

██████████ (CDR) █████

SGW-C

OmniSGW □ *Omnitouch* □□□□□

2

1. □□
 2. CDR □□□□
 3. CDR □□
 4. CDR □□
 5. □□□□
 6. □□
 7. CDR □□□□
 8. □□□□□□
 9. □□
 10. □□

2

SGW-CDR

PGW-C CDR EPC

1

-  **CSV**  - 
 - -

- 3GPP - 3GPP TS 32.298
- 3GPP - 3GPP TS 32.251
- **3GPP** - 3GPP TS 32.298 CDR

CDR

CDR	CDR
CDR	CDR

CDR

CDR

<epoch_timestamp>

CDR

1726598022

CDR Unix timestamp

SGW-C

CDR

- SGW-C: /var/log/sgw_c/cdrs/

CDR directory

CDR

CDR

```
# CDR
# HH:MM:SS (unix_timestamp)
# HH:MM:SS (unix_timestamp)
# <gateway_name>
#
epoch,imsi,event,charging_id,msisdn,ue_imei,timezone_raw,plmn,tac,eci
```

CDR

- - CDR Unix
 - - CDR Unix
 - - SGW-C
 - - CSV
-

CDR ䷮

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索引	字段名	类型	描述
0	epoch	整数	Unix 时间戳
1	imsi	字符串	国际移动用户识别码
2	event	字符串	CDR 事件，如“default_bearer_start”
3	charging_id	整数	计费ID
4	msisdn	字符串	ISDN 号码
5	ue_imei	字符串	UE IMEI
6	timezone_raw	字符串	UE 时区原始值
7	plmn	整数	PLMN 编号
8	tac	整数	跟踪区域码
9	eci	整数	E-UTRAN ECI
10	sgw_ip	字符串	SGW-C S5/S8 接口 IP 地址
11	ue_ip	字符串	UE IP 地址 IPv4 IPv6 地址
12	pgw_ip	字符串	PGW-C S5/S8 接口 IP 地址
13	apn	字符串	APN
14	qci	整数	QoS QCI

00	0000	00	00
15	octets_in	00	0000000000
16	octets_out	00	0000000000

CDR 00

0000

CDR 000000000000

0000	00	00	0000
0000	<type>_bearer_start	0000	0000000000
0000	<type>_bearer_update	0000000000	0000000000
0000	<type>_bearer_end	0000	000000/00

00000

- **default** - 00000000 PDN 00000
- **dedicated** - 00000000 PDN 00000000

0000

default_bearer_start	- 00000000
default_bearer_update	- 00000000
default_bearer_end	- 00000000
dedicated_bearer_start	- 00000000
dedicated_bearer_update	- 00000000
dedicated_bearer_end	- 00000000

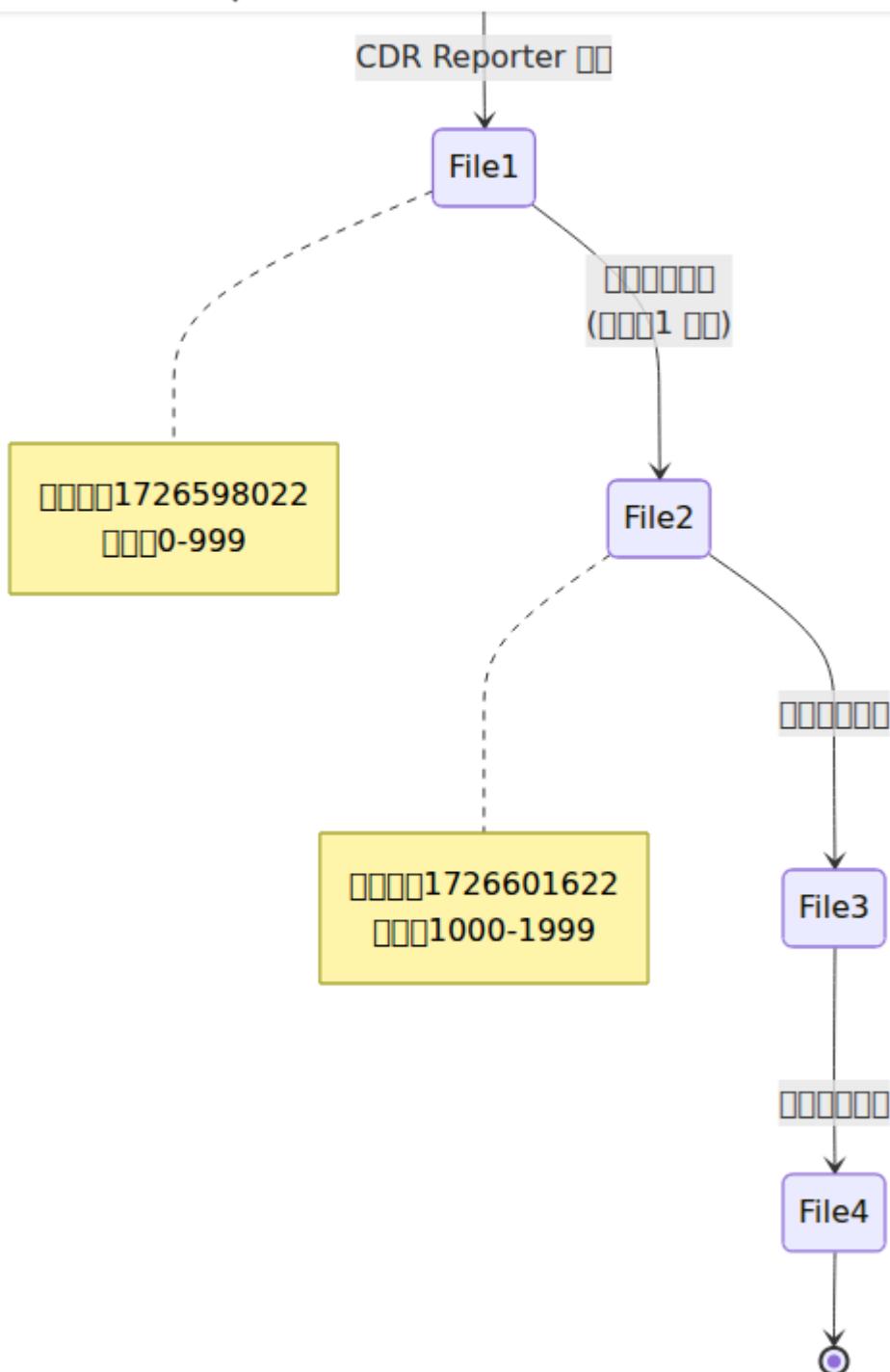


CDR

```
# 00 CDR 000
# 0000000018:53:42 (1726598022)
# 0000000019:53:42 (1726601622)
# 0000sgw-c-prod-01
# epoch,imsi,event,charging_id,msisdn,ue_imei,timezone_raw,plmn,tac,epsilon
1726598022,310260123456789,default_bearer_start,12345,15551234567,123
1726598322,310260123456789,default_bearer_update,12345,15551234567,123
1726598622,310260123456789,default_bearer_update,12345,15551234567,123
1726598922,310260123456789,default_bearer_end,12345,15551234567,12345
```



CDR



1726598022

1. 1726598022
2. 1726601622
3. 1726601622
4. 1726601622



配置参数

参数	类型	值	描述	示例
gateway_name	字符串	SGW-C 000001	-	设备唯一ID
duration	整数	360000001	-	3,600,000,001 毫秒
directory	字符串	CDR 日志目录	-	/var/log/sgw_c/cdrs

示例配置

生产环境

- gateway_name:** "sgw-c-prod-01"
- duration:** 3,600,000 毫秒1 秒
- directory:** "/var/log/sgw_c/cdrs"

开发环境

- gateway_name:** "sgw-c-dev"
- duration:** 300,000 毫秒5 秒
- directory:** "/tmp/sgw_c_cdrs"

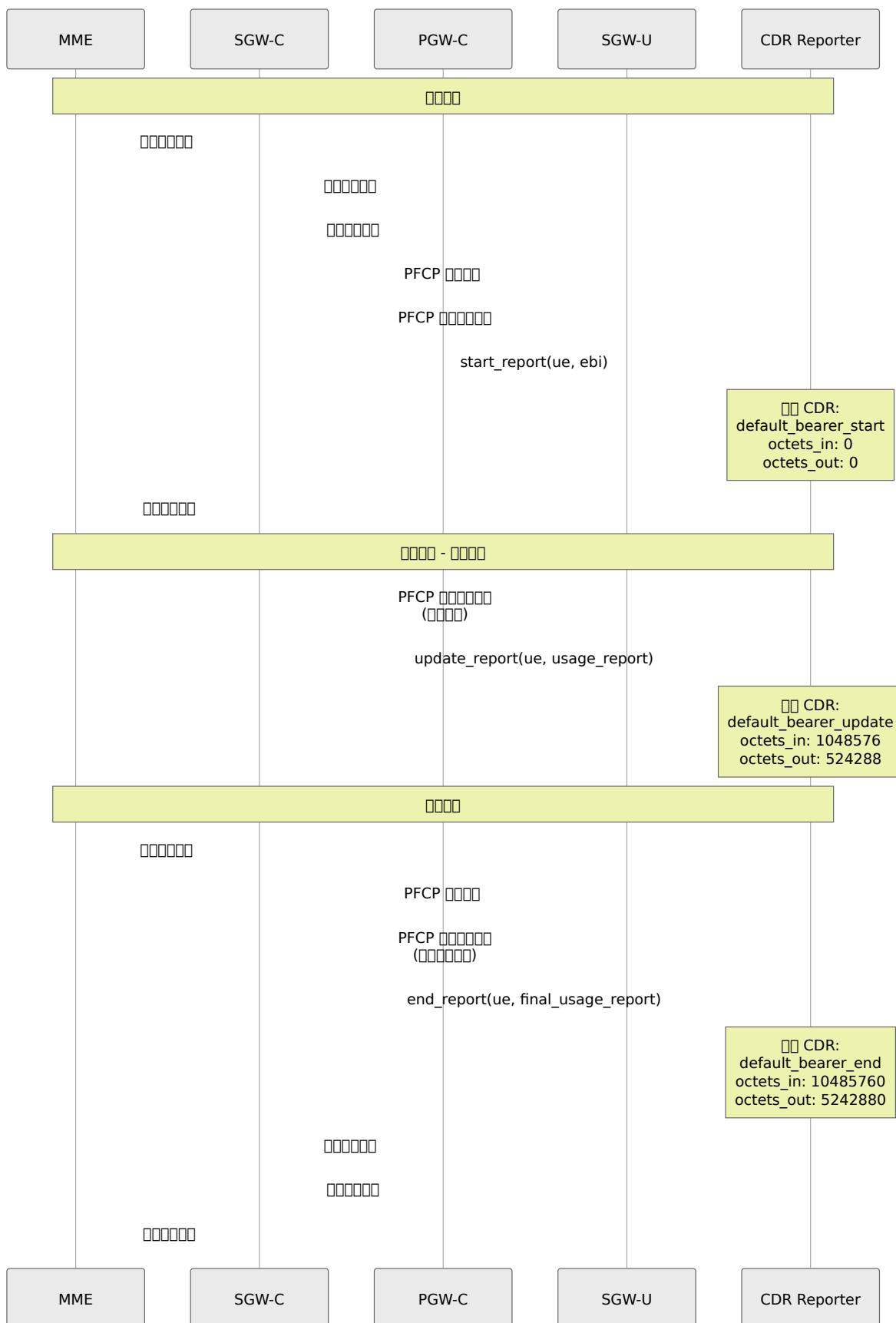
测试环境

- gateway_name:** "sgw-c-prod-heavy"
- duration:** 1,800,000 毫秒30 秒
- directory:** "/mnt/fast-storage/cdrs"

CDR 〇〇〇〇

〇〇〇〇〇〇 **CDR** 〇〇

SGW-C CDR 〇〇〇



CDR ၂၀၂၂

၁. ၂၀၂၂၀၉

- ၂၀၂၂ ၂၀၂၂၀၉၀၈၀၈
- ၂၀၂၂ ၂၀၂၂၀၉၀၈၀၈
- octets_in** ၀
- octets_out** ၀

၂. ၂၀၂၂၀၉

- ၂၀၂၂ ၂၀၂၂၀၉၀၈ PFCP ၂၀၂၂၀၉
- ၂၀၂၂ ၂၀၂၂၀၉၀၈
- octets_in** ၂၀၂၂၀၉၀၈၀၈၀၈၀၈
- octets_out** ၂၀၂၂၀၉၀၈၀၈၀၈၀၈

၃. ၂၀၂၂၀၉

- ၂၀၂၂ ၂၀၂၂ PFCP ၂၀၂၂၀၉၀၈၀၈၀၈၀၈
- ၂၀၂၂ ၂၀၂၂၀၉၀၈၀၈၀၈၀၈
- octets_in** ၂၀၂၂၀၉၀၈၀၈၀၈၀၈
- octets_out** ၂၀၂၂၀၉၀၈၀၈၀၈၀၈

၂၀၂၂၀၉၀၈

၁. epoch (၂၀၂၂)

၂၀၂၂ Unix ၂၀၂၂၀၉၀၈၀၈၀၈၀၈၀၈

၂၀၂၂ CDR ၂၀၂၂၀၉၀၈

၂၀၂၂

1726598022 → 2025-09-17 18:53:42 UTC

2. imsi (国际移动用户识别码)

由三部分组成 15 位数

由 MCCMNC + MSIN

由 3 位数的国家代码、2 位数的网络代码和 10 位数的用户识别号组成

示例

310260123456789
 | | |
 MCC MNC MSIN
(310) (260) (123456789)

由 UE 生成的唯一标识符

3. event (CDR 事件)

由三部分组成

由 <bearer_type>_bearer_<event>

示例

- default_bearer_start
- default_bearer_update
- default_bearer_end
- dedicated_bearer_start
- dedicated_bearer_update
- dedicated_bearer_end

示例

- EBI EPS ID LBI ID default
- EBI LBI dedicated

4. charging_id (ဗုဒ္ဓန)

အောက်ပါ 32 ခုမှ

အောက်ပါ အာမာန်အာမာန်အာမာန်

အောက်

12345

အောက်မှ PGW-C အာမာန်အာမာန်

အောက်

- SGW ၏ PGW အာမာန်အာမာန်
 - Diameter Gy/Gz အာမာန်
 - ဖူးဖူးဖူးအာမာန်အာမာန်
-

5. msisdn (ဗုဒ္ဓန)

အောက် အာမာန် E.164 အောက်

အောက် အာမာန် ISDN အာမာန်အာမာန်

အောက် အာမာန် + အာမာန်

အောက်

15551234567
└ └ └
CC National
(1) (5551234567)

အောက် အာမာန်အာမာန် MME ၏ HSS ၏

6. ue_imei (UE IMEI)

UE IMEI 15 位数

UE TAC 8+ SNR 6+ Spare 1+

UE 15 位数由 TAC、SNR 和 S 组成

示例

123456789012345

 | | |
TAC SNR S

UE UE 15 位数 MME 15

7. timezone_raw (UE 时区)

UE 时区信息/UTC

UE 时区信息

时区信息 CSV 格式

时区信息 15 位数

示例

, (时区)

8. plmn (PLMN)

PLMN 信息

PLMN 15 位数

UEID

MCC: 505, MNC: 57

↓

"50557"

↓

UEID "055570"

↓

UEIDhex 0x055570 = 349552

UEID

349552 → MCC: 505, MNC: 57

UEID MME UE ID

UEID UE ID

9. tac (UEID)

UEID 16 bit

UEID UE ID

UEID 0 - 65535

UEID

1234

UEID UE ID MME UE ID

UEID

- UEID
- UEID

- TAI အမြတ်စွမ်းအမြတ်
-

10. eci (E-UTRAN အမြတ်)

၂၀၁၂ ခုနှစ် 28 ဧပြီ

၂၀၁၃ E-UTRAN အမြတ်အမြတ် UE အမြတ်

၂၀၁၃ eNodeB ID ၂၀ + ၈ ID ၈ ။

၂၀၁၃ ၀ - 268,435,455

၂၀၁၃

5678

၂၀၁၃ ၁ MME အမြတ် UE အမြတ်

၂၀၁၃

- အမြတ်အမြတ်
 - အမြတ်အမြတ်
 - အမြတ်အမြတ်
-

11. sgw_ip (SGW အမြတ် IP)

၂၀၁၃ အမြတ် IPv4 ၁ IPv6 အမြတ်

၂၀၁၃ SGW-C ၏ S5/S8 အမြတ် IP အမြတ် F-TEID ၏

၂၀၁၃ အမြတ် IPv4 အမြတ်အမြတ် IPv6 ၏

၂၀၁၃

10.0.0.15 (IPv4)
2001:db8::15 (IPv6)

UE IP 地址 S5/S8 接口

12. ue_ip (UE IP 地址)

UE IP 地址 IPv4|IPv6 地址

UE IP 地址 IP 地址 PDN 接口

UE IP 地址 <ipv4>|<ipv6>

UE IP 地址

172.16.1.100	(IPv4)
2001:db8::1	(IPv6)
172.16.1.100 2001:db8::1	(UE IP 地址)

PGW-C IP 地址 PDN 地址 PAA

PGW-C IP 地址

- UE IP 地址 IPv4 地址
 - UE IP 地址 IPv6 地址
 - UE IP 地址 PDN 接口
-

13. pgw_ip (PGW IP 地址)

PGW IP 地址 IPv4 和 IPv6 地址

PGW-C S5/S8 接口 IP 地址 F-TEID

PGW IP 地址 IPv4 和 IPv6 地址

PGW IP 地址

10.0.0.20	(IPv4)
2001:db8::20	(IPv6)

14. apn (ଅପନ୍‌ଟାଇପ୍)

ମୋବାଇଲ୍ କାମିଙ୍ଗ୍ 100 ବିଷୟ

ମୋବାଇଲ୍ ପର୍ଯ୍ୟନ୍ତ ଏବଂ PDN ବିଷୟ

ମୋବାଇଲ୍ ଏବଂ DNS ବିଷୟ

ମୋବାଇଲ୍

```
internet  
ims  
mms  
enterprise.corporate
```

ମୋବାଇଲ୍ ପର୍ଯ୍ୟନ୍ତ ଏବଂ MME ବିଷୟ

ମୋବାଇଲ୍

- ମୋବାଇଲ୍ ଏବଂ MME ବିଷୟ
- ମୋବାଇଲ୍ ଏବଂ IP ବିଷୟ
- ମୋବାଇଲ୍ ଏବଂ IP ବିଷୟ

15. qci (QoS ବିଷୟ)

ମୋବାଇଲ୍ କାମିଙ୍ଗ୍ 8 ବିଷୟ

ମୋବାଇଲ୍ QoS ବିଷୟ

ମୋବାଇଲ୍ 1 - 9 ଏବଂ 128-254 ବିଷୟ

ମୋବାଇଲ୍ **QCI** ବିଷୟ

QCI	GBR	Non-GBR	GBR	Non-GBR	GBR
1	GBR	2	100 Mbps	10^{-2}	GBR
2	GBR	4	150 Mbps	10^{-3}	GBR
3	GBR	3	50 Mbps	10^{-3}	GBR
4	GBR	5	300 Mbps	10^{-6}	GBR
5	Non-GBR	1	100 Mbps	10^{-6}	IMS
6	Non-GBR	6	300 Mbps	10^{-6}	GBR
7	Non-GBR	7	100 Mbps	10^{-3}	GBR
8	Non-GBR	8	300 Mbps	10^{-6}	GBR
9	Non-GBR	9	300 Mbps	10^{-6}	GBR

QoS

9 → QoS Configuration

PGW-C QoS

16. octets_in (octets)

64 octets

UE → QoS

QoS

QoS

1048576 → 1 MB □□

SGW-U PFCP

三

- update
 - end
 - start 0

17. octets_out (□□□)

64

□□□ □□□□□UE → □□□□□□□□

三

524288 → 512 KB □□

SGW-U PFCP

三

-  update 
 -  end 
 -  start  0



III 1 ဗိုလ်ချုပ်ကြောင်း

ဗိုလ်ချုပ်

1. ဗိုလ်ချုပ်
2. 5 ဗိုလ်ချုပ် 10 MB မှာ 5 MB ရှိ
3. ဗိုလ်ချုပ်

CDR ဗိုလ်ချုပ်

```
# ၁။ CDR ဗိုလ်ချုပ်  
# ၂၀၁၅၀၇၀၈၀၀ 10:00:00 (1726570800)  
# ၂၀၁၅၀၇၀၉၀၀ 11:00:00 (1726574400)  
# ၂၀၁၅၀၇၀၈၀၀sgw-c-01  
# epoch,imsi,event,charging_id,msisdn,ue_imei,timezone_raw,plmn,tac,  
1726570800,31026011111111, default_bearer_start,10001,15551111111,111  
1726571100,31026011111111, default_bearer_update,10001,15551111111,111  
1726571400,31026011111111, default_bearer_end,10001,15551111111,11111
```

III 2 ဗိုလ်ချုပ်ကြောင်း

ဗိုလ်ချုပ်

1. ဗိုလ်ချုပ် IPv4 + IPv6
2. ဗိုလ်ချုပ်
3. ဗိုလ်ချုပ်

CDR ဗိုလ်ချုပ်

```
1726570800,31026022222222, default_bearer_start,10002,15552222222,222  
1726571100,31026022222222, default_bearer_update,10002,15552222222,222  
1726571400,31026022222222, default_bearer_update,10002,15552222222,222  
1726571700,31026022222222, default_bearer_update,10002,15552222222,222  
1726572000,31026022222222, default_bearer_end,10002,15552222222,22222
```

