EIR[illegible]

[illegible]

HSS [illegible] EIR[illegible]EIR [illegible] IMEI[illegible]

[illegible]

- **S13** [illegible] Diameter [illegible]
- **IMEI** [illegible] IMEI/IMEISV [illegible]
- [illegible] IMEI[illegible]IMEISV [illegible] IMSI [illegible]
- [illegible]
- [illegible]
- **REST API**[illegible]EIR [illegible] CRUD [illegible]

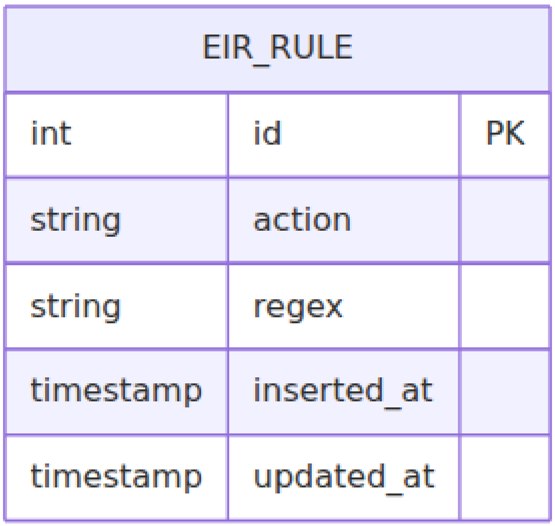
[illegible]

Diameter [illegible]

[illegible]	[illegible] **ID**	[illegible]	[illegible]
S13	16,777,252	MME/SGSN	[illegible]

[illegible]

EIR [illegible]



EIR_RULE		
int	id	PK
string	action	
string	regex	
timestamp	inserted_at	
timestamp	updated_at	

[illegible]

- `whitelist` - [illegible]
- `blacklist` - [illegible]
- `greylist` - [illegible]

[illegible] IMEI[illegible]IMEISV [illegible] IMSI [illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0	[illegible]	[illegible]
[illegible]	1	[illegible]/[illegible]	[illegible]
[illegible]	2	[illegible]	[illegible]

S13 [illegible]

[illegible]

[illegible]**ECR**[illegible]/[illegible]**ECA**[illegible]

[illegible]MME/SGSN → HSS[illegible]EIR[illegible]

□□□MME □□□□□□□□□□□□□□□□□□

□□ AVP□

- Session-Id
- Origin-Host, Origin-Realm
- Destination-Realm
- Auth-Session-State
- Terminal-Information
  - IMEI□15 □□□□
  - Software-Version□2 □□□□□□□
- User-Name□IMSI□□□□
- Vendor-Specific-Application-Id

EIR □□□

1. □□ IMEI□Software-Version□□□□□□□ IMSI□□□□□□
2. □□□□□ IMSI□
   - □□□□□□□□□□□□□
   - □□□□□□□□□□□□□□□□
3. □□□□□□□□□□□□
   - **IMEISV** □□□IMEI + Software-Version □□□
   - **IMEI** □□□□ IMEI□
   - **IMSI** □□□□□□□□□□□□
   - □□□□□□□□□□□□□□□
4. □□□□□□

□□ AVP□

- Session-Id□□□□□□□□
- Result-Code: 2001□□□□
- Equipment-Status: 0□□□□□/ 1□□□□□/ 2□□□□□

□□□□□

- Experimental-Result: 5422□□□/□□□□□□□
- Experimental-Result: 5012□□□□□□

□□□□□□

□□□□

EIR □□□□□□□□□□□□□□□

```
1. IMEISV□IMEI + Software-Version□
   ↓□□□□□□□□
2. □ IMEI
   ↓□□□□□□□□
3. IMSI□□□□□□□□□□
   ↓□□□□□□□□
4. □□□□□□
```

□□□□

□□ 1□IMEISV □□

- □□ IMEI + Software-Version□`"35979139461611" + "08" = "3597913946161108"`
- □□□□ EIR □□□□□□□□□
- □□□□□□□□□□□□□“whitelist”□“blacklist”□“greylist”□

□□ 2□IMEI □□□□□□

- □□□ IMEI□`"35979139461611"`
- □□□□ EIR □□□□□□□□□
- □□□□□□□□□□□□

□□ 3□IMSI □□□□□□□ IMSI□□□□□

- □□□□□□ IMSI□`"999999876543210"`
- □□□□ EIR □□□□□□□□□
- □□□□□□□□□□□□
- □□□□□□□□□□□□□□□

□□ 4□□□□□□□□□□□□□□

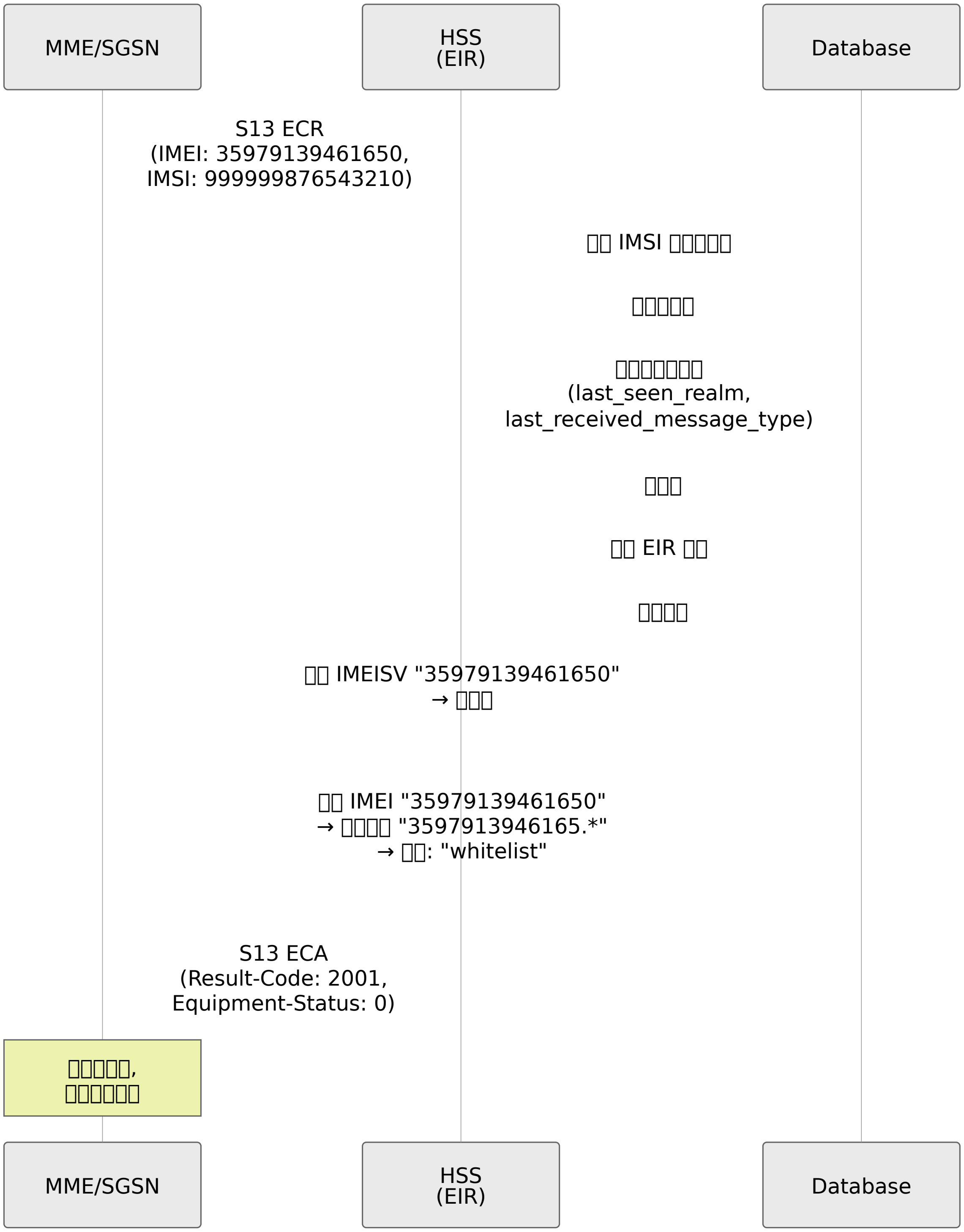
- □□□□□`eir_unknown_equipment_behaviour`
- □□□
  - `:whitelist` - □□□□□□□□□□
  - `:blacklist` - □□□□□□□□□□
  - `:greylist` - □□□□□□□□□□
  - `:reject_unknown_equipment` - □□□□ 5422□□□□

□□□□□□□□□

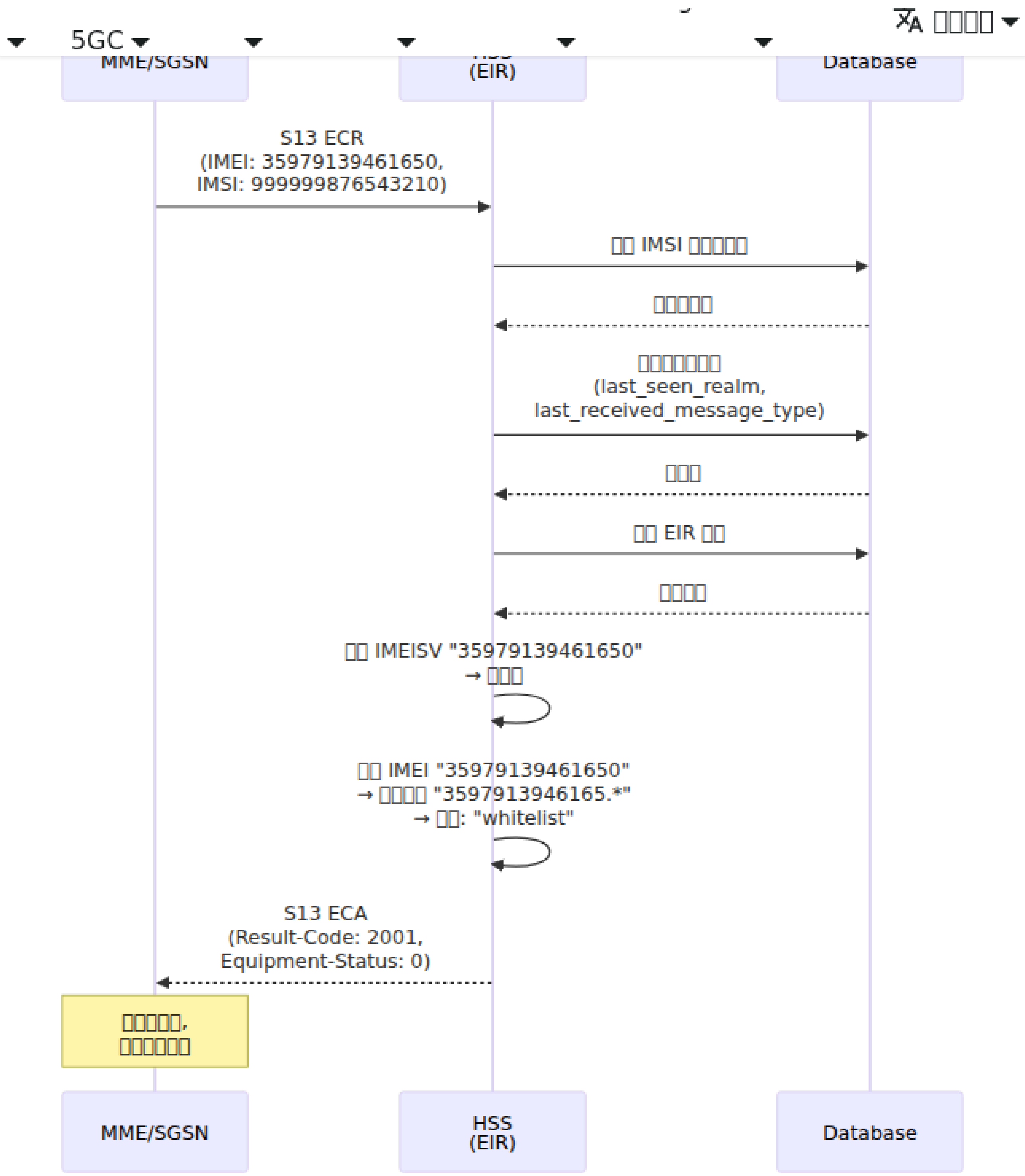
□□	□□	□□
`"35979139461650"`	□□ IMEI	□□□□□□□/□□□
`"3597913946165.*"`	IMEI □□□□□	□□□/□□□□
`"3597913946161108"`	□□ IMEISV	□□□□□□□□□
`"999999876543210"`	IMSI	□□□□□□□□□□□
`"359791.*"`	TAC □□□	□□□□□□□□

□□□□□

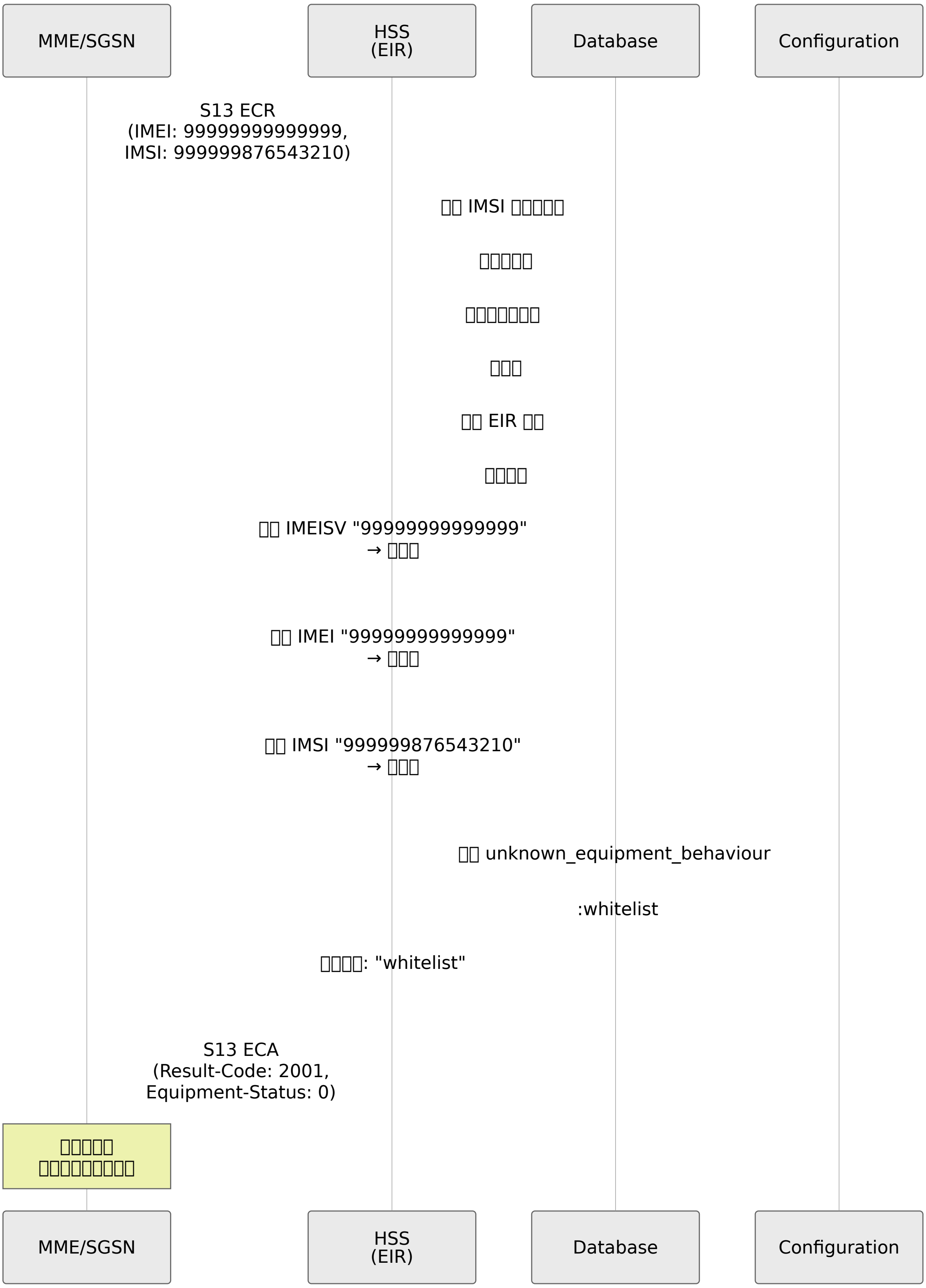
□□ 1□□□□□ - □□□□□ IMEI


MME/SGSN
HSS
(EIR)
Database
S13 ECR
(IMEI: 35979139461650,
IMSI: 999999876543210)
□□ IMSI □□□□□
□□□□□
□□□□□□□
(last_seen_realm,
last_received_message_type)
□□□
□□ EIR □□
□□□□
□□ IMEISV "35979139461650"
→ □□□
□□ IMEI "35979139461650"
→ □□□□ "3597913946165.*"
→ □□: "whitelist"
S13 ECA
(Result-Code: 2001,
Equipment-Status: 0)
□□□□□,
□□□□□□
MME/SGSN
HSS
(EIR)
Database

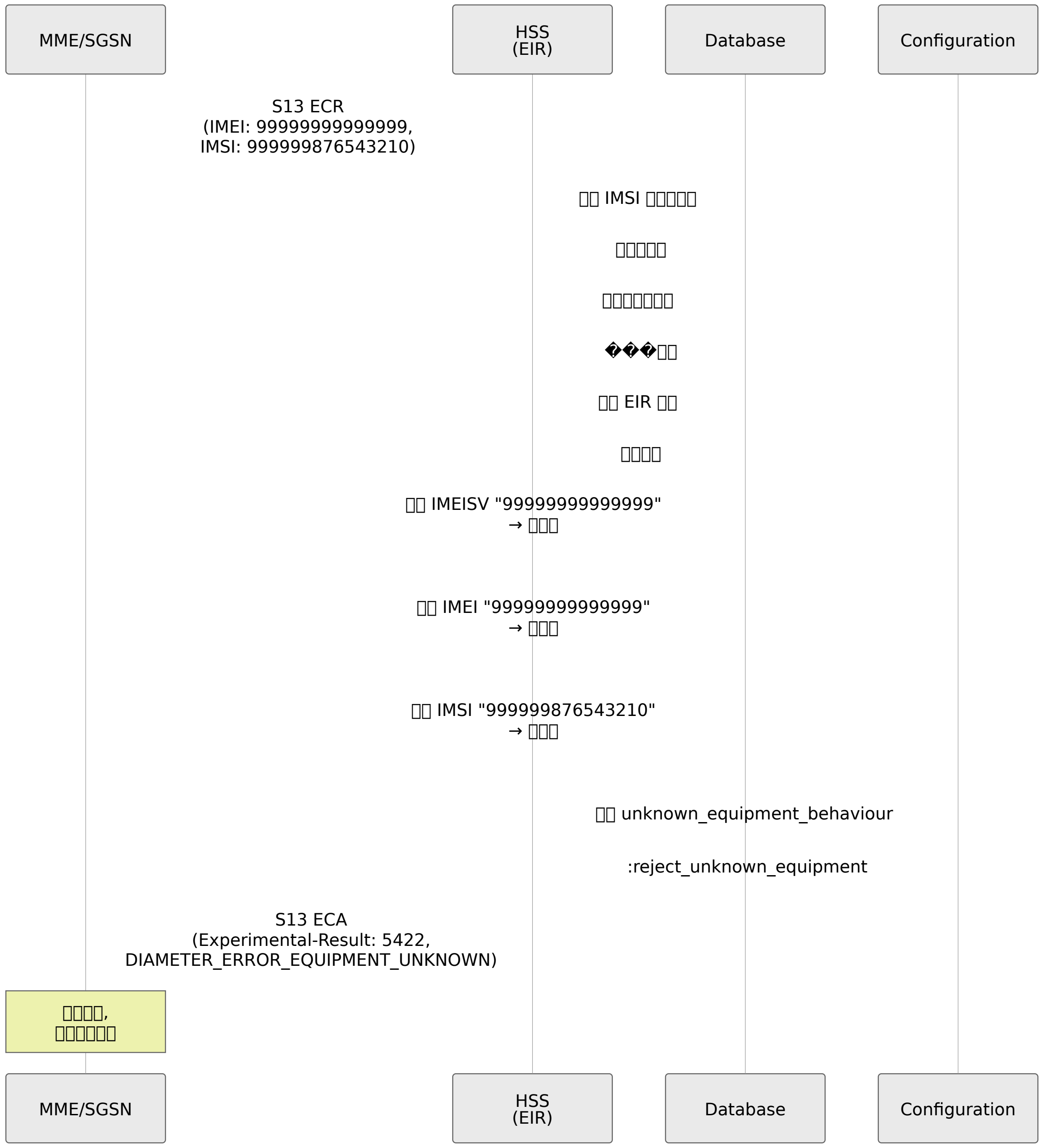
□□ 2□□□□□ - □□□ IMEI□□□□□□


5GC
文A □□□□
MME/SGSN
HSS
(EIR)
Database
S13 ECR
(IMEI: 35979139461650,
IMSI: 999999876543210)
□□ IMSI □□□□□
□□□□□
□□□□□□□
(last_seen_realm,
last_received_message_type)
□□□
□□ EIR □□
□□□□
□□ IMEISV "35979139461650"
→ □□□
□□ IMEI "35979139461650"
→ □□□□ "3597913946165.*"
→ □□: "whitelist"
S13 ECA
(Result-Code: 2001,
Equipment-Status: 0)
□□□□□,
□□□□□□
MME/SGSN
HSS
(EIR)
Database

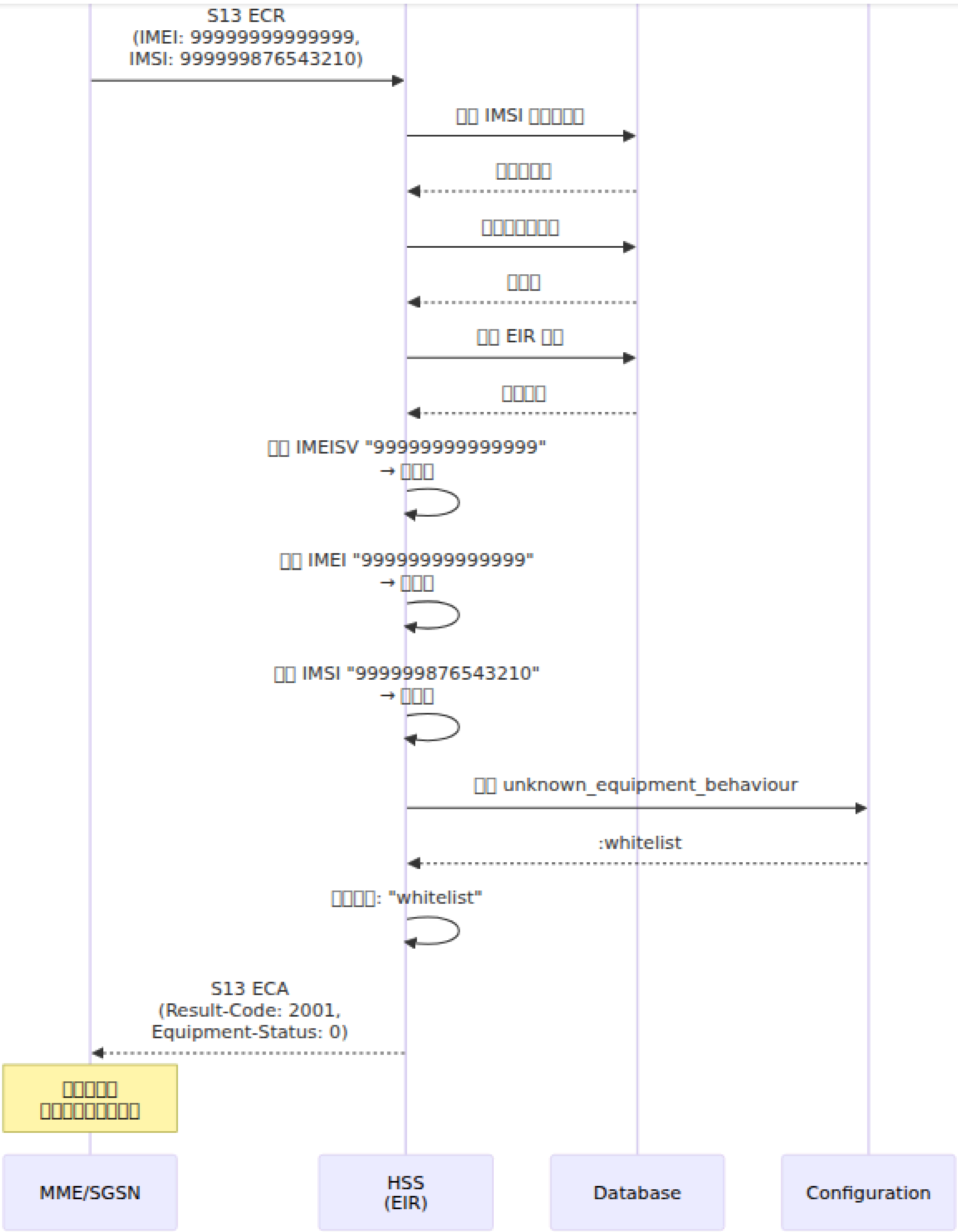
[illegible] 3[illegible] - [illegible]


MME/SGSN
HSS
(EIR)
Database
Configuration
S13 ECR
(IMEI: 99999999999999,
IMSI: 999999876543210)
[illegible] IMSI [illegible]
[illegible]
[illegible]
[illegible]
[illegible] EIR [illegible]
[illegible]
[illegible] IMEISV "99999999999999"
→ [illegible]
[illegible] IMEI "99999999999999"
→ [illegible]
[illegible] IMSI "999999876543210"
→ [illegible]
[illegible] unknown_equipment_behaviour
:whitelist
[illegible]: "whitelist"
S13 ECA
(Result-Code: 2001,
Equipment-Status: 0)
[illegible]
[illegible]
MME/SGSN
HSS
(EIR)
Database
Configuration

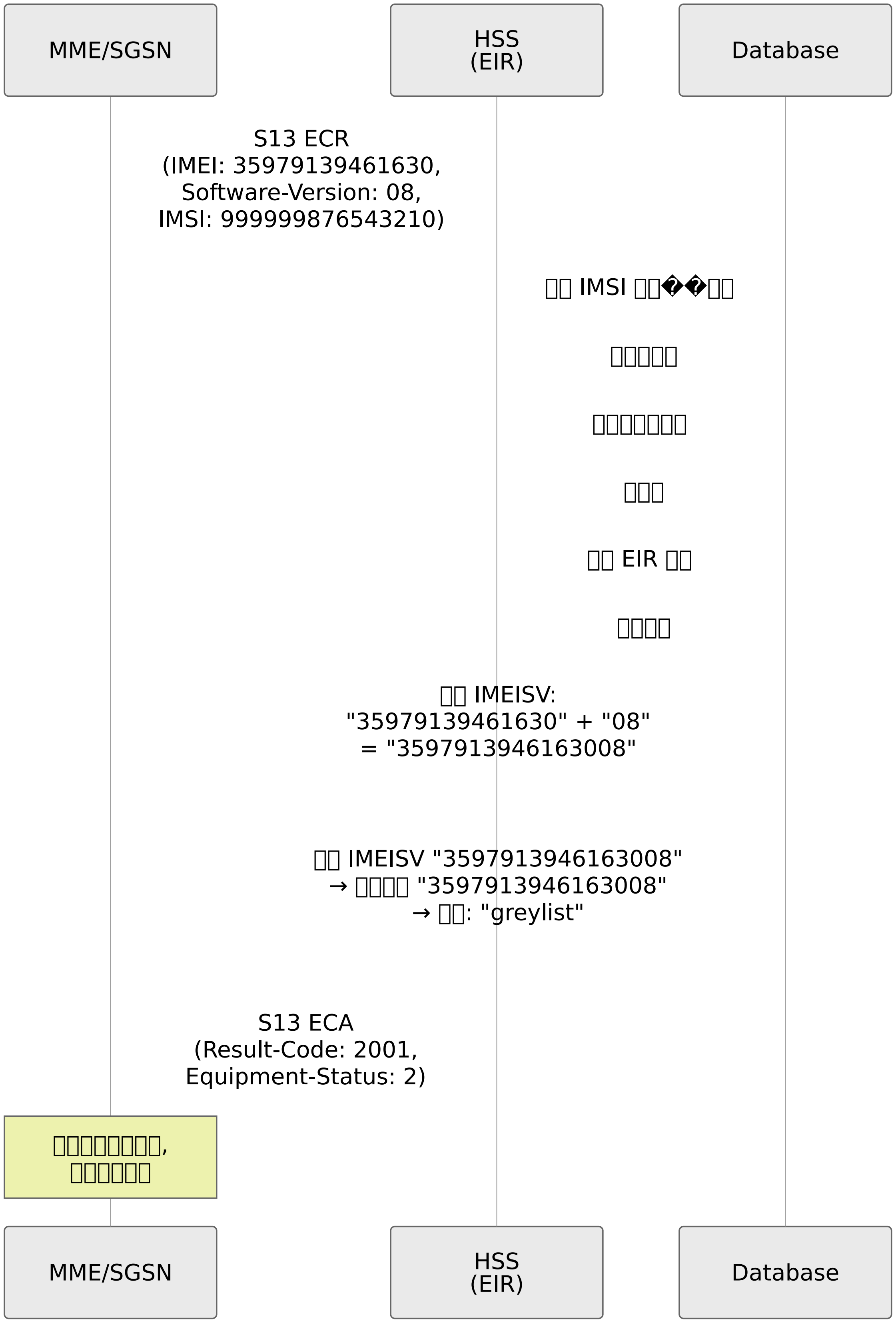
[illegible] 4[illegible] - [illegible]


MME/SGSN
HSS (EIR)
Database
Configuration
S13 ECR (IMEI: 99999999999999, IMSI: 999999876543210)
[illegible] IMSI [illegible]
[illegible] EIR [illegible]
[illegible] IMEISV "99999999999999" → [illegible]
[illegible] IMEI "99999999999999" → [illegible]
[illegible] IMSI "999999876543210" → [illegible]
[illegible] unknown_equipment_behaviour
:reject_unknown_equipment
S13 ECA (Experimental-Result: 5422, DIAMETER_ERROR_EQUIPMENT_UNKNOWN)
MME/SGSN
HSS (EIR)
Database
Configuration

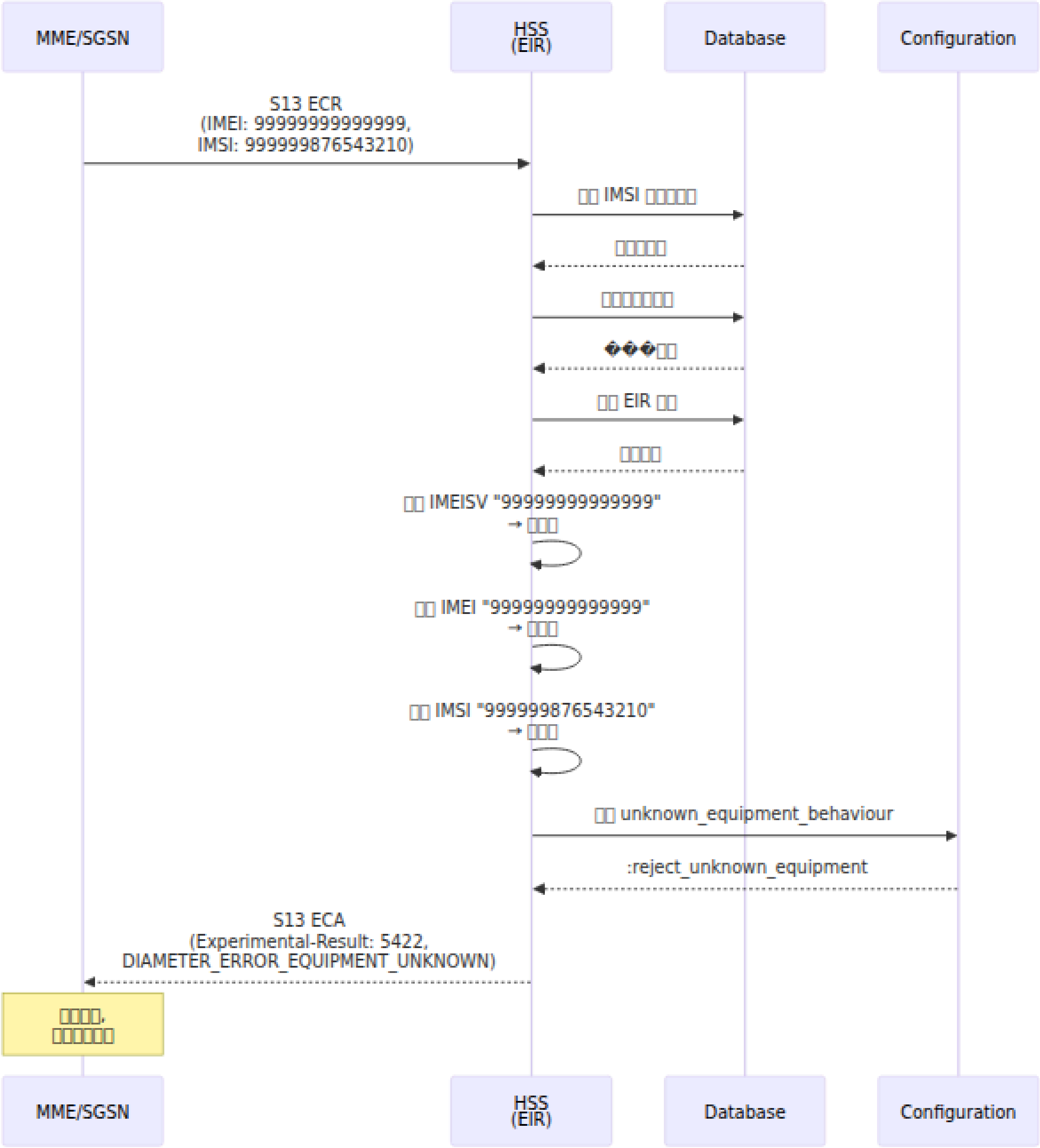
□□ 5□□□□□ - □□□□□


S13 ECR
(IMEI: 99999999999999,
IMSI: 999999876543210)
□□ IMSI □□□□□
□□□□□
□□□□□□□
□□□
□□ EIR □□
□□□□
□□ IMEISV "99999999999999"
→ □□□
□□ IMEI "99999999999999"
→ □□□
□□ IMSI "999999876543210"
→ □□□
□□ unknown_equipment_behaviour
:whitelist
□□□□: "whitelist"
S13 ECA
(Result-Code: 2001,
Equipment-Status: 0)
□□□□□
□□□□□□□□□
MME/SGSN
HSS
(EIR)
Database
Configuration

[illegible] 6[illegible] - IMEISV [illegible]


MME/SGSN
HSS
(EIR)
Database
S13 ECR
(IMEI: 35979139461630,
Software-Version: 08,
IMSI: 999999876543210)
[illegible] IMSI [illegible]
[illegible]
[illegible]
[illegible]
[illegible] EIR [illegible]
[illegible]
[illegible] IMEISV:
"35979139461630" + "08"
= "3597913946163008"
[illegible] IMEISV "3597913946163008"
→ [illegible] "3597913946163008"
→ [illegible]: "greylist"
S13 ECA
(Result-Code: 2001,
Equipment-Status: 2)
[illegible],
[illegible]
MME/SGSN
HSS
(EIR)
Database

□□ 7□□□□□ - IMSI □□


MME/SGSN
HSS
(EIR)
Database
Configuration
S13 ECR
(IMEI: 99999999999999,
IMSI: 999999876543210)
□□ IMSI □□□□□
□□□□□
□□□□□□□
���□□
□□ EIR □□
□□□□
□□ IMEISV "99999999999999"
→ □□□
□□ IMEI "99999999999999"
→ □□□
□□ IMSI "999999876543210"
→ □□□
□□ unknown_equipment_behaviour
:reject_unknown_equipment
S13 ECA
(Experimental-Result: 5422,
DIAMETER_ERROR_EQUIPMENT_UNKNOWN)
□□□□,
□□□□□□
MME/SGSN
HSS
(EIR)
Database
Configuration

REST API

EIR □□□□

□□□□□`/api/eir/rule`

□□□□ EIR □□

□□□

```
GET /api/eir/rule
```

□□□HTTP 200□□

```json
{
  "data": [
    {
      "id": "e7f6a5b4-c3d2-4e1f-8a9b-0c1d2e3f4a5b",
      "action": "whitelist",
      "regex": "3597913946165.*",
      "inserted_at": "2025-01-15T10:30:00Z",
      "updated_at": "2025-01-15T10:30:00Z"
    },
    {
      "id": "f8a7b6c5-d4e3-4f2a-9b0c-1d2e3f4a5b6c",
      "action": "blacklist",
      "regex": "35979139461640",
      "inserted_at": "2025-01-16T14:20:00Z",
      "updated_at": "2025-01-16T14:20:00Z"
    }
  ]
}
```

□□□□ EIR □□

□□□

```
GET /api/eir/rule/{id}
```

□□□HTTP 200□□

```json
{
  "data": {
    "id": "e7f6a5b4-c3d2-4e1f-8a9b-0c1d2e3f4a5b",
    "action": "whitelist",
    "regex": "3597913946165.*"
  }
}
```

□□ EIR □□

□□□

```
POST /api/eir/rule
Content-Type: application/json

{
  "action": "blacklist",
  "regex": "35979139461640"
}
```

□□□

- `action`□□□□□□□ "whitelist"□"blacklist" □ "greylist"
- `regex`□□□□□□□□□□□□□□□□□□□��□□□□□□

□□□HTTP 201□□

```json
{
  "data": {
    "id": "0362b7ab-9bd6-4d8a-8b1a-2f4c6e8d0a1c",
    "action": "blacklist",
    "regex": "35979139461640"
  }
}
```

□□□□□HTTP 400□□

```
{
  "errors": {
    "regex": ["□□□□"]
  }
}
```

□□ EIR □□□□□□

□□□

```
PATCH /api/eir/rule/{id}
Content-Type: application/json

{
  "action": "greylist"
}
```

□□□HTTP 200□□

```
{
  "data": {
    "id": "0362b7ab-9bd6-4d8a-8b1a-2f4c6e8d0a1c",
    "action": "greylist",
    "regex": "35979139461640"
  }
}
```

□□ EIR □□

□□□

```
PUT /api/eir/rule/{id}
Content-Type: application/json

{
  "action": "whitelist",
  "regex": "359791394616.*"
}
```

□□□HTTP 200□□

```json
{
  "data": {
    "id": "0362b7ab-9bd6-4d8a-8b1a-2f4c6e8d0a1c",
    "action": "whitelist",
    "regex": "359791394616.*"
  }
}
```

□□ EIR □□

□□□

```
DELETE /api/eir/rule/{id}
```

□□□HTTP 204 □□□□

□□

Diameter □□□□

S13 □□□`config/runtime.exs`□□

```elixir
%{
  application_name: :s13,
  application_dictionary: :diameter_gen_3gpp_s13,
  vendor_specific_application_ids: [
    %{vendor_id: 10415, auth_application_id: 16_777_252}
  ]
}
```

□□□□□□

□ `config/runtime.exs` □□□□□□□□□□□□□□□□□□□

[illegible]

```
config :hss, :eir,
  unknown_equipment_behaviour: :whitelist
```

[illegible]

- `:whitelist` - [illegible]
- `:blacklist` - [illegible]
- `:greylist` - [illegible]
- `:reject_unknown_equipment` - [illegible] Diameter [illegible] 5422[illegible]

[illegible]

- [illegible]/[illegible]`:whitelist` - [illegible]
- [illegible]`:whitelist` - [illegible]
- [illegible]`:greylist` - [illegible]
- [illegible]`:reject_unknown_equipment` - [illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
2001	[illegible]	DIAMETER_SUCCESS	[illegible]
5422	[illegible]	DIAMETER_ERROR_EQUIPMENT_UNKNOWN	[illegible]
5012	[illegible]	DIAMETER_ERROR_UNKNOWN	[illegible]

[illegible]

1. [illegible]

[illegible]

[illegible]

```
POST /api/eir/rule
{
  "action": "blacklist",
  "regex": "35979139461640"  # [illegible] IMEI
}
```

[illegible]

2. [illegible]

[illegible]

[illegible]

```
POST /api/eir/rule
{
  "action": "whitelist",
  "regex": "359791394.*"  # [illegible]/[illegible] TAC
}
```

[illegible] TAC [illegible]

3. [illegible]

[illegible]SIM [illegible]

[illegible]

```
POST /api/eir/rule
{
  "action": "blacklist",
  "regex": "999999876543210"  # IMSI
}
```

□□□□□□□ SIM □□□□□□□□□□□

4. □□□□□□□

□□□□□□□□□□□□□

□□□

```
POST /api/eir/rule
{
  "action": "greylist",
  "regex": "35979139.*"  # □□□□ TAC □□
}
```

□□□□□□□□□□□□□□

5. □□□□□□

□□□□□□□□□□□□□□□□

□□□

```
POST /api/eir/rule
{
  "action": "blacklist",
  "regex": "359791394616.*05"  # IMEI □□ + □□□□ 05
}
```

□□□□□□ IMEI □□□□□□□□□ "05" □□□

[illegible]

[illegible]

EIR [illegible]

- **S13 [illegible]** - ECR/ECA [illegible]���
- [illegible] - [illegible] IMEI/IMEISV/IMSI [illegible]
- **EIR [illegible]** - [illegible]
- **REST API [illegible]** - [illegible]

[illegible]

[illegible]

1. **IMEISV** [illegible] IMEI + [illegible]
2. **IMEI** [illegible] IMEI
3. **IMSI** [illegible] IMSI[illegible]
4. [illegible]

[illegible]

- `whitelist` - [illegible]
- `blacklist` - [illegible]
- `greylist` - [illegible]
- `reject_unknown_equipment` - [illegible]

[illegible]

IMEI [illegible]

IMEI [illegible]EIR[illegible]

- [illegible] IMEI [illegible]
- [illegible]

- □□ API □□□□□□□□□□□□□□

□□□□

EIR □□□□□□□□□□ ID□□□□□□□□□□□□□

```
□□ 1□□□ "359791.*" □□ "whitelist"  □□□□
□□ 2□□□ "35979139461640" □□ "blacklist"  □□□□
```

□□□□□□□□□□□□□□□□□□□□□□□□□□□

□□□□

□□□□□□□□□□□□□□

- □□□□□□□□□□ S13 ECR □□
- REST API EIR □□□□
- IMEI □□□��□□□□□□□

□□□□

- Diameter □□ - S13 □□□□
- API □□ - □□ API □□
- □□ - □□ HSS □□
- □□□□ - □□□□

□□□IMEI □□

IMEI □□□15 □□□□

```
35 9791 394616 1
│  │    │      └─ □□□□Luhn □□□
│  │    └─ □□□□6 □□□□
│  └─ FAC□□□□□□□□4 □□□□
└─ TAC□□□□□□□□□□ 8 □□□□□□ RBI□
   │  └─ RBI□□□□□□□□□2 □□□□
   └─ □□□/□□□6 □□□□
```

IMEISV □□□16 □□□□

```
35 9791 394616 1 08
│  │    │      │ └─ □□□□□2 □□□□
└─ IMEI□15 □□□□
```

□□□□

IMEI/IMEISV	□□	□□
359791394616108	`3597913946161.*`	□□ TAC+FAC+□□□□ 359791394616* □□□
359791394616140	`35979139461614.`	□□□□□□ 359791394616141-9 □□□□
35979139461640	`35979139461640`	□□ IMEI □□
3597913946163008	`3597913946163008`	□□ IMEISV□IMEI + SV□□□

PCRF□□□□□□□□□□□

□□

HSS □□□□□ PCRF□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□PCRF □□ LTE □□□□□□□□□□□□□□□□QoS□□□□□□□□□□□□□□

□□□□

- **Gx** □□□PGW/PCEF□□□□□□□/□□□□□□□□□□□□□□□
- **Rx** □□□IMS□IP □□□□□□□□□□□□□□ QoS
- **Sy** □□□□□□□ OCS □□□□□□□□□ - □□ Sy □□
- □□□□□□□□□□□□□□□□RAR□□□□□□□□□
- **VoLTE** □□□□□□□□□□□□ QoS □□□□□
- □□□□□□□□□□□□□TFT□□□□□□□□□□□□
- **REST API**□□□□□□□□□□□□□□□

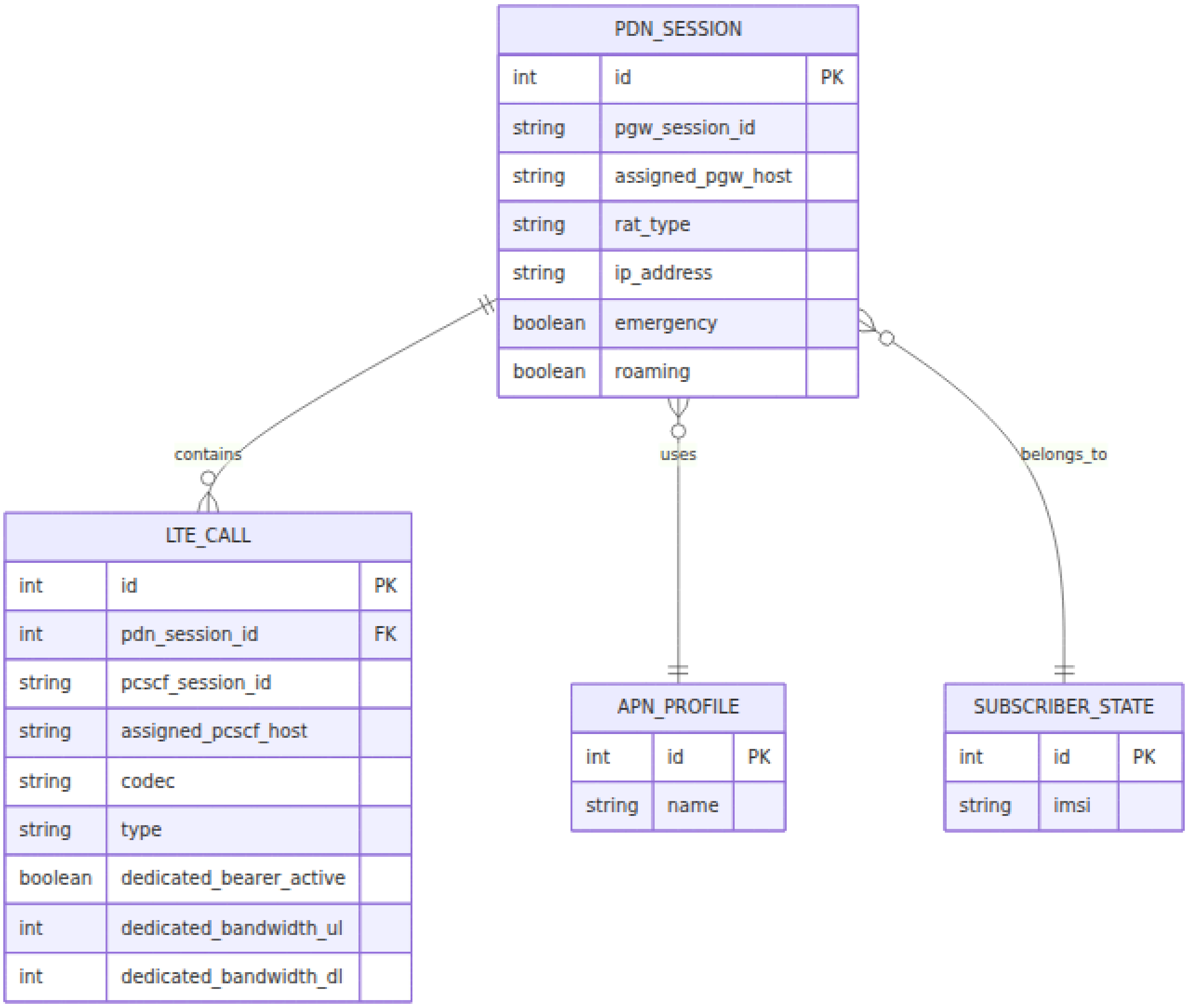
□□

Diameter □□

□□	□□ **ID**	□□□	□□
Gx	16,777,238	PGW□PCEF□	PDN □□□□□QoS □□□□□□□
Rx	16,777,236	P-CSCF□AF□	IMS □□□□□□□□□
Sy	16,777,302	OCS	□□□□□□□□□□□□□□□□□ - □□ Sy □□

□□□□□□

PCRF □□□□ PDN □□□ VoLTE □□□□□□□□


PDN_SESSION
int id PK
string pgw_session_id
string assigned_pgw_host
string rat_type
string ip_address
boolean emergency
boolean roaming
contains
uses
belongs_to
LTE_CALL
int id PK
int pdn_session_id FK
string pcscf_session_id
string assigned_pcscf_host
string codec
string type
boolean dedicated_bearer_active
int dedicated_bandwidth_ul
int dedicated_bandwidth_dl
APN_PROFILE
int id PK
string name
SUBSCRIBER_STATE
int id PK
string imsi

Gx □□

□□□□□

1. □□□□□□ - □□□CCR-I□

□□□PGW □□□□□□□ PDN □□

□□ AVPs□

- Session-Id

- Origin-Host, Origin-Realm
- Subscription-Id□□□ IMSI□
- Called-Station-Id□APN □□□
- IP-CAN-Type□IP □□□□□□□□
- RAT-Type□□□□□□□□
- Framed-IP-Address□□□□□ IP □□□

PCRF □□□

1. □□ IMSI □□□□
2. □□ APN □□□□□ QoS □□
3. □□□□□□□□
4. □ APN □□□□□□ QoS □□

□□ **AVPs**□

- Result-Code: 2001□DIAMETER_SUCCESS□
- QoS-Information□APN □□□□□□□
- Default-EPS-Bearer-QoS□QCI, ARP, □□□□
- Bearer-Control-Mode
- □□/□□□□□□□□□□□□ - □□ □□□□□/□□□□□

2. □□□□□□ - □□□CCR-U□

□□□PGW □□□□□□□□□□□□RAT □□□□

PCRF □□□

1. □□□□ ID □□□□□□
2. □□□□□□□RAT □□□□□□□
3. □□□□□□□□□□□□

□□□Result-Code 2001□□□□□□□□□□

3. □□□□□□ - □□□CCR-T□

□□□PGW □□ PDN □□

PCRF □□□

1. □□□□ ID □□□□
2. □□□□□□□□□□□
3. □□□□

□□□Result-Code 2001

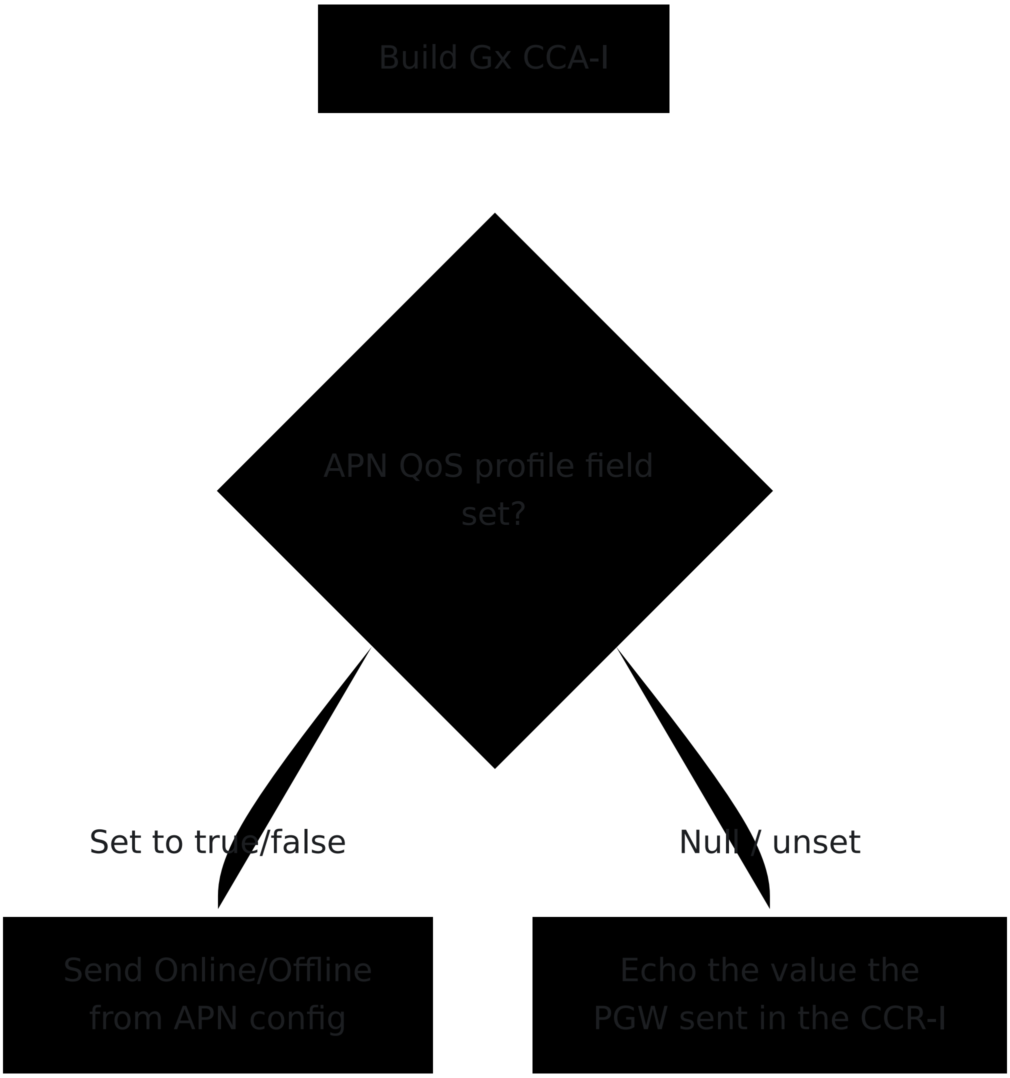
□□□□□/□□□□

□ Gx CCA-I □□□□□ `Online`□AVP 1009□□ `Offline`□AVP 1008□ AVPs □□ □□ **IP-CAN** □□□□□□□□□□□□□□□□□ 3GPP TS 29.212 □□□□□□□□□□□ `Online`/`Offline` □□□□□□□□□ □□□□□□□□□□□

□□□□□□PCRF □□ PGW/PCEF □ CCR-I □□□□□□□□APN QoS □□□□□□ □□ □□□□□□□□□□□ □□□□ APN QoS □□□□□□□□□□□□□□□

□□	□□	**AVP**	□□
`online_charging_enabled`	□□	`Online`□1009□	`true` → `ENABLE_ONLINE (1)`□`false` → `DISABLE_ONLINE (0)`
`offline_charging_enabled`	□□	`Offline`□1008□	`true` → `ENABLE_OFFLINE (1)`□`false` → `DISABLE_OFFLINE (0)`

□□□□□□□□□


Build Gx CCA-I
APN QoS profile field set?
Set to true/false
Null / unset
Send Online/Offline from APN config
Echo the value the PGW sent in the CCR-I

□□□□ **AVP** □□TS 29.212□□

AVP	□□	□	□□	□□
`Online`	1009	0	DISABLE_ONLINE	□□□□□OCS / Gy□□□□□□□
`Online`	1009	1	ENABLE_ONLINE	□□□□□□□ - □□□□□□□□□□□□□
`Offline`	1008	0	DISABLE_OFFLINE	□□□□□CDR / Gz□□□□□□□
`Offline`	1008	1	ENABLE_OFFLINE	□□□□□□□ - □□□□□□□□□

□□□□□□ `online_charging_enabled`/`offline_charging_enabled` □□□□□□□□□□□□□ □□□□□□□□□□□□ - PCRF □□ PGW □□ APN □□□ CCR-I □□□□□□□□□□□ PGW □□□□□□□□

□□□□□□□ APN □□□□□□□□□□ PGW □□□□ OCS□□□□□□□□□□□□□□□/□□□ APN □□□□□□□□□ □ CDR □□□□□□□□□ APN QoS □□□□□□□□□□□□□□□□□□□□□ APN□

> □□□□□□□ *□□□□□*□□□□□□□□□□ □□□□ □□
> `online_charging_enabled`/`offline_charging_enabled` □□□□□□□□□□□□
> Charging-Rule-Definition AVPs □□

4. □□□□□□□RAR□

□□□PCRF → PGW□HSS □□□

□□□

- IMS □□□□□Rx AAR □□ Gx RAR□
- IMS □□□□□Rx STR □□ Gx RAR□
- □□ REST API □□□□□□

RAR AVPs□

- Session-Id□PGW □□ ID□
- Auth-Application-Id: 16,777,238
- Re-Auth-Request-Type□0 = □□□□
- Charging-Rule-Install/Remove
- QoS-Information□□□□□□□□

PGW □□□□□□□□□□□/□□/□□□□□□

□□□□□□□□□□

PCRF □□□□□□□□□□TFT□□□□□□□□□□□□

- □□□□□□ - □□□□□□□□□□□□□□□
- □□□□ - □□□□□□□□□□□□□□□□
- □□□□□□□ - □□□□□□□□□□□□□□□ QoS

□□□□□□□

- □□□□□□□□ Gx RAR □□□□

- □□□□□□□□□□□□□□□□□□□□□
- □□□□□□□□□□5 □□□□□□□/□□ IP□□/□□□□□□ TFT □□

□□□□□

- □□□ - □□□□□□Spotify□WhatsApp□Facebook□□□□□□□□□□□□□□□
- □□□□□ - □□□□□□□□□□□□□□□□□□□□□□□□□□□
- □□□□ - □□□□□□□□□□□□□□□□□
- □□□□□□□ - □□□□□□□□□□□□□□□□□□
- □□□□ - □□□□□□□���□□□□□□
- □□ **SLA** - □□□□□□□□□ QoS

QoS □□□□

□□□□ **QoS**□□□ APN □□□□□□

```
{
  "QoS-Class-Identifier": 9,          // QCI□9 = □□□□□
  "APN-Aggregate-Max-Bitrate-UL": 50000,  // kbps
  "APN-Aggregate-Max-Bitrate-DL": 100000, // kbps
  "Allocation-Retention-Priority": {
    "Priority-Level": 8,
    "Pre-emption-Capability": 1,      // □□□□
    "Pre-emption-Vulnerability": 1    // □□□□□
  }
}
```

□□□□ **QoS**□□□ VoLTE□□

```
{
  "QoS-Class-Identifier": 1,          // QCI 1 = □□□□
  "Max-Requested-Bandwidth-UL": 128000,   // bps
  "Max-Requested-Bandwidth-DL": 128000,   // bps
  "Guaranteed-Bitrate-UL": 128000,
  "Guaranteed-Bitrate-DL": 128000
}
```

Rx □□

□□□□□

1. AA □□□AAR□/ AA □□□AAA□

□□□P-CSCF □□ IMS □□□□□□□□VoLTE □□□□□

□□ AVPs□

- Session-Id□P-CSCF □□□□□□
- Subscription-Id□IMSI □ SIP URI□
- □□□□□□
  - □□□□□□□□□□□
  - Max-Requested-Bandwidth-UL/DL
  - Codec-Data
  - Flow-Description□5 □□□□□□□□□
- AF-Application-Identifier

PCRF □□□

1. □□ IMSI □ SIP URI □□□□
2. □□□□ IMS □□
3. □□□□□□□□□□□□□□□□□□□
4. □□□□□□□□
5. □□ **Gx RAR** □ **PGW** □□□□□□
6. □□ Gx RAA □□
7. □□ Rx AAA □□□□□

□□ AVPs□

- Result-Code: 2001□□□□□ 5063□□□□□□□

□□□SOS□□□□□□□□□□/□ SIM □□□□□

□□□□□`urn:service:sos`□□□□□□□□□□□□□□□ SIM □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ QoS□TS 23.167□□

PCRF [illegible] AAR[illegible]

1. [illegible] `Subscription-Id` [illegible] `sos` [illegible] SIP URI[illegible] AAR [illegible] `Framed-IP-Address` [illegible] Gx CCR-I [illegible] PDN [illegible]Gx [illegible] APN / `Called-Station-Id` [illegible] `sos` [illegible] INVITE[illegible]
2. [illegible] `Subscription-Id` [illegible] `Framed-IP-Address` [illegible] **PDN**[illegible] Gx [illegible]`subscriber_state_id: nil`[illegible]AAR [illegible]
3. **SOS APN** [illegible] QoS [illegible] SOS APN [illegible]“[illegible]���[illegible] SOS APN [illegible]”[illegible]
4. Gx RAR [illegible]PDN [illegible]QCI 1[illegible]AAA [illegible] `2001`[illegible]

> [illegible] `Framed-IP-Address` [illegible] Gx [illegible] PDN [illegible] UE [illegible] P-CSCF [illegible] AAR [illegible] PCRF[illegible]

[illegible] **SOS APN** [illegible] `sos` APN [illegible]PCRF [illegible] SOS APN [illegible]

- [illegible] APN [illegible] APN [illegible] `sos` [illegible]
- [illegible] OmniHSS [illegible] SOS APN [illegible]

[illegible] PDN [illegible] `apn_profile_id: nil` - [illegible] QoS[illegible]

[illegible]	[illegible]
[illegible] SOS [illegible] QCI	5
[illegible] QCI	1[illegible]ARP [illegible] 2[illegible]
[illegible]	1
[illegible]	[illegible]
[illegible]	[illegible]
APN-AMBR [illegible]/[illegible]	10000 kbps

[illegible] PCRF [illegible] `sos` APN [illegible] - [illegible]

2. [illegible]STR[illegible]/ [illegible]STA[illegible]

[illegible]P-CSCF [illegible] IMS [illegible]

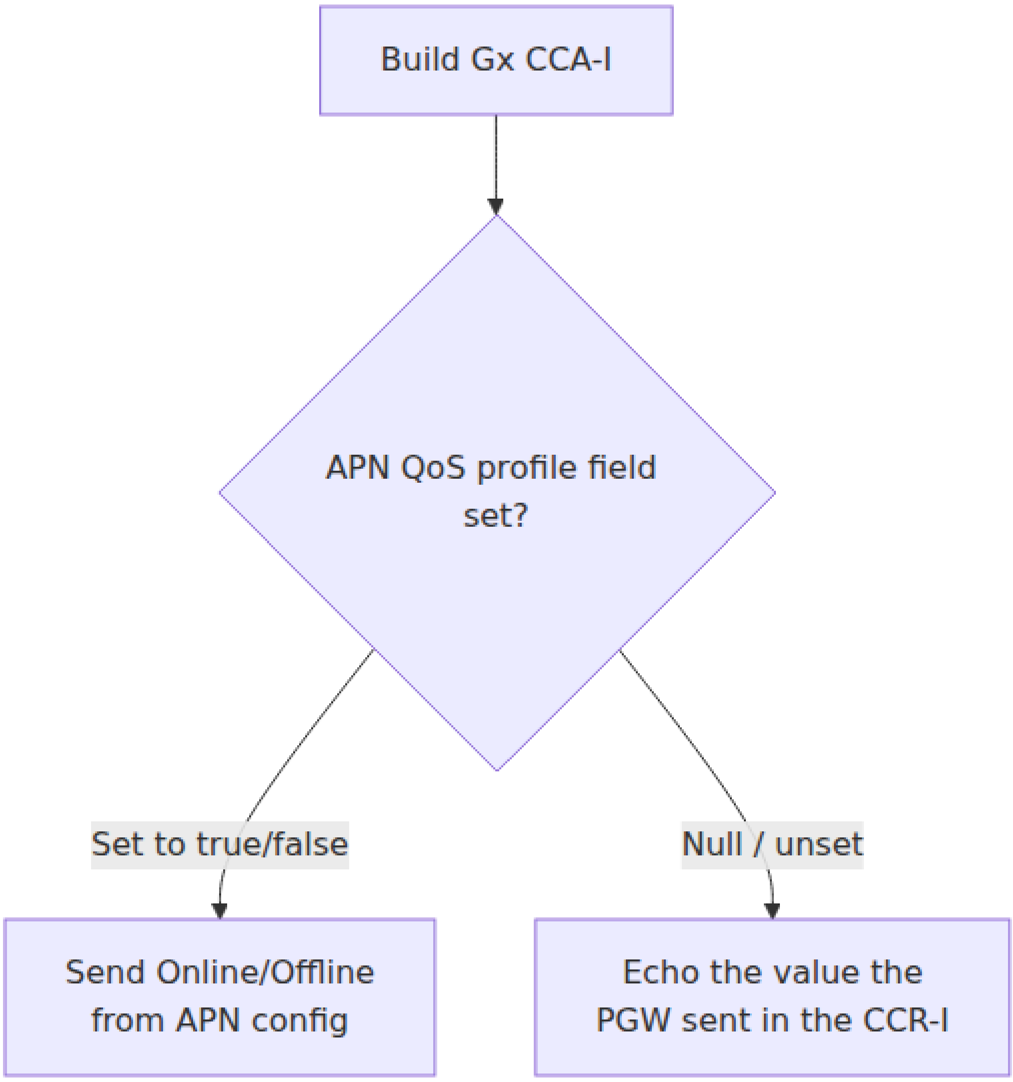
PCRF [illegible]

1. [illegible] P-CSCF [illegible] ID [illegible]
2. [illegible] **Gx RAR** [illegible] **PGW** [illegible]
3. [illegible]
4. [illegible] STA [illegible]

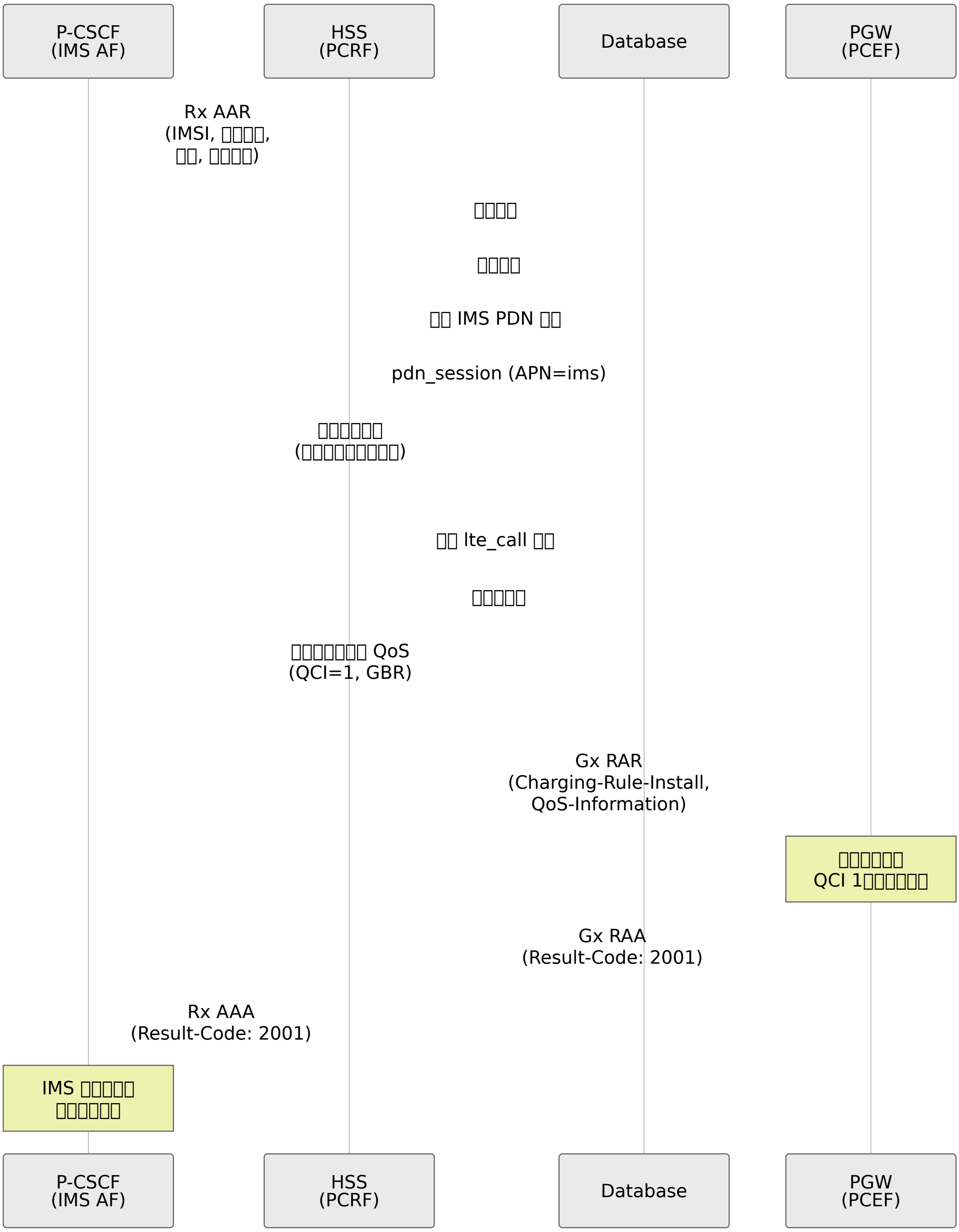
[illegible]Result-Code 2001

[illegible]

