ggsn.home.net.tw
PCC Integration Architecture for IMS Service

Through the *Policy and Charging Control* (PCC) defined in 3GPP R7 [3GP07c], integration of QoS policy and charging rules can be realized in the IMS network. In the PCC architecture, the SBLP and the FBC functionality are utilized to integrate the QoS policy and charging control.

PCEF: Policy and Charging Enforcement Function
PCRF: Policy and Charging Rules Function

- **Charging Data Function (CDF)**
- **Online Charging System (OCS)**
- **Traffic Plane Function (TPF)**
- **Policy Enforcement Function (PEF)**
- **Policy Decision Function (PDF)**
- **Subscription Profile Repository (SPR)**
- **Gx**
- **Gy**
- **Gz**
- **Go**
- **Gq**
- **Rx**
- **CSCF**
- **Application Function (AF)**
REFERENCE

- 3GPP. 3rd Generation Partnership Project; Technical Specification Group Service and System Aspects; Telecommunication management; Charging management; Online Charging System (OCS): Applications and interfaces (Release 6), 3G TS 32.296.
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