III 3. 3GPP2020

3GPP

1. 3GPP2020 QCI 9
2. 3GPP2020 QCI 6
3. 3GPP2020 QCI 5
4. 3GPP2020
5. 3GPP2020

CDR 3GPP

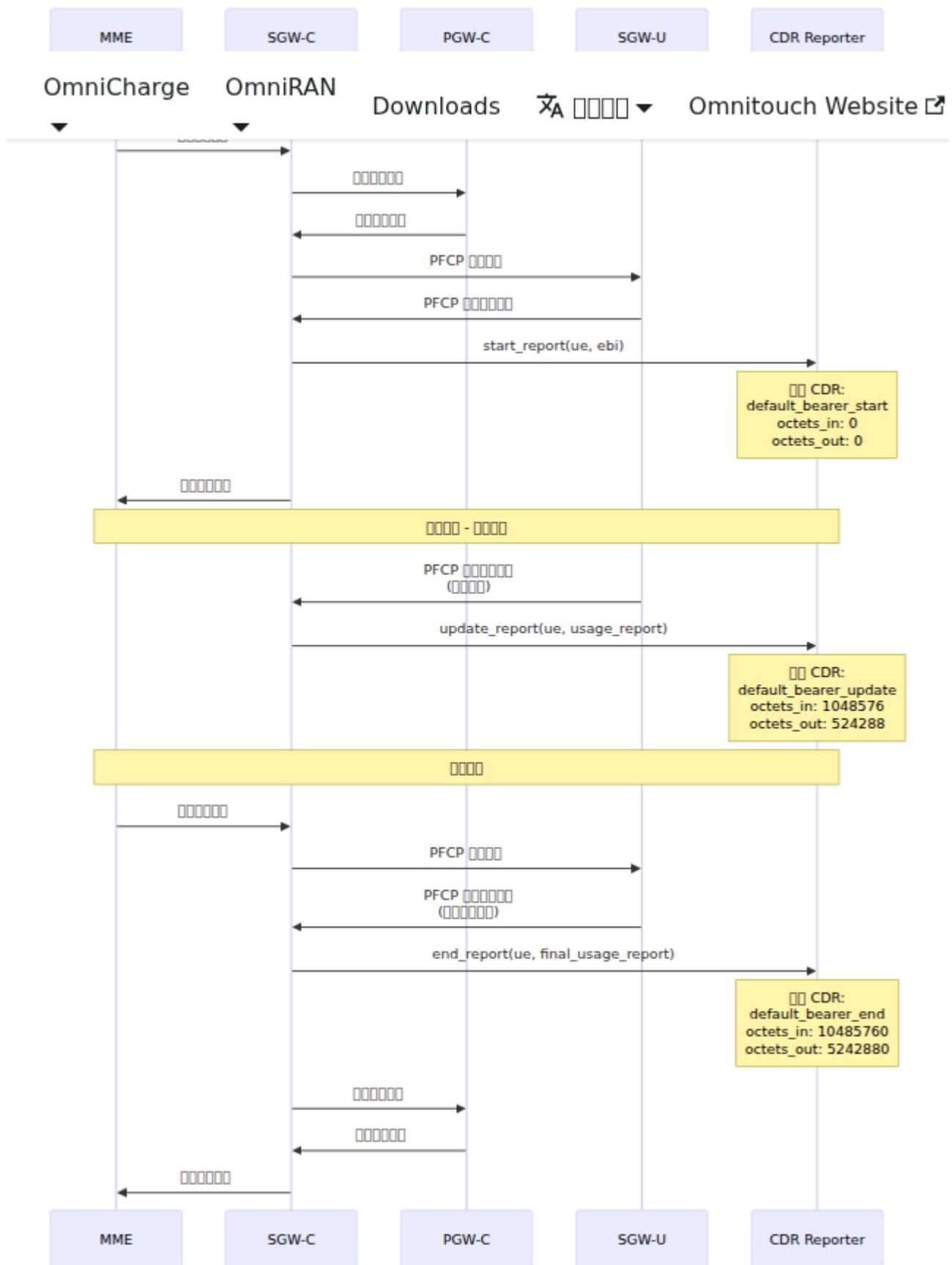
```
1726570800,3102603333333333,default_bearer_start,10003,155533333333,333  
1726571100,3102603333333333,dedicated_bearer_start,10004,155533333333,333  
1726571400,3102603333333333,default_bearer_update,10003,155533333333,333  
1726571400,3102603333333333,dedicated_bearer_update,10004,155533333333,333  
1726571700,3102603333333333,dedicated_bearer_end,10004,155533333333,333  
1726572000,3102603333333333,default_bearer_end,10003,155533333333,3333
```

3GPP

- 3GPP 10003 3GPP2020 10 MB 3GPP4 MB 3GPP
 - 3GPP 10004 3GPP2020 200 MB 3GPP2 MB 3GPP
 - 3GPP QCI 9 3GPP6 3GPP2020 QoS 3GPP
-

□□

CDR □□□



CDR

```
# 监听 CDR 目录
inotifywait -m /var/log/sgw_c/cdrs/ -e close_write | while read
path action file; do
    # 处理 CDR
    process_cdr "$path$file"
done
```

2.

```
# 读取日志文件  
tail -F /var/log/sgw_c/cdrs/* | process_cdr_stream
```

-  - 
 -  - 
 -  - 

3GPP 

- TS 32.251 - 3GPP PS GTP-C
 - TS 29.274 - 3GPP EPS GTP-C
 - TS 29.244 - CP UP PFCP
 - TS 32.298 - CDR

CDR - SGW-C

 Omnitouch

测试报告 1.0 测试日期 2025-12-10

SGW-C

Omni runtime.exs

OmniSGW / Omnitouch



1. 5G
 2. 4G/5G
 3. 4G/5G
 4. S11 4G/5G
 5. S5/S8 4G/5G
 6. Sxa 4G/5G
 7. CDR 4G
 8. 4G/5G
-



OmniSGW 配置文件 config/runtime.exs 包含以下内容

- 4G/5G
- 4G/5GMME/PGW-C/SGW-U
- 4G/5G
- CDR 4G
- 4G/5G

配置文件 - runtime.exs 包含以下内容

Web UI 配置文件



```
# config/runtime.exs
import Config

config :sgw_c,
  metrics: %{ ... },
  s11: %{ ... },
  s5s8: %{ ... },
  sxa: %{ ... },
  cdr: %{ ... }
```

SGW Metrics

配置文件

```
config :sgw_c,
  metrics: %{
    # 用于暴露 HTTP 端口
    metrics_bind_address: "127.0.0.40",
    metrics_port: 42068,

    # 暴露间隔
    poll_interval_ms: 10000
  }
```

配置文件

```
config :sgw_c,
  metrics: %{
    # 用于暴露 HTTP 端口
    metrics_bind_address: System.getenv("MGT_IP") || "10.0.0.40",
    metrics_port: 42068,

    # 暴露间隔
    poll_interval_ms: 5000
  }
```

抓取数据

```
# 从 Prometheus 抓取数据
curl http://10.0.0.40:42068/metrics

# 例如
# - teid_registry_count: S11/S5S8 TEID
# - seid_registry_count: PFCP 端口
# - s11_inbound_messages_total: S11 入站消息
# - sxa_inbound_messages_total: Sxa 入站消息
```

S11 服务

配置

```
config :sgw_c,
s11: %{
  # S11 本地 IPv4 地址 MME 地址
  local_ipv4_address: "10.0.0.10",

  # 本地 IPv6 地址
  local_ipv6_address: nil,

  # 本地端口
  local_port: 2123,

  # 消息超时
  message_timeout_ms: 5000,

  # 重试
  max_retries: 3,
  retry_backoff_ms: 1000
}
```

SGW配置

```
# SGW本地IP地址
config :sgw_c,
  s11: %{
    local_ipv4_address: "10.0.0.10" # S11本地IP
  }

# SGW本地IP地址和Sxa本地IP地址
config :sgw_c,
  s11: %{
    local_ipv4_address: "10.0.0.10"      # SGW本地IP
  },
  sxa: %{
    local_ip_address: "10.1.0.20"        # Sxa本地IP
  }
```

S11配置

```
config :sgw_c,
  s11: %{
    # 重传次数> 100ms RTT
    message_timeout_ms: 10000,
    max_retries: 5,
    retry_backoff_ms: 2000,

    # 重传次数< 50ms RTT
    message_timeout_ms: 3000,
    max_retries: 2,
    retry_backoff_ms: 500
  }
```

S5/S8 接口

配置文件

```
config :sgw_c,
  s5s8: %{
    # S5/S8 接口 IPv4 地址 PGW 地址
    local_ipv4_address: "10.0.0.15",

    # 本地 IPv6 地址
    local_ipv6_address: nil,

    # 本地端口号
    local_port: 2123,

    # PGW-C 地址
    pgw_peers: [
      %{
        ip_address: "10.0.0.20",
        name: "pgw-c-primary"
      },
      %{
        ip_address: "10.0.0.21",
        name: "pgw-c-secondary"
      }
    ],

    # 超时
    message_timeout_ms: 5000,
    max_retries: 3,
    retry_backoff_ms: 1000
  }
```

PGW 配置示例

```
# PGW 配置示例
config :sgw_c,
s5s8: %{
    pgw_peers: [
        %{
            ip_address: "10.0.0.20",
            name: "pgw-c-prod"
        }
    ]
}

# PGW 配置示例
config :sgw_c,
s5s8: %{
    pgw_peers: [
        %{ip_address: "10.0.0.20", name: "pgw-c-1"},
        %{ip_address: "10.0.0.21", name: "pgw-c-2"},
        %{ip_address: "10.0.0.22", name: "pgw-c-3"}
    ]
}

# PGW 配置示例
config :sgw_c,
s5s8: %{
    pgw_peers: [
        %{ip_address: "10.0.0.20", name: "pgw-c-primary"},
        %{ip_address: "10.0.0.21", name: "pgw-c-backup"}
    ]
}
```

Sxa     

    

```
config :sgw_c,
  sxa: %{
    # Sxa      IP   
    local_ip_address: "10.0.0.20",

    #         
    local_port: 8805,

    # SGW-U    
    peers: [
      %{
        ip_address: "10.0.0.30",
        node_id: "sgw-u-1.example.com"
      }
    ],
    #         
    heartbeat_interval_s: 20,

    #         
    session_timeout_ms: 5000,

    #     
    max_retries: 3
  }
```

SGW-U ◉◉?

```
# ◉◉ SGW-U
config :sgw_c,
  sxa: %{
    peers: [
      %{
        ip_address: "10.0.0.30",
        node_id: "sgw-u-prod-01"
      }
    ]
  }

# ◉◉ SGW-U
config :sgw_c,
  sxa: %{
    peers: [
      %{
        ip_address: "10.0.0.30",
        node_id: "sgw-u-prod-01"
      },
      %{
        ip_address: "10.0.0.31",
        node_id: "sgw-u-prod-02"
      }
    ]
  }
```

SGW配置

```
# SGW心跳间隔
config :sgw_c,
  sxa: %{
    heartbeat_interval_s: 10,
    max_retries: 2
  }

# SGW心跳间隔
config :sgw_c,
  sxa: %{
    heartbeat_interval_s: 20,
    max_retries: 3
  }

# SGW心跳间隔
config :sgw_c,
  sxa: %{
    heartbeat_interval_s: 40,
    max_retries: 5
  }
```

CDR 介绍

配置文件

```
config :sgw_c,
  cdr: %{
    # CDR 服务名
    gateway_name: "sgw-c-prod-01",

    # 旋转间隔毫秒
    rotation_interval_ms: 3600000, # 1 小时

    # CDR 目录
    directory: "/var/log/sgw_c/cdrs"
  }
```

配置文件

```
config :sgw_c,
  cdr: %{
    # 服务名，通过环境变量 HOSTNAME 替换
    gateway_name: System.get_env("HOSTNAME") || "sgw-c-prod-01",

    # 旋转间隔毫秒
    rotation_interval_ms: 3600000,

    # CDR 目录
    directory: System.get_env("CDR_DIR") || "/var/log/sgw_c/cdrs"
  }
```

配置文件

```
config :sgw_c,
  cdr: %{
    gateway_name: "sgw-c-prod-high-vol",
    # 间隔时间
    rotation_interval_ms: 1800000,  # 30 分钟
    # 目录
    directory: "/mnt/fast-ssd/sgw_c/cdrs"
  }
```



SGW Configuration

```
import Config

config :sgw_c,
  metrics: %{
    metrics_bind_address: "127.0.0.40",
    metrics_port: 42068,
    poll_interval_ms: 10000
  },
  s11: %{
    local_ipv4_address: "10.0.0.10",
    local_port: 2123,
    message_timeout_ms: 5000,
    max_retries: 3,
    retry_backoff_ms: 1000
  },
  s5s8: %{
    local_ipv4_address: "10.0.0.10",
    pgw_peers: [
      %{ip_address: "10.0.0.20", name: "pgw-c-prod"}
    ],
    message_timeout_ms: 5000,
    max_retries: 3,
    retry_backoff_ms: 1000
  },
  sxa: %{
    local_ip_address: "10.0.0.10",
    peers: [
      %{ip_address: "10.0.0.30", node_id: "sgw-u-prod-01"}
    ],
    heartbeat_interval_s: 20,
    session_timeout_ms: 5000,
    max_retries: 3
  },
  cdr: %{
    gateway_name: "sgw-c-prod-01",
    rotation_interval_ms: 3600000,
```

```
    directory: "/var/log/sgw_c/cdrs"  
}
```

SGW Configuration

```
import Config

sgw_s11_ip = System.get_env("SGW_S11_IP") || "10.0.0.10"
sgw_s5s8_ip = System.get_env("SGW_S5S8_IP") || "10.0.0.15"
sgw_sxa_ip = System.get_env("SGW_SXA_IP") || "10.0.0.20"
mgt_ip = System.get_env("MGT_IP") || "10.0.0.40"

config :sgw_c,
  metrics: %{
    metrics_bind_address: mgt_ip,
    metrics_port: 42068,
    poll_interval_ms: 5000
  },
  s11: %{
    local_ipv4_address: sgw_s11_ip,
    message_timeout_ms: 5000,
    max_retries: 3,
    retry_backoff_ms: 1000
  },
  s5s8: %{
    local_ipv4_address: sgw_s5s8_ip,
    pgw_peers: [
      %{ip_address: "10.0.0.20", name: "pgw-c-1"},
      %{ip_address: "10.0.0.21", name: "pgw-c-2"},
      %{ip_address: "10.0.0.22", name: "pgw-c-3"}
    ],
    message_timeout_ms: 5000,
    max_retries: 3,
    retry_backoff_ms: 1000
  },
  sxa: %{
    local_ip_address: sgw_sxa_ip,
    peers: [
      %{ip_address: "10.0.0.30", node_id: "sgw-u-1"},
      %{ip_address: "10.0.0.31", node_id: "sgw-u-2"},
      %{ip_address: "10.0.0.32", node_id: "sgw-u-3"}
    ],
    heartbeat_interval_s: 20,
    session_timeout_ms: 5000,
    max_retries: 3
  },
}
```

```
cdr: %{
    gateway_name: System.get_env("HOSTNAME") || "sgw-c-prod-01",
    rotation_interval_ms: 3600000,
    directory: "/var/log/sgw_c/cdrs"
}
```

Config

```
import Config

# SGW IP Configuration
sgw_s11_ip = System.fetch_env!("SGW_S11_IP")
sgw_s5s8_ip = System.fetch_env!("SGW_S5S8_IP")
sgw_sxa_ip = System.fetch_env!("SGW_SXA_IP")
mgt_ip = System.fetch_env!("MGT_IP")
hostname = System.get_env("HOSTNAME")

# PGW Peers Configuration
pgw_peers_env = System.get_env("PGW_PEERS", "[]")
{:ok, pgw_peers} = Jason.decode(pgw_peers_env)
pgw_peers = Enum.map(pgw_peers, &Map.to_atom/1)

# SGW-U Peers Configuration
sgwu_peers_env = System.get_env("SGWU_PEERS", "[]")
{:ok, sgwu_peers} = Jason.decode(sgwu_peers_env)
sgwu_peers = Enum.map(sgwu_peers, &Map.to_atom/1)

config :sgw_c,
  metrics: %{
    metrics_bind_address: mgt_ip,
    metrics_port: 42068,
    poll_interval_ms: 5000
  },
  s11: %{
    local_ipv4_address: sgw_s11_ip,
    message_timeout_ms: 5000,
    max_retries: 3,
    retry_backoff_ms: 1000
  },
  s5s8: %{
    local_ipv4_address: sgw_s5s8_ip,
    pgw_peers: pgw_peers,
    message_timeout_ms: 5000,
    max_retries: 3,
    retry_backoff_ms: 1000
  },
  sxa: %{
    local_ip_address: sgw_sxa_ip,
    peers: sgwu_peers,
```

```
    heartbeat_interval_s: 20,  
    session_timeout_ms: 5000,  
    max_retries: 3  
,  
cdr: %{  
    gateway_name: hostname,  
    rotation_interval_ms: 1800000, # 30 分钟  
    directory: "/mnt/fast-ssd/sgw_c/cdrs"  
}
```

IP 地址表

IP 地址

IP	IP	IP
SGW_S11_IP	S11 接口 IP	10.0.0.10
SGW_S5S8_IP	S5/S8 接口 IP	10.0.0.15
SGW_SXA_IP	Sxa 接口 IP	10.0.0.20
MGT_IP	管理 IP	10.0.0.40

环境变量

参数	值	说明
HOSTNAME	CDR 服务器名	必填
PGW_PEERS	PGW 对等体 JSON 数组	[]
SGWU_PEERS	SGW-U 对等体 JSON 数组	[]
CDR_DIR	CDR 存储目录	/var/log/sgw_c/cdrs

配置脚本

```
export SGW_S11_IP="10.0.0.10"
export SGW_S5S8_IP="10.0.0.15"
export SGW_SXA_IP="10.0.0.20"
export MGT_IP="10.0.0.40"
export HOSTNAME="sgw-c-prod-01"
export PGW_PEERS='[{"ip_address": "10.0.0.20", "name": "pgw-c-1"}]'
export SGWU_PEERS='[{"ip_address": "10.0.0.30", "node_id": "sgw-u-1"}]'

mix run --no-halt
```

启动

启动命令

./mix run --no-halt

```
mix run --no-halt 2>&1 | grep -E "S11|S5/S8|Sxa|Metrics"

# OmniSGW
# [info] Starting SGW-C...
# [info] Starting Metrics Exporter on 10.0.0.40:42068
# [info] Starting S11 Broker on 10.0.0.10
# [info] Starting S5/S8 Broker on 10.0.0.15
# [info] Starting Sxa Broker on 10.0.0.20
# [info] OmniSGW successfully started
```

SGW启动

```
# OmniSGW启动
curl http://10.0.0.40:42068/metrics | head -20

# 检查 S11 端口
netstat -an | grep 2123

# 检查 S11 日志
tail -f /var/log/sgw_c/sgw_c.log | grep "S11"
```

SGW端口

"2123"

SGW 端口

端口

```
# 檢查連接埠  
lsof -i :2123  
  
# 停止服務  
killall sgw_c  
# 配置  
config :sgw_c, s11: %{local_port: 2124}
```

"**PGW**"

ping S5/S8 連接 PGW-C

連接埠

```
# 檢查 PGW IP  
ping 10.0.0.20  
  
# 檢查連接埠  
iptables -L | grep 2123  
  
# 測試連接埠  
nc -u -v 10.0.0.20 2123
```

"**SGW-U**"

ping Sxa 連接

連接埠

```
# 檢查 SGW-U 連接埠  
ping 10.0.0.30  
  
# 檢查 PFCP 連接埠  
netstat -an | grep 8805  
  
# 檢查 PFCP 連接埠  
iptables -L | grep 8805
```



Prometheus と Grafana の構成

OmniSGW と Omnitouch の構成

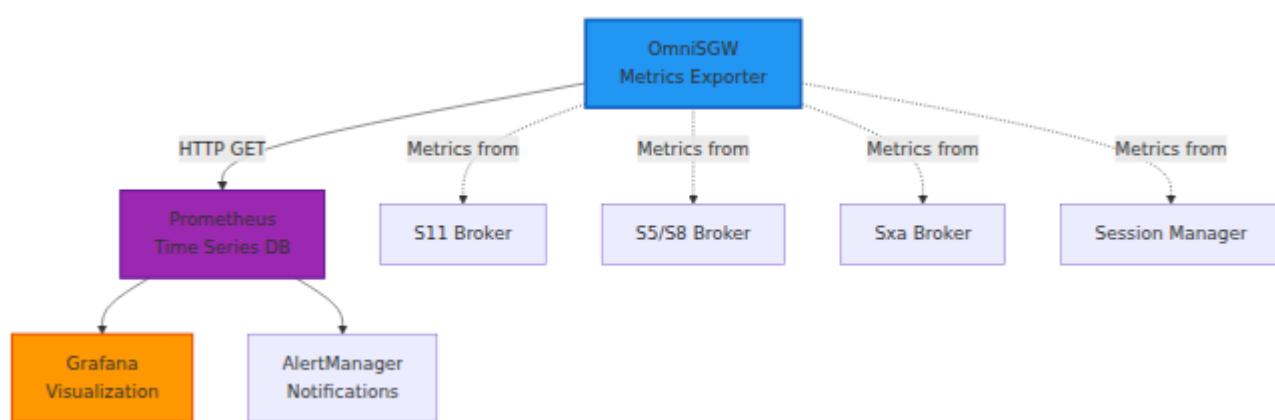


1. データ
 2. メトリクス
 3. ブローカー
 4. Prometheus データ
 5. Grafana データ
 6. データ
 7. データ
-



OmniSGW が Prometheus の構成を示す

構成



HTTP

HTTP

HTTP HTTP

```
# HTTP
curl http://127.0.0.40:42068/metrics

# HTTP
curl http://127.0.0.40:42068/metrics > metrics.txt

# HTTP
watch -n 5 'curl -s http://127.0.0.40:42068/metrics | head -30'
```

HTTP HTTP HTTP HTTP HTTP HTTP

Prometheus

Prometheus Prometheus

```
# HELP teid_registry_count TEID
# TYPE teid_registry_count gauge
teid_registry_count 1234

# HELP s11_inbound_messages_total S11
# TYPE s11_inbound_messages_total counter
s11_inbound_messages_total{message_type="create_session_request"} 5432
s11_inbound_messages_total{message_type="delete_session_request"} 5100
s11_inbound_messages_total{message_type="modify_bearer_request"} 12000
```

UE

UE Statistics

UE

```
teid_registry_count
├── S11/S5S8 TEID 00
├── Gauge
├── 0 00000000
└── 1234 1234 000000

seid_registry_count
├── PFCP 00000 SGW-U 0000
├── Gauge
├── peer_ip
└── seid_registry_count{peer_ip="10.0.0.30"} 1234

active_ue_sessions
├── UE 00
├── Gauge
└── 5000

active_bearers
├── 0000000000 + 00
├── Gauge
└── 5500 1 00 + 000 0.1 000

charging_id_registry_count
├── ID
├── Gauge
└── 5000
```

UE

S11 MME 0000

```
s11_inbound_messages_total
├─ ┌─┐Counter
└─ ┌─┐message_type
└─ ┌─┐
    ├─ create_session_request
    ├─ delete_session_request
    ├─ modify_bearer_request
    ├─ create_bearer_request
    ├─ delete_bearer_request
    ├─ release_access_bearers_request
    ├─ downlink_data_notification
    └─ echo_request
└─ ┌─┐
s11_inbound_messages_total{message_type="create_session_request"}
5432
```

S5/S8~~U~~PGW ┌─┐

```
s5s8_inbound_messages_total
├─ ┌─┐Counter
└─ ┌─┐message_type
└─ ┌─┐ S11 ┌─┐
└─ ┌─┐
s5s8_inbound_messages_total{message_type="create_session_request"}
4500
```

Sxa~~U~~SGW-U ┌─┐

```
sxa_inbound_messages_total
├── Counter
├── message_type
└── 
    ├── session_establishment_request
    ├── session_modification_request
    ├── session_deletion_request
    ├── session_report_request
    ├── association_setup_request
    └── heartbeat_request
└── 
sxa_inbound_messages_total{message_type="session_report_request"} 67000
```

HTTP

HTTP/2

```
s11_inbound_duration_seconds
├── Histogram
├── S11 丢弃
└── _count, _sum, _bucket
└── s11_inbound_duration_seconds_bucket{le="0.1"} 5000
```

```
s5s8_inbound_duration_seconds
├── Histogram
└── S5/S8 丢弃
```

```
sxa_inbound_duration_seconds
├── Histogram
└── Sxa 丢弃
```

PFCP 丢弃

```
pfcp_association_status
├── Gauge
├── 1
├── peer_ip, node_id
└── pfcp_association_status{peer_ip="10.0.0.30"} 1

pfcp_heartbeat_latency_ms
├── Gauge
├──
├── peer_ip
└── pfcp_heartbeat_latency_ms{peer_ip="10.0.0.30"} 15
```

PFCP

PFCP

```
s11_inbound_errors_total
├── Counter
├── error_type
├──
│   ├── parse_error
│   ├── validation_error
│   ├── timeout
│   └── other
└── s11_inbound_errors_total{error_type="timeout"} 12

s5s8_inbound_errors_total
├── Counter
└── S5/S8

sxa_inbound_errors_total
├── Counter
└── Sxa
```

PFCP Metrics

```
create_session_response_cause
├── 3GPPCounter
├── cause_code
├── 3GPP Cause
└── 3GPPCause
    ├── cause_code="0": 0
    ├── cause_code="16": 0
    ├── cause_code="25": 0
    └── cause_code="49": 0
```

Prometheus 安装

安装

```
# 安装 Prometheus
wget
https://github.com/prometheus/prometheus/releases/download/v2.45.0/prometheus-2.45.0.linux-amd64.tar.gz
tar xzf prometheus-2.45.0.linux-amd64.tar.gz
cd prometheus-2.45.0.linux-amd64
```

配置文件

prometheus.yml:

```
global:
  scrape_interval: 15s
  evaluation_interval: 15s
  external_labels:
    monitor: 'sgw-c-prod'

scrape_configs:
  - job_name: 'sgw-c'
    static_configs:
      - targets: ['127.0.0.40:42068']
        labels:
          instance: 'sgw-c-prod-01'

  - job_name: 'sgw-c-backup'
    static_configs:
      - targets: ['127.0.0.41:42068']
        labels:
          instance: 'sgw-c-prod-02'

alerting:
  alertmanagers:
    - static_configs:
      - targets: ['127.0.0.50:9093']
```

☰ Prometheus

```
./prometheus --config.file=prometheus.yml \
  --storage.tsdb.path=/var/lib/prometheus \
  --web.console.libraries=console \
  --web.console.templates=console_templates
```

☰ Prometheus

<http://localhost:9090>

Grafana 介绍

一、

```
# Docker启动命令  
docker run -d \  
  --name=grafana \  
  -p 3000:3000 \  
  -e GF_SECURITY_ADMIN_PASSWORD=admin \  
  grafana/grafana
```

二、安装

1. 打开 **Grafana** <http://localhost:3000>
2. 登录 → 新建
3. 新建 → **Prometheus**
4. URL → <http://prometheus:9090>

三、配置

四、

- ```
└ 1 └
 └── Gauge └
 └── Gauge └
 └── S11 └ └ / └
 └── S5/S8 └ └ / └
```

- 2□
    - └ Sxa □□/□□□□□
    - └ S11 □□ p95□□□□
    - └ S5/S8 □□ p95□□□□□
    - └ Sxa □□ p95□□□□

- └ 3└
    - └ S11 └/└└└└└└
    - └ S5/S8 └/└└└└└└
    - └ Sxa └/└└└└└└
    - └ PFCP └/└└└└└└

A horizontal row of eight empty rectangular boxes, likely for handwriting practice or filling in information.