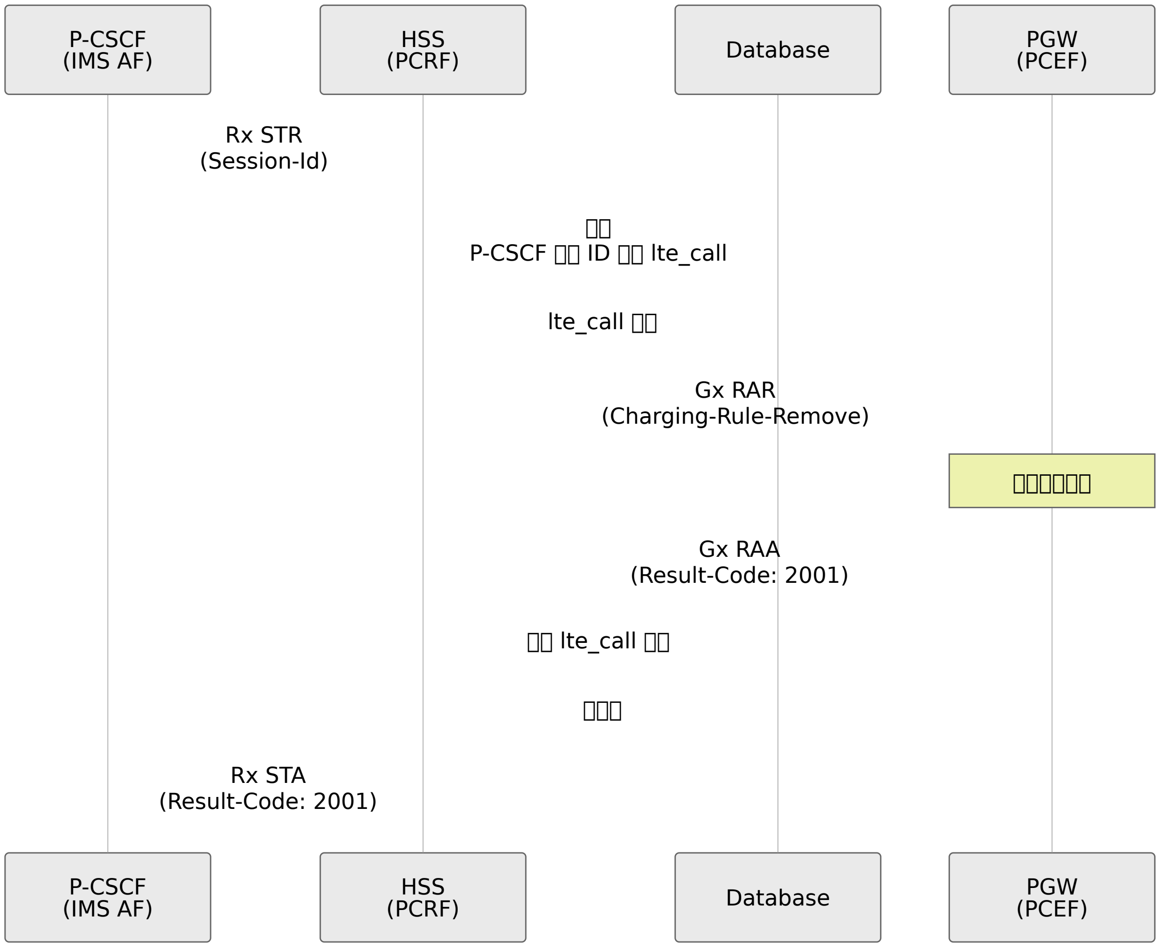
[illegible] 1[illegible]PDN [illegible]


Build Gx CCA-I
APN QoS profile field set?
Set to true/false
Null / unset
Send Online/Offline from APN config
Echo the value the PGW sent in the CCR-I

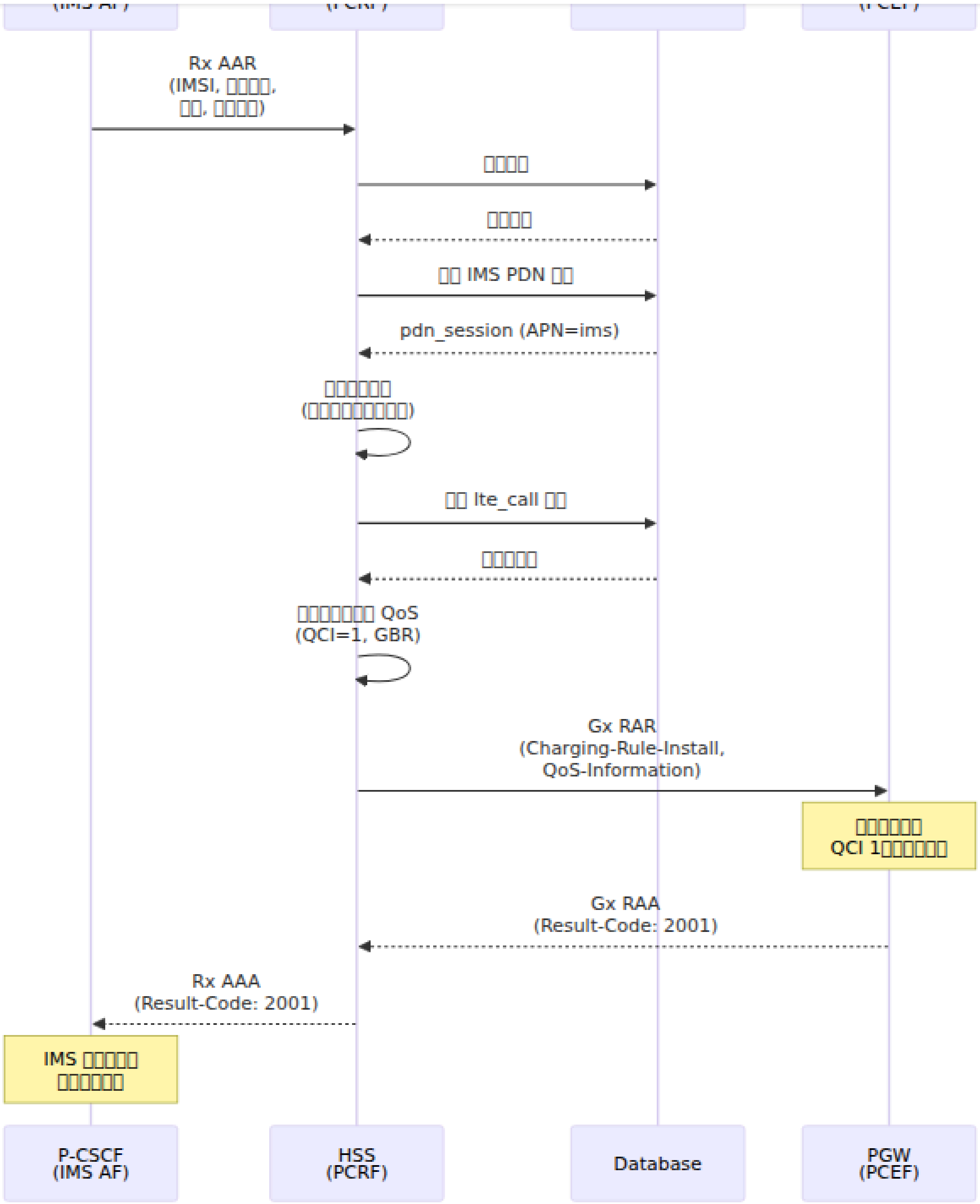
□□ 2□VoLTE □□□□□Rx AAR → Gx RAR□


P-CSCF
(IMS AF)
HSS
(PCRF)
Database
PGW
(PCEF)
Rx AAR
(IMSI, □□□□,
□□, □□□□)
□□□□
□□□□
□□ IMS PDN □□
pdn_session (APN=ims)
□□□□□□
(□□□□□□□□□)
□□ lte_call □□
□□□□□
□□□□□□□ QoS
(QCI=1, GBR)
Gx RAR
(Charging-Rule-Install,
QoS-Information)
□□□□□□
QCI 1□□□□□□
Gx RAA
(Result-Code: 2001)
Rx AAA
(Result-Code: 2001)
IMS □□□□□
□□□□□□
P-CSCF
(IMS AF)
HSS
(PCRF)
Database
PGW
(PCEF)

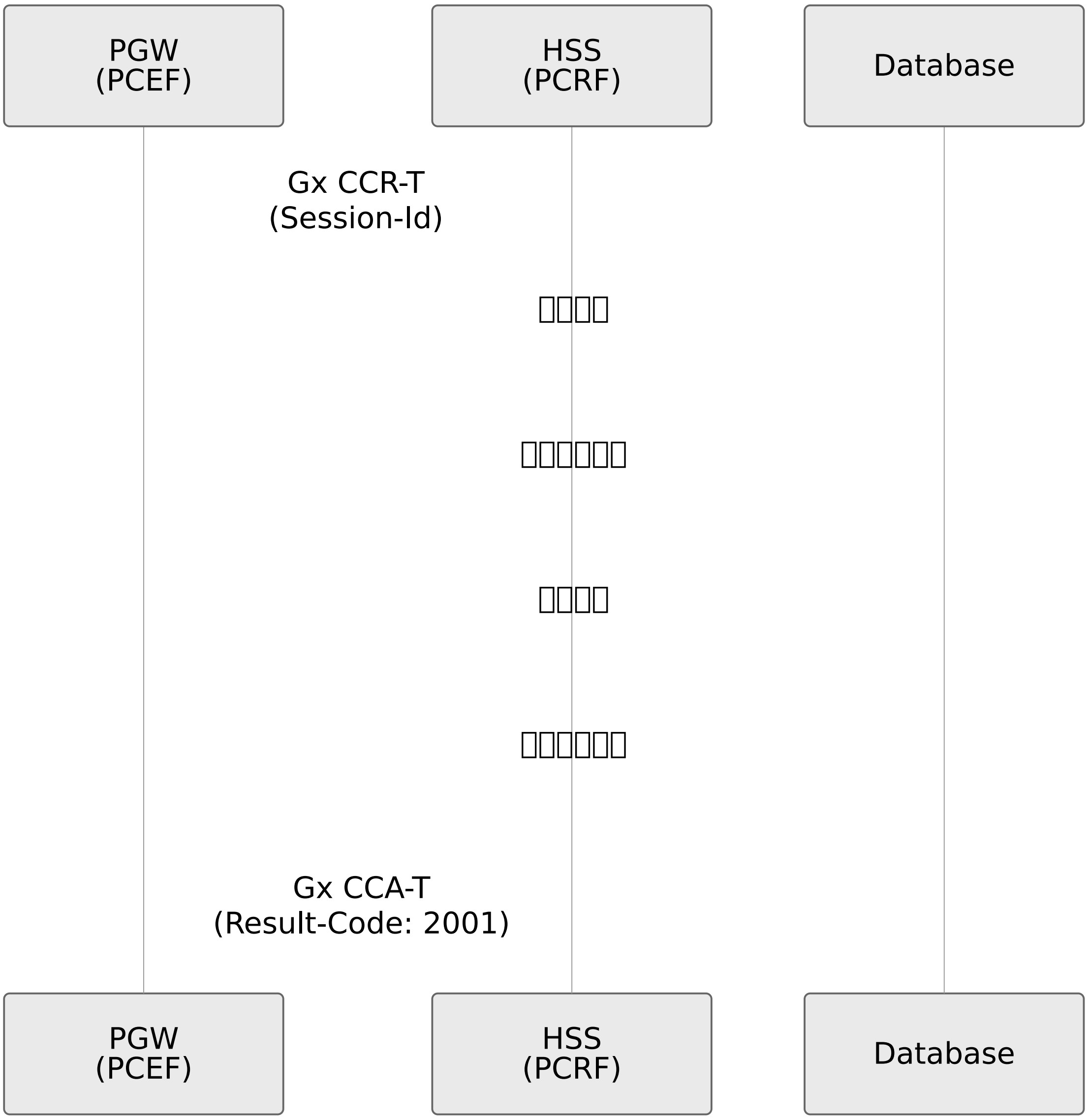
□□ 3□VoLTE □□□□□Rx STR → Gx RAR□


P-CSCF
(IMS AF)
HSS
(PCRF)
Database
PGW
(PCEF)
Rx STR
(Session-Id)
□□
P-CSCF □□ ID □□ lte_call
lte_call □□
Gx RAR
(Charging-Rule-Remove)
□□□□□□
Gx RAA
(Result-Code: 2001)
□□ lte_call □□
□□□
Rx STA
(Result-Code: 2001)
P-CSCF
(IMS AF)
HSS
(PCRF)
Database
PGW
(PCEF)

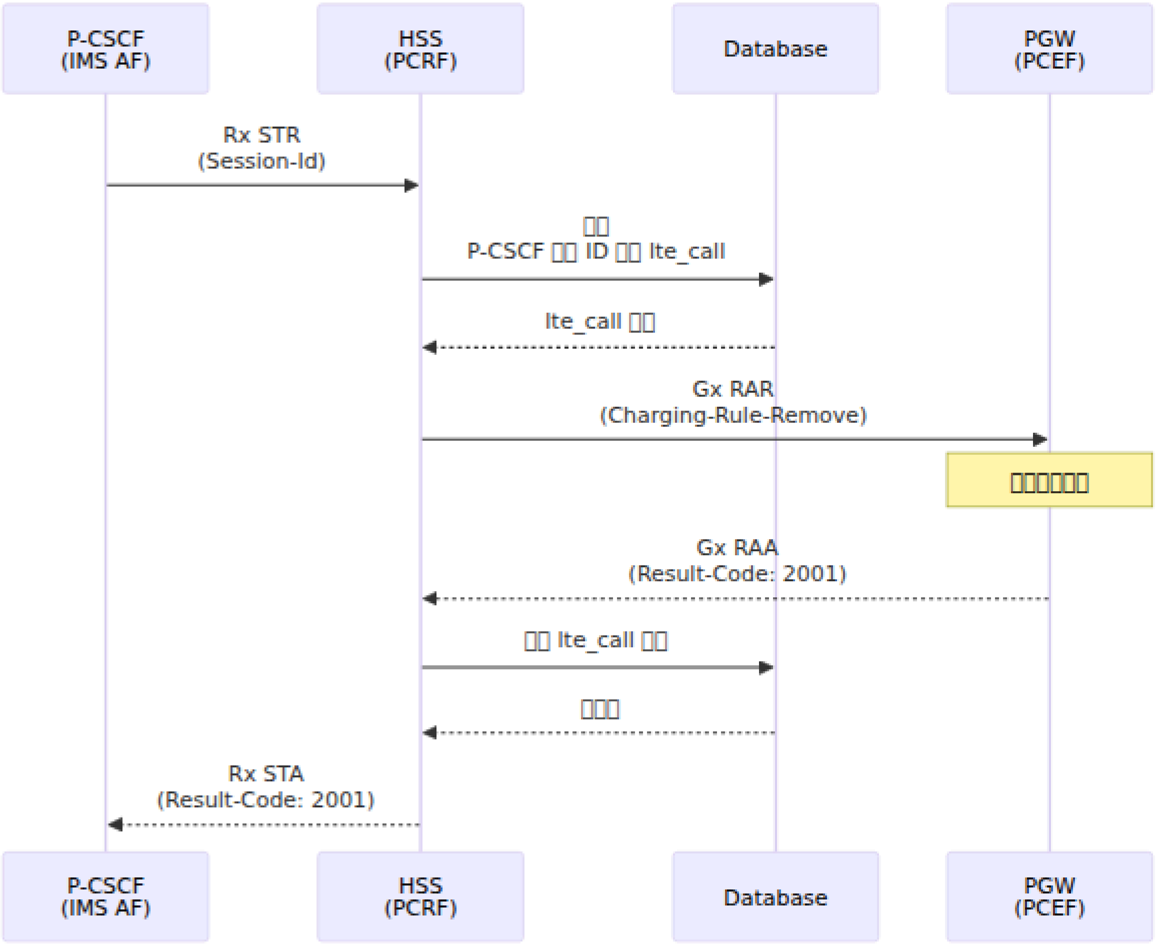
□□ 4□PDN □□□□


(IMS AF)
(PCRF)
(PCEF)
Rx AAR
(IMSI, □□□□,
□□, □□□□)
□□□□
□□□□
□□ IMS PDN □□
pdn_session (APN=ims)
□□□□□□
(□□□□□□□□□□)
□□ lte_call □□
□□□□□
□□□□□□□ QoS
(QCI=1, GBR)
Gx RAR
(Charging-Rule-Install,
QoS-Information)
□□□□□□
QCI 1□□□□□□□
Gx RAA
(Result-Code: 2001)
Rx AAA
(Result-Code: 2001)
IMS □□□□□
□□□□□□
P-CSCF
(IMS AF)
HSS
(PCRF)
Database
PGW
(PCEF)

□□ 5□PDN □□□□


PGW
(PCEF)
HSS
(PCRF)
Database
Gx CCR-T
(Session-Id)
□□□□
□□□□□□
□□□□
□□□□□□
Gx CCA-T
(Result-Code: 2001)
PGW
(PCEF)
HSS
(PCRF)
Database

[illegible] 6[illegible] REST API [illegible]


P-CSCF
(IMS AF)
HSS
(PCRF)
Database
PGW
(PCEF)
Rx STR
(Session-Id)
[illegible]
P-CSCF [illegible] ID [illegible] lte_call
lte_call [illegible]
Gx RAR
(Charging-Rule-Remove)
[illegible]
Gx RAA
(Result-Code: 2001)
[illegible] lte_call [illegible]
[illegible]
Rx STA
(Result-Code: 2001)
P-CSCF
(IMS AF)
HSS
(PCRF)
Database
PGW
(PCEF)

REST API

PCRF [illegible]

[illegible]`POST /api/operation/pcrf_re_auth`

[illegible] Gx [illegible]

[illegible] APN QoS [illegible] - [illegible]

[illegible]

```
{
  "imsi": "999999876543210",
  "apn": "ims"
}
```

□□□□□HTTP 200□□

```
{
  "data": "Gx □□□□□□□□□□ pgw.epc.mnc999.mcc999.3gppnetwork.org□ Result-Code: 2001"
}
```

□□□□□HTTP 400□□

```
{
  "error": "□□□□ 999999876543210 □□□□□□□□□□□□□ PDN □□"
}
```

□□□□□ API

PCRF □□□□□□□□□ APN □□□□□ QoS □□□□□□□□□□□ REST API □□□□□□

□□□□□□□□□□□ APN QoS □□□□□□□□□□□□□□□ QCI□□□□□□□□□□□□□□ APN □□□ PDN □□□ PGW □□ Gx □□□□□□□RAR□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

□□□□

□□□□□□□□□□□

```
APN □□□ → APN QoS □□□□ → APN □□□□
     ↓                  ↓                ↓
  "internet"      QCI, AMBR, ARP   □□□□□□□□
```

1. □□ APN □□□

□□ APN □□□ IP □□□□□

□□□`POST /api/apn/identifier`

□□□□

```json
{
  "apn_identifier": {
    "apn": "internet",
    "ip_version": "ipv4v6"
  }
}
```

IP □□□□□

- `"ipv4"` - □ IPv4
- `"ipv6"` - □ IPv6
- `"ipv4v6"` - □□□IPv4 □ IPv6□
- `"ipv4_or_ipv6"` - □□□□□IPv4 □ IPv6□

□□□HTTP 201□□

```json
{
  "data": {
    "id": "4fa85f64-5717-4562-b3fc-2c963f66afa6",
    "apn": "internet",
    "ip_version": "ipv4v6"
  }
}
```

□□□

- `apn`□□□□1-254 □□□□□□
- `ip_version`□□□□□□□□□□□□□□□

□□ **APN** □□□□`GET /api/apn/identifier`

2. □□ APN QoS □□□□

□□ QoS □□□□□□QCI□□□□□□

□□□`POST /api/apn/qos_profile`

□□□□

```
{
  "apn_qos_profile": {
    "name": "□□□□□□□",
    "qci": 9,
    "allocation_retention_priority": 8,
    "apn_ambr_dl_kbps": 100000,
    "apn_ambr_ul_kbps": 50000,
    "pre_emption_capability": false,
    "pre_emption_vulnerability": true,
    "online_charging_enabled": false,
    "offline_charging_enabled": true
  }
}
```

QoS □□□

[illegible]	[illegible]	[illegible]	[illegible]
`name`	[illegible]	1-254 [illegible]	[illegible]
`qci`	[illegible]	1-254	QoS [illegible]1-4 = GBR[illegible]5-9 = [illegible] GBR[illegible]
`allocation_retention_priority`	[illegible]	1-15	ARP [illegible]1 = [illegible]
`apn_ambr_dl_kbps`	[illegible]	1-4,294,967,293	APN [illegible][illegible]kbps[illegible]
`apn_ambr_ul_kbps`	[illegible]	1-4,294,967,293	APN [illegible][illegible]kbps[illegible]
`pre_emption_capability`	[illegible]	true/false	[illegible]
`pre_emption_vulnerability`	[illegible]	true/false	[illegible]
`online_charging_enabled`	[illegible]	true/false/null	[illegible] `Online` AVP [illegible] Gx CCA-I[illegible]`null`[illegible] PGW [illegible] CCR-I [illegible] [illegible]/[illegible]
`offline_charging_enabled`	[illegible]	true/false/null	[illegible] `Offline` AVP [illegible] Gx CCA-I[illegible]`null`[illegible] PGW [illegible] CCR-I [illegible] [illegible]/[illegible]

□□ QCI □□

- `1` - □□□□□VoLTE□ - GBR□100ms □□□□
- `2` - □□□□ - GBR□150ms □□□□
- `5` - IMS □□ - □ GBR□100ms □□□□
- `9` - □□□□□□□□□ - □ GBR□300ms □□□□

□□□HTTP 201□□

```json
{
  "data": {
    "id": "8d8ac610-566d-4ef0-9c22-186b2a5ed793",
    "name": "□□□□□□□",
    "qci": 9,
    "allocation_retention_priority": 8,
    "apn_ambr_dl_kbps": 100000,
    "apn_ambr_ul_kbps": 50000,
    "pre_emption_capability": false,
    "pre_emption_vulnerability": true,
    "online_charging_enabled": false,
    "offline_charging_enabled": true
  }
}
```

□□ QoS □□□□□`GET /api/apn/qos_profile`

3. □□ APN □□□□

□ APN □□□□ QoS □□□□□□□

□□□`POST /api/apn/profile`

□□□□

```
{
  "apn_profile": {
    "name": "□□□ APN",
    "apn_identifier_id": "4fa85f64-5717-4562-b3fc-2c963f66afa6",
    "apn_qos_profile_id": "8d8ac610-566d-4ef0-9c22-186b2a5ed793"
  }
}
```

□□□

- `name`□□□□□□□□□□□□□□□□
- `apn_identifier_id`□□□ □□ APN □□□ □ ID
- `apn_qos_profile_id`□□□ □□ APN QoS □□□□ □ ID

□□□HTTP 201□□

```
{
  "data": {
    "id": "a1b2c3d4-e5f6-4a3b-8c2d-1e0f9a8b7c6d",
    "name": "□□□ APN",
    "apn_identifier_id": "4fa85f64-5717-4562-b3fc-2c963f66afa6",
    "apn_qos_profile_id": "8d8ac610-566d-4ef0-9c22-186b2a5ed793"
  }
}
```

□□□

- `apn_identifier_id` □ `apn_qos_profile_id` □□□□□□□
- □□ APN □□□□ QoS □□□□□□□□□□□□□

□□ APN □□□□□`GET /api/apn/profile`

□□□□□□□□

□□ 1□□□ IMS APN □□□VoLTE□

```
# 1. □□ APN □□□
curl -X POST https://hss.example.com:8443/api/apn/identifier \
  -H "Content-Type: application/json" \
  -d '{
    "apn_identifier": {
      "apn": "ims",
      "ip_version": "ipv4v6"
    }
  }'
# □□□{"data": {"id": "2c3e4f5a-6b7c-4d8e-9f0a-1b2c3d4e5f6a", ...}}

# 2. □□ QoS □□□□□IMS □□□
curl -X POST https://hss.example.com:8443/api/apn/qos_profile \
  -H "Content-Type: application/json" \
  -d '{
    "apn_qos_profile": {
      "name": "IMS □□ QoS",
      "qci": 5,
      "allocation_retention_priority": 2,
      "apn_ambr_dl_kbps": 5000,
      "apn_ambr_ul_kbps": 5000,
      "pre_emption_capability": true,
      "pre_emption_vulnerability": false
    }
  }'
# □□□{"data": {"id": "7b44a3e0-27cc-4b21-8d7a-3f19e5c2b8d4", ...}}

# 3. □□ APN □□□□
curl -X POST https://hss.example.com:8443/api/apn/profile \
  -H "Content-Type: application/json" \
  -d '{
    "apn_profile": {
      "name": "IMS APN",
      "apn_identifier_id": "2c3e4f5a-6b7c-4d8e-9f0a-1b2c3d4e5f6a",
      "apn_qos_profile_id": "7b44a3e0-27cc-4b21-8d7a-3f19e5c2b8d4"
    }
  }'
# □□□{"data": {"id": "91c2f3a4-5d6e-4f7a-8b9c-0d1e2f3a4b5c", ...}}
```

□□ 2□□□□□□

□□□□APN □□□□□□ EPC □□□□□□□□□□□□□ API □□ □□□ APN □□□□□□□□

[illegible]

[illegible] QoS [illegible]

```
PATCH /api/apn/qos_profile/{id}
PUT /api/apn/qos_profile/{id}
```

[illegible] - [illegible]

```
# [illegible] QoS [illegible]
curl -X PATCH
https://hss.example.com:8443/api/apn/qos_profile/8d8ac610-566d-
4ef0-9c22-186b2a5ed793 \
  -H "Content-Type: application/json" \
  -d '{
    "apn_qos_profile": {
      "apn_ambr_dl_kbps": 150000,
      "apn_ambr_ul_kbps": 75000
    }
  }'
```

[illegible]

1. [illegible] QoS [illegible]
2. [illegible] QoS [illegible] APN [illegible] PDN [illegible]
3. [illegible] PGW [illegible] Gx RAR
4. PGW [illegible] QoS [illegible]
5. [illegible]

[illegible] 100 [illegible] QoS [illegible]“[illegible]” APN [illegible] API [illegible] 100 [illegible] 150 Mbps [illegible]/75 Mbps [illegible]

[illegible] APN QoS [illegible] [illegible] APN [illegible] PDN [illegible]

[illegible]

```
DELETE /api/apn/identifier/{id}
DELETE /api/apn/qos_profile/{id}
DELETE /api/apn/profile/{id}
```

□□□□□

- □□□□□ APN □□□□□□□ APN □□□□ QoS □□□□
- □□□□□□□□□□□□ APN □□□□

□□□□

□□□□□□□□ 100 Mbps / □□ 50 Mbps□□

```json
{
  "apn_qos_profile": {
    "name": "□□□□□",
    "qci": 9,
    "allocation_retention_priority": 8,
    "apn_ambr_dl_kbps": 100000,
    "apn_ambr_ul_kbps": 50000,
    "pre_emption_capability": false,
    "pre_emption_vulnerability": true
  }
}
```

□□□□□□□□ 500 Mbps / □□ 100 Mbps□□

```json
{
  "apn_qos_profile": {
    "name": "□□□□□",
    "qci": 8,
    "allocation_retention_priority": 5,
    "apn_ambr_dl_kbps": 500000,
    "apn_ambr_ul_kbps": 100000,
    "pre_emption_capability": true,
    "pre_emption_vulnerability": false
  }
}
```

[illegible]/M2M[illegible]

```
{
  "apn_qos_profile": {
    "name": "[illegible] M2M",
    "qci": 9,
    "allocation_retention_priority": 10,
    "apn_ambr_dl_kbps": 1024,
    "apn_ambr_ul_kbps": 512,
    "pre_emption_capability": false,
    "pre_emption_vulnerability": true
  }
}
```

[illegible]

```
{
  "apn_qos_profile": {
    "name": "[illegible] APN",
    "qci": 5,
    "allocation_retention_priority": 1,
    "apn_ambr_dl_kbps": 10000,
    "apn_ambr_ul_kbps": 10000,
    "pre_emption_capability": true,
    "pre_emption_vulnerability": false
  }
}
```

[illegible]

Diameter [illegible]

Gx [illegible]`config/runtime.exs`[illegible]

```
%{
  application_name: :gx,
  application_dictionary: :diameter_gen_3gpp_gx,
  vendor_specific_application_ids: [
    %{vendor_id: 10415, auth_application_id: 16_777_238}
  ]
}
```

Rx □□□`config/runtime.exs`□□

```
%{
  application_name: :rx,
  application_dictionary: :diameter_gen_3gpp_rx,
  vendor_specific_application_ids: [
    %{vendor_id: 10415, auth_application_id: 16_777_236}
  ]
}
```

QoS □□

QoS □□□□□□

- □□□□□□□□□□ APN □□□□
    - `apn_qos_profile.qci`□QoS □□□□□
    - `apn_qos_profile.apn_ambr_ul_kbps`□□□□□□□□□□□
    - `apn_qos_profile.apn_ambr_dl_kbps`□□□□□□□□□□□
    - `apn_qos_profile.priority_level`□□□□□□□□□
- □□□□□□ Rx AAR □□□□□□□□□
    - QCI□1□□□□□□
    - □□□□□□□□ Max-Requested-Bandwidth AVPs
    - □□□□□□□ Flow-Description AVPs

□□□□

□□□□	□□	□□	□□
2001	□□	DIAMETER_SUCCESS	□□□□□□
5001	□□□	□□□□□	IMSI □□□□□□□□
5002	□□□	□□□□□	PDN □□□□□□□□□□□/□□
5063	□□□	□□□□□	IMS □□□□□□□

□□□□

□□□□

PCRF □□□

- □□ **PDN** □□ - □□ APN □□□□□□
- **VoLTE** □□ - □□ IMS □□□□□□□□□□□□□□
- **QoS** □□ - □□ APN □□□□□□
- □□□□ - □□□□□□□□□□□□

□□□□□□

PCRF □□□□□□□□□□□□

- □□ Gx □□□ □□□□□□/□□
- □□□□□□**TFT**□□□ □□□□□□□
- □□□□□□□□□□□□□□□□
- □□□□□□□□□□□□□□□□□□□□

□□□□□□□□□□□□□□□□□□□□□□□□□□ TFT □□□□□□□

□□□□

- Sy □□ - □□□□ OCS □□□□□□□□□
- Diameter □□ - □□□□□□□
- API □□ - □□□ API □□
- □□ - □□ HSS □□
- □□□□ - □□□□ Diameter AVP □□□

API [illegible]

← [illegible] API [illegible]

[illegible]

- [illegible]
- [illegible]

[illegible]

400 [illegible]

```
{
  "error": "Invalid JSON format"
}
```

[illegible]

- JSON [illegible]
- [illegible]
- [illegible]

404 [illegible]

```
{
  "error": "Resource not found"
}
```

[illegible]

- [illegible]/[illegible]/[illegible]
- URL [illegible] ID [illegible]

422 [illegible]

```json
{
  "errors": {
    "imsi": ["has already been taken"],
    "key_set_id": ["does not exist"]
  }
}
```

[illegible]

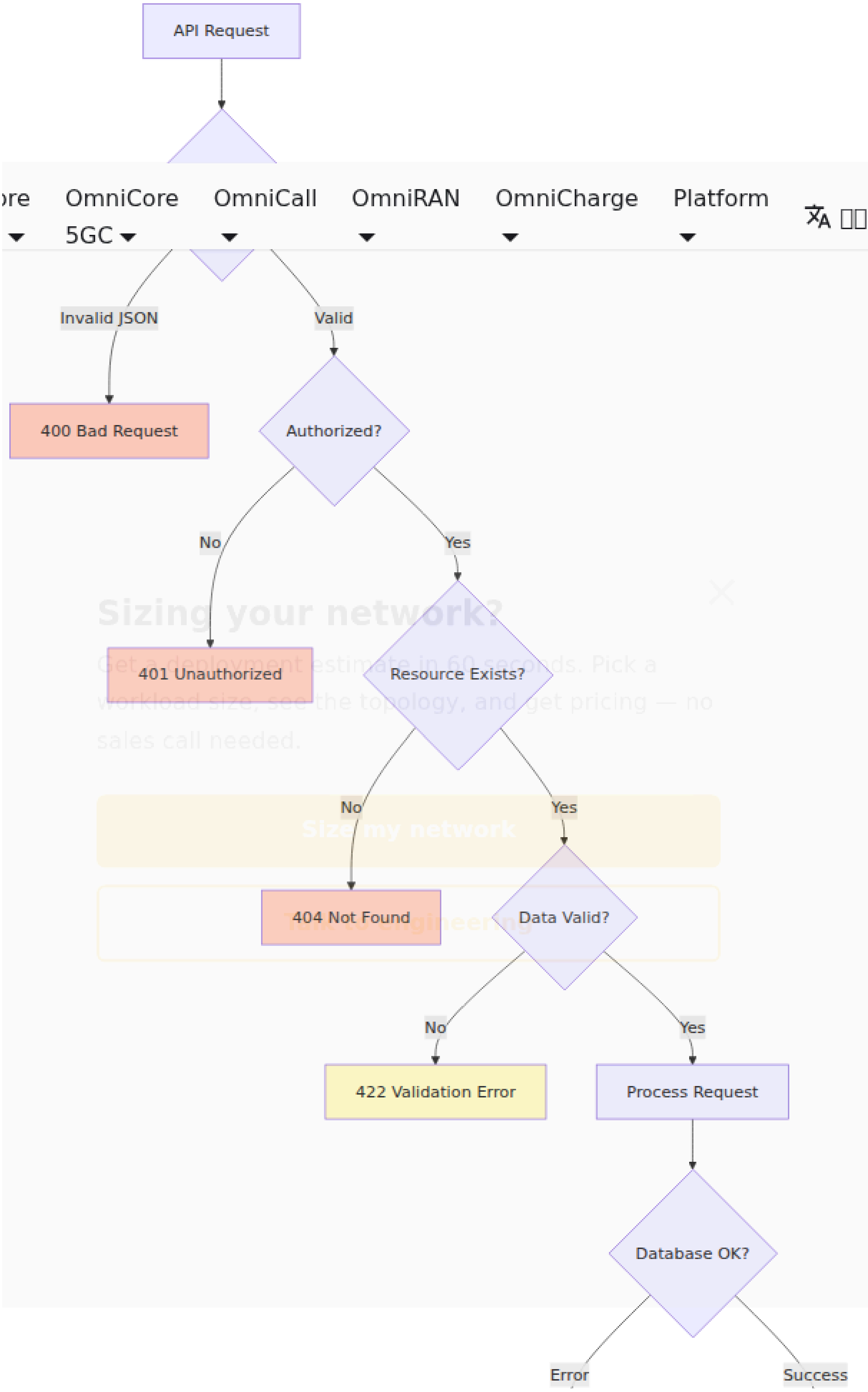
- [illegible]
- [illegible]
- [illegible]

500 [illegible]

```json
{
  "error": "Internal server error"
}
```

[illegible]

- [illegible]
- [illegible]


API Request
Invalid JSON
Valid
400 Bad Request
Authorized?
No
Yes
401 Unauthorized
Resource Exists?
No
Yes
404 Not Found
Data Valid?
No
Yes
422 Validation Error
Process Request
Database OK?
Error
Success

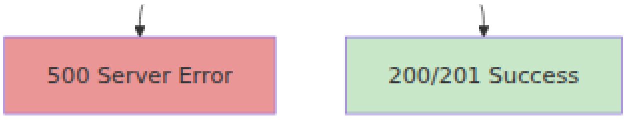
ore OmniCore 5GC OmniCall OmniRAN OmniCharge Platform

Sizing your network?

Get a deployment estimate in 60 seconds. Pick a workload size, see the topology, and get pricing — no sales call needed.

Size my network

Talk to engineering


500 Server Error
200/201 Success

← [illegible] API [illegible]

API [illegible]

← [illegible] API [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible] IP [illegible]

[illegible]

[illegible]

[illegible] [illegible] `jq` [illegible] JSON [illegible] `apt-get install jq` [illegible] `brew install jq` [illegible]

[illegible]

- [illegible]
- APN [illegible]
- EPC [illegible]
- [illegible]

```
# 1. □□□□□
KEY_SET_ID=$(curl -k -X POST
https://hss.example.com:8443/api/key_set \
  -H "Content-Type: application/json" \
  -d '{
    "ki": "0123456789ABCDEF0123456789ABCDEF",
    "opc": "FEDCBA9876543210FEDCBA9876543210",
    "authentication_algorithm": "milenage",
    "amf": "8000",
    "sqn": 0
  }' | jq -r '.response.id')

# 2. □□ APN QoS □□□□
APN_QOS_ID=$(curl -k -X POST
https://hss.example.com:8443/api/apn/qos_profile \
  -H "Content-Type: application/json" \
  -d '{
    "name": "□□□□□ QoS",
    "allocation_retention_priority": 8,
    "apn_ambr_dl_kbps": 50000,
    "apn_ambr_ul_kbps": 25000,
    "pre_emption_capability": true,
    "pre_emption_vulnerability": true,
    "qci": 9
  }' | jq -r '.response.id')

# 3. □□ APN □□□
APN_ID=$(curl -k -X POST
https://hss.example.com:8443/api/apn/identifier \
  -H "Content-Type: application/json" \
  -d '{
    "apn": "internet",
    "ip_version": "ipv4v6"
  }' | jq -r '.response.id')

# 4. □□ APN □□□□
APN_PROFILE_ID=$(curl -k -X POST
https://hss.example.com:8443/api/apn/profile \
  -H "Content-Type: application/json" \
  -d "{
    \"apn_identifier_id\": \"$APN_ID\",
    \"apn_qos_profile_id\": \"$APN_QOS_ID\",
    \"name\": \"□□□ APN\"
  }" | jq -r '.response.id')

# 5. □□ EPC □□□□
EPC_PROFILE_ID=$(curl -k -X POST
https://hss.example.com:8443/api/epc/profile \
  -H "Content-Type: application/json" \
  -d "{
    \"apn_profiles\": [$APN_PROFILE_ID],
    \"name\": \"□□□□□□\",
    \"network_access_mode\": \"packet_only\",
    \"tracking_area_update_interval_seconds\": 600,
    \"ue_ambr_dl_kbps\": 100000,
    \"ue_ambr_ul_kbps\": 50000
  }" | jq -r '.response.id')

# 6. □□□□
SUBSCRIBER_ID=$(curl -k -X POST
https://hss.example.com:8443/api/subscriber \
  -H "Content-Type: application/json" \
  -d "{
    \"imsi\": \"001001123456789\",
    \"key_set_id\": \"$KEY_SET_ID\",
    \"epc_profile_id\": \"$EPC_PROFILE_ID\"
  }" | jq -r '.response.id')

echo "□□□□□□□ID: $SUBSCRIBER_ID"
```

□□□□□□□

□□□□□□□□□□□□□□□□□□□□□

1. □□□□ (□□□) - □□□□□□
2. □□□□□□□□ (EPC □□□□) - □□□□□□□□□
3. **APN** □□ (APN □□□□) - □ QoS □□□□
4. □□□□ (□□) - □□□□□□□

□□□□□

- □□□□□□□□□□ MSISDN □□
- □□□□□□□□□□□□ IMS □□□□
- □□□□□□□□□□ □□□□□□

- [illegible]SIM[illegible]SIM

[illegible]

- [illegible]MSISDN[illegible] - [illegible]
- [illegible] - [illegible]

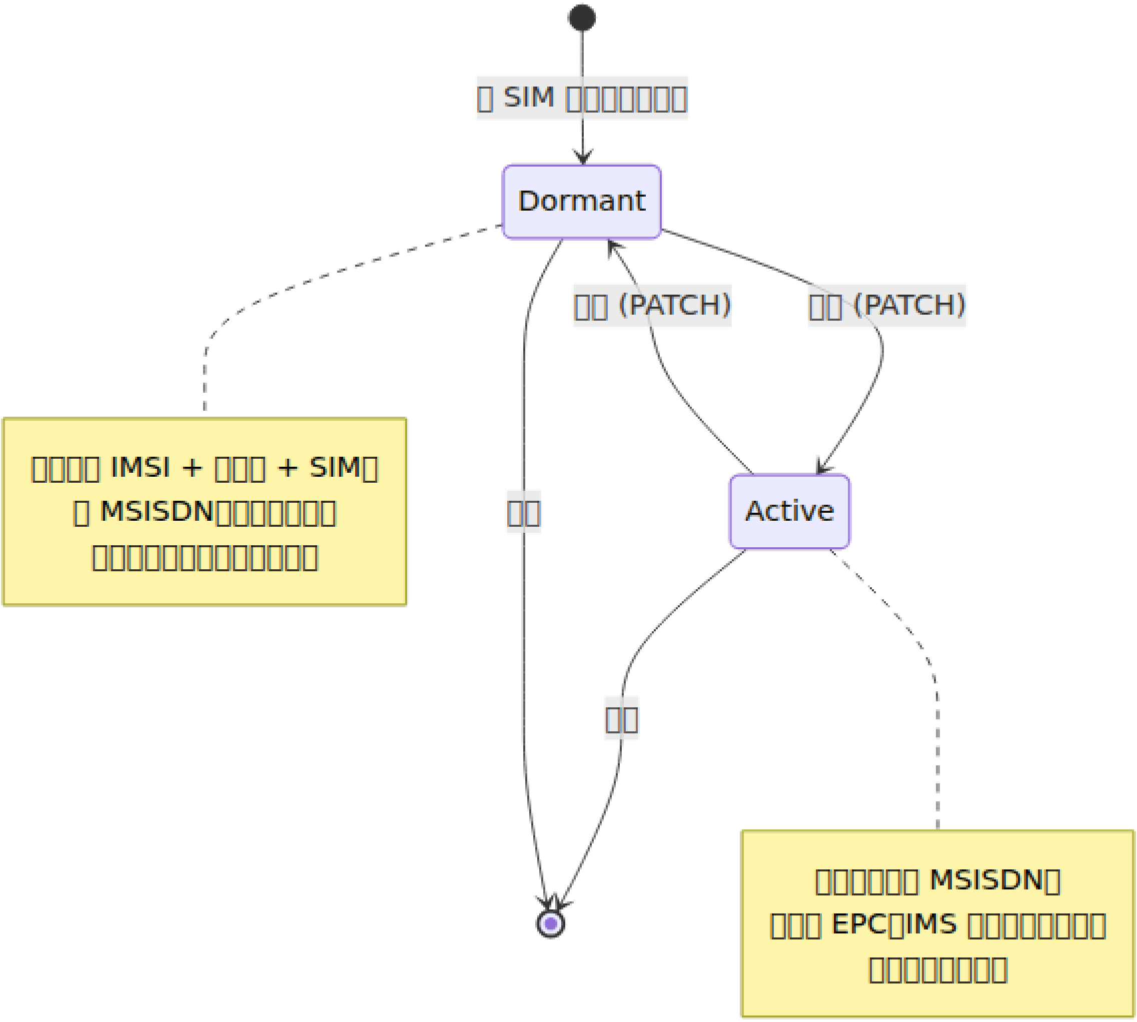
[illegible]

[illegible]SIM[illegible]

[illegible]SIM[illegible]SIM[illegible]ICCID[illegible]PIN[illegible]PUK[illegible]ADM[illegible]Ki[illegible]OPc[illegible]

[illegible]IMSI[illegible]EPC[illegible]IMS[illegible]MSISDN[illegible]SIM[illegible]SIM[illegible]SIM[illegible]

[illegible]


[illegible] SIM [illegible]
Dormant
[illegible] (PATCH)
[illegible] (PATCH)
Active
[illegible]
[illegible]
[illegible] IMSI + [illegible] + SIM[illegible]
[illegible] MSISDN[illegible]
[illegible]
[illegible] MSISDN[illegible]
[illegible] EPC[illegible]IMS [illegible]
[illegible]

[illegible] 1 [illegible] SIM[illegible]

[illegible] SIM [illegible] SIM [illegible] `jq` [illegible]

```
# 1. □ SIM □□□□□□□□□□ (Ki, OPc)
KEY_SET_ID=$(curl -k -X POST
https://hss.example.com:8443/api/key_set \
  -H "Content-Type: application/json" \
  -d '{
    "ki": "0123456789ABCDEF0123456789ABCDEF",
    "opc": "FEDCBA9876543210FEDCBA9876543210",
    "authentication_algorithm": "milenage",
    "amf": "8000",
    "sqn": 0
  }' | jq -r '.response.id')

# 2. □ SIM □□□□□□□ SIM (ICCID, PIN/PUK/ADM)
SIM_ID=$(curl -k -X POST https://hss.example.com:8443/api/sim \
  -H "Content-Type: application/json" \
  -d '{
    "iccid": "8944000000000000001",
    "is_esim": false,
    "ind_length": 5
  }' | jq -r '.response.id')

# 3. □□□□□□□□□□
#    imsi □ key_set_id □□□□□□□ SIM□□□□ MSISDN □□□□□□□
SUBSCRIBER_ID=$(curl -k -X POST
https://hss.example.com:8443/api/subscriber \
  -H "Content-Type: application/json" \
  -d "{
    \"imsi\": \"001010000000001\",
    \"key_set_id\": \"$KEY_SET_ID\",
    \"sim_id\": \"$SIM_ID\",
    \"enabled\": false,
    \"ims_enabled\": false
  }" | jq -r '.response.id')
```

□□□HSS □□□□□□□□□ □□□□□□□□□□□□□

□ 2 □□□□□□□□□□□□□□□□□□□□□

□□□□□□□□□□□ `PATCH` □□□□□ MSISDN□□□□□□□□□□ `enabled` □□□ `true`□

```
curl -k -X PATCH
https://hss.example.com:8443/api/subscriber/$SUBSCRIBER_ID \
  -H "Content-Type: application/json" \
  -d "{
    \"enabled\": true,
    \"ims_enabled\": true,
    \"msisdns\": [\"$MSISDN_ID\"],
    \"epc_profile_id\": \"$EPC_PROFILE_ID\",
    \"ims_profile_id\": \"$IMS_PROFILE_ID\",
    \"roaming_profile_id\": \"$ROAMING_PROFILE_ID\"
  }"
```

`PATCH` [illegible]IMSI[illegible] SIM [illegible] MSISDN [illegible] [illegible] [illegible]

[illegible] 3 [illegible]

[illegible] `enabled` [illegible] `false`[illegible]

```
curl -k -X PATCH
https://hss.example.com:8443/api/subscriber/$SUBSCRIBER_ID \
  -H "Content-Type: application/json" \
  -d '{
    "enabled": false,
    "ims_enabled": false
  }'
```

[illegible] IMS [illegible] `ims_enabled` [illegible] `false`[illegible] `enabled` [illegible] `true`[illegible]

[illegible]

[illegible]HSS [illegible]HSS [illegible]

- [illegible]`enabled` [illegible] `false`[illegible]
- [illegible] IMS [illegible]`ims_enabled` [illegible] `false`[illegible]
- [illegible] LTE [illegible] EPC [illegible] IMS [illegible] IMS [illegible]

□□□□□□□□□□ `DIAMETER_ERROR_USER_UNKNOWN (5001)` □ S6a □ Cx □□□□□□ 3GPP TS 29.272 □ 3GPP TS 29.229□□□□□□□ IMSI □□□□□□□□□□□□□□□□□□□□□□ IMSI□

□□□□□ IP □□

□□□□□□□□□□□□□□□□ IP □□□□□□

□□□ □□□□□□□“□□□” APN □□□□□ IPv4 □□□ IoT □□□□□

```
# □□□□□□□□□ jq (apt-get install jq □ brew install jq)

# 1. □□□□□
KEY_SET_ID=$(curl -k -X POST
https://hss.example.com:8443/api/key_set \
  -H "Content-Type: application/json" \
  -d '{
    "ki": "0123456789ABCDEF0123456789ABCDEF",
    "opc": "FEDCBA9876543210FEDCBA9876543210",
    "authentication_algorithm": "milenage",
    "amf": "8000",
    "sqn": 0
  }' | jq -r '.response.id')

# 2. □□ APN QoS □□□□
APN_QOS_ID=$(curl -k -X POST
https://hss.example.com:8443/api/apn/qos_profile \
  -H "Content-Type: application/json" \
  -d '{
    "name": "IoT □□□□",
    "allocation_retention_priority": 8,
    "apn_ambr_dl_kbps": 10000,
    "apn_ambr_ul_kbps": 5000,
    "pre_emption_capability": false,
    "pre_emption_vulnerability": false,
    "qci": 9
  }' | jq -r '.response.id')

# 3. □□ APN □□□
APN_ID=$(curl -k -X POST
https://hss.example.com:8443/api/apn/identifier \
  -H "Content-Type: application/json" \
  -d '{
    "apn": "internet",
    "ip_version": "ipv4"
  }' | jq -r '.response.id')

# 4. □□ APN □□□□
APN_PROFILE_ID=$(curl -k -X POST
https://hss.example.com:8443/api/apn/profile \
  -H "Content-Type: application/json" \
  -d "{
    \"apn_identifier_id\": \"$APN_ID\",
    \"apn_qos_profile_id\": \"$APN_QOS_ID\",
    \"name\": \"IoT □□□ APN\"
  }" | jq -r '.response.id')

# 5. □ APN □□□□ IP
STATIC_IP_ID=$(curl -k -X POST
https://hss.example.com:8443/api/epc/static_ip \
  -H "Content-Type: application/json" \
  -d "{
    \"apn_profile_id\": \"$APN_PROFILE_ID\",
    \"ipv4_static_ip\": \"100.64.1.100\"
  }" | jq -r '.response.id')

# 6. □□ EPC □□□□
EPC_PROFILE_ID=$(curl -k -X POST
https://hss.example.com:8443/api/epc/profile \
  -H "Content-Type: application/json" \
  -d "{
    \"apn_profiles\": [$APN_PROFILE_ID],
    \"name\": \"IoT □□□□\",
    \"network_access_mode\": \"packet_only\",
    \"tracking_area_update_interval_seconds\": 600,
    \"ue_ambr_dl_kbps\": 10000,
    \"ue_ambr_ul_kbps\": 5000
  }" | jq -r '.response.id')

# 7. □□ MSISDN□□□□□□
MSISDN_ID=$(curl -k -X POST
https://hss.example.com:8443/api/msisdn \
  -H "Content-Type: application/json" \
  -d '{
    "msisdn": "14155551000"
  }' | jq -r '.response.id')

# 8. □□□□□□ IP □□□
SUBSCRIBER_ID=$(curl -k -X POST
https://hss.example.com:8443/api/subscriber \
  -H "Content-Type: application/json" \
  -d "{
    \"imsi\": \"001001999999999\",
    \"key_set_id\": \"$KEY_SET_ID\",
    \"epc_profile_id\": \"$EPC_PROFILE_ID\",
    \"msisdns\": [$MSISDN_ID],
    \"static_ips\": [$STATIC_IP_ID]
  }" | jq -r '.response.id')

echo "IoT □□□□□□□"
echo "  □□ ID: $SUBSCRIBER_ID"
echo "  IMSI: 001001999999999"
echo "  MSISDN: 14155551000"
echo "  □□ IPv4: 100.64.1.100□□ 'internet' APN □□"
```

□□□□□□□

□□□□□□□□□□□□□□□ IoT □□□□□□

1. □□□□ (□□□) - □□□□□□
2. **APN** □□ (APN □□□□) - “□□��”□□□
3. □□ **IP** □□ (□□ IP) - □□□ IPv4 □□ 100.64.1.100
4. □□□□□□□□ (EPC □□□□) - IoT □□□□□□□
5. □□□□ (MSISDN) - □□□□□□
6. □□□□ (□□) - □□□□□□□

□□□

□□□□□□□□□□□□□“□□□” APN □□□□□□□□□ IP □□ `100.64.1.100`□□□□□□ DHCP □□□

□□□□□

- □□□□□□ IP □□□ APN□□□□ APN □□□□ 2-5
- □□□□□□□□□□□□ IMS □□□□
- □□□□□□□□□□ □□□□□□
- □□□□ SIM□□□□□□ SIM

□□□

- □□ IP □□ - □□□□□ IP □□
- □□□□□□□ - □□□□ IP □□□□□
- □ MSISDN □□ - □□□□□□□□

← □□ API □□

OmniHSS API [illegible]

← [illegible]

[illegible]

- API [illegible]
- [illegible]
- [illegible]
- Sh RepositoryData ([illegible])
- MSISDN [illegible]
- IMS [illegible]
- SIM [illegible]
- [illegible]
- [illegible]
- [illegible] IP [illegible]
- [illegible]
- EIR [illegible]
- [illegible]
- [illegible]
- API [illegible]

API [illegible]

[illegible] URL

```
https://[hostname]:8443/api
```

[illegible]

- **Content-Type:** `application/json`
- **[illegible]:** [illegible] HTTPS
- **[illegible]:** 8443[illegible]

[illegible]: [illegible] API [illegible]“[illegible]” JSON [illegible]

[illegible]:

```json
{
  "name": "value",
  "field": "value"
}
```

[illegible]:

```json
{
  "subscriber": {
    "name": "value",
    "field": "value"
  }
}
```

[illegible]:

```
# ✓ [illegible]
curl -X POST https://hss.example.com:8443/api/ims/profile \
  -H "Content-Type: application/json" \
  -d '{"name": "default", "ifc_template": "..."}'

# ✗ [illegible]
curl -X POST https://hss.example.com:8443/api/ims/profile \
  -H "Content-Type: application/json" \
  -d '{"ims_profile": {"name": "default", "ifc_template": "..."}}'
```

□□□□

□□□□□□ JSON□□□□□□□□

□□□□:

```json
{
  "status": "success",
  "response": { ... }
}
```

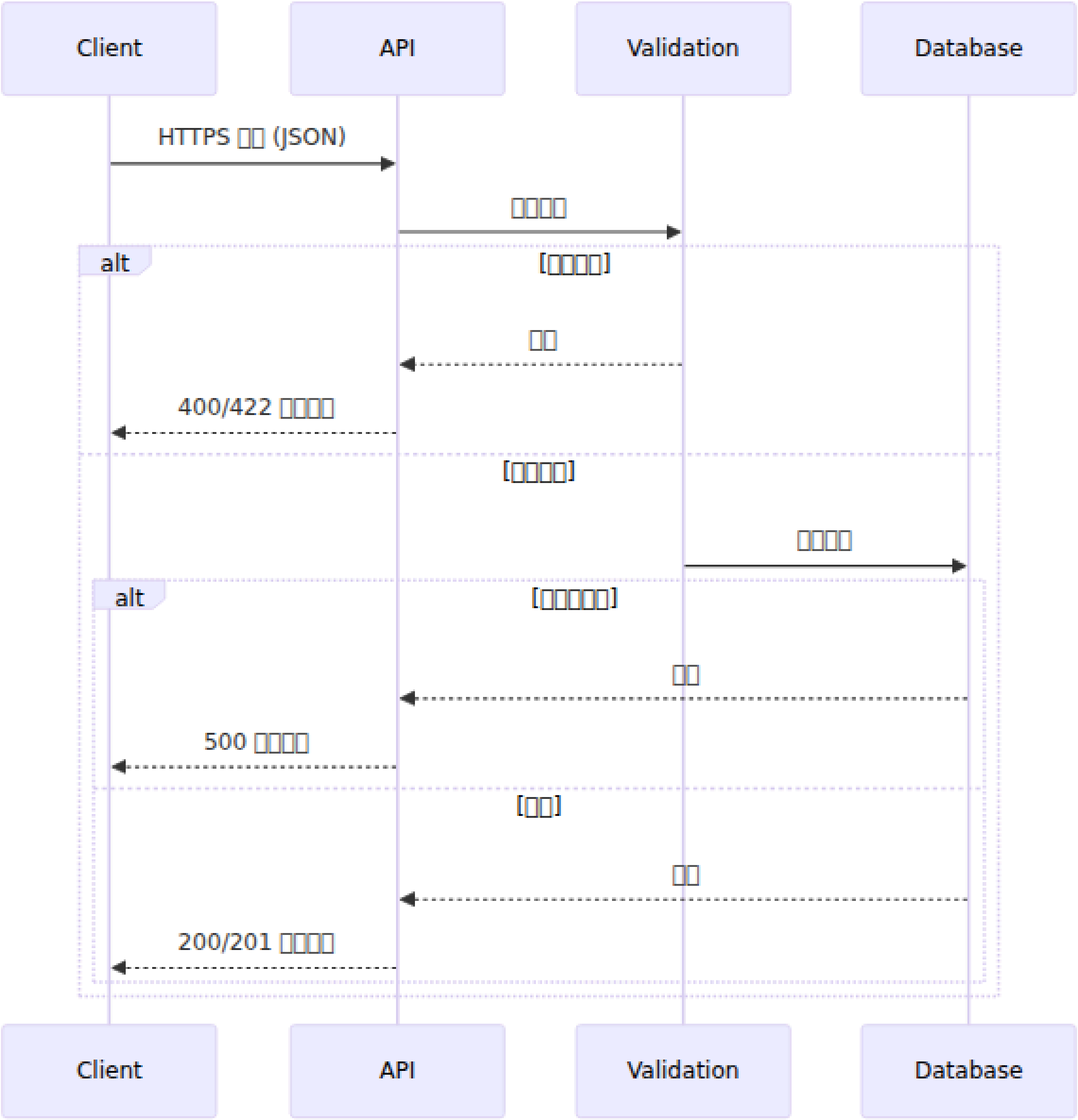
□□□□:

```json
{
  "status": "error",
  "response": {
    "invalid_fields": {
      "field_name": "error message"
    }
  }
}
```

HTTP □□□

□□	□□	□□
200	OK	□□□ GET□PUT□DELETE
201	□□	□□□ POST
400	□□□□	□□□□□□
404	□□□	□□□□□
422	□□□□□□□	□□□□
500	□□□□□□□	□□□□□□

API □□□□


Client
API
Validation
Database
HTTPS □□ (JSON)
□□□□
alt
[□□□□]
□□
400/422 □□□□
[□□□□]
□□□□
alt
[□□□□□]
□□
500 □□□□
[□□]
□□
200/201 □□□□
Client
API
Validation
Database

□□□□

□□□□

□□□□□□□□□□□□□

□□: `GET /api/subscriber`

□□□□:

□□	□□	□□
`enabled`	boolean	□□□□□□
`ims_enabled`	boolean	□ IMS □□□□□□

□□□□:

```
curl -k https://hss.example.com:8443/api/subscriber
```

□□□□:

```
{
  "data": [
    {
      "id": "d290f1ee-6c54-4b01-90e6-d701748f0851",
      "imsi": "001001123456789",
      "enabled": true,
      "ims_enabled": true,
      "sim_id": "3f2504e0-4f89-41d3-9a0c-0305e82c3301",
      "key_set_id": "6ba7b810-9dad-41d1-80b4-00c04fd430c8",
      "epc_profile_id": "e58ed763-928c-4155-bee9-fdbaaadc15f3",
      "ims_profile_id": "7c9e6679-7425-40de-944b-e07fc1f90ae7",
      "roaming_profile_id": "9c858901-8a57-4791-81fe-
4c455b099bc9",
      "custom_attributes": {},
      "inserted_at": "2025-10-15T10:30:00Z",
      "updated_at": "2025-10-15T10:30:00Z"
    }
  ]
}
```

□ ID □□□□

□□□□□ ID □□□□□□□

□□: `GET /api/subscriber/:id`

□□□□:

□□	□□	□□
`id`	string (UUID)	□□□□□ ID

□□□□:

```
curl -k https://hss.example.com:8443/api/subscriber/d290f1ee-6c54-4b01-90e6-d701748f0851
```

□ IMSI □□□□

□□□ IMSI □□□□□

□□: `GET /api/subscriber/imsi/:imsi`

□□□□:

□□	□□	□□	□□
`imsi`	string	□□□□□□□□	14-15 □□□

□□□□:

```
curl -k https://hss.example.com:8443/api/subscriber/imsi/001001123456789
```

□□: □□□ IMSI □□□□□□□□□□□□

□ MSISDN □□□□

□□□□□□□□□□□□

□□: `GET /api/subscriber/msisdn/:msisdn`

□□□□:

□□	□□	□□	□□
`msisdn`	string	□□□ ISDN □���	1-15 □□□ (E.164)

□□□□:

```
curl -k
https://hss.example.com:8443/api/subscriber/msisdn/14155551234
```

□□: □□□□□□□□□□□□□□□□□□□

□□□□

□□□□□□□□

□□: `POST /api/subscriber`

□□□:

```
{
  "subscriber": {
    "imsi": "001001123456789",
    "enabled": true,
    "ims_enabled": true,
    "sim_id": "3f2504e0-4f89-41d3-9a0c-0305e82c3301",
    "key_set_id": "6ba7b810-9dad-41d1-80b4-00c04fd430c8",
    "epc_profile_id": "e58ed763-928c-4155-bee9-fdbaaadc15f3",
    "ims_profile_id": "7c9e6679-7425-40de-944b-e07fc1f90ae7",
    "roaming_profile_id": "9c858901-8a57-4791-81fe-4c455b099bc9",
    "custom_attributes": {
      "note": "□□□□"
    }
  }
}
```

□□□□:

- `imsi` - □□□ 14-15 □□□□□□
- `key_set_id` - □□□□□□□ □□□
- `epc_profile_id` - □□□□□□□ EPC □□□□

□□□□:

- `enabled` - □□□: true
- `ims_enabled` - □□□: true
- `sim_id` - □□ SIM □
- `ims_profile_id` - □□ IMS □□□□□IMS □□□□□
- `roaming_profile_id` - □□ □□□□□□□□□□□□□���
- `msisdns` - MSISDN ID □□□□□□□□
- `static_ips` - □□ IP ID □□□□□ APN □□
- `ims_subscription_id` - □□ IMS □□□□□□□□□□□□□□□□□□□□□□ S-CSCF □
- `custom_attributes` - □□□□□□

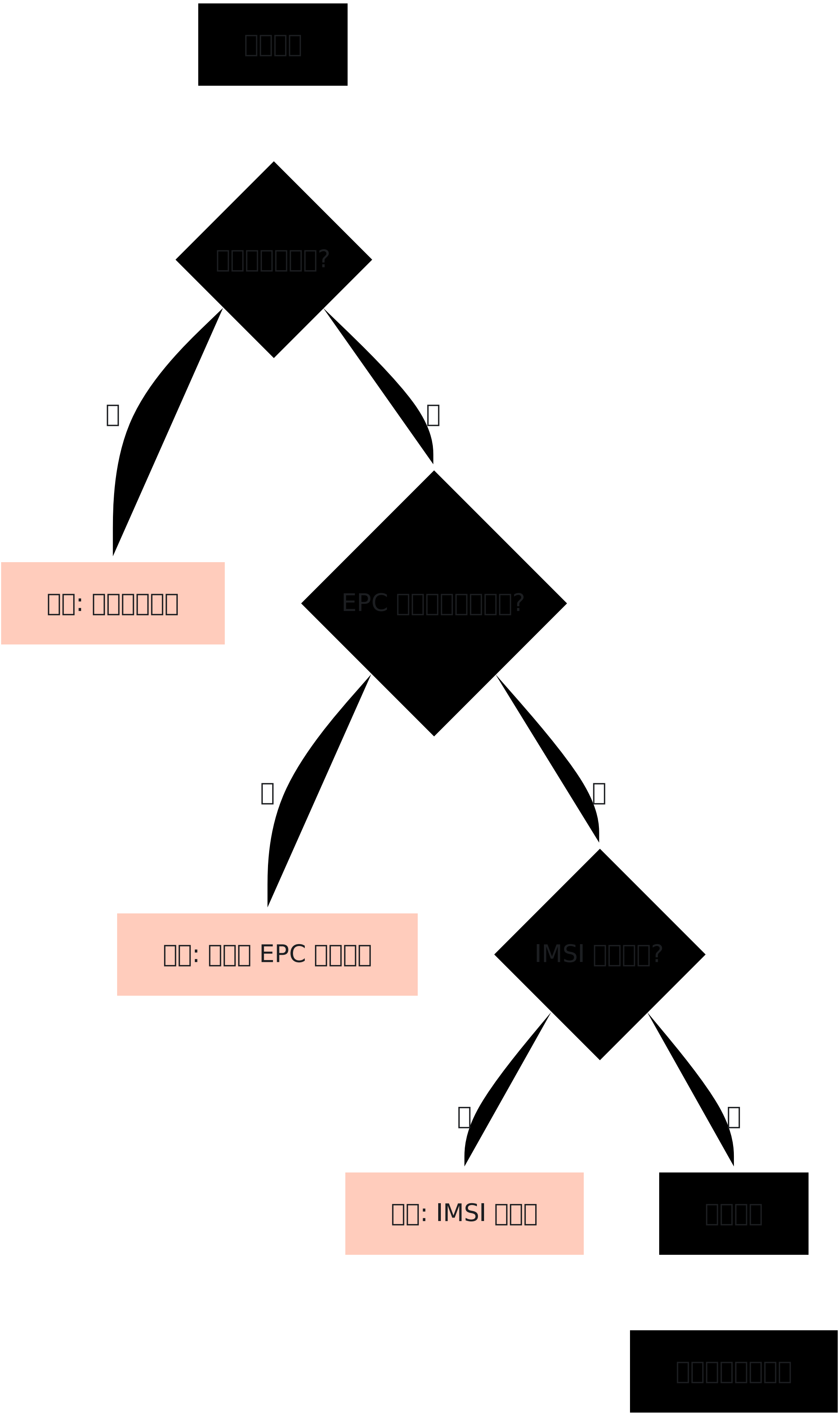
□□:

- □□□□□□□□□ - □□□□□□
- □ MSISDN □□ - □□□□□□□□□□
- □□ IP □□ - □□□ IP □□□ APN

□□□□:

```
curl -k -X POST https://hss.example.com:8443/api/subscriber \
  -H "Content-Type: application/json" \
  -d '{
    "subscriber": {
      "imsi": "001001123456789",
      "key_set_id": "6ba7b810-9dad-41d1-80b4-00c04fd430c8",
      "epc_profile_id": "e58ed763-928c-4155-bee9-fdbaaadc15f3"
    }
  }'
```

□□□□:


?
EPC ?
EPC
IMSI ?
IMSI

201 □□□□

□□□□

□□□□□□□

□□: `PUT /api/subscriber/:id`

□□□□:

□□	□□	□□
`id`	string (UUID)	□□□□□ ID

□□□:

```json
{
  "subscriber": {
    "enabled": false,
    "ims_enabled": false,
    "epc_profile_id": "f47ac10b-58cc-4372-a567-0e02b2c3d479",
    "custom_attributes": {
      "note": "□□□□"
    }
  }
}
```

□□□□□:

- `enabled` - □□/□□□□□□
- `ims_enabled` - □□/□□ IMS □□
- `sim_id` - □□ SIM □ □□
- `key_set_id` - □□ □□□□□□□□□
- `epc_profile_id` - □□ □□□□□□□□
- `ims_profile_id` - □□ □□□□□□□□
- `roaming_profile_id` - □□ □□□□

- `msisdns` - □□□□□□□□ □□□□
- `static_ips` - □□□□□ APN □ □□ IP
- `custom_attributes` - ��□□□□□□

□□□□:

- `imsi` - □□□□ IMSI□□□□□□□□□□□□

□□:

- □□□□□□ - □□□□□□□□

□□□□:

```
curl -k -X PUT
https://hss.example.com:8443/api/subscriber/d290f1ee-6c54-4b01-
90e6-d701748f0851 \
  -H "Content-Type: application/json" \
  -d '{
    "subscriber": {
      "enabled": false
    }
  }'
```

□□:

- □□□□□□: `{"enabled": false}`
- □□□□□□□: `{"ims_enabled": false}`
- □□□□□□□□□: `{"epc_profile_id": "f47ac10b-58cc-4372-a567-0e02b2c3d479"}`□□ EPC □□□□□
- □□□□□□: `{"roaming_profile_id": "1b671a64-40d5-491e-99b0-da01ff1f3341"}`□□ □□□□□

□□□□

□□□□□□□□□

□□: `DELETE /api/subscriber/:id`

□□□□:

□□	□□	□□
`id`	string (UUID)	□□□□□ ID

□□□□:

```
curl -k -X DELETE
https://hss.example.com:8443/api/subscriber/d290f1ee-6c54-4b01-
90e6-d701748f0851
```

□□: □□□□□□□□□□□□□□□□□□□□PDN □□□□□□□□□□□□□□□□□ IMSI□

□□: □□□□□□□□□□□□:

- ��□□ - □□□□□□□□□□
- SIM - □□□□□□□□□□□
- □□□□ - □□□□□□□□□□
- MSISDNs - □□□□□□□□□□□□

□□□□□□□□□□□□□

□□□□□□□□□□CLR□□□□□□□□□□□□□□ MME □□□□

□□: `POST /api/subscriber/cancel_location`

□□□:

```json
{
  "imsi": "001001123456789"
}
```

□□:

□□	□□	□□	□□
`imsi`	string	□	□□□□□□□ IMSI□14-15 □□□□

□□□□:

```
curl -k -X POST
https://hss.example.com:8443/api/subscriber/cancel_location \
  -H "Content-Type: application/json" \
  -d '{"imsi": "001001123456789"}'
```

□□□□ (200 OK):

```json
{
  "data": {
    "message": "□□□□□□□□□□□□",
    "imsi": "001001123456789",
    "destination_host": "mme01.operator.com",
    "destination_realm": "epc.operator.com"
  }
}
```

□□□□ (404 □□□):

```json
{
  "error": "□□□□□□□□□□□□□□ MME □□"
}
```

□□:

- □□□□□□ MME □□ S6a CLR□`subscriber_state.last_seen_mme`□
- □��� `Cancellation-Type: subscription_withdrawal`□□□□□□□□
- □□ `CLR-Flags: {s6a_indicator: 1, reattach_required: 1}`□UE □□□□□□□
- □□□□□□□□□ `last_seen_mme` □ null□□□□ 404
- □□□□□ **IMSI** □□□ **MSISDNs**□□□□□□□/SIM□

□□:

- **□□□□:** □□□□□□□□
- **□□□□:** □□□□□□□□□□□
- **□□□□:** □□□□□ MME □□□□□□□
- **□□:** □□□□□□□□□□□□□□□□□
- **□□:** □□□□□□□□□□

□ IMSI □□:

□□□ CLR □□ MSISDN □□□□

1. □□ **MSISDN□□□ IMSI:**

    ```
    // □□□ IMSI □ 001001123456789□MSISDNs □ ["+1234567890",
    "+9876543210"]
    POST /api/subscriber/cancel_location
    {"imsi": "001001123456789"}