1

- └ 10
    - └ S11 ┌─────────┐
    - └ S5/S8 ┌─────────┐
    - └ SGW-U ┌─────────┐
    - └ ┌─────────┐Gauge└

- 2□
    - S11 □□□□□□□□
    - S5/S8 □□□□□□□□
    - Sxa □□□□□□□□

- 3□

## 5G NR KPI

NR

```
□ 1□
└─ NR吞吐量Gauge + NR吞吐量Gauge + NR吞吐量
└─ PFCP NR吞吐量
└─ APN NR吞吐量
```

```
□ 2□
└─ NR吞吐量
└─ NR吞吐量
└─ NR吞吐量
└─ NR吞吐量
```

## 5G NR KPI

NR

```
teid_registry_count
```

NR

```
rate(s11_inbound_messages_total{message_type="create_session_request"
[5m])
```

## S11 NR 95th NR

```
histogram_quantile(0.95,
rate(s11_inbound_duration_seconds_bucket[5m]))
```

NR

```
rate(s11_inbound_errors_total[5m]) +
rate(s5s8_inbound_errors_total[5m]) +
rate(sxa_inbound_errors_total[5m])
```

## PFCP 丢包率

```
pfcp_association_status{peer_ip=~"10.0.0.3[0-2]"}

```



**sgw-c-alerts.yml:**

```

groups:
 - name: sgw-c-alerts
 interval: 30s
 rules:
 # SGW Capacity High
 - alert: SGWCapacityHigh
 expr: (teid_registry_count / 100000) > 0.8
 for: 5m
 annotations:
 summary: "SGW ȿȿȿȿȿ 80%"
 description: "ȿȿȿ{{ $value }} / 100000"

 # S11 Peer Down
 - alert: S11PeerDown
 expr: absent(s11_inbound_messages_total) > 0
 for: 2m
 annotations:
 summary: "S11 ȿȿȿȿȿ"

 - alert: PGWPeerDown
 expr: create_session_response_cause{cause_code="49"} > 100
 for: 2m
 annotations:
 summary: "PGW-C ȿȿȿȿȿ"

 - alert: SGWUAssociationDown
 expr: pfcp_association_status == 0
 for: 1m
 annotations:
 summary: "SGW-U ȿȿȿ"
 description: "ȿȿȿ{{ $labels.peer_ip }}"

 # S11 Latency High
 - alert: S11LatencyHigh
 expr: histogram_quantile(0.95,
rate(s11_inbound_duration_seconds_bucket[5m])) > 1
 for: 5m
 annotations:
 summary: "S11 ȿȿȿ 1 ȿ"
 description: "p95: {{ $value }}s"

 - alert: S5S8LatencyHigh
 expr: histogram_quantile(0.95,

```

```

rate(s5s8_inbound_duration_seconds_bucket[5m])) > 1
 for: 5m
 annotations:
 summary: "S5/S8 ȏȿȿ 1 ȿ"

ȏȿȿȿ
- alert: S11ErrorRate
 expr: rate(s11_inbound_errors_total[5m]) > 10
 for: 3m
 annotations:
 summary: "ȿ S11 ȏȿȿ"
 description: "{{ $value }} errors/sec"

- alert: SessionEstablishmentFailure
 expr: rate(create_session_response_cause{cause_code!="0"}) [5m]) > 20
 for: 3m
 annotations:
 summary: "ȏȿȿȿȿȿȿȿ"
 description: "{{ $value }} failures/sec"

```

## ȿȿ AlertManager

**alertmanager.yml:**

```
global:
 resolve_timeout: 5m

route:
 receiver: 'sgw-alerts'
 group_by: ['alertname', 'instance']
 group_wait: 30s
 group_interval: 5m
 repeat_interval: 12h

receivers:
 - name: 'sgw-alerts'
 webhook_configs:
 - url: 'http://slack-webhook-url'
 email_configs:
 - to: 'noc@example.com'
 from: 'sgw-alerts@example.com'
 smarthost: 'smtp.example.com:587'
```

SGW Alert

**Slack** 亂

SGW 亂  
SGW Alert  
85,000 / 100,000 (85%)  
2025-12-10 15:30:00 UTC  
SGW Alert

SGW Alert

SGW-C[11] S11 ဆောင်ရွက်

SGW-C S11 ဆုံး 2 ဆောင်ရွက်ခဲ့သည်

မြန်မာ

- MME ဆောင်ရွက်
- မြန်မာ SGW-C
- S11 ဆောင်ရွက်

ဆောင်ရွက်ခဲ့သည့် S11 ၏



မြန်မာ 404

မြန်

```
မြန်မာနှင့်
curl -v http://127.0.0.40:42068/metrics

မြန်မာနှင့်
tail -f /var/log/sgw_c/sgw_c.log | grep -i metric

မြန်
cat config/runtime.exs | grep metrics
```

မြန်မာ

၁. မြန် SGW-C ၏
၂. မြန် IP/မြန်မာနှင့်
၃. မြန်မာနှင့်
၄. မြန်မာနှင့်

## ၁၁။ အောက်တို့မှာ

၁၁။ S11 အောက်မှာ S5/S8 ဗုံး Sxa ၏

၁၁။

၁. အောက်တို့မှာ
၂. အောက်တို့မှာ
၃. အောက်တို့မှာ

၁၁။

- အောက်တို့မှာ
- အောက်တို့မှာ
- အောက်တို့မှာ

၁၁။

၁၁။ အောက်တို့မှာ

၁၁။

```
အောက်တို့မှာ
ps aux | grep sgw_c | grep -v grep | awk '{print $6}'

အောက်တို့မှာ
watch -n 5 'ps aux | grep sgw_c'
```

၁၁။

၁. အောက်တို့မှာ
၂. အောက်တို့မှာ
၃. အောက်တို့မှာ
၄. အောက်တို့မှာ

---

# Omni

## SGW

- 15-30 ms
- 15-30 ms
- 15-30 ms
- 15-30 ms

## NGW

- 15-30 ms
- 15-30 ms → 15-30 ms
- 15-30 ms
- 15-30 ms

## OT

- 15-30 ms → 15-30 ms
  - 15-30 ms
  - 15-30 ms +20% ms
  - 15-30 ms
- 

❖❖❖ - *OmniSGW* ❖❖❖

❖ *Omnitouch* ❖

❖❖❖ 1.0 ❖❖❖ 2025-12-10

# S11 ████

█ MME █ GTP-C █

*OmniSGW* █ *Omnitouch* ████

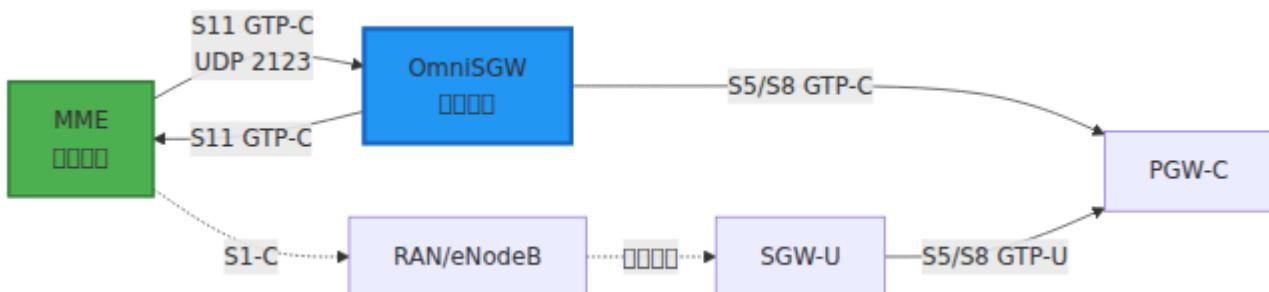
---



1. █
  2. ████
  3. █
  4. ████
  5. ████
  6. ████
  7. ████
  8. ████
  9. ████
- 



**S11** █ █ **GTP-C v2** █ GPRS █ - █ OmniSGW █ MME █ PGW-C █  
█ UE █ RAN/eNodeB █ SGW-U █



1

- **GTP-C v2** یعنی - گروپ پروتکل
  - یعنی **TEID** یعنی - گروپ پرتو
  - گروپ پرتو - گروپ پرتو UE یعنی
  - گروپ پرتو - یعنی MME یعنی MME گروپ
  - گروپ پرتو - گروپ پرتو
  - گروپ پرتو - گروپ پرتو

\_\_\_\_\_

GTP-C 2

- GTP-C v2 (3GPP TS 29.274)
  - UDP
  - 2123
  - 100000 0000
  - 100000/00

# TEID

██████████ TEID ██████████

- **TEID** - OmniSGW ↔ MME ↔ EPC
  - **TEID** - MME ↔ MME ↔ EPC

5 of 5

MME → SGW: OmniSGW TEID

SGW → MME: ━━━━━━ MME ━━ TEID

1

S11 GTP-C v2

GTP-C 头 (12-16 字节)

- ├── 头 (3 字节): 0x2 (GTP-C v2)
- ├── 版本 (1 字节)
- ├── TEID 头 (1 字节): 1 (TEID 头)
- ├── 保留 (8 字节): 00000000
- ├── 保留 (16 字节): 0000000000000000
- ├── TEID (32 字节): 00000000000000000000000000000000
- ├── 保留 (24 字节): 0000/00000000000000000000000000000000
- └── 头 (8 字节): 0000 0

IE 头 (4 字节)

- ├── IE 头 (IE)
- │ ├── IE 头 (8 字节)
- │ ├── 头 (16 字节)
- │ └── 头 (4 字节)
- └── ... 头 IE

□□

□□□□

```
config/runtime.exs
config :sgw_c,
 s11: %{
 # S11 □□□□ IPv4 □□
 local_ipv4_address: "10.0.0.10",

 # □□□□ IPv6 □□□□□□
 local_ipv6_address: nil,

 # □□□□□□□
 local_port: 2123,

 # □□□
 message_timeout_ms: 5000,

 # □□□
 max_retries: 3,
 retry_backoff_ms: 1000
 }
```

□□□□

□□□□□□

```
□□□ MME □□□ GTP-C□□□
iptables -A INPUT -p udp --dport 2123 -s <mme_network>/24 -j
ACCEPT

□□□ MME □□□ GTP-C
iptables -A OUTPUT -p udp --dport 2123 -d <mme_network>/24 -j
ACCEPT
```

□□□

```
为 MME 配置路由
ip route add <mme_network>/24 via <gateway_ip> dev eth0
```

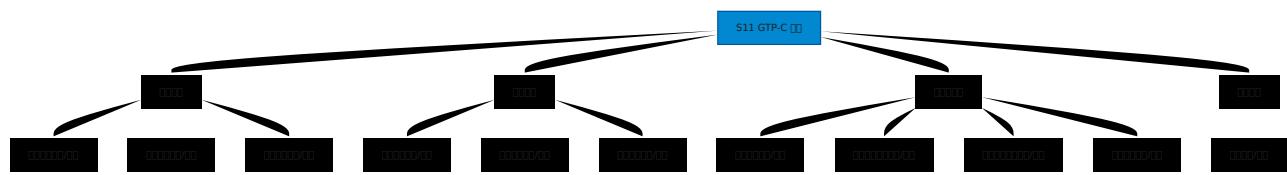
配置完成

```
在 MME 上配置 GTP 端口
显示连接状态 "S11 Broker connected" 等

检查 S11 端口
curl http://127.0.0.40:42068/metrics | grep teid_registry_count
```

端口映射

## S11 端口



端口映射图

## 端口映射图 S11

MME → OmniSGW

OmniSGW UE 端口映射到 PDN 端口

端口映射图

| IE 名称  | 类型   | 描述                |
|--------|------|-------------------|
| IMSI   | 比特串  | 国际移动用户识别码         |
| MSISDN | BCD  | 国际移动用户识别码         |
| MEI    | 比特串  | 国际移动设备识别码         |
| RAT 信息 | 比特串  | 支持的无线接入技术(EUTRAN) |
| 位置区    | 比特串  | 位置区识别码            |
| UE 信息  | 比特串  | UE 识别码            |
| ULI    | 比特串  | 小区识别码(TAI, ECGI)  |
| PLMN   | PLMN | MCC/MNC           |
| APN    | 比特串  | 访问点名称             |

UE 附着流程

| IE 名称  | 类型  | 描述           |
|--------|-----|--------------|
| UE 信息  | 比特串 | UE 识别码/IMSI  |
| TEID   | 比特串 | 隧道端点标识符 TEID |
| PDN 连接 | 比特串 | PGW 和 IP 地址  |
| APN 信息 | 比特串 | APN 识别码      |

UE 附着流程

UE 附着流程 **S11**

UE MME → OmniSGW MME 间

UE 信息

UEID

| IE ID | 名称   | 值            |
|-------|------|--------------|
| MEI   | UEID | UEID         |
| ULI   | UEID | UEID         |
| UE ID | UEID | UEID         |
| TAI   | TAI  | TAI          |
| ECGI  | ECGI | E-UTRAN UEID |

UE 位置

| IE ID | 名称   | 值    |
|-------|------|------|
| UEID  | UEID | UEID |
| 位置    | UEID | UEID |

UE 位置

位置/UE

UE 间 MME 与 SGW 间

UE 间 QoS 信息

UE 间

- UE 间

- ۴۳۰۰۰
- ۴۳۰۰۰۰

۴۳۰۰۰۰۰/۰۰

۰۰۰ ۰۰۰ MME → SGW۰۰۰ PGW۰۰۰

۰۰۰ ۰۰۰۰۰۰۰۰۰۰۰۰

۰۰۰۰

۰۰۰۰۰۰۰۰۰/۰۰

۰۰۰ MME → OmniSGW

۰۰۰ ۰۰۰۰۰۰۰۰۰۰۰۰۰۰۰

۰۰۰

- ۰۰۰۰۰۰۰۰۰۰۰۰۰۰
- ۰۰۰۰۰۰۰۰
- → SGW-U ۰۰۰۰۰۰۰
- UE ۰۰۰۰۰۰۰۰۰

۰۰۰۰۰۰۰۰۰/۰۰

۰۰۰ OmniSGW → MME → MME → OmniSGW

۰۰۰ ۰۰۰۰۰۰۰۰۰۰۰۰۰

۰۰۰۰

۰۰۰۰۰۰۰**S11**۰

۰۰۰ PGW-C → OmniSGW → MME

۰۰۰ ۰۰ MME ۰۰ UE ۰۰۰۰۰۰۰

۰۰۰۰۰۰۰

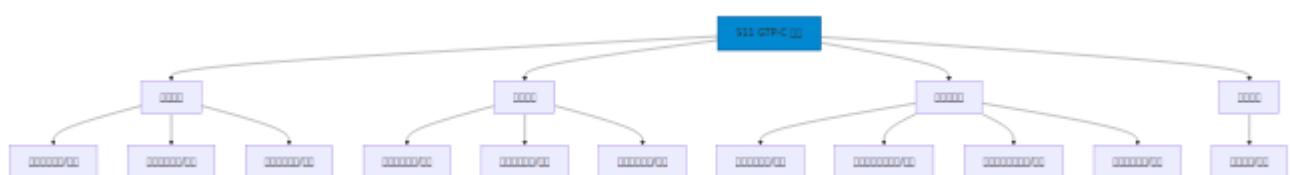
|           |    |                  |
|-----------|----|------------------|
| <b>IE</b> | UE | UE               |
| EBI       | UE | EPS UE ID        |
| IMSI      | UE | 0000000000000000 |

UE 信息

---



## UE 信息

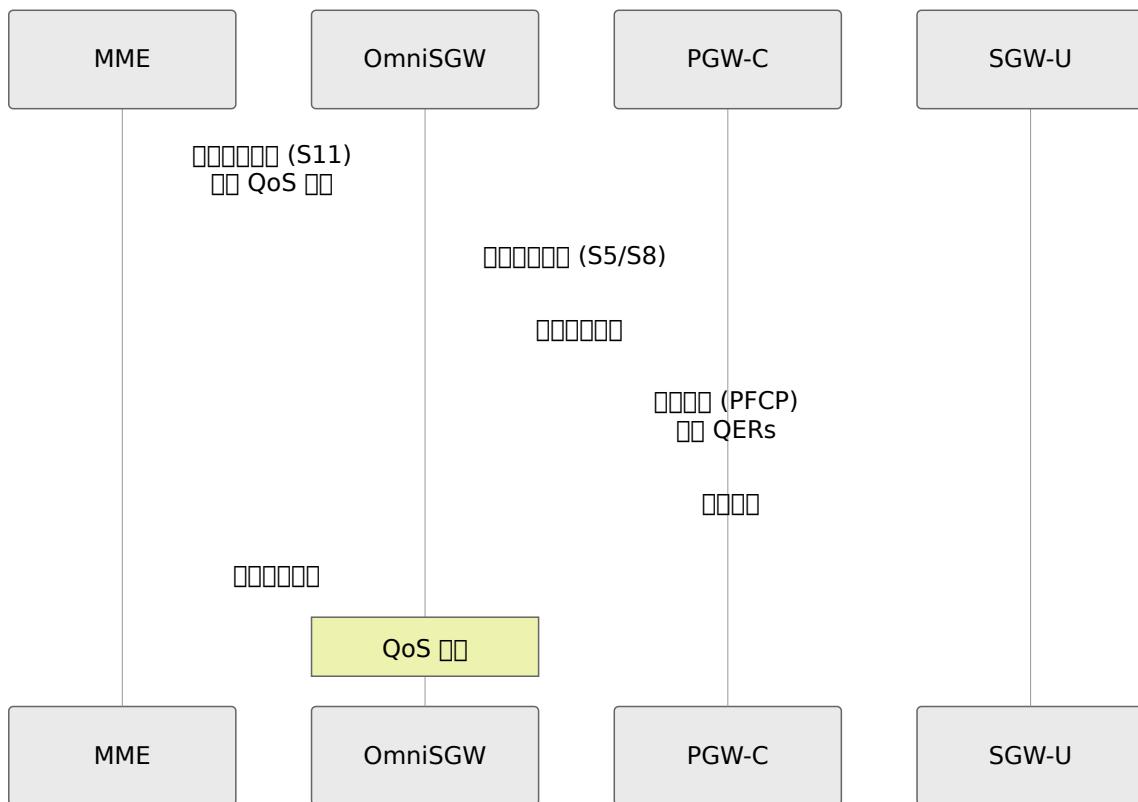


UE 信息

[UE 信息]  
 ↓ (UE)  
 [UE 信息 PGW 信息]  
 ↓ (PGW 信息)  
 [UE 信息 PGW 信息]  
 ↓ (PFCP 信息)  
 [PFCP 信息]



## QoS چیزی



## TAU چیزی

### SGW چیزی TAU

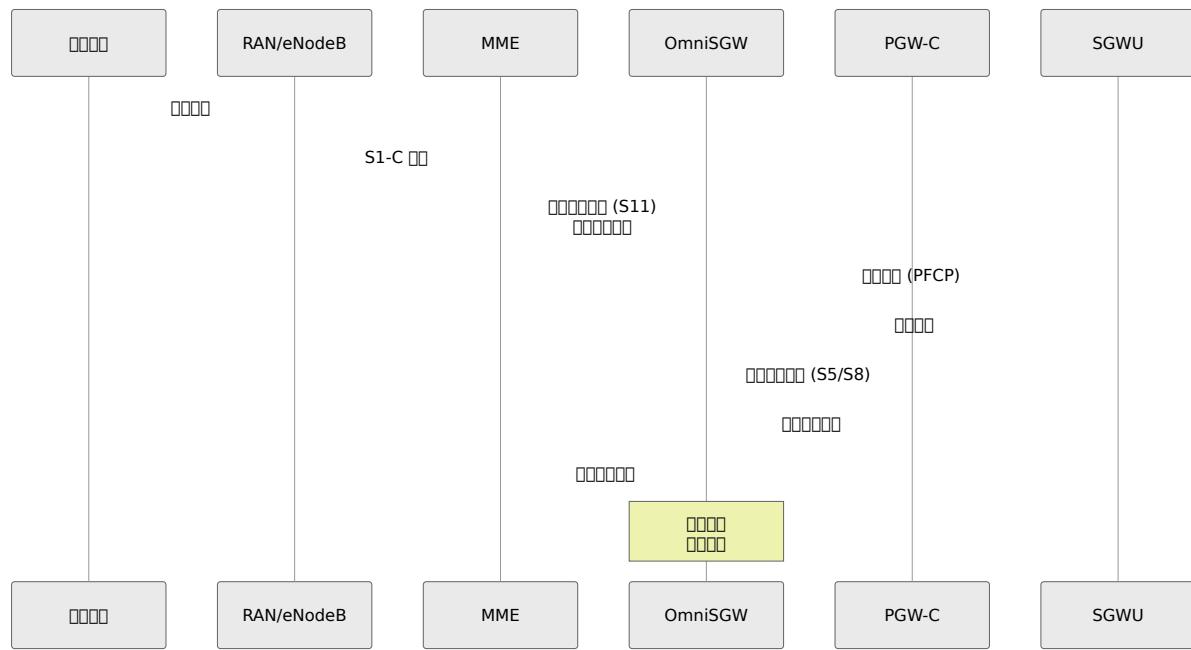
- MME چیزی UE چیزی
- ULI/TAI چیزی SGW
- SGW چیزی UE چیزی
- چیزی

### SGW چیزی TAU

- SGW چیزی MME چیزی
- SGW چیزی
- SGW چیزی SGW چیزی
- چیزی SGW چیزی

□□□□

□□□□□□



□□□□

[UE]  
↓ (RAN/eNodeB)  
[MME]  
↓ (PFCP MME)  
[PGW]  
↓ (PGW MME)  
[SGWU]

□□□□

□□□□

UE S11 MME

```

监控 S11 入站消息
watch -n 1 'curl -s http://127.0.0.40:42068/metrics | grep s11_inbound'

消息统计
#
s11_inbound_messages_total{message_type="create_session_request"} 1245
#
s11_inbound_messages_total{message_type="delete_session_request"} 1200
s11_inbound_messages_total{message_type="modify_bearer_request"} 3450

```

## UE

### UE 相关的 S11 消息

Web UI → UE 相关

- UE 相关
  - IMSI 或 GUTI
  - 或 TAI 相关
  - 或 TEID 相关 S11
  - 或 TEID 相关 MME
  - 或 QoS 相关
  - 或 PGW-C

## SGW

### SGW 相关

```

监控 SGW 相关消息
curl -s http://127.0.0.40:42068/metrics | grep modify_bearer_request_total

相关
"TAU with SGW change" 或

```

□□□

□□□□□

□□□ □□□□□□□□

□□□

1. □□ Web UI → UE □□□□□□□□
2. □□□□□ s11\_inbound\_errors\_total
3. □□□□□□□□□□□□

□□□□□□□□□

| □□        | □□        | □□□□                 |
|-----------|-----------|----------------------|
| <b>16</b> | □□□□□     | □□ SGW-U □□□PFCP □□□ |
| <b>25</b> | IE □□□□□  | □□□□□□□□□□           |
| <b>49</b> | PGW ♦♦□□□ | □□□ PGW-C □ S5/S8 □□ |
| <b>65</b> | □□□□ APN  | □□ APN □□            |

□□□□□

□□□ "□□□□□□ TEID"

□□□

```
□□ TEID □□□
curl -s http://127.0.0.40:42068/metrics | grep teid_registry_count

□□ TEID □□
Web UI → UE □□ → □ IMSI □□
```

## 3GPP 5G

- 3GPP 5G TEID
- 3GPP TEID 3GPP2
- 3GPP MME 3GPP2 TEID

## 3GPP2

3GPP 3GPP2

## 3GPP

1. 3GPP 3GPP2/3GPP2
2. 3GPP2 "RAN" + "TAU" 3GPP2
3. 3GPP2 PFCP 3GPP2

## 3GPP2

- 3GPP2 SGW-U 3GPP2
- 3GPP2 HSS 3GPP2
- 3GPP2 MME 3GPP2

## 3GPP2

3GPP2 S11 3GPP2

3GPP2

```
3GPP2
curl -s http://127.0.0.40:42068/metrics | grep
s11_inbound_duration_seconds

3GPP2
curl -s http://127.0.0.40:42068/metrics | grep active_ue_sessions

3GPP2
curl -s http://127.0.0.40:42068/metrics | grep active_bearers
```

1. ۰۰۰۰۰۰۰۰۰۰۰
  2. ۰۰۰ ◆◆◆ PFCP ۰۰۰۰۰
  3. ۰۰۰ SGW-C ۰۰۰۰۰۰۰
  4. ۰۰۰۰۰۰۰ CPU ۰۰۰۰۰۰۰

# Prometheus

10 of 10

1

-  S11 
  -  RTT 
  -  

2

- ۰۰۰۰۰ ۰۰۰۰۰۰۰۰۰
  - ۰۰۰۰۰ ۰۰ MME ۰۰۰
  - ۰۰۰۰۰ ۰۰۰ S11 ۰۰۰۰۰۰۰۰۰
  - ۰۰۰۰۰ ۰۰۰۰۰۰۰۰۰

1

- ۰۰۰۰۰ S11 ۰۰۰۰۰۰۰۰
  - ۰۰۰۰۰ ۰۰ S11 ۰۰۰۰۰۰ MME IP
  - ۰۰۰ ۰۰۰۰۰۰۰۰۰۰۰۰۰

## SGW-C

| 协议       | 功能        | 消息         | 状态 |
|----------|-----------|------------|----|
| SGSN/MME | MME → SGW | SGSN       | 空  |
| SGSN/MME | MME → SGW | SGSN       | 空  |
| SGSN/MME | MME ↔ SGW | QoS 信息 TAU | 空  |
| SGSN/MME | MME ↔ SGW | SGSN       | 空  |
| SGSN/MME | MME ↔ SGW | SGSN       | 空  |
| SGSN/MME | MME → SGW | SGSN       | 空  |
| SGSN/MME | MME ↔ SGW | SGSN       | 空  |
| SGSN/MME | SGW → MME | SGSN       | 空  |
| SGSN/MME | MME ↔ SGW | SGSN       | 空  |

---

**S11** 协议 - MME ↔ SGW-C 消息列表

# S5/S8 接口

## PGW-C 和 GTP-C

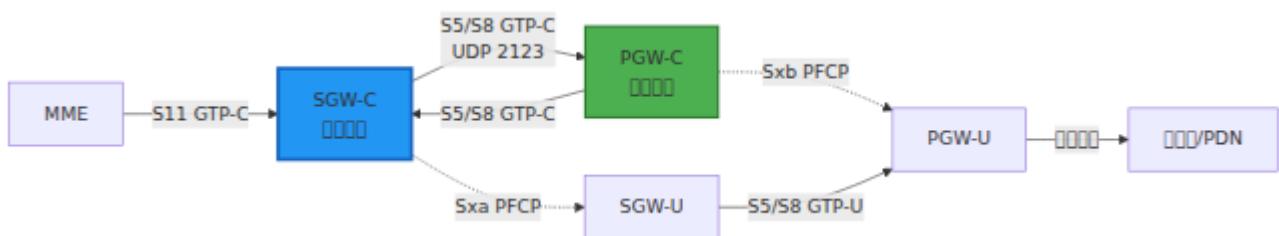
OmniSGW 和 Omnitouch



1. ①
2. ②
3. ④
4. ③
5. ⑤
6. ⑥
7. ⑦
8. ⑧
9. ⑨



**S5/S8** 接口的 **GTP-C v2** GPRS ① - ② OmniSGW ③ PGW-C ④ ⑤ ⑥ ⑦ ⑧ ⑨ PDN ⑩



## ମୁଖ୍ୟ

- **GTP-C v2** କେ - ପରିବହନ
  - ଏହା **TEID** କେଣ୍ଟିବା - ପରିବହନକାରୀ
  - **PDN କେଣ୍ଟିବା** - ଏହା/ଏହା/ଏହା PDN କେ
  - ଏହାକି - ପରିବହନକାରୀ
  - ଏହା **ID କେଣ୍ଟିବା** - ପରିବହନକାରୀ
  - **IP କେଣ୍ଟିବା** - ଏହା PGW କେଣ୍ଟିବା UE IP
- 

## ମୁଖ୍ୟ

### **GTP-C କେଣ୍ଟି 2**

- ଏହା GTP-C v2 (3GPP TS 29.274)
- ଏହା UDP
- ଏହା 2123 ପରିବହନ
- ଏହାକି ପରିବହନ
- ଏହା ପରିବହନ/ଏହା

### **TEID କେଣ୍ଟିବାରୀତି**

ଏହା PDN କେଣ୍ଟିବାରୀତିରେ TEID କେଣ୍ଟିବାରୀତି

- **SGW TEID** - ଏହା SGW-C କେଣ୍ଟିବା PGW କେଣ୍ଟିବା S5/S8 କେଣ୍ଟିବା
- **PGW TEID** - ଏହା PGW-C କେଣ୍ଟିବା SGW କେଣ୍ଟିବା S5/S8 କେଣ୍ଟିବା

#### ମୁଖ୍ୟ

SGW-C → PGW-C କେଣ୍ଟିବା PGW-C କେଣ୍ଟିବା TEID  
PGW-C → SGW-C କେଣ୍ଟିବା SGW-C କେଣ୍ଟିବା TEID

### **ID କେଣ୍ଟିବାରୀତି**

ଏହା ID କେଣ୍ଟିବାରୀତି

- PGW-C ްަމްގަންމްލް
  - SGW-C ްަމްގަންމްލް CDR
  - SGW ް PGW CDR ްަމްގަންމްލް
  - 3GPP 32 ްަމްގަންމްލް PDN ްަމްގަންމްލް
- 



## ްަމްގަންމްލް

```
config/runtime.exs
config :sgw_c,
 s5s8: %{
 # S5/S8 ްަމްގަންމްލް IPv4 ްަމްގަންމްލް
 local_ipv4_address: "10.0.0.15",

 # ްަމްގަންމްލް IPv6 ްަމްގަންމްލް
 local_ipv6_address: nil,

 # ްަމްގަންމްލް
 local_port: 2123,

 # PGW-C ްަމްގަންމްލް
 pgw_peers: [
 %{
 ip_address: "10.0.0.20",
 name: "pgw-c-primary"
 },
 %{
 ip_address: "10.0.0.21",
 name: "pgw-c-secondary"
 }
],
 # ްަމްގަންމްލް
 message_timeout_ms: 5000,
 max_retries: 3,
 retry_backoff_ms: 1000
 }
```

## PGW-C

### PGW-C 配置

```
允许 PGW-C 的 GTP-C
iptables -A INPUT -p udp --dport 2123 -s <pgw_network>/24 -j
ACCEPT
```

```
允许 PGW-C 的 GTP-C
iptables -A OUTPUT -p udp --dport 2123 -d <pgw_network>/24 -j
ACCEPT
```

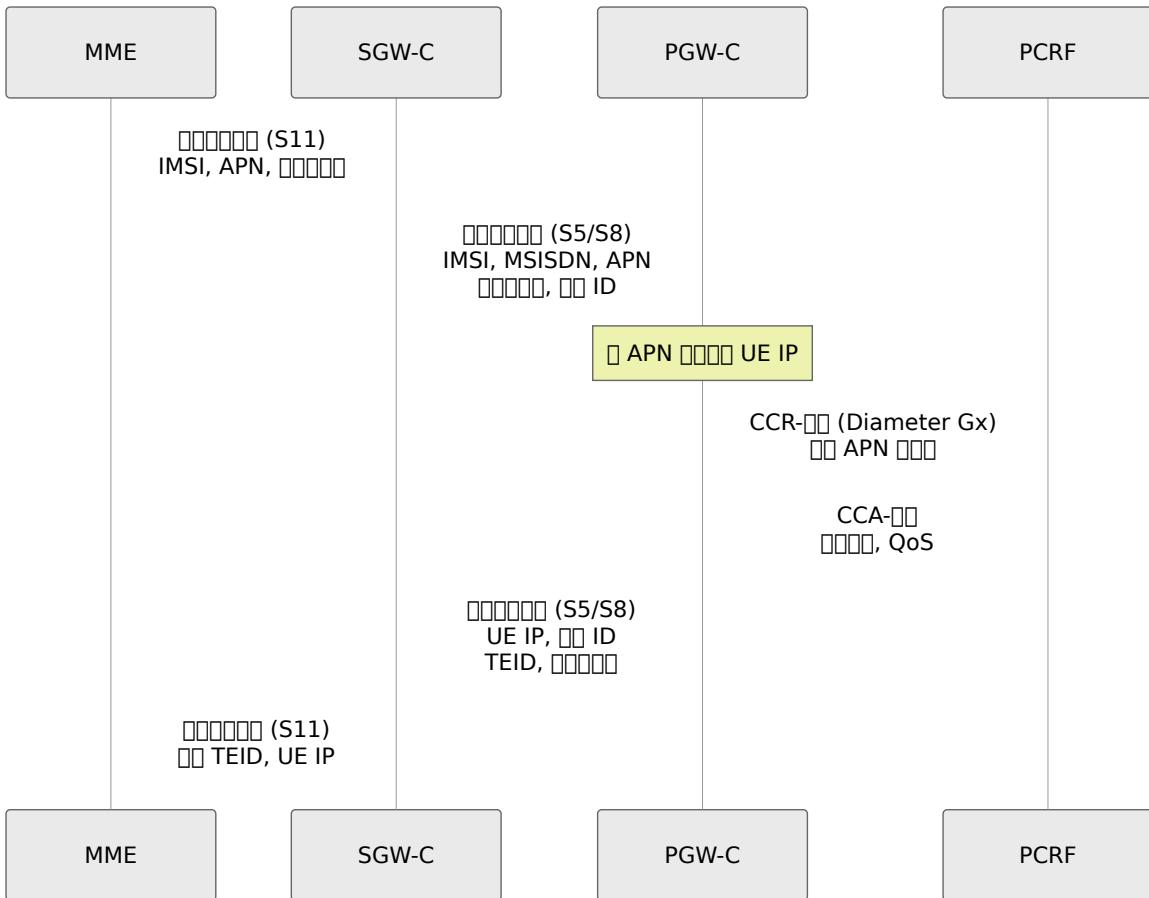
### 路由

```
允许 PGW-C 的路由
ip route add <pgw_network>/24 via <gateway_ip> dev eth0
```

## PDN 配置

### PDN 配置

MME 通过 S11 接口与 PDN 互通，SGW-C 通过 S5/S8 接口与 PGW-C 互通。



## 会員情報を SGW-C → PGW-C へ

会員情報を

| <b>IKE</b> |     |                  |
|------------|-----|------------------|
| IMSI       | MME | UEID             |
| MSISDN     | MME | UEID             |
| MEI        | MME | UEID             |
| PCI        | MME | QCI, ARP         |
| APN        | MME | PLMN ID, MCC/MNC |
| PLMN       | MME | PLMN ID, MCC/MNC |
| RAT        | MME | EUTRAN           |
| ULI        | MME | TAI, ECGI        |
| SGW ID     | SGW | SGW ID           |

## PGW-C → SGW-C

UEID

| IE ID  |     |            |
|--------|-----|------------|
|        | PGW | IP/TEID    |
|        | PGW | UE TEID    |
| PDN IP | PGW | UE IP      |
| APN ID | PGW | PGW APN ID |
| TEID   | PGW | S5/S8 IP   |

## IE ID

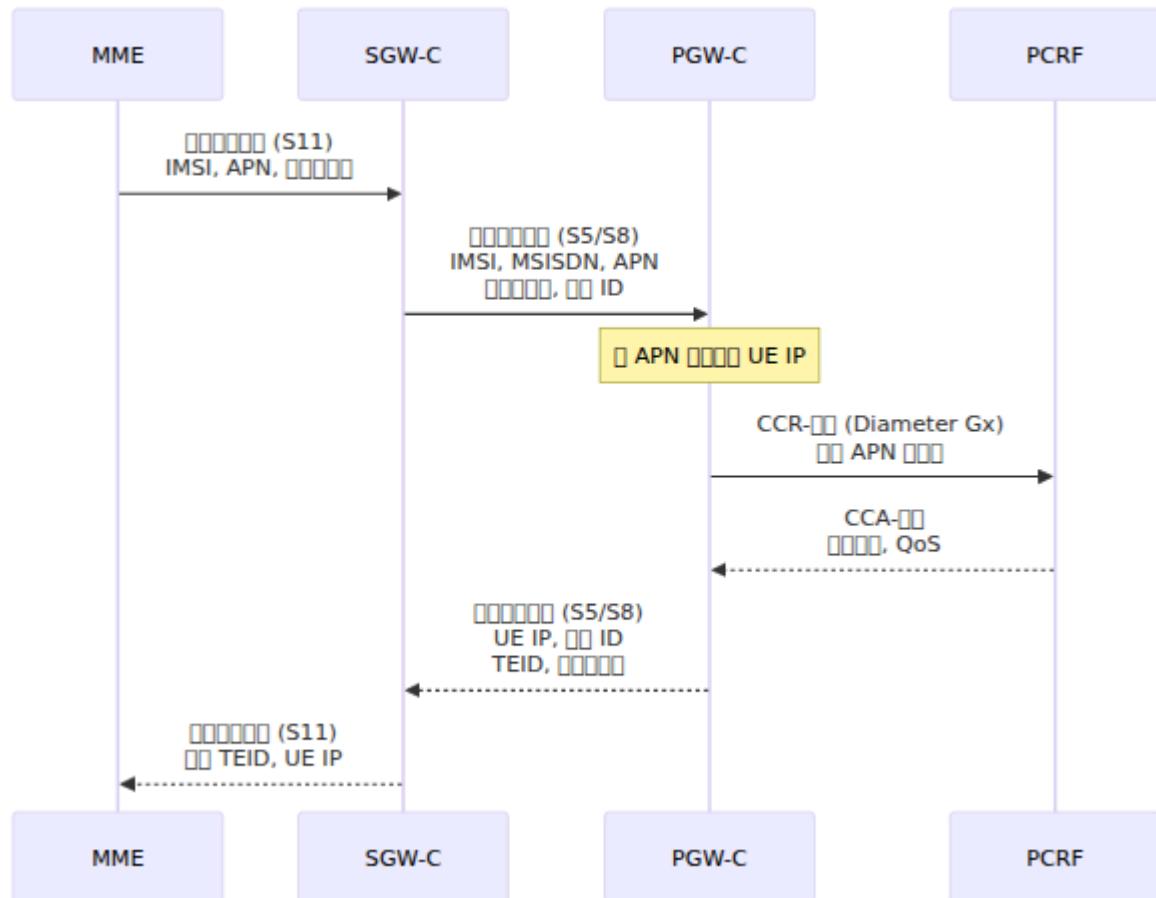
| IE ID |              |             |
|-------|--------------|-------------|
| 0     | UE IP        | UE IP       |
| 16    | UE TEID      | UE MME TEID |
| 25    | IE IP        | IP          |
| 49    | PGW-C IP     | PGW-C IP    |
| 64    | PGW IP       | IP          |
| 65    | PGW IP       | PGW IP      |
| 72    | IP/PGW IP IE | IP          |