    // □□: □□□□ CLR□□□ MSISDN □□□□□□□□□
    ```

2. □□ **IMSIs□□□□□□:**

    ```
    // □□□□□□□□□ MSISDN□□□□□ IMSIs□□□□□□□□
    // □□ A: IMSI 001001111111111, MSISDN "+1234567890"
    // □□ B: IMSI 001001222222222, MSISDN "+1234567890"

    POST /api/subscriber/cancel_location
    {"imsi": "001001111111111"}

    // □□: □□□ A □□□□□□ B □□□□
    ```

��□□□:

- **□□ IMSI:** CLR □□□ IMSI □□□□□□□ MSISDN
- **□□:** CLR □□□□□□□□□□□□□□ CLR □□□□□□□ MME □□□
- **□□□ MME □□:** □□ MME □□□□□□□□□ CLR□□□ HSS □□□
- **□□□:** □□□ IMSI □□□□□□□□

□□□□:

- □□□□□□□□□□
- □ IMSI □□
- S6a □□□□

Sh RepositoryData (□□□□)

□□□□ Sh □□□□□MMTEL-□□□IMS-ODB-□□□□□□□□□□□□□□□□□□□□□ Diameter Sh □□□□□□□□□□□□□□□□□□□□□ `GET`/`PUT`/`DELETE /api/subscriber/repository_data/:imsi`□

□□□ **Sh RepositoryData (□□□□)** □□□□□□□□□□□□**SequenceNumber** □□□□□□□□ **REST API** □□□

MSISDN □□

MSISDN□□□ □ MSISDN □□□

`shared` □□

□□ MSISDN □□□□□□□□□□□□□□ `shared` □□□□□□□□ □□□□ □□□□□□□□□□□□□□□□□ SIM □□□□□□□□ IMSI □□□□□□□□ `true`□□□□ `false`□□□□□ MSISDN □□□`GET /api/msisdn` □ `GET /api/msisdn/:id`□□□□□□□□□□□□`GET /api/subscriber/:id`□□□□□ `GET /api/subscriber/msisdn/:msisdn` □□□□□□□□□□□□□□□□□□□HSS □□□□□□□□ □□□□ MSISDN □□□

□□ MSISDNs

□□□□□□□□□

□□: `GET /api/msisdn`

□□□□:

```
curl -k https://hss.example.com:8443/api/msisdn
```

□□ MSISDN

□□□□□□□□□

□□: `GET /api/msisdn/:id`

□□□□:

```
curl -k https://hss.example.com:8443/api/msisdn/16fd2706-8baf-433b-82eb-8c7fada847da
```

□□□□:

```json
{
  "status": "success",
  "response": {
    "id": "16fd2706-8baf-433b-82eb-8c7fada847da",
    "msisdn": "14155551234",
    "shared": false
  }
}
```

□□ MSISDN

□□□□□□□□□□□

□□: `POST /api/msisdn`

□□□:

```json
{
  "msisdn": {
    "msisdn": "14155551234"
  }
}
```

□□:

- □□□ 1-15 □□□
- □□��□
- □□□□ E.164 □□□□□□□□□□ + □□□

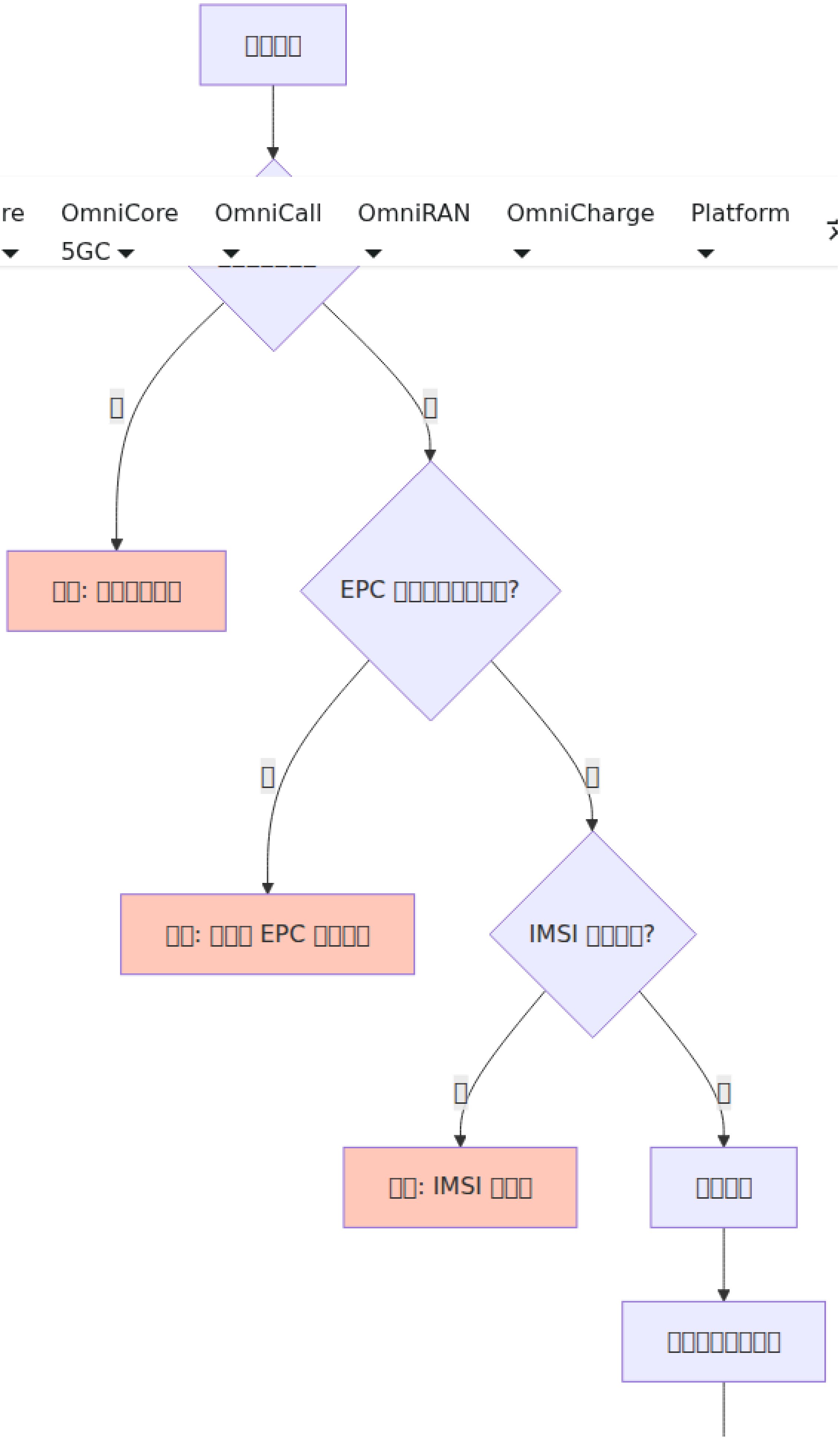
□□□□:

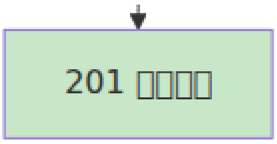
```
curl -k -X POST https://hss.example.com:8443/api/msisdn \
  -H "Content-Type: application/json" \
  -d '{
    "msisdn": {
      "msisdn": "14155551234"
    }
  }'
```

□ MSISDN □□□□□

□□

□ MSISDN □□:


EPC ?
IMSI ?
EPC
IMSI



□□□ □ MSISDN □□ IMSI □□ □□□□□□□□

□□ MSISDN

□□□□□□□□□

□□: `DELETE /api/msisdn/:id`

□□□□:

```
curl -k -X DELETE
https://hss.example.com:8443/api/msisdn/16fd2706-8baf-433b-82eb-
8c7fada847da
```

IMS □□□□

IMS □□□□□□□□IMSI / IMPIs□□□□□□ IMS □□□□□□□□□□□□□□□□□□□□□□□ S-CSCF□□□□ □□□□□□□□□

□□ IMS □□

□□: `GET /api/ims_subscription`

```
curl -k https://hss.example.com:8443/api/ims_subscription
```

□□ IMS □□

□□: `GET /api/ims_subscription/:id`

```
curl -k
https://hss.example.com:8443/api/ims_subscription/16fd2706-8baf-
433b-82eb-8c7fada847da
```

□□ IMS □□

□□: `POST /api/ims_subscription`

```
curl -k -X POST https://hss.example.com:8443/api/ims_subscription
\
  -H "Content-Type: application/json" \
  -d '{"name": "Smith family - shared number"}'
```

□□:

- `name` - □□□□□□□□□□□□
- `ims_profile_id` - □□□□□ IMS □□□□□□□□□□□□□□

`assigned_scscf` □ `last_seen_scscf_timestamp` □□ HSS □□□□□□□□□□□□□□□□□

□□ IMS □□

□□: `PATCH /api/ims_subscription/:id`

□□ IMS □□

□□: `DELETE /api/ims_subscription/:id`

□□ IMS □□□□□□□□□□□□□ `ims_subscription_id` □□□□□□□□□□□□□□□□□□□□□□□ `ims_subscription_id`□□□□ □□□□□□

SIM □□

SIM □□□□□□□ SIM □□□□□□ ICCID□□□□□□□□□PIN/PUK □□□ OTA □□□SIM □□□□□□□□□□□ □□□

□□:

- □ IMSI □□ - □□□□□ SIM □□□□□□

□□ SIMs

□□□□ SIM □□

□□: `GET /api/sim`

□□□□:

```
curl -k https://hss.example.com:8443/api/sim
```

□□ SIM

□□□□ SIM □□

□□: `GET /api/sim/:id`

□□□□:

```
curl -k https://hss.example.com:8443/api/sim/3f2504e0-4f89-41d3-9a0c-0305e82c3301
```

□□ SIM

□□□□□□ SIM □□□□

□□: `POST /api/sim`

□□□:

```json
{
  "sim": {
    "iccid": "89911012000003204510",
    "sim_vendor": "Gemalto",
    "batch_name": "2025-Q1-Batch-01",
    "is_esim": false,
    "pin1": "1234",
    "pin2": "5678",
    "puk1": "12345678",
    "puk2": "87654321",
    "adm1": "admin-code-1",
    "kic": "0123456789ABCDEF0123456789ABCDEF",
    "kid": "FEDCBA9876543210FEDCBA9876543210"
  }
}
```

[illegible]

- `iccid` - 19-20 [illegible]

[illegible]

- `sim_vendor` - [illegible]
- `batch_name` - [illegible]
- `is_esim` - eSIM [illegible]
- `pin1`, `pin2` - [illegible] PIN [illegible]
- `puk1`, `puk2` - PIN [illegible]
- `adm1-adm10` - [illegible]
- `kic`, `kid` - OTA [illegible]

[illegible]

```
curl -k -X POST https://hss.example.com:8443/api/sim \
  -H "Content-Type: application/json" \
  -d '{
    "sim": {
      "iccid": "8991101200003204510",
      "sim_vendor": "Gemalto"
    }
  }'
```

□□ SIM

□□ SIM □□□□

□□□ `PUT /api/sim/:id`

□□□□□

```
curl -k -X PUT https://hss.example.com:8443/api/sim/3f2504e0-4f89-
41d3-9a0c-0305e82c3301 \
  -H "Content-Type: application/json" \
  -d '{
    "sim": {
      "batch_name": "Updated-Batch-Name"
    }
  }'
```

□□ SIM

□□ SIM □□□□

□□□ `DELETE /api/sim/:id`

□□□ □□□□□□□□□□□□□□ SIM□

□□□□□

□□□□□□□□□ Milenage □□□□□□□□□□□□□□□□Ki□OPC/OP□AMF□SQN□□□□ □□ □□□□□□□□

□□

□□□

- □□□□ - □□□□□□□□□□□□

□□□□

□□□□□□□□□□

□□□ `GET /api/key_set`

□□□□□

```
curl -k https://hss.example.com:8443/api/key_set
```

□□□□

□□□□□□□□□

□□□ `GET /api/key_set/:id`

□□□□□

```
curl -k https://hss.example.com:8443/api/key_set/6ba7b810-9dad-
41d1-80b4-00c04fd430c8
```

□□□□□

```
{
  "data": {
    "id": "6ba7b810-9dad-41d1-80b4-00c04fd430c8",
    "ki": "0123456789ABCDEF0123456789ABCDEF",
    "opc": "FEDCBA9876543210FEDCBA9876543210",
    "op": null,
    "amf": "8000",
    "sqn": 0,
    "authentication_algorithm": "milenage",
    "ota_counter": 0
  }
}
```

[illegible]

[illegible]

[illegible] `POST /api/key_set`

[illegible]

```
{
  "key_set": {
    "ki": "0123456789ABCDEF0123456789ABCDEF",
    "opc": "FEDCBA9876543210FEDCBA9876543210",
    "amf": "8000",
    "sqn": 0,
    "authentication_algorithm": "milenage"
  }
}
```

[illegible]

- `ki` - 128 [illegible]32 [illegible]
- `opc` [illegible] `op`[illegible]OPC [illegible] OP [illegible]
- `authentication_algorithm` - [illegible] "milenage"

[illegible]

- `amf` - □□□□ "8000"
- `sqn` - □□□□ 0
- `ota_counter` - □□□□ 0

□□□□□

- □□□□□□□□□□□□□
- Ki□OPC□OP□32 □□□□□□□128 □□
- AMF□4 □□□□□□□□16 □□

□□□□□

```
curl -k -X POST https://hss.example.com:8443/api/key_set \
  -H "Content-Type: application/json" \
  -d '{
    "key_set": {
      "ki": "0123456789ABCDEF0123456789ABCDEF",
      "opc": "FEDCBA9876543210FEDCBA9876543210",
      "authentication_algorithm": "milenage"
    }
  }'
```

□□□□□ □□□□□□□□□□□□□□□□□□□□ API □□□

□□□□□

□□□□□□□□

□□□ `PUT /api/key_set/:id`

□□□ □□□□ □□ □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

□□□ □□

□□□□□

□□□□□□□□

□□□ `DELETE /api/key_set/:id`

□□□ □□□□□□□□□ □□ □□□□□□□□□□□□□□□□□□□

□□□□□□

EPC □□□□

EPC□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□ □□□□□

□□ EPC □□□□

□□□ `GET /api/epc/profile`

□□ EPC □□□□

□□□ `GET /api/epc/profile/:id`

□□ EPC □□□□

□□□ `POST /api/epc/profile`

□□□□

```json
{
  "apn_profiles": [],
  "name": "□□□□□□",
  "network_access_mode": "□□□□",
  "tracking_area_update_interval_seconds": 600,
  "ue_ambr_dl_kbps": 100000,
  "ue_ambr_ul_kbps": 50000
}
```

□□□

□□	□□	□□	□□□
`name`	□□□□□□	□□	□□□□□
`ue_ambr_dl_kbps`	□□□□□□	Kbps	10000-1000000
`ue_ambr_ul_kbps`	□□□□□□	Kbps	5000-500000
`network_access_mode`	□□□□	□□□	"□□□□" □ "□□□□□□"
`tracking_area_update_interval_seconds`	TAU □□□	□	600□□□□
`apn_profiles`	APN ���□□□ ID □□	□□	[] □ [1, 2, 3]

□□□□□

```
curl -k -X POST https://hss.example.com:8443/api/epc/profile \
  -H "Content-Type: application/json" \
  -d '{
    "apn_profiles": [],
    "name": "□□ 100Mbps",
    "network_access_mode": "□□□□",
    "tracking_area_update_interval_seconds": 600,
    "ue_ambr_dl_kbps": 100000,
    "ue_ambr_ul_kbps": 50000
  }'
```

□□□

- □□□□□□ - □□□□□□□□□□□
- □□□□□□ - □□□□□□ EPC □□□□

□□ EPC □□□□

□□□ `PUT /api/epc/profile/:id`

□□□ □ EPC □□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□

□□ EPC □□□□

□□□ `DELETE /api/epc/profile/:id`

□□□ □□□□□□□□□ □□ □□□□□□□□

IMS □□□□

IMS□IP □□□□□□□□□□□□□□□□□□□□□□□□□□□IFC□□□□□□□□□□□□□□□□□□ IMS □□□ □□ □□□□□

□□ IMS □□□□

□□□ `GET /api/ims/profile`

□□ IMS □□□□

□□□ `POST /api/ims/profile`

□□□□

```
{
  "name": "□□ VoLTE",
  "ifc_template": "<IMS-XML-Template-Here>"
}
```

□□□□□

- `name` - □□□□□□□□□□□□
- `ifc_template` - □□ Liquid □□□□□ IFC□□□□□□□□XML □□

IFC □□□□□

IFC □□□□□□ Liquid □□□□□□□□□□□□□□□

[illegible]	[illegible]	[illegible]
`{{ imsi }}`	[illegible] IMSI	`001001123456789`
`{{ msisdns }}`	MSISDN [illegible]	`["14155551234", "14155555678"]`
`{{ mcc }}`	[illegible]	`001`
`{{ mnc }}`	[illegible]	`001`

[illegible]

IFC [illegible] **Liquid** [illegible] Jinja2[illegible] IMS [illegible] [illegible] [illegible]

1. [illegible] IMS [illegible] `{{ imsi }}` [illegible] `{% for msisdn in msisdns %}`
2. [illegible]API [illegible] XML [illegible]
3. [illegible] IMS [illegible]MAA/SAA[illegible]HSS[illegible]
    - [illegible] IMS [illegible]
    - [illegible]
        - `{{ imsi }}` → [illegible] IMSI
        - `{{ msisdns }}` → [illegible]
        - `{{ mcc }}` → [illegible]
        - `{{ mnc }}` → [illegible]
    - [illegible] Cx/Diameter [illegible] XML [illegible] S-CSCF

[illegible]

```
<!-- □□□□□□□ -->
{{ imsi }}

<!-- □□□□□□ -->
{% for msisdn in msisdns %}
  <MSISDN>{{ msisdn }}</MSISDN>
{% endfor %}

<!-- □□□□ -->
{{ imsi }}@ims.mnc{{ mnc }}.mcc{{ mcc }}.3gppnetwork.org
```

IFC □□□□□

```xml
<?xml version="1.0" encoding="UTF-8"?>
<IMSSubscription>
<PrivateID>{{ imsi }}@ims.mnc{{ mnc }}.mcc{{ mcc
}}.3gppnetwork.org</PrivateID>
<ServiceProfile>
{% for msisdn in msisdns %}
<PublicIdentity>
<Identity>sip:{{ msisdn }}@ims.mnc{{ mnc }}.mcc{{ mcc
}}.3gppnetwork.org</Identity>
<Extension>
<IdentityType>0</IdentityType>
</Extension>
</PublicIdentity>
<PublicIdentity>
<Identity>tel:{{ msisdn }}</Identity>
<Extension>
<IdentityType>0</IdentityType>
</Extension>
</PublicIdentity>
{% endfor %}
<InitialFilterCriteria>
<Priority>10</Priority>
<TriggerPoint>
<ConditionTypeCNF>0</ConditionTypeCNF>
<SPT>
<ConditionNegated>0</ConditionNegated>
<Group>0</Group>
<Method>REGISTER</Method>
</SPT>
</TriggerPoint>
<ApplicationServer>
<ServerName>sip:as.ims.mnc{{ mnc }}.mcc{{ mcc
}}.3gppnetwork.org</ServerName>
<DefaultHandling>0</DefaultHandling>
</ApplicationServer>
</InitialFilterCriteria>
</ServiceProfile>
</IMSSubscription>
```

□□□□curl□□

```
curl -k -X POST https://hss.example.com:8443/api/ims/profile \
  -H "Content-Type: application/json" \
  -d '{
    "name": "default",
    "ifc_template": "<?xml version=\"1.0\" encoding=\"UTF-8\"?>
<IMSSubscription><ServiceProfile>...</ServiceProfile>
</IMSSubscription>"
  }'
```

□□□□□Python□□

```python
import requests

response = requests.post(
    "https://hss.example.com:8443/api/ims/profile",
    json={
        "name": "default",
        "ifc_template": ifc_template_string
    },
    verify=False  # □□□□□□□
)
```

□□□□□201 □□□□

```json
{
  "status": "success",
  "response": {
    "id": "0f8fad5b-d9cb-469f-a165-70867728950e",
    "name": "default",
    "ifc_template": "<?xml version=\"1.0\" encoding=\"UTF-8\"?
>..."
  }
}
```

□□□

- API □□ IFC □□□□□□□□ XML
- □□□□□□□□□□□□□□□□□□□
- `name` □□□□□□□□□

□□□

- □□□□□□ - IFC □□□□□□□□□
- □□□□ - IMS □□□□□□□
- □□ IFC □□ - □□□□

APN □□□□

APN□□□□□□□□□□□□□□□□□□□□□□□□□□

1. **APN □□□** - □□ APN □□□ IP □□
2. **APN QoS □□□□** - □□□□□□□□
3. **APN □□□□** - □□□□□□ QoS□□□□ EPC □□□□

□□ **PCRF □□** □□□□□□□□□□□**QoS** □□□□□□□□□□ □□ □□□□□□ □□□ APN □□□□□

□□ APN □□□

□□□ `GET /api/apn/identifier`

□□ APN □□□

□□□ `POST /api/apn/identifier`

□□□□

```json
{
  "apn": "internet",
  "ip_version": "ipv4v6"
}
```

IP □□□□

- `"ipv4"` - □ IPv4
- `"ipv6"` - □ IPv6
- `"ipv4v6"` - IPv4v6□□□□
- `"ipv4_or_ipv6"` - IPv4 □ IPv6□□□□□□

□□ APN QoS □□□□

□□□ `GET /api/apn/qos_profile`

□□ APN QoS □□□□

□□□ `POST /api/apn/qos_profile`

□□□□

```json
{
  "name": "□□□□□□□",
  "allocation_retention_priority": 8,
  "apn_ambr_dl_kbps": 50000,
  "apn_ambr_ul_kbps": 25000,
  "pre_emption_capability": false,
  "pre_emption_vulnerability": true,
  "qci": 9
}
```

□□ APN □□□□

□□□ `GET /api/apn/profile`

□□ APN □□□□

□□□ `POST /api/apn/profile`

□□□□

```json
{
  "apn_identifier_id": "4fa85f64-5717-4562-b3fc-2c963f66afa6",
  "apn_qos_profile_id": "8d8ac610-566d-4ef0-9c22-186b2a5ed793",
  "name": "□□□ APN"
}
```

□□□□□

- `apn_identifier_id` - □□□□□□□ APN □□□
- `apn_qos_profile_id` - □□□□□□□ APN QoS □□□□

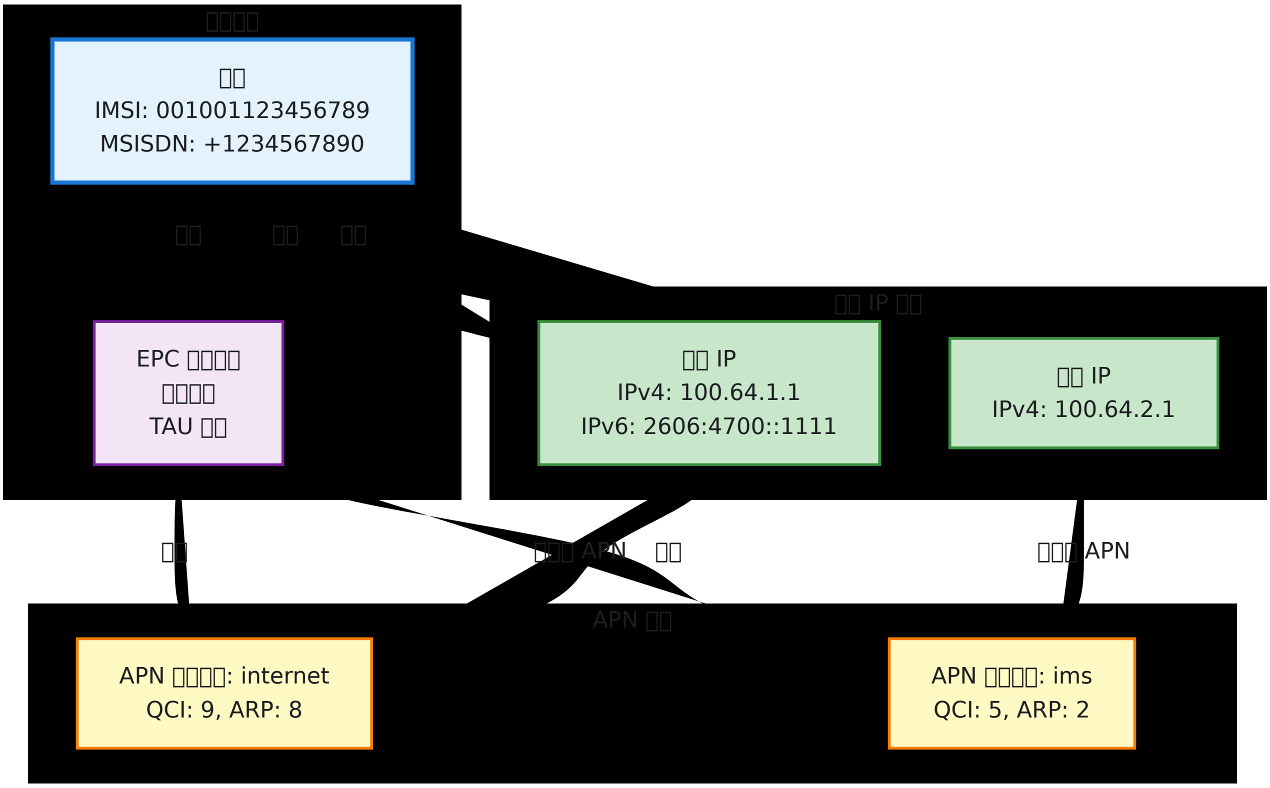
□□□

- □□□□□□ - □□ APN □□□□□□□
- EPC □□□□ - APN □□□□□□□ EPC □□□□

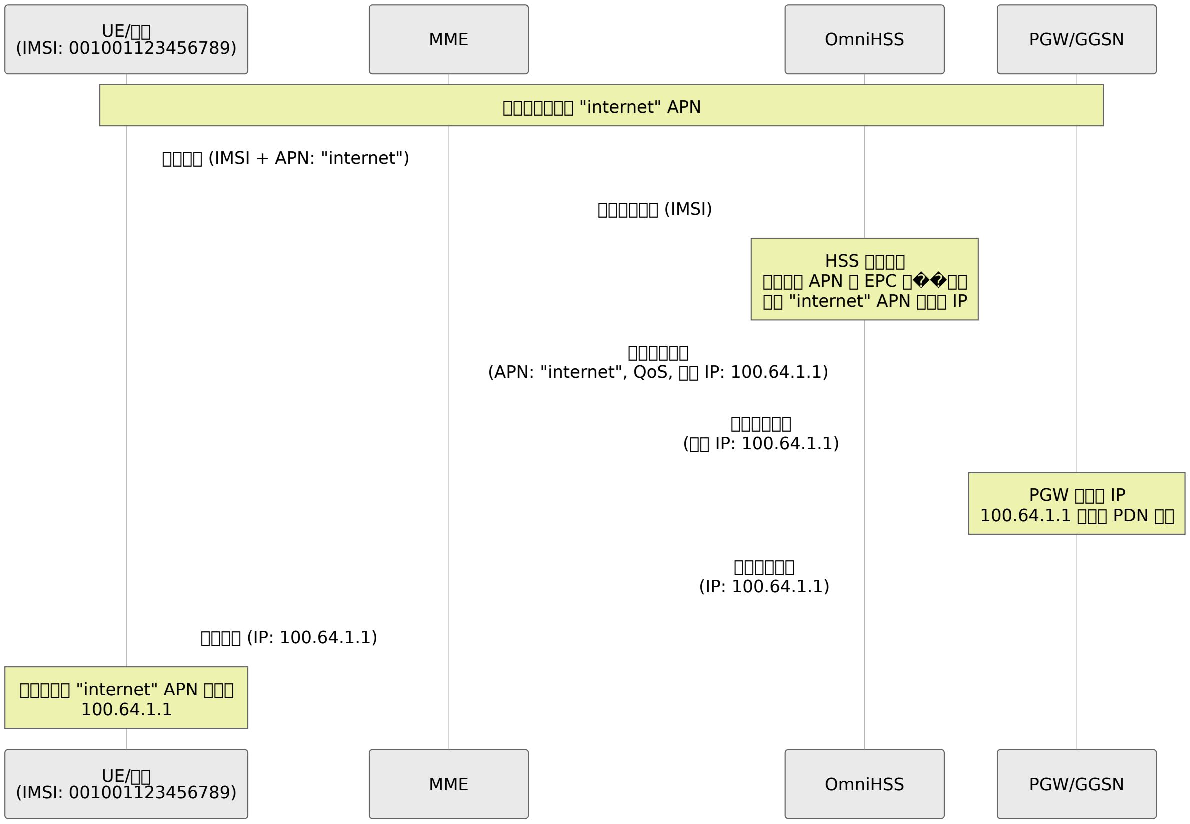
□□ IP □□

□□ IP □□□□□□□□□ APN□□□□□□□□□□□□□□□□□□□□□ APN □□□□□□ IPv4 □/□ IPv6 □□□□□□□ DHCP □□□□□□□□□

□□□

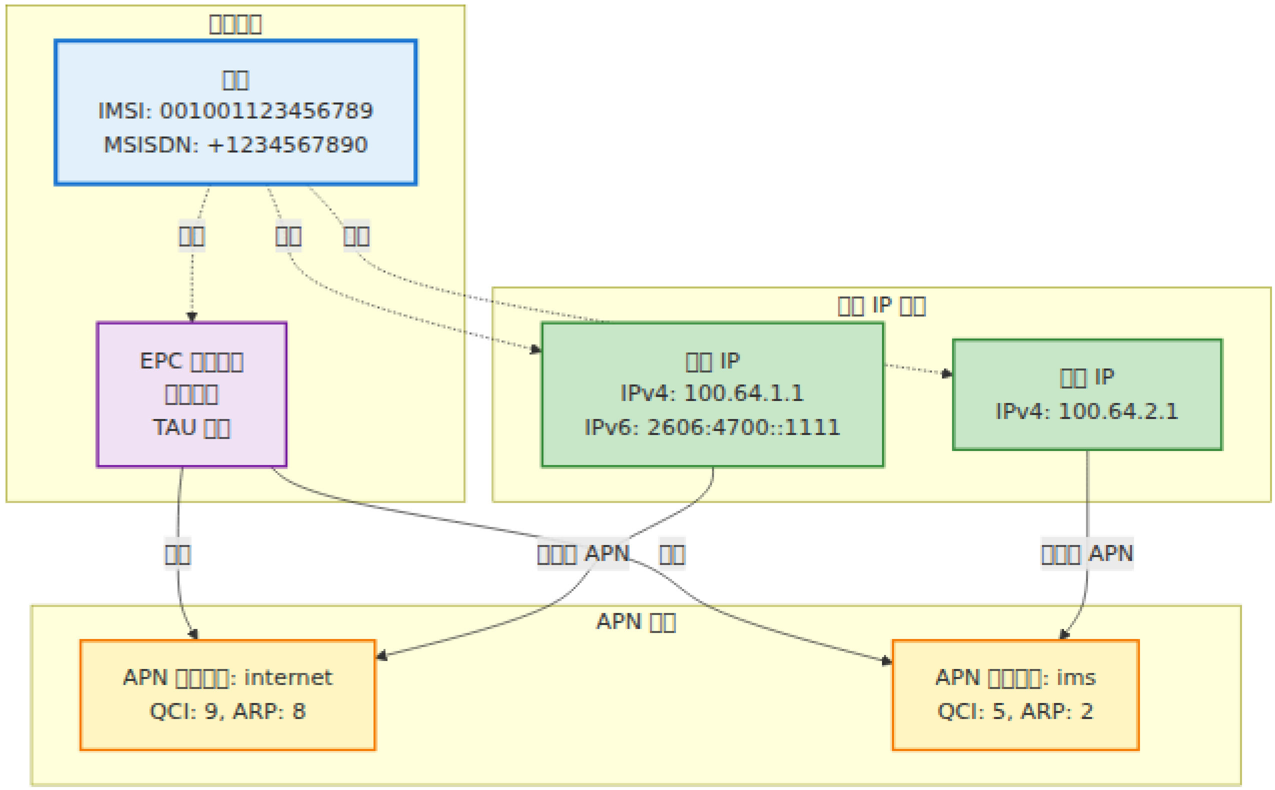

□□□□
□□
IMSI: 001001123456789
MSISDN: +1234567890
□□
□□
□□
EPC □□□□
□□□□
TAU □□
□□ IP □□
□□ IP
IPv4: 100.64.1.1
IPv6: 2606:4700::1111
□□ IP
IPv4: 100.64.2.1
□□
□□□ APN
□□
□□□ APN
APN □□
APN □□□□: internet
QCI: 9, ARP: 8
APN □□□□: ims
QCI: 5, ARP: 2

□□□□□□□□□□


UE/[illegible]
(IMSI: 001001123456789)
MME
OmniHSS
PGW/GGSN
[illegible] "internet" APN
[illegible] (IMSI + APN: "internet")
[illegible] (IMSI)
HSS [illegible]
[illegible] APN [illegible] EPC [illegible]
[illegible] "internet" APN [illegible] IP
[illegible]
(APN: "internet", QoS, [illegible] IP: 100.64.1.1)
[illegible]
([illegible] IP: 100.64.1.1)
PGW [illegible] IP
100.64.1.1 [illegible] PDN [illegible]
[illegible]
(IP: 100.64.1.1)
[illegible] (IP: 100.64.1.1)
[illegible] "internet" APN [illegible]
100.64.1.1

[illegible] - APN [illegible]

[illegible] S6a [illegible] APN-[illegible] AVP [illegible]


[illegible]
[illegible]
IMSI: 001001123456789
MSISDN: +1234567890
[illegible]
[illegible]
[illegible]
EPC [illegible]
[illegible]
TAU [illegible]
[illegible] IP [illegible]
[illegible] IP
IPv4: 100.64.1.1
IPv6: 2606:4700::1111
[illegible] IP
IPv4: 100.64.2.1
[illegible]
[illegible] APN
[illegible]
[illegible] APN
APN [illegible]
APN [illegible]: internet
QCI: 9, ARP: 8
APN [illegible]: ims
QCI: 5, ARP: 2

[illegible]

- [illegible]**APN**[illegible]IP[illegible]APN[illegible]
- [illegible]**APN**[illegible]**IP**[illegible]APN[illegible]IP[illegible]
- **IPv4**[illegible]**IPv6**[illegible]IP[illegible]IPv4[illegible]IPv6[illegible]
- [illegible]**IP**[illegible]IP[illegible]IP[illegible]
  - [illegible]IPv4[illegible]IPv6[illegible]APN[illegible]
  - [illegible]IP[illegible]
  - [illegible]`ipv4_static_ip`[illegible]`ipv6_static_ip`[illegible]
- [illegible]IP[illegible]

[illegible]

- IoT[illegible]IP[illegible]
- [illegible]IP[illegible]
- [illegible]IP[illegible]
- [illegible]IP[illegible]
- [illegible]IP[illegible]

[illegible]IP

[illegible]IP[illegible]

[illegible] `GET /api/epc/static_ip`

[illegible]

```
curl -k https://hss.example.com:8443/api/epc/static_ip
```

[illegible]

```json
{
  "data": [
    {
      "id": "c56a4180-65aa-42ec-a945-5fd21dec0538",
      "apn_profile_id": "a1b2c3d4-e5f6-4a3b-8c2d-1e0f9a8b7c6d",
      "ipv4_static_ip": "100.64.1.1",
      "ipv6_static_ip": "2606:4700:4700::1111",
      "apn_profile": {
        "id": "a1b2c3d4-e5f6-4a3b-8c2d-1e0f9a8b7c6d",
        "name": "Internet APN",
        "apn_identifier": {
          "apn": "internet",
          "ip_version": "ipv4v6"
        }
      },
      "inserted_at": "2025-11-15T10:30:00Z",
      "updated_at": "2025-11-15T10:30:00Z"
    }
  ]
}
```

□□□□IP

□□□□□□□IP□□□

□□□ `GET /api/epc/static_ip/:id`

□□□□□

□□	□□	□□
`id`	string (UUID)	□□IP□□□ID

□□□□□

```
curl -k https://hss.example.com:8443/api/epc/static_ip/c56a4180-
65aa-42ec-a945-5fd21dec0538
```

[illegible]IP

[illegible]APN[illegible]IP[illegible]

[illegible] `POST /api/epc/static_ip`

[illegible]

```
{
  "static_ip": {
    "apn_profile_id": "a1b2c3d4-e5f6-4a3b-8c2d-1e0f9a8b7c6d",
    "ipv4_static_ip": "100.64.1.1",
    "ipv6_static_ip": "2606:4700:4700::1111"
  }
}
```

[illegible]

- `apn_profile_id` - [illegible]APN[illegible]
- [illegible]`ipv4_static_ip`[illegible]`ipv6_static_ip`

[illegible]

- `ipv4_static_ip` - IPv4[illegible]
- `ipv6_static_ip` - IPv6[illegible]

IP[illegible]

- IPv4[illegible]`100.64.1.1`[illegible]
- IPv6[illegible]`2606:4700:4700::1111`[illegible]
- IPv4[illegible]IPv6[illegible]**IP**[illegible]
  - [illegible]IP[illegible]
  - [illegible]IP[illegible]APN[illegible]
  - [illegible]

[illegible]

□□	IPv4	IPv6	□□
□IPv4	✓	-	`{"ipv4_static_ip": "100.64.1.1"}`
□IPv6	-	✓	`{"ipv6_static_ip": "2606:4700:4700::1111"}`
□□	✓	✓	□□□□□□□□

□□□□□

□IPv4□□□IP□

```
curl -k -X POST https://hss.example.com:8443/api/epc/static_ip \
  -H "Content-Type: application/json" \
  -d '{
    "static_ip": {
      "apn_profile_id": "a1b2c3d4-e5f6-4a3b-8c2d-1e0f9a8b7c6d",
      "ipv4_static_ip": "100.64.1.1"
    }
  }'
```

□IPv6□□□IP□

```
curl -k -X POST https://hss.example.com:8443/api/epc/static_ip \
  -H "Content-Type: application/json" \
  -d '{
    "static_ip": {
      "apn_profile_id": "b2c3d4e5-f6a7-4b1c-9d2e-3f4a5b6c7d8e",
      "ipv6_static_ip": "2606:4700:4700::1111"
    }
  }'
```

□□□□□IP□

```
curl -k -X POST https://hss.example.com:8443/api/epc/static_ip \
  -H "Content-Type: application/json" \
  -d '{
    "static_ip": {
      "apn_profile_id": "a1b2c3d4-e5f6-4a3b-8c2d-1e0f9a8b7c6d",
      "ipv4_static_ip": "100.64.1.1",
      "ipv6_static_ip": "2606:4700:4700::1111"
    }
  }'
```

□□□□□201□□□□□

```
{
  "data": {
    "id": "c56a4180-65aa-42ec-a945-5fd21dec0538",
    "apn_profile_id": "a1b2c3d4-e5f6-4a3b-8c2d-1e0f9a8b7c6d",
    "ipv4_static_ip": "100.64.1.1",
    "ipv6_static_ip": "2606:4700:4700::1111",
    "inserted_at": "2025-11-15T10:30:00Z",
    "updated_at": "2025-11-15T10:30:00Z"
  }
}
```

□□□□□

- □□□IP□□□□□□ - □□□□□□□□□□
- APN□□□□ - □□APN□□

□□□□IP

□□□□□□□IP□□□

□□□ `PUT /api/epc/static_ip/:id`

□□□□□

□□	□□	□□
`id`	string (UUID)	□□IP□□□ID

□□□□

```json
{
  "static_ip": {
    "ipv4_static_ip": "100.64.1.2",
    "ipv6_static_ip": "2606:4700:4700::1112"
  }
}
```

□□□□□□

- `ipv4_static_ip` - □□IPv4□□
- `ipv6_static_ip` - □□IPv6□□
- `apn_profile_id` - □□APN□□

□□□□□

- `id` - □□□□□□

□□□ □□□□□□□□IP□□□□□□□□□PDN□□□□□PDN□□□□□□□□IP□□□□□□□□□□□□□

□□□□□

```
curl -k -X PUT
https://hss.example.com:8443/api/epc/static_ip/c56a4180-65aa-42ec-
a945-5fd21dec0538 \
  -H "Content-Type: application/json" \
  -d '{
    "static_ip": {
      "ipv4_static_ip": "100.64.1.2"
    }
  }'
```

□□□□IP

□□□□IP□□□

□□□ `DELETE /api/epc/static_ip/:id`

□□□□□

□□	□□	□□
`id`	string (UUID)	□□IP□□□ID

□□□□□

```
curl -k -X DELETE
https://hss.example.com:8443/api/epc/static_ip/c56a4180-65aa-42ec-
a945-5fd21dec0538
```

□□□

- □□□□IP□□
- □□□APN□□□□□APN□□□□□□□□□□□
- □□□□□IP□□□□□□□□□□□□□□□IP
- IP□□□□□□□□□□□

□□□ □□□□□□□□□□□□IP□□□□□□□□□□□□PDN□□□□□□□IP□□□□□□□□□□□□□□□□□□□□□□□□□□□

□□□IP□□□□□□

□□□□IP□□□□□□□□□□□□□□□□□□□IP□□□□□□□□□

□□□□□

1. □□□□**IP**□□□□□□IP□
2. □□`static_ips`□□□□□□□□

□□□□□□**IP**□□□□□

```
# □□1□□“internet”APN□□□□IP
STATIC_IP_ID=$(curl -k -X POST
https://hss.example.com:8443/api/epc/static_ip \
  -H "Content-Type: application/json" \
  -d '{
    "static_ip": {
      "apn_profile_id": "a1b2c3d4-e5f6-4a3b-8c2d-1e0f9a8b7c6d",
      "ipv4_static_ip": "100.64.1.1",
      "ipv6_static_ip": "2606:4700:4700::1111"
    }
  }' | jq -r '.data.id')

# □□2□□□□□□□□IP□□□□
curl -k -X POST https://hss.example.com:8443/api/subscriber \
  -H "Content-Type: application/json" \
  -d "{
    \"subscriber\": {
      \"imsi\": \"001001123456789\",
      \"key_set_id\": \"6ba7b810-9dad-41d1-80b4-00c04fd430c8\",
      \"epc_profile_id\": \"e58ed763-928c-4155-bee9-
fdbaaadc15f3\",
      \"static_ips\": [$STATIC_IP_ID]
    }
  }"
```

□□□□□□□□□IP□□□□□

```
curl -k -X PUT
https://hss.example.com:8443/api/subscriber/d290f1ee-6c54-4b01-
90e6-d701748f0851 \
  -H "Content-Type: application/json" \
  -d '{
    "subscriber": {
      "static_ips": ["c56a4180-65aa-42ec-a945-5fd21dec0538",
"5a8f9c3e-2d4b-4e6f-8a1b-3c5d7e9f0a2b"]
    }
  }'
```

□□□□IP□□□APN□□

□□□□□□□□□□□□□IP□□□□□IP□□□□□APN□

```
# □“internet”APN□□□□IP
INTERNET_IP=$(curl -k -X POST
https://hss.example.com:8443/api/epc/static_ip \
  -H "Content-Type: application/json" \
  -d '{
    "static_ip": {
      "apn_profile_id": "a1b2c3d4-e5f6-4a3b-8c2d-1e0f9a8b7c6d",
      "ipv4_static_ip": "100.64.1.1"
    }
  }' | jq -r '.data.id')

# □“ims”APN□□□□IP
IMS_IP=$(curl -k -X POST
https://hss.example.com:8443/api/epc/static_ip \
  -H "Content-Type: application/json" \
  -d '{
    "static_ip": {
      "apn_profile_id": "b2c3d4e5-f6a7-4b1c-9d2e-3f4a5b6c7d8e",
      "ipv4_static_ip": "100.64.2.1"
    }
  }' | jq -r '.data.id')

# □□□IP□□□□□□□
curl -k -X POST https://hss.example.com:8443/api/subscriber \
  -H "Content-Type: application/json" \
  -d "{
    \"subscriber\": {
      \"imsi\": \"001001123456789\",
      \"key_set_id\": \"6ba7b810-9dad-41d1-80b4-00c04fd430c8\",
      \"epc_profile_id\": \"e58ed763-928c-4155-bee9-
fdbaaadc15f3\",
      \"static_ips\": [$INTERNET_IP, $IMS_IP]
    }
  }"
```

□□□□□

- ✓ □□□□□APN□□□□□IP
- ✗ □□□□□APN□□□□□IP

□□□□ - □□APN□

```
# □□□□□□IP□□□□□APN□□□□□
curl -k -X POST https://hss.example.com:8443/api/subscriber \
  -H "Content-Type: application/json" \
  -d '{
    "subscriber": {
      "imsi": "001001123456789",
      "static_ips": ["c56a4180-65aa-42ec-a945-5fd21dec0538",
"5a8f9c3e-2d4b-4e6f-8a1b-3c5d7e9f0a2b"]
    }
  }'

# □□□□□
{
  "errors": {
    "static_ips": [
      "□□□□□□□APN□□□IP□□□□□□□□□□□□□□□□internet□□□□IP 100.64.1.1□□□
□□internet□□□□IP 100.64.1.2"
    ]
  }
}
```

□□□□□

- □□□□□ - □□□□□
- □□□□□ - □□□□□□□
- □□□□□IP□□□□ - □□□□□□

□□□□

□□□□□□□□□□□□□□□□□□□□□□□□□□IMS□□□□□□□□□□□□□MCC/MNC□□□□□□□□

□□□□□□□□

□□□ `GET /api/roaming/profile`

[illegible]

[illegible] `POST /api/roaming/profile`

[illegible]

```json
{
  "roaming_profile": {
    "name": "[illegible]",
    "data_action_if_no_rules_match": "deny",
    "ims_action_if_no_rules_match": "deny",
    "roaming_rules": []
  }
}
```

[illegible]

- `"allow"` - [illegible]
- `"deny"` - [illegible]

[illegible]

- `data_action_if_no_rules_match` - [illegible]
- `ims_action_if_no_rules_match` - IMS[illegible]

[illegible]

[illegible] `GET /api/roaming/rule`

[illegible]

[illegible] `POST /api/roaming/rule`

[illegible]

```json
{
  "roaming_rule": {
    "name": "□□AT&T",
    "mcc": "310",
    "mnc": "410",
    "data_action": "allow",
    "ims_action": "allow"
  }
}
```

□□□

- `mcc` - □□□□□□□3□□□□
- `mnc` - □□□□□□□2-3□□□□
- `data_action` - `"allow"`���`"deny"`□□□□
- `ims_action` - `"allow"`□`"deny"`IMS/□□□□

□□□□□

- □□□□ - □□□□□□□
- □□□□ - □□□□□Diameter□□□□□□□□

EIR□□

OmniHSS□□S13 Diameter□□□□□□□□□□□□EIR□□□□EIR□□□□IMEI□□□□□□□□□

□□□□□□□□□**S13□□□□□IMEI**□□□□□□□□□□□**EIR□□**□

□□EIR□□

□□□ `GET /api/eir/rule`

□□EIR□□

□□□ `POST /api/eir/rule`

□□□□

```json
{
  "eir_rule": {
    "name": "□□iPhone 6",
    "imei_regex": "^35[0-9]{6}0[0-9]{7}$",
    "action": 1
  }
}
```

□□□

- `name` - □□□□□□□□
- `imei_regex` - □□IMEI□□□□□□□□
- `action` - □□□□0□□□□□□1□□□□□□2□

□□□□

- `0` - □□□□□□□
- `1` - □□□□□□□
- `2` - □□□□□□□□□□

□□□

- □□□□□□□□□□□□IMEI□
- □□□□□□□□□□TAC□□□□□□
- □□□□□□□□□□□□□□□□□□□□□□□□

□□□□□

- □□□□ - S13□□□EIR□□□□
- □□□□ - OmniHSS EIR□□

□□□□

□□□□□□□□□□□□□□□

- [illegible] - API[illegible]
- [illegible] - [illegible]
- **API[illegible]** - [illegible]

← [illegible] | [illegible] →

API [illegible]

← [illegible] API [illegible]

[illegible]

[illegible] API [illegible]

[illegible] `GET /api/status`

[illegible]

```
curl -k https://hss.example.com:8443/api/status
```

[illegible]

```
{
  "status": "ok"
}
```

[illegible] [illegible]

← [illegible] API [illegible]

OmniHSS □□□□

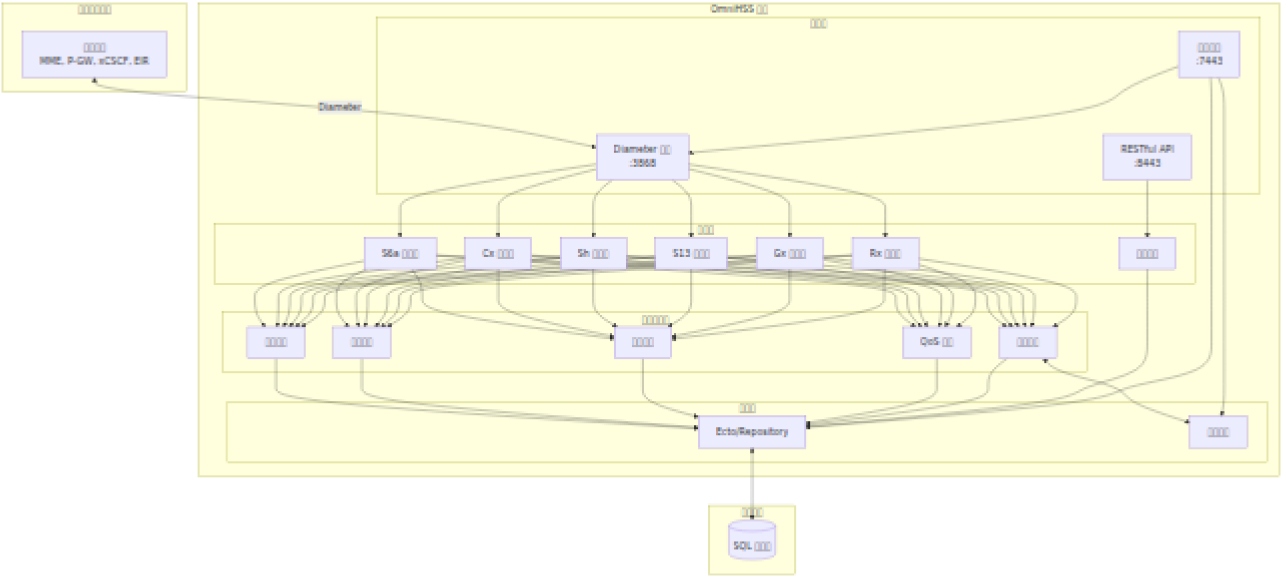
← □□□□□□

□□

- □□□□
- □□□□
- Diameter □
- □□□
- □□□
- □□□□
- □□□□

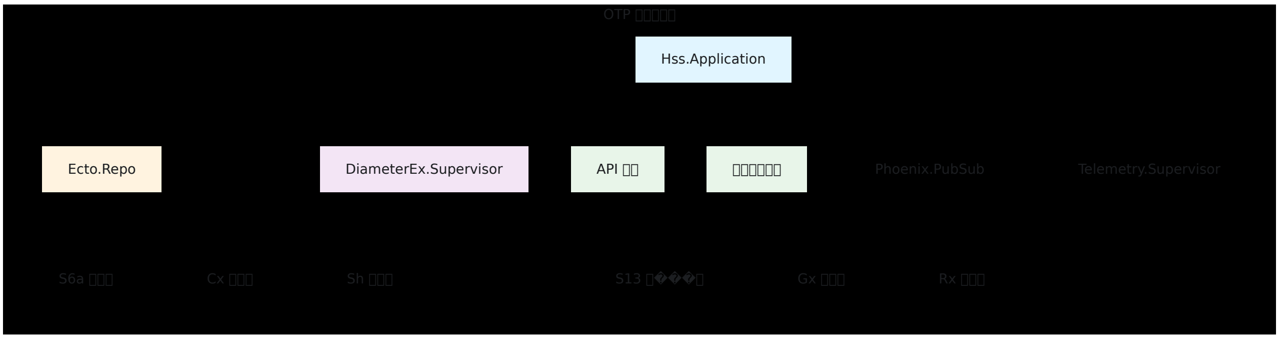
□□□□

OmniHSS □□ Elixir □ Erlang/OTP □□


OmniHSS □□
MME, P-GW, xCSCF, EIR
Diameter
Diameter □□ :3868
:7443
RESTful API :8443
S6a □□□
Cx □□□
Sh □□□
S13 □□□
Gx □□□
Rx □□□
QoS □□
Ecto/Repository
SQL □□□

□□□□

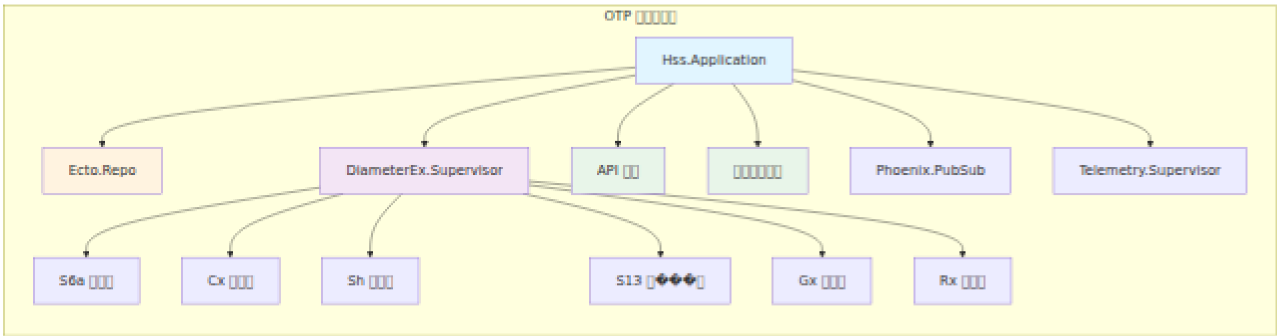
□□□□


OTP □□□□□
Hss.Application
Ecto.Repo
DiameterEx.Supervisor
API □□
□□□□□□
Phoenix.PubSub
Telemetry.Supervisor
S6a □□□
Cx □□□
Sh □□□
S13 □���□
Gx □□□
Rx □□□

Diameter □□□□□

□□ Diameter □□□S6a, Cx, Sh, S13, Gx, Rx□□□□□□□ DiameterEx □□□□□□□□□□□□□

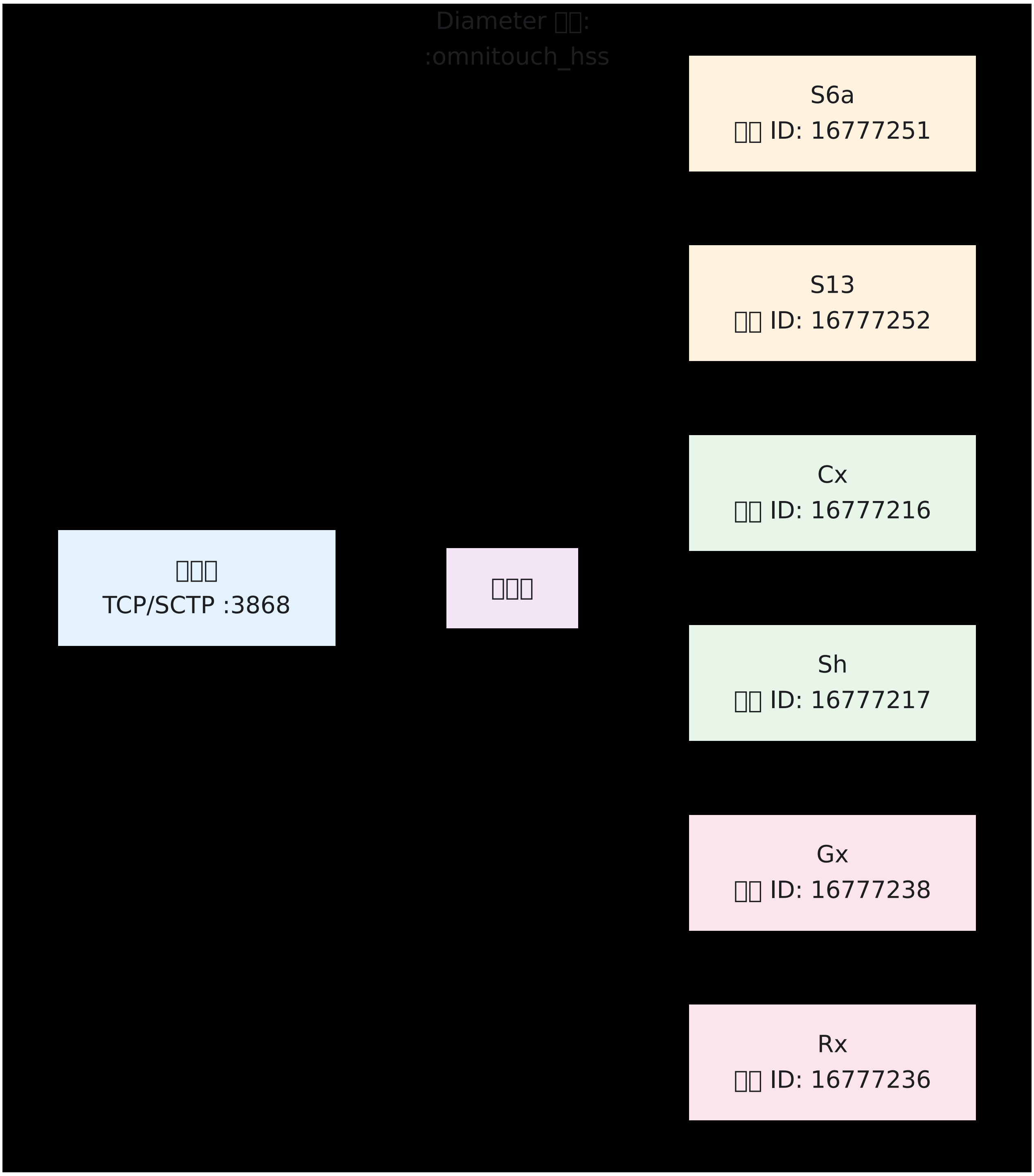
1. □ **DiameterEx** □□ - □□□□□ Diameter □□ ID
2. □□□□ - □□ AVP□□□□□□□□
3. □□□□□□ - □□□□□□□□□□□
4. □□□□ - □□ AVP □□ Diameter □□□□
5. □□□□ - □□□□□ Diameter □□□□


OTP □□□□□
Hss.Application
Ecto.Repo
DiameterEx.Supervisor
API □□
□□□□□□
Phoenix.PubSub
Telemetry.Supervisor
S6a □□□
Cx □□□
Sh □□□
S13 □���□
Gx □□□
Rx □□□

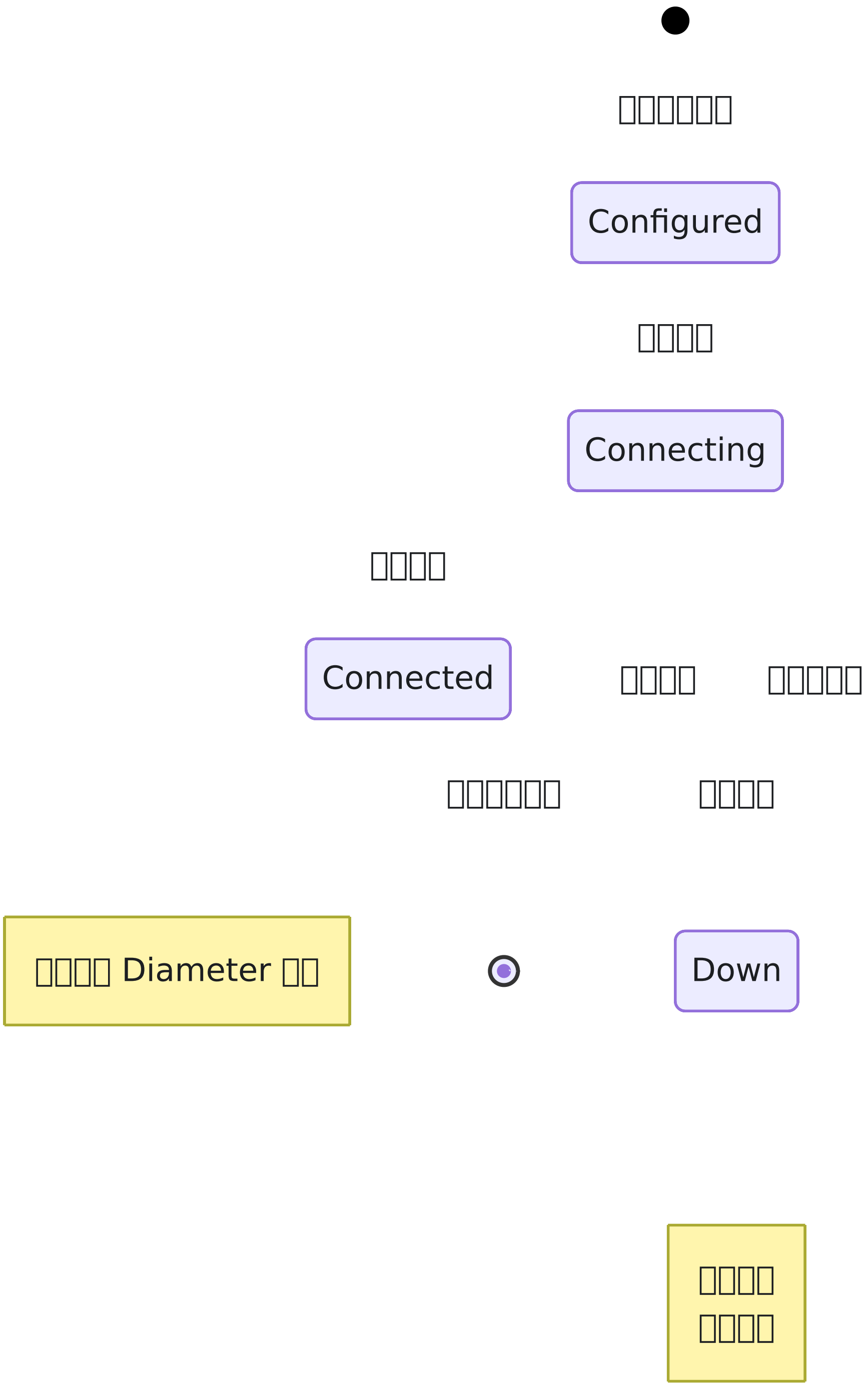
Diameter □

Diameter □□□□

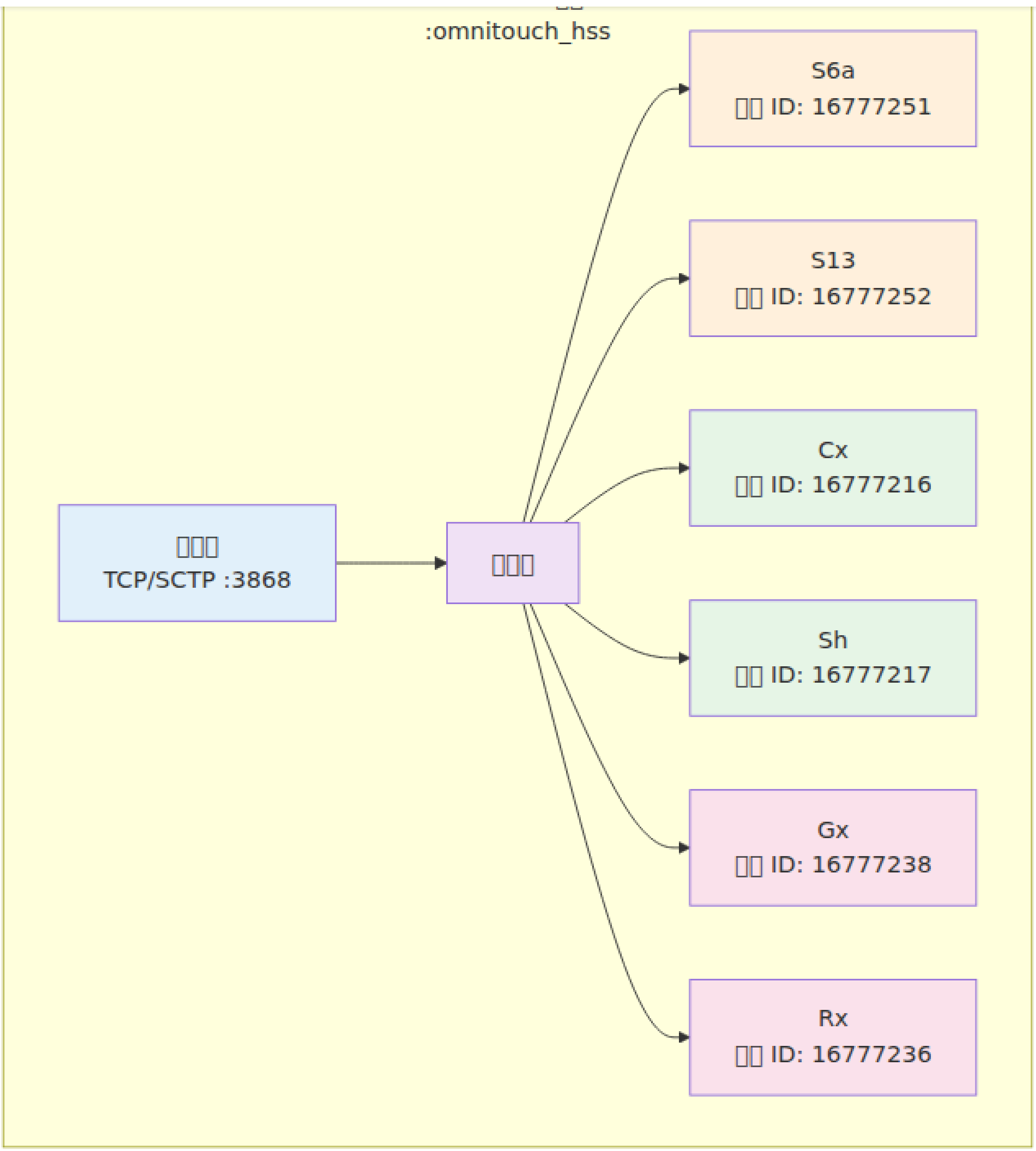
OmniHSS □□□□□□□□ Diameter □���□□□□□□□□□


Diameter □□:
:omnitouch_hss
S6a
□□ ID: 16777251
S13
□□ ID: 16777252
Cx
□□ ID: 16777216
□□□
TCP/SCTP :3868
□□□
Sh
□□ ID: 16777217
Gx
□□ ID: 16777238
Rx
□□ ID: 16777236

[illegible]


Configured
Connecting
Connected
Down
Diameter

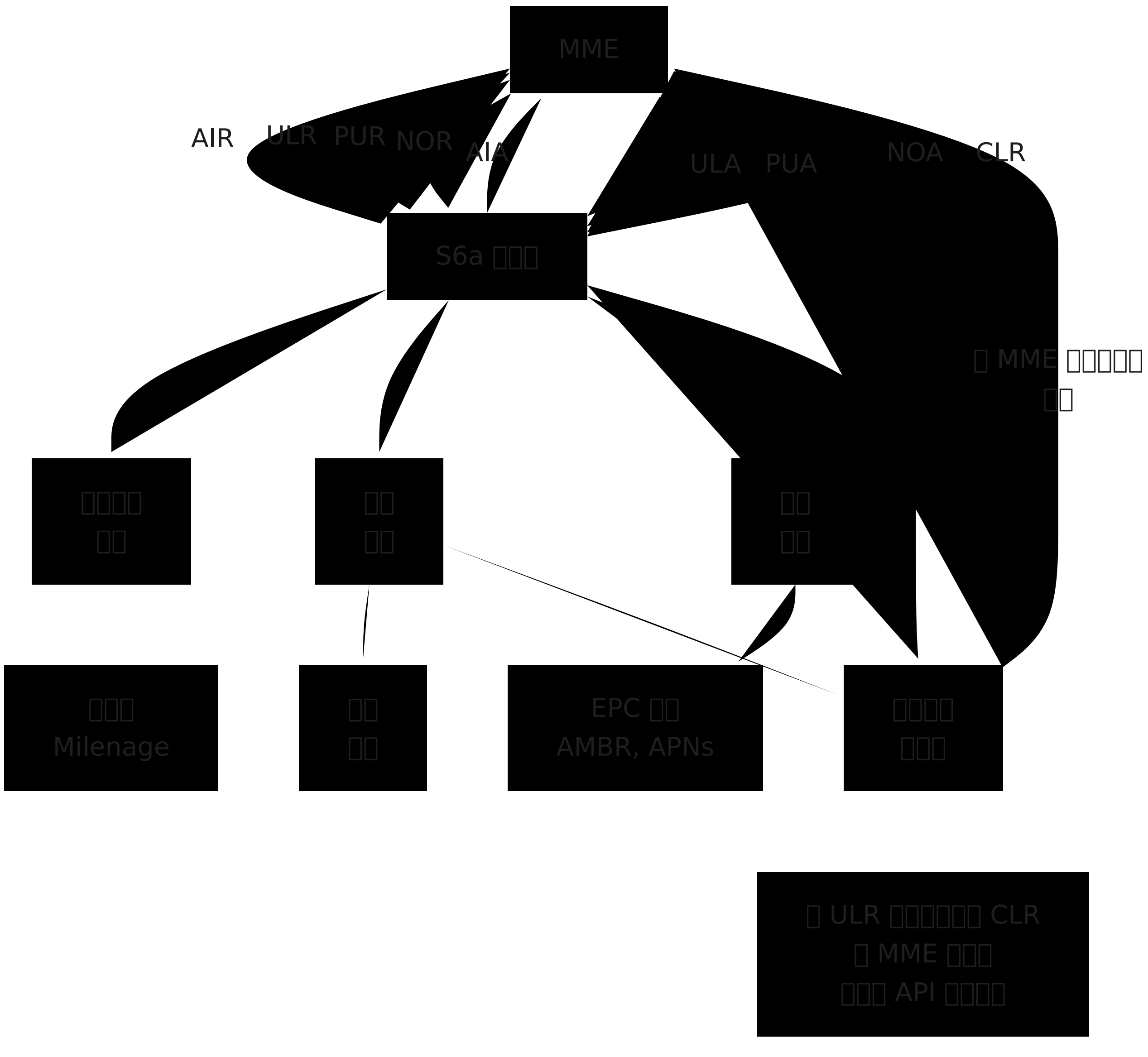
Diameter □□□


□□
:omnitouch_hss
□□□
TCP/SCTP :3868
□□□
S6a
□□ ID: 16777251
S13
□□ ID: 16777252
Cx
□□ ID: 16777216
Sh
□□ ID: 16777217
Gx
□□ ID: 16777238
Rx
□□ ID: 16777236