---

# QoS

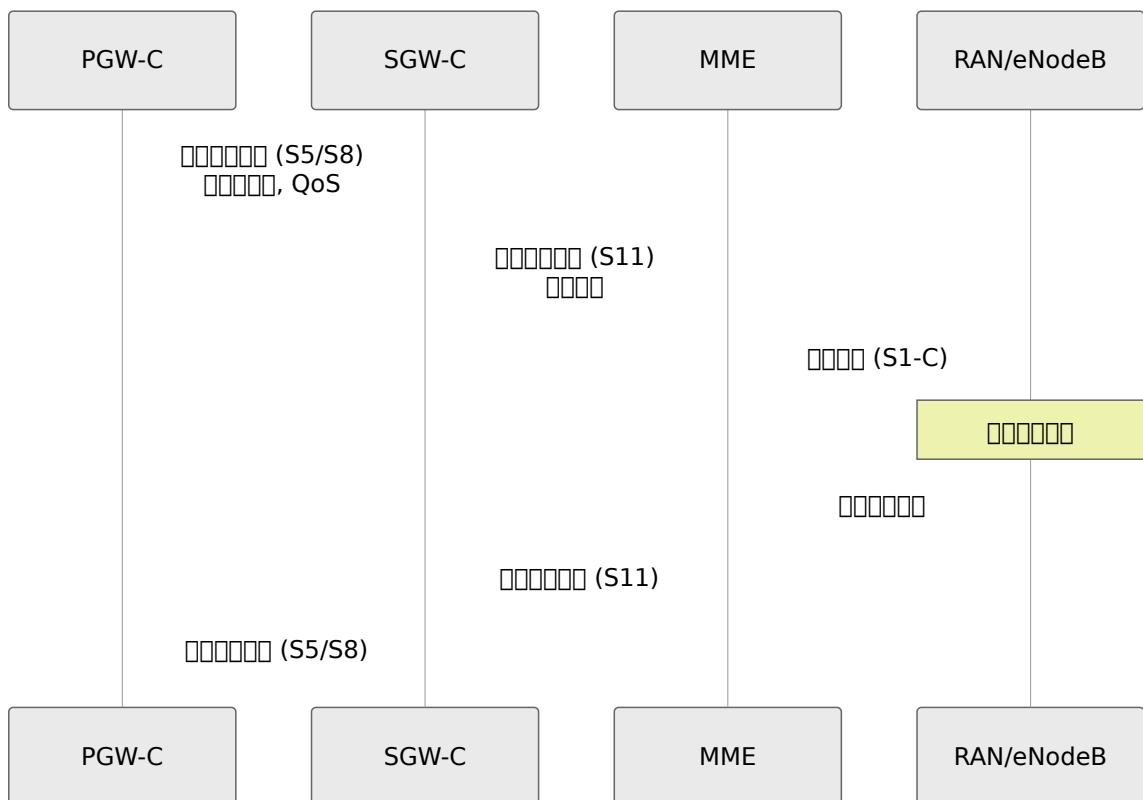
## QoS Flow

MME → S11 → QoS → SGW-C → S5/S8 → PGW-C



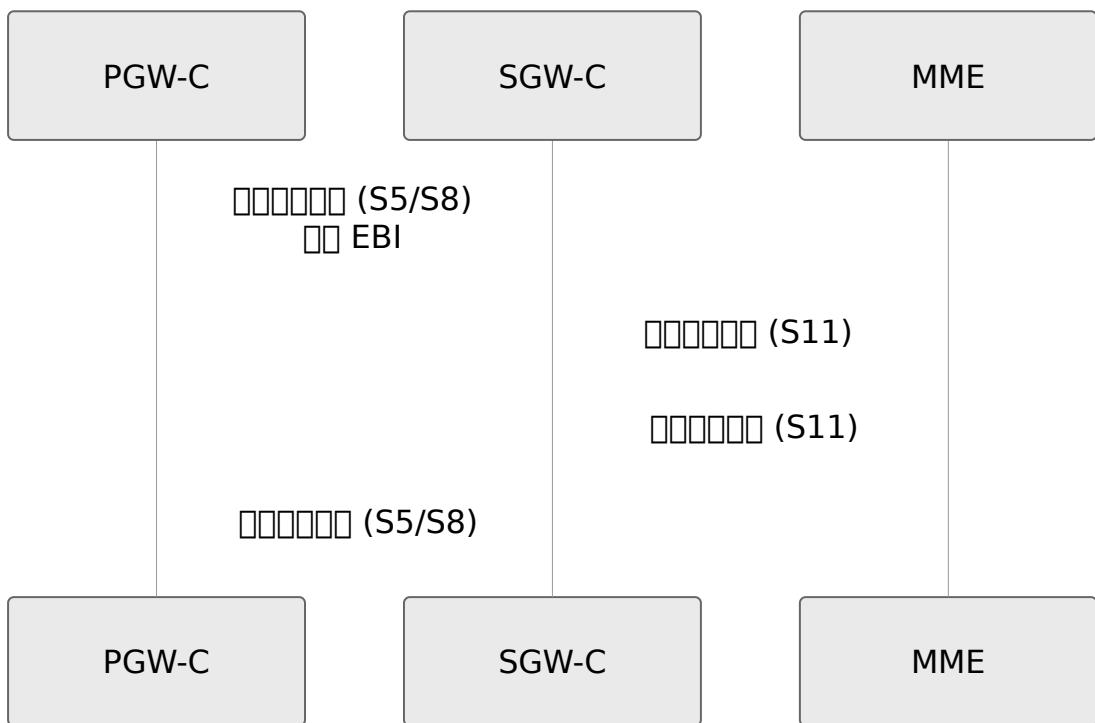
## QoS Flow Setup

PGW-C → S5/S8 → QoS Flow Setup



PGW-C  
SGW-C  
MME  
RAN/eNodeB

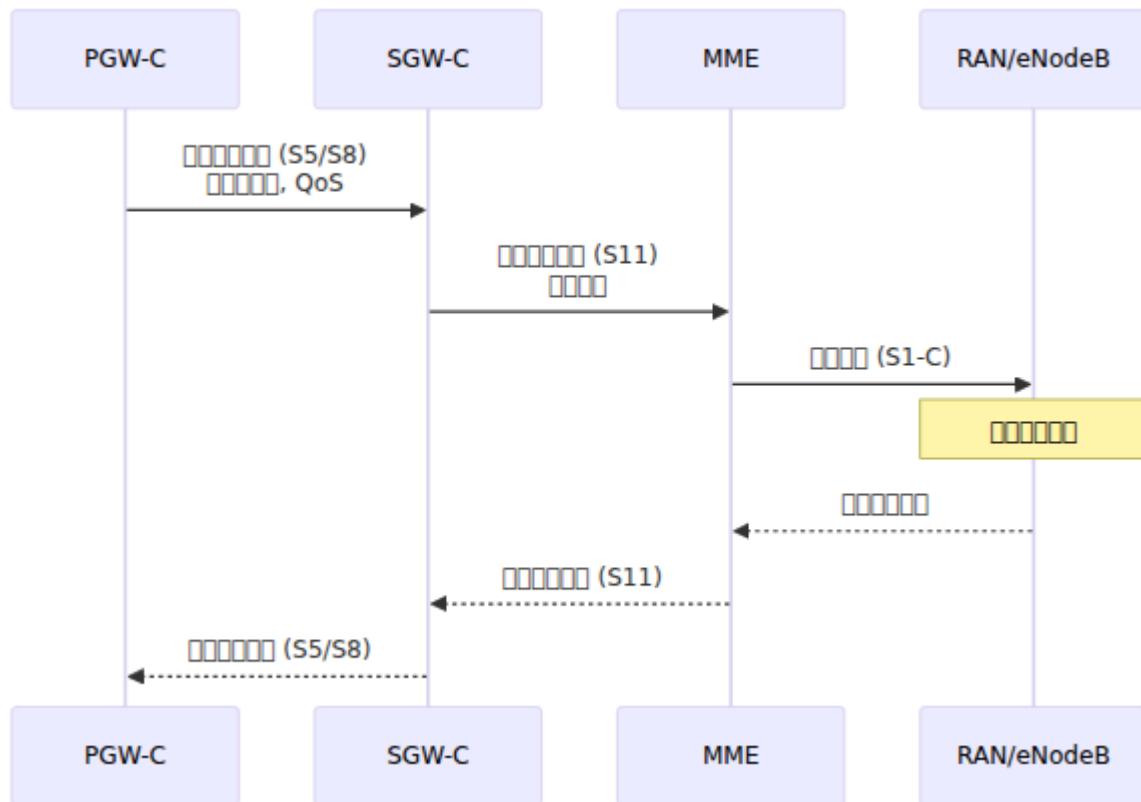
PGW-C  
SGW-C  
MME  
RAN/eNodeB




---

PDN

## PDN چیست



PDN چیست

[PDN چیست]

↓ (MME چیست)

[PGW چیست]

↓ (PGW چیست)

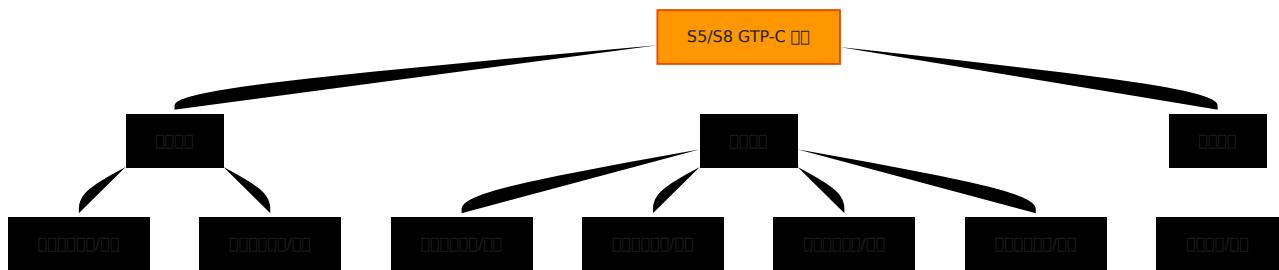
[SGW چیست]

↓ (TEID چیست CDR چیست)

[PDN چیست]



## S5/S8 接続



### PDN/接続

- ・ ユニット 構成するPDN ルート
- ・ 同じ UE が PDN ルート 1 つ
- ・ ルート 2つ

### PDN/接続

- ・ ユニット 構成するPDN ルート
- ・ 同じ UE が PDN ルート 1 つ
- ・ ルート 2つ

### QoS/接続

- ・ ユニット QoS ルート
- ・ ルート ルート数 0 ルート
- ・ ルート 2つ

### QoS/接続

- ・ ユニット QoS ルート
- ・ ルート ルート数 0 ルート
- ・ ルート 2つ

### QoS/接続

-        /      
  -                1   
  -           
- 

##       

###       

   PGW-C     

```
       S5/S8 TEID
curl -s http://127.0.0.40:42068/metrics | grep s5s8_teid

   S5/S8    
curl -s http://127.0.0.40:42068/metrics | grep
s5s8_inbound_messages_total

      /   /          
```

## PDN     

       PDN    

```
Web UI → UE     
└──              
 ├──              
 ├──              
 ├──              
 ├──              
 ├──              
 └── S5/S8 TEID   
```

##       

   S5/S8       

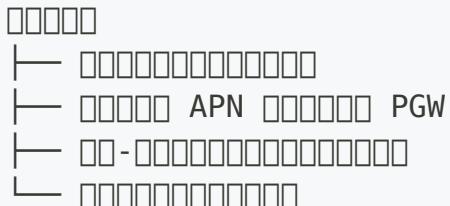
```
ȫȫȫȫȫȫȫȫ
curl -s http://127.0.0.40:42068/metrics | grep
create_session_request_total

ȫȫȫȫȫ
curl -s http://127.0.0.40:42068/metrics | grep modify_bearer

ȫȫȫȫ
curl -s http://127.0.0.40:42068/metrics | grep
s5s8_inbound_errors_total
```

**PGW** 

PGW-C



5 of 5

Four empty rectangular boxes arranged horizontally, intended for handwritten responses.

1

□□□ "□□□□□□ PGW □"

1

```
5GQoS
curl -s http://127.0.0.40:42068/metrics | grep
create_session_response_cause

PGW 状态
curl -s http://127.0.0.40:42068/metrics | grep s5s8_peer_status
```

## 5GQoS 流程

| 步骤        | 事件              | 涉及网元      |
|-----------|-----------------|-----------|
| <b>16</b> | UE向PGW发送会话建立请求  | PGW IP 地址 |
| <b>25</b> | PGW向MME发送会话建立请求 | MME       |
| <b>49</b> | PGW向APN发送会话建立请求 | APN       |
| <b>72</b> | UE向IE发送会话建立请求   | MME       |

## 5GQoS 流程

包含 "5GQoS 流程"

### 步骤

- UE向PGW发送会话建立请求
- PGW向QoS策略库查询QoS
- PGW向MME发送会话建立请求

### 5GQoS

- QoS策略库
- PGW根据QoS策略进行流量分类和速率限制
- PGW向PCRF/策略库查询策略

## HTTP API

用于 "S5/S8 会话"

命令

```
会话
curl -s http://127.0.0.40:42068/metrics | grep
s5s8_inbound_duration_seconds

会话
curl -s http://127.0.0.40:42068/metrics | grep s5s8_timeout_total
```

会话

- 会话 RTT 会话 message\_timeout\_ms
- 会话
- 会话 PGW CPU/会话
- 会话

## CDR ID 会话

用于 "CDR 会话 ID 会话"

命令

- 会话 PGW 会话会话会话 ID
- 会话 CDR 会话会话会话 ID
- 会话 SGW 会话 PGW CDR

会话

- 会话 PGW 会话会话会话 ID
- 会话 CDR 会话会话会话 ID

会话 Prometheus 会话会话会话 会话会话会话

## PGW

### SGW

- **PGW** ဆုတေသန PGW-C ဆုတေသနအတွက်
- မြတ်စွာ ဆုတေသနအတွက်
- မြတ် ၂၁ WAN RTT ဆုတေသနအတွက် 5-10 ။
- မြတ် 2-3 ဆုတေသနအတွက်

### PGW

- မြတ်စွာ ဆုတေသနအတွက်
- **APN** ဆုတေသန SGW APN ဆုတေသန PGW APN ။
- မြတ်စွာ ဆုတေသန S5/S8 ဆုတေသန
- မြတ်စွာ ဆုတေသန PGW ၏ IP ဆုတေသန

## SGW

- မြတ်စွာ ဆုတေသန PGW ဆုတေသန
  - မြတ်စွာ ဆုတေသန + မြတ်စွာ
  - **QoS** ဆုတေသန PGW ဆုတေသန QoS ။
  - မြတ် ဆုတေသနအတွက် ID
-

SGW-C

## S11 ↔ S5/S8 接続

S11 接続 MME

↓

SGW-C 接続

↓

S5/S8 接続 PGW-C

↓

PGW-C

↓

S11 接続 MME

## S5/S8 ↔ Sxa 接続

S5/S8 接続 PGW

↓

QoS/QoS 接続

↓

Sxa 接続 SGW-U

↓

SGW-U 接続

↓

SGW-U S11 接続



## UE ကြည်းလမ်း

*OmniSGW* နှင့် *Omnitouch* ကြည်းလမ်း

---



1. ၁၁
  2. ၂၃၄၅၆၇
  3. ၃၄၅၆
  4. ၂၃၄၅
  5. ၂၃၄၅၆
  6. ၂၃၄၅
  7. ၂၃၄၅
  8. ၂၃၄၅
  9. ၂၃၄၅
- 

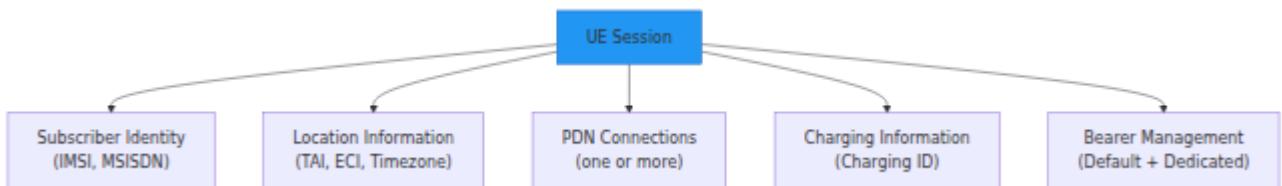


UE ကြည်းလမ်းအတွက် SGW-C ကြည်းလမ်း

- **MME** - ကြည်းလမ်း S11
- **PGW-C** - ကြည်းလမ်း S5/S8
- **SGW-U** - ကြည်းလမ်း Sxa

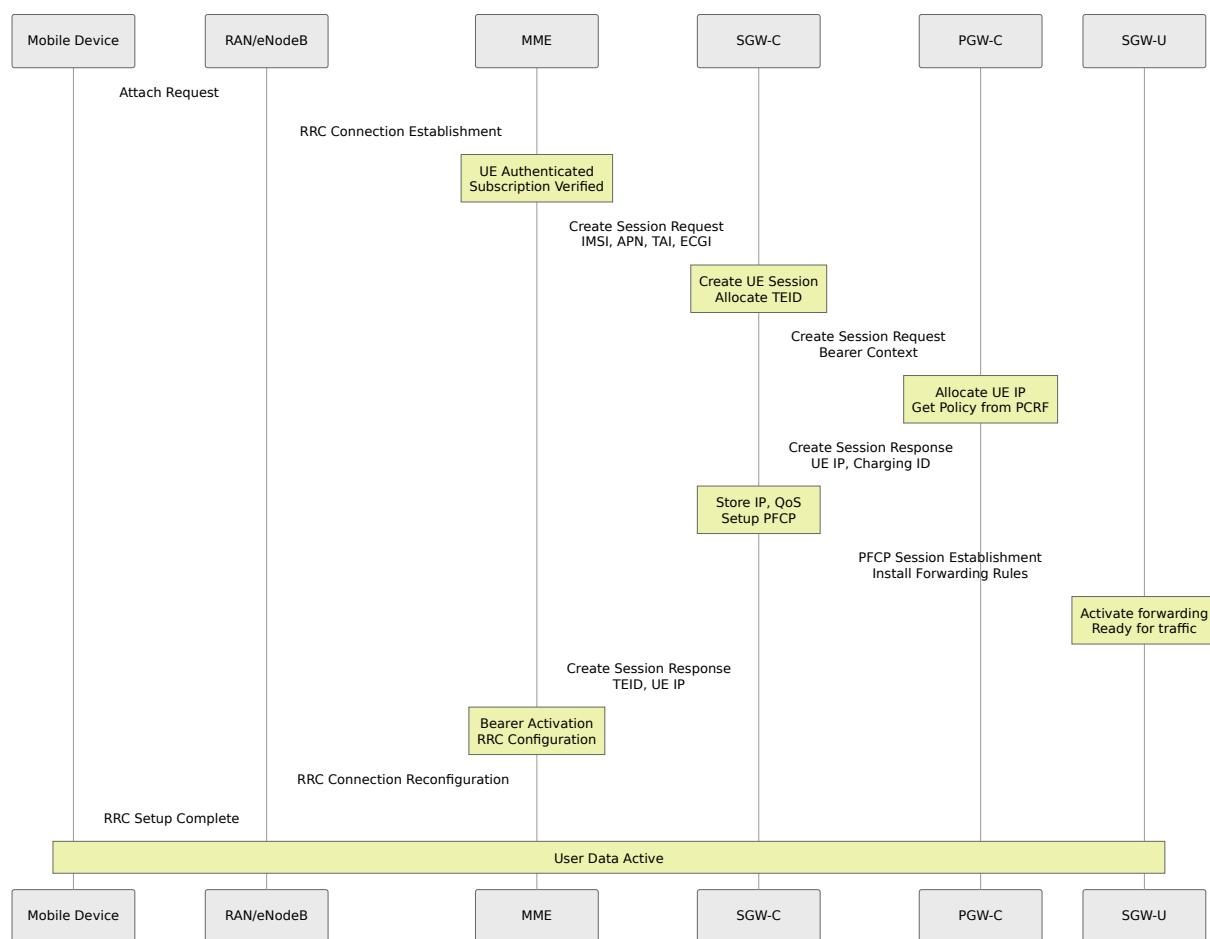
ကြည်းလမ်းအတွက် IMSI ကြည်းလမ်းအတွက် PDN ကြည်း

UE Session

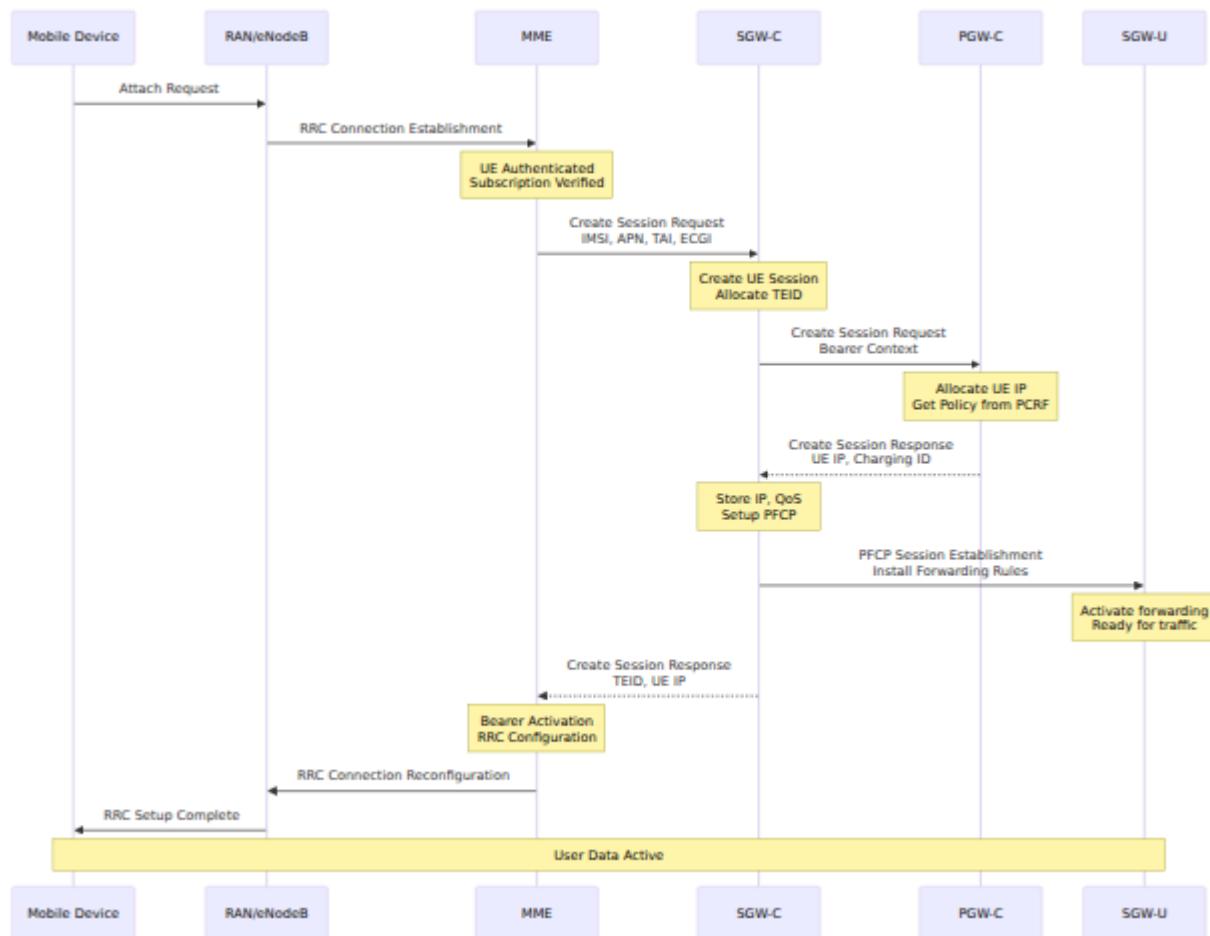


UE Session Flow

## UE Session Flow



# UE Attach Flow





## UE 信令流程

```
[No Session]
 ↓ (Create Session Request from MME)
[Creating Session - PGW]
 ↓ (Create Session Response from PGW)
[Creating Session - User Plane]
 ↓ (PFCP Session Establishment Response)
[Session Active]
 ↓ (Modify Bearer Request or bearer changes)
[Session Modifying]
 ↓ (Modification Complete)
[Session Active]
 ↓ (Delete Session Request or network error)
[Session Terminating]
 ↓ (All responses received, CDR logged)
[Session Terminated]
```

## UE Context

### Session State:

- IMSI: Mobile subscriber identity
- GUTI: Temporary ID from MME
- Location:
  - TAI: Current tracking area
  - ECI: Current cell
  - Timezone: UE timezone
- PDN Connections: Array of PDN connection contexts
  - APN: Access Point Name
  - TEID (S11): To MME
  - TEID (S5/S8): To PGW-C
  - Charging ID: From PGW-C
  - UE IP: From PGW-C
  - PGW-C Address: S5/S8 peer
  - Bearers: Default + Dedicated
    - EBI: Bearer ID
    - QCI: QoS class
    - ARP: Priority
    - GBR: Guaranteed rate
    - MBR: Maximum rate
  - Charging: Charging ID, event log

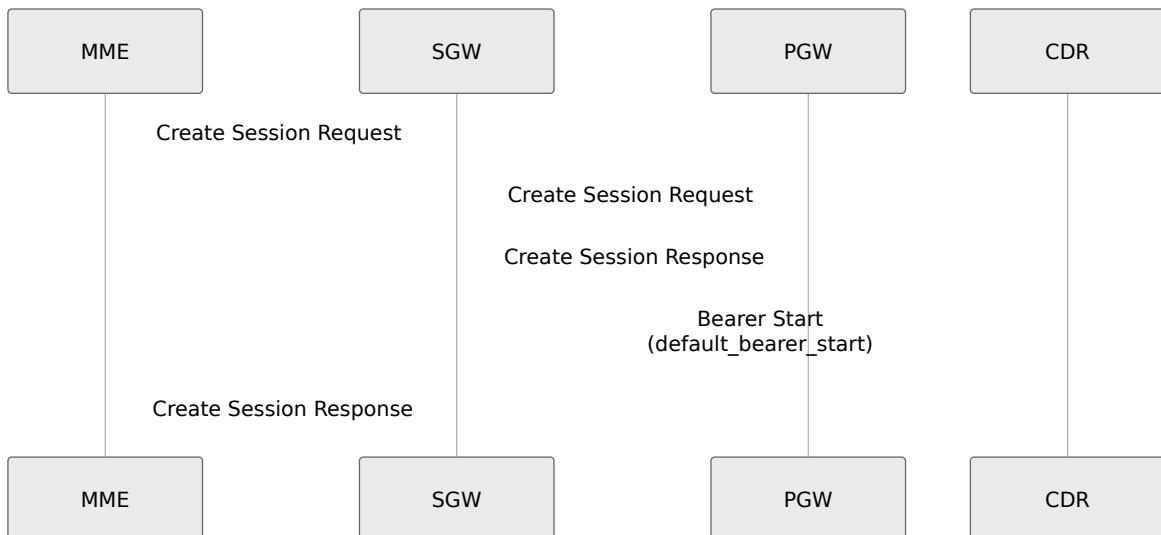
## PDN Context

### PDN Context

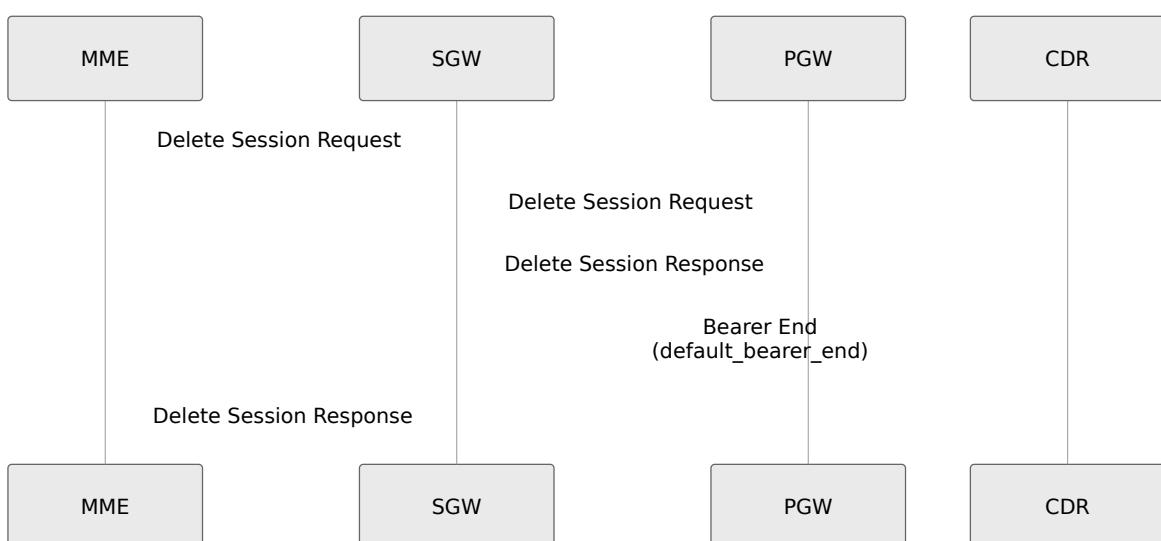
#### PDN Contexts

- **QoS:** QCI 9
- **APN:** A
- **IP:** 192.168.1.100
- **IP:** 192.168.1.101

#### PDN Context:



Session Creation:



Session Deletion:

Quality of Service (QoS)

- QCI: Quality of Service Class Identifier
- **QoS:** QCI 1-8服务质量
- 优先级: 优先级 PDN 服务
- 丢弃: 丢弃 PDN 服务质量

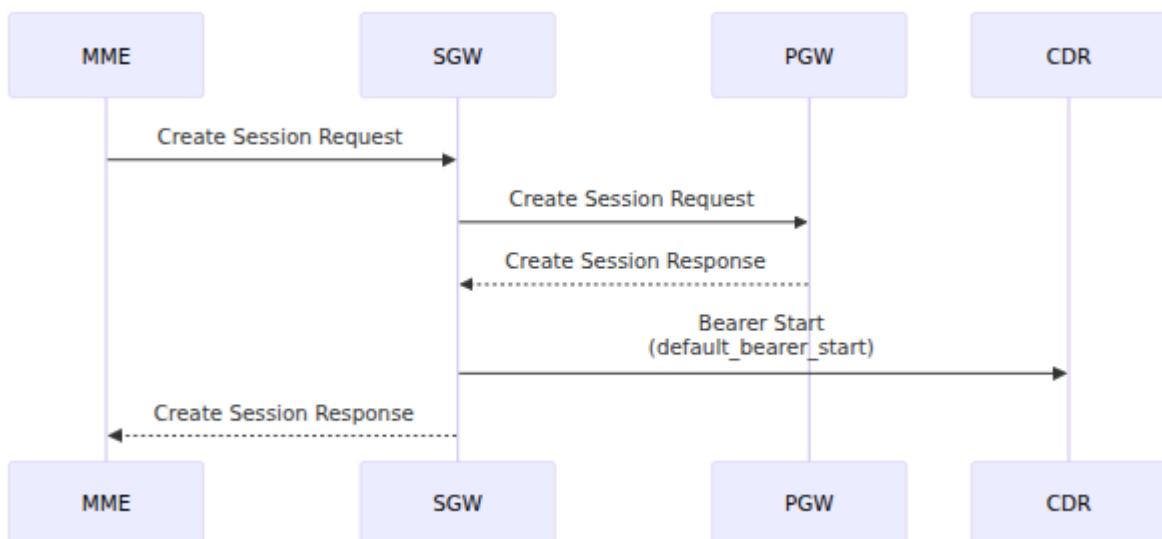
Session Management:

Application Trigger  
 ↓  
 PGW-C Policy Decision (via PCRF)  
 ↓  
 Create Bearer Request (S5/S8)  
 ↓  
 SGW forwards to MME (S11)  
 ↓  
 MME activates bearer on RAN  
 ↓  
 Create Bearer Response back through SGW to PGW

刪除：

Network or Application Decision  
 ↓  
 Delete Bearer Request (S5/S8)  
 ↓  
 SGW forwards to MME (S11)  
 ↓  
 MME deactivates bearer on RAN  
 ↓  
 Delete Bearer Response back through SGW to PGW

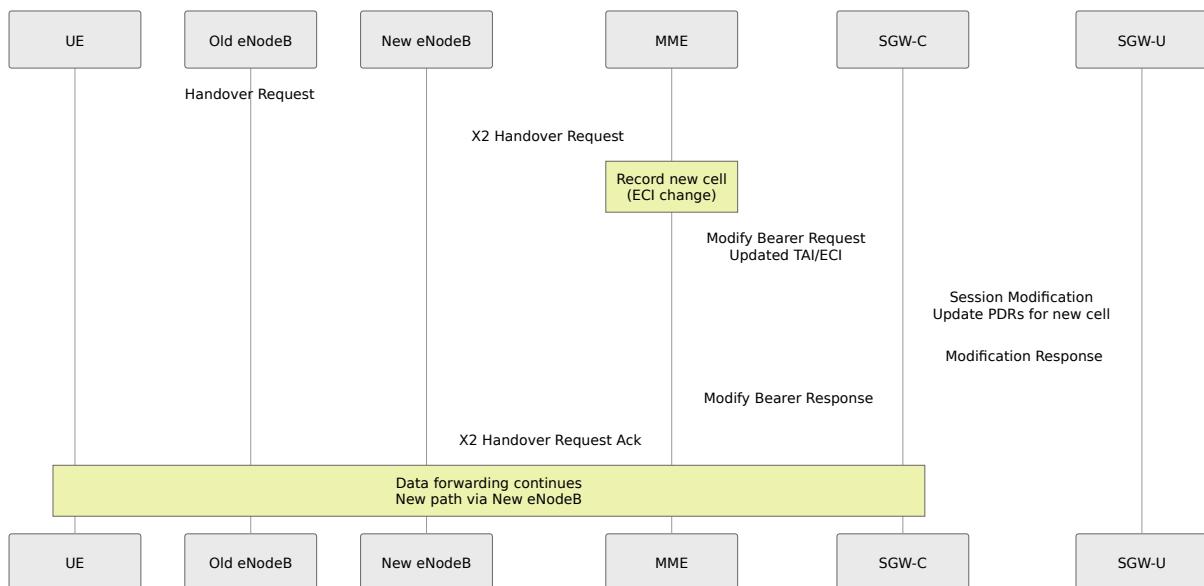
## QoS





## UE MME SGW SGW

UE MME SGW SGW

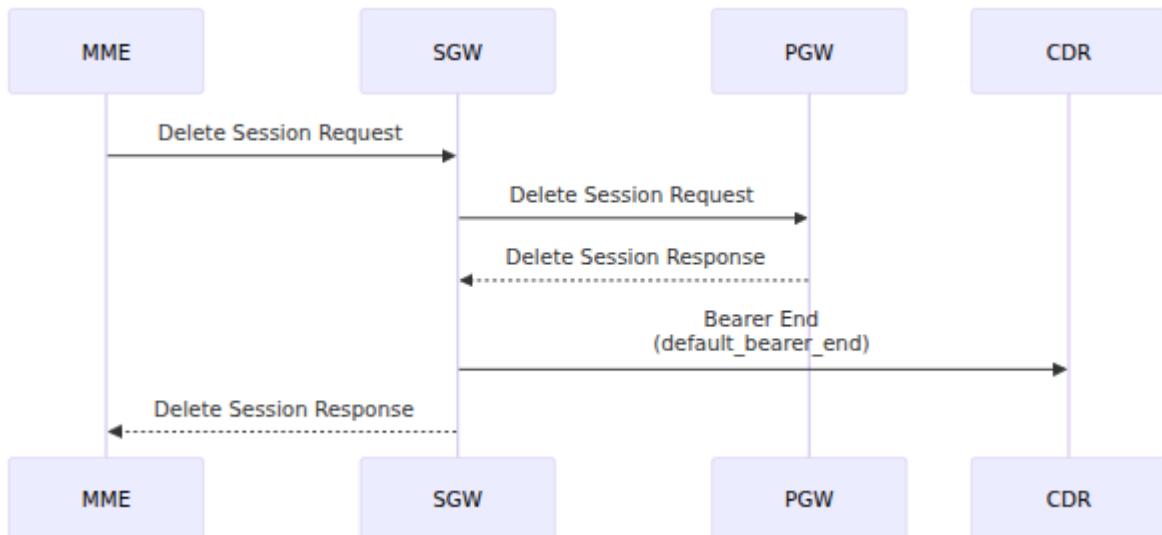


UE MME SGW SGW

- TEID
- TAI
- ECI
- CDR Charging ID

## UE MME SGW SGW

UE MME SGW SGW



លទ្ធផល

- ត្រូវបាន CDR នៅ “លើ” នៅ
- ត្រូវបាន ផ្តល់លទ្ធផល Charging ID
- ត្រូវបាន សម្រាប់
- ត្រូវបាន ផ្តល់លទ្ធផល SGW-U នៅលើ

## លទ្ធផល TAU

### SGW នៃ TAU:

```

UE នៅលើ
↓
MME នឹង TAU នូវ
↓
MME នឹង SGW នៅលើ
↓
SGW នឹង TAI នូវ ECI នូវ
↓
នៅលើ

```

### SGW នៃ TAU:

- ត្រូវបាន MME នូវ
- ត្រូវបាន ផ្តល់លទ្ធផល SGW
- CDR នឹង SGW នឹង SGW នៅលើ

---

██████

██████

██████████

1. █ **SGW-U** █ - ██████████
2. **PDR** █ - ██████████████
3. ████ - ████████████████████
4. ████ - S11/S5/S8 ████

██████████

██████████

- █ **SGW-U** ████ - ██████████
- █ **SGW-U** ████ - ████
- **GTP** █ - ██████████████████
- ████ - ████

██████

██████████

1. ████ - ██████████████
  2. ████ - ██████████████
  3. ████ - ██████████████
  4. ████ - ██████ TEID
-

## UE Session

### UE Session

通过 Web UI 管理 UE Session

1. 访问 `http://<sgw-ip>:<port>/ue_sessions`
2. 选择要管理的 UE
3. 在 IMSI/GUTI 列表中选择
4. 显示以下参数
  - 地理 (TAI, ECI)
  - QoS
  - PGW-C
  - TEID
  - Charging ID

UE Session Management

显示 TEID、QoS 和 PDN 信息

5G NR 5G NR Web UI 5G NR Metrics

## Metrics

### NR Metrics

```
NR Metrics
curl -s http://10.0.0.40:42068/metrics | grep active_ue_sessions

NR Metrics
curl -s http://10.0.0.40:42068/metrics | grep active_bearers

APN Metrics
curl -s http://10.0.0.40:42068/metrics | grep sessions_by_apn

NR Metrics
curl -s http://10.0.0.40:42068/metrics | grep
s11_inbound_messages_total
```

NR Metrics Prometheus NR Metrics Metrics

## NR Metrics

### NR Metrics

1. NR API NR Metrics
2. NR Metrics Metrics

3. ፩፻፻፻፻ ፩፻፻
4. ፩፻ **CDR** ፩፻፻፻፻

## ፩፻፻፻

### ፩፻፻፻፻

```
፩፻፻፻፻፻
curl -s http://10.0.0.40:42068/metrics | \
 grep -E "active_ue_sessions|active_bearers" | \
 awk '{print $NF}'
```

# ፩፻፻፻፻ 80% ፩፻፻፻

# ፩፻፻፻፻፻፻፻

## ፩፻፻፻

### ፩፻፻፻፻፻

፩፻፻ ፩፻፻፻፻፻፻

፩፻፻

1. ፩፻፻፻፻፻፻፻
2. ፩፻ S11 ፩፻፻
3. ፩፻ PGW ፩፻
4. ፩፻ Charging ID ፩፻

### ፩፻፻፻

|        |                 |
|--------|-----------------|
| PGW IP | S5/S8 Interface |
| APN IP | PGW IP          |
| SGW-U  | PGW IP          |
|        | PGW IP          |

A horizontal row of six empty rectangular boxes, likely intended for a child to draw or write in.

A horizontal row of fifteen empty square boxes, intended for children to write their names in, likely as part of a classroom activity.

三

1. ██████████
  2. █ SGW-U █
  3. █ PGW █
  4. ██████████

10 of 10

|       |       |
|-------|-------|
| SGW-U | SGW-U |
| PGW   | PGW   |
| RR    | RR    |

## 3GPP

3GPP 3GPP2 3GPP3GPP4GPP5GPP

3GPP

1. 3GPP2 3GPP3GPP4GPP5GPP
2. 3GPP PFCP 3GPP
3. 3GPP2 3GPP3GPP4GPP5GPP
4. 3GPP2 3GPP3GPP4GPP5GPP

3GPP2 3GPP3GPP4GPP5GPP

| 3GPP                   | 3GPP2                          |
|------------------------|--------------------------------|
| 3GPP2                  | 3GPP PFCP 3GPP3GPP4GPP5GPP BAR |
| PDR 3GPP               | 3GPP2 3GPP PFCP 3GPP           |
| 3GPP2 3GPP3GPP4GPP5GPP | 3GPP2 SGW-U 3GPP               |
| 3GPP2 3GPP3GPP4GPP5GPP | 3GPP2 3GPP3GPP4GPP5GPP         |

3GPP2 3GPP3GPP4GPP5GPP

3GPP S11/S5S8 3GPP2 3GPP3GPP4GPP5GPP

3GPP

```
ȫȫȫȫȫȫ
curl -s http://10.0.0.40:42068/metrics | \
 grep "inbound_duration_seconds"

ȫȫȫȫȫȫ
curl -s http://10.0.0.40:42068/metrics | \
 grep queue_depth

ȫȫȫȫȫȫ
top -n1 | head -1
```

5 of 5

1. 5G UE RTT 100ms-1000ms
  2. 5G SGW-C 100ms-1000ms
  3. 5G RRC Setup 10ms-100ms
  4. 5G RRC Release 10ms-100ms

**CDR** 

CDR

三



5

```
፩ CDR ፩
tail -f /var/log/sgw_c/cdrs/*

የ፩፩፩
ls -la /var/log/sgw_c/cdrs/

የ፩፩፩
chmod 755 /var/log/sgw_c/cdrs/
```

፩፩፩ CDR የ፩፩፩ የ፩፩፩፩ CDR የ፩፩፩፩፩፩፩፩

---

## ፩፩፩፩

### ፩፩፩፩

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- የ፩፩፩፩ በ 70-80% የ፩፩፩፩
- የ፩፩፩፩ የ፩፩፩፩፩
- የ፩፩፩፩ የ፩፩፩፩፩

### ፩፩፩፩

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- የ፩፩፩፩ በ SGW-U የ፩፩
- የ፩፩፩፩፩ የ፩፩፩፩፩

### ፩፩፩፩

- የ፩ Charging ID የ፩ PGW የ፩
- **CDR** የ፩ የ፩ SGW የ፩ PGW የ፩ CDR
- የ፩፩፩፩ የ፩፩፩፩፩ CDR የ፩
- የ፩፩፩፩፩ CDR

# Sxa ████

## PFCP █ SGW-U █

OmniSGW █ Omnitouch ████

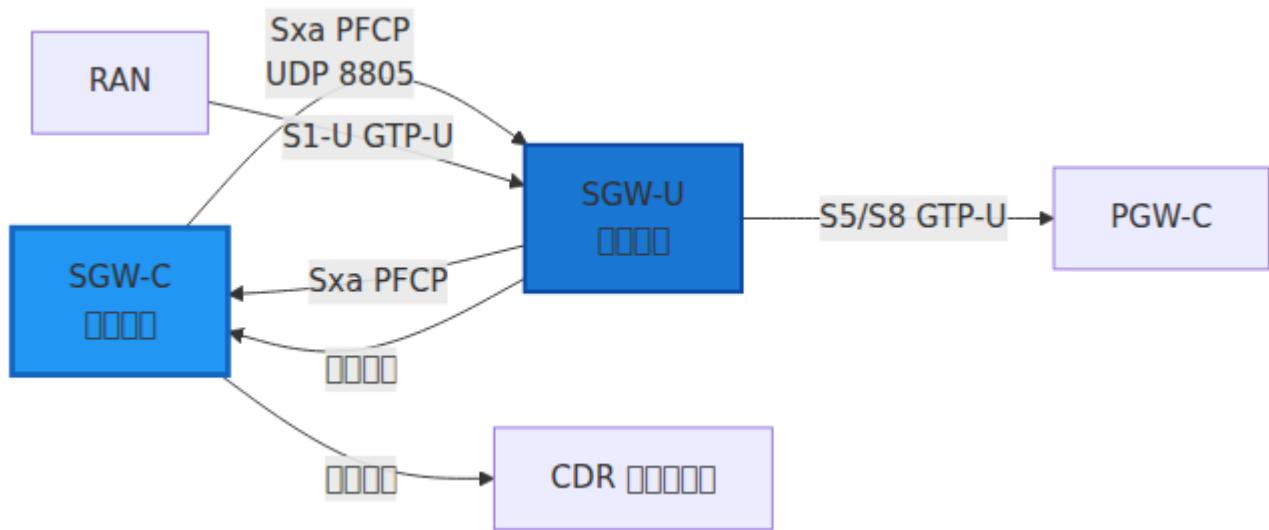
---



1. █
  2. ████
  3. █
  4. PFCP █
  5. ████
  6. PFCP █
  7. ████
  8. ████
  9. ████
- 



**Sxa** █ █ **PFCP** █ OmniSGW █ SGW-U █ QoS █



## PFPCP

- **PFCP v1.0** - 3GPP TS 29.244
- **SEID** - 3GPP TS 29.244
- **QoS** - 3GPP TS 29.244

## PFCP v1.0

- PFCP v1.0 (3GPP TS 29.244)
- UDP
- 8805 port
- Sxa interface
- CP & UP interface

# SEID

██████████ SEID █████

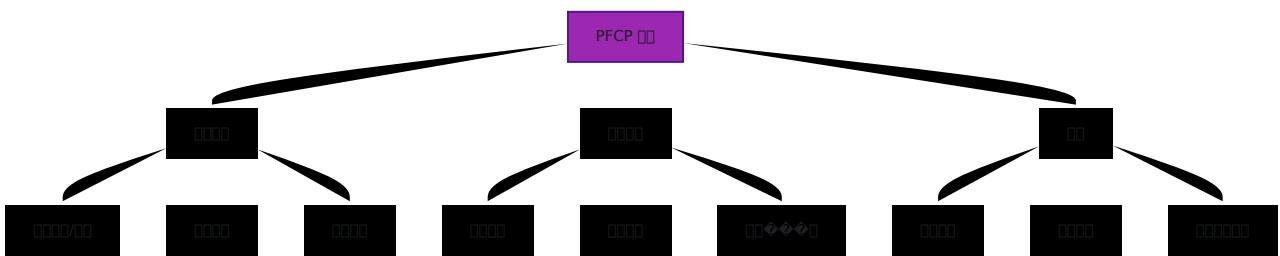
- **CP SEID** - □ SGW-C □□□□□□□ SGW-U □□□□
  - **UP SEID** - □ SGW-U □□□□□□□ SGW-C □□□□

5

SGW-C → SGW-U: 00 SGW-U 0 UP SEID

SGW-U → SGW-C:    SGW-C    CP    SEID

ANSWER





## 配置文件

```
config/runtime.exs
config :sgw_c,
 sxa: %{
 # Sxa 相关的 IP 地址
 local_ip_address: "10.0.0.20",

 # 相关端口号
 local_port: 8805,

 # SGW-U 相关
 peers: [
 %{
 ip_address: "10.0.0.30",
 node_id: "sgw-u-1.example.com"
 },
 %{
 ip_address: "10.0.0.31",
 node_id: "sgw-u-2.example.com"
 }
],

 # 相关心跳间隔
 heartbeat_interval_s: 20,

 # 相关会话超时
 session_timeout_ms: 5000,

 # 相关重试次数
 max_retries: 3
 }
```

## 启动命令

./bin/sgw\_c

```
ְּ SGW-U ְּ PFCP
iptables -A INPUT -p udp --dport 8805 -s <sgwu_network>/24 -j
ACCEPT

ְּ SGW-U ְּ PFCP
iptables -A OUTPUT -p udp --dport 8805 -d <sgwu_network>/24 -j
ACCEPT
```

ְּ

```
ְּ SGW-U ְּ
ip route add <sgwu_network>/24 via <gateway_ip> dev eth0
```

ְּ

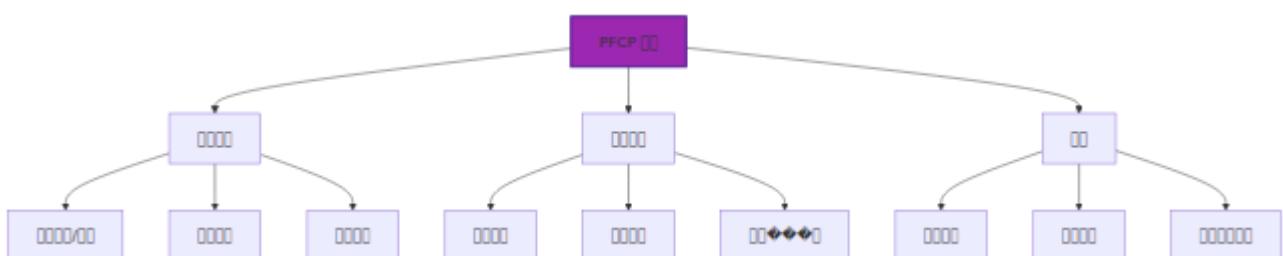
```
ְּ PFCP ְּ
ְּ "ְּ" ְּ

ְּ PFCP ְּ
curl http://127.0.0.40:42068/metrics | grep seid_registry_count
```