[illegible]

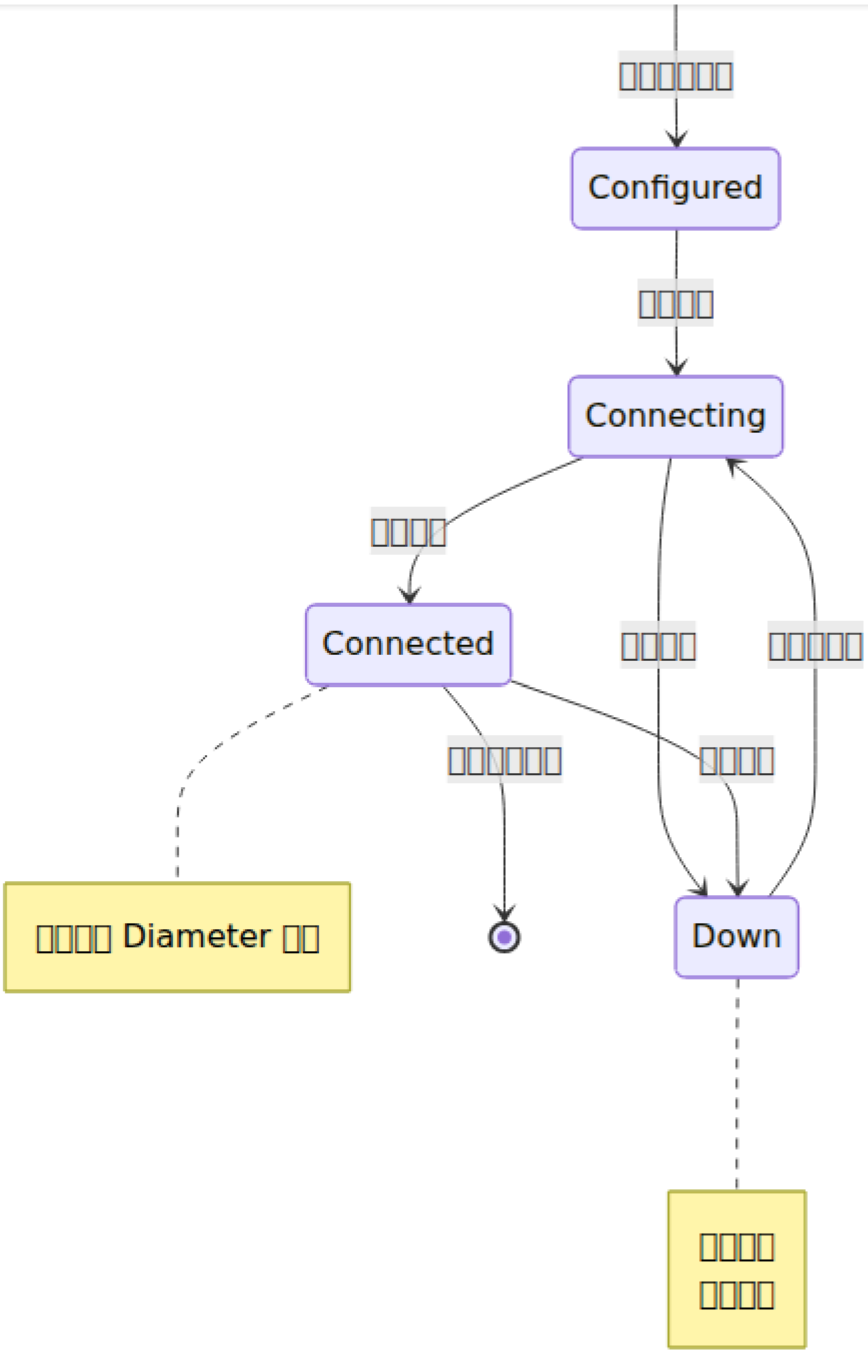
S6a [illegible] (LTE/EPC)

[illegible] LTE [illegible]


MME
AIR
ULR
PUR
NOR
AIA
ULA
PUA
NOA
CLR
S6a [illegible]
MME [illegible]
Milenage
EPC [illegible]
AMBR, APNs
ULR [illegible] CLR
MME [illegible]
API [illegible]

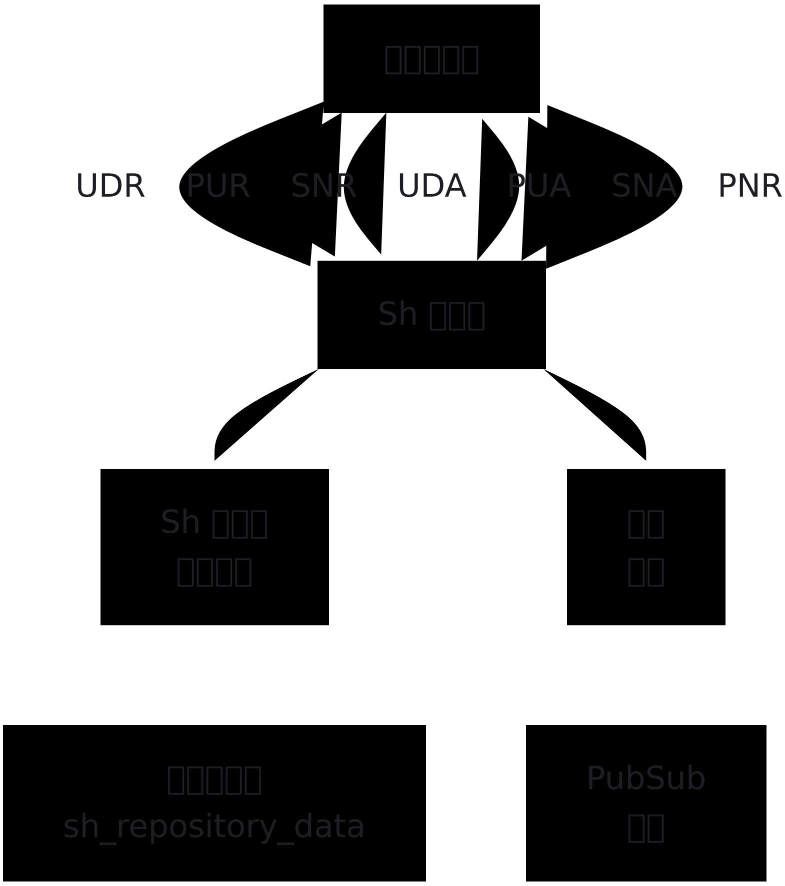
Cx [illegible] (IMS)

[illegible] IMS [illegible]��[illegible]


Configured
Connecting
Connected
Down
Diameter

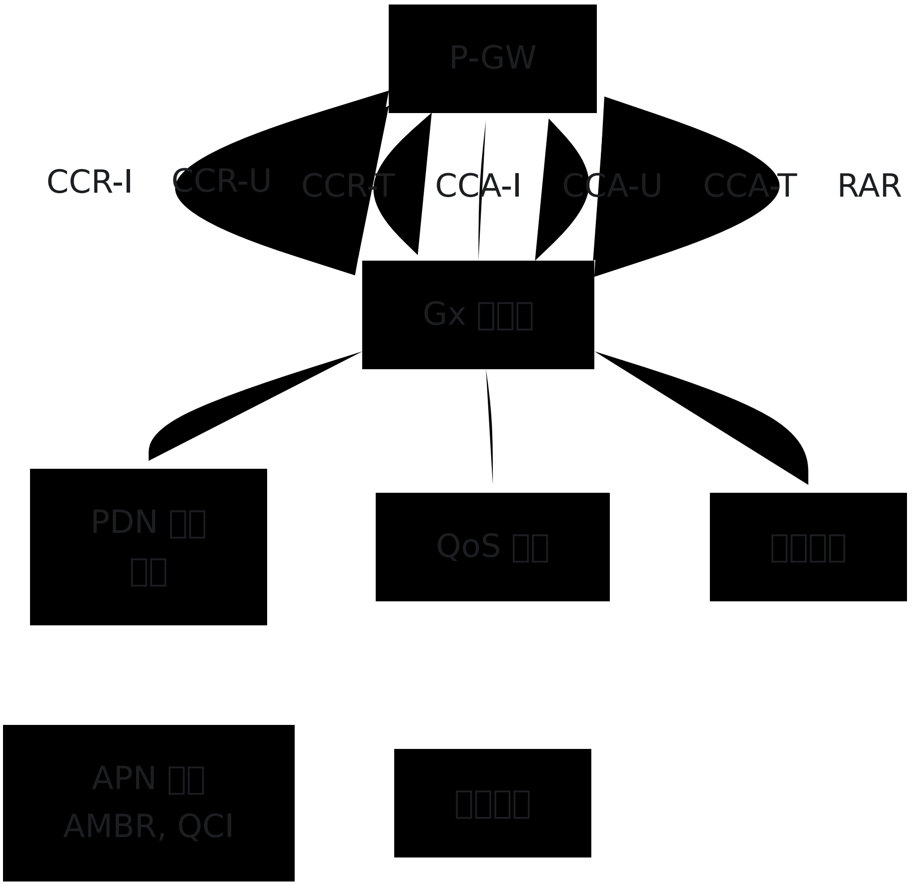
Sh [illegible] (IMS [illegible])

[illegible] IMS [illegible]


[illegible]
UDR
PUR
SNR
UDA
PUA
SNA
PNR
Sh [illegible]
Sh [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
sh_repository_data
PubSub
[illegible]

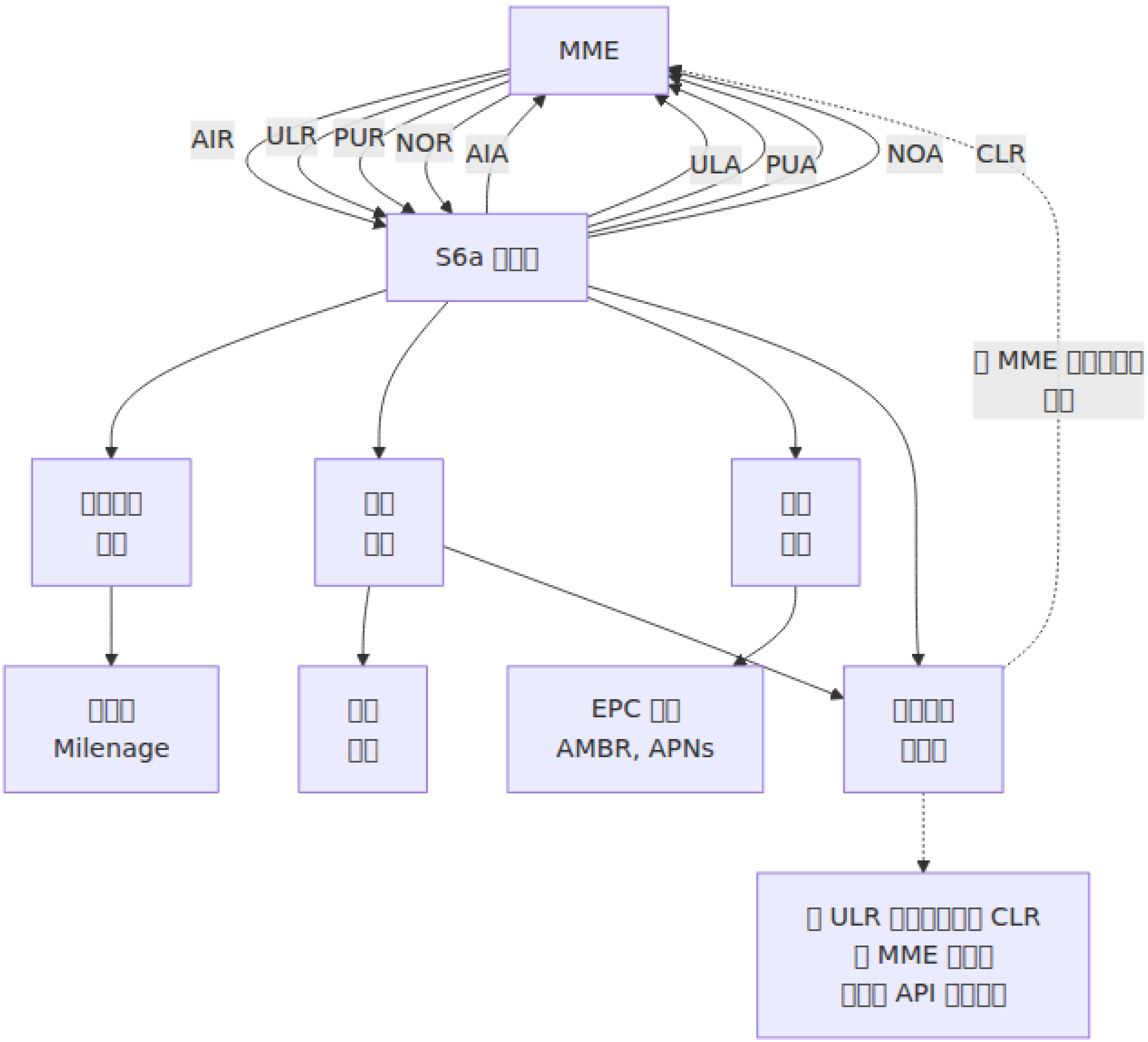
Gx [illegible] ([illegible])

[illegible] **PCRF [illegible]**[illegible]


P-GW
CCR-I
CCR-U
CCR-T
CCA-I
CCA-U
CCA-T
RAR
Gx
PDN
QoS
APN
AMBR, QCI

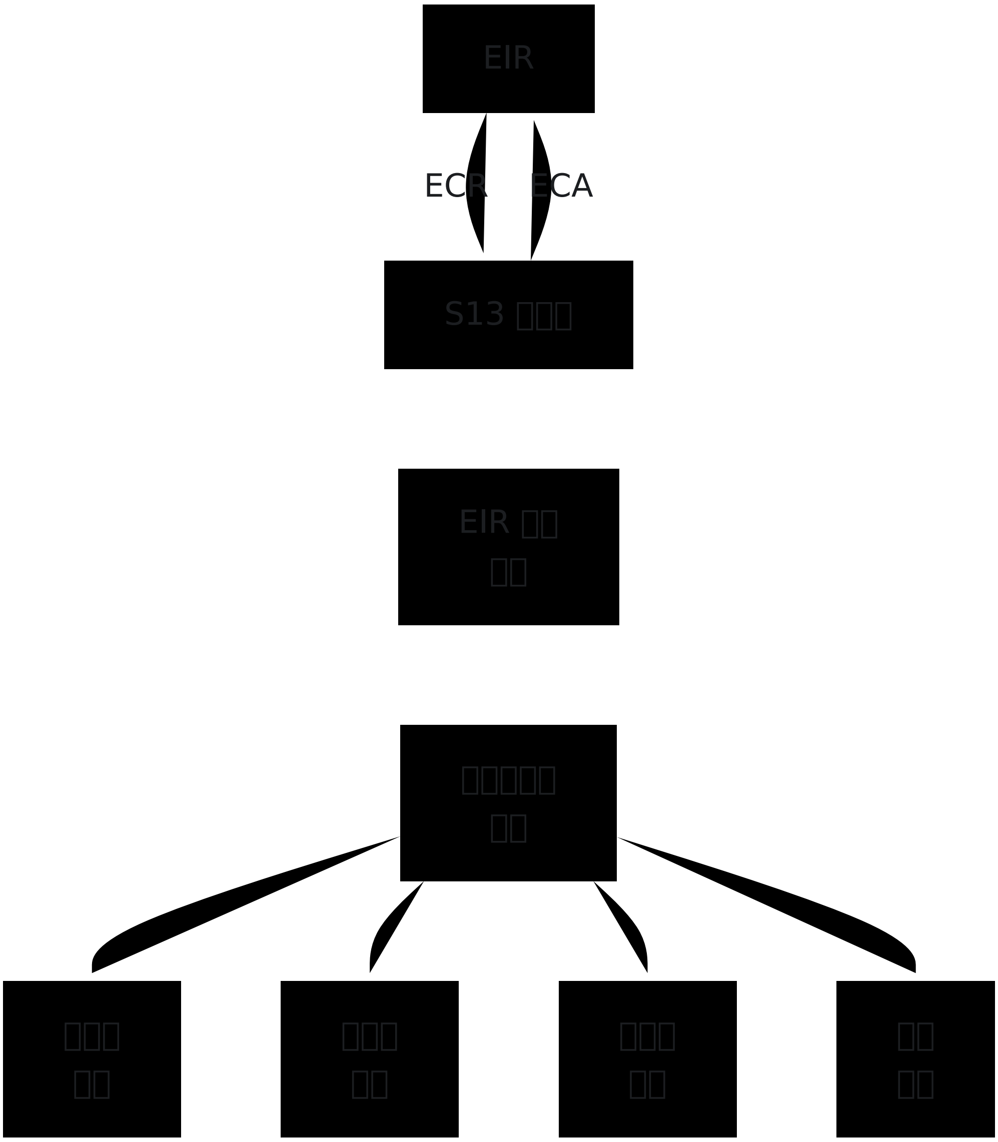
Rx [illegible] (IMS [illegible])

[illegible] IMS [illegible] VoLTE [illegible] **PCRF [illegible]**[illegible]


MME
AIR
ULR
PUR
NOR
AIA
ULA
PUA
NOA
CLR
S6a □□□
□ MME □□□□□ □□
□□□□ □□
□□ □□
□□ □□
□□□ Milenage
□□ □□
EPC □□ AMBR, APNs
□□□□ □□□
□ ULR □□□□□□ CLR □ MME □□□ □□□ API □□□□

S13 □□ (EIR)

□□□□□□□□□□□□ IMEI□□□□□□□□□□□ **EIR □□**□


EIR
ECR
ECA
S13 [illegible]
EIR [illegible]
[illegible]

[illegible]

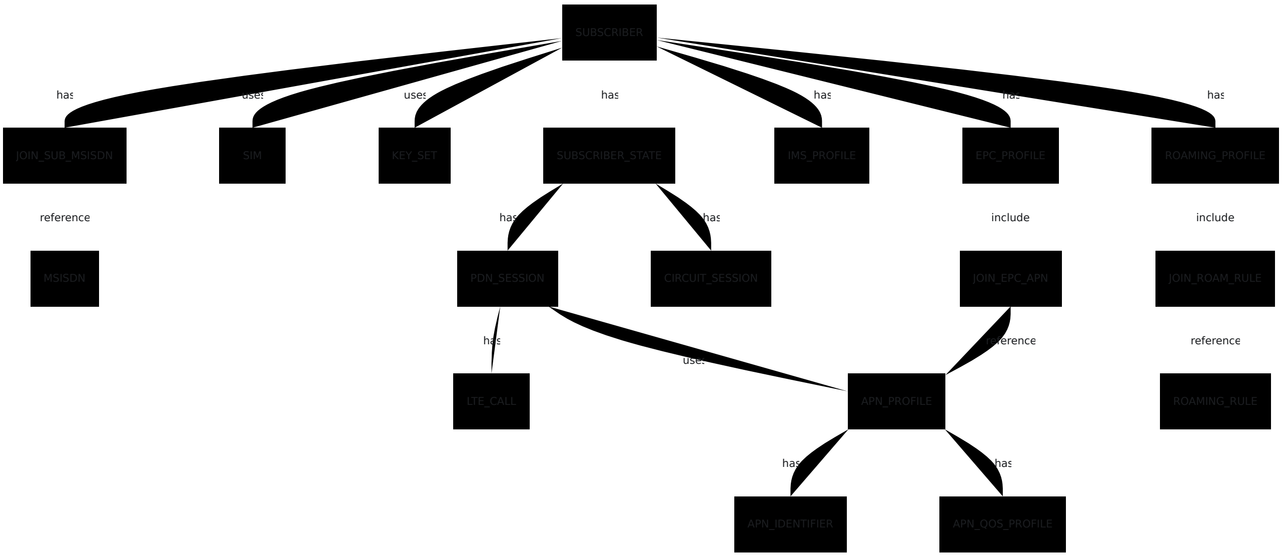
[illegible]

OmniHSS [illegible] **PostgreSQL** [illegible] **Ecto** [illegible] UUID [illegible]

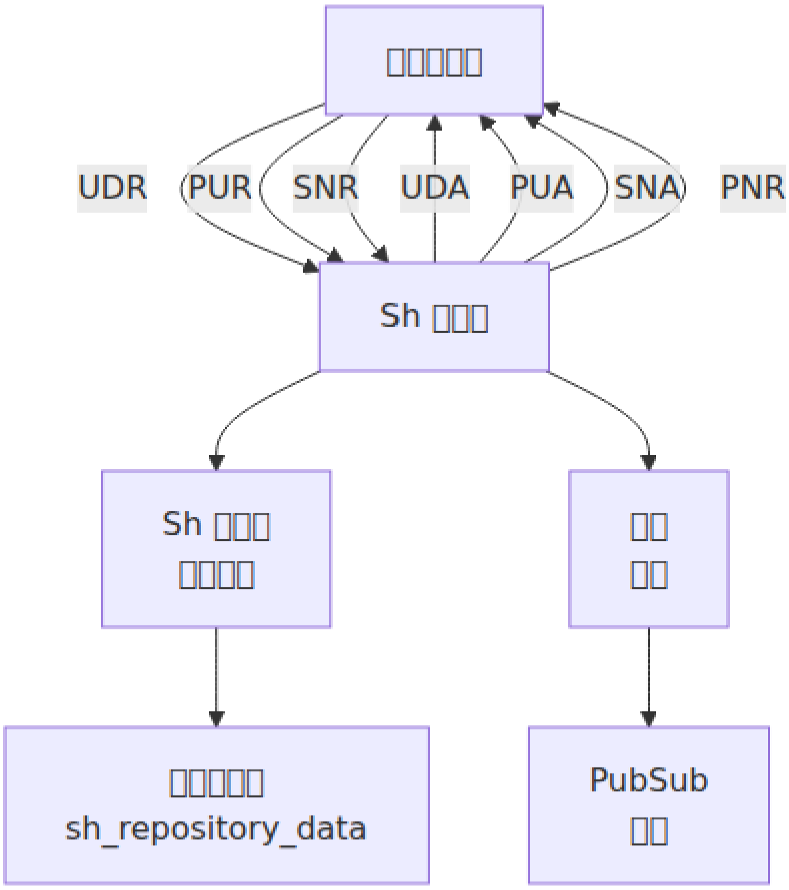
[illegible]OmniHSS [illegible] PostgreSQL [illegible]/[illegible] WAL [illegible]

[illegible] [illegible]

[illegible]

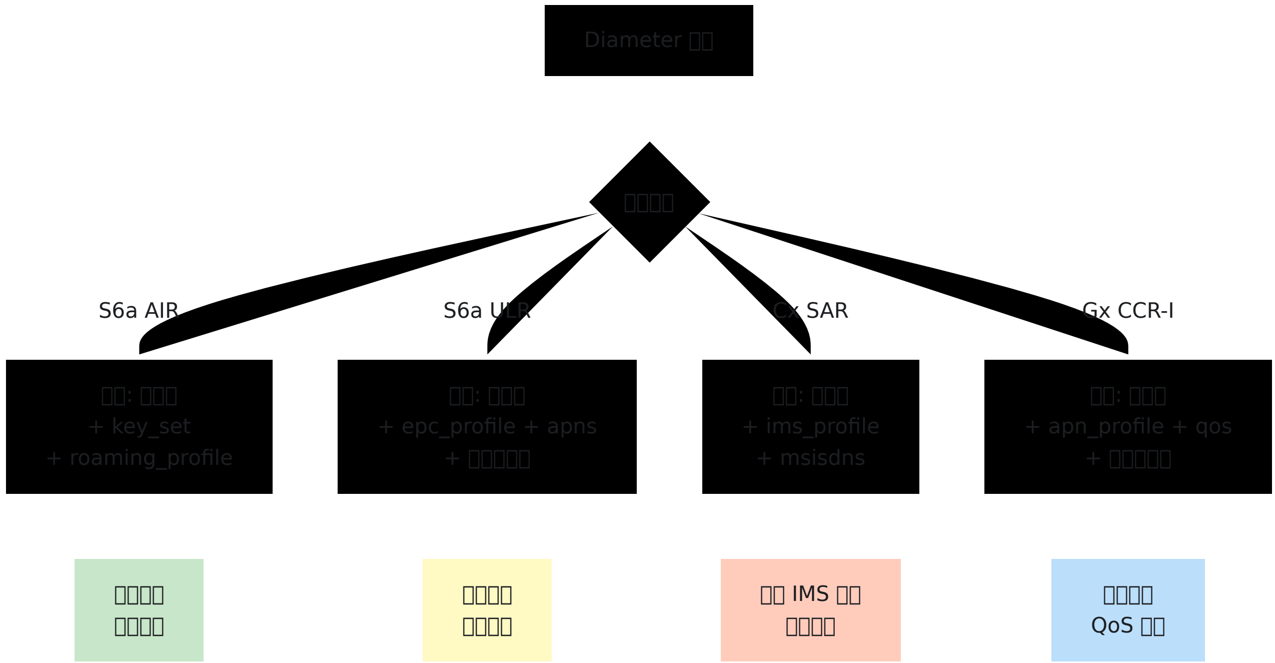

SUBSCRIBER
has
uses
uses
has
has
has
has
JOIN_SUB_MSISDN
SIM
KEY_SET
SUBSCRIBER_STATE
IMS_PROFILE
EPC_PROFILE
ROAMING_PROFILE
reference
has
has
include
include
MSISDN
PDN_SESSION
CIRCUIT_SESSION
JOIN_EPC_APN
JOIN_ROAM_RULE
has
uses
reference
reference
LTE_CALL
APN_PROFILE
ROAMING_RULE
has
has
APN_IDENTIFIER
APN_QOS_PROFILE

Ecto [illegible]


UDR
PUR
SNR
UDA
PUA
SNA
PNR
Sh
Sh
sh_repository_data
PubSub

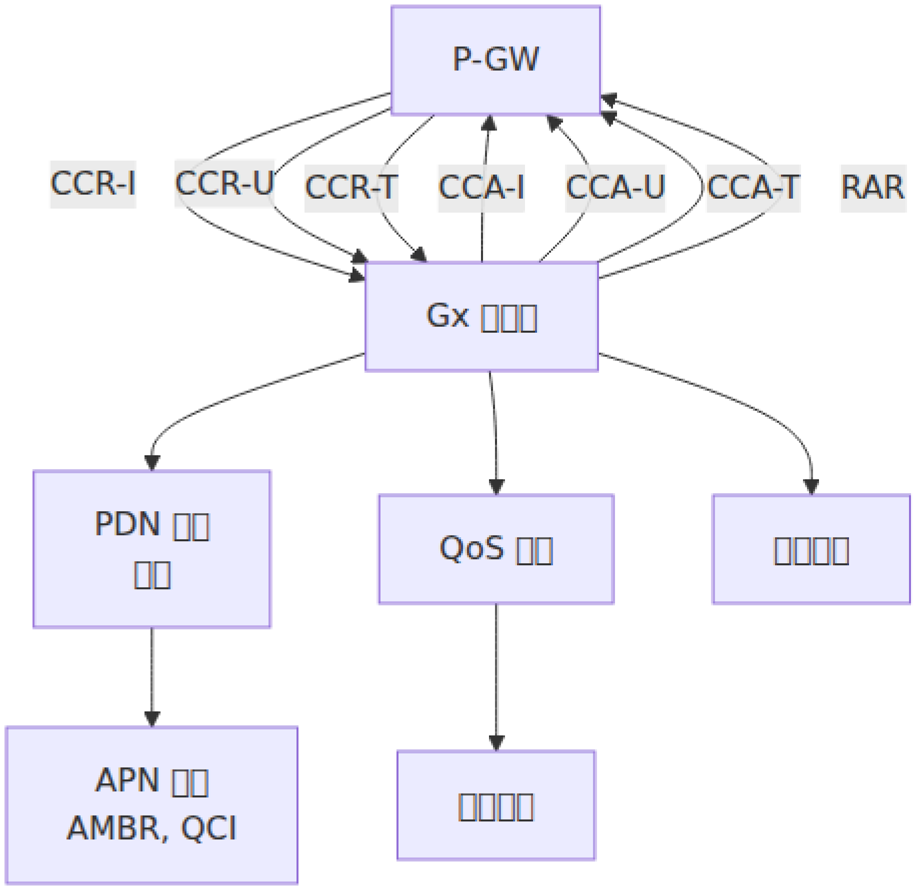
[illegible]

[illegible] Diameter [illegible]

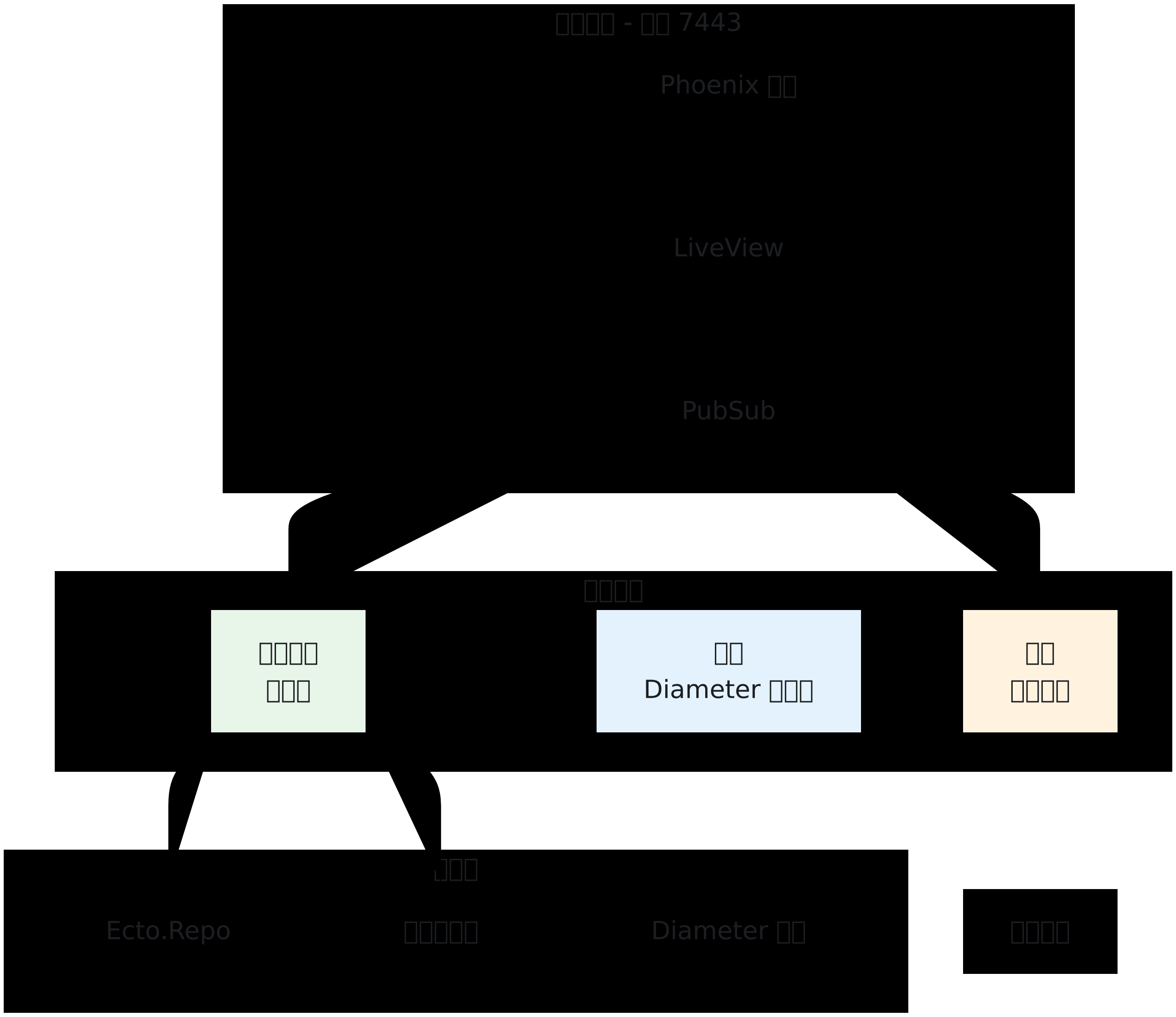

Diameter
S6a AIR
S6a ULR
Cx SAR
Gx CCR-I
+ key_set
+ roaming_profile
+ epc_profile + apns
+ ims_profile
+ msisdns
+ apn_profile + qos
IMS
QoS

[illegible]

API [illegible]

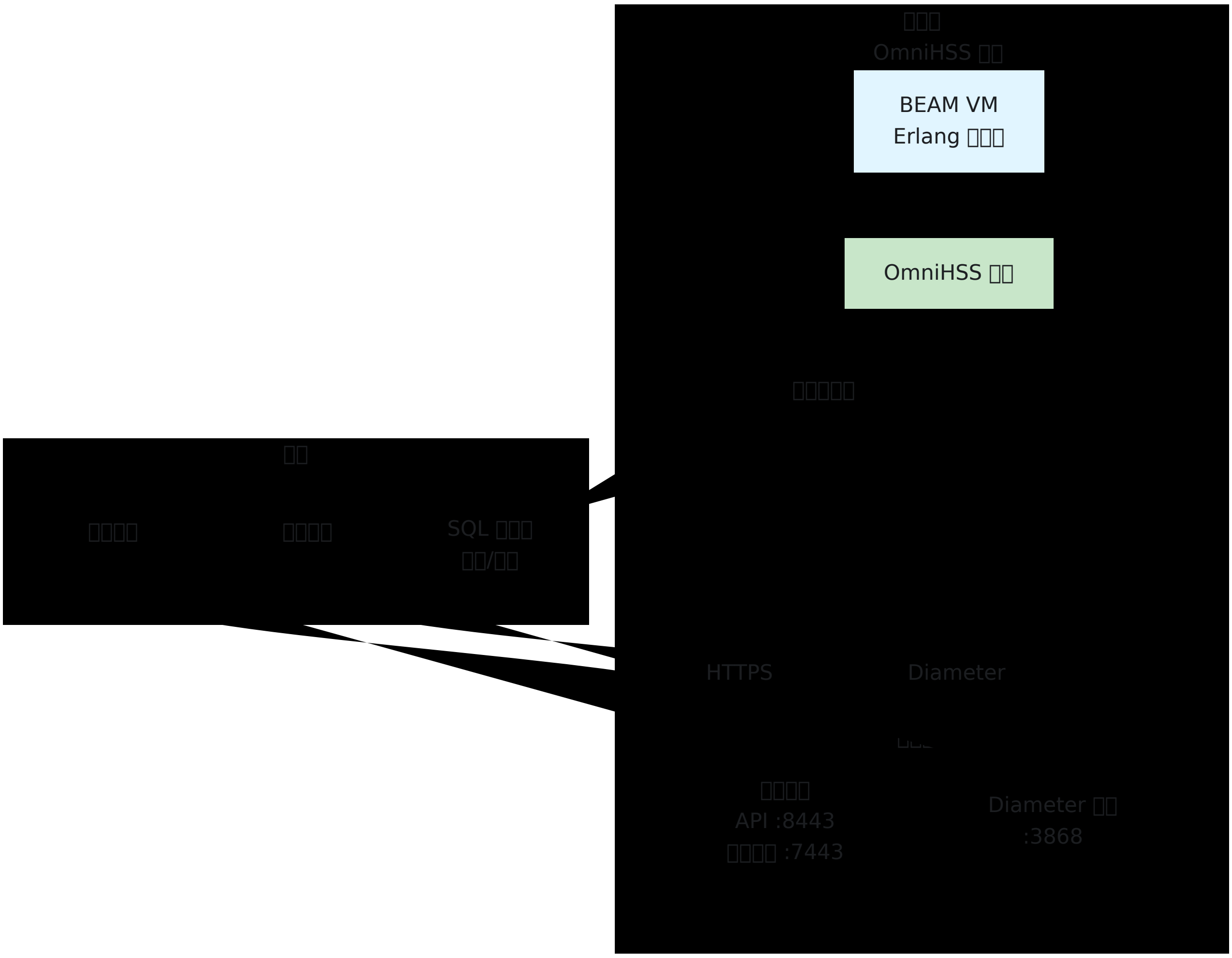

P-GW
CCR-I
CCR-U
CCR-T
CCA-I
CCA-U
CCA-T
RAR
Gx [illegible]
PDN [illegible]
QoS [illegible]
[illegible]
APN [illegible]
AMBR, QCI
[illegible]

[illegible]


- 7443
Phoenix
LiveView
PubSub
Diameter
Ecto.Repo
Diameter

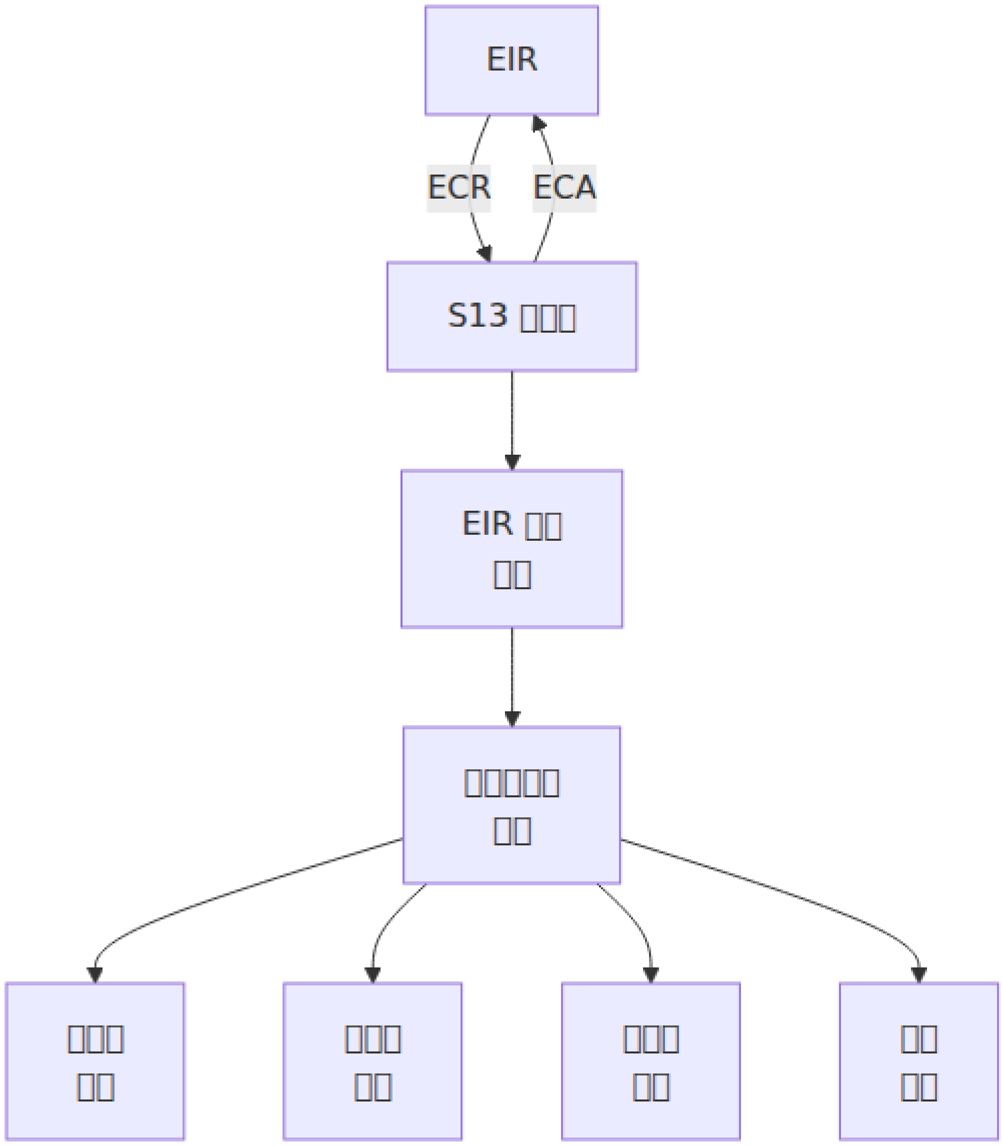
[illegible]

[illegible]


[illegible]
OmniHSS [illegible]
BEAM VM
Erlang [illegible]
OmniHSS [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
SQL [illegible]
[illegible]/[illegible]
HTTPS
Diameter
[illegible]
API :8443
[illegible] :7443
Diameter [illegible]
:3868

[illegible]

[illegible]OmniHSS [illegible] PostgreSQL [illegible]/[illegible]


EIR
ECR
ECA
S13 □□□
EIR □□
□□
□□□□□
□□
□□□
□□
□□□
□□
□□□
□□
□□
□□

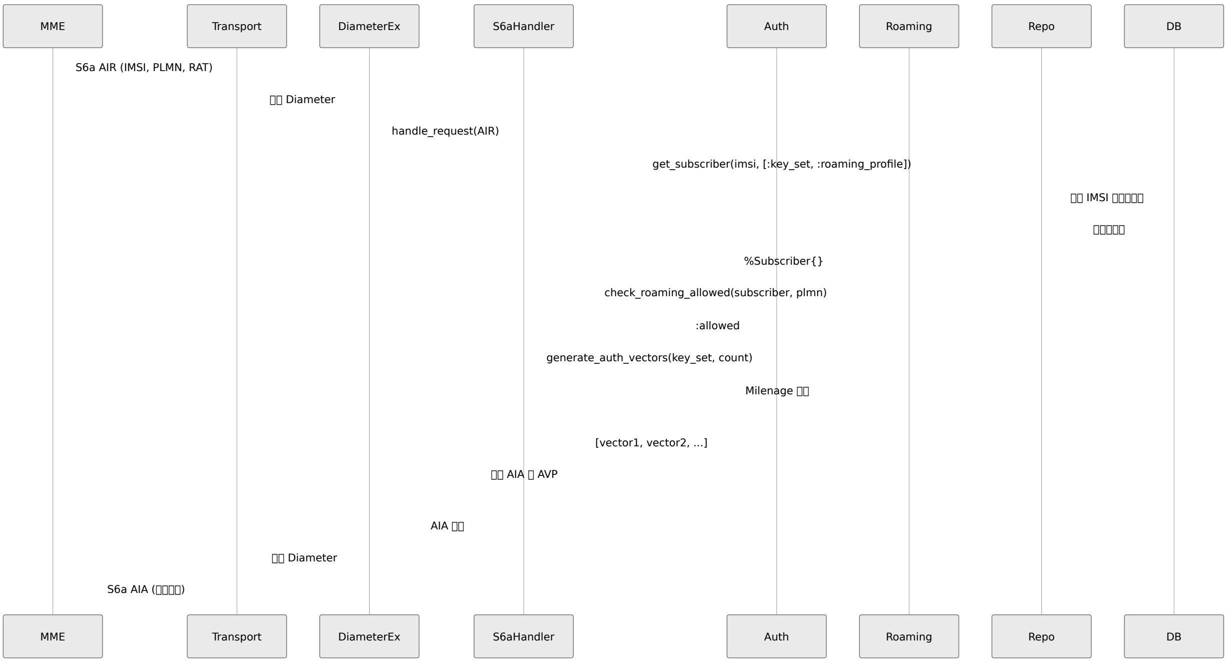
□□□□□

- □□□□□□□/□□□□□□□□□□□□□□□□□□
- □□□□□□□□□ WAL □□□□□□□□□□□□□□□□
- □□□□□□□□□□□□□□□□□□□□□□□□WAL □□□□□□□□□□□
- □□ **quorum**□□□□□□□□□□□□□□□□□□□□□□□□□□
- **UUID** □□□□□□□ ID □□□□□□□□□

□□□□□□□□□□□□□ □□□□□□

□□□□□□□□□

□□□□□□□□□□□□□□□□□


MME
Transport
DiameterEx
S6aHandler
Auth
Roaming
Repo
DB
S6a AIR (IMSI, PLMN, RAT)
□□ Diameter
handle_request(AIR)
get_subscriber(imsi, [:key_set, :roaming_profile])
□□ IMSI □□□□□
□□□□□
%Subscriber{}
check_roaming_allowed(subscriber, plmn)
:allowed
generate_auth_vectors(key_set, count)
Milenage □□
[vector1, vector2, ...]
□□ AIA □ AVP
AIA □□
□□ Diameter
S6a AIA (□□□□)
MME
Transport
DiameterEx
S6aHandler
Auth
Roaming
Repo
DB

□□□□□□

1. □□□

- Erlang/OTP □□□□□□□□□□□□
- □□□ Diameter □□□□□□□□□
- □□□□□□□□□□□□□□

2. □□□

- □□ Diameter □□□□□□□□□□□□
- □□□□□□□□□□□□□
- □□□□□□□□□□□□

3. [illegible]

- [illegible] Diameter [illegible]
- [illegible]
- [illegible]

4. [illegible]

- [illegible]
- [illegible]
- [illegible]

5. [illegible]

- [illegible]���[illegible]
- [illegible]
- Diameter [illegible]
- [illegible]

← [illegible] | [illegible] →

OmniHSS [illegible]

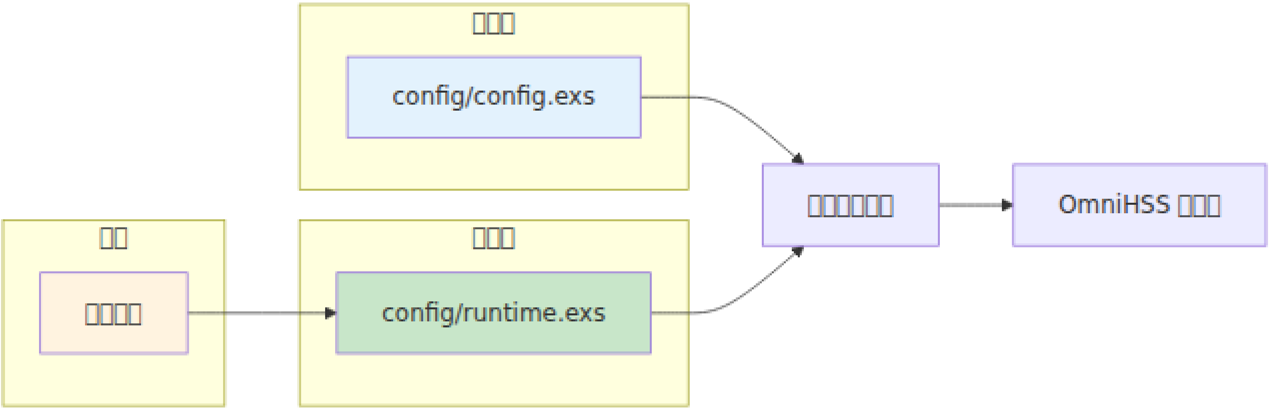
← [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- Diameter [illegible]
- [illegible]
  - [illegible] PLMN [illegible]
  - HSS [illegible]
- IMS [illegible]
- EIR [illegible]
- API [illegible]
- [illegible]

[illegible]

OmniHSS [illegible]



config/config.exs
config/runtime.exs
OmniHSS

config/config.exs (□□□)

□□□□□□□□□□□□□□□□□□□□

- □□□□□□□□
- API □□□□
- □□□□

config/runtime.exs (□□□)

□□□□□□□□□□□□□□□□

- □□□□□□□
- Diameter □□□□□
- □□ PLMN □□
- IMS S-CSCF □□
- □□□□□□

□□□□□□

□□□□□□□□□□□□□□□□□□ HSS □□□□

```
# config/runtime.exs

config :license_client,
  # □□□□□□ API □□□□□□□□□□□□□
  license_server_api_urls:
["https://license.example.com:8443/api"],

  # □□□□□□□
  licensee: "□□□□□□□",

  # □□□□□
  product_name: "omnihss"
```

□□□□□□□□

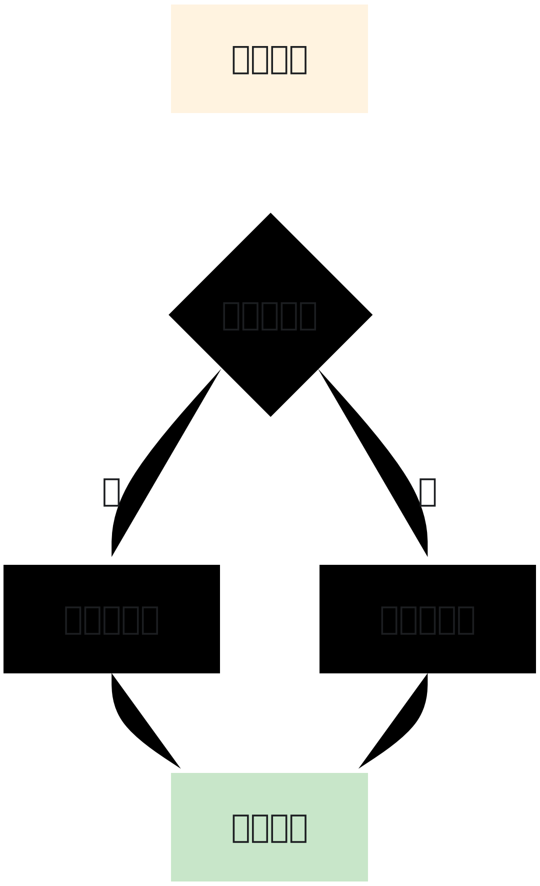
[illegible]	[illegible]	[illegible]	[illegible]
`license_server_api_urls`	[illegible] URL [illegible]	[illegible]	`["https://10.0.0.1:8443/api"]`
`licensee`	[illegible]	[illegible]	`"ACME Telecom"`
`product_name`	[illegible]	[illegible]	`"omnihss"`

[illegible]

- [illegible] HSS [illegible]
- [illegible] HTTPS [illegible]
- [illegible] URL [illegible]
- [illegible]

[illegible]

[illegible]



[illegible]

OmniHSS [illegible]

- [illegible]
- [illegible] runtime.exs [illegible]
- [illegible]

□□□□□

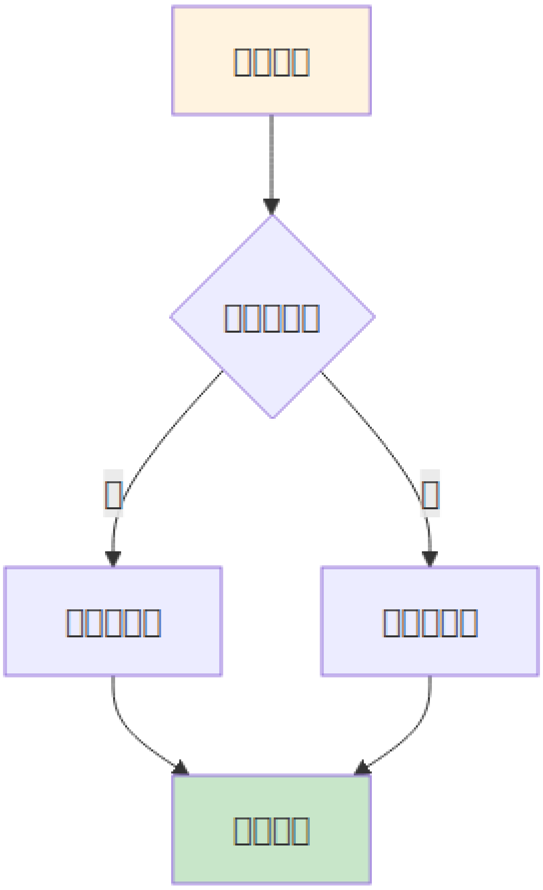
□□□□□□□

```
# config/runtime.exs

config :hss, Hss.Repo,
  # □□□□□□□
  username: System.get_env("DATABASE_USERNAME", "root"),
  password: System.get_env("DATABASE_PASSWORD", "password"),
  hostname: System.get_env("DATABASE_HOSTNAME", "localhost"),
  database: System.get_env("DATABASE_NAME", "omnihss"),

  # □□□□□
  pool_size:
String.to_integer(System.get_env("DATABASE_POOL_SIZE", "20")),

  # □□□□□□□□□□
  timeout: 15_000,
  connect_timeout: 15_000,

  # □□□□
  show_sensitive_data_on_connection_error: false
```

□□□□□□□

□□	□□	□□	□□
`username`	SQL □□□□□□	`"root"`	□□□□□□□□□□
`password`	SQL □□□□□	`"password"`	□□□□□□□□□□□□□□
`hostname`	SQL □□□□□□□□□	`"localhost"`	□□□□□□ FQDN □ IP
`database`	□□□□□	`"omnihss"`	□□□□□□□□□□□□□□
`pool_size`	□□□□□	`20`	□□□□□□□10-50 □□□□

[illegible]



[illegible]

- [illegible] 20 [illegible]
- [illegible]“[illegible]”[illegible]
- [illegible] 10
- [illegible] 4MB [illegible]
- [illegible] SQL [illegible]

□□□□□□□□□□

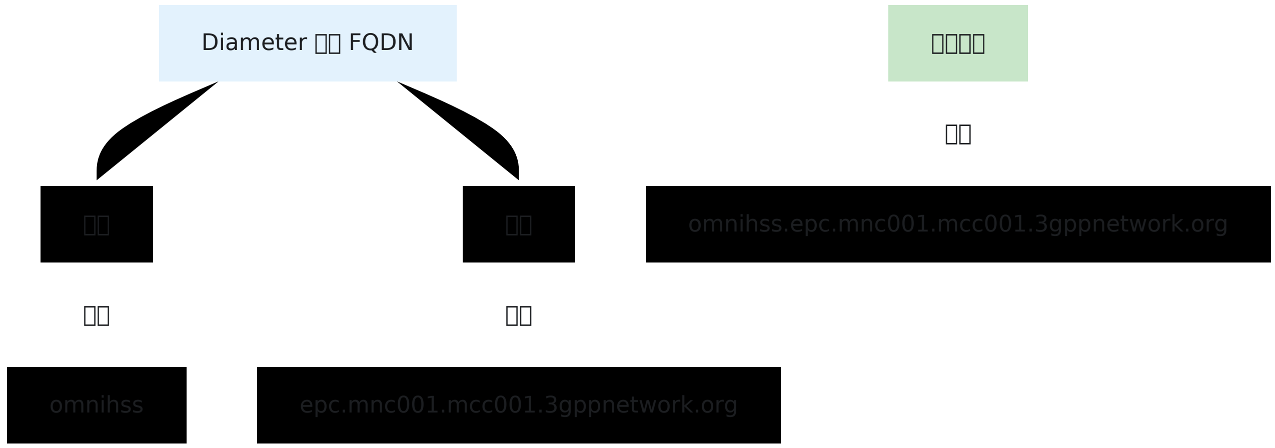
```
# config/runtime.exs - □□□□

config :hss, Hss.Repo,
  username: System.fetch_env!("DATABASE_USERNAME"),      # □□□□□
  password: System.fetch_env!("DATABASE_PASSWORD"),      # □□□□□
  hostname: System.get_env("DATABASE_HOSTNAME",
"db.internal.example.com"),
  database: System.get_env("DATABASE_NAME", "omnihss"),
  port: String.to_integer(System.get_env("DATABASE_PORT",
"5432")),
  pool_size:
String.to_integer(System.get_env("DATABASE_POOL_SIZE", "30")),
  ssl: true,
  ssl_opts: [
    cacertfile: "/etc/ssl/certs/postgres-ca.pem",
    verify: :verify_peer
  ]
```

Diameter □□

Diameter □□□□

```
# config/runtime.exs

diameter_config = %{
  service_name: :omnitouch_hss,

  # □□□□
  listen_ip: System.get_env("DIAMETER_LISTEN_IP", "10.7.25.186"),
  listen_port:
String.to_integer(System.get_env("DIAMETER_LISTEN_PORT", "3868")),

  # Diameter □□
  host: System.get_env("DIAMETER_HOST", "omnihss"),
  realm: System.get_env("DIAMETER_REALM",
"epc.mnc001.mcc001.3gppnetwork.org"),

  # □□□□
  product_name: "OmniHSS",
  vendor_id: 10415,  # 3GPP
  supported_vendor_ids: [5535, 10415],

  # □□□□
  request_timeout: 5000,

  # □□□□□
  peers: [
    # □□□□□□□□□
  ]
}

config :hss, :diameter, diameter_config
```

Diameter □□□□



Diameter □□ FQDN
□□□□
□□
□□
□□
omnihss.epc.mnc001.mcc001.3gppnetwork.org
□□
□□
omnihss
epc.mnc001.mcc001.3gppnetwork.org

□□□□□

- □□□ HSS □□□□□□□□□“omnihss”□“hss01”□
- □□□ □□□ PLMN □□□ Diameter □□□□ □□“epc.mnc001.mcc001.3gppnetwork.org”□
- □□□□□ □□□ `{host}.{realm}`

□□ Diameter □□□

□□□□□□□□□□□□□

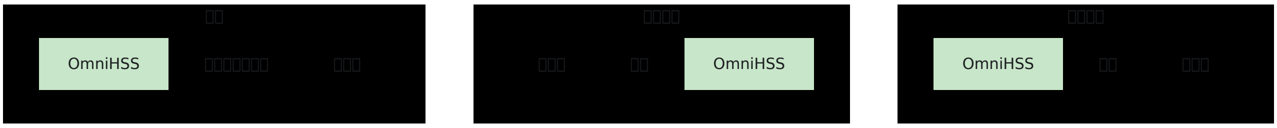
```
# config/runtime.exs

peers: [
  # MME □□□□□
  %{
    host: "mme01.epc.mnc001.mcc001.3gppnetwork.org",
    realm: "epc.mnc001.mcc001.3gppnetwork.org",
    ip: "10.7.25.100",
    port: 3868,
    transport: :sctp,  # □ :tcp
    applications: [:s6a]
  },

  # P-GW □□□□□
  %{
    host: "pgw01.epc.mnc001.mcc001.3gppnetwork.org",
    realm: "epc.mnc001.mcc001.3gppnetwork.org",
    ip: "10.7.25.101",
    port: 3868,
    transport: :sctp,
    applications: [:gx]
  },

  # I-CSCF □□□□□
  %{
    host: "icscf01.ims.mnc001.mcc001.3gppnetwork.org",
    realm: "ims.mnc001.mcc001.3gppnetwork.org",
    ip: "10.7.25.102",
    port: 3868,
    transport: :tcp,
    applications: [:cx]
  }
]
```

□□□□□

□□□□□□□□□ HSS □□□□

```
# config/runtime.exs

diameter_config = %{
  # ... [illegible] ...
  peers: []  # [illegible] - [illegible]
}
```

Diameter [illegible]


OmniHSS
OmniHSS
OmniHSS

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
SCTP	[illegible]	[illegible]	[illegible] Diameter
TCP	[illegible]	[illegible]	[illegible] SCTP [illegible]

[illegible]

[illegible] PLMN [illegible]

[illegible] PLMN [illegible]

```
# config/runtime.exs

config :hss, :home_plmn, %{
  mcc: System.get_env("HOME_PLMN_MCC", "001"),  # [illegible]
  mnc: System.get_env("HOME_PLMN_MNC", "001")   # [illegible]
}
```

HSS [illegible]

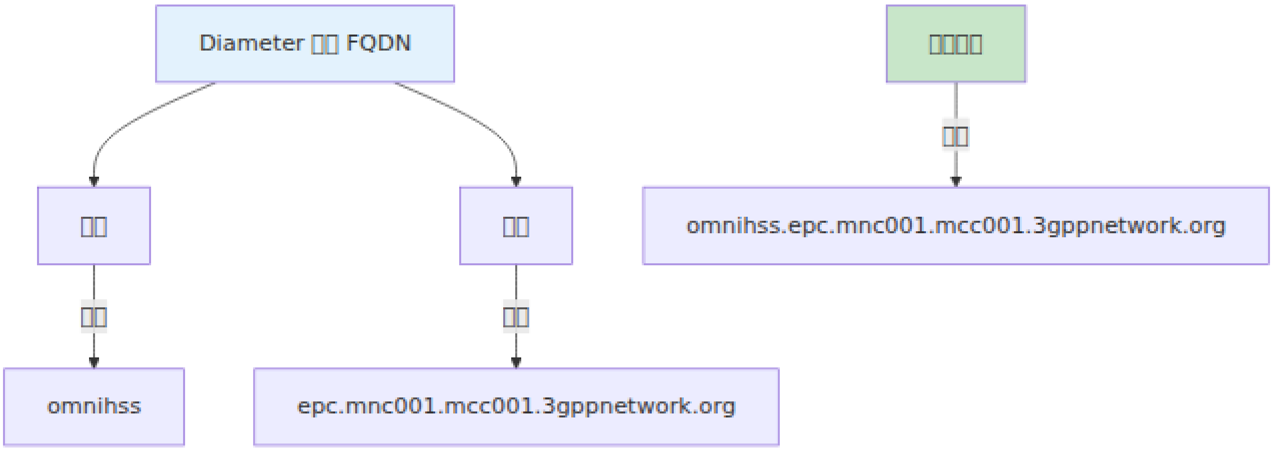
[illegible] HSS [illegible]

```
# config/runtime.exs

config :hss,
  # [illegible] Ecto [illegible]
  ecto_repos: [Hss.Repo],

  # MME [illegible] CLR[illegible]
  send_clr_on_mme_change: true,

  # [illegible] Diameter [illegible]
  stop_diameter_on_database_failure: true,

  # [illegible]
  license_enforced: true,
  license_module: LicenseClient
```

HSS [illegible]

□□	□□	□□	□□
`ecto_repos`	□□□□□□□ Ecto □□□□□	`[Hss.Repo]`	□□□□□□□
`send_clr_on_mme_change`	□□□□□□ MME □□□□□□□□□	`true`	□□□□□□□□□□□□□
`stop_diameter_on_database_failure`	□□□□□□□□□□□□□□ Diameter □□	`true`	□□□□□□□□□□
`license_enforced`	□□□□□□□	`true`	□□□□□
`license_module`	□□□□□□□□□□	`LicenseClient`	□□□□

PLMN □□□□


Diameter □□ FQDN
□□□□
□□
omnihss.epc.mnc001.mcc001.3gppnetwork.org
□□
□□
□□
□□
omnihss
epc.mnc001.mcc001.3gppnetwork.org

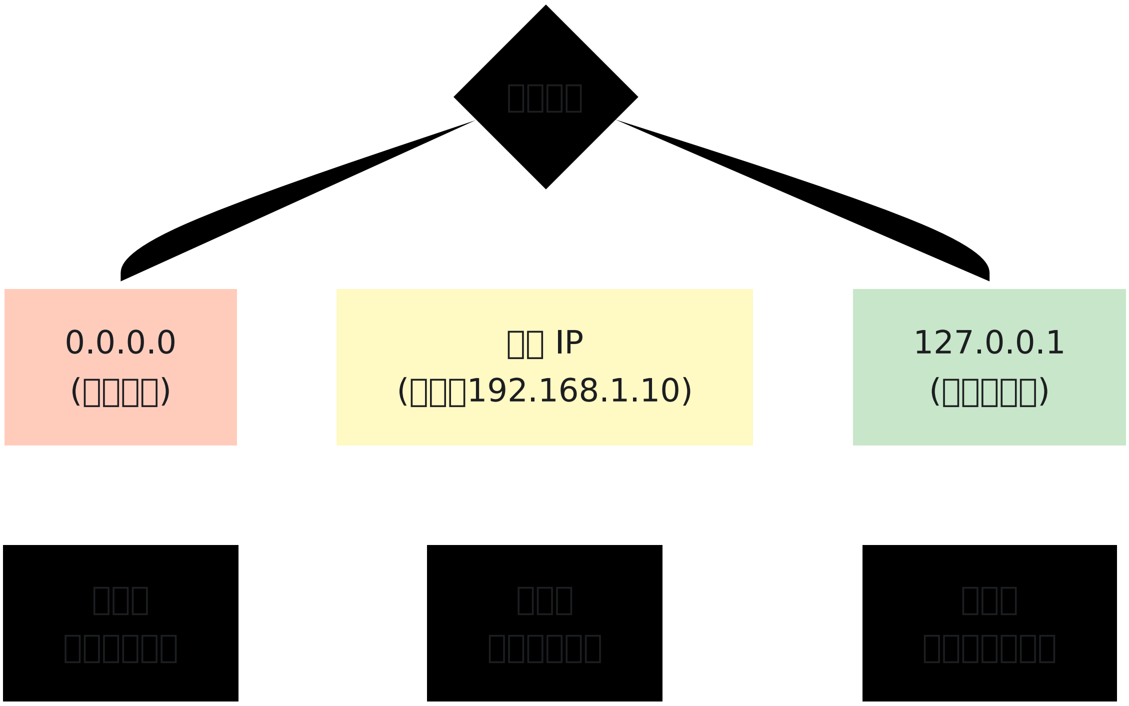
□□□

- AT&T□□□□□MCC=310□MNC=410
- Verizon□□□□□MCC=311□MNC=480
- Vodafone□□□□□MCC=234□MNC=15
- □□□□□MCC=001□MNC=01

[illegible]

```
# config/runtime.exs

# Diameter [illegible]
listen_ip: System.get_env("DIAMETER_LISTEN_IP", "0.0.0.0"),  # [illegible]
# [illegible]
# listen_ip: "10.7.25.186",

# API [illegible]
config :hss, HssWeb.Api.Endpoint,
  http: [
    ip: {0, 0, 0, 0},  # [illegible]
    port: 8443
  ]

# [illegible]
config :hss, HssWeb.ControlPanel.Endpoint,
  http: [
    ip: {0, 0, 0, 0},  # [illegible]
    port: 7443
  ]
```

[illegible]


0.0.0.0
([illegible])
[illegible] IP
([illegible]192.168.1.10)
127.0.0.1
([illegible])

IMS [illegible]

S-CSCF [illegible]

HSS [illegible] REGISTER [illegible] S-CSCF[illegible] S-CSCF [illegible] S-CSCF [illegible]HSS [illegible] REGISTER [illegible] IMS-AKA [illegible] S-CSCF [illegible]

[illegible] S-CSCF [illegible]HSS [illegible] SAR [illegible] SAR [illegible] HSS [illegible] UAR [illegible] LIR [illegible] IMS [illegible] S-CSCF[illegible]

```
# config/runtime.exs

config :hss, :ims, %{
  scscf: %{
    # □□□ REGISTER □□□□□:pool_uri □ :random_peer
    selection_method: :pool_uri,

    # :pool_uri □□□ S-CSCF □□□□□□□□□□□ I-CSCF □□□□□ SRV □□□HSS □□□□□ REGISTER □□□□□□□□□□□□□□□□□ S-CSCF□
    pool_uri: "sip:scscf.ims.mnc001.mcc001.3gppnetwork.org",

    # IMS-AKA □□□ HSS □□□□□□ S-CSCF □□□□□□□□□□
    auth_pending_ttl_seconds: 30,

    # :random_peer □ S-CSCF □□□□□□□□ S-CSCF □□□
    peers: [
      %{
        host: "sip:scscf01.ims.mnc001.mcc001.3gppnetwork.org:5060"
      },
      %{
        host: "sip:scscf02.ims.mnc001.mcc001.3gppnetwork.org:5060"
      }
    ]
  }
}
```

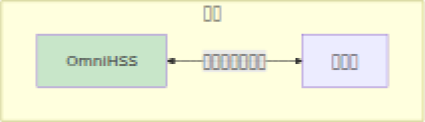
□□□

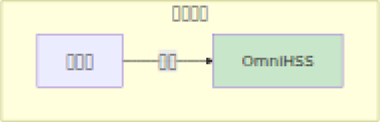
□□	□□	□□	□□	□□
`selection_method`	□□	□	`:pool_uri`	□□□ REGIST S-CSCF □□□ □ `:pool_ur` `:random_pe` □□□ S-CSCF □□□
`pool_uri`	□□□	□□ `:pool_uri` □□□□	-	□□□ REGIST □□□□□ S-CS □□□□□□□□□□ I-CSCF □□ S □□□□□ DNS □□□□□HSS □ □□□□□□□□□□ S-CSCF□□□□ `pool_uri`□ □□□□□□□□□ `peers` □□□□
`auth_pending_ttl_seconds`	□□	□	30	HSS □□□□□□□ CSCF □□□□□□ □□□□□□□□□ □□□□□□□□□□ □□□□□ S-CS □□□□□□
`peers`	□□	□□ `:random_peer` □□□□	-	S-CSCF □□□□ □□□□□□□□□□ □□

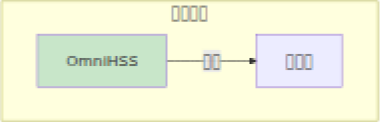
□□□□□□

□□	□□	□□	□□	□□
`host`	□□□	□	-	S-CSCF SIP URI□□ FQDN □□□□I-CSCF □□□□□□□□

S-CSCF □□□□







□□□□□

□□	□□	□□
`:pool_uri`	□□□□ `pool_uri`□I-CSCF □□ DNS SRV □□□□□□□□□DNS □□□□ REGISTER □□□□□□□□□□□□□	□□□□□□□□□ REGISTER □□□□□□□□□□□
`:random_peer`	□ `peers` □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ IMSI □□□□□□□□□□□□□□□□	□□□□□□□□ S-CSCF□□□□□ SRV □□□

□□ `:random_peer` □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□���□□□□□□□□ REGISTER □□□□ S-CSCF□