## PFCP ְּ

ְּ

ְּ SGW-C ְּ SGW-U ְּ PFCP ְּ



## PFCP消息

```
[会话]
 ↓ (会话建立)
[会话]
 ↓ (会话建立 OK)
[会话]
 ↓ (会话建立)
[会话建立]
 ↓ (会话建立)
[会话建立]
 ↓ (会话建立 OK)
[会话建立]
```

## PFCP消息

### 1. 会话建立

- 会话建立请求?
- 会话建立响应
- 会话建立

### 2. 会话修改

- 会话修改请求
- SGW-U 会话修改
- 会话修改响应

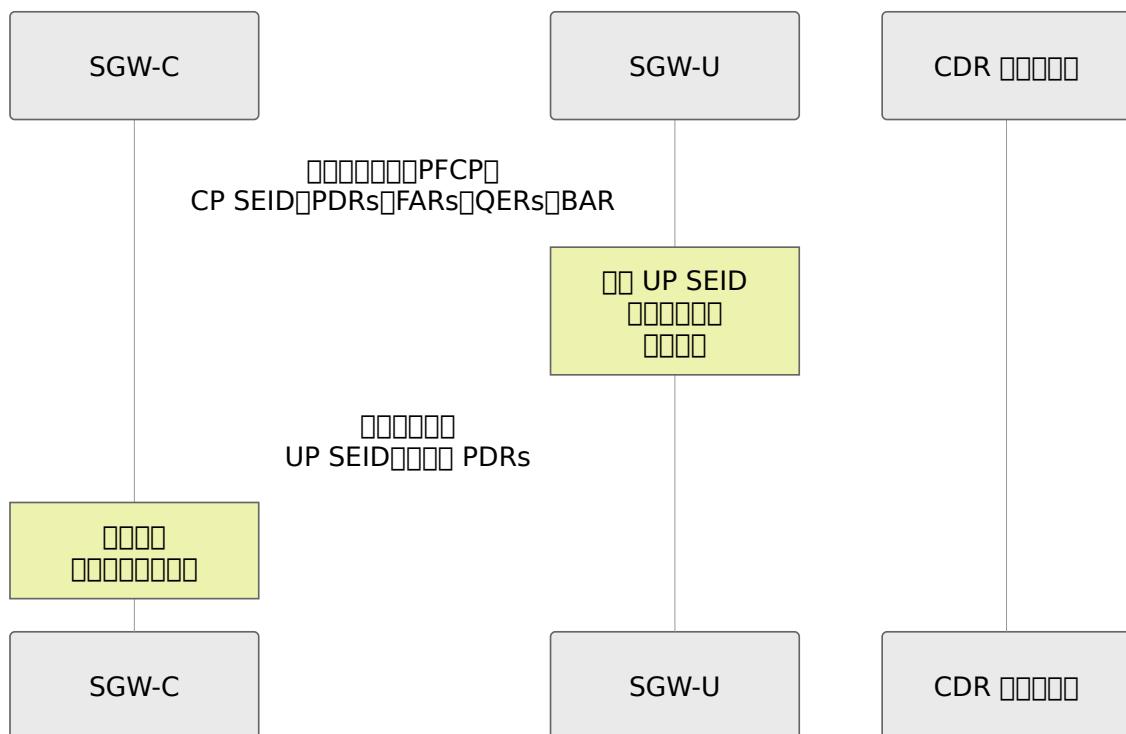
### 3. 会话释放

- SGW-U 会话释放
- PDR 会话释放
- 会话释放响应

SGW-C

SGW-U

SGW-C MME ဆိုတောင်းမှု S11 ဆိုတောင်း



SGW-C ဆိုတောင်း

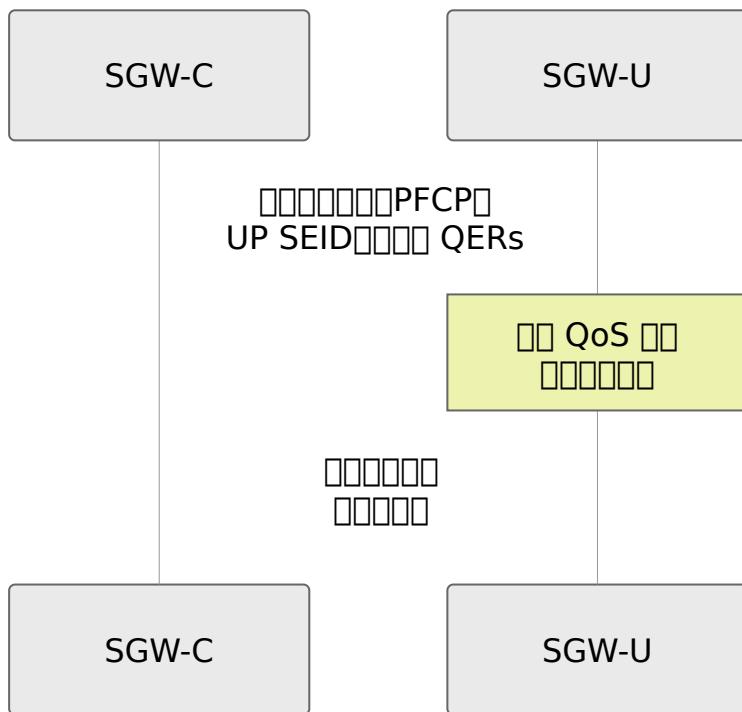
| ဗိ      | ဗိ                    |
|---------|-----------------------|
| CP SEID | SGW-C ဆိုတောင်း       |
| PDRs    | ဗိုးရေးပြန်လည်ခွဲချွဲ |
| FARs    | ဗိုးရေး               |
| QERs    | QoS ဗိုး              |
| BAR     | ဗိုးရေးပြန်လည်ခွဲချွဲ |
| ဗိ PDR  | ဗိုးရေးပြန်လည်ခွဲချွဲ |

ဗိုလ်ချုပ်

[ မြတ် ]  
↓ ( အောက် )  
[ မြတ် ]  
↓ ( အောက် )  
[ မြတ် ]

ဗိုလ်ချုပ်

မြတ် ။ MME မြတ်ဆောင်ရန် QoS မြတ်ဆောင်

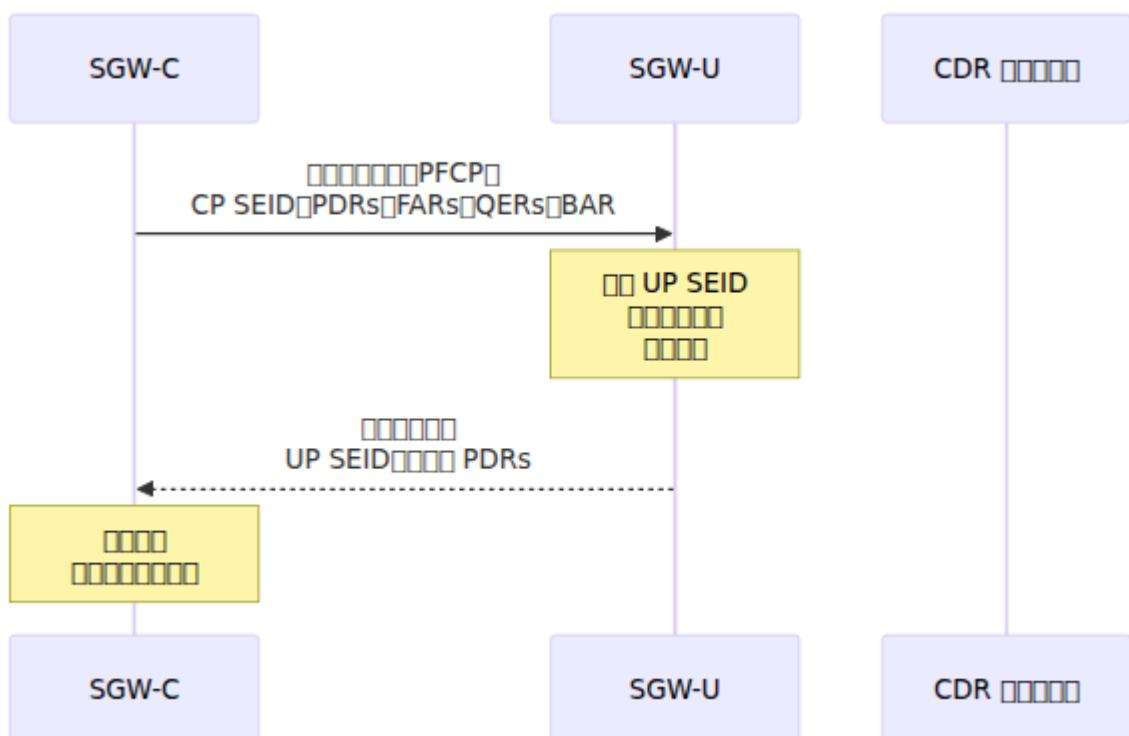


ဗိုလ်ချုပ်

|               |                |                    |
|---------------|----------------|--------------------|
| □□            | □□□□□          | □□                 |
| <b>QoS □□</b> | QERs           | □□□□/□□            |
| □□            | PDRs□FARs      | eNodeB □□□SGW-U □□ |
| □□□□          | □ PDR□FAR□QER  | □□□□□              |
| □□□□          | □□ PDR□FAR□QER | □□□□               |

## □□□□

□□□ □□ MME □□□□□□□□□□



## □□□□

```
[□□□□]
 ↓ (□□□□)
[□□□]
 ↓ (□□□□)
[□□□□]
```

# PFCP چی

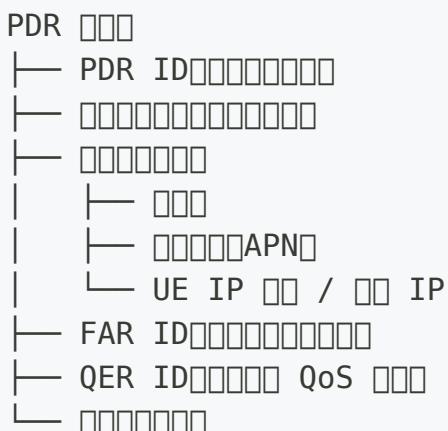
## PDR چی

پروتکل پایه آنچه ؟ ؟

پارامترها

| چی    | چی                   | چی                     |
|-------|----------------------|------------------------|
| پی‌سی | پی‌سی‌پی‌پی‌سی       | S1-U پی‌سی‌پی‌پی‌س۵/۸۰ |
| IP چی | UE IP پی‌سی‌پی‌پی‌سی | 10.45.0.50             |
| IP چی | پی‌سی‌پی‌پی‌سی IP    | 8.8.8.8                |
| پی‌سی | IP پی‌سی             | TCP۶۰۰۰UDP۱۷۰          |
| پی‌سی | پی‌سی                | 1024-65535             |
| پی‌سی | پی‌سی                | 80 HTTP ۴۴۳ HTTPS      |
| TEID  | GTP-U پی‌سی‌پی‌پی‌سی | پی‌سی‌پی‌پی‌سی         |

## PDR چی



## UE - IP

- UE IP 地址
- PDN GSN/PGW-U 地址
- QoS 属性

## UE - GBR

- GBR QoS 属性
- GBR 速率
- QoS 属性 GBR

## FAR

UE IP 地址 ◆◆◆◆◆

UE GBR

| UE | IP 地址         | 速率          |
|----|---------------|-------------|
| UE | 192.168.1.100 | 1Mbps       |
| UE | 192.168.1.101 | 1Mbps/1Mbps |
| UE | 192.168.1.102 | 1Mbps/1Mbps |
| UE | 192.168.1.103 | 1Mbps       |

UE GBR

- GTP-U** - GTP-U 接口 S1-U/S5/S8
- IP - IP 地址
- IPv4** - IPv4 地址
- IPv6** - IPv6 地址

IP - UE 地址

PDR 000000 = 000UE IP = 10.45.0.50

FAR 000

- $\square\square = \square$
  - $\square\square\square\square\square = \square\square\square\square\square\square\square\square$
  - $\square\square\square\square = \square\square\square\square$

# QER|QoS

## QoS

|     |     |     |     |
|-----|-----|-----|-----|
| QCI | MBR | GBR | ARP |
| 00  | 00  | 00  | 00  |
| 00  | 00  | 00  | 00  |
| 00  | 00  | 00  | 00  |

## **QoS ━━ QCI ━━**

| <b>QCI</b> | <b>QoS Class</b> | <b>QoS Parameters</b>       |
|------------|------------------|-----------------------------|
| <b>1</b>   | GBR              | MBR: 64 kbps                |
| <b>2</b>   | GBR              | MBR: 256 kbps               |
| <b>3</b>   | GBR              | MBR: 50 kbps                |
| <b>4</b>   | GBR              | GBR: 128 kbps MBR: 256 kbps |
| <b>5</b>   | IMS VOIP         | GBR: 100 kbps MBR: 256 kbps |
| <b>6</b>   | MBB              | MBR: 10 Mbps                |
| <b>7</b>   | MBB              | GBR: 64 kbps MBR: 384 kbps  |
| <b>8</b>   | MBB              | MBR: 5 Mbps                 |
| <b>9</b>   | MBB              | MBR: 3 Mbps                 |

### VoIP - QoS Class QCI 9 VOIP

QCI: 9  
 MBR: 100 Mbps  
 GBR: 100 GBR  
 ARP: 15ms

### MBB - QoS Class QCI 1 MBB

QCI: 1  
 MBR: 128 kbps + 100  
 GBR: 64 kbps  
 ARP: 10ms

# BAR

A horizontal row of twelve empty square boxes, intended for children to draw or color in.

5 of 5

1.

- UE ↔ eNodeB 連絡
  - データ転送
  - リソース割り当て

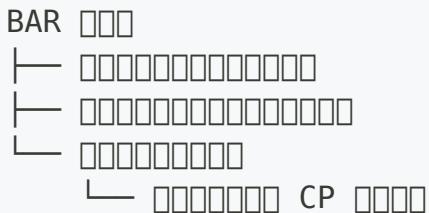
2.

- UE 111111111111
  - 11111111
  - 11111 UE 11111

### 3. SGW □□□

- SGW MME
  - SGW SGW
  -

BAR □□□



SGW-U  
SGW-C

CDR

SGW-U SGW-C CDR

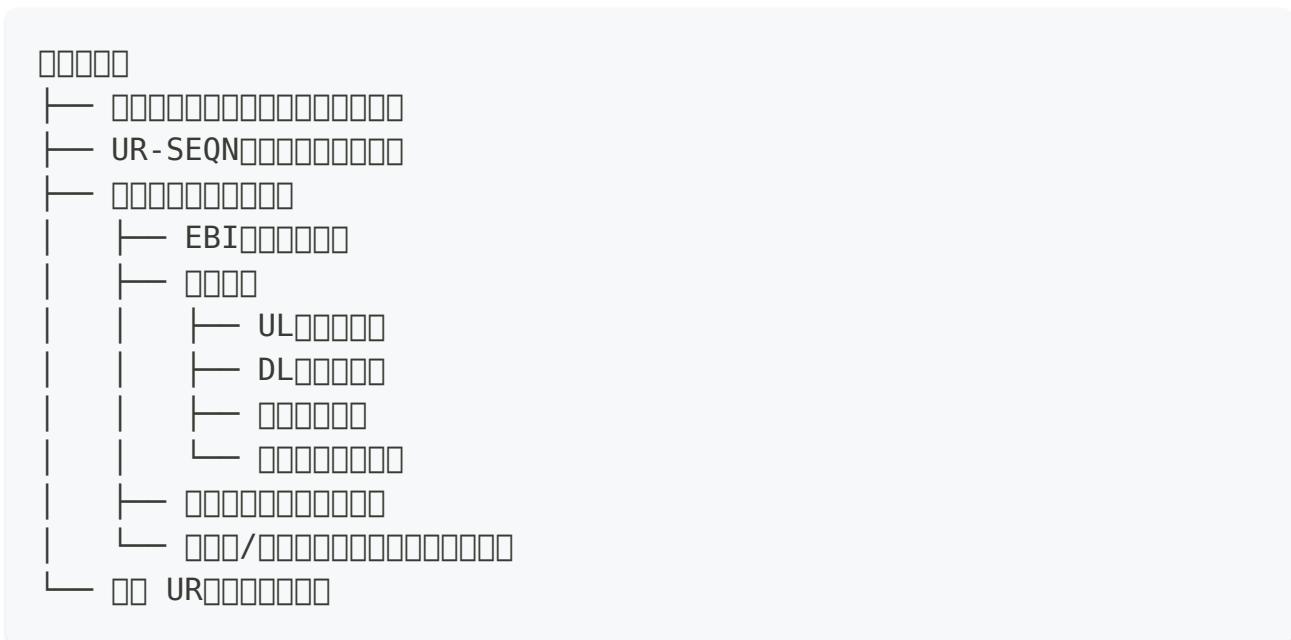


SGW-U SGW-C

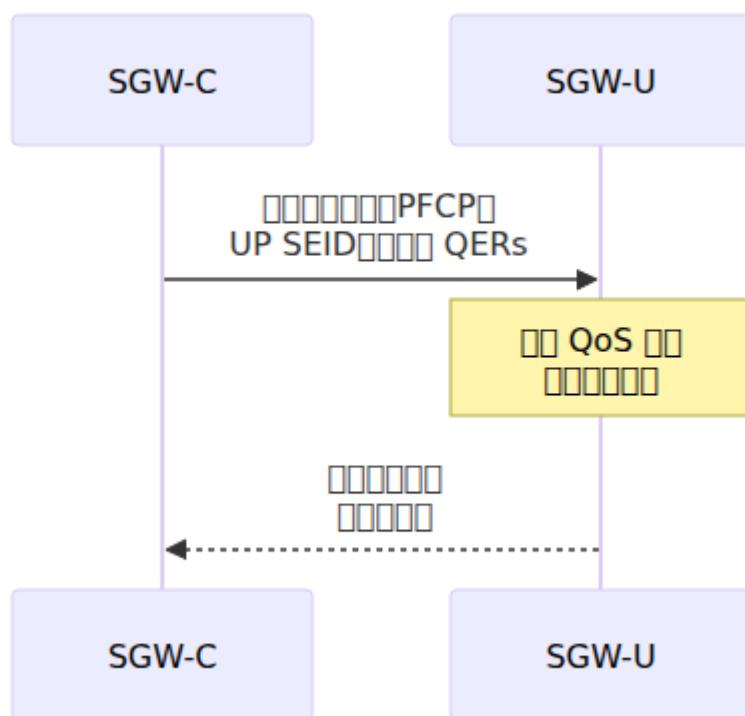
CDR

| SGW-U         | SGW-C         |
|---------------|---------------|
| SGW-U         | SGW-C N SGW-C |
| SGW-C         | SGW-C N SGW-C |
| SGW-C N SGW-C | SGW-C N SGW-C |
| SGW-C N SGW-C | SGW-C N SGW-C |
| SGW-C N SGW-C | SGW-C N SGW-C |
| SGW-C N SGW-C | SGW-C N SGW-C |

A row of six empty rectangular boxes for writing.



# CDR



## PFCP

### PFCP چیزی

PFCP چیزی

```
چیزی
curl -s http://127.0.0.40:42068/metrics | grep pfcp_association

چیزی
pfcp_association_status{peer_ip="10.0.0.30"} 1 (چیزی)
pfcp_association_status{peer_ip="10.0.0.31"} 1 (چیزی)

Web UI → SGW-U چیزی
چیزی "چیزی" چیزی
```

## PFCP

PFCP چیزی

```
چیزی
curl -s http://127.0.0.40:42068/metrics | grep seid_registry_count

چیزی SGW-U چیزی
curl -s http://127.0.0.40:42068/metrics | grep seid_by_peer

چیزی/چیزی
curl -s http://127.0.0.40:42068/metrics | grep usage_octets_rate
```

## PFCP

PFCP چیزی

```
监控 PFCP 流量
watch -n 1 'curl -s http://127.0.0.40:42068/metrics | grep sxa_inbound

监控消息

sxa_inbound_messages_total{message_type="session_establishment_respon
5432

sxa_inbound_messages_total{message_type="session_modification_respons
12100
sxa_inbound_messages_total{message_type="session_report_request"} 6
```

## SGW-U 流量

### SGW-U SGW-U 流量

```
监控 SGW-U/SGW-U 流量
curl -s http://127.0.0.40:42068/metrics | grep
sxa_session_establishment

监控 PDR 安装
curl -s http://127.0.0.40:42068/metrics | grep pdr_installation

监控
curl -s http://127.0.0.40:42068/metrics | grep sxa_timeout_total
```

## SGW-U

### SGW-U

SGW-U "SGW-U"

### SGW-U

1. SGW-U ping <sgwu\_ip>
2. SGW-U netstat -an | grep 8805

### 3. 5G NR 5G Core

SGW-U 5G Core

| 5G Core         | SGW-U | SGW-U       |
|-----------------|-------|-------------|
| SGW-U           | SGW-U | SGW-U SGW-U |
| SGW-U           | SGW-U | SGW-U       |
| <b>SGW-U</b>    | SGW-U | SGW-U SGW-U |
| <b>SGW-U ID</b> | SGW-U | SGW-U SGW-U |

SGW-U

"SGW-U"

SGW-U

```
SGW-U
curl -s http://127.0.0.40:42068/metrics | grep seid_registry_count

SGW-U
tail -f /var/log/sgw_c/sgw_c.log | grep "SGW-U"
```

SGW-U

| SGW-U        | SGW-U     | SGW-U |
|--------------|-----------|-------|
| <b>SGW-U</b> | "SGW-U"   | SGW-U |
| <b>PDR</b>   | "PDR IE"  | PDR   |
| <b>SEID</b>  | "SEID IE" | SEID  |
|              | "SGW-U"   | SGW-U |

A horizontal row of six empty rectangular boxes, likely used for input fields or placeholder text in a form.