□□ `selection_method` □□□□□□HSS □□□□□□□□□□ `:random_peer` □□□HSS □□□□ UAR□

□□□□□□□□□ REGISTER□ □□□□□□□□□□ UAA □□□□□□

□□□□□	**UAA □□□□□**	**UAA □□□□**
□□ S-CSCF □□	□□□□`pool_uri` □ `peers` □□□□	2001□□□□□□□□
IMS-AKA □□□□□□	□□□ S-CSCF □□	2002□□□□□□□
□□□□□□□□□□□□□	□□ S-CSCF □□	2002□□□□□□□
□□ IMS □□□□□□□□□□□□□□□□	□□□□□ S-CSCF □□	2001 □ 2002

IMS [illegible]

[illegible]IMS [illegible] EPC [illegible]

```
# EPC [illegible]
"epc.mnc001.mcc001.3gppnetwork.org"

# IMS [illegible]
"ims.mnc001.mcc001.3gppnetwork.org"
```

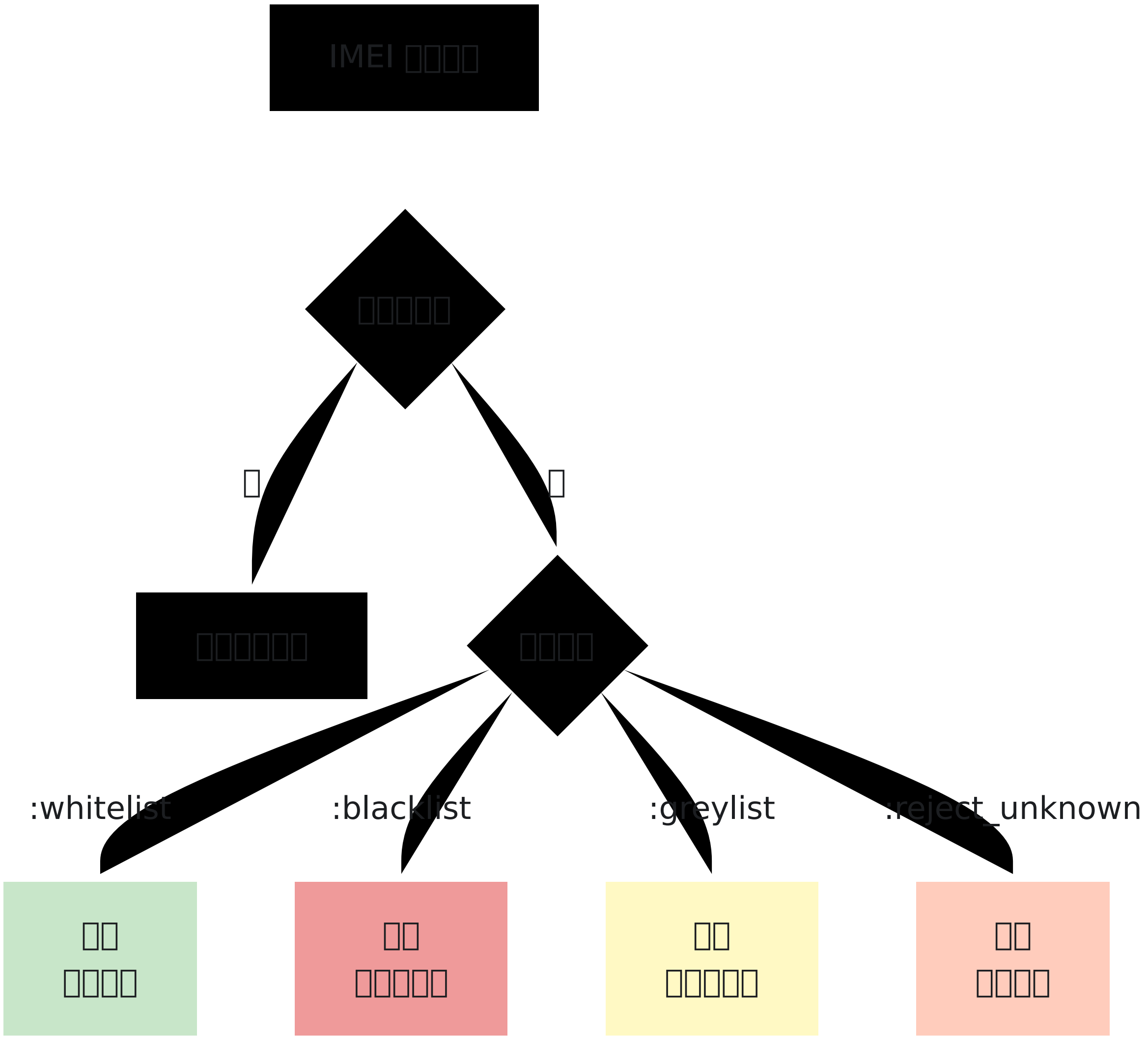
EIR [illegible]

[illegible] **EIR [illegible]** [illegible]

[illegible]

```
# config/runtime.exs

config :hss, :eir, %{
  # [illegible]
  unknown_equipment_behaviour: :whitelist
  # [illegible]
  #   :whitelist - [illegible]
  #   :blacklist - [illegible]
  #   :greylist - [illegible]
  #   :reject_unknown_equipment - [illegible]
}
```

□□□□□□


IMEI □□□□
□□□□□
□
□
□□□□□□
□□□□
:whitelist
:blacklist
:greylist
:reject_unknown
□□
□□□□
□□
□□□□□
□□
□□□□□
□□
□□□□

□□□□□

□□	□□	□□
`:whitelist`	□□□□□□□ IMEI	□□□□□□□
`:blacklist`	□□□□□□□ IMEI	□□□□□
`:greylist`	□□□□□□□□ IMEI	□□□□
`:reject_unknown_equipment`	□□□□□□□	□□□□

□□□ □□□□□□ `:whitelist` □□□□□ `:greylist` □□□□□□□□□ `:blacklist` □□□□□□□□

API [illegible]

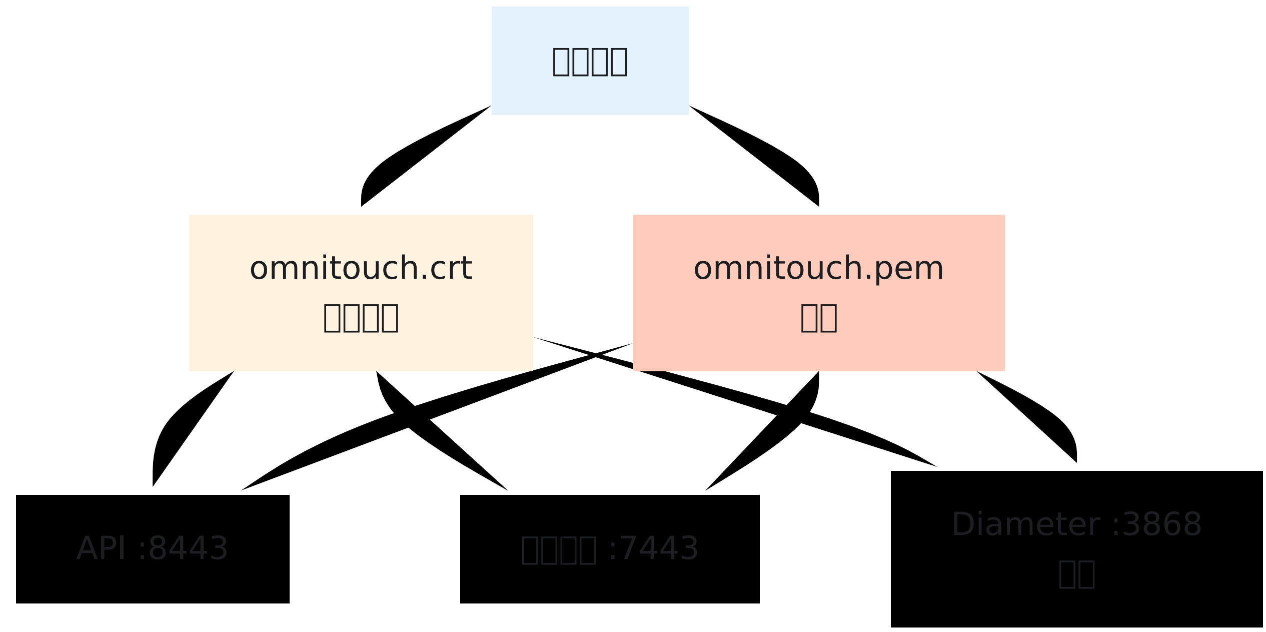
API [illegible]

```
# config/config.exs

config :hss, HssWeb.Api.Endpoint,
  url: [host: "localhost"],
  render_errors: [view: HssWeb.ErrorView, accepts: ~w(json)],
  pubsub_server: Hss.PubSub,

  # HTTPS [illegible]
  https: [
    port: 8443,
    cipher_suite: :strong,
    certfile: "priv/cert/omnitouch.crt",
    keyfile: "priv/cert/omnitouch.pem"
  ]
```

[illegible]

```
# config/config.exs

config :hss, HssWeb.ControlPanel.Endpoint,
  url: [host: "localhost"],
  render_errors: [view: HssWeb.ErrorView, accepts: ~w(html json)],
  pubsub_server: Hss.PubSub,
  live_view: [signing_salt: "some-secret"],

  # HTTPS [illegible]
  https: [
    port: 7443,
    cipher_suite: :strong,
    certfile: "priv/cert/omnitouch.crt",
    keyfile: "priv/cert/omnitouch.pem"
  ]
```

TLS [illegible]


[illegible]
omnitouch.crt
[illegible]
omnitouch.pem
[illegible]
API :8443
[illegible] :7443
Diameter :3868
[illegible]

[illegible]

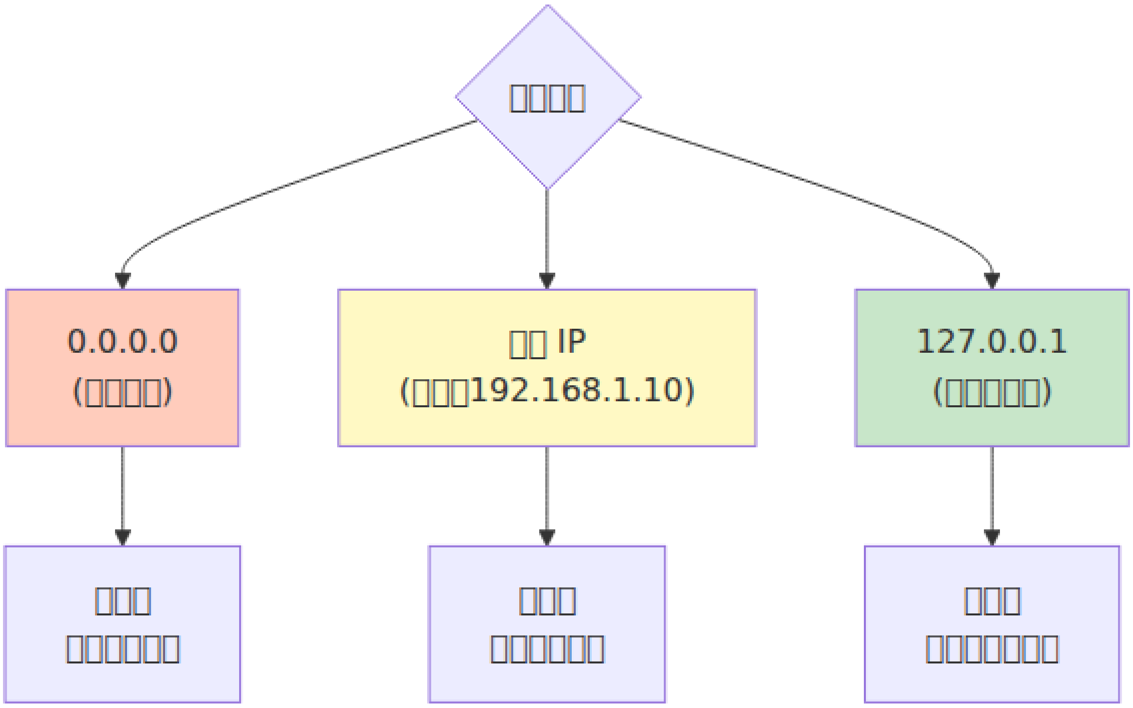
- [illegible] X.509 [illegible]
- [illegible]
- [illegible]
- CN [illegible] SAN [illegible]

[illegible]

```
https: [
  port: 8443,
  cipher_suite: :strong,
  certfile: System.get_env("TLS_CERT_FILE", "/etc/ssl/certs/omnihss.crt"),
  keyfile: System.get_env("TLS_KEY_FILE", "/etc/ssl/private/omnihss.key"),
  cacertfile: System.get_env("TLS_CA_FILE", "/etc/ssl/certs/ca-bundle.crt")
]
```

[illegible]

[illegible]


[illegible]
0.0.0.0
([illegible])
[illegible] IP
([illegible]192.168.1.10)
127.0.0.1
([illegible])
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

[illegible]

[illegible]

- ☐ [illegible]���[illegible]
- ☐ [illegible] PLMN[illegible]MCC[illegible]MNC[illegible]
- ☐ [illegible]
- ☐ [illegible] IP [illegible]
- ☐ API [illegible] TLS [illegible]
- ☐ [illegible] URL[illegible]
- ☐ HSS [illegible]send_clr_on_mme_change[illegible]stop_diameter_on_database_failure[illegible]

[illegible]

- ☐ [illegible]
- ☐ [illegible] 3868[illegible]
- ☐ [illegible] HTTPS [illegible] 7443[illegible]8443[illegible]

- ☐ □□□□□ DNS □□

IMS □□□□□□□ IMS □□□

- ☐ □□ S-CSCF □□□□□
- ☐ □□ S-CSCF □□□□
- ☐ □□ IMS □□

□□□□

- ☐ □□ EIR □□
- ☐ □□□□□□□□
- ☐ □□□□□□□□

□□□□

□□□□□□

1. □□□□□

   ```
   □□□□□□□□□□□□□□□
   ```

2. □□□□□□□

   ```
   □□ https://[hostname]:7443
   □□□□□□□□□□□
   ```

3. **API □□□**

   ```
   curl -k https://[hostname]:8443/api/status
   ```

4. □□□□□

   ```
   □□□□□□□□□□□
   □□□□□□□
   ```

5. [illegible]

```
[illegible]
[illegible] SQL [illegible]
```

[illegible]

```
# config/runtime.exs - [illegible]

import Config

#
=====================================================================
# [illegible]
#
=====================================================================
config :hss, Hss.Repo,
  username: System.fetch_env!("DATABASE_USERNAME"),
  password: System.fetch_env!("DATABASE_PASSWORD"),
  hostname: System.get_env("DATABASE_HOSTNAME", "db.omnihss.internal'
  database: System.get_env("DATABASE_NAME", "omnihss"),
  port: String.to_integer(System.get_env("DATABASE_PORT", "5432")),
  pool_size: String.to_integer(System.get_env("DATABASE_POOL_SIZE", '
  timeout: 15_000,
  connect_timeout: 15_000,
  ssl: true,
  ssl_opts: [
    cacertfile: "/etc/ssl/certs/postgres-ca.pem",
    verify: :verify_peer
  ]

#
=====================================================================
# [illegible]
#
=====================================================================
config :license_client,
  license_server_api_urls: [System.get_env("LICENSE_SERVER_URL",
"https://license.example.com:8443/api")],
  licensee: System.get_env("LICENSE_ORGANIZATION", "[illegible]"),
  product_name: "omnihss"

#
=====================================================================
# [illegible] PLMN [illegible] HSS [illegible]
#
=====================================================================
config :hss,
  ecto_repos: [Hss.Repo],
  home_plmn: %{
    mcc: System.get_env("HOME_PLMN_MCC", "001"),
    mnc: System.get_env("HOME_PLMN_MNC", "001")
  },
  send_clr_on_mme_change: true,
  stop_diameter_on_database_failure: true,
  license_enforced: true,
  license_module: LicenseClient

#
====================================================================
# □□□□
#
====================================================================
diameter_config = %{
  service_name: :omnitouch_hss,
  listen_ip: System.get_env("DIAMETER_LISTEN_IP", "10.7.25.186"),
  listen_port: String.to_integer(System.get_env("DIAMETER_LISTEN_PORT
"3868")),
  host: System.get_env("DIAMETER_HOST", "omnihss01"),
  realm: System.get_env("DIAMETER_REALM",
"epc.mnc001.mcc001.3gppnetwork.org"),
  product_name: "OmniHSS",
  vendor_id: 10415,
  supported_vendor_ids: [5535, 10415],
  request_timeout: 5000,
  peers: [
    %{
      host: "mme01.epc.mnc001.mcc001.3gppnetwork.org",
      realm: "epc.mnc001.mcc001.3gppnetwork.org",
      ip: "10.7.25.100",
      port: 3868,
      transport: :sctp,
      applications: [:s6a]
    }
  ]
}

config :hss, :diameter, diameter_config

#
====================================================================
# IMS □□
#
====================================================================
config :hss, :ims, %{
  scscf: %{
    selection_method: :random_peer,
    peers: [
      %{host: "sip:scscf01.ims.mnc001.mcc001.3gppnetwork.org:5060"},
      %{host: "sip:scscf02.ims.mnc001.mcc001.3gppnetwork.org:5060"}
    ]
  }
}

#
====================================================================
# EIR □□
#
====================================================================
config :hss, :eir, %{
  unknown_equipment_behaviour: :whitelist
}

#
====================================================================
# API □□□□
#
====================================================================
config :hss, HssWeb.Api.Endpoint,
  http: [ip: {0, 0, 0, 0}, port: 8443],
  https: [
    port: 8443,
    cipher_suite: :strong,
    certfile: System.get_env("TLS_CERT_FILE", "/etc/ssl/certs/omnihss
    keyfile: System.get_env("TLS_KEY_FILE", "/etc/ssl/private/omnihss
  ],
  url: [host: System.get_env("API_HOST", "api.omnihss.internal"), por
8443]

#
====================================================================
# □���□□□□□□
#
====================================================================
config :hss, HssWeb.ControlPanel.Endpoint,
  http: [ip: {0, 0, 0, 0}, port: 7443],
  https: [
    port: 7443,
    cipher_suite: :strong,
    certfile: System.get_env("TLS_CERT_FILE", "/etc/ssl/certs/omnihss
    keyfile: System.get_env("TLS_KEY_FILE", "/etc/ssl/private/omnihss
  ],
  url: [host: System.get_env("CP_HOST", "hss.omnihss.internal"), port
```

← [illegible] | [illegible] →

OmniHSS □□□□□□

← □□□□□□

□□

- □□□□□□
- □□□□□□
- □□□□
- □□□□
- □□□□
- □□□□
- □□□□□

□□□□□□

OmniHSS □□□ Phoenix LiveView □□□□□□□□□□□□□□□□□

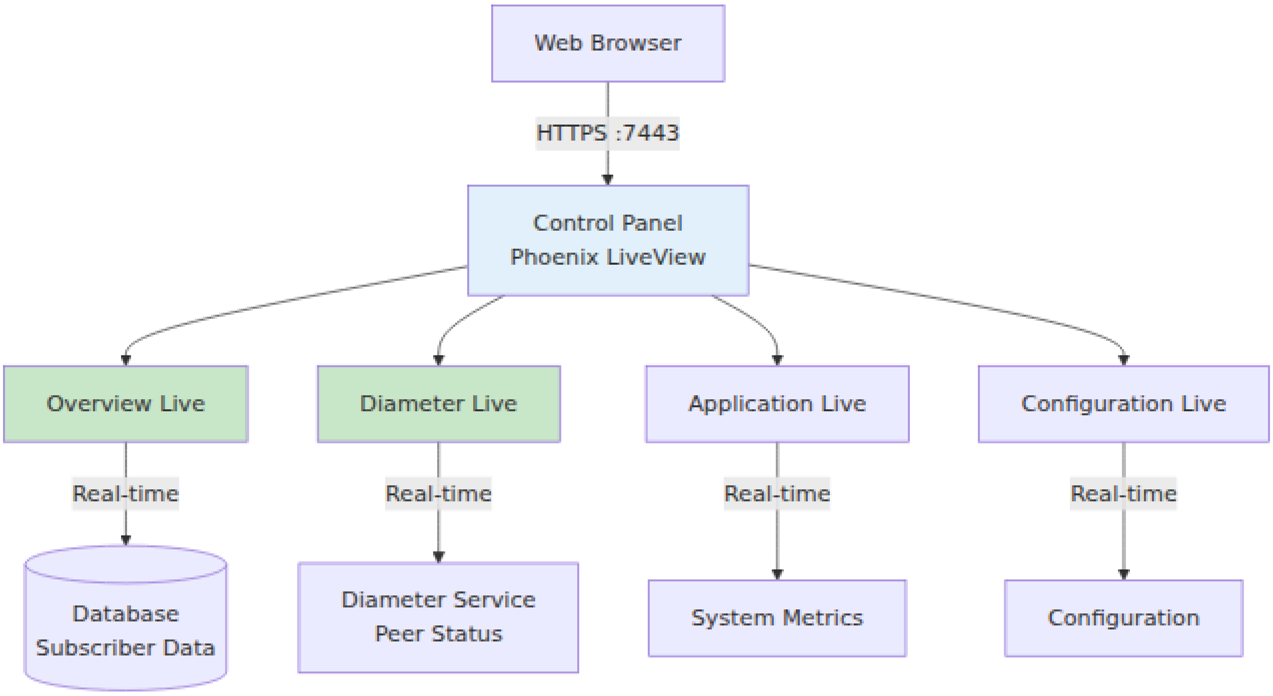
□□□□

- □□□□ - □□□□□□
- □□□□ - □□□□□□□□□□□□
- □□□□ - □□□□□□□□
- □□□□ - □□□□□□
- □□□□□ - □□□□□□□

[illegible]

```
URL: https://[hostname]:7443
Protocol: HTTPS Only
Port: 7443 (configurable)
Certificate: Configured in config/config.exs
```

[illegible]


Web Browser
HTTPS :7443
Control Panel
Phoenix LiveView
Overview Live
Diameter Live
Application Live
Configuration Live
Real-time
Real-time
Real-time
Real-time
Database
Subscriber Data
Diameter Service
Peer Status
System Metrics
Configuration

[illegible]

[illegible]

1. [illegible]
2. [illegible] `https://[hostname]:7443`
3. [illegible] TLS [illegible]
4. [illegible]

TLS □□□□

□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

□□□□□□□ □□□□□□□□□□□□□□□□□□

□□□□

- □□ **7443** □□□□□□□□□□□□□
- **HTTPS** □□□□□ - □□□ HTTP
- □□□□□ □□□□□□□□□□ 7443

□□□□□□

□□□□□□□□□□□□□LiveView, WebSockets□□

- Chrome/Chromium□□□□
- Firefox
- Safari
- Edge

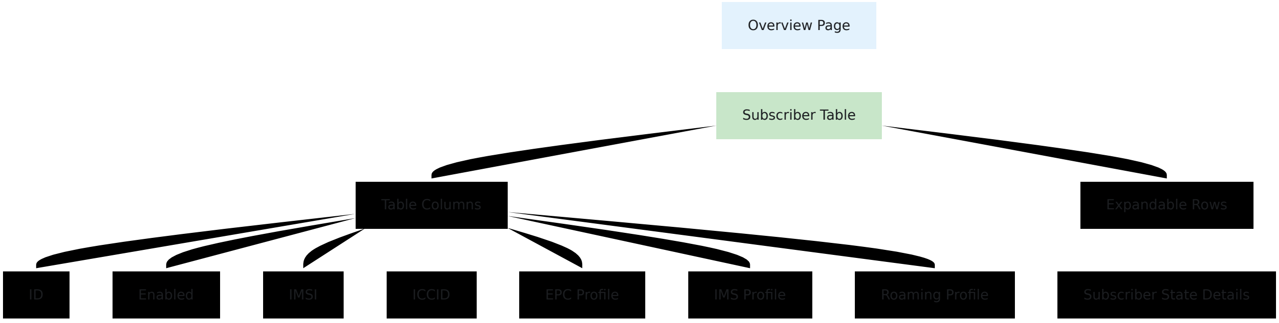
□□□ □□□ Internet Explorer□

□□□□

URL: `https://[hostname]:7443/overview`

□□□□□□□□□□□□□□□□□□□

[illegible]


Overview Page
Subscriber Table
Table Columns
Expandable Rows
ID
Enabled
IMSI
ICCID
EPC Profile
IMS Profile
Roaming Profile
Subscriber State Details

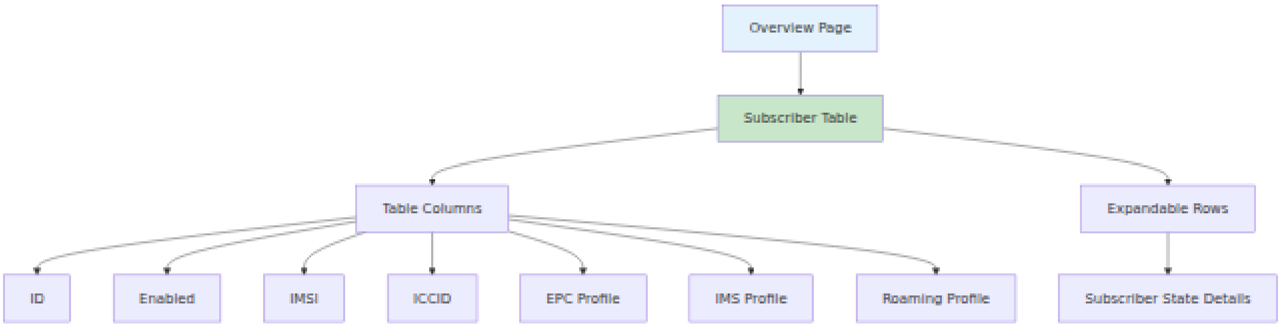
[illegible]

[illegible]	[illegible]	[illegible]
ID	[illegible] ID	[illegible] (UUID)
Enabled	[illegible]	✓ ([illegible]) / ✗ ([illegible])
IMSI	[illegible]	14-15 [illegible]
ICCID	SIM [illegible] ID	19-20 [illegible] "N/A"
EPC Profile	[illegible]	[illegible] ID
IMS Profile	[illegible]	[illegible]ID [illegible] "N/A"
Roaming Profile	[illegible]	[illegible]ID [illegible] "N/A"

[illegible]

[illegible]

[illegible]


Overview Page
Subscriber Table
Table Columns
Expandable Rows
ID
Enabled
IMSI
ICCID
EPC Profile
IMS Profile
Roaming Profile
Subscriber State Details

□□□

- **MCC** - □□□□□□□3 □□□□
- **MNC** - □□□□□□□2-3 □□□□
- **TAC** - □□□□□□
- **Cell ID** - □□□□□□□
- **eNodeB ID** - □□□□□
- **ECI** - E-UTRAN □□□□□

□□□□

□□□

- **□□□□□ MME** - □□□□□ MME □□□
- □□□□□□□ - MME □□□□□
- **RAT □□** - □□□□□□□□□□“E-UTRAN”□□ LTE□
- □□□□□□□ - □□□□□□□□□□

IMS □□

□□□

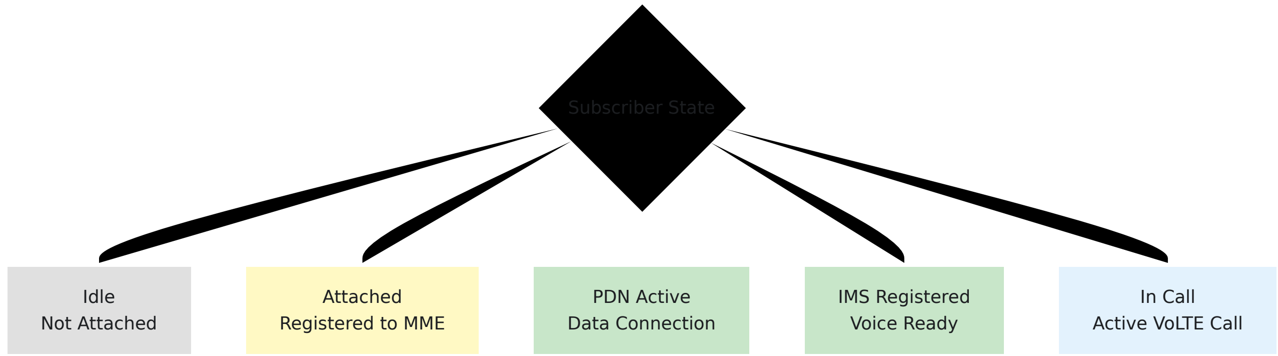
- **□□□ S-CSCF** - □□□□□ S-CSCF SIP URI
- **IMS □□□□** - SIP URI□□□□sip:+14155551234@ims.example.com□
- **□□□□□ P-CSCF** - □□□□□□ HSS □ P-CSCF
- **□□□□□ I-CSCF** - □□□□□□ HSS □ I-CSCF

□□□□

□□□

- **PDN [illegible]** - [illegible]
- [illegible] - [illegible] VoLTE [illegible]

[illegible]


Subscriber State
Idle
Not Attached
Attached
Registered to MME
PDN Active
Data Connection
IMS Registered
Voice Ready
In Call
Active VoLTE Call

[illegible]

- **Idle:** [illegible] MME
- **Attached:** [illegible] MME [illegible]
- **PDN Active:** PDN [illegible] > 0
- **IMS Registered:** [illegible] S-CSCF [illegible]
- **In Call:** [illegible] > 0

[illegible]

[illegible] **1** [illegible] [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

1. [illegible]
    - [illegible]
    - [illegible]

  - [illegible] IMS [illegible]

2. [illegible]

  - [illegible]
  - [illegible]
  - [illegible]
  - [illegible]

3. [illegible]

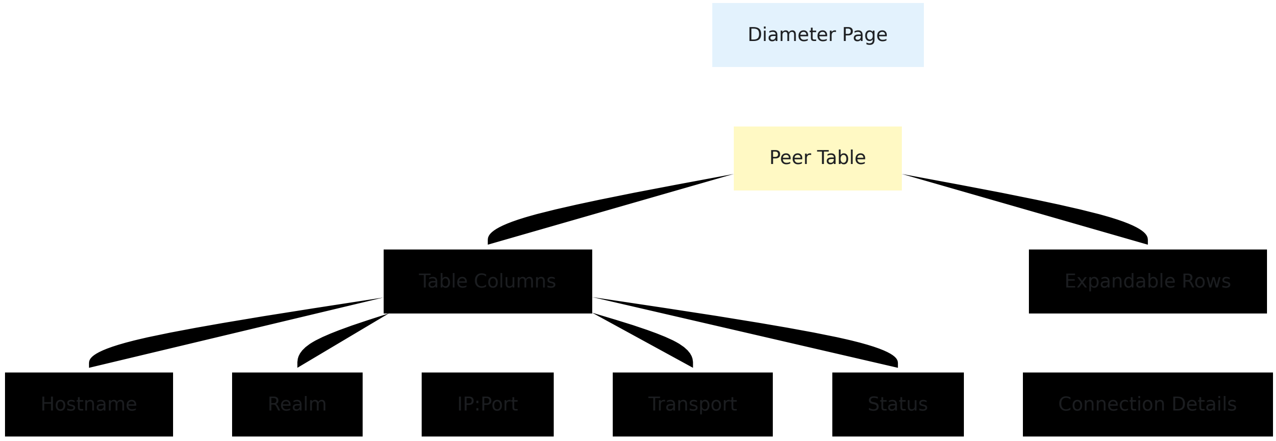
  - [illegible]
  - [illegible] PDN [illegible]
  - [illegible] VoLTE [illegible]

[illegible]

URL: `https://[hostname]:7443/diameter`

[illegible]��[illegible]

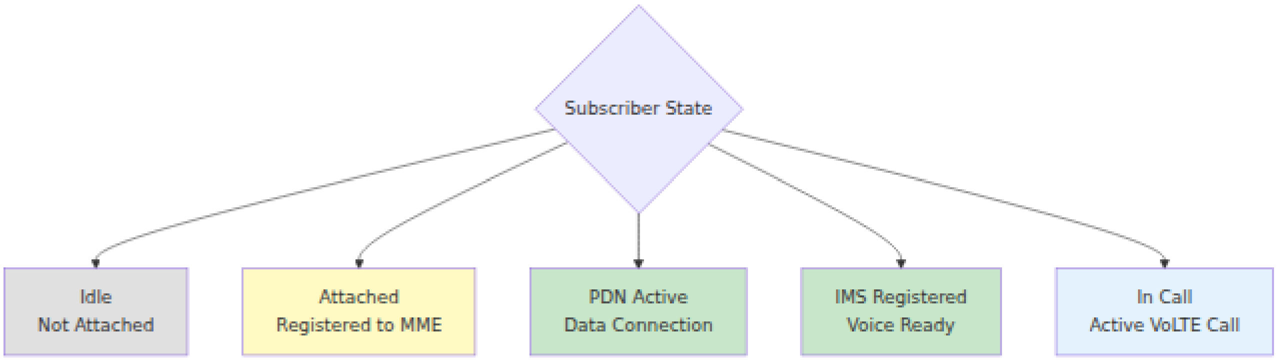
[illegible]


Diameter Page
Peer Table
Table Columns
Expandable Rows
Hostname
Realm
IP:Port
Transport
Status
Connection Details

□□□

□	□□	□
Hostname	□□□□□□□	FQDN
Realm	□□□□	□□
IP:Port	□□□□	IP □□□□□
Transport	□□□□	TCP □ SCTP
Status	□□□□	Connected / Disconnected

□□□□


Subscriber State
Idle
Not Attached
Attached
Registered to MME
PDN Active
Data Connection
IMS Registered
Voice Ready
In Call
Active VoLTE Call

□□□□□□□□

□□□□□□□□□□□□□□

□□□□□

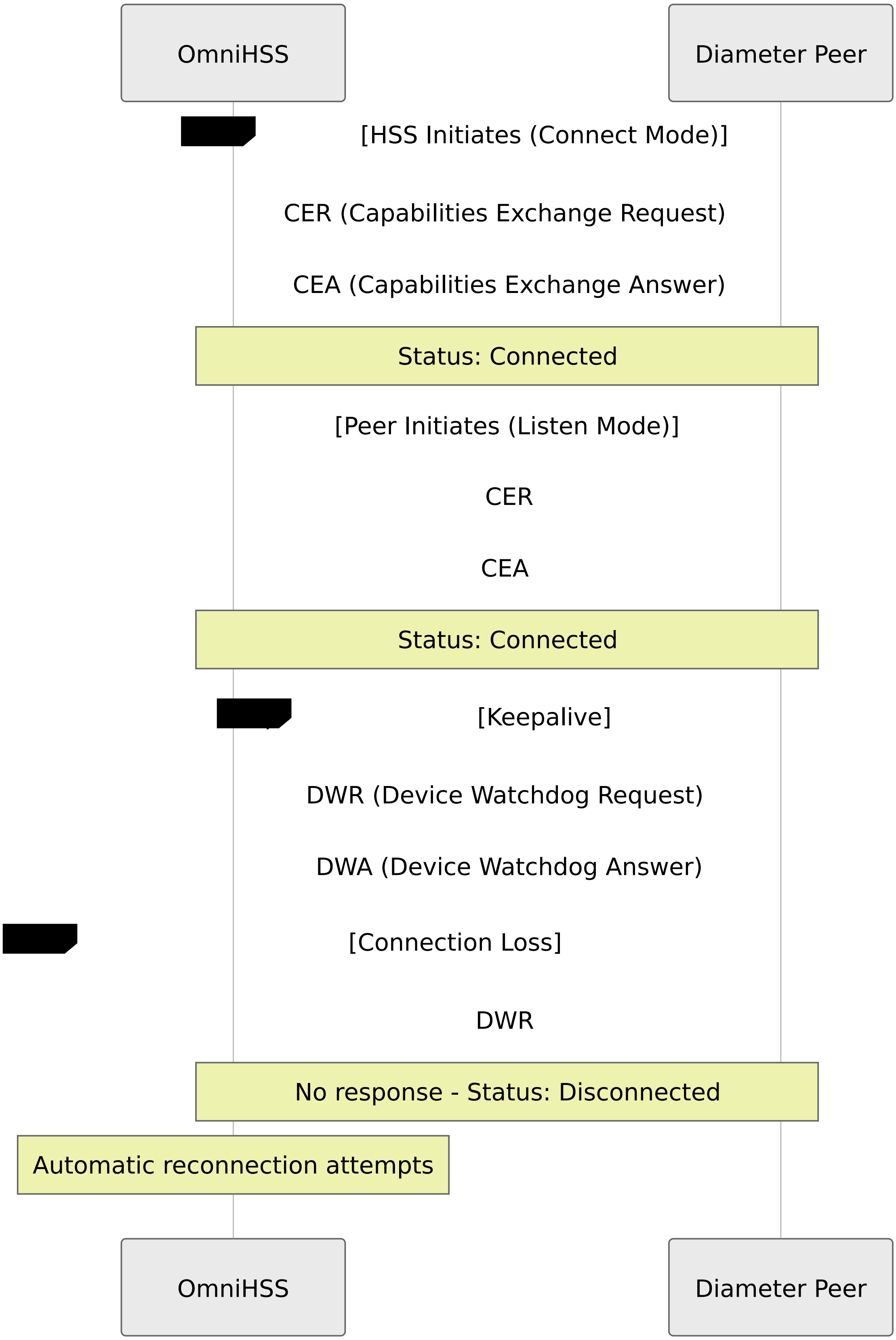
- □□□□ - □ HSS □□□□□□
- □□□□ - □□□□□□□□
- □□□□ **ID** - □□□□□□□□□

□□□□ **ID** □□□

- 16777251 - S6a (MME)

- 16777238 - Gx (P-GW)
- 16777216 - Cx (I-CSCF, S-CSCF)
- 16777217 - Sh ([illegible])
- 16777236 - Rx (P-CSCF)
- 16777252 - S13 (EIR [illegible])

□□□□□□


OmniHSS
Diameter Peer
[HSS Initiates (Connect Mode)]
CER (Capabilities Exchange Request)
CEA (Capabilities Exchange Answer)
Status: Connected
[Peer Initiates (Listen Mode)]
CER
CEA
Status: Connected
[Keepalive]
DWR (Device Watchdog Request)
DWA (Device Watchdog Answer)
[Connection Loss]
DWR
No response - Status: Disconnected
Automatic reconnection attempts
OmniHSS
Diameter Peer

[illegible]

[illegible] **1** [illegible] [illegible]

[illegible]

1. [illegible]
    - [illegible]
    - [illegible]
    - [illegible]
2. [illegible]
    - [illegible]
    - [illegible]TCP [illegible] SCTP[illegible]
    - [illegible] ID [illegible]
    - [illegible]
3. [illegible]
    - [illegible]
    - [illegible]
    - [illegible]

[illegible]

[illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible] TLS[illegible]

[illegible]

1. □□□□□□□`ping [peer-ip]`
2. □□□□□□□□□`telnet [peer-ip] 3868`
3. □□□□□□□
4. □□ HSS □□□□□□□□
5. □□□□□□□□□□□ HSS □□

□□□□□□□□□□

□□□□□

1. □□□□□
2. □□□□□□□□□
3. □□□□□□□
4. □□□□□□□□□

□□□□□□□

1. □□□□□□□
2. □□□□□□□□□□□□
3. □□□□□□□□□
4. □□□□□□□□□ ID □□□□

□□□□

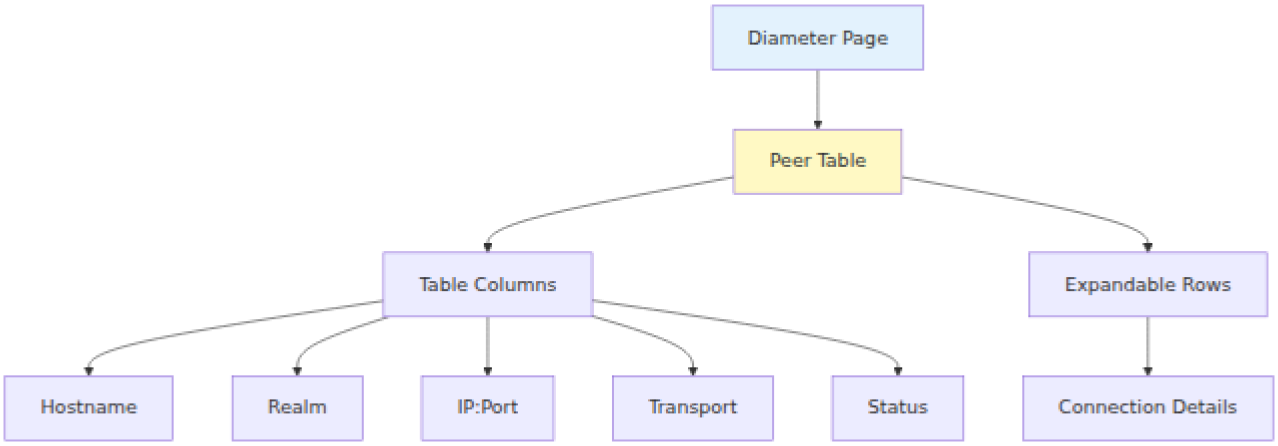
URL: `https://[hostname]:7443/application`

□□□□□□□□□□□□□□□□□□□

□□

- □□□□ - Erlang VM □□□□□□□
- □□□□ - □□□□□□□□
- □□□□□□ - OmniHSS □□□□□
- **Erlang VM □□** - □□□□□□□

[illegible]


Diameter Page
Peer Table
Table Columns
Expandable Rows
Hostname
Realm
IP:Port
Transport
Status
Connection Details

[illegible]

1. [illegible]
   - [illegible]
   - [illegible]
   - [illegible]
2. [illegible]
   - [illegible]
   - [illegible]
   - [illegible]
3. [illegible]
   - [illegible]
   - [illegible]
   - [illegible] Erlang VM [illegible]

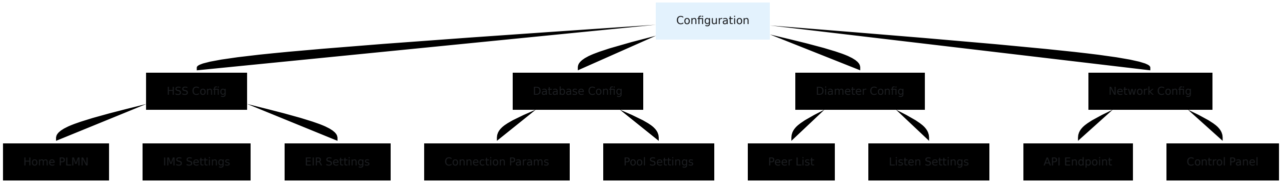
[illegible]

URL: `https://[hostname]:7443/configuration` [illegible] OmniHSS [illegible]

[illegible]

- [illegible] - [illegible]
- [illegible] - [illegible]
- [illegible] - [illegible]

[illegible]


Configuration
HSS Config
Database Config
Diameter Config
Network Config
Home PLMN
IMS Settings
EIR Settings
Connection Params
Pool Settings
Peer List
Listen Settings
API Endpoint
Control Panel

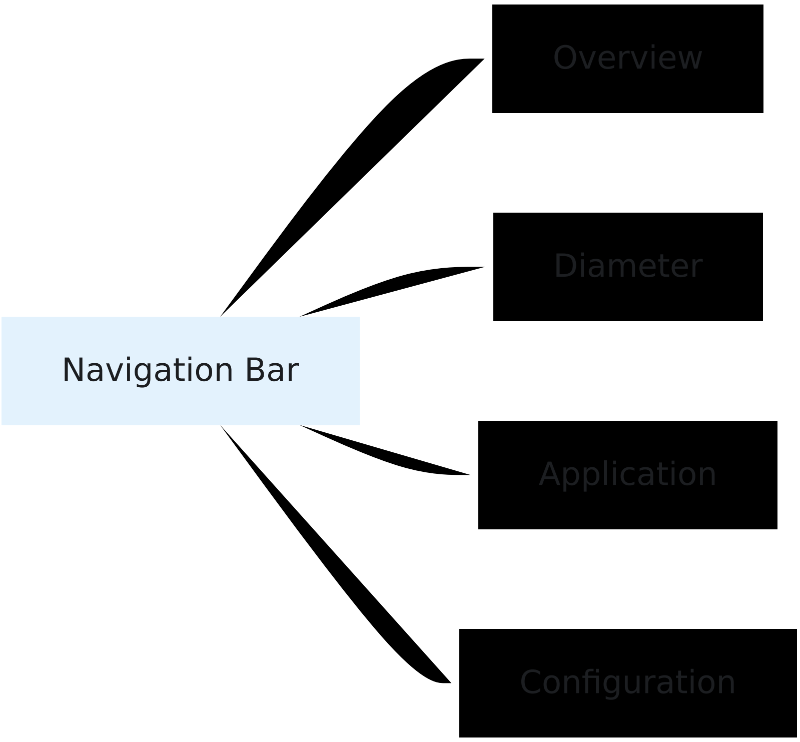
[illegible]

1. [illegible]
    - [illegible] runtime.exs [illegible]
    - [illegible]
    - [illegible]
2. [illegible]
    - [illegible]
    - [illegible]
    - [illegible]
3. [illegible]
    - [illegible]
    - [illegible]

[illegible] [illegible]

[illegible]

[illegible]


Navigation Bar
Overview
Diameter
Application
Configuration

[illegible]

[illegible]

[illegible]

- **Ctrl+R / F5** - [illegible]
- **Ctrl+F** - [illegible]
- **Ctrl+T** - [illegible]

[illegible]

[illegible]

[illegible]��[illegible]

- [illegible] 1[illegible]
- [illegible] 2[illegible]

- □□ 3□□□□□□□□□□□

□□□□□□□□□□□□

□□□□□

□□

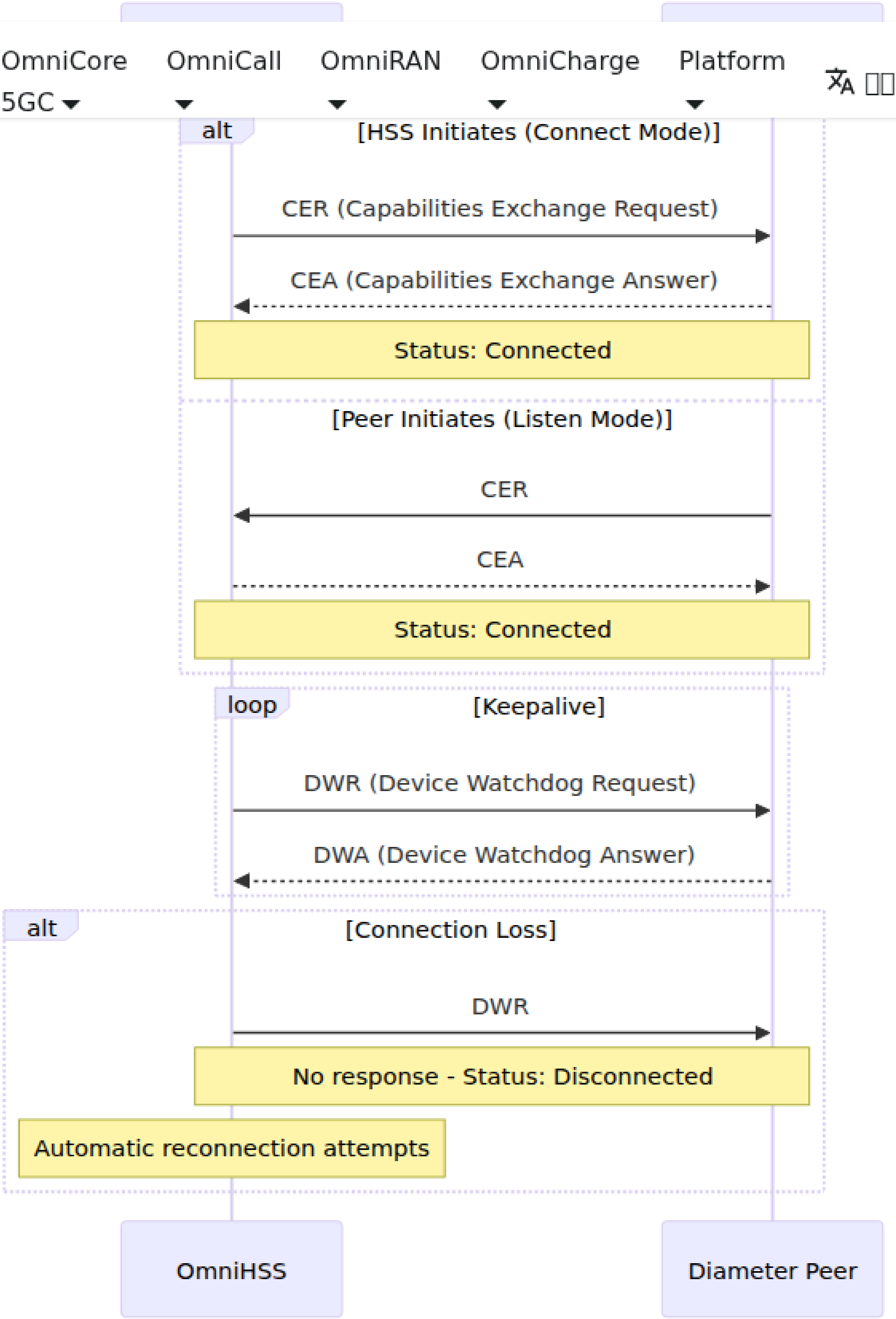
□□□□□□ 1920x1080 □□□□□□□□□□□

□□□□□□

□□□□

1. □□□□
    - □□□□□□□□□□
    - □□□□□□□□□□□□□□
    - □□□□□□ - □□□□□□□□
2. □□□□
    - □□□□□□□□□□□□□□□
    - □□□□□□□□
    - □□□□□□□□□□□□□□□□
3. □□□□
    - □□□□□□□□
    - □□□□□□□□□□□□□
    - □□□□□□

□□□□□□□□


alt
[HSS Initiates (Connect Mode)]
CER (Capabilities Exchange Request)
CEA (Capabilities Exchange Answer)
Status: Connected
[Peer Initiates (Listen Mode)]
CER
CEA
Status: Connected
loop
[Keepalive]
DWR (Device Watchdog Request)
DWA (Device Watchdog Answer)
alt
[Connection Loss]
DWR
No response - Status: Disconnected
Automatic reconnection attempts
OmniHSS
Diameter Peer

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	1 [illegible]	2+ [illegible]
[illegible]	> 80%	> 90%
[illegible]	> 5%	> 10%
[illegible]	> 80% [illegible]	> 95% [illegible]

← [illegible] | [illegible] →

[illegible]

← [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

OmniHSS [illegible] **PostgreSQL** [illegible] [illegible] [illegible]/[illegible] [illegible]

[illegible]

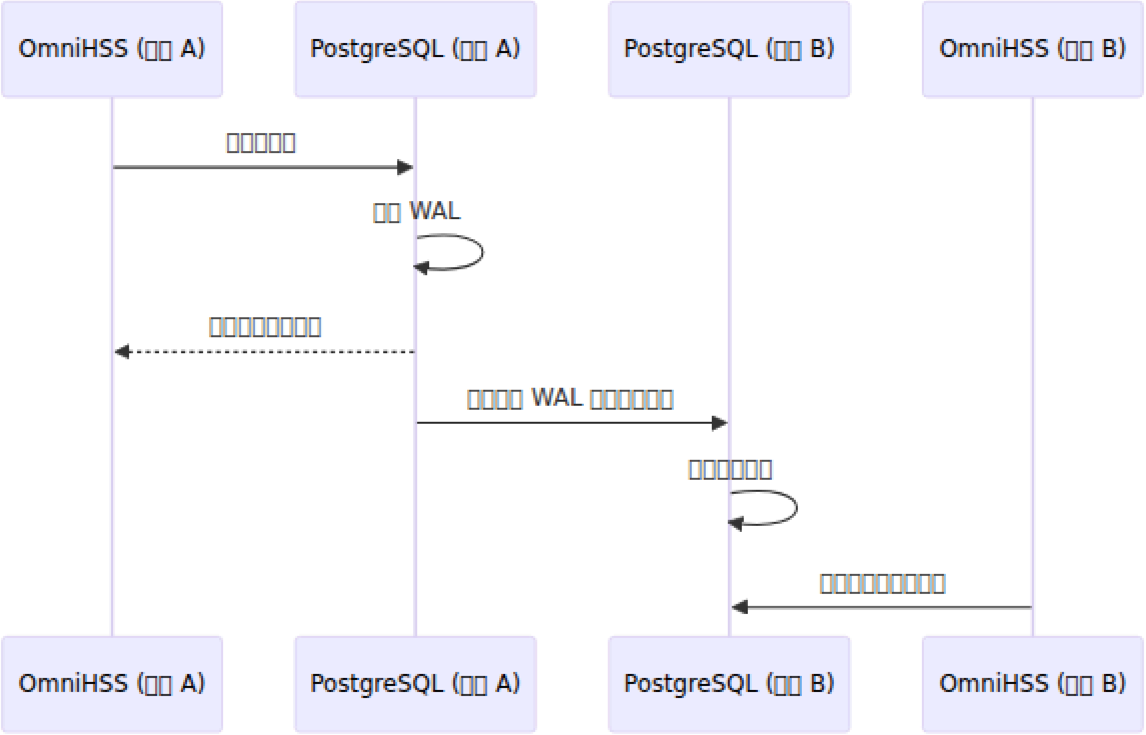
- [illegible]/[illegible]
- [illegible] PostgreSQL [illegible]WAL[illegible]
- [illegible]WAL [illegible]
- [illegible]���[illegible]
- **UUID** [illegible] UUIDv4 [illegible] ID [illegible]

[illegible]

	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]/[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]WAL [illegible]

[illegible]

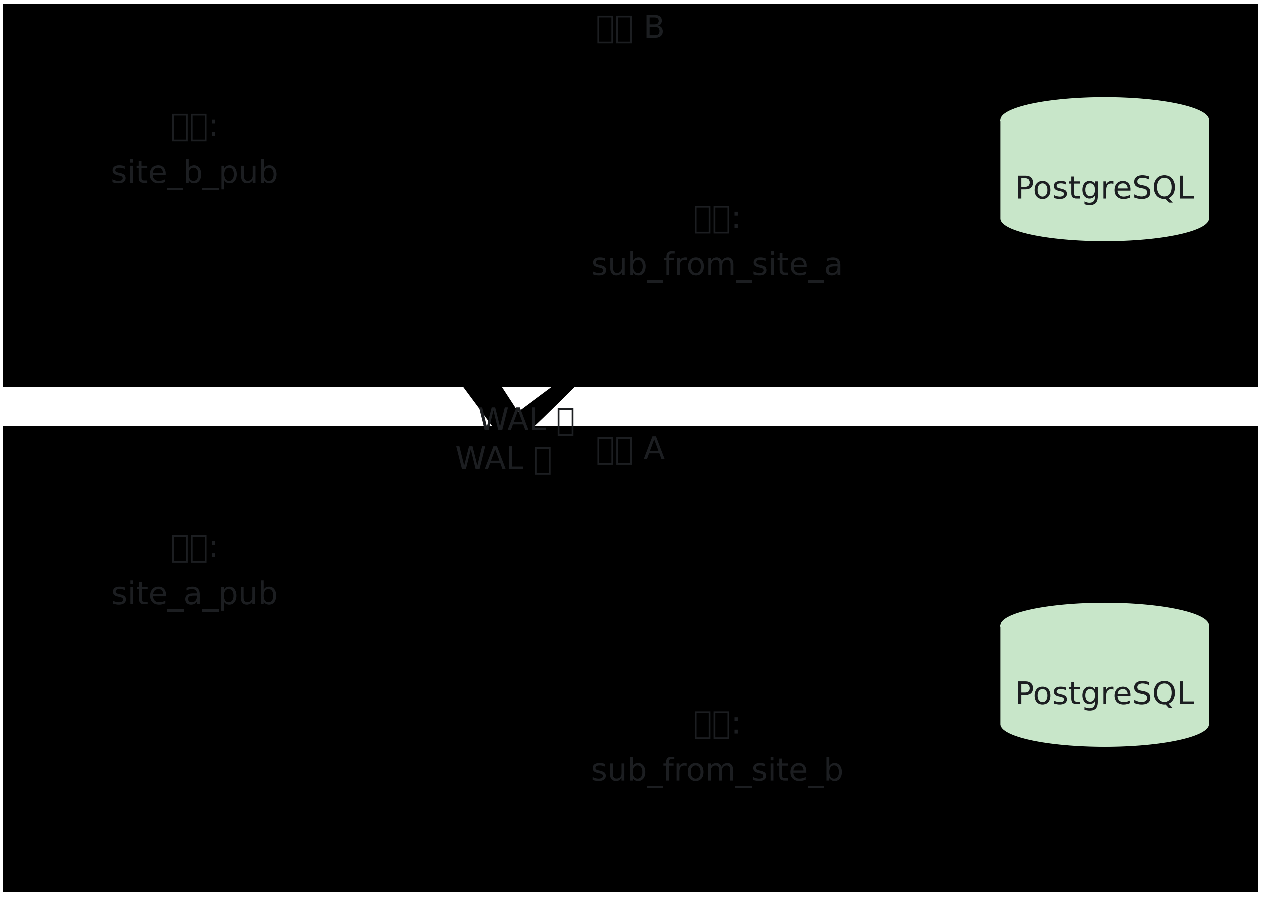
[illegible]


OmniHSS ([illegible] A)
PostgreSQL ([illegible] A)
PostgreSQL ([illegible] B)
OmniHSS ([illegible] B)
[illegible]
[illegible] WAL
[illegible]
[illegible] WAL [illegible]
[illegible]
[illegible]
OmniHSS ([illegible] A)
PostgreSQL ([illegible] A)
PostgreSQL ([illegible] B)
OmniHSS ([illegible] B)

□□/□□□□

□□□□□□□

- □□ □□□□□□□□□□□□□□ `schema_migrations`□
- □□ □□□□□□□□□□□□□□


□□ B
□□:
site_b_pub
PostgreSQL
□□:
sub_from_site_a
WAL □
WAL □
□□ A
□□:
site_a_pub
PostgreSQL
□□:
sub_from_site_b

□□□□□□□ **WAL** □□

□□□□□□□□□□□□□

1. □□□□□□□□□□□□□
2. WAL □□□□□□□
3. □□□□□□□□□□□□□□□
4. □□□□□□□□□□ WAL □□□□□□□□□□
5. □□□□□□□□□□□□

WAL □□□ `max_slot_wal_keep_size` □□□□□□□□□□□□□□□□□□□□□

[illegible]

UUID [illegible]INSERT [illegible]

`origin = none` [illegible]

`schema_migrations` [illegible]

[illegible]

[illegible]`subscriber_state`[illegible]`pdn_session`[illegible]`lte_call`[illegible] Diameter [illegible] ULR [illegible] MME[illegible] CCR [illegible] PGW [illegible] AAR [illegible]

[illegible] `subscriber_state` [illegible] MME[illegible]

OmniHSS [illegible] [illegible] **(LWW)** [illegible]

```
CREATE TRIGGER lww_subscriber_state_trigger
  BEFORE UPDATE ON subscriber_state
  FOR EACH ROW
  EXECUTE FUNCTION lww_subscriber_state();
```

[illegible] `updated_at` [illegible]

- [illegible] A [illegible] B [illegible] B [illegible]
- [illegible] A [illegible]
- [illegible]

[illegible] **LWW** [illegible]

[illegible]	[illegible]	[illegible]
`subscriber_state`	ULR, SAR, AIR, PUR	[illegible]/[illegible]
`pdn_session`	CCR-I, CCR-T	[illegible] PDN [illegible]/[illegible]
`lte_call`	AAR, STR	[illegible]�� VoLTE [illegible]/[illegible]
`ims_subscription`	UAR, SAR[illegible] S-CSCF[illegible]	[illegible]

[illegible]APN[illegible] LWW[illegible] API [illegible]

[illegible]

LWW [illegible] [illegible] `foo`[illegible] `lww_foo()`[illegible] `lww_foo_trigger`[illegible]

OmniCore [illegible] `omnihss` Ansible [illegible] [illegible] [illegible] `lww_<table>_trigger` [illegible] `ENABLE REPLICA` [illegible]

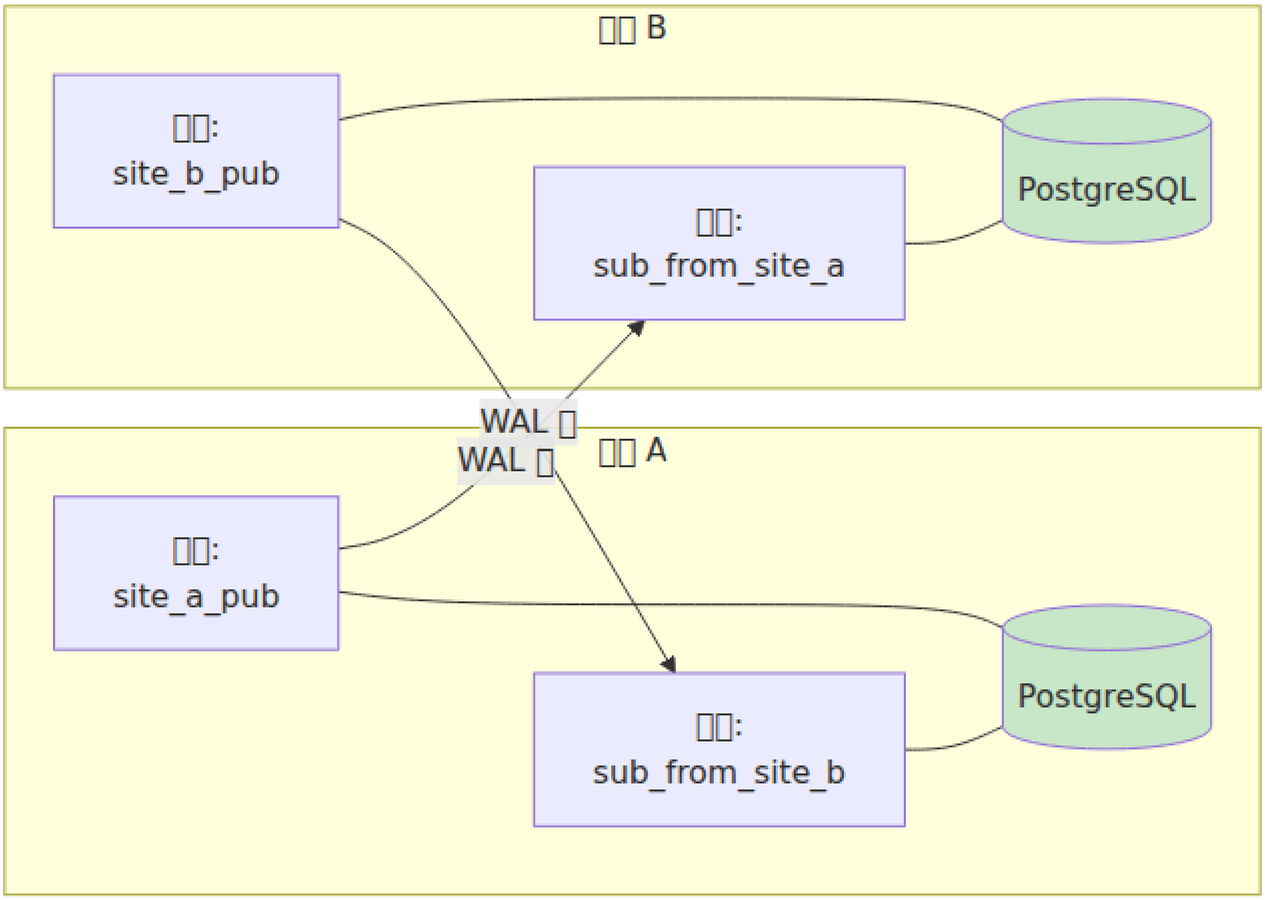
[illegible]

1. [illegible] `updated_at` [illegible]Ecto [illegible] `timestamps()` [illegible]
2. [illegible] `lww_<table>()` [illegible] `lww_<table>_trigger`[illegible]
3. [illegible] `ALTER TABLE <table> ENABLE REPLICA TRIGGER lww_<table>_trigger`[illegible]

`ims_subscription` [illegible]��[illegible] `lww_ims_subscription()` [illegible] `lww_ims_subscription_trigger`[illegible]

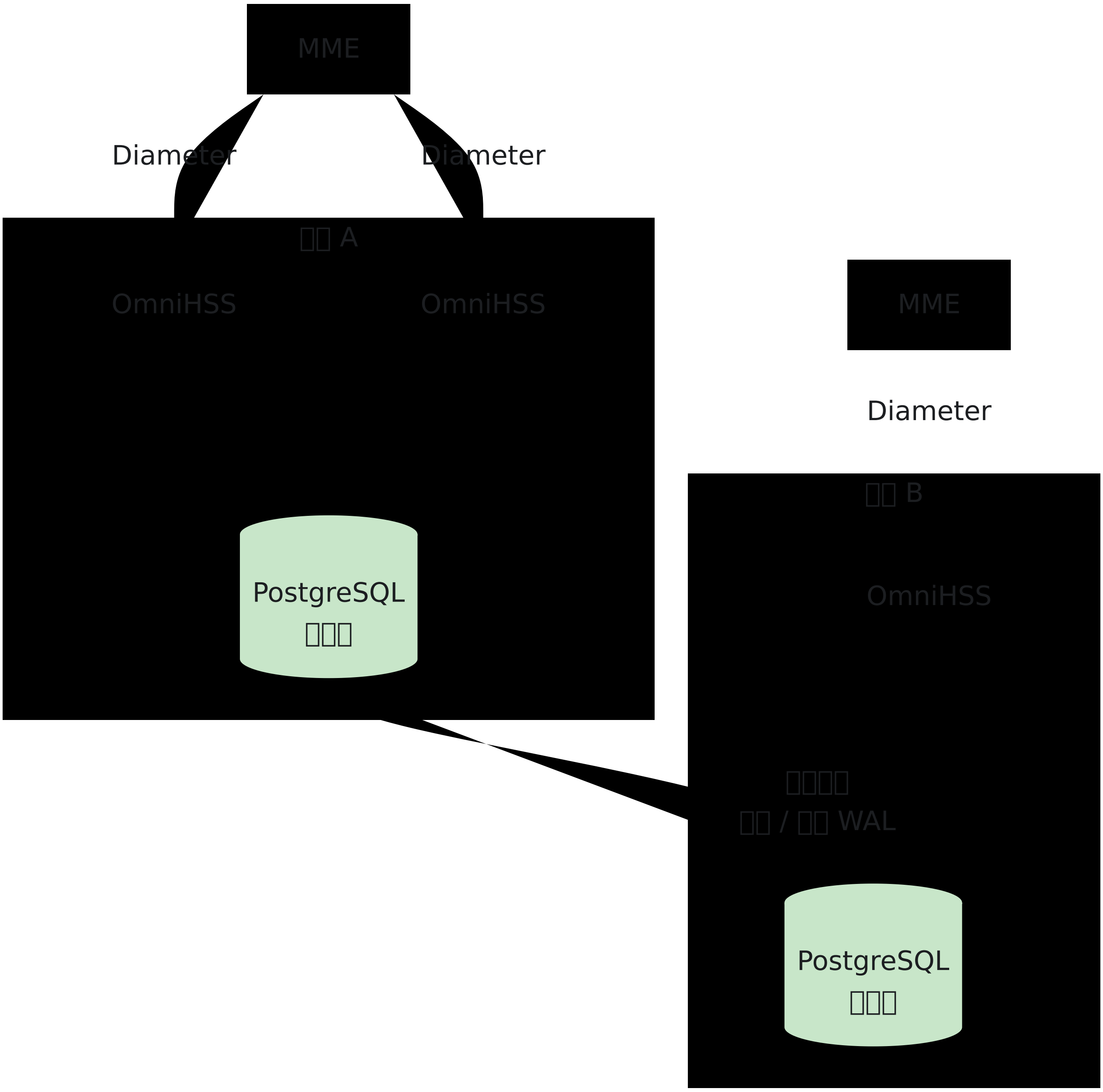
[illegible]

[illegible]


[illegible] B
[illegible]:
site_b_pub
[illegible]:
sub_from_site_a
PostgreSQL
WAL [illegible]
WAL [illegible]
[illegible] A
[illegible]:
site_a_pub
[illegible]:
sub_from_site_b
PostgreSQL

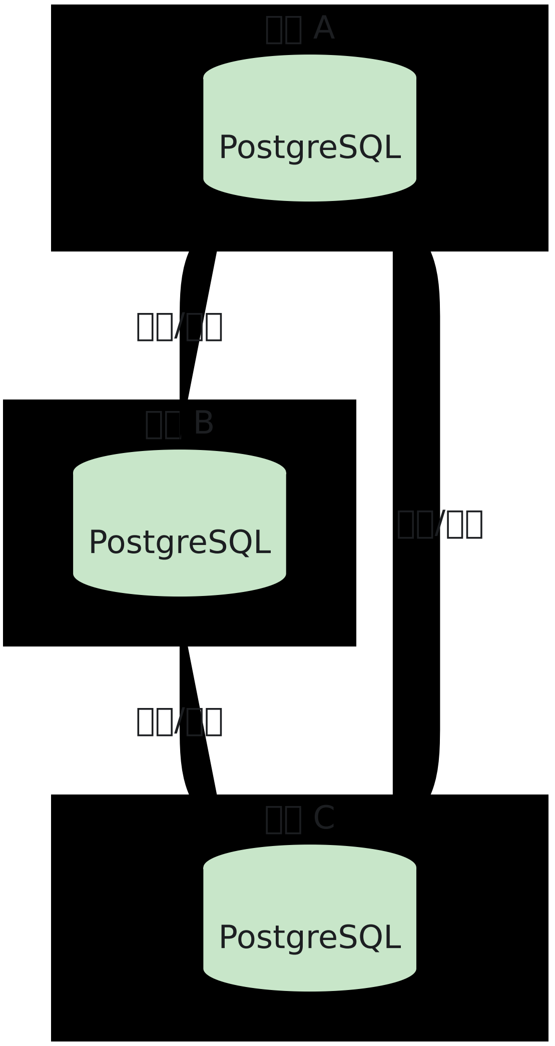
[illegible] HSS [illegible] PostgreSQL [illegible] PostgreSQL [illegible]

□□□□□


MME
Diameter
Diameter
□□ A
OmniHSS
OmniHSS
PostgreSQL
□□□
MME
Diameter
□□ B
OmniHSS
□□□□
□□ / □□ WAL
PostgreSQL
□□□

□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ MME □□□□□□ HSS□□□□□□□ Diameter □□□

□□□□□


□□ A
PostgreSQL
□□/□□
□□ B
PostgreSQL
□□/□□
□□/□□
□□ C
PostgreSQL

□□□□□□□□□□□□□□□□□□□□□ Ansible □□□□□□□□□□□□□□□□□□□□□□ `hss` □□□□□□□□□□

□□□□

□□	□□	□□
5432	TCP	PostgreSQL □□□□□□□□

[illegible]

Ansible [illegible]

[illegible] HSS [illegible]

```yaml
hss:
  hosts:
    site-a-hss01:
      ansible_host: 10.80.12.140
    site-a-hss02:
      ansible_host: 10.80.12.141
  vars:
    omnihss:
      database_type: postgres
      database_host: localhost
      database_port: 5432
      database_name: omnihss
      database_username: omnihss
      database_password: "secure_password"
      replication:
        enabled: true
```

Ansible [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
`database_type`	[illegible]	[illegible]	`postgres`	[illegible] `postgres`[illegible]
`database_host`	[illegible]	[illegible]	`localhost`	PostgreSQL [illegible] Postgres [illegible] OmniHSS [illegible] `localhost`[illegible]
`database_port`	[illegible]	[illegible]	`5432`	PostgreSQL [illegible]
`database_name`	[illegible]	[illegible]	`omnihss`	[illegible]
`database_username`	[illegible]	[illegible]	-	PostgreSQL [illegible] `CREATEDB` [illegible] `REPLICATION` [illegible]
`database_password`	[illegible]	[illegible]	-	PostgreSQL [illegible]
`replication.enabled`	[illegible]	[illegible]	`false`	[illegible] `true` [illegible] Ansible [illegible] `pg_hba.conf` [illegible]

[illegible]

[illegible]

1. [illegible]`hss` Ansible [illegible]

2. □□□□□□□ `prod_master_peers.yml` □ `connected_sites.hss` □□□□

□□□□□□□□□□□□□□□□□□□ `hss` □□ `connected_sites.hss` □□□□□□□□□

□□□□□ (prod_master_peers.yml)

□□□□□□□□□□□□□□

```yaml
# group_vars/prod_master_peers.yml
connected_sites:
  hss:
    - remote-site-hss01: 10.80.20.140
    - remote-site-hss02: 10.80.20.141
```

PostgreSQL □□

□□□□□□□Ansible □□□□□□□□□ PostgreSQL □□□

□□	□	□□
`wal_level`	`logical`	□□□□□□□□ WAL □□□□□□□□□□
`max_wal_senders`	`10`	□□□□ WAL □□□□□□□□□□□□□□
`max_replication_slots`	`10`	□□□□□□□□□□□□□□□□□
`listen_addresses`	`*`	□□□□□□□□□□□□

□□□□□□□ `pg_hba.conf` □□□□□□□□□□□□□□□ IP □□□□□□

□□□□

□□□□□

1. □□□□□□□ `hss` □□□□□□ `prod_master_peers.yml` □□□□ `connected_sites.hss`

2. [illegible] OmniHSS [illegible]

[illegible]

- [illegible] PostgreSQL [illegible] OmniHSS
- [illegible]
- [illegible]
- [illegible]
- [illegible] `pg_hba.conf` [illegible]
- [illegible]

[illegible]

```
ansible-playbook -i hosts site.yml --tags hss-remove-peer \
  -e "peer_name=site_b confirm_remove=yes"
```

`confirm_remove=yes` [illegible]��[illegible]

[illegible]

- [illegible]
- [illegible] `pg_hba.conf` [illegible] IP
- [illegible]
- [illegible]

[illegible]

[illegible]

```
ansible-playbook -i hosts site.yml --tags hss-add-peer \
  -e "peer_name=site_b peer_host=10.80.20.140"
```

[illegible]

Prometheus [illegible]

postgres_exporter [illegible] HSS [illegible] `9187`[illegible] Prometheus [illegible] PostgreSQL [illegible]

[illegible]

[illegible]	[illegible]	[illegible]
`pg_replication_slots_active`	Gauge	[illegible] `1`[illegible] `0`
`pg_replication_slots_pg_wal_lsn_diff`	Gauge	[illegible] WAL [illegible]
`pg_stat_replication_pg_current_wal_lsn_bytes`	Gauge	[illegible] WAL [illegible]

[illegible] **Prometheus** [illegible]

```
# [illegible]1 = [illegible]0 = [illegible]
pg_replication_slots_active{slot_name=~"sub_from_.*"}

# [illegible]���[illegible]
pg_replication_slots_pg_wal_lsn_diff / 1048576

# [illegible] 60 [illegible]
pg_replication_slots_active == 0
```

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	`pg_replication_slots_active == 0` [illegible] 60 [illegible]	[illegible]	[illegible] WAL [illegible]
WAL [illegible]	`pg_replication_slots_pg_wal_lsn_diff > 104857600` [illegible] 5 [illegible]	[illegible]	[illegible] 100MB[illegible]
WAL [illegible]	WAL [illegible] `lost`	[illegible]	[illegible]

Ansible [illegible]

OmniHSS [illegible]

1. [illegible]
2. [illegible]
3. WAL [illegible] 100MB[illegible]
4. WAL [illegible] `reserved` [illegible] `extended`[illegible] `lost`[illegible]

[illegible]

□□□□

```
# □□□□□□□□□□□□□□□
sudo -u postgres psql -d omnihss -c \
  "SELECT subname, pid IS NOT NULL as worker_alive FROM
pg_stat_subscription;"

# □□□□□□□□
sudo -u postgres psql -d omnihss -c \
  "SELECT slot_name, active,
    pg_wal_lsn_diff(pg_current_wal_lsn(), confirmed_flush_lsn) as
lag_bytes,
    wal_status
  FROM pg_replication_slots WHERE slot_type = 'logical';"

# □□□□□□□□□□□□
sudo -u postgres psql -d omnihss -c "SELECT count(*) FROM
subscriber;"
```

□□□□

□□□□□□□

□□□`pg_stat_subscription` □□□□□□□ `pid IS NULL`□Ansible □□□□□□□“□□□□□”□

□□□□□

- □□□□□□□□□□□□□□□□DDL □□□□
- □□□□□□□□□□□□□
- □□□□□□□□□□□ WAL □□□

□□□□□

1. □□ PostgreSQL □□□□□□□□□□

   ```
   journalctl -u postgresql | grep "logical replication" | tail
   -20
   ```

2. [illegible] DDL [illegible]
3. [illegible]

   ```
   ALTER SUBSCRIPTION sub_from_<peer> ENABLE;
   ```

[illegible]

[illegible]`pg_replication_slots` [illegible] `active = false`[illegible]Prometheus [illegible]

[illegible]

- [illegible]
- [illegible] PostgreSQL [illegible]
- [illegible] IP [illegible] 5432 [illegible]

[illegible]

1. [illegible]

   ```
   pg_isready -h <peer_ip> -U <db_user> -d omnihss
   ```

2. [illegible] PostgreSQL [illegible]
3. [illegible] IP [illegible] 5432 [illegible]

[illegible]

WAL [illegible]

[illegible]`pg_replication_slots` [illegible] `wal_status = 'lost'`[illegible]Ansible [illegible]“WAL [illegible]”[illegible]

[illegible] WAL [illegible] `max_slot_wal_keep_size` [illegible]

[illegible]

1. [illegible]

   ```
   DROP SUBSCRIPTION sub_from_<peer>;
   ```

2. [illegible]

   ```
   SELECT pg_drop_replication_slot('sub_from_<this_site>');
   ```

3. [illegible] OmniHSS [illegible] `copy_data = true` [illegible]

WAL [illegible]

[illegible]`pg_replication_slots_pg_wal_lsn_diff` [illegible]Prometheus [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible] WAL

[illegible]

1. [illegible]

   ```
   SELECT slot_name,
     pg_wal_lsn_diff(pg_current_wal_lsn(), confirmed_flush_lsn) as
   lag_bytes
   FROM pg_replication_slots WHERE slot_type = 'logical';
   ```

2. [illegible]
3. [illegible]
4. [illegible]

[illegible]

[illegible] OmniHSS [illegible]

1. [illegible] [illegible] [illegible]/[illegible]
2. Ansible [illegible]
3. [illegible]

   ```
   /opt/omnihss/bin/hss rpc "Hss.Command.Database.migrate()"
   ```

OmniHSS [illegible]

← [illegible]

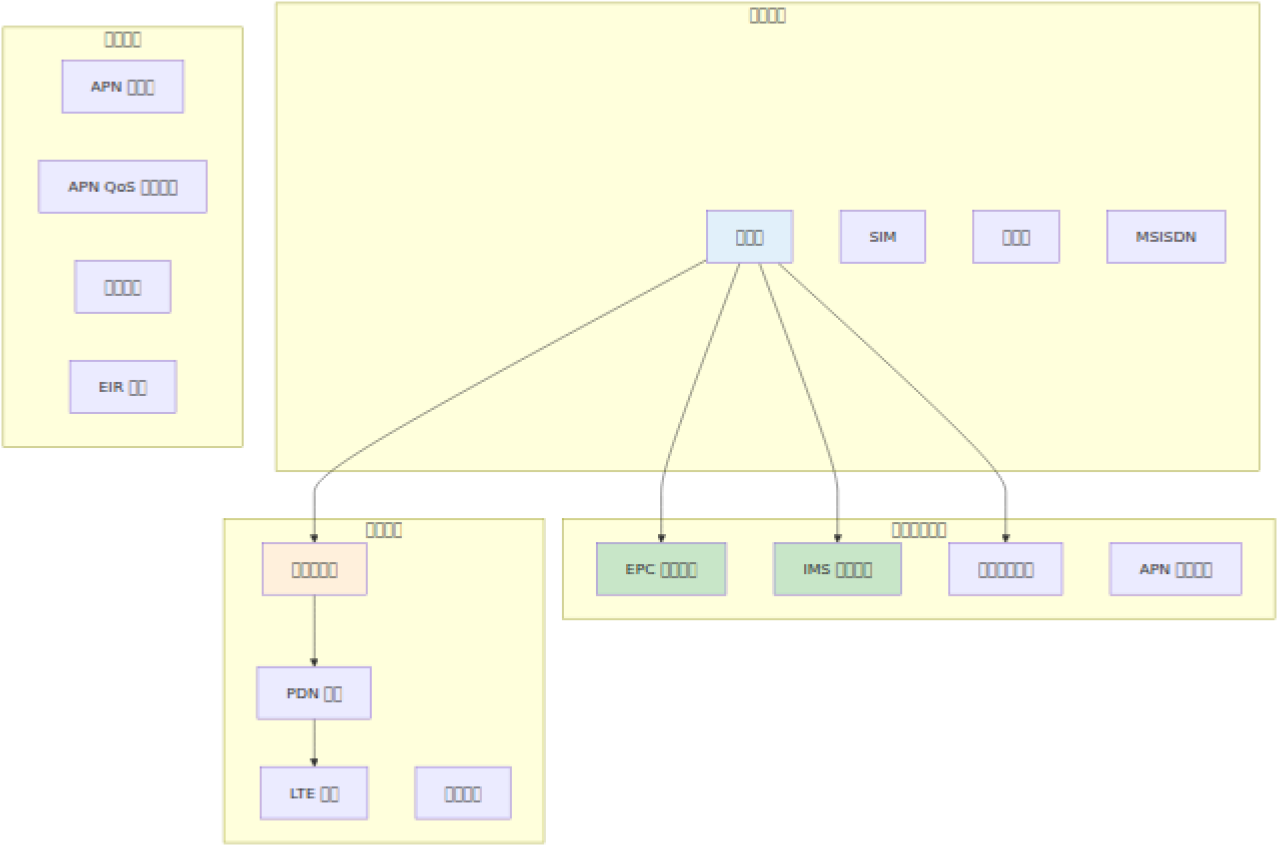
[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

OmniHSS [illegible]

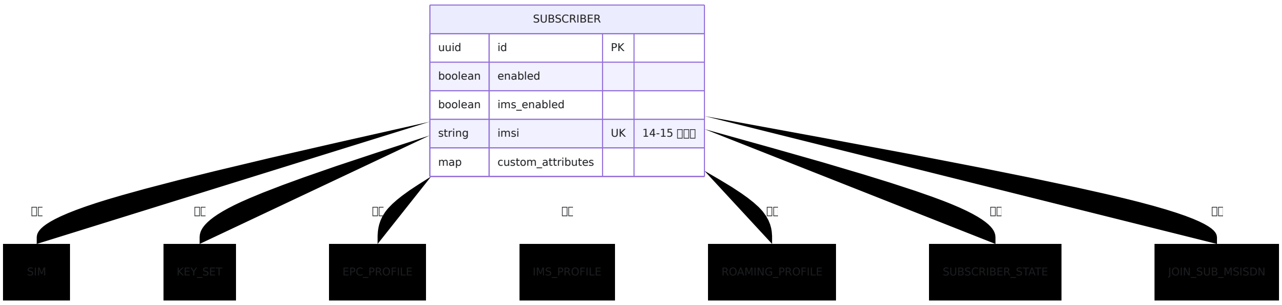
□□□□


□□□□
APN □□□
APN QoS □□□□
□□□□
EIR □□
□□□□
□□□
SIM
□□□
MSISDN
□□□□
□□□□□
PDN □□
LTE □□
□□□□
□□□□□□
EPC □□□□
IMS □□□□
□□□□□□
APN □□□□

□□□□

□□□

□□□□□□□□□□□□□□□□□



SUBSCRIBER			
uuid	id	PK	
boolean	enabled		
boolean	ims_enabled		
string	imsi	UK	14-15 □□□
map	custom_attributes		

□□
□□
□□
□□
□□
□□
□□
SIM
KEY_SET
EPC_PROFILE
IMS_PROFILE
ROAMING_PROFILE
SUBSCRIBER_STATE
JOIN_SUB_MSISDN

□□□

□□	□□	□□	□□
`id`	uuid	□□	UUID□□□ (`gen_random_uuid()`)
`enabled`	boolean	□□□□□□	□□□true
`ims_enabled`	boolean	IMS □□□□	□□□true
`imsi`	string	□□□□□□□□	14-15 □□□□□□
`custom_attributes`	map	□□□□□□□	□□
`sim_id`	uuid	SIM □□□	□□□□□□□□□□□□□□□□ null□
`key_set_id`	uuid	□□□□□□	□□
`epc_profile_id`	uuid	EPC □□□□□□□	□□□□□□□□□□□□□□□□ null□
`ims_profile_id`	uuid	IMS □□□□□□□	IMS/□□□□□□□□□□□□□□ null□
`roaming_profile_id`	uuid	□□□□□□□□□	□□□□□□ null□□□□□□□□□□□□□□□□□
`subscriber_state_id`	uuid	□□□□□□□□	□□□□
`ims_subscription_id`	uuid	IMS □□□□□	□□

□□□“□□”□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ IMSI □□□□□□□□□□□□□□□□*□□□*□□□ □□□□□□□□□

□□□□□□□□□□

□□□□□	□□□□□
□□□□□□□□IMS □□□□□	`key_set` □ `sim`
LTE □□□□□S6a □□□	`epc_profile`
IMS / □□□Cx □□□	`ims_profile`□□□□□□□ MSISDN
□□□□□□□	□□□□□□□□□ `roaming_profile`

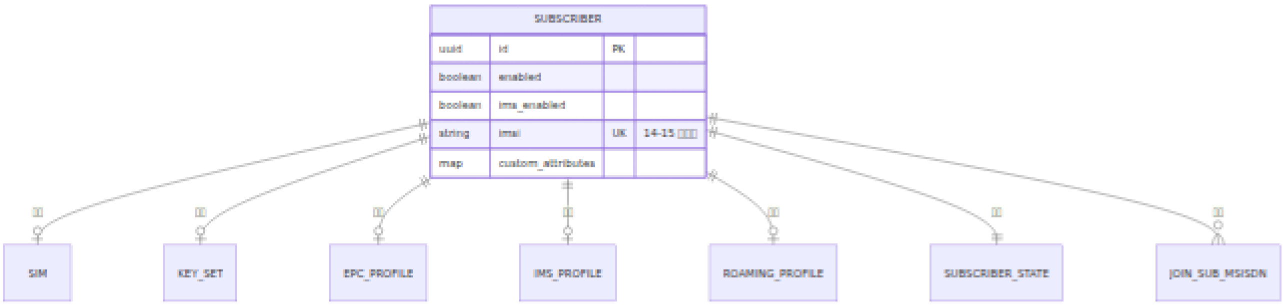
□□□□□□□□□□□□□□□□□□□□HSS □□□□□□□□□□□□□□□□ □□□□□□□□□□□□□

□□□□

- □□□□□□□□□□□ IMSI□
- IMSI □□□ 14-15 □□□□□□□□□□□□□□
- □□□□□□□□□□□ MSISDN□□□□□□□
- □□□□□□□□□□□□□□□□□
- `enabled` □□□□□□□□□□□□ IMS□□
- `ims_enabled` □□□□□ IMS □□□
- □□□□□□ IMSI □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ IMS □□□□□□□□□□□□ IMS□□□□□□□□□□□□□□□□□□□□□
- □□ `ims_subscription_id` □□□□□□□□□□ `ims_subscription_id` □□□□□□□□□ □IMSI□□□□□□ IMS □□□□□□□□□□□□□□□□ S-CSCF□□□□ IMS □□ □ □□□□□□□□□

SIM

SIM □□□□□□□□□□ SIM □□


SUBSCRIBER
uuid
id
PK
boolean
enabled
boolean
ims_enabled
string
imsi
UK
14-15 □□□
map
custom_attributes
□□
□□
□□
□□
□□
□□
□□
SIM
KEY_SET
EPC_PROFILE
IMS_PROFILE
ROAMING_PROFILE
SUBSCRIBER_STATE
JOIN_SUB_MSISDN

□□□

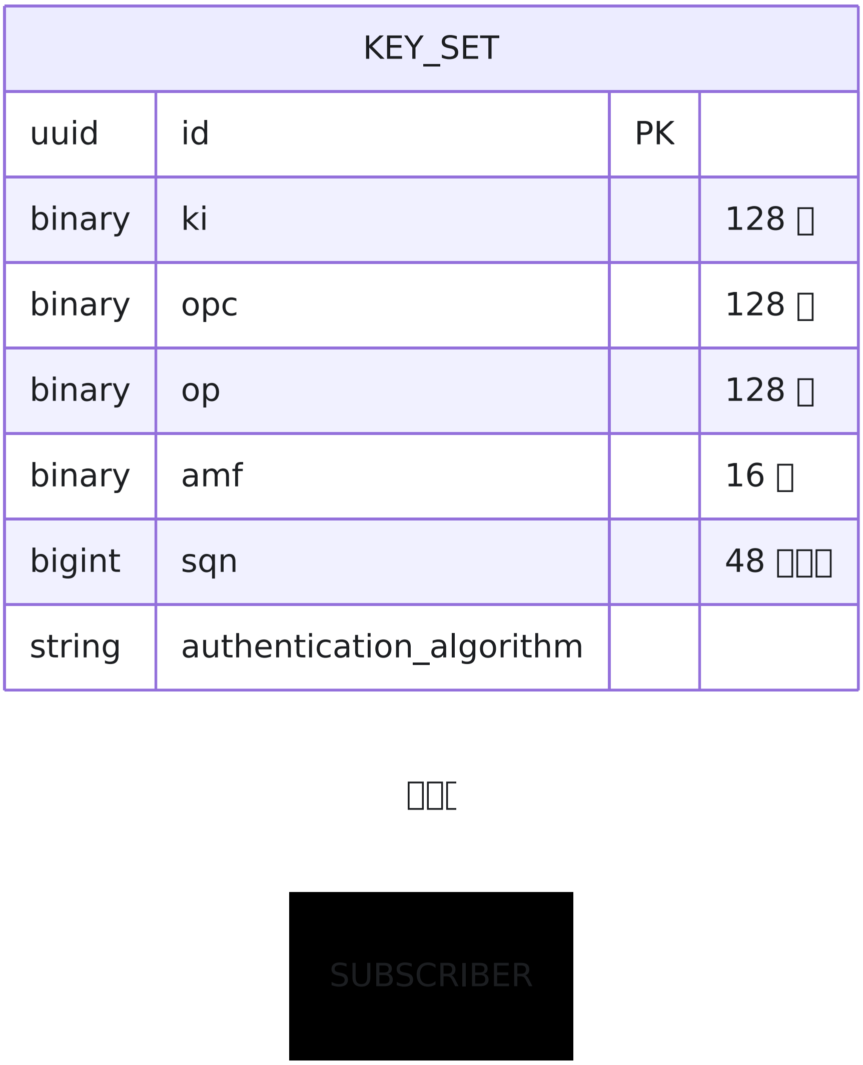
□□	□□	□□	□□□□
`iccid`	string	□□□□□ ID	□□
`sim_vendor`	string	SIM □□□	□□
`batch_name`	string	□□□□	□□
`is_esim`	boolean	□□□ SIM □□	□□
`pin1`, `pin2`	string	PIN □□	□□
`puk1`, `puk2`	string	PUK □□	□□
`adm1` - `adm10`	string	□□□□	□□□□
`kic`, `kid`	binary	OTA □□□□	□□□□

□□□□

- ICCID □□□□ SIM □
- □□ SIM □□□□□□□□□□□□□
- PIN/PUK □□□□□□□□ SIM □□
- ADM □□□□□□ SIM □□
- KIC/KID □□ SIM OTA□□□□□□

□□□

□□□□□□□□□□□□□□□□□



KEY_SET			
uuid	id	PK	
binary	ki		128 [illegible]
binary	opc		128 [illegible]
binary	op		128 [illegible]
binary	amf		16 [illegible]
bigint	sqn		48 [illegible]
string	authentication_algorithm		

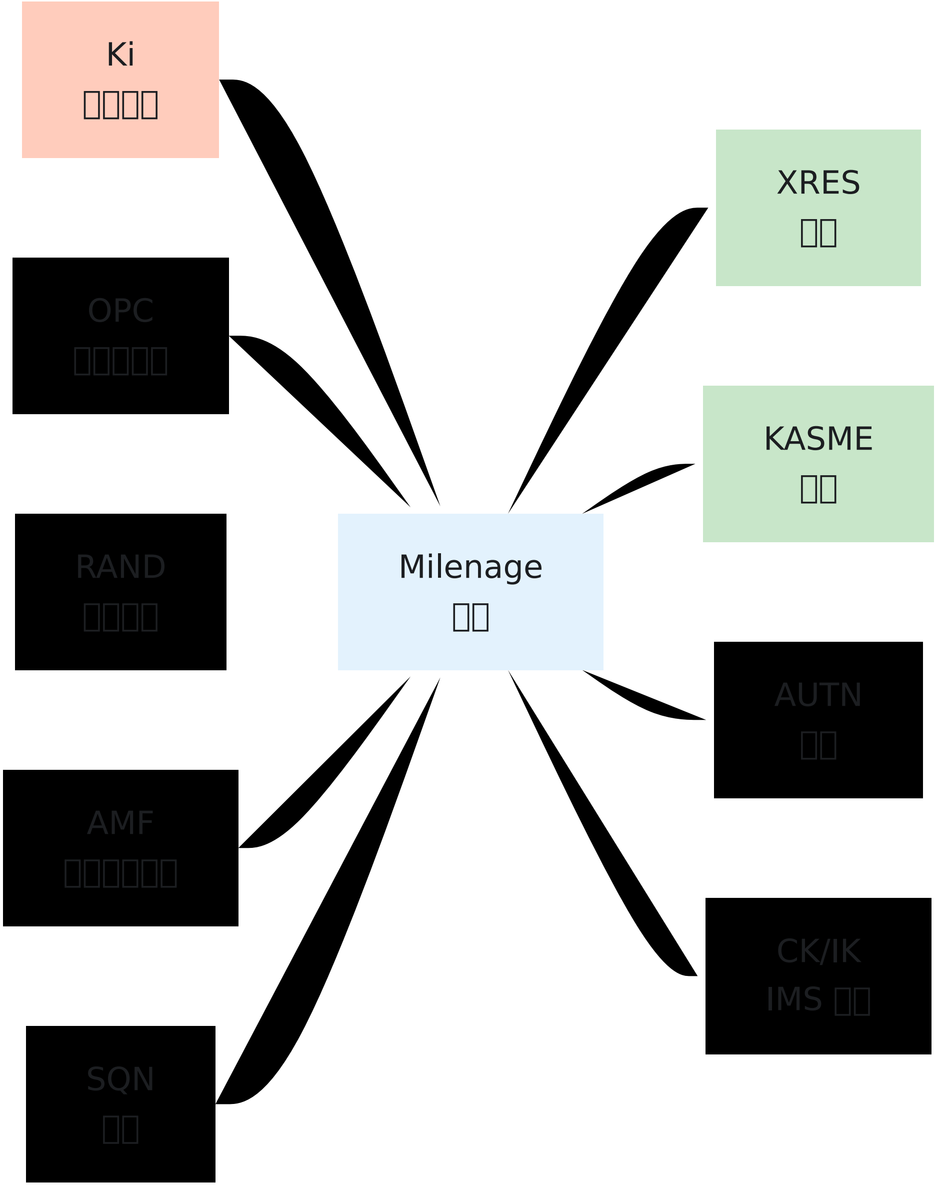
[illegible]

□□	□□	□□	□□
`ki`	binary	□□□□	128 □□16 □□□
`opc`	binary	□□□□□□□□□□□	128 □
`op`	binary	□□□□□□□□□□OPC□	128 □
`amf`	binary	□□□□□□□□	16 □□2 □□□
`sqn`	bigint	□□□□□□□□	48 □
`authentication_algorithm`	string	□□□□	□□□ "milenage"
`ota_counter`	bigint	OTA □□□□□	□□

□□□□

- □□□□□□□□□□□□□□□
- Ki □□ SIM □□□□□□
- □□□□ OPC □ OP□OPC □□□ OP □□□
- SQN □□□□□□□□□□
- Milenage □□□□□□□□□□

□□□□□□□

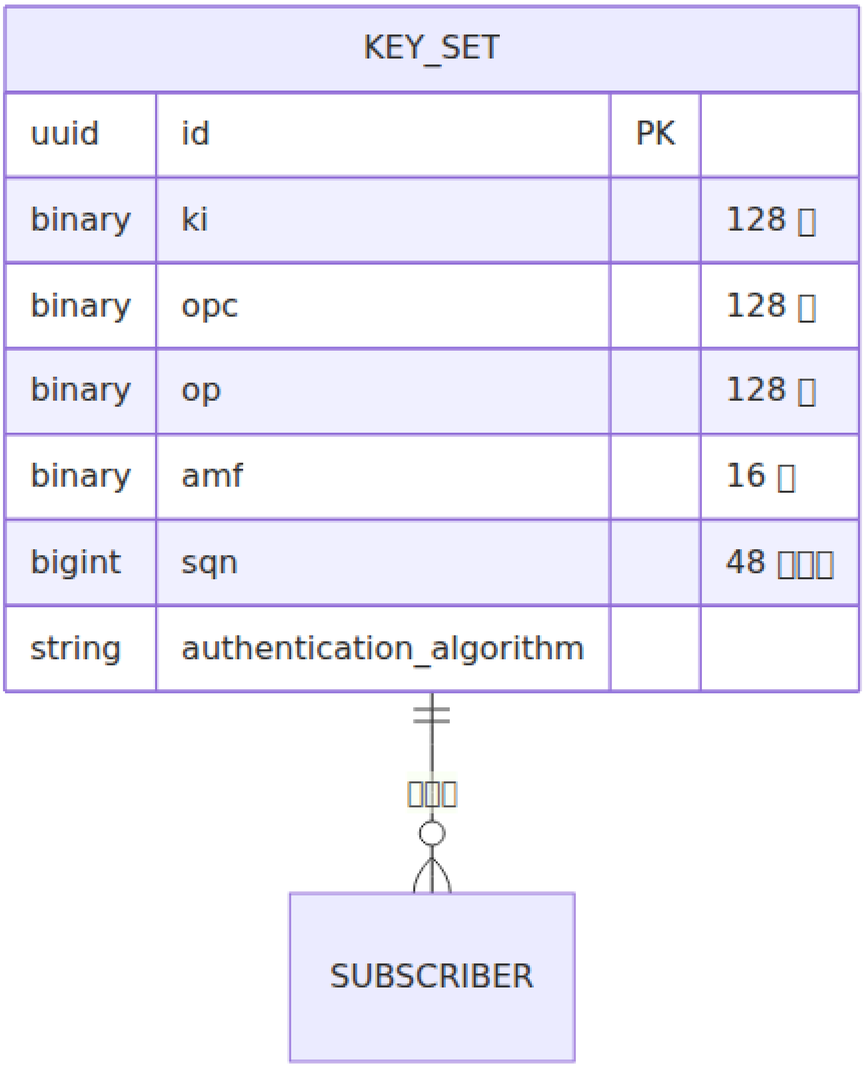

Ki
OPC
RAND
AMF
SQN
Milenage
XRES
KASME
AUTN
CK/IK
IMS

[illegible]SIM [illegible]

SIM[illegible]

- **SIM** - [illegible] eSIM[illegible] ICCID [illegible] PIN[illegible]PUK [illegible] ADM [illegible]
- [illegible] - [illegible]Ki[illegible]OPc[illegible]AMF[illegible]SQN[illegible]
- [illegible] - [illegible]IMSI[illegible]MSISDN[illegible]

[illegible] SIM (`sim_id`) [illegible] (`key_set_id`)[illegible] SIM[illegible] SIM[illegible]


KEY_SET
uuid
id
PK
binary
ki
128 [illegible]
binary
opc
128 [illegible]
binary
op
128 [illegible]
binary
amf
16 [illegible]
bigint
sqn
48 [illegible]
string
authentication_algorithm
[illegible]
SUBSCRIBER

[illegible]

[illegible]

- **SIM** [illegible] [illegible] SIM[illegible] MSISDN[illegible]���[illegible] IMS [illegible] SIM [illegible]
- [illegible] **IMSI SIM**[illegible] [illegible] ICCID [illegible] IMSI[illegible] IMSI [illegible] IMSI [illegible] IMSI [illegible] IMSI[illegible] [illegible] IMSI SIM [illegible][illegible]
- [illegible] SIM [illegible] IMSI [illegible] HSS [illegible] IMSI [illegible] IMSI[illegible] IMSI [illegible]

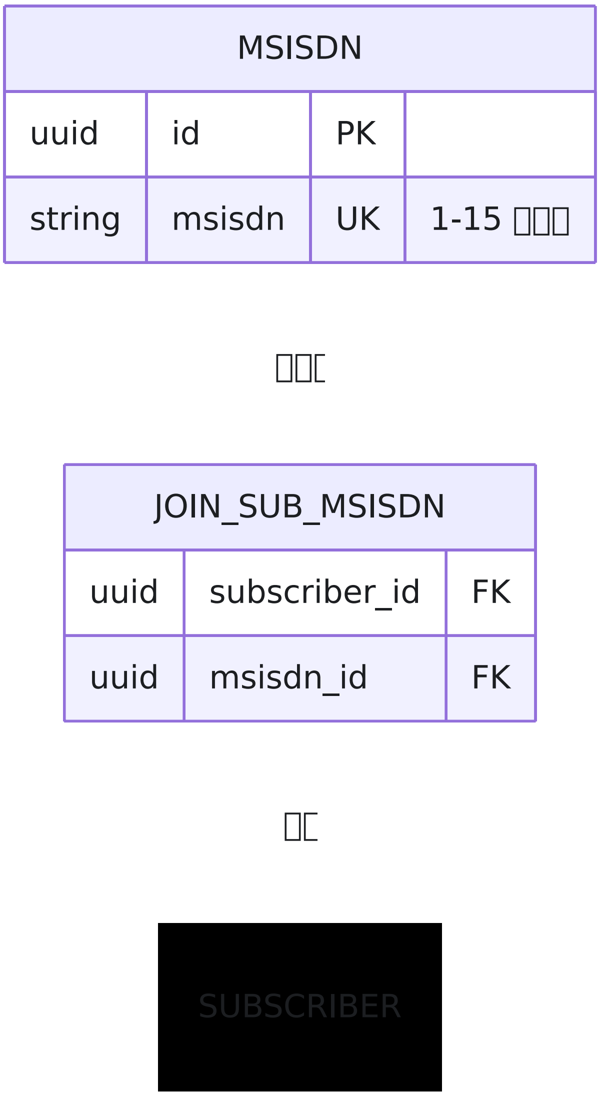
[illegible] SIM [illegible]

[illegible]

SIM [illegible] ICCID [illegible] SIM[illegible] [illegible][illegible]

MSISDN

MSISDN □□□□□□□□□


MSISDN
uuid
id
PK
string
msisdn
UK
1-15 □□□
□□□
JOIN_SUB_MSISDN
uuid
subscriber_id
FK
uuid
msisdn_id
FK
□□
SUBSCRIBER

□□□

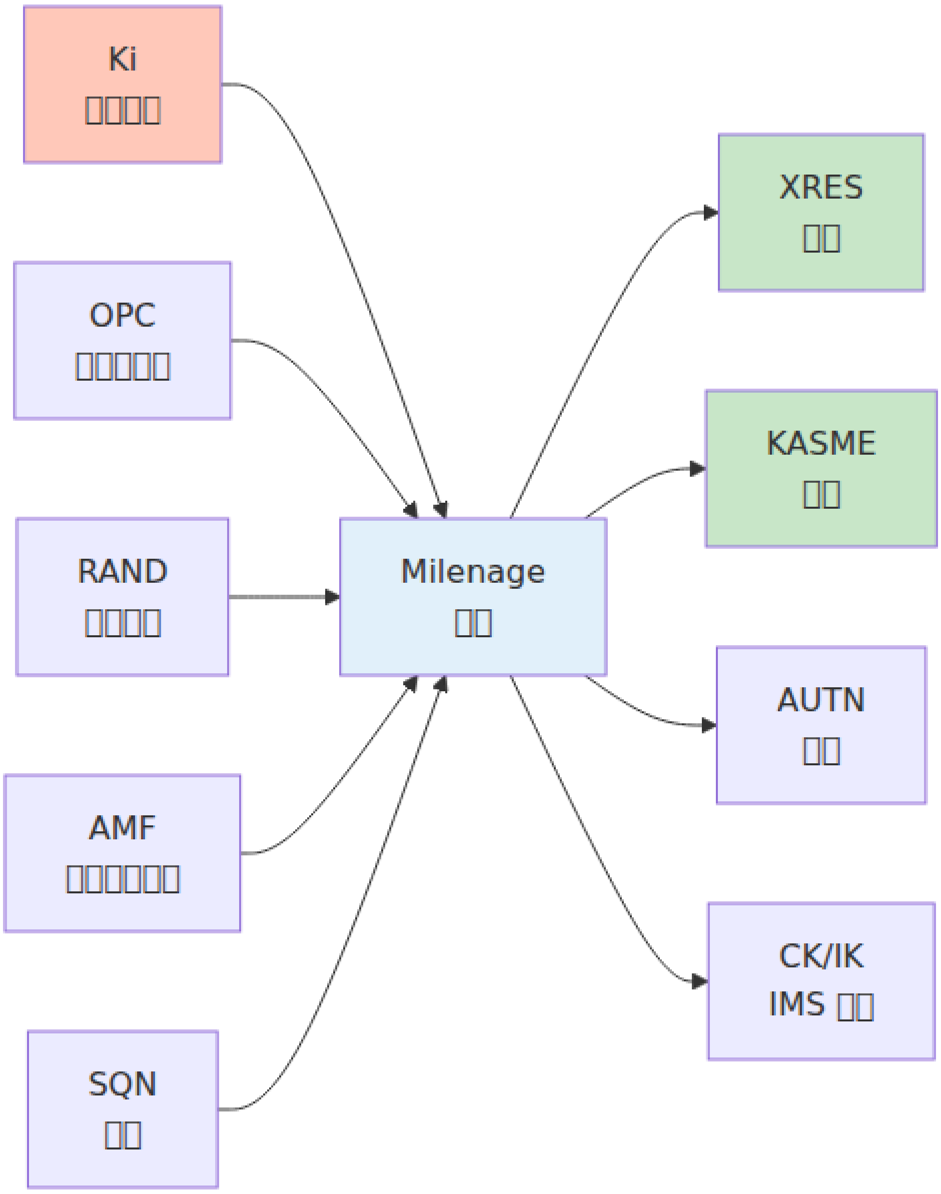
□□	□□	□□	□□
`msisdn`	string	□□□ ISDN □□	1-15 □□□□E.164 □□

□□□□

- MSISDN □□□□□□□□□□□
- □□□□□□□□□□ MSISDN□□□ IMSI□□□□□□□

- □□ MSISDN □□□□□□□□□□□□□ IMSI□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ MSISDN □□□□□□□□□□□□□□□□
- □□ MSISDN □□□□□□□□□ API `GET /subscriber/msisdn/:msisdn`□□□□□□□□ Diameter □□□□□□□□□□□□□□□□□□□□□ IMSI □ ICCID □□□□□□□□□
- □□□□□□□ + □□□□□□□□ - □□ `+` □□□□□□`14155551234` □□□ `+14155551234`□
- □ Diameter Cx/Rx □□□□□□ S-CSCF □ P-CSCF □□□□□□ `+` □ SIP URI □□`+` □□□□□□ □□

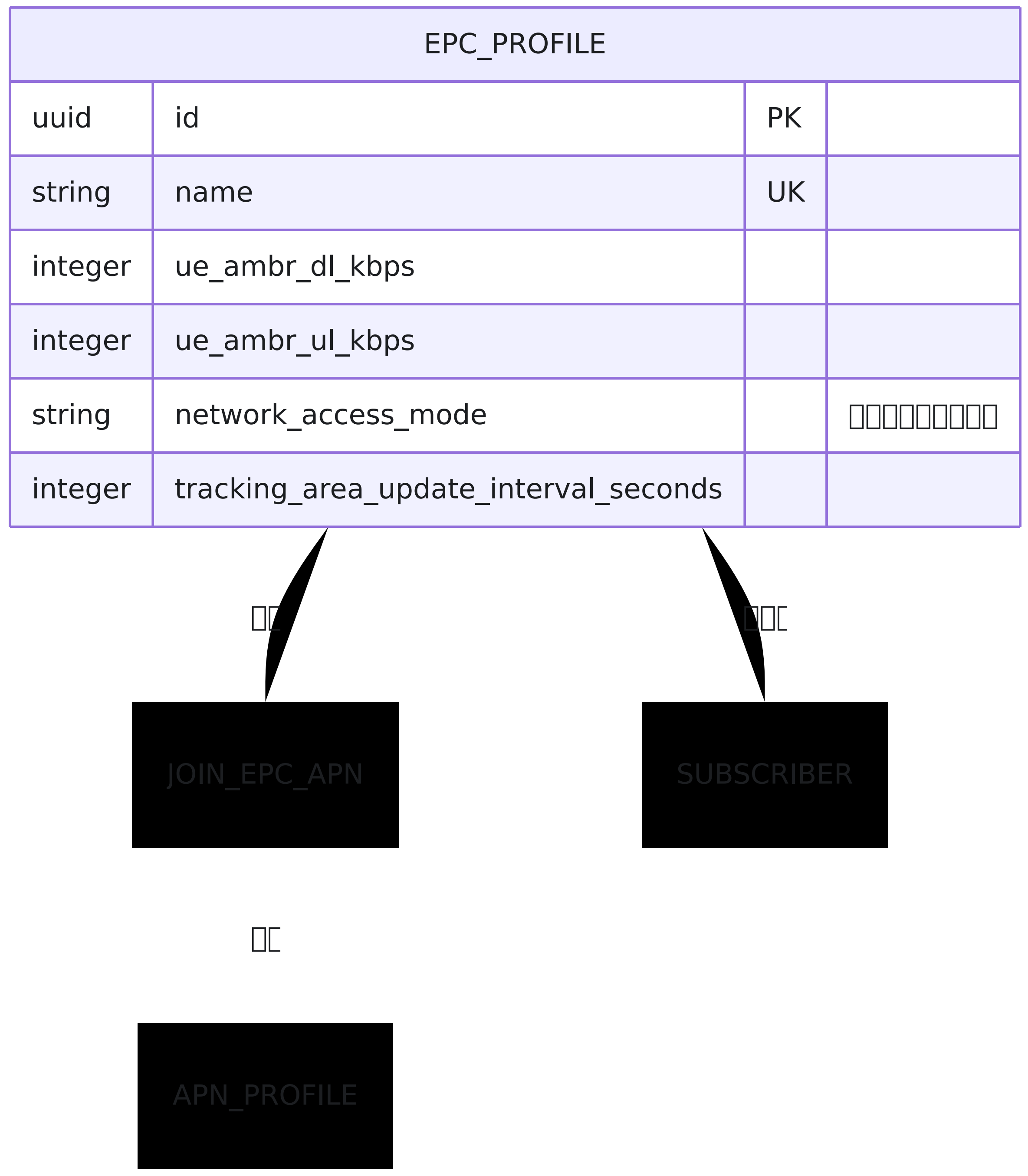
□ MSISDN □□□


Ki
□□□□
OPC
□□□□□
RAND
□□□□
AMF
□□□□□□
SQN
□□
Milenage
□□
XRES
□□
KASME
□□
AUTN
□□
CK/IK
IMS □□

[illegible]

EPC [illegible]

EPC [illegible] LTE [illegible]



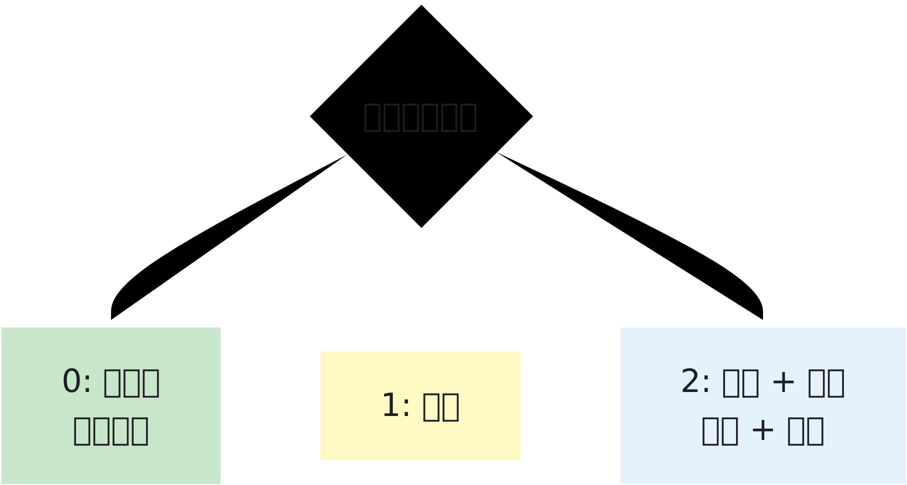
EPC_PROFILE			
uuid	id	PK	
string	name	UK	
integer	ue_ambr_dl_kbps		
integer	ue_ambr_ul_kbps		
string	network_access_mode		[illegible]
integer	tracking_area_update_interval_seconds		

JOIN_EPC_APN
SUBSCRIBER
APN_PROFILE

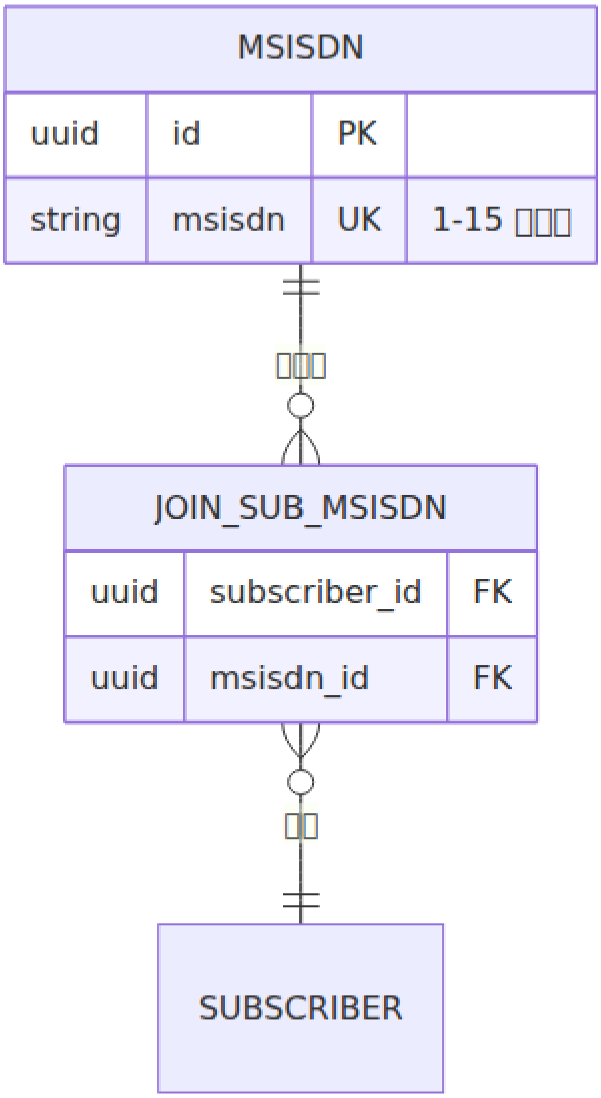
[illegible]

□□	□□	□□	□□
`name`	string	□□□□□□	□□
`ue_ambr_dl_kbps`	integer	□□□□□□	Kbps
`ue_ambr_ul_kbps`	integer	□□□□□□	Kbps
`network_access_mode`	string	□□□□	"□□□" □ "□□□□□"
`tracking_area_update_interval_seconds`	integer	TAU □□	□

□□□□□□□



AMBR□□□□□□□□□□



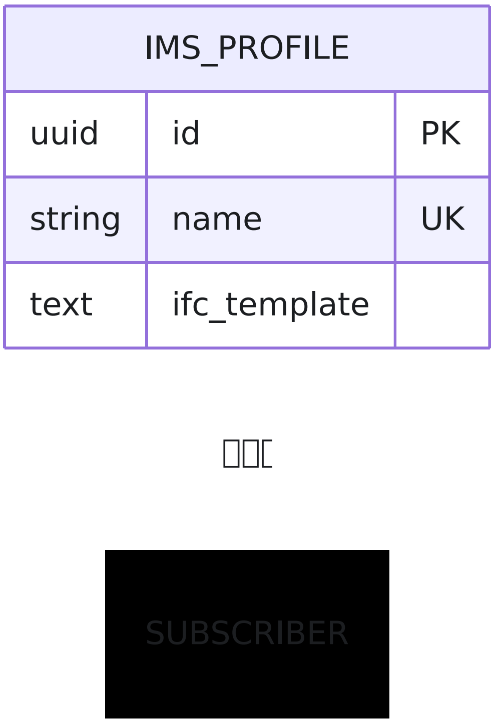
MSISDN			
uuid	id	PK	
string	msisdn	UK	1-15 □□□

JOIN_SUB_MSISDN		
uuid	subscriber_id	FK
uuid	msisdn_id	FK

□□□
□□
SUBSCRIBER

IMS □□□□

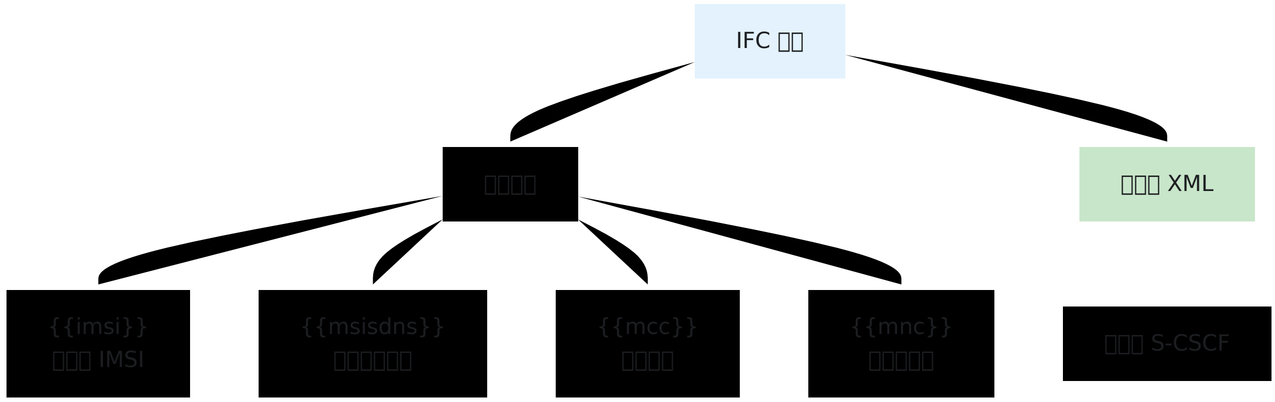
IMS □□□□□□□□/□□□□□□□


IMS_PROFILE
uuid
id
PK
string
name
UK
text
ifc_template
□□□
SUBSCRIBER

□□□

□□	□□	□□	□□
`name`	string	□□□□□□	□□
`ifc_template`	text	□□□□□□ XML □□	□□□□ XML

IFC □□□□□


IFC □□
□□□□
□□□ XML
{{imsi}}
□□□ IMSI
{{msisdns}}
□□□□□□
{{mcc}}
□□□□
{{mnc}}
□□□□□
□□□ S-CSCF

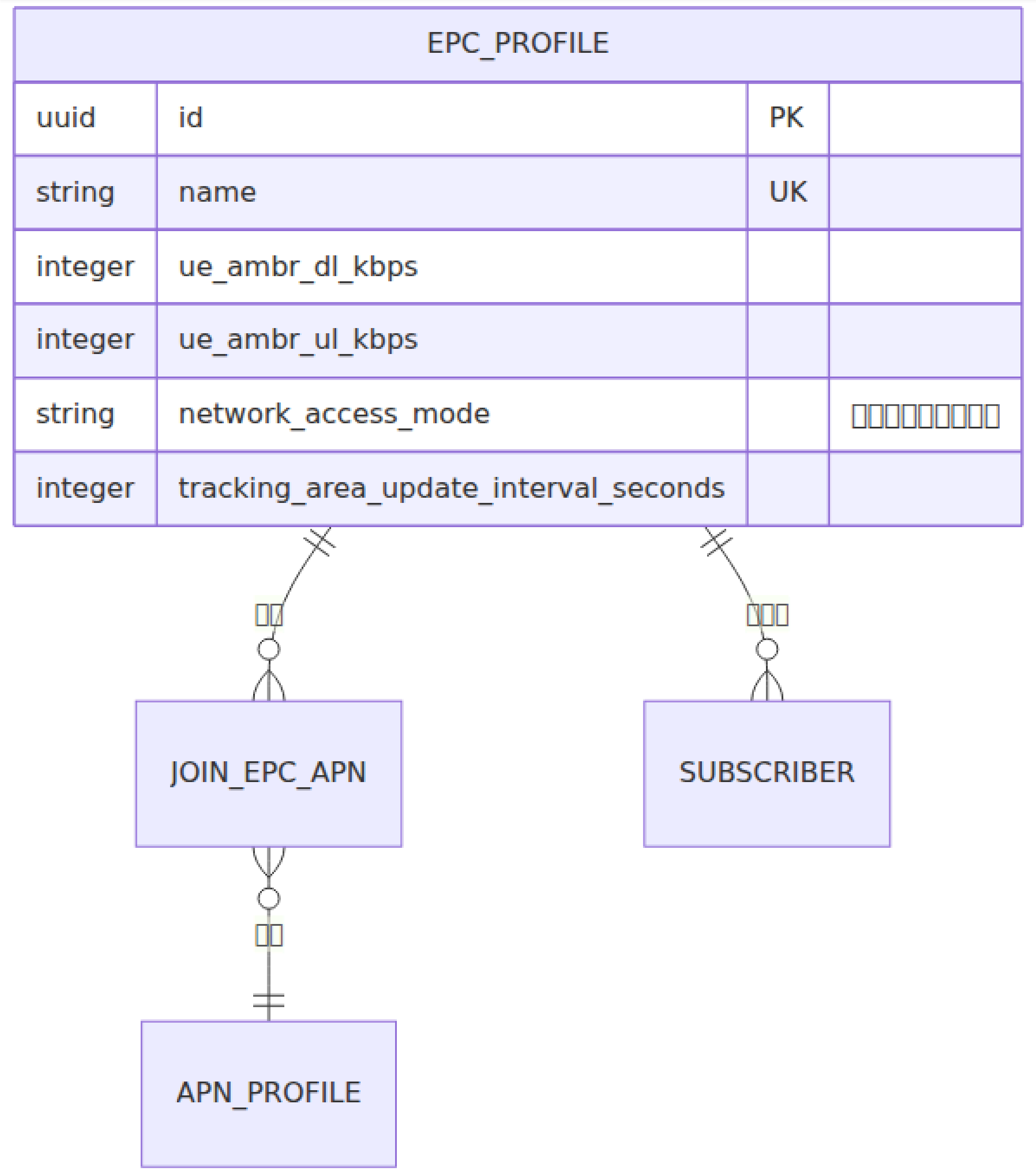
□□□□

- IFC□□□□□□□□□□ IMS □□□□□□
- □□□□□□□□□□□

- □□□□□□□□□□□□□
- □ IMS □□□□□□□ S-CSCF

APN □□□□

APN □□□□□□□□□□□□□□□□□



EPC_PROFILE			
uuid	id	PK	
string	name	UK	
integer	ue_ambr_dl_kbps		
integer	ue_ambr_ul_kbps		
string	network_access_mode		□□□□□□□□□
integer	tracking_area_update_interval_seconds		

□□
□□□
JOIN_EPC_APN
SUBSCRIBER
□□
APN_PROFILE

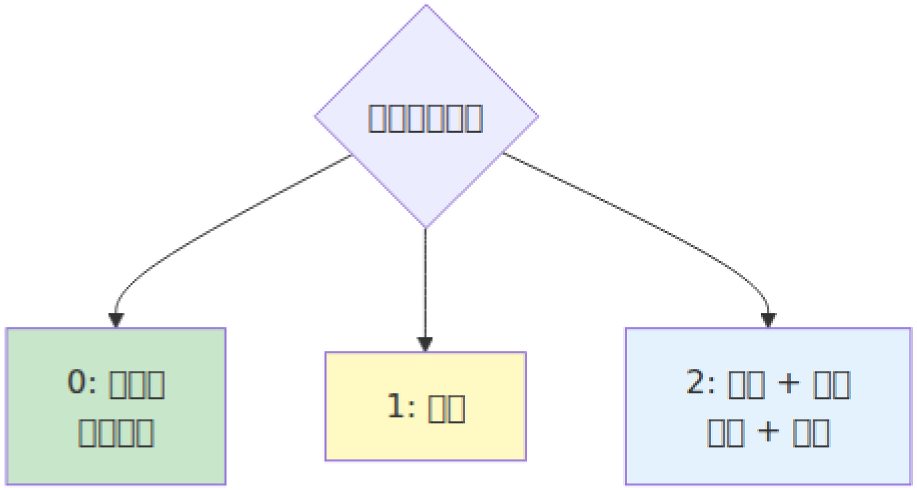
□□□□□

APN □□□

APN_IDENTIFIER			
uuid	id	PK	
string	apn	UK	
string	ip_version		ipv4, ipv6, ipv4v6, □ ipv4_or_ipv6

□□	□□	□□	□□
`apn`	string	APN □□	"internet", "ims", "mms"
`ip_version`	string	IP □□□□	□□□

IP □□□□□



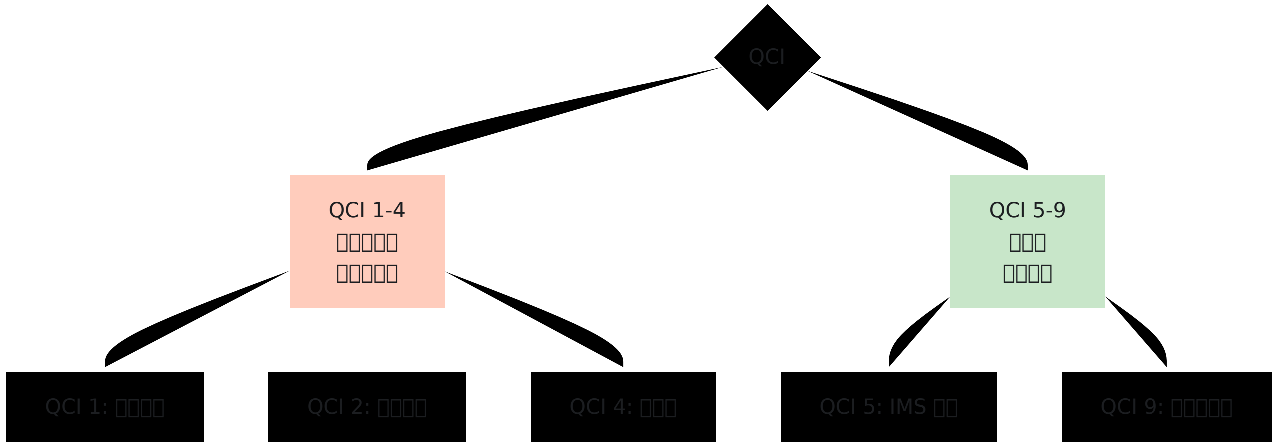
APN QoS □□□□

APN_QOS_PROFILE		
uuid	id	PK
string	name	UK
integer	qci	
integer	allocation_retention_priority	
integer	apn_ambr_dl_kbps	
integer	apn_ambr_ul_kbps	
boolean	pre_emption_capability	
boolean	pre_emption_vulnerability	

QoS □□□

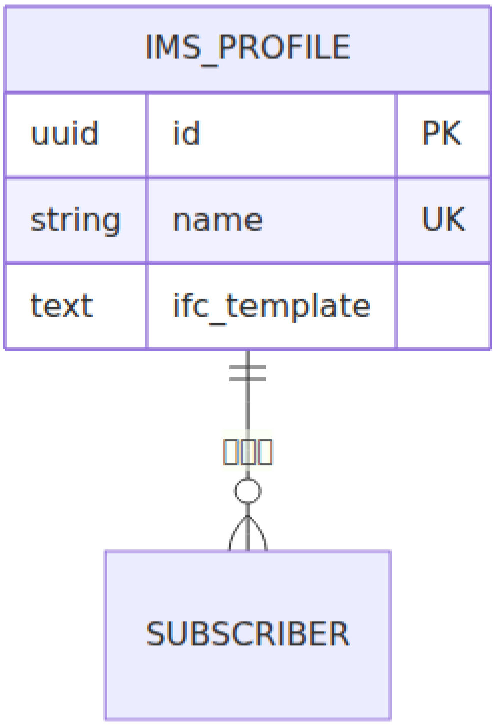
□□	□□	□□	□□□□
`qci`	QoS □□□□□	1-9	QCI 9□□□□□
`allocation_retention_priority`	ARP □□□	1-15	8□□□□□□□
`apn_ambr_dl_kbps`	APN □□□□	0+	□□
`apn_ambr_ul_kbps`	APN □□□□	0+	□□
`pre_emption_capability`	□□□□□□	true/false	false
`pre_emption_vulnerability`	□□□□□	true/false	true

QCI □□

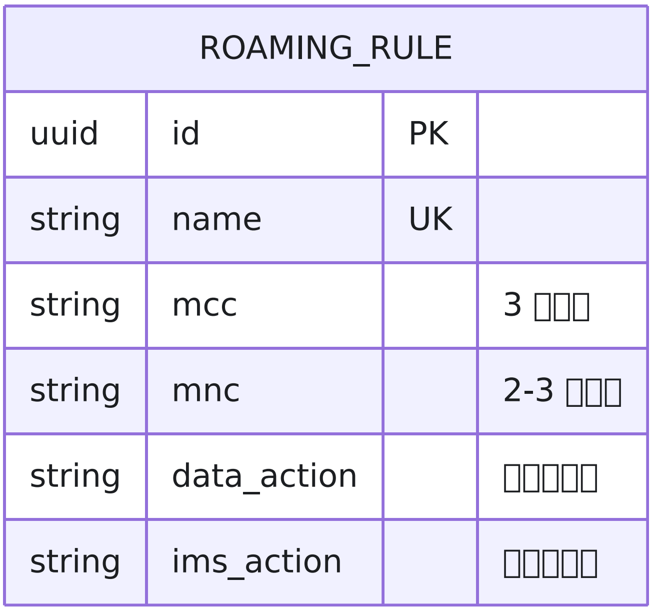

QCI
QCI 1-4
[illegible]
QCI 5-9
[illegible]
QCI 1: [illegible]
QCI 2: [illegible]
QCI 4: [illegible]
QCI 5: IMS [illegible]
QCI 9: [illegible]

[illegible]

[illegible]

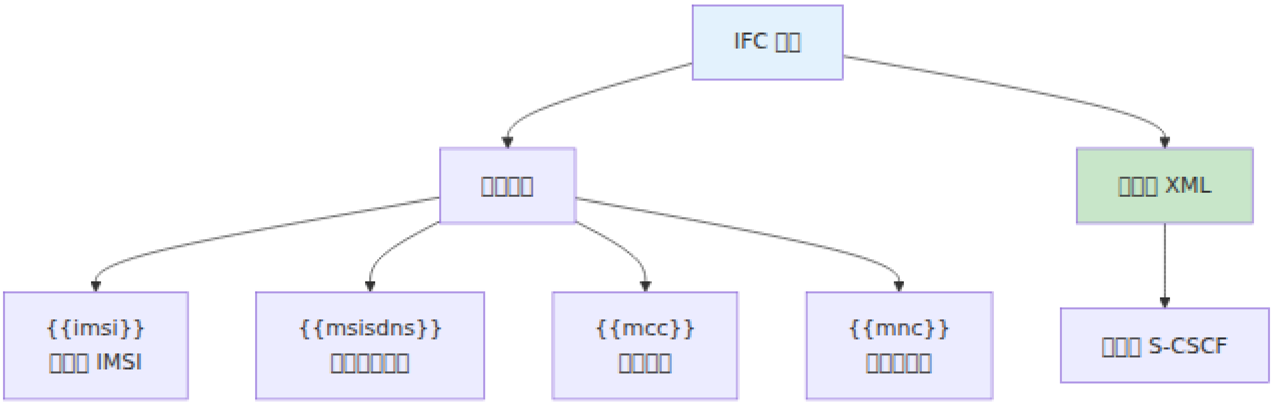

IMS_PROFILE
uuid
id
PK
string
name
UK
text
ifc_template
[illegible]
SUBSCRIBER

[illegible]



ROAMING_RULE			
uuid	id	PK	
string	name	UK	
string	mcc		3 □□□
string	mnc		2-3 □□□
string	data_action		□□□□□
string	ims_action		□□□□□

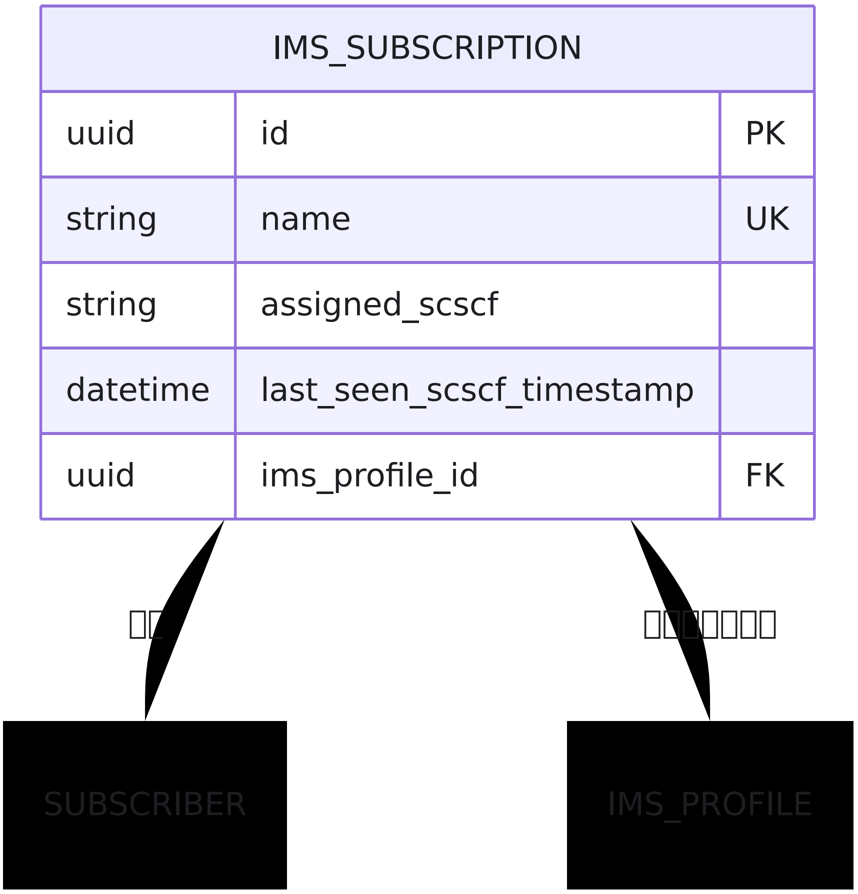
□□□□□


IFC □□
□□□□
□□□ XML
{{imsi}}
□□□ IMSI
{{msisdns}}
□□□□□□
{{mcc}}
□□□□
{{mnc}}
□□□□□
□□□ S-CSCF

□□□□

IMS □��

IMS □□□□□□□□□IMPIs / IMSIs□□□□□□ IMS □□□□□□□□□□□□□□□□□□□□□ S-CSCF□3GPP TS 23.228 □□ IMPU□□□□□□□□□□□□□□□□□□□□□□□ SIM □□□□□□□□□□



IMS_SUBSCRIPTION		
uuid	id	PK
string	name	UK
string	assigned_scscf	
datetime	last_seen_scscf_timestamp	
uuid	ims_profile_id	FK

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
`name`	string	[illegible]	[illegible]
`assigned_scscf`	string	[illegible] S-CSCF	[illegible] HSS [illegible]
`last_seen_scscf_timestamp`	datetime	[illegible] S-CSCF [illegible]	[illegible]
`ims_profile_id`	uuid	[illegible]	[illegible]

[illegible]

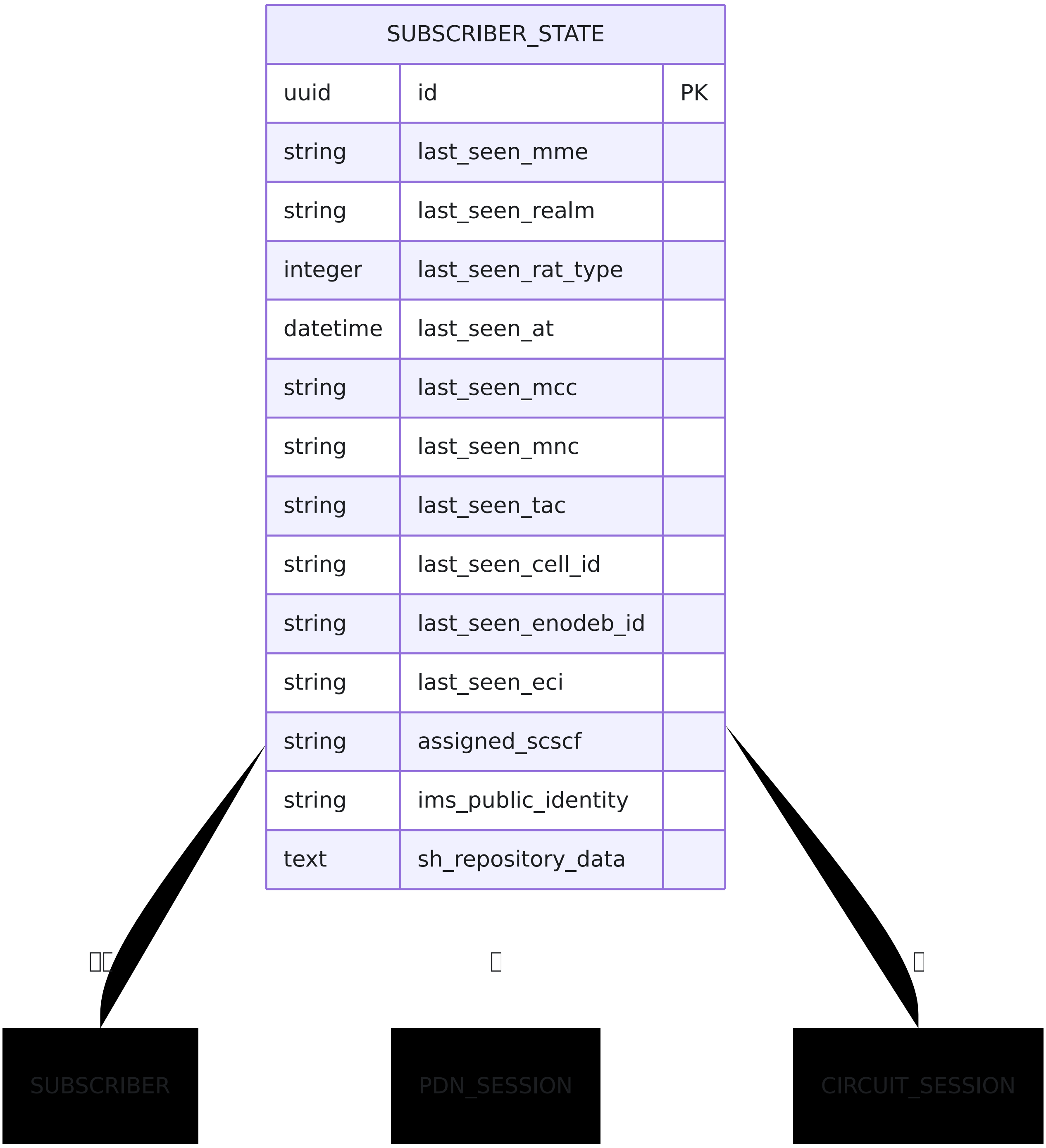
- [illegible] `subscriber.ims_subscription_id` [illegible]
- HSS [illegible] S-CSCF[illegible] `assigned_scscf`[illegible]