□□□ "□□□□□□"

1

1

- SGW-U
  - CDR
  - SGW-U

1

PFCP

1

```
սահմանագործ
curl -s http://127.0.0.40:42068/metrics | grep
sxa_inbound_duration_seconds

սահմանագործ
curl -s http://127.0.0.40:42068/metrics | grep seid_by_peer

պատճեն
curl -s http://127.0.0.40:42068/metrics | grep pfcp_queue_depth
```

## Առաջին

1. Առաջին SGW-U պահանջմանը
2. Առաջին պահանջմանը
3. Առաջին պահանջմանը
4. Առաջին SGW-C պահանջմանը

Առաջին պահանջմանը կազմությունը կազմությունը

---

## Հաջողական

### Հաջողական

- Առաջին պահ 20-30 պահանջմանը
- Առաջին պահ RTT պահ 5-10 ս
- Առաջին պահ 2-3 պահանջմանը
- Առաջին պահ SGW-U պահանջմանը

### Հաջողական

- Առաջին պահ SGW-U պահանջմանը
- Առաջին պահանջմանը
- Առաջին պահանջմանը
- Առաջին պահանջմանը

## ▷▷▷▷

- ဗိုလ်ချုပ် ၂၁ PFCP ဖြန့်မေးခွဲခြင်း
  - ဗိုလ် ၂ S11 ၂၁ PFCP ဖြန့်မေးခွဲခြင်း
  - ဗိုလ်ချုပ် ဖြန့်မေးခွဲခြင်း
  - ဗိုလ်ချုပ် ၂၁ SGW-U ဖြန့်မေးခွဲခြင်း
-

# OmniSGW

## OmniSGW - 3GPP (SGW)

Omnitouch 3GPP

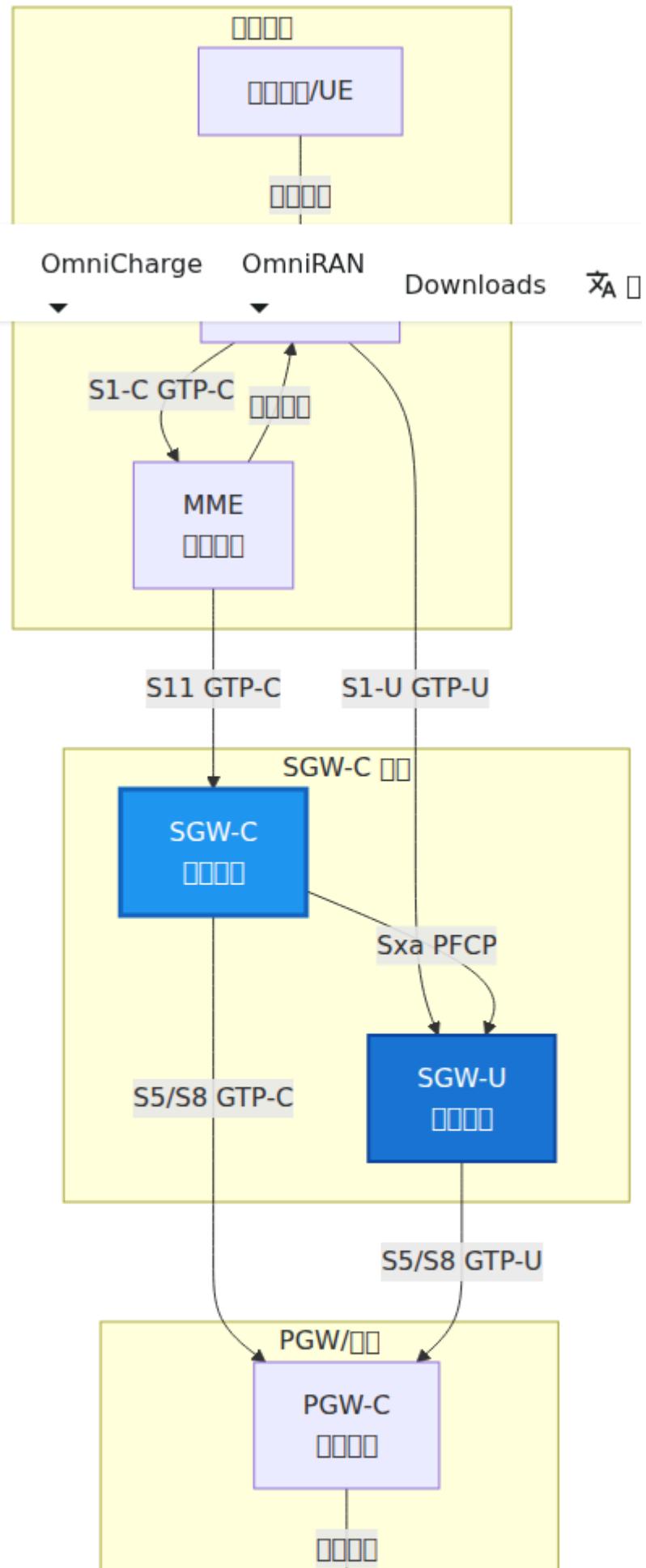


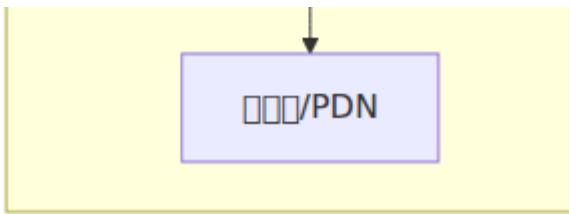
- SGW
- SGW
- SGW
- SGW
- SGW
- SGW
- Web UI - SGW
- SGW
- SGW
- SGW
- SGW
- SGW



**OmniSGW** 3GPP 3GPP LTE 3GPP (EPC) 3GPP (SGW) 3GPP Omnitouch 3GPP SGW 3GPP UE 3GPP

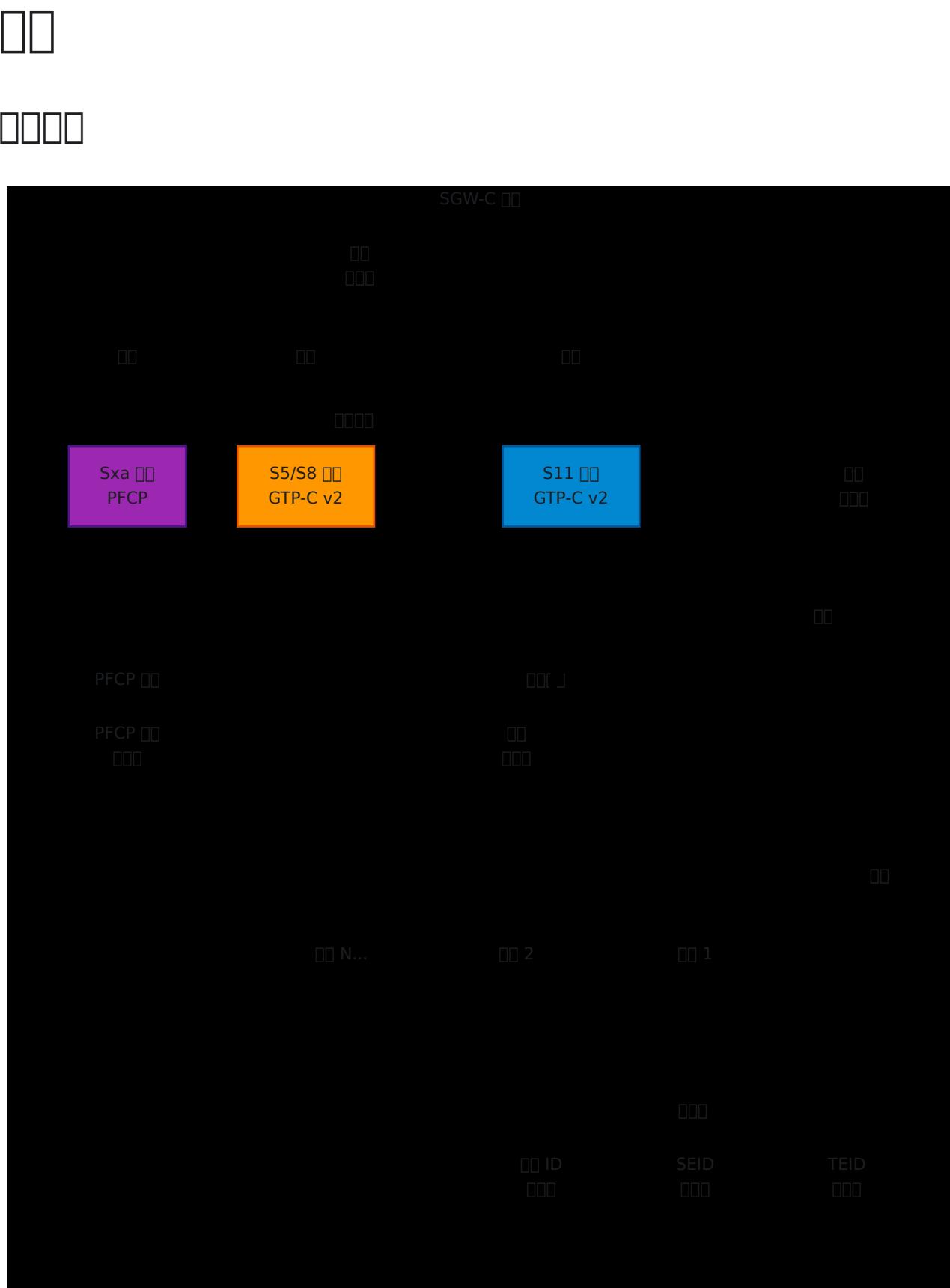
- SGW - 3GPP UE (3GPP) 3GPP
- SGW - 3GPP eNodeB 3GPP
- SGW - 3GPP QoS 3GPP
- SGW - 3GPP
- SGW - 3GPP SGW-U (3GPP) 3GPP





## SGW-C 接口

- 連接 **MME** 通過 S11 接口 (GTP-C)
  - 連接 **PGW-C** 通過 S5/S8 接口 (GTP-C) 連接 PDN 網絡
  - 連接 **eNodeB** 通過 Sxa 接口 (PFCP)
  - 連接 **UE** 通過 S1 接口
  - 連接 **UE** 通過 S1 接口
-



1

SGW-C Elixir/OTP

- 3GPP - 3GPP3GPP3GPP
  - 3GPP - 3GPP3GPP (S11, S5/S8, Sxa)
  - 3GPP - 3GPP UE 3GPP GenServer
  - 3GPP - 3GPP (TEID\SEID\3GPP ID \)
  - **PFCP** 3GPP - 3GPP SGW-U 3GPP PFCP 3GPP

A decorative horizontal bar consisting of a series of small, evenly spaced rectangular blocks, likely made of wood or metal, arranged in a straight line.

# Web UI

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SGW-C 3GPP

S11 || (GTP-C v2)

MME □ SGW-C □□□□□□□□□

UDP GTP-C 2

1

- ۰۰۰۰۰۰۰/۰۰
- ۰۰۰۰۰۰۰/۰۰
- ۰۰۰۰۰۰۰/۰۰
- ۰۰۰۰۰۰۰/۰۰
- ۰۰۰۰۰۰۰/۰۰
- ۰۰۰۰۰۰۰/۰۰

۰۰۰ ۰۰۰ **S11 ۰۰۰۰۰**

## **Sxa ۰۰ (PFCP)**

۰۰۰ SGW-C ۰ SGW-U ۰۰۰۰۰۰۰۰۰

۰۰۰ ۰۰ UDP ۰ PFCP (۰۰۰۰۰۰۰۰۰)

۰۰۰۰۰

- ۰۰۰۰۰۰۰/۰۰
- ۰۰۰۰۰۰۰/۰۰
- ۰۰۰۰۰۰۰/۰۰
- ۰۰۰۰۰۰۰/۰۰
- ♦♦۰۰۰۰۰۰/۰۰
- ۰۰۰۰/۰۰

۰۰۰ ۰۰۰ **PFCP/Sxa ۰۰۰۰۰**

## **S5/S8 ۰۰ (GTP-C v2)**

۰۰۰ SGW-C ۰ PGW-C ۰۰۰۰۰۰۰۰۰۰۰۰۰ PDN ۰۰

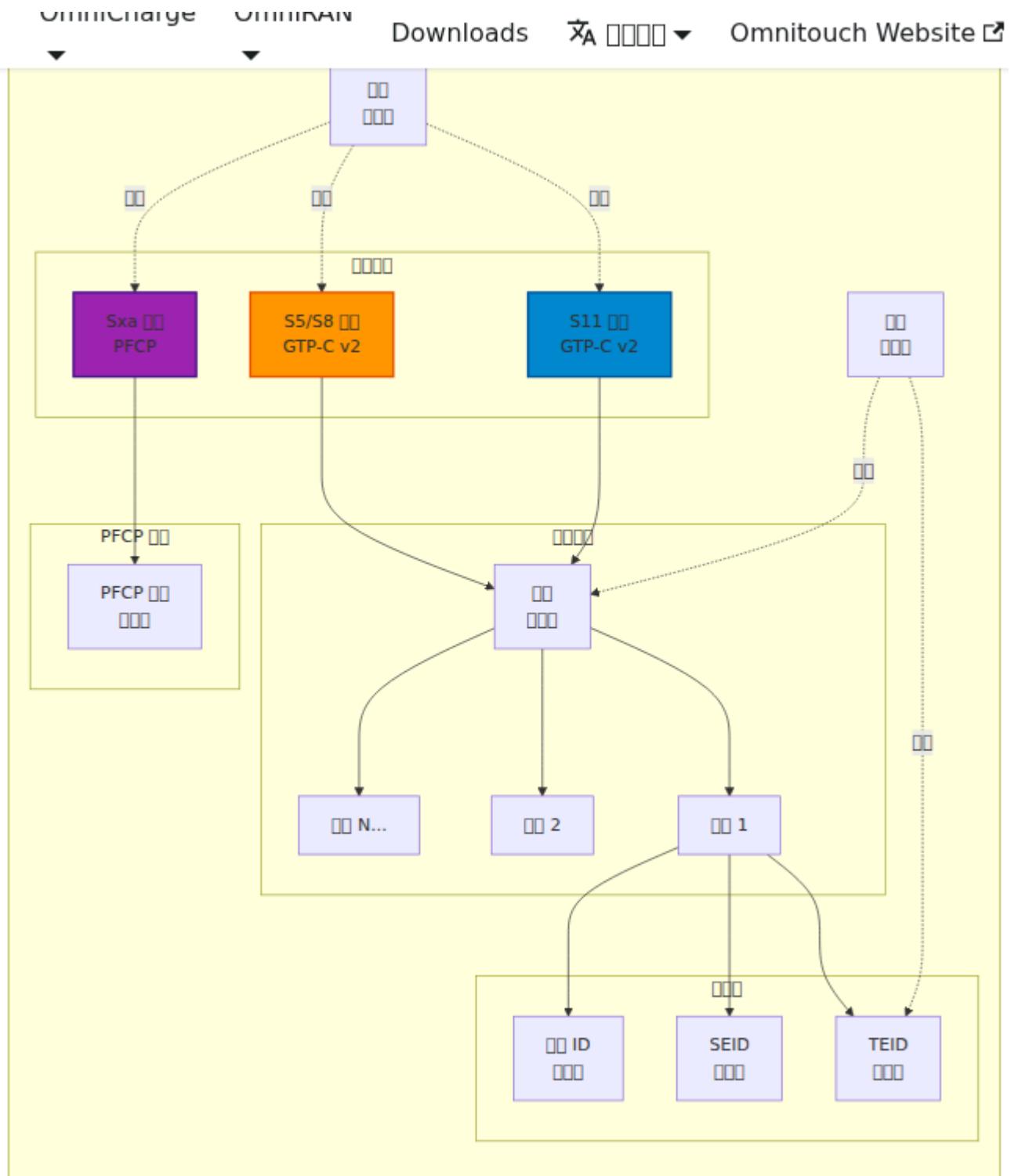
۰۰۰ ۰۰ UDP ۰ GTP-C ۰۰ 2

۰۰۰۰۰

- ۰۰۰۰۰۰۰/۰۰
- ۰۰۰۰۰۰۰/۰۰
- ۰۰۰۰۰۰۰/۰۰

- 3GPP 3GPP/3GPP2
- 3GPP2 3GPP/3GPP2

## 3GPP 3GPP S5/S8 接口



# UE ID

## UE ID

UE ID များအတွက် အမြတ်ဆင့် ဖော်လုပ်မှု

- **IMSI** (အမြတ်ဆင့်) - မြတ်လုပ်မှု
- **GUTI** (အမြတ်ဆင့်) - ၏ MME ၏ UE ID
- **MSISDN** - နေဂါန
- **TAI** (အမြတ်ဆင့်) - မြတ်လုပ်မှု
- ၏ **TEID** - S11 ၏ S5/S8 မြတ်လုပ်မှု
- အမြတ်ဆင့် - မြတ်လုပ်မှု

## PDN ID

PDN (မြတ်လုပ်မှု) ၏ အမြတ်ဆင့် မြတ်လုပ်မှု PGW-C မြတ်လုပ်မှု

- **APN** (အမြတ်ဆင့်) - မြတ်လုပ်မှု
- ၏ **ID** - ၏ SGW ၏ PGW မြတ်လုပ်မှု
- **TEID** (အမြတ်ဆင့် ID) - S5/S8 မြတ်လုပ်မှု
- **SEID** (အမြတ်ဆင့် ID) - Sxa မြတ်လုပ်မှု
- အမြတ်ဆင့် - ၏ PDN မြတ်လုပ်မှု
- အမြတ်ဆင့် - ၏ QoS မြတ်လုပ်မှု

# QoS

QoS မြတ်လုပ်မှု

- အမြတ်ဆင့် - ၏ PDN မြတ်လုပ်မှု
- အမြတ်ဆင့် - မြတ်လုပ်မှု (QoS)
- **EBI** (EPS ၏ ID) - ၏ ARP (မြတ်လုပ်မှု) (MBR, GBR)
- **QoS** ၏ - QCI (QoS ၏ ID) (MBR, GBR)

## PFCP چی

SGW-C և SGW-U հարաբերություն

- **PDR** (Պարագայություն) - հարաբերություն (ՀԱ/ՀՅ)
- **FAR** (Փակագում) - հարաբերություն
- **QER** (QoS հարաբերություն) - հարաբերություն
- **BAR** (Բարեֆուլ առաջարկ) - հարաբերություն

Հարաբերություն **Sxa** հարաբերություն

## Հարաբերություն

SGW-C և UE և eNodeB հարաբերություն

- Ա **MME** է - մի մեք ՄՄԵ հարաբերություն (ՀԱ/SGW)
  - Ա **MME** է - մ ՄՄԵs հարաբերություն SGW է
  - Հարաբերություն - Հարաբերություն
  - Հարաբերություն - UE հարաբերություն
- 

## Հարաբերություն

Հարաբերություն

- Elixir ~1.16
- Erlang/OTP 26+
- Ա MME ՍԳՎ-ՈՒ և PGW-Ը հարաբերություն
- Ա և LTE EPC հարաբերություն

## Հարաբերություն

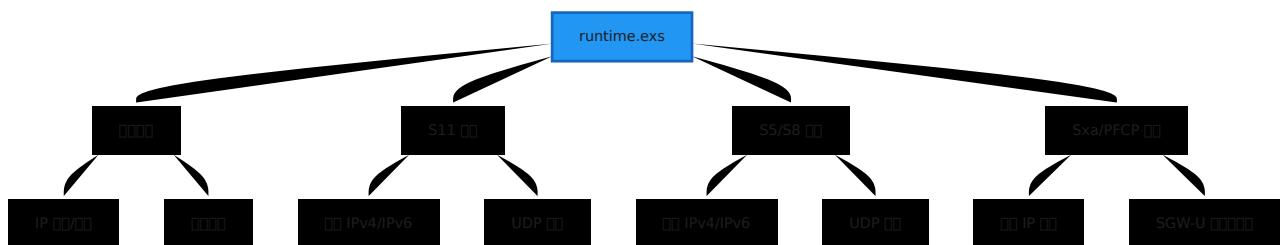
Հարաբերություն

```
[info] OmniSGW...
[info] 127.0.0.40:42068
[info] 127.0.0.10 S11
[info] 127.0.0.15 S5/S8
[info] 127.0.0.20 Sxa
[info] PFCP
[info] OmniSGW
```

访问地址 <http://127.0.0.40:42068/metrics> (Metrics)



配置文件 config/runtime.exs 内容如下所示



| <b>metrics</b> | Prometheus 监控 | Metrics |
|----------------|---------------|---------|
| <b>s11</b>     | GTP-C 与 MME   | S11     |
| <b>s5s8</b>    | GTP-C 与 PGW-C | S5/S8   |
| <b>sxa</b>     | PFCP 与 SGW-U  | Sxa     |

配置文件 config/runtime.exs 内容如下所示

# Web UI - 简介

OmniSGW 提供了一个 Web UI，用于管理和监控网络设备。

## Web UI

`http://<omnisgw-ip>:<web-port>/`

访问方法

| 模块       | URL            | 描述                 | 状态  |
|----------|----------------|--------------------|-----|
| UE 会话    | /ue_sessions   | 显示所有 UE 会话         | 2 个 |
| PFCP 会话  | /pfcp_sessions | 显示 SGW-U 和 PFCP 会话 | 2 个 |
| SGW-U 状态 | /sgwu_status   | 显示 PFCP 状态         | 2 个 |
| 日志       | /logs          | 显示日志               | 无   |

功能模块

主要功能

- 会话管理 (UE 会话)
- OmniSGW 网络状态
- 日志查看 (日志/状态)

会话信息

- IMSI/GUTI/UE 识别码
- 会话详细信息

日志查看

- Առաջարկություններ
- Առաջարկություն QoS մասին
- Առաջարկություններ

### Առաջարկ (Առաջարկ) մաս

- Առաջարկություններ
- Առաջարկ NOC/Առաջարկություններ
- Առաջարկ IP պատճեններ

### Առաջարկ

#### Առաջարկություններ

1. Առաջարկություններ
2. Առ ՍԵ պատճեն
3. Առ ԻՄՍԻ պատճեններ
4. Առաջարկություններ  
- Առաջարկ  
- Առաջարկ QoS  
- Առաջարկություններ  
- Առ ՊԳՎ-Ը պատճեն
5. Առաջարկներ → Առաջարկություններ

#### Առաջարկություններ

1. Առ ՏԳՎ-Ը պատճեն → Առաջարկ ՏԳՎ-Ը պատճեն “Առաջարկ”
2. Առ ՍԵ պատճեն → Առաջարկություններ
3. Առ ԱՊՆ պատճեններ

### Առաջարկ

- Առ ՍԵ պատճեն
- Առաջարկ/Առաջարկություններ
- Առաջարկություններ
- Առաջարկություններ

# Web UI 介绍

## Web UI 功能

- 监控与告警
- 配置管理
- 日志查看
- 报表生成
- 安全审计

## Prometheus 监控

- 网元状态
- 信令流量
- 会话统计
- UE行为
- 基站性能

综合监控平台 - Web UI 直接集成 Prometheus 监控数据

---

## OmniSGW

Web UI 和 OmniSGW 通过 Prometheus 实现数据集成

## 指标

- S11/S5S8 TEID
  - teid\_registry\_count - S11/S5S8 TEID
  - seid\_registry\_count - PFCP SEID
  - charging\_id\_registry\_count - 会话 ID
  - active\_ue\_sessions - 活跃 UE 会话
  - active\_bearers - 活跃bearer 会话
- 其他
  -

1

## HTTP

```
curl http://127.0.0.40:42068/metrics
```

4 of 4

 OmniSGW 

## OmniSGW

```
OmniSGW
├── OPERATIONS.md (operations)
└── docs/
 ├── 网络架构
 │ └── configuration.md
 │ └── runtime.exs
 ├── 接口规范
 │ ├── sxa-interface.md
 │ ├── s11-interface.md
 │ └── s5s8-interface.md
 └── UE
 ├── session-management.md
 ├── bearer-management.md
 │ └── cdr-format.md
 └── monitoring.md
 └── Prometheus
```

## OmniSGW 文档

### 操作文档

| 文件                   | 描述        | 状态 |
|----------------------|-----------|----|
| <b>OPERATIONS.md</b> | 操作手册 (待审) | 待审 |

### 配置文档

| 文件                      | 描述               |
|-------------------------|------------------|
| <b>configuration.md</b> | 配置文件 runtime.exs |

### UE 文档

| ◎                        | ◎                   |
|--------------------------|---------------------|
| <b>sxa-interface.md</b>  | PFCP/Sxa ◎ SGW-U    |
| <b>s11-interface.md</b>  | GTP-C S11 ◎ MME     |
| <b>s5s8-interface.md</b> | GTP-C S5/S8 ◎ PGW-C |

◎ ◎◎◎◎

| ◎                            | ◎                         |
|------------------------------|---------------------------|
| <b>session-management.md</b> | UE ◎◎◎◎◎◎◎                |
| <b>bearer-management.md</b>  | ◎◎◎◎◎◎◎                   |
| <b>cdr-format.md</b>         | ◎◎◎◎◎◎◎                   |
| <b>monitoring.md</b>         | Prometheus ◎ Grafana ◎◎◎◎ |

◎◎◎

◎◎◎◎◎

1. [OPERATIONS.md](#) - ◎ (◆◆◆)
2. [configuration.md](#) - ◎
3. [monitoring.md](#) - ◎
4. [session-management.md](#) - ◎◎◎

◎◎◎◎◎

1. [OPERATIONS.md](#) - ◎◎◎ (◎◎)
2. [sxa-interface.md](#) - ◎◎◎◎
3. [s11-interface.md](#) - ◎◎◎
4. [s5s8-interface.md](#) - PDN ◎
5. [session-management.md](#) - ◎◎◎◎◎

## 6. bearer-management.md - ۳GPP

۳GPP

1. configuration.md - ۳GPP
  2. monitoring.md - ۳GPP
- 

۳GPP

## 3GPP ۳GPP

| ۳GPP      | ۳GPP                           |
|-----------|--------------------------------|
| TS 29.274 | GTP-C v2 (S11 ۳GPP S5/S8 ۳GPP) |
| TS 29.244 | PFCP (Sxa ۳GPP)                |
| TS 32.251 | ۳GPP                           |
| TS 32.298 | CDR ۳GPP                       |
| TS 23.401 | EPC ۳GPP                       |