- [illegible] `ims_profile_id` [illegible] IMS [illegible]���[illegible] IMS [illegible]
- [illegible] IMS [illegible] `ims_subscription_id` [illegible]

[illegible] [illegible] [illegible]

[illegible]

[illegible] [illegible]



SUBSCRIBER_STATE		
uuid	id	PK
string	last_seen_mme	
string	last_seen_realm	
integer	last_seen_rat_type	
datetime	last_seen_at	
string	last_seen_mcc	
string	last_seen_mnc	
string	last_seen_tac	
string	last_seen_cell_id	
string	last_seen_enodeb_id	
string	last_seen_eci	
string	assigned_scscf	
string	ims_public_identity	
text	sh_repository_data	

[illegible]

□□□□□

- `last_seen_mcc`, `last_seen_mnc` - □□□□□
- `last_seen_tac` - □□□□□□
- `last_seen_cell_id` - □□ ID
- `last_seen_enodeb_id` - eNodeB ID
- `last_seen_eci` - E-UTRAN □□□□□

□□□□□

- `last_seen_mme` - □□□□□□□□ MME
- `last_seen_realm` - MME □ Diameter □□
- `last_seen_rat_type` - □□□□□□ (LTE, 5G □)

IMS □□□

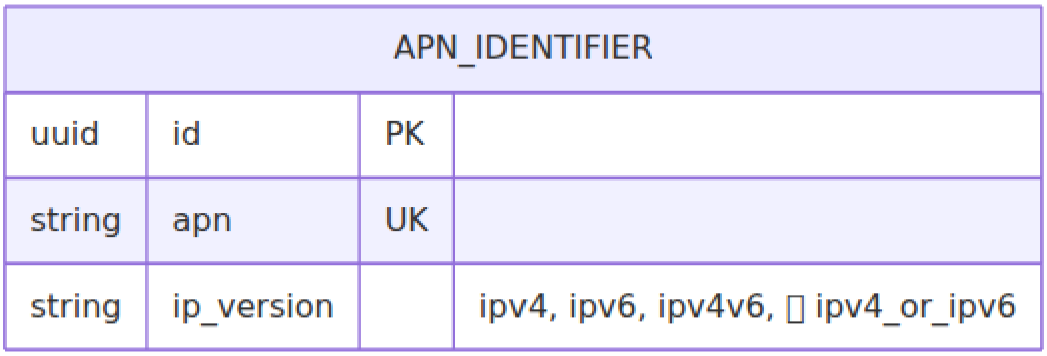
- `assigned_scscf` - □□□□□□□□ S-CSCF
- `ims_public_identity` - SIP URI (□□□sip:+14155551234@ims.example.com)
- `sh_repository_data` - □□□ IMS □□□□□□

□□□□

- `last_seen_at` - □□□□□□ Diameter □□
- □□ `last_*_at` □□□□□□□□□□

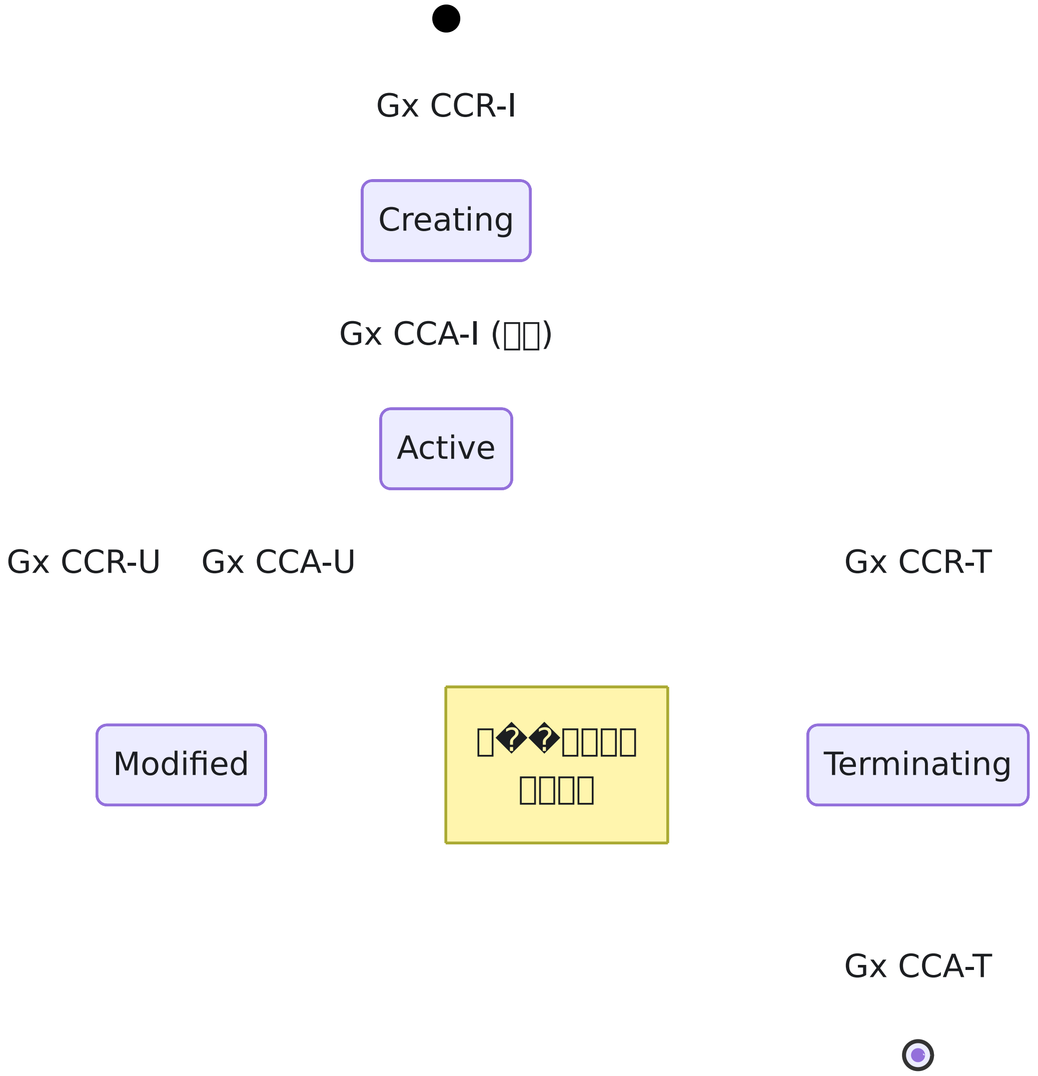
PDN □□

PDN □□ □□□□□□□□□□□□



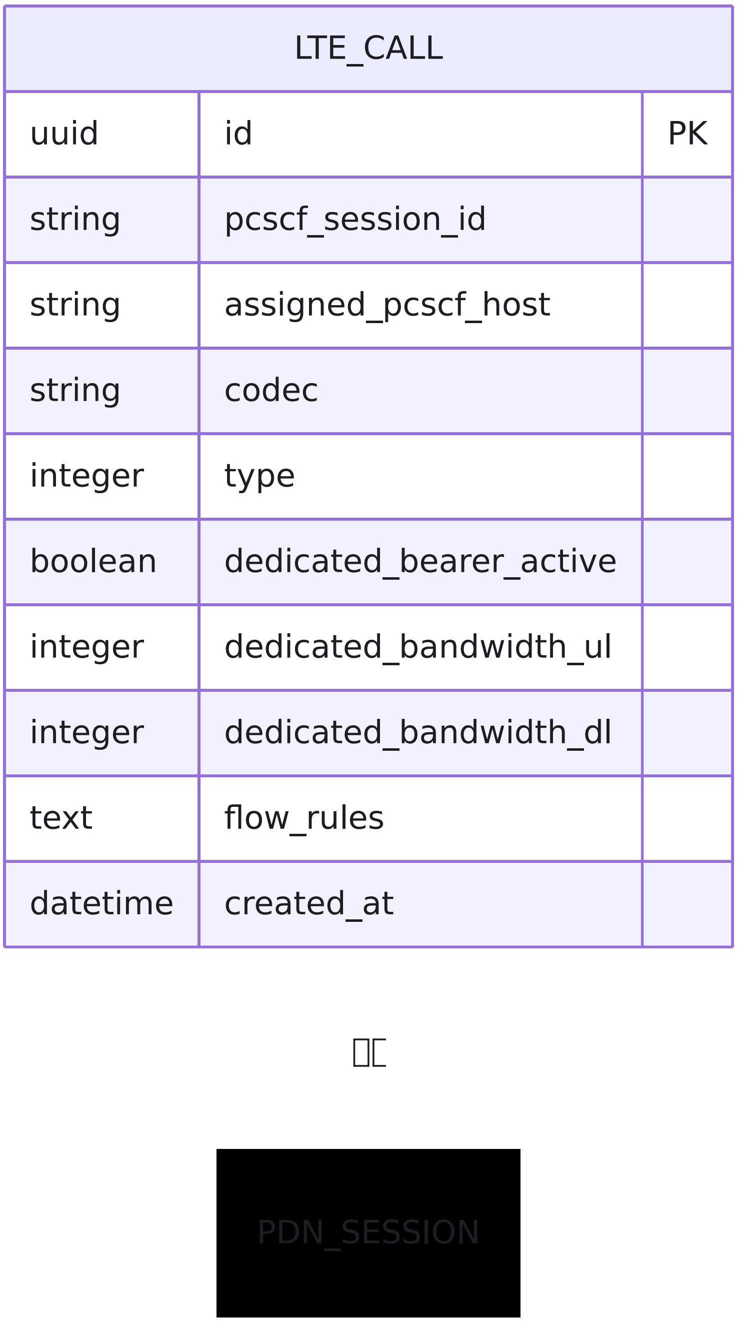
APN_IDENTIFIER			
uuid	id	PK	
string	apn	UK	
string	ip_version		ipv4, ipv6, ipv4v6, □ ipv4_or_ipv6

PDN □□□□□□□

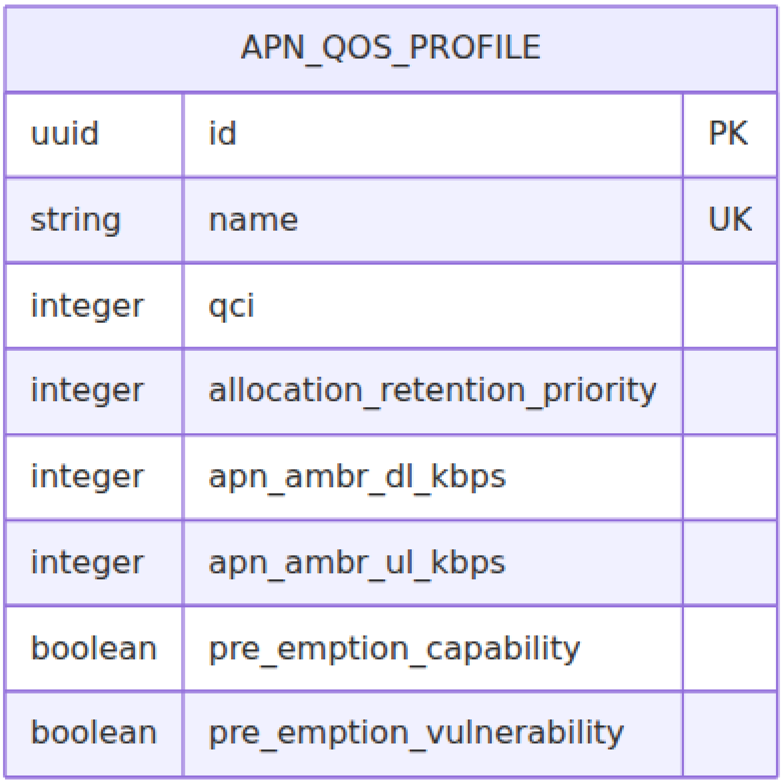

Gx CCR-I
Creating
Gx CCA-I ([illegible])
Active
Gx CCR-U
Gx CCA-U
Gx CCR-T
Modified
Terminating
Gx CCA-T

LTE [illegible]

LTE [illegible] [illegible] VoLTE [illegible]/[illegible]

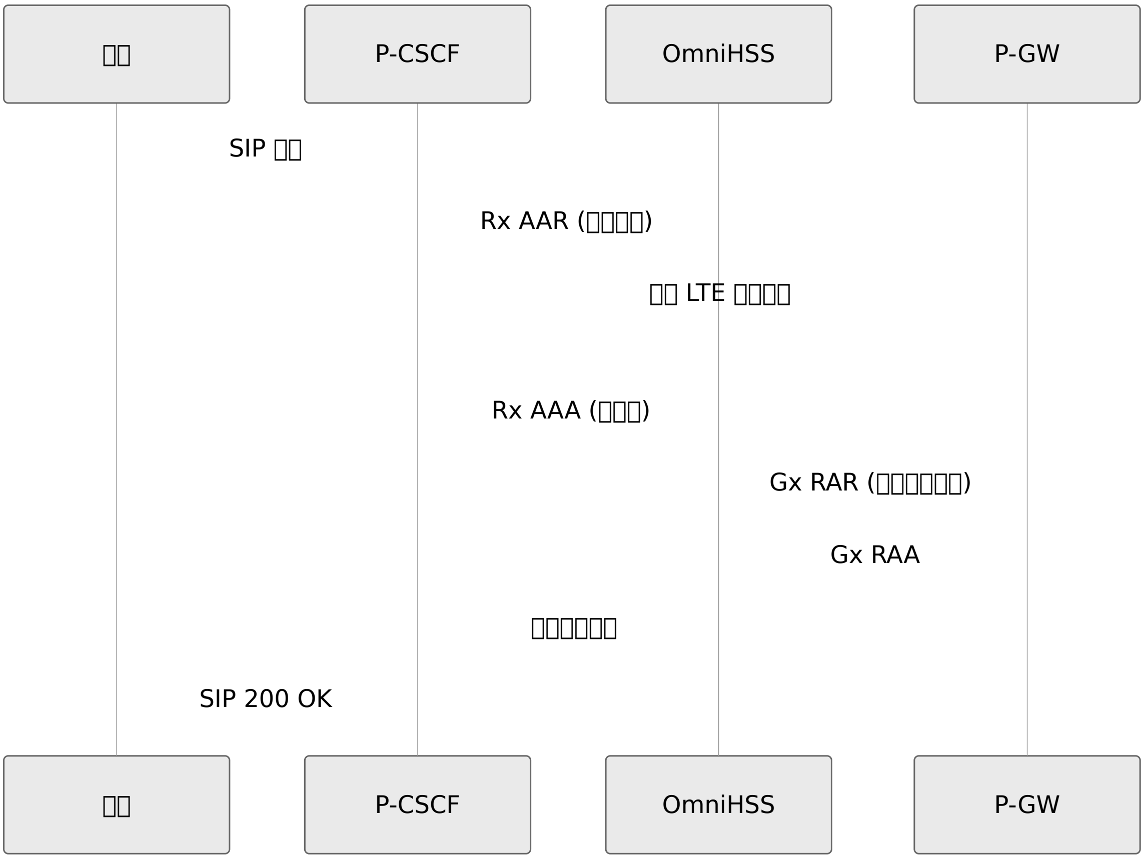


LTE_CALL		
uuid	id	PK
string	pcscf_session_id	
string	assigned_pcscf_host	
string	codec	
integer	type	
boolean	dedicated_bearer_active	
integer	dedicated_bandwidth_ul	
integer	dedicated_bandwidth_dl	
text	flow_rules	
datetime	created_at	



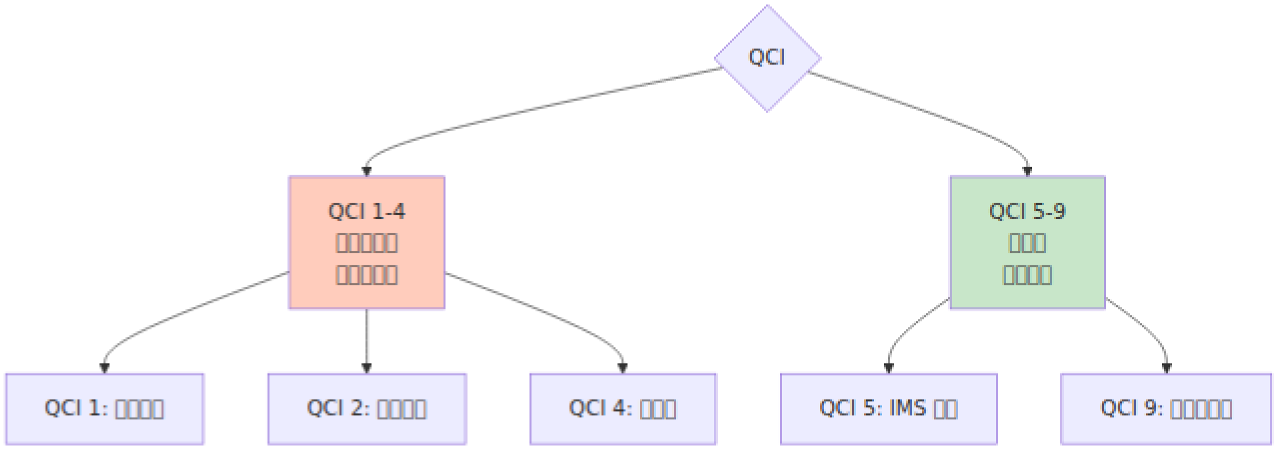
APN_QOS_PROFILE		
uuid	id	PK
string	name	UK
integer	qci	
integer	allocation_retention_priority	
integer	apn_ambr_dl_kbps	
integer	apn_ambr_ul_kbps	
boolean	pre_emption_capability	
boolean	pre_emption_vulnerability	

VoLTE [illegible]


[illegible]
P-CSCF
OmniHSS
P-GW
SIP [illegible]
Rx AAR ([illegible])
[illegible] LTE [illegible]
Rx AAA ([illegible])
Gx RAR ([illegible])
Gx RAA
[illegible]
SIP 200 OK
[illegible]
P-CSCF
OmniHSS
P-GW

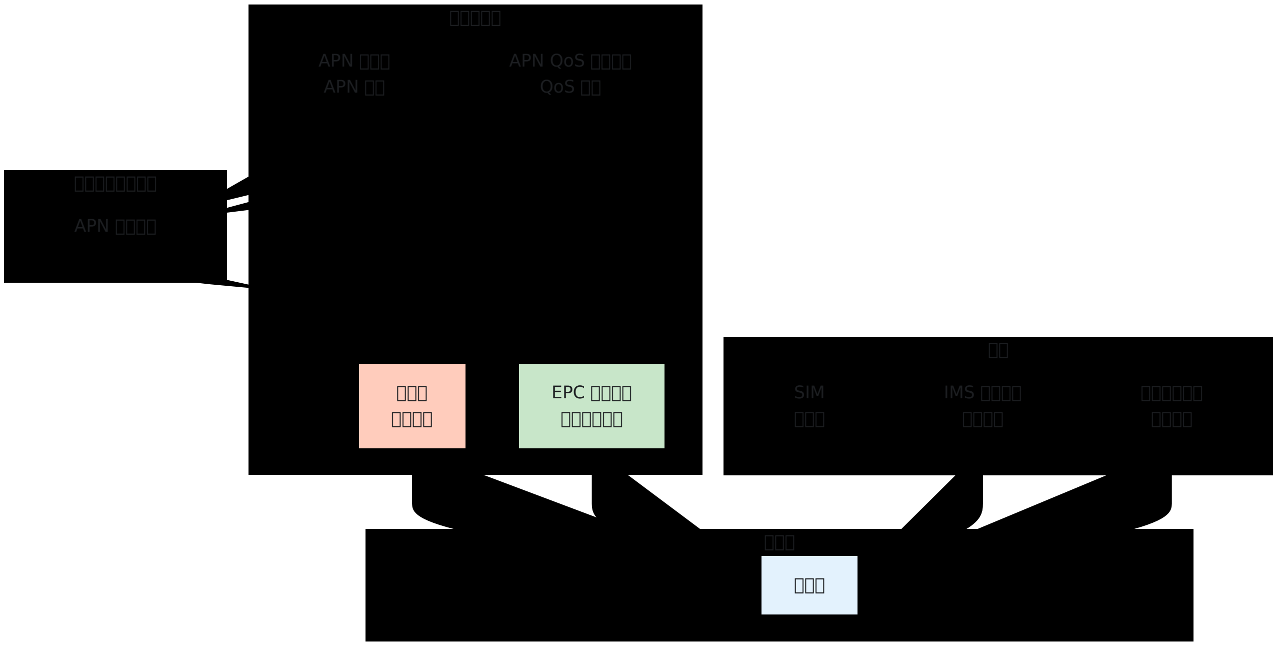
[illegible]

[illegible]

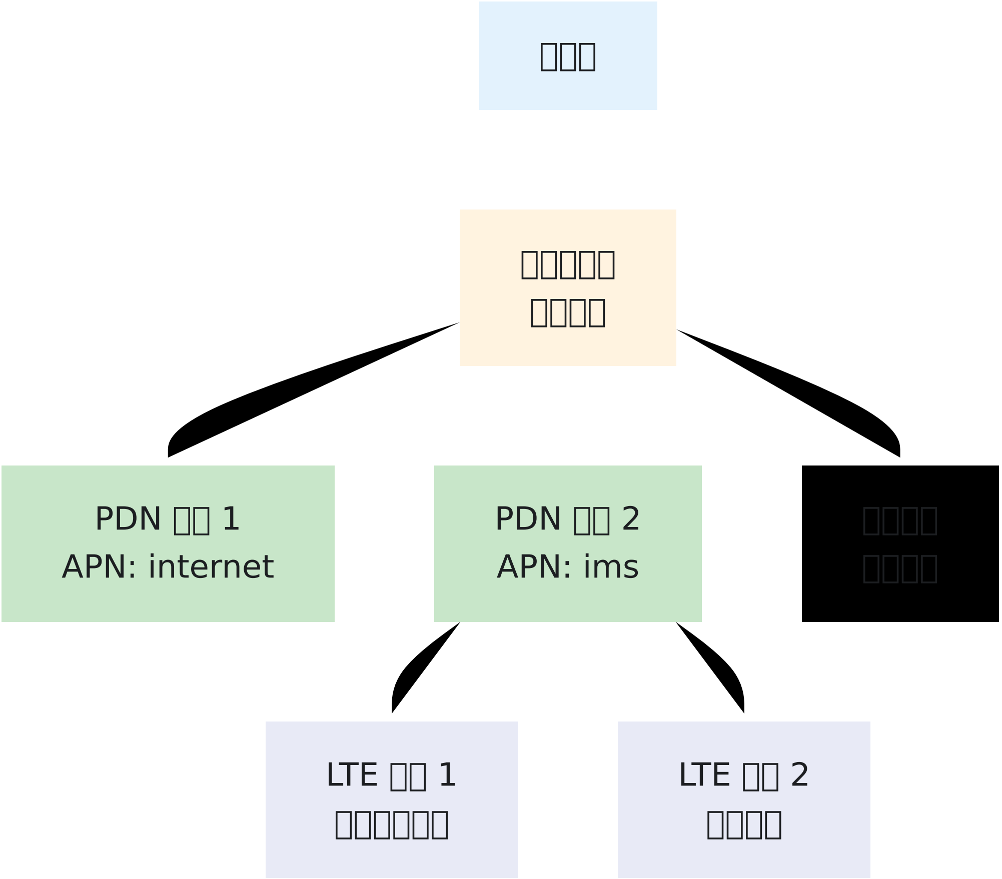

QCI
QCI 1-4
QCI 5-9
QCI 1:
QCI 2:
QCI 4:
QCI 5: IMS
QCI 9:

[illegible]

[illegible]


APN
APN
APN QoS
QoS
APN
EPC
SIM
IMS

[illegible]

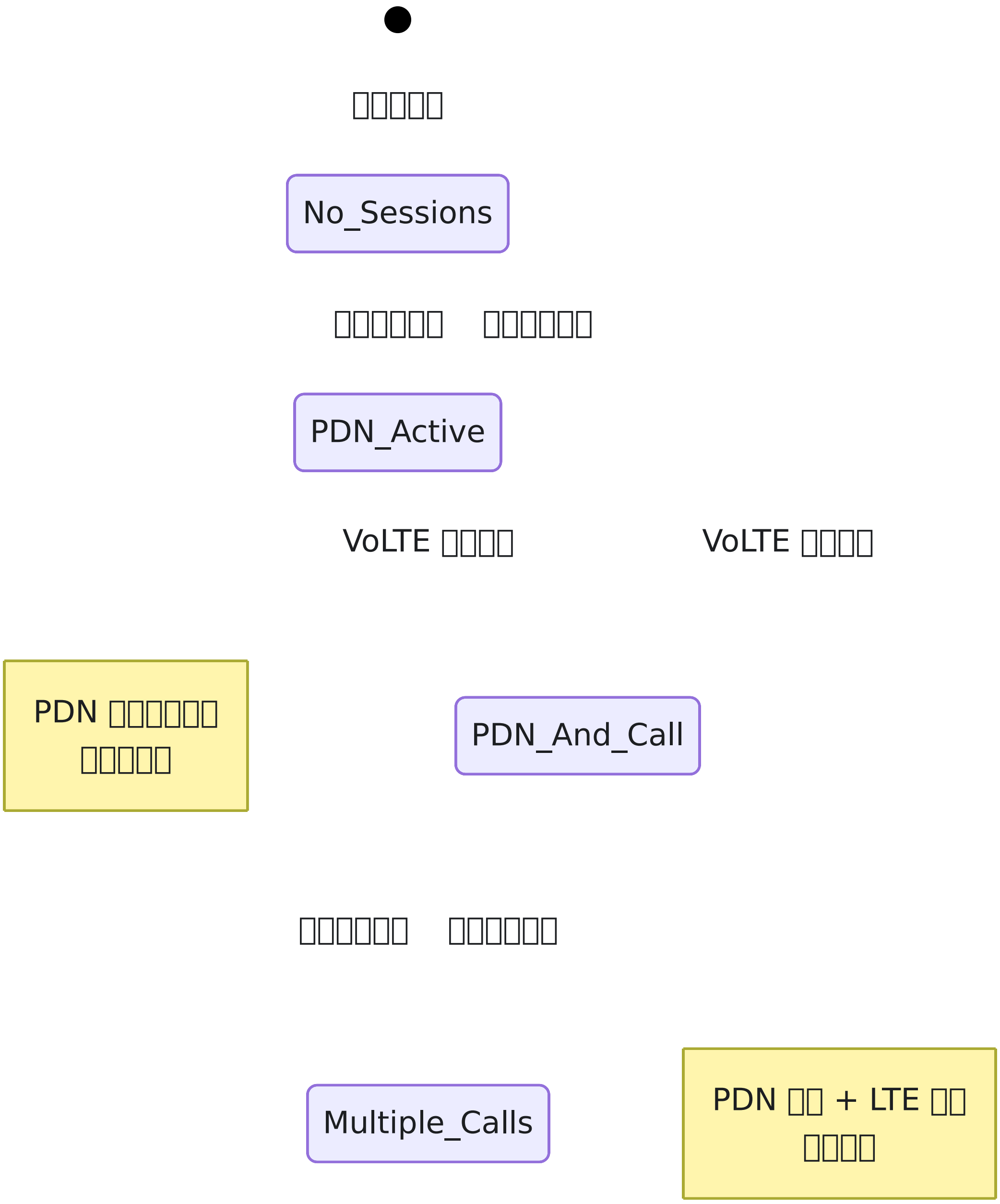

[illegible]
[illegible]
PDN [illegible] 1
APN: internet
PDN [illegible] 2
APN: ims
[redacted]
LTE [illegible] 1
[illegible]
LTE [illegible] 2
[illegible]

[illegible]

[illegible]

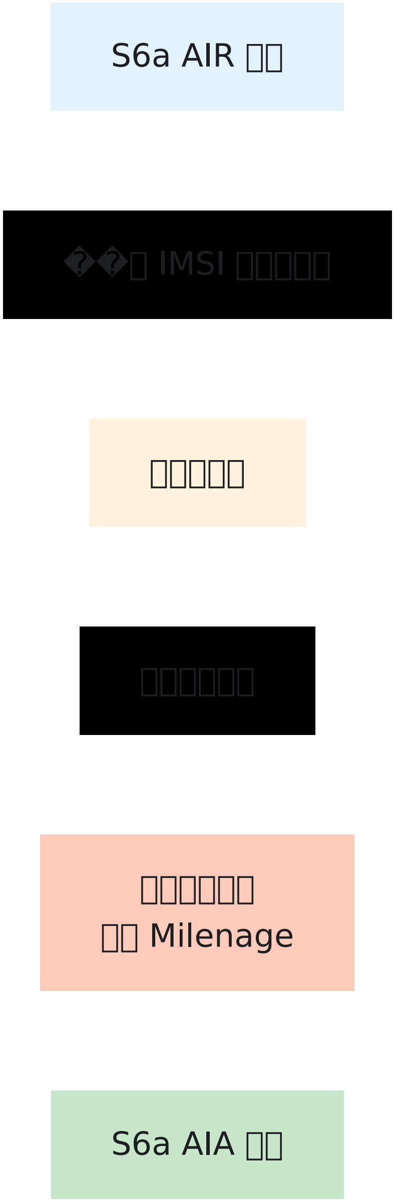
ROAMING_RULE			
uuid	id	PK	
string	name	UK	
string	mcc		3 [illegible]
string	mnc		2-3 [illegible]
string	data_action		[illegible]
string	ims_action		[illegible]

[illegible]

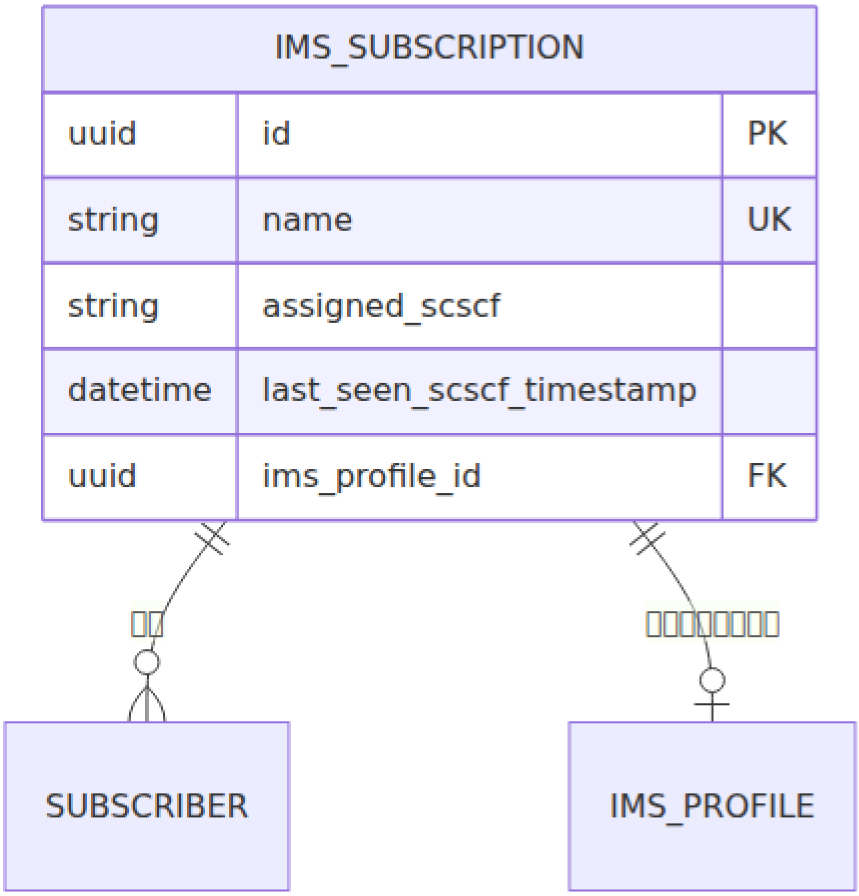

No_Sessions
PDN_Active
VoLTE
VoLTE
PDN
PDN_And_Call
Multiple_Calls
PDN + LTE

[illegible]

[illegible]


S6a AIR [illegible]
[redacted]
[illegible]
[redacted]
[illegible]
[illegible] Milenage
S6a AIA [illegible]

□□□□□□



IMS_SUBSCRIPTION		
uuid	id	PK
string	name	UK
string	assigned_scscf	
datetime	last_seen_scscf_timestamp	
uuid	ims_profile_id	FK

□□
□□□□□□□□
SUBSCRIBER
IMS_PROFILE

IMS □□□□

Cx SAR □□

[redacted]

□□ IMS □□□□
+ MSISDN

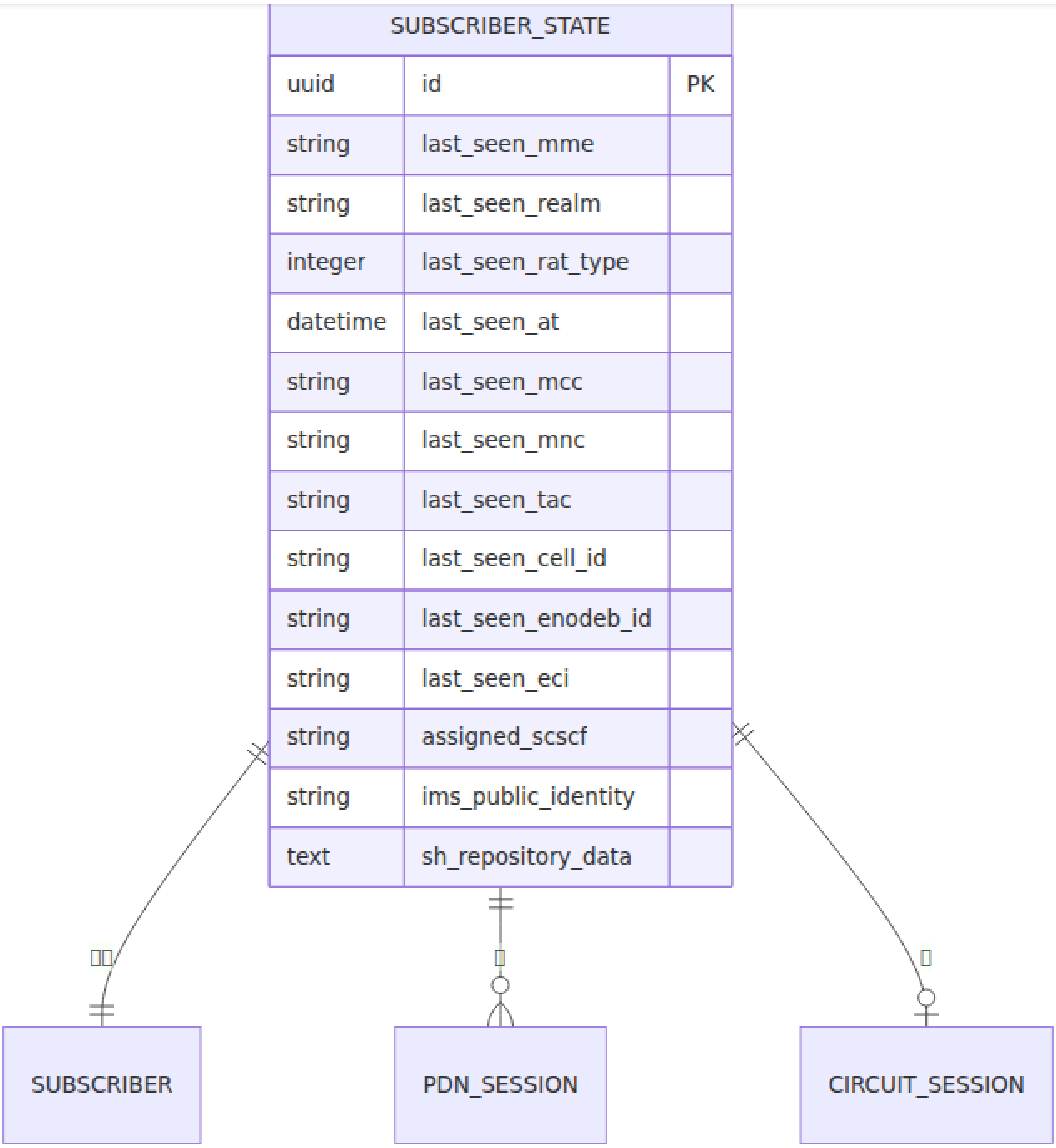
□□ S-CSCF
□□/□□

□□ IFC □□
□□□

[redacted]

Cx SAA □□

□□□□□□



SUBSCRIBER_STATE

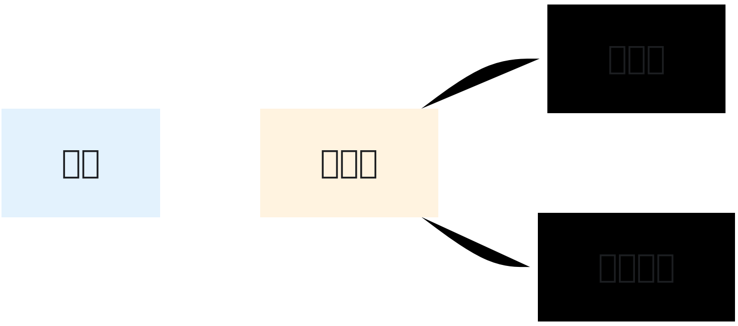
uuid	id	PK
string	last_seen_mme	
string	last_seen_realm	
integer	last_seen_rat_type	
datetime	last_seen_at	
string	last_seen_mcc	
string	last_seen_mnc	
string	last_seen_tac	
string	last_seen_cell_id	
string	last_seen_enodeb_id	
string	last_seen_eci	
string	assigned_scscf	
string	ims_public_identity	
text	sh_repository_data	

□□
□
□
SUBSCRIBER
PDN_SESSION
CIRCUIT_SESSION

□□□□□□

OmniHSS □□□□□□□□□□□□□□□□□□□□□□□□□□

[illegible] ([illegible])



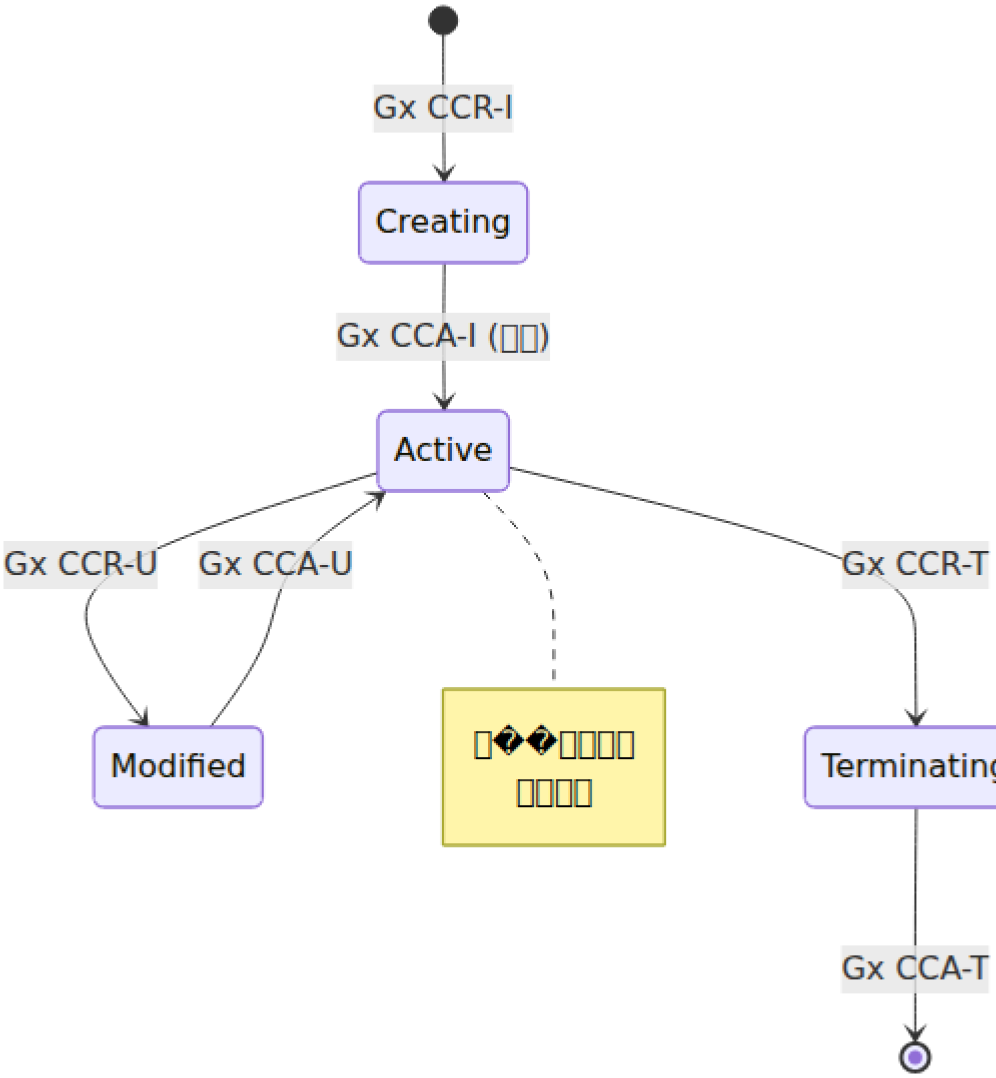
[illegible] S6a AIR - [illegible]

[illegible] ([illegible])

APN [illegible]
EPC [illegible]
APN [illegible]
APN QoS

[illegible] S6a ULR - [illegible] EPC [illegible]

□□□□ (IMS □□)


Gx CCR-I
Creating
Gx CCA-I (□□)
Active
Gx CCR-U
Gx CCA-U
Gx CCR-T
Modified
□��□□□□
□□□□
Terminating
Gx CCA-T

□□□ Cx SAR - □□ IMS □□□□□□□□□□□

← □□□□□□ | □□□□API □□ →

Diameter [illegible]

← [illegible]

[illegible] mermaid [illegible] Diameter [illegible] OmniHSS [illegible]

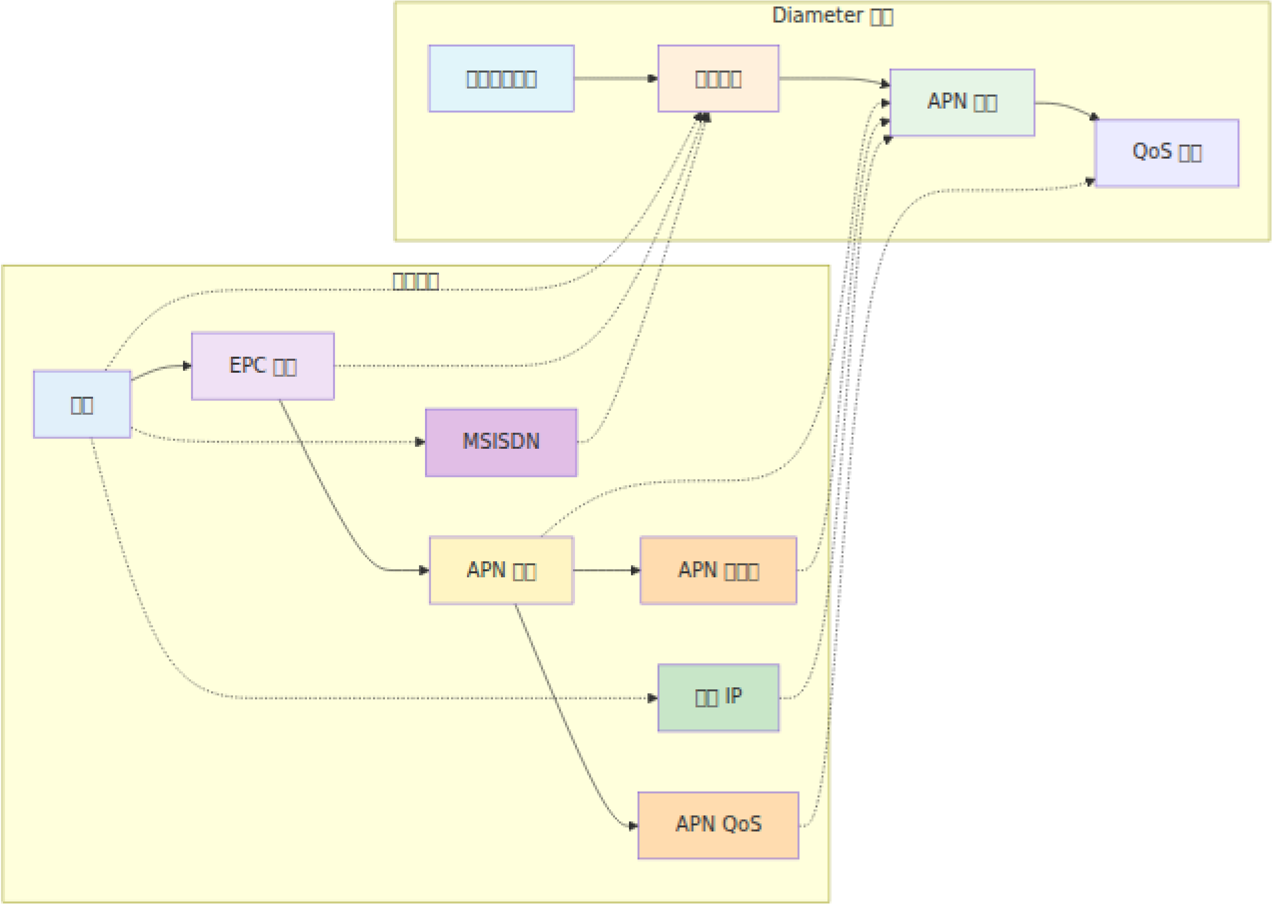
[illegible]

- [illegible] (S6a ULA)
- [illegible] (S6a AIA)
- [illegible] (Cx SAA)
- [illegible] (Gx CCA)
- [illegible] (Sh UDA)
- ME [illegible] (S13 ECA)

[illegible] (S6a ULA)

[illegible] HSS [illegible] LTE [illegible] MME[illegible] Diameter AVP [illegible]

[illegible]


Diameter
APN
QoS
EPC
MSISDN
APN
APN
IP
APN QoS

□□□□□□

□□□□	□□	D
subscriber.enabled	`true/false`	Su St
msisdn.msisdn	`'14155551234'`	MS
epc_profile.ue_ambr_ul_kbps	`50000`	Ma Re Ba UL
epc_profile.ue_ambr_dl_kbps	`100000`	Ma Re Ba DL
epc_profile.network_access_mode	`'packet_only'`	Ne Ac Mo
apn_identifier.apn	`'internet'`	Se Se
apn_identifier.ip_version	`'ipv4v6'`	PD
apn_qos_profile.qci	`9`	Qo Id
apn_qos_profile.allocation_retention_priority	`8`	Pr Le

□□□□	□□	**D**
apn_qos_profile.pre_emption_capability	`false`	Pr en Ca
apn_qos_profile.pre_emption_vulnerability	`true`	Pr en Vu
apn_qos_profile.apn_ambr_ul_kbps	`25000`	AF UL
apn_qos_profile.apn_ambr_dl_kbps	`50000`	AF DL
static_ip.ipv4_static_ip	`'100.64.1.1'`	Se Pa Ac (IF
static_ip.ipv6_static_ip	`'2606:4700::1111'`	Se Pa Ac (IF

□□□□□

1. **AMBR** □□□□□□□ kbps □□□Diameter □□ bps□□□ 1000□
2. **IP** □□□□□`0=IPv4, 1=IPv6, 2=IPv4v6, 3=IPv4_or_IPv6`
3. □□□□□`enabled: true → 0 (SERVICE_GRANTED)`, `enabled: false → 1 (OPERATOR_DETERMINED_BARRING)`
4. □□□□□□□□□ APN □□□□□□□□□□□□0, 1, 2…□
5. □□ **IP**□□□□□ `static_ips` □□□□□□□□□□

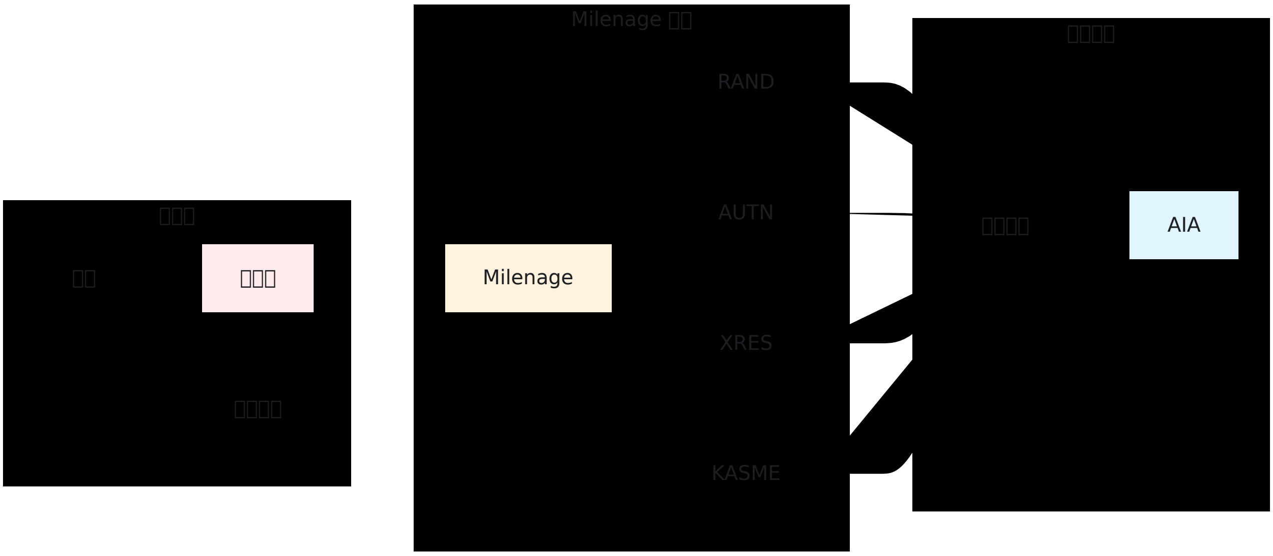
□□□□□□□

- □□□□□□□□□□□ PLMN □ `roaming_profile.roaming_rules`
- □□□□□□□□`subscriber.enabled == true`
- □□ APN□□□□□□□□□□ IMS□□□□□□ IMS APN

□□□□□□ (S6a AIA)

□□□□□□□□ LTE/EPC □□□□□□□□□□

□□□□□



Milenage □□
RAND
AUTN
XRES
KASME
□□□□
□□□□
AIA
□□□
□□
□□□
□□□□
Milenage

□□□□□

1. □□□□□□□□□□□□□□□□□□□□ `key_set` □□
2. **SQN** □□□□□□□□□□□□□□□□□□□□□□□□□
3. **Milenage** □□□3GPP TS 35.206 - □□□□□□
4. **KASME** □□□□□ CK||IK □□ KDF □ TS 33.401 □□□□

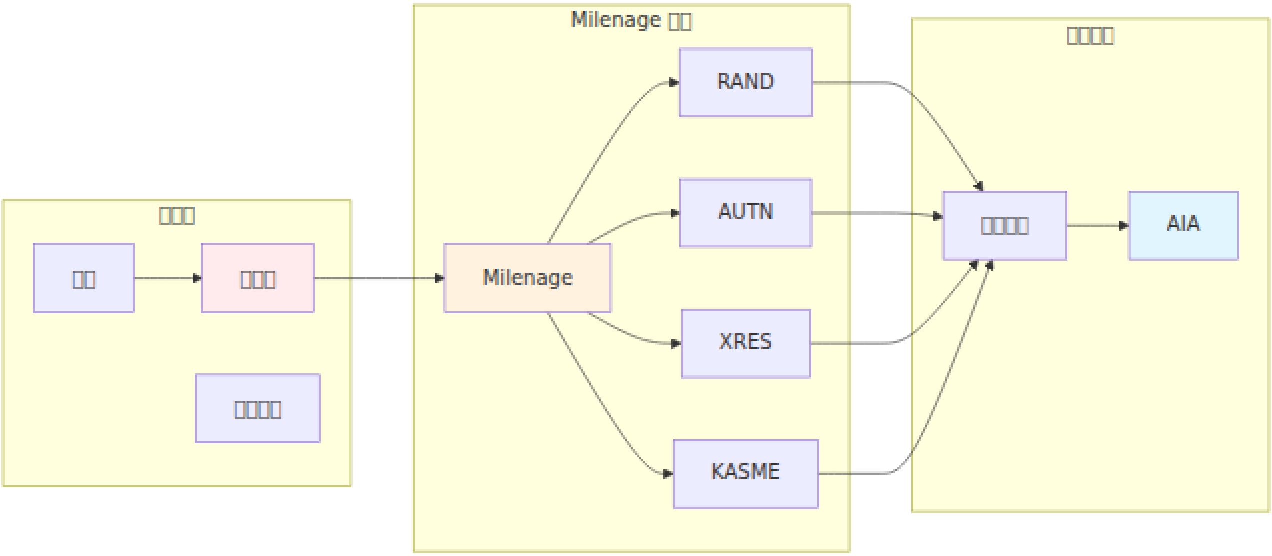
□□□□□

- □□□□□□ SQN□□□□□
- Ki/OPc □□□□□ HSS□□□□□□□□
- AUTN □□□□□□SQN□□ AMF □□□□□□
- Milenage □□□□ UE □□□□□□□□□□

□□□□□□□ (Cx SAA)

□□□□□□□□ HSS □ IMS □□□□□□□□ S-CSCF□

□□□□□


Milenage
RAND
AUTN
XRES
KASME
Milenage
AIA

□□□□□

1. **IFC** □□□XML ���□□□□ `ims_profile.ifc_template`
2. □□□□□□□□□□□□ `{{msisdn}}`□`{{imsi}}`□`{{impu}}`
3. **S-CSCF** □□□□ `subscriber_state.assigned_scscf` □□□□□□ S-CSCF
4. **IMS** □□□□□□□□`sip:+{msisdn}@{ims_domain}` □ `tel:+{msisdn}`

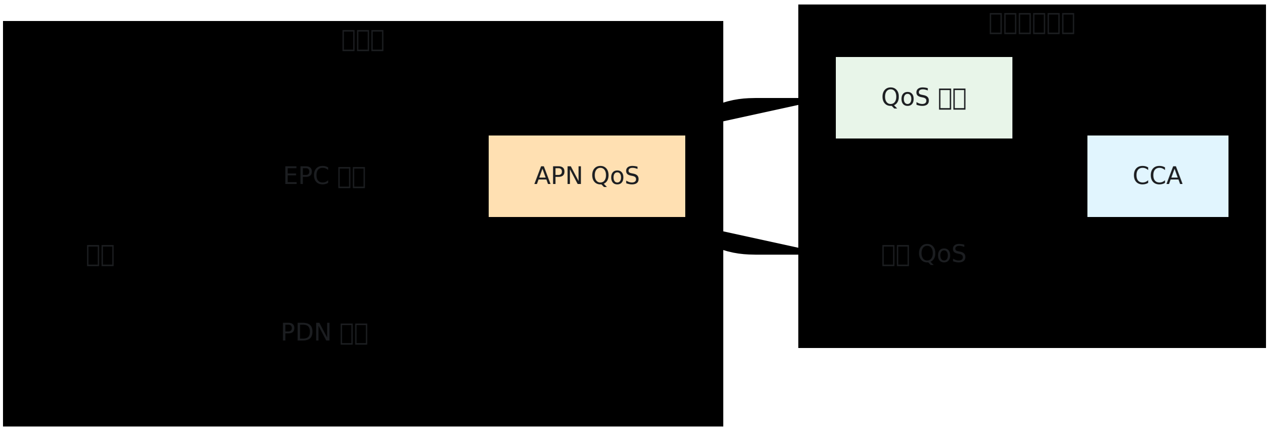
IFC □□□□□

- `{{msisdn}}` - □□□□□□ MSISDN
- `{{imsi}}` - □□ IMSI
- `{{impu}}` - IMS □□□□□□□□□ subscriber_state□
- `{{impi}}` - IMS □□□□□□□□□□ IMSI@realm□

□□□□□□ (Gx CCA)

□□□□□□□ PCRF □□□□□□□□□□□□ PGW□

□□□□□


□□□
EPC □□
APN QoS
□□
PDN □□
□□□□□□
QoS □□
CCA
□□ QoS

□□□□□

1. □□□□□□□□□□□□/□□ `pdn_session` □□
2. **QoS** □□□□□□□ APN QoS □□□ QCI □□□□□
3. □□□□□□□□□□□□□□□□□□□□
4. **CC-Request-Type**□□□ INITIAL (1)□UPDATE (2)□TERMINATION (3)

□□□□□□□

- `INITIAL_REQUEST`□□□□□ PDN □□□□
- `UPDATE_REQUEST`□□□□□ PDN □□
- `TERMINATION_REQUEST`□□□ PDN □□□□

□□□□□□ (Sh UDA)

□□□□□□□ HSS □□ Sh □□□□□ AS□□□□□□□□

□□□□□

□□□
□□□□
□□
MSISDN
□□
□□ XML
Sh XML □□
□□□□□□
□□□□ AVP
UDA

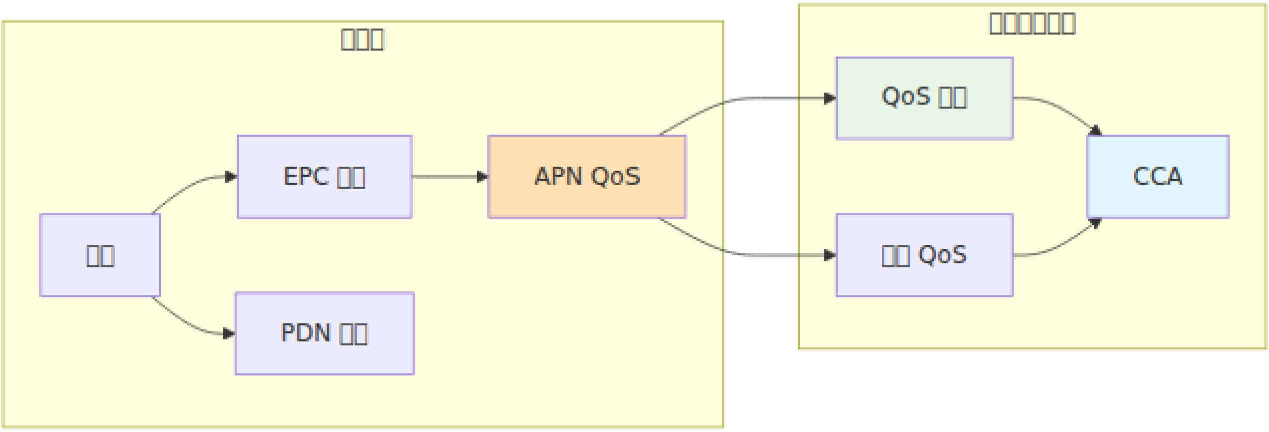
□□□□□

1. □□□□□□□□□ `subscriber_state.sh_repository_data` □□□□□□ XML
2. □□□□□□□□□□□□□□□□□□□□□□□□□
3. □□□□□□□□□□□□ IMS □□□□
4. □□□□□□□□□���□□□□□□□

ME □□□□□□ (S13 ECA)

ME □□□□□□□ EIR □□□□□ MME □□ IMEI □□□

□□□□□


□□□
□□□□□□
EPC □□
APN QoS
QoS □□
CCA
□□
□□ QoS
PDN □□

□□□□□

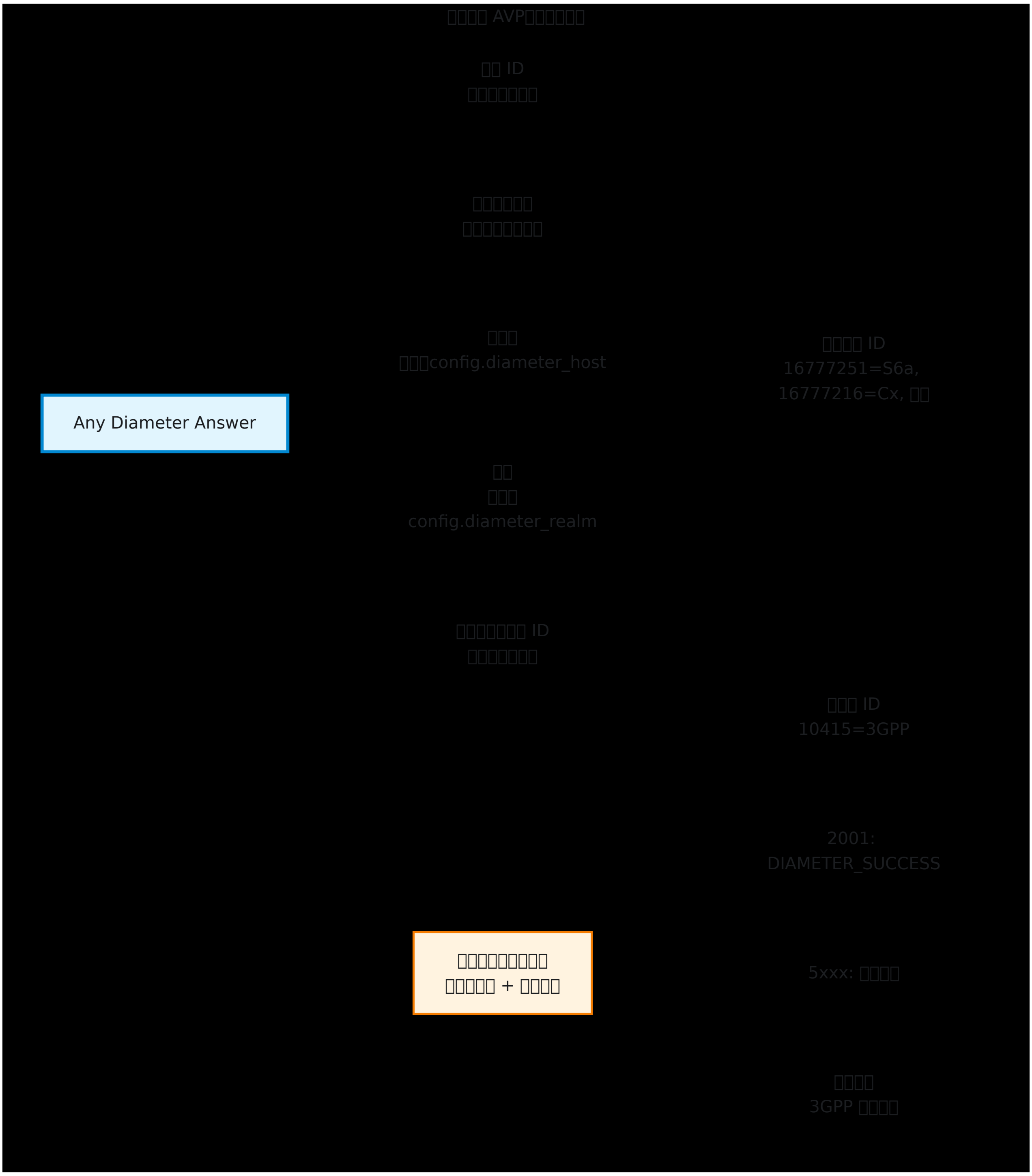
1. **IMEI** □□□□□□□□□□□□□□□□□□□□
2. □□ **TAC** □□□□□□□□□□□□□□□□ 8 □□□□
3. □□□□□□□□□□ IMEI□□□□□□□
4. □□□□□□
   - `0` = □□□□□□□□□
   - `1` = □□□□□□/□□□
   - `2` = □□□□□□□□□□
   - `5` = □□□□□□□□□□

□□□

- [illegible] IMEI [illegible]
- [illegible] TAC [illegible]
- [illegible]
- [illegible]

[illegible]

[illegible] Diameter [illegible] AVP[illegible]

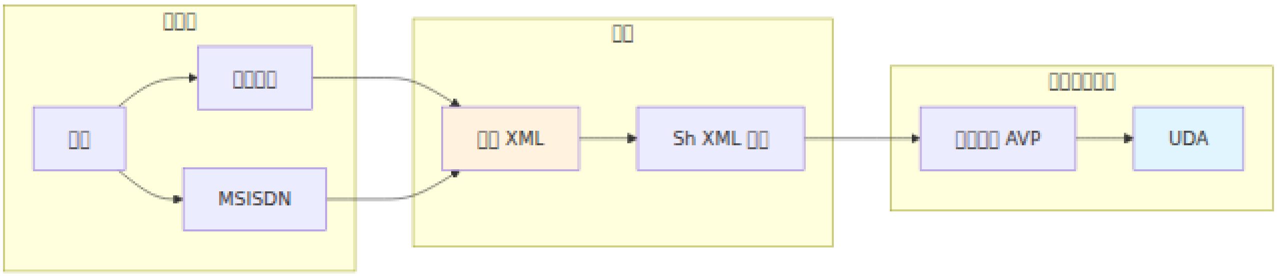

□□□□ AVP□□□□□□
□□ ID
□□□□□□□
□□□□□□
□□□□□□□□
□□□
□□□config.diameter_host
□□□□ ID
16777251=S6a,
16777216=Cx, □□
Any Diameter Answer
□□
□□□
config.diameter_realm
□□□□□□□ ID
□□□□□□□
□□□ ID
10415=3GPP
2001:
DIAMETER_SUCCESS
□□□□□□□□□□
□□□□□ + □□□□
5xxx: □□□□
□□□□
3GPP □□□□

□□□□□

```
config :diameter_ex,
  diameter_host: "hss",
  diameter_realm: "example.com",
  diameter_service_name: "OmniHSS"
```

□□□□□

□□□□□□


□□□
□□
□□□□
MSISDN
□□
□□ XML
Sh XML □□
□□□□□□
□□□□ AVP
UDA

□□□□

□□□□□□

□□□□□□□ Diameter □□□□□□□□

- **S6a** - LTE/MME □□□□□□□□□□□
- **Cx** - IMS/CSCF □□□□ IMS □□□□□□□□
- **Sh** - IMS/AS □□□□□□□□□□
- **Gx** - PCRF □□□□□□□□□□□
- **Rx** - IMS/AF □□□□□□□□
- **S13** - EIR □□□□ IMEI □□
- **SWx** - WiFi/IMS □□□□��� 3GPP □□□□

□□□□

□□□□□□□□□□□□□□

- □□ - □□□□□□□□□ IMSI
- □□□ - □□□□□□□□□
- **EPC** □□ - LTE □□□□
- **APN** □□ - □□□□□
- **IMS** □□ - □□ IFC □□□ IMS □□□□

- [illegible] - [illegible]
- [illegible] - [illegible]
- **PDN [illegible]** - [illegible]
- **[illegible] IP** - [illegible] IP [illegible]
- **EIR [illegible]** - IMEI [illegible]

← [illegible] | API [illegible] → | [illegible] →

OmniHSS □□□□□□□□

← □□□□□□

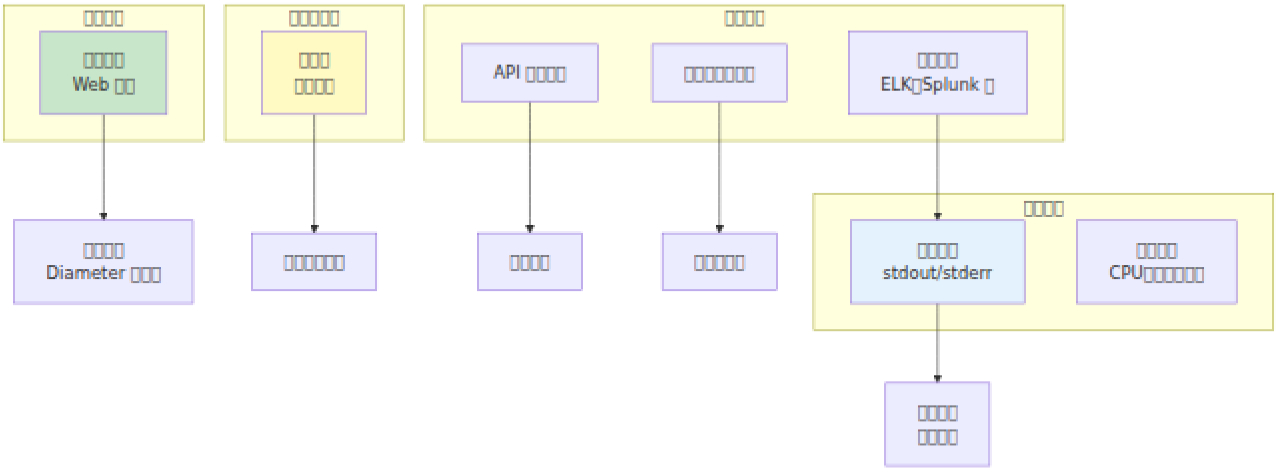
□□

- □□□□
- □□□□□□
- □□□□□
- □□□□
- □□□□□□
- □□□□□□
- □□□□

□□□□

OmniHSS □□□

□□□



□□□□
□□□□
Web □□
□□□□□
□□□
□□□□
□□□□
API □□□□
□□□□□□□
□□□□
ELK□Splunk □
□□□□
Diameter □□□
□□□□□□
□□□□
□□□□□
□□□□
□□□□
stdout/stderr
□□□□
CPU□□□□□□
□□□□
□□□□

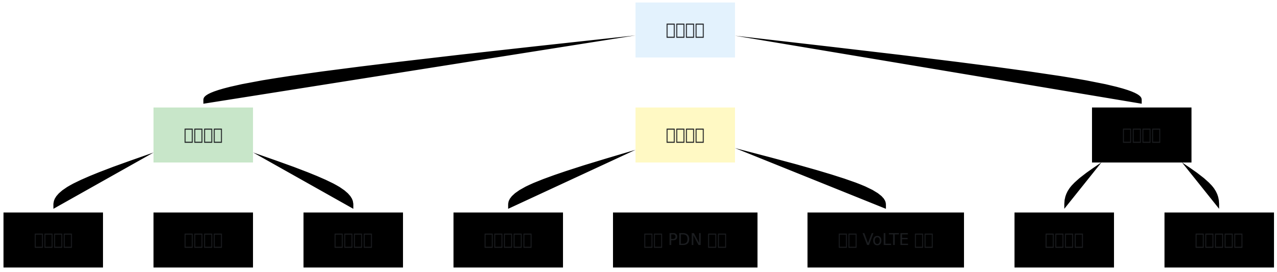
[illegible]

[illegible]

[illegible]

URL: `https://[hostname]:7443/overview`

[illegible]



[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	MME [illegible]	[illegible]
PDN [illegible]	PDN [illegible] > 0	[illegible]
IMS [illegible]	S-CSCF [illegible]	[illegible]
[illegible]	[illegible] > 0	VoLTE [illegible]

[illegible]

[illegible]

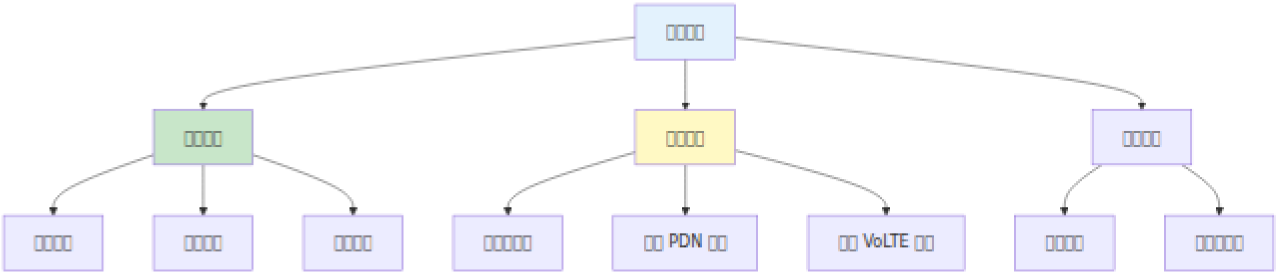
1. [illegible]
2. [illegible]
3. [illegible]

4. □□□□□□□□□□□□□□□□

Diameter □□□□

URL: `https://[hostname]:7443/diameter`

□□□□



□□□□□□□

□□□□□□□□□□□□□□

□□□□□	□□□	□□□□□□
MME	□	□□□□□□ LTE □□
P-GW	□	□□□□□□□□
S-CSCF	□	□□□□ IMS □□
P-CSCF	□	□□□□ VoLTE □���
I-CSCF	□	IMS □□□□
AS	□-□	□□□□□□□

□□□□□□

URL: `https://[hostname]:7443/application`

□□□□

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] Erlang [illegible]	[illegible]	> 90% [illegible]
[illegible]	[illegible]	< 80%	> 90%
[illegible]	[illegible]	N/A	[illegible]

[illegible]

[illegible]

[illegible] SQL [illegible]

[illegible]

[illegible]

- [illegible]
- [illegible]
- IMS [illegible]

[illegible]

[illegible]

- [illegible] PDN [illegible]
- [illegible] VoLTE [illegible]
- [illegible] APN [illegible] PDN [illegible]

[illegible]

[illegible]

- [illegible]MCC-MNC [illegible]
- [illegible] PLMN 001-001 [illegible]

- [illegible]

[illegible]

[illegible]

- [illegible]
- [illegible] MME [illegible]
- [illegible]

[illegible]

[illegible]��[illegible]

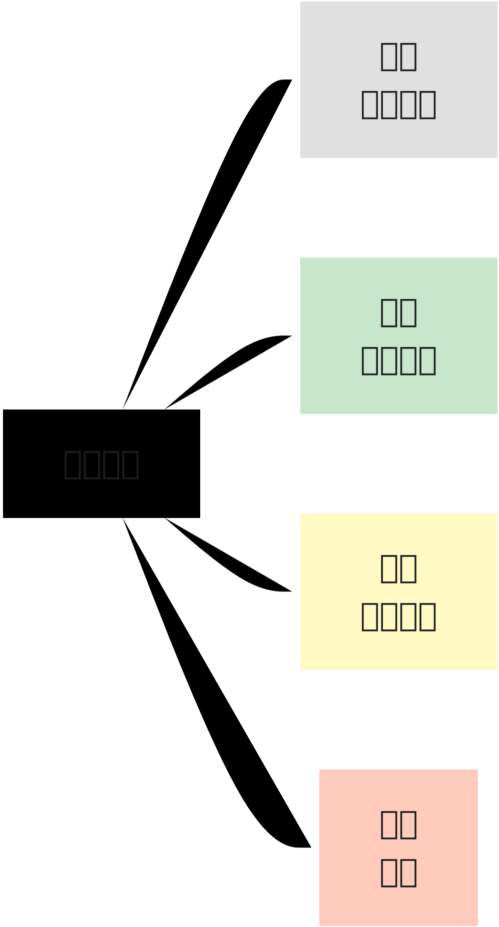
- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

[illegible]

OmniHSS [illegible] **stdout/stderr**[illegible]

[illegible]



□□□□□□□□

Diameter □□□□□:

```
[info] Diameter peer connected: mme01.epc.example.com
[warn] Diameter peer disconnected: pgw01.epc.example.com
[error] Diameter peer connection failed: timeout
```

□□□□□:

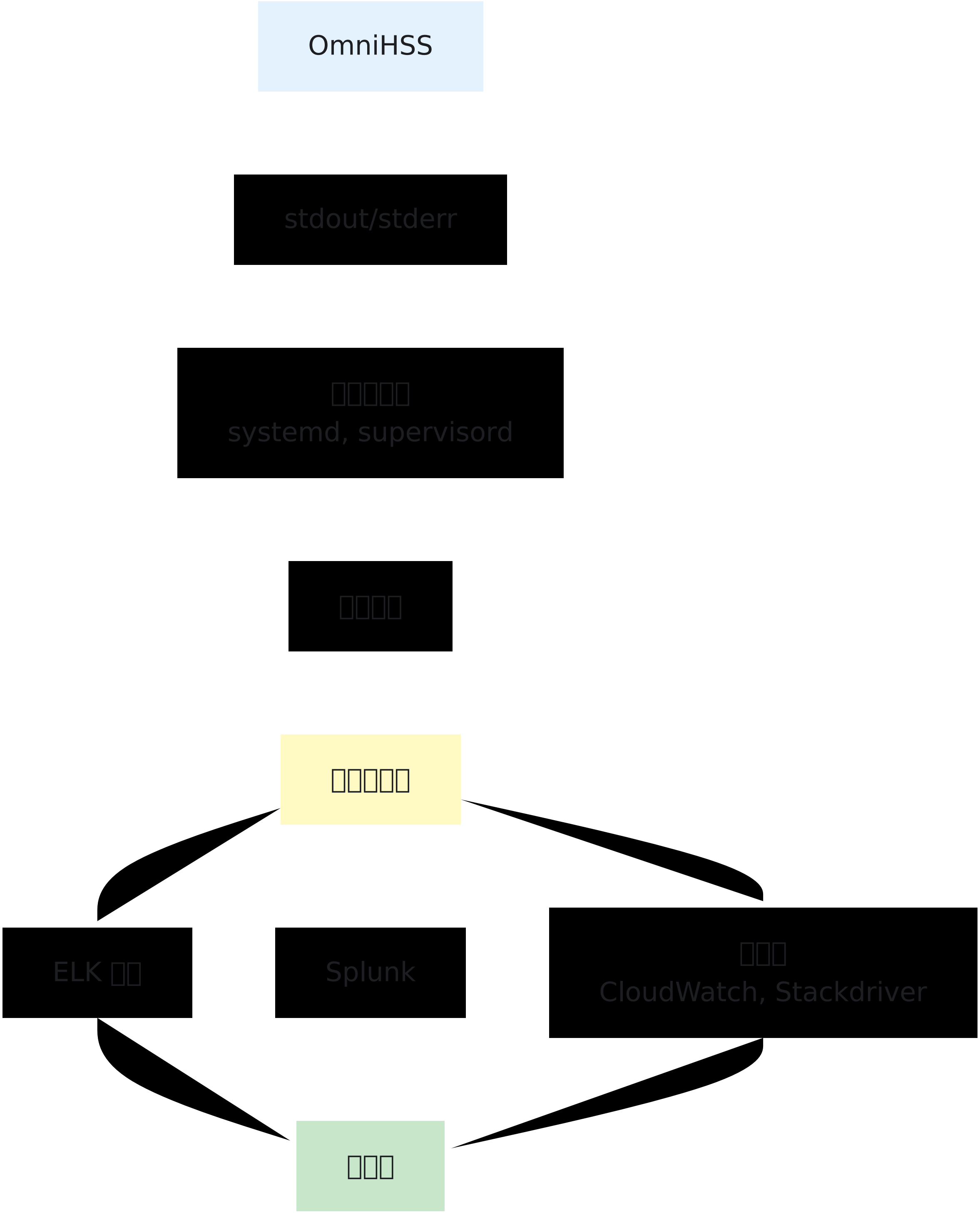
```
[info] Database connection established
[error] Database connection lost: timeout
[error] Database query failed: deadlock detected
```

□□□□:

```
[info] Authentication successful: IMSI 001001123456789
[warn] Authentication failed: IMSI 001001123456789, invalid vector
[error] Roaming denied: IMSI 001001123456789, MCC 310 MNC 410
```

□□□□

□□□□□□□□□□□□□□


OmniHSS
stdout/stderr
□□□□□
systemd, supervisord
□□□□
□□□□□
ELK □□
Splunk
□□□
CloudWatch, Stackdriver
□□□

□□□□□□

□□□□□□

API □□□□: `GET /api/status`

```
curl -k https://hss.example.com:8443/api/status
```

□□□□:

```
{"status": "ok"}
```

HTTP □□: 200 OK

□□□□□□

Nagios/Icinga □□

```
#!/bin/bash
# check_omnihss.sh

API_URL="https://hss.example.com:8443/api/status"

response=$(curl -k -s -o /dev/null -w "%{http_code}" "$API_URL" --max-time 5)

if [ "$response" = "200" ]; then
    echo "OK - OmniHSS API responding"
    exit 0
else
    echo "CRITICAL - OmniHSS API not responding (HTTP $response)"
    exit 2
fi
```

Prometheus □□

OmniHSS □□□□□□ Prometheus □□□□□□□ `http://<host>:9568/metrics`□□□□ `prometheus_metrics_port` □□□□□□□ `9568`□

□□□□□ BEAM □□□□□□□□□□□□□Diameter □□□□□□□□□□□ Diameter □□□□□□□□□□□ Cx □□□□

S-CSCF □□□□□□□

□□: `hss_cx_auth_abandon_total` □□: □□□ □□: □□□□ IMS-AKA □□□□□□□□□ Cx SAR□□□□□□□□□□□□□□□□□ `auth_vector_timeout` □□□□□□□□□□□□S-CSCF □□ `AUTHENTICATION_TIMEOUT` SAR□□□□□□□□□□□ `AUTHENTICATION_FAILURE` SAR□□□□ S-CSCF □□□□□ □□:

- `sar_type` - □□□□□□□: `authentication_timeout` □ `authentication_failure`□
- `outcome` - □ S-CSCF □□□□□□□ `name_cleared`□□□□□□□□□□□□□□ `kept_registered`□□□□□□□□□HSS □□□□□□□□□ SAR □□□□□□□□□ S-CSCF □□□□□□□□□□□□□□ I-CSCF □□□□□ REGISTER□□□□□□□□□□□□□□□□□□□□□□□□□□
- `origin_host` - □□ SAR □ S-CSCF□

□□□□:

```
# □□□□□/□□□□□□
rate(hss_cx_auth_abandon_total[5m])

# □□□□□
sum by (sar_type) (rate(hss_cx_auth_abandon_total[5m]))

# □□□□□□□ S-CSCF □□
topk(5, sum by (origin_host)
(rate(hss_cx_auth_abandon_total[5m])))
```

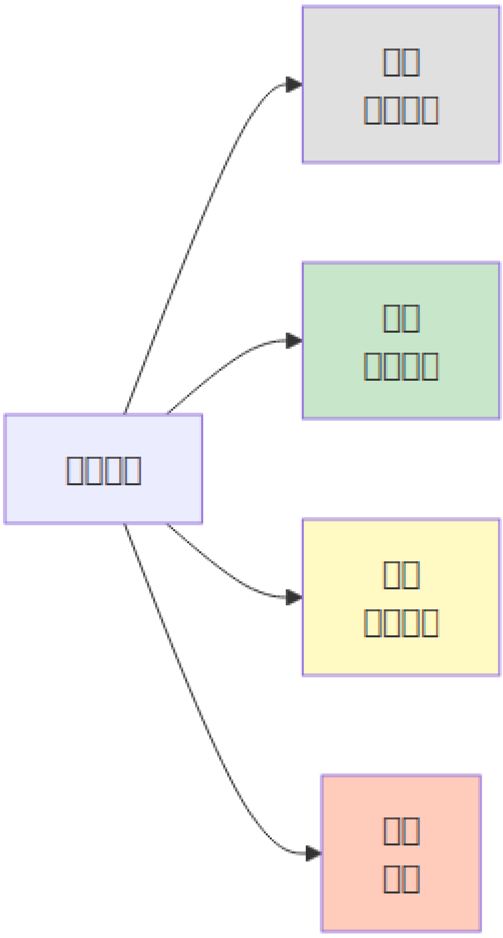
□□ `origin_host` □□□□□□□□□ S-CSCF □□□□□□□□□□□□□□□□□□□□□

SNMP □□

□□□□ SNMP □□□□□□□□□□□□□□□□□ SNMP □□□□□□□ API □□□□□□□□ SNMP OID □□□□

[illegible]

[illegible] KPI



□□□ KPI □□

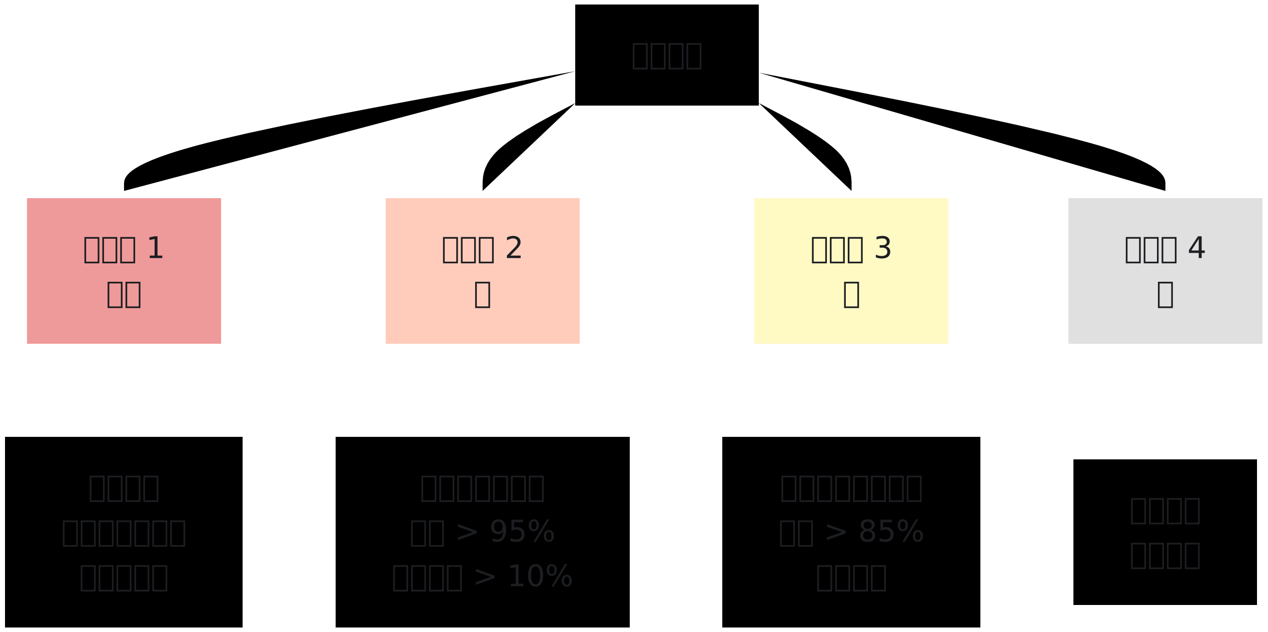
KPI	□□	□□	□□
□□□□□□□□	99.99%	< 99.95%	< 99.9%
Diameter □□□□□□□□□	99.9%	< 99.5%	< 99%
□□□□□	> 99%	< 99%	< 95%
Diameter □□□□	< 100ms	> 200ms	> 500ms
□□□□□□□	< 50ms	> 100ms	> 500ms
□□□	< 0.1%	> 0.5%	> 1%

□□ KPI

□□	□□	□□□□
□□□□	□□□□	□□□□□ 80%
□□ **PDN** □□	□□□□	□□□□□□ 70%
□□□□□	□□□ MB	□□□□□ 80%
□□□□□	□□□□	□□□□ 80%

[illegible]

[illegible]


[illegible]
[illegible] 1
[illegible]
[illegible] 2
[illegible]
[illegible] 3
[illegible]
[illegible] 4
[illegible]
[illegible]
[illegible] > 95%
[illegible] > 10%
[illegible] > 85%

[illegible]

[illegible] (P1)

[illegible]:

- API [illegible]
- [illegible]
- [illegible]
- [illegible]: [illegible]

[illegible] Diameter [illegible]:

- [illegible]
- [illegible]: [illegible]

[illegible]:

- [illegible] SQL [illegible]

- □□: □□□□□□□□□□□□□□□

□□□□□□ (P2)

□□ Diameter □□□□□:

- □ MME □□
- □ P-GW □□
- □ S-CSCF □□
- □□: □ 15 □□□□□□□□□□

□□□□□:

- □□ > 95%
- □□: □□□□□□□□□□□

□□□□□□:

- > 10% □□□□□□□
- □□: □□□□□□□□□□□

□□□□□□ (P3)

□□□□□□□□:

- □□□□□□□
- □□□□□□□
- □□: □ 1 □□□□□

□□□□□□:

- □□ > 85%
- □□: □□□□□□□□□□□

□□□□□:

- □□□ > 1%
- □□: □□□□□□□□□□□

[illegible] (P4)

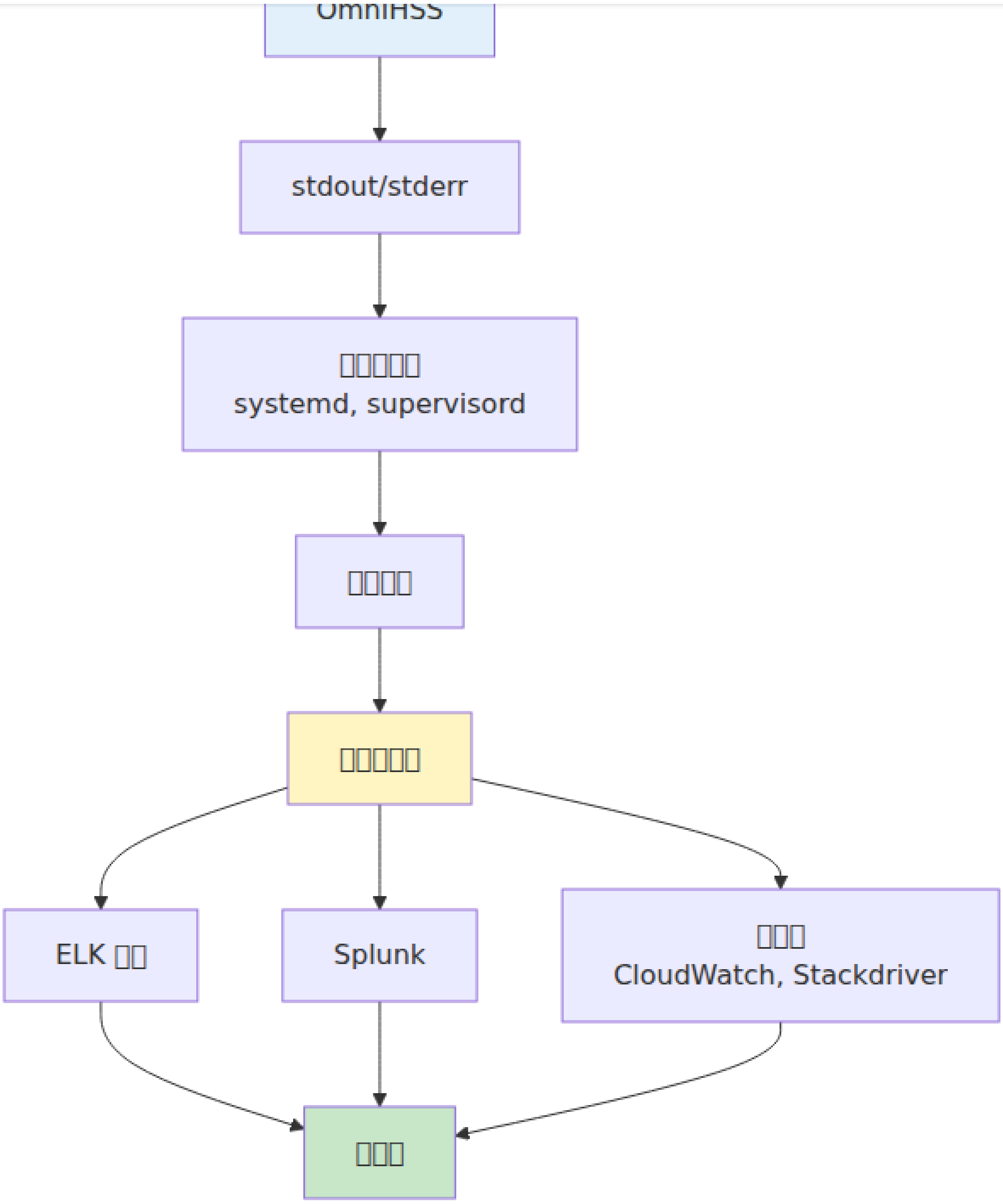
[illegible]:

- [illegible] > 80% [illegible]
- [illegible] > 80% [illegible]
- [illegible]: [illegible]

[illegible]:

- [illegible]
- [illegible]: [illegible]

[illegible]


OmniHSS
stdout/stderr
systemd, supervisord
ELK
Splunk
CloudWatch, Stackdriver

[illegible]

[illegible]

- ☐ [illegible] - [illegible]
- ☐ [illegible] Diameter [illegible] - [illegible]
- ☐ [illegible] - [illegible]
- ☐ [illegible] - [illegible] 24 [illegible]
- ☐ [illegible]

[illegible]

- ☐ [illegible] - [illegible]
- ☐ [illegible] - [illegible]
- ☐ [illegible] - [illegible]
- ☐ [illegible] - [illegible]
- ☐ [illegible] - [illegible]

[illegible]

- ☐ [illegible] - [illegible] 6 [illegible]
- ☐ [illegible] - [illegible]
- ☐ [illegible] - [illegible]
- ☐ [illegible] - [illegible]
- ☐ [illegible] - [illegible]

← [illegible] | [illegible]: [illegible] →

OmniHSS [illegible] MSISDN [illegible] IMSI [illegible]

← [illegible]

[illegible]

- [illegible]
- [illegible] MSISDN[illegible]
- [illegible] IMSI SIM[illegible]
- [illegible]
- [illegible] MSISDN [illegible]
- [illegible]
- [illegible]
- [illegible]

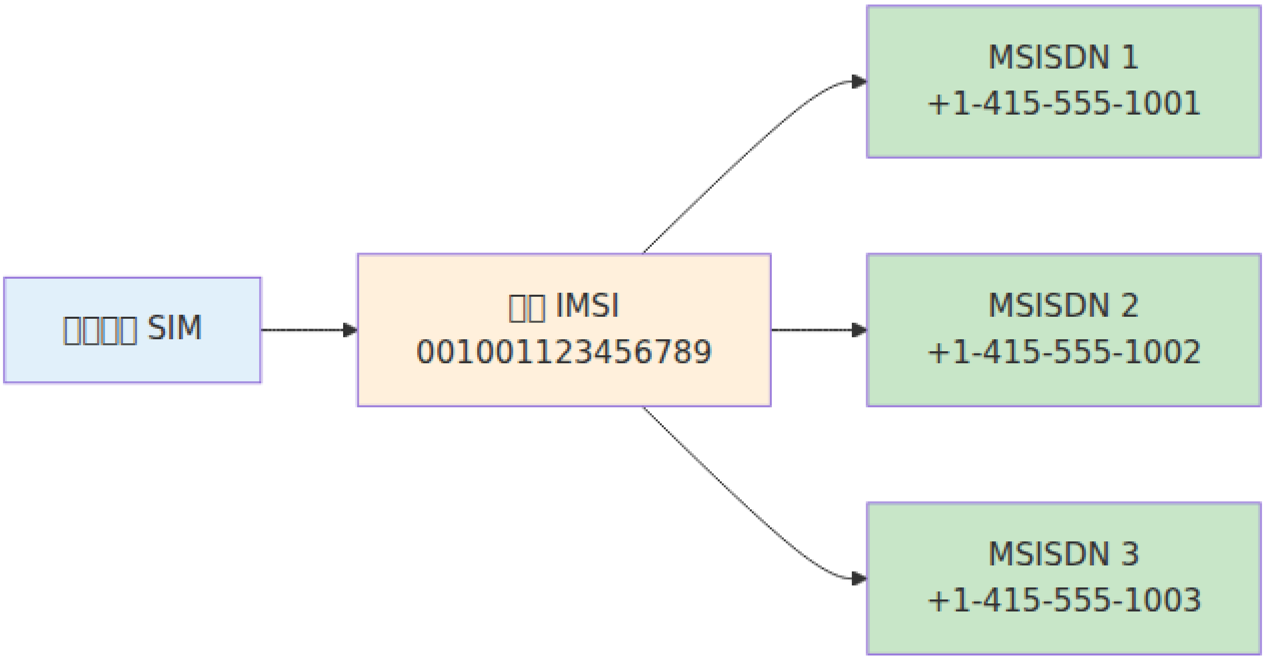
[illegible]

OmniHSS [illegible]

[illegible] MSISDN [illegible]

[illegible] **IMSI →** [illegible]

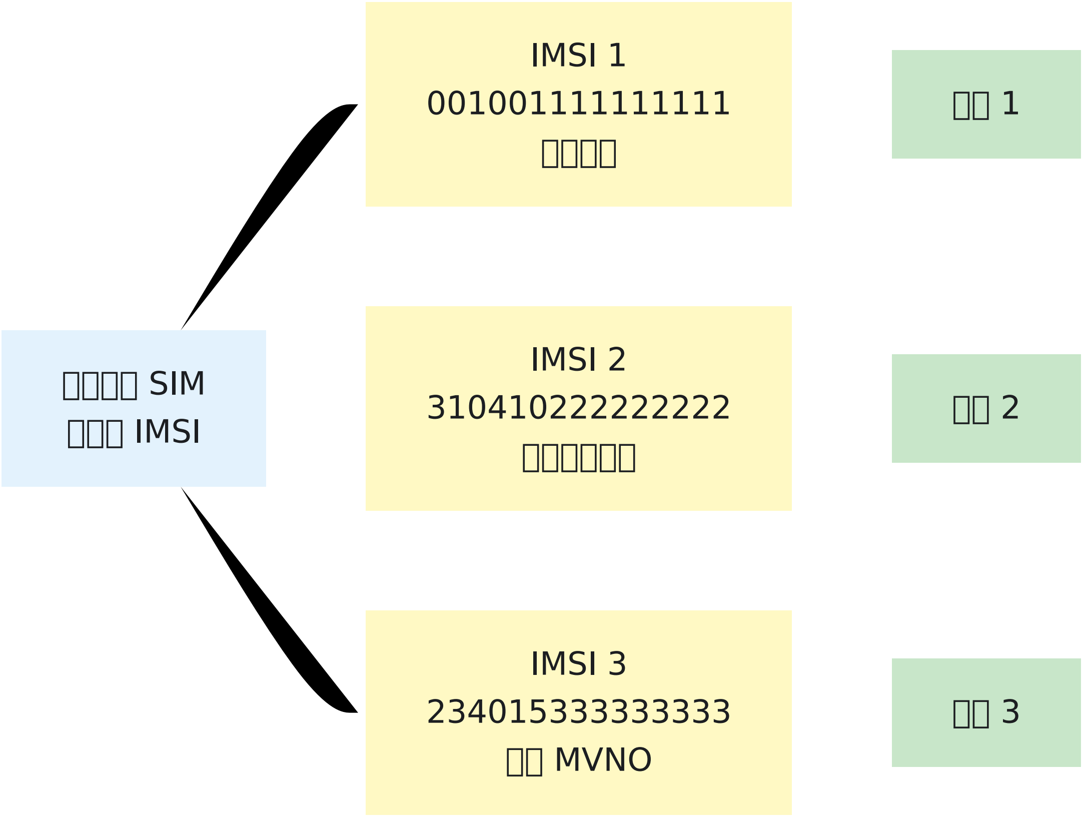
[illegible] IMSI [illegible] MSISDN[illegible]


□□□□ SIM
□□ IMSI
001001123456789
MSISDN 1
+1-415-555-1001
MSISDN 2
+1-415-555-1002
MSISDN 3
+1-415-555-1003

□ IMSI SIM □□

□□ SIM → □□ IMSI

□□□□ SIM □□□□□□□ IMSI□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ MVNO □□□□□□□□


□□□□ SIM
□□□ IMSI
IMSI 1
001001111111111
□□□□
IMSI 2
310410222222222
□□□□□□
IMSI 3
234015333333333
□□ MVNO
□□ 1
□□ 2
□□ 3

[illegible] MSISDN[illegible]

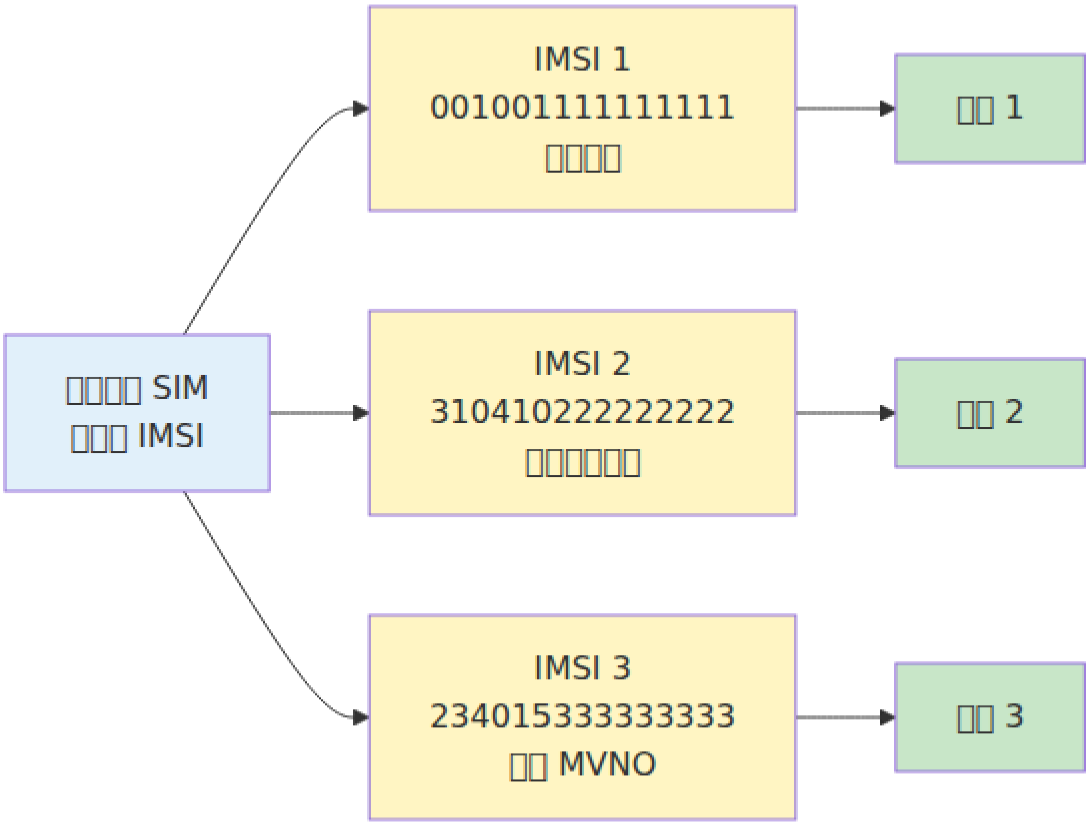
[illegible]

HSS [illegible] MSISDN[illegible] IMS [illegible] MSISDN [illegible] IMS [illegible]

[illegible]

- [illegible] **IMSI** - [illegible] SIM [illegible] IMSI
- [illegible] **MSISDN** - [illegible]��[illegible]
- **IMS** [illegible] - [illegible] MSISDN [illegible] IMS [illegible]
- [illegible] - [illegible]EPC[illegible]IMS[illegible]

[illegible]

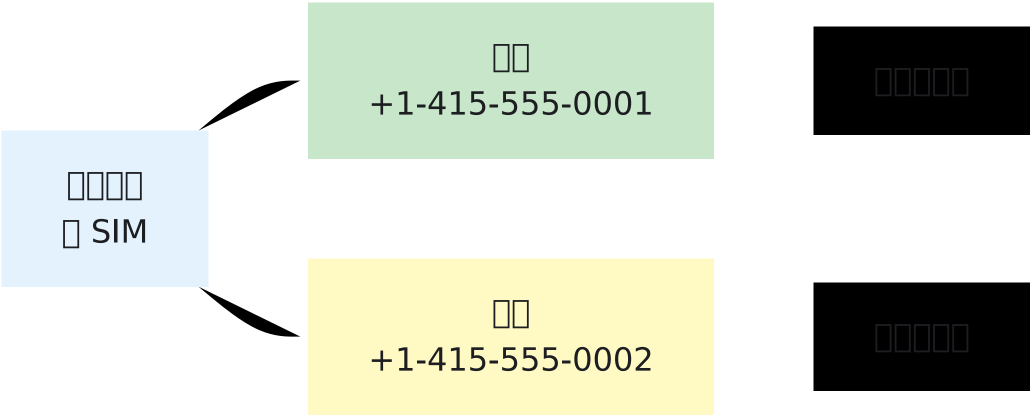

[illegible] SIM
[illegible] IMSI
IMSI 1
001001111111111
[illegible]
IMSI 2
310410222222222
[illegible]
IMSI 3
234015333333333
[illegible] MVNO
[illegible] 1
[illegible] 2
[illegible] 3

[illegible] MSISDN [illegible] MSISDN[illegible]

[illegible]

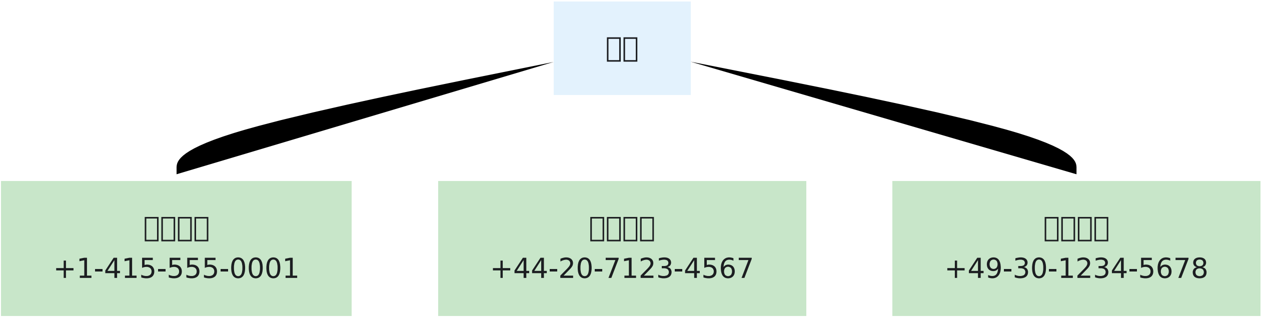
1. [illegible]

[illegible]


+1-415-555-0001
SIM
+1-415-555-0002

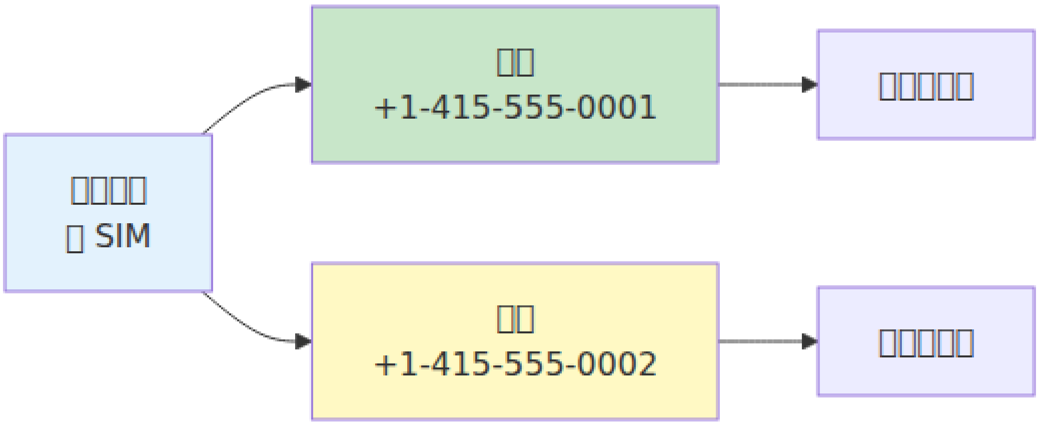
2. [illegible]

[illegible]���[illegible]


+1-415-555-0001
+44-20-7123-4567
+49-30-1234-5678

3. [illegible]

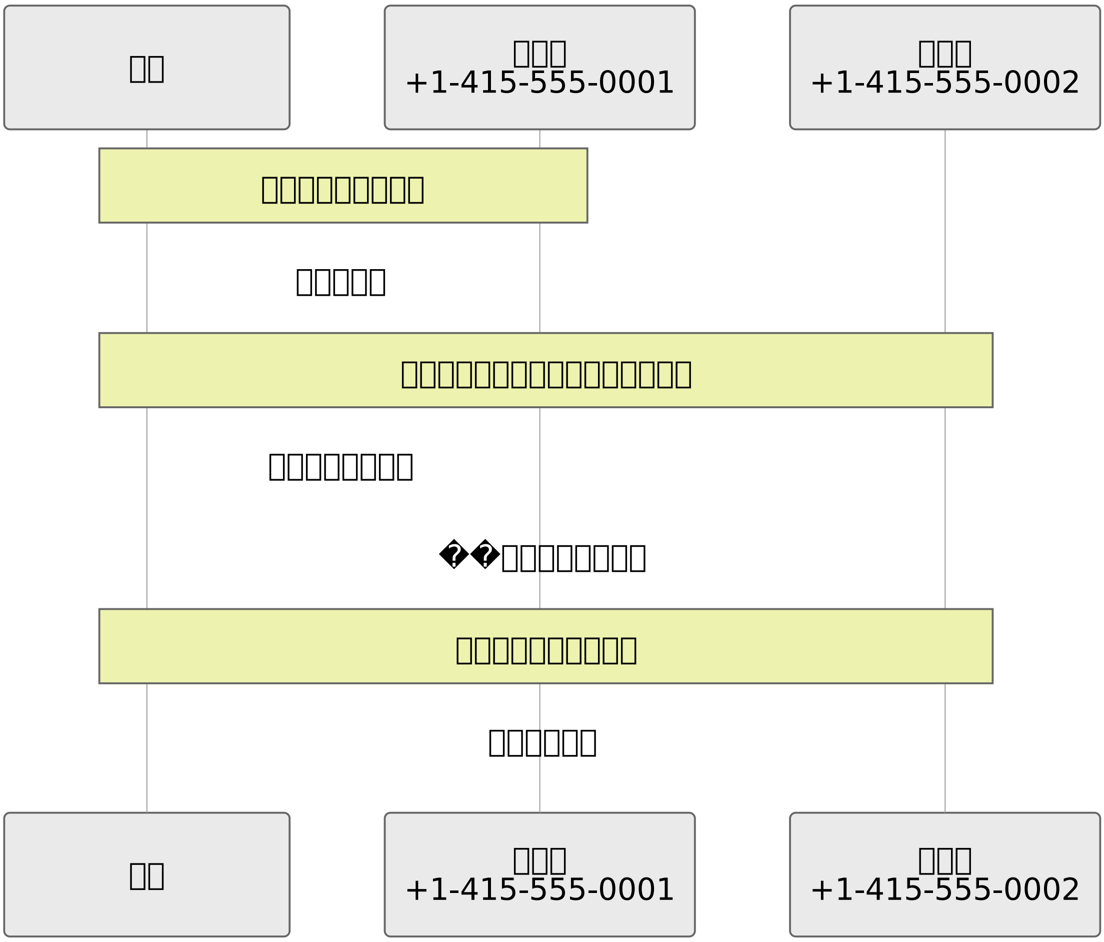
[illegible]


+1-415-555-0001
SIM
+1-415-555-0002

[illegible] [illegible] OmniHSS [illegible] SIM/IMSI [illegible] MSISDN[illegible]

4. [illegible]

[illegible]


[illegible]
[illegible]
+1-415-555-0001
[illegible]
+1-415-555-0002
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
+1-415-555-0001
[illegible]
+1-415-555-0002

[illegible]

[illegible] MSISDN

[illegible] MSISDN[illegible]

```
# □□□□□ MSISDN
curl -k -X POST https://hss.example.com:8443/api/msisdn \
  -H "Content-Type: application/json" \
  -d '{"msisdn": {"msisdn": "14155551001"}}'

# □□□□□ MSISDN
curl -k -X POST https://hss.example.com:8443/api/msisdn \
  -H "Content-Type: application/json" \
  -d '{"msisdn": {"msisdn": "14155551002"}}'
```

□ MSISDN □□□□□

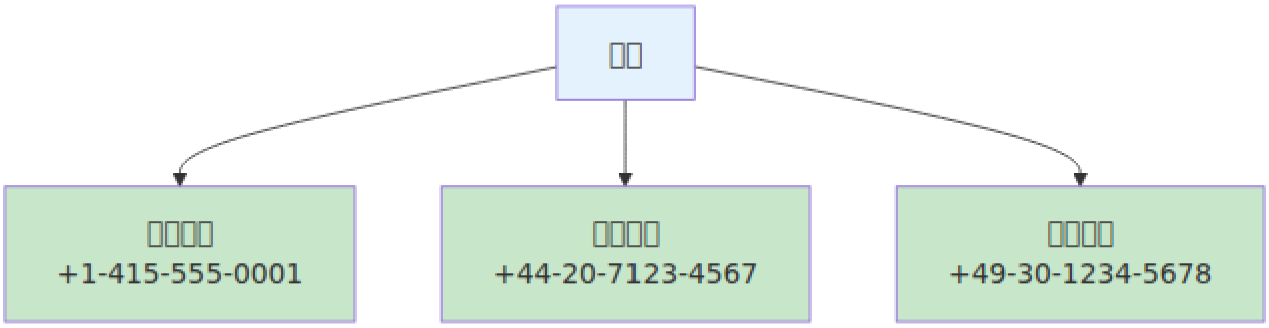
□□□□□□□□□□□□□□□

□□□□□□

1. □□□□□□□□□□ IMSI □□□ ID
2. □□□□□□□□□□□□□ MSISDN ID
3. □□□□□□□□□□ subscriber_id □□□□□ msisdn_id

□□□□□□□□□□□□□□□□□□□□□

□□□□□


□□
□□□□
+1-415-555-0001
□□□□
+44-20-7123-4567
□□□□
+49-30-1234-5678

□□□□

□□□□□□□□□□□□□□□□□ MSISDN□

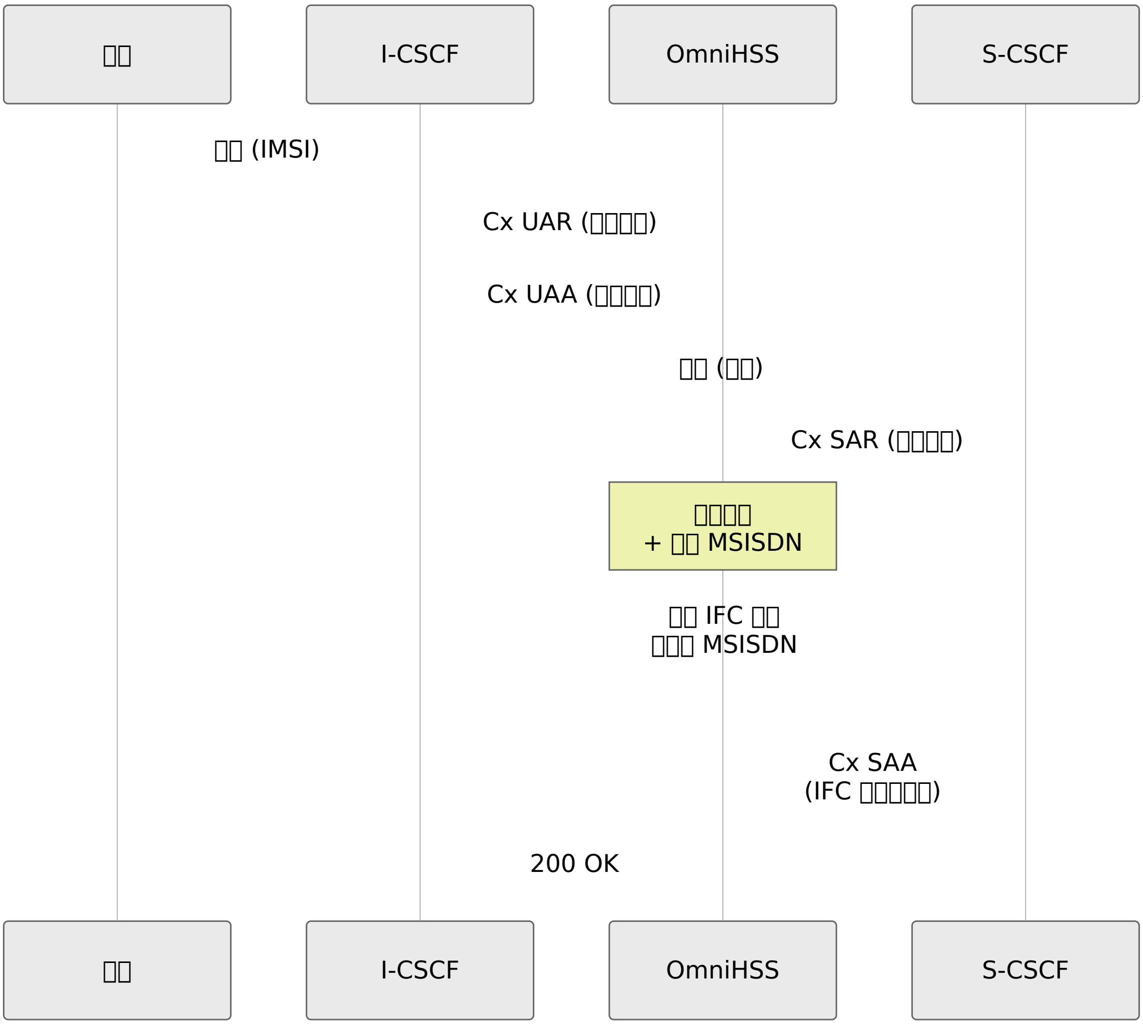
- □□□□□□□□□□
- □□□□□ msisdn □□□
- □□□□□□□□□□□□□□□□

□□□□□□ ID□IMSI □□□□□□ MSISDN □□□

IMS □□

IMS □□

□□□□□□ IMS □□□□□□□ **MSISDN** □□□□□□□ S-CSCF □ IMS □□□□□□


□□
I-CSCF
OmniHSS
S-CSCF
□□ (IMSI)
Cx UAR (□□□□)
Cx UAA (□□□□)
□□ (□□)
Cx SAR (□□□□)
□□□□
+ □□ MSISDN
□□ IFC □□
□□□ MSISDN
Cx SAA
(IFC □□□□□)
200 OK
□□
I-CSCF
OmniHSS
S-CSCF

IFC □□□□

IMS IFC □□□□□□ `{{msisdns}}` □□□□□□ MSISDN□

□□ **IFC** □□□

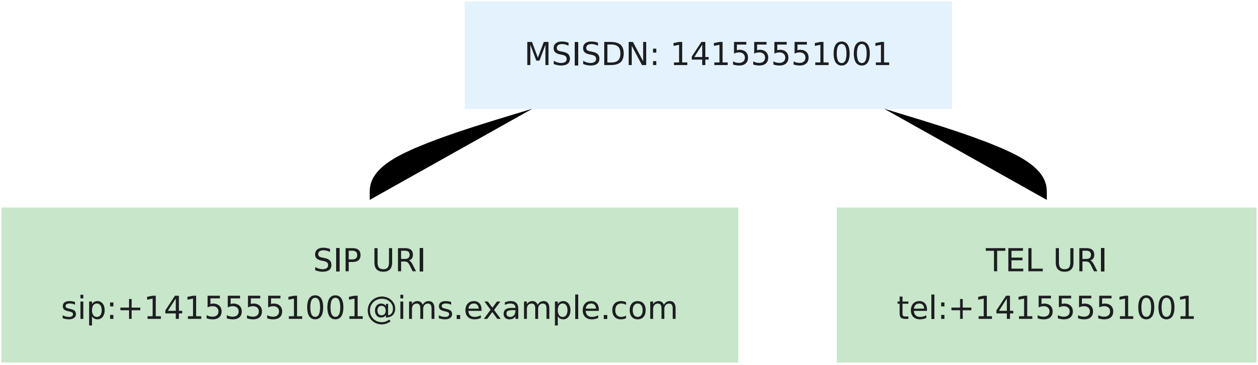
```
<ServiceProfile>
  <PublicIdentity>
    <Identity>sip:
{{imsi}}@ims.mnc{{mnc}}.mcc{{mcc}}.3gppnetwork.org</Identity>
  </PublicIdentity>
  <!-- □□□ MSISDN □□ -->
  <PublicIdentity>
    <Identity>sip:+14155551001@ims.example.com</Identity>
  </PublicIdentity>
  <PublicIdentity>
    <Identity>tel:+14155551001</Identity>
  </PublicIdentity>
  <PublicIdentity>
    <Identity>sip:+14155551002@ims.example.com</Identity>
  </PublicIdentity>
  <PublicIdentity>
    <Identity>tel:+14155551002</Identity>
  </PublicIdentity>
  <!-- ... -->
</ServiceProfile>
```

□□□□□

- `{{msisdns}}` - □□□□□□□□ MSISDN □□

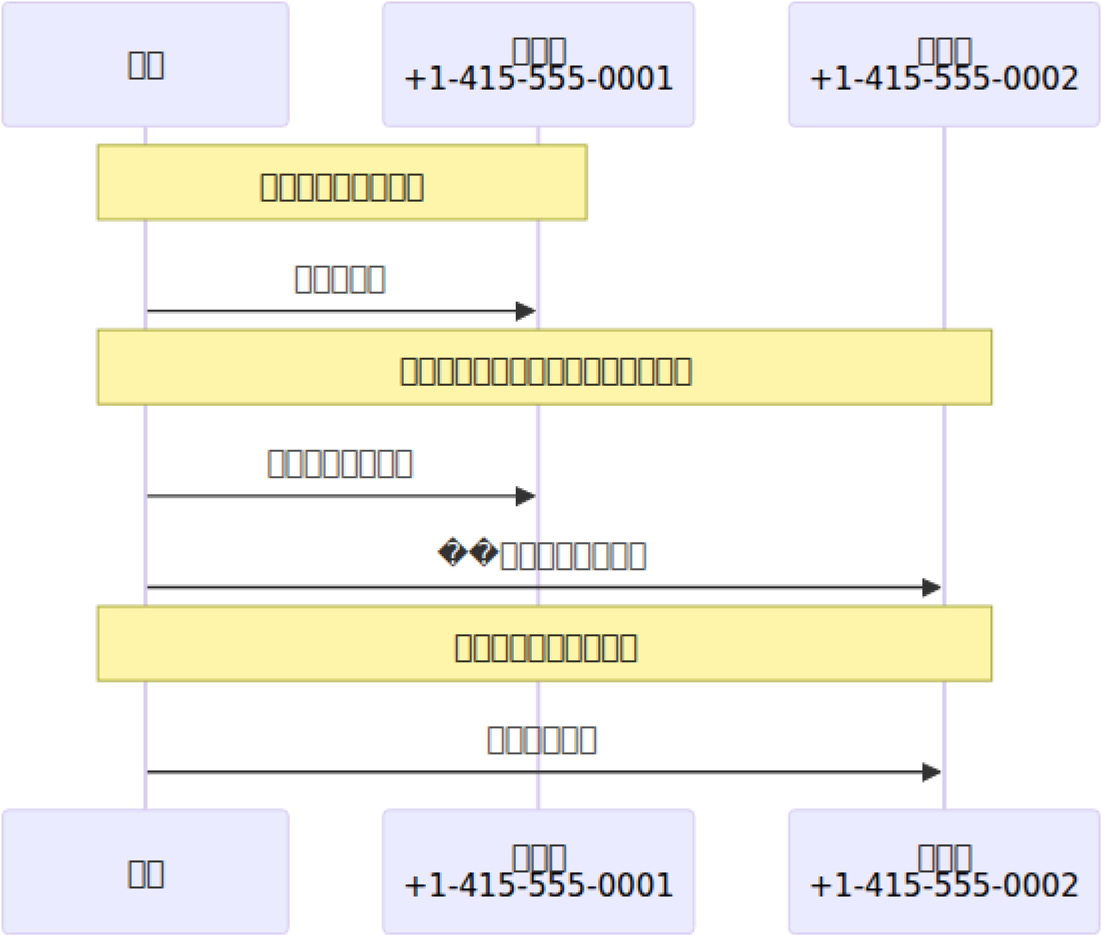
□□□□

□□ MSISDN □□□□□□□ IMS □□□□□


MSISDN: 14155551001
SIP URI
sip:+14155551001@ims.example.com
TEL URI
tel:+14155551001

□□□□□□

□□□□□□□□□□□□IMS □□□□□□□□□ SIP URI□


[illegible]
[illegible] +1-415-555-0001
[illegible] +1-415-555-0002
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible] +1-415-555-0001
[illegible] +1-415-555-0002

[illegible]

[illegible]

SIP INVITE [illegible]

```
INVITE sip:+15105551234@ims.example.com SIP/2.0
From: "+14155551002" <sip:+14155551002@ims.example.com>;tag=123
To: <sip:+15105551234@ims.example.com>
P-Asserted-Identity: <sip:+14155551002@ims.example.com>
```

`From` [illegible] `P-Asserted-Identity` [illegible]

[illegible] MSISDN

[illegible]MSISDN [illegible] IMS [illegible]

[illegible]

- S-CSCF [illegible]
- [illegible]

[illegible]

1. [illegible] **MSISDN** [illegible]
   - [illegible] IMSI [illegible] MSISDN
   - [illegible]
2. [illegible] **IMS** [illegible]
   - [illegible] `{{msisdns}}` [illegible]
   - [illegible] XML
3. [illegible] **HSS** [illegible]
   - [illegible] IMS [illegible]Cx SAR[illegible]
   - [illegible] MSISDN [illegible]
4. [illegible] **IMS** [illegible]
   - [illegible]
   - [illegible] S-CSCF [illegible]

[illegible] **MSISDN** [illegible]��

[illegible]

- [illegible]
- [illegible]“[illegible]”[illegible]“[illegible]”

[illegible]

1. **MSISDN** [illegible]
   - [illegible] MSISDN [illegible]
   - [illegible] [illegible]
2. **MSISDN** [illegible]

    - □□□□□□□□ MSISDN □□□□□□
    - □□□□□ □□□□ API □□□□□□□□ MSISDN □□

□□□□□□□□□□□□□□□□□□□□□

□□□

- □□□□□□□
- □□□□□□□□□□□□□□

□□□□□□□

1. □□ **IMS □□□□□□□□□**
    - □□ S-CSCF □□□□□□□
    - □□□□ SIP URI □□
2. □□ **IMS □□□□□**
    - □□ IFC □□□□□□□□□□□□□
    - □□□□□□□□□□□□□□
3. □□□□□□□

```
# □ SIP □□□□□
sip:+14155551001@ims.example.com  # □□□□
sip:+14155551002@ims.example.com  # □□□□□
```

□□□API □ MSISDN □□□□□□□□□

□□□

- API □□ `/api/subscriber/msisdn/:msisdn` □□□□□□□

□□□

□□□□□□□□ MSISDN □□□□□□□□□□□□□□□□□□□□□□□□���□□□□□□□□□□□□□□□□□□□□□□□□□□

□□□□

□□□□

1. □□□□□□ MSISDN
2. □□□□
3. □ MSISDN □□□□□
4. □□□□□□□□□

MSISDN □□

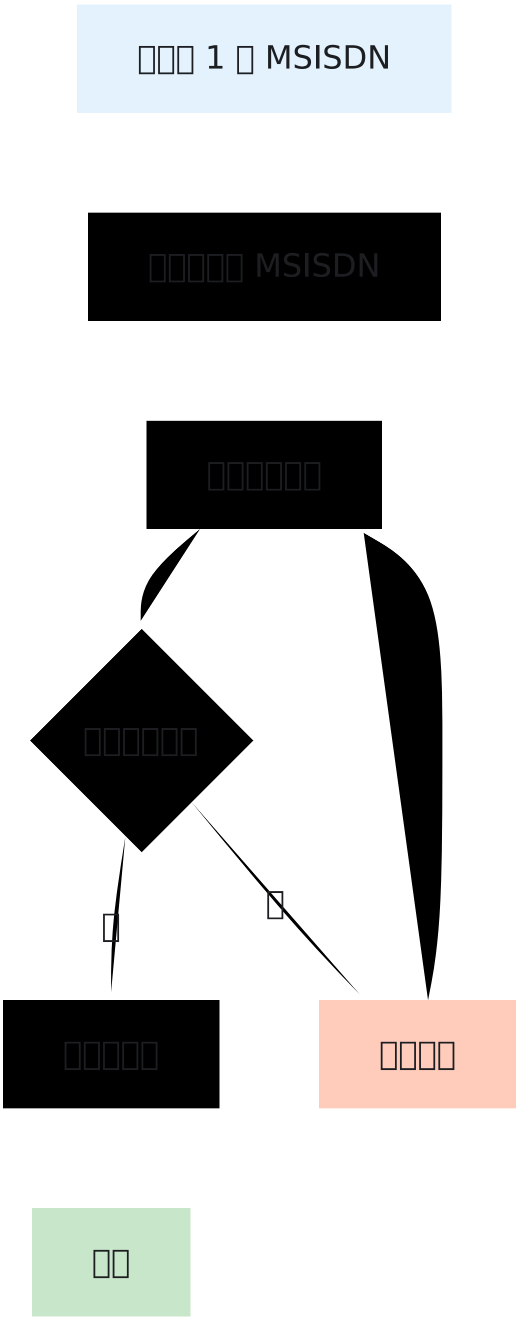
- **□□□□ custom_attributes □□□□□□□□□□**
- □□□□□□□□□□□□□□□□□□
- □□□□□□□□□□□□□□

IMS □□

- □□ IFC □□□□□□□□□□□□
- □□□□□□□□□□□
- □□□□□□□□□□□

□□

□□□□□ MSISDN □□□□


[illegible] 1 [illegible] MSISDN
[illegible] MSISDN

[illegible] IMSI SIM[illegible]

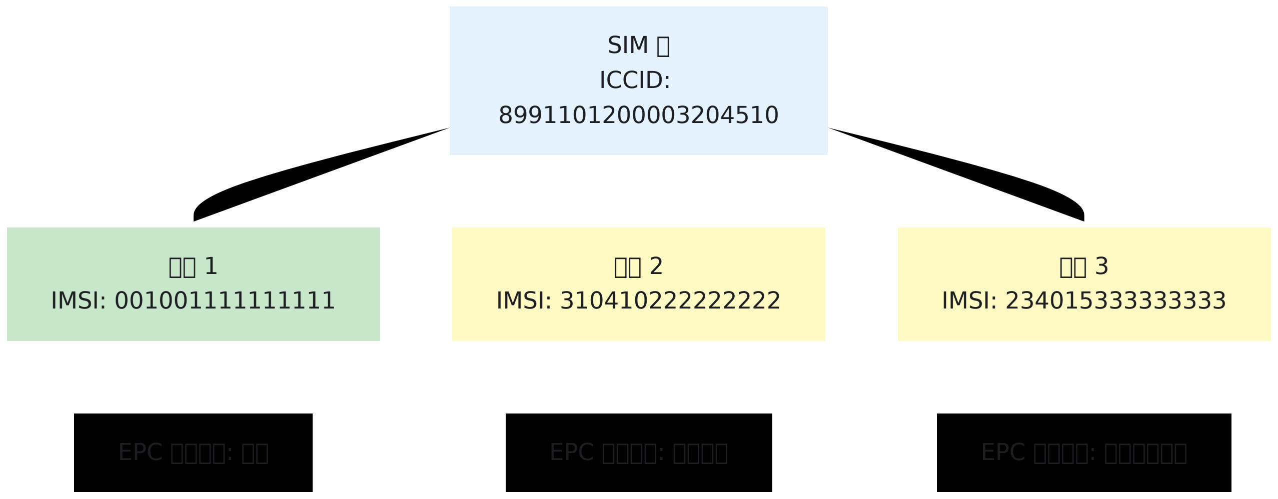
[illegible]

[illegible] IMSI SIM [illegible] IMSI[illegible] IMSI [illegible]

□□□ □□□□□□ □���□□ **IMSI**□□□□□□□ SIM □□□□□□□□ IMSI □□HSS □□□□□□□□□□ IMSI□

OmniHSS □□

□ OmniHSS □□□ IMSI SIM □□□□ IMSI □□□□ □□□□□□□□□□□□ □□□ **SIM** □□


SIM □
ICCID:
8991101200003204510
□□ 1
IMSI: 001001111111111
□□ 2
IMSI: 310410222222222
□□ 3
IMSI: 234015333333333
EPC □□□□: □□
EPC □□□□: □□□□
EPC □□□□: □□□□□□

□□

1. □□□□□□

- □□ IMSI: 001-001□□□□□□□□
- □□□□ IMSI: 310-410□□□□□□□□
- □□□□ IMSI: 234-015□□□□□□□□
- □□□□□□□□ IMSI

2. MVNO □□

- □ IMSI: MVNO □□□□□□□
- □□ IMSI: □□□□□□□□□
- □□ MVNO □□□□□□□□□□□□

3. IoT/M2M □□□

- IMSI 1: □□□□□
- IMSI 2: □□□□□□□□□□

- IMSI 3: □□/□□□□□
- □□□□□□□□

4. □□□

- □□□ IMSI □□□□□□□□□
- □□□□□□□□□□
- □□□□□□□□□□□□□

□ IMSI □□

□□□□

- □□ IMSI □□□□□ Ki□OPC □□□□
- □□ IMSI □□□□□□□
- □□□□□□□□□□□

□□□□□□□□□

- □□□ EPC □□□□□□□□APN□
- □□□ IMS □□□□□□□□□□
- □□ IMSI □□□□□□□

□□□□□□

- □□ IMSI □□□□ SIM□□□ sim_id□
- □□□□□□□□□□□ ICCID
- □□ SIM □□□□□□□

□□□□

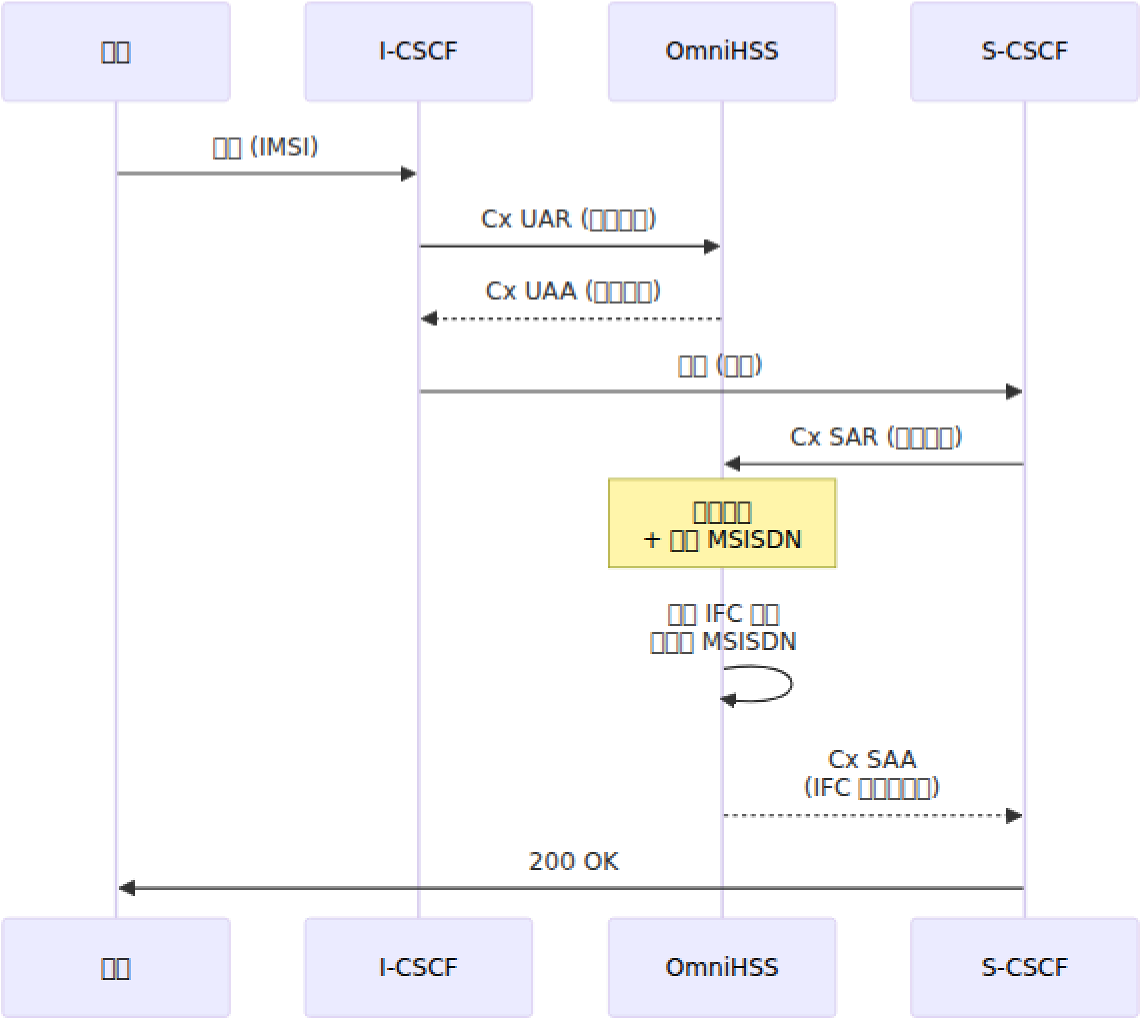
- □□□ SIM □□□□□□□ IMSI
- □□□□□□□□□□□□
- HSS □□□□□□□□□ IMSI

□□

```
# 1. □□ SIM □□□□□ IMSI□
SIM_ID=$(curl -k -X POST https://hss.example.com:8443/api/sim \
  -d '{"sim": {"iccid": "8991101200003204510", "is_esim": false}}'
\
  | jq -r '.data.id')

# 2. □ IMSI 1 □□□□□□□□□□□
KEYSET1=$(curl -k -X POST https://hss.example.com:8443/api/key_set
\
  -d '{"key_set": {"ki": "0123456789ABCDEF...", "opc":
"FEDCBA9876..."}}' \
  | jq -r '.data.id')

# 3. □□□□ 1□□□ IMSI□
curl -k -X POST https://hss.example.com:8443/api/subscriber \
  -d "{\"subscriber\": {
    \"imsi\": \"001001111111111\",
    \"sim_id\": \"$SIM_ID\",
    \"key_set_id\": \"$KEYSET1\",
    \"epc_profile_id\": \"e58ed763-928c-4155-bee9-fdbaaadc15f3\"
  }}"

# 4. □ IMSI 2 □□□□□□□□□□□□□
KEYSET2=$(curl -k -X POST https://hss.example.com:8443/api/key_set
\
  -d '{"key_set": {"ki": "1111111111111111...", "opc":
"2222222222..."}}' \
  | jq -r '.data.id')

# 5. □□□□ 2□□□ IMSI□
curl -k -X POST https://hss.example.com:8443/api/subscriber \
  -d "{\"subscriber\": {
    \"imsi\": \"310410222222222\",
    \"sim_id\": \"$SIM_ID\",
    \"key_set_id\": \"$KEYSET2\",
    \"epc_profile_id\": \"f47ac10b-58cc-4372-a567-0e02b2c3d479\"
  }}"

# 6. □ SIM □□□□ IMSI □□□□□...
```

□□□□

□□ IMSI □□□□□□


□□
I-CSCF
OmniHSS
S-CSCF
□□ (IMSI)
Cx UAR (□□□□)
Cx UAA (□□□□)
□□ (□□)
Cx SAR (□□□□)
□□□□
+ □□ MSISDN
□□ IFC □□
□□□ MSISDN
Cx SAA
(IFC □□□□□)
200 OK
□□
I-CSCF
OmniHSS
S-CSCF

HSS □□□□□□□□□□ IMSI SIM□□□□□□□□□□□□ IMSI□

IMSI □□□□□□□□

□□ IMSI SIM □□□ IMSI □□□□□□ IMSI □□□□□□□□□□□ IMSI□OmniHSS □□□□□ IMSI □□□ SIM □□□□□□□□ □□□□□□ **(CLR)** □□□□□□□□□□□□□□ IMSI□

□□□□ **IMSI** □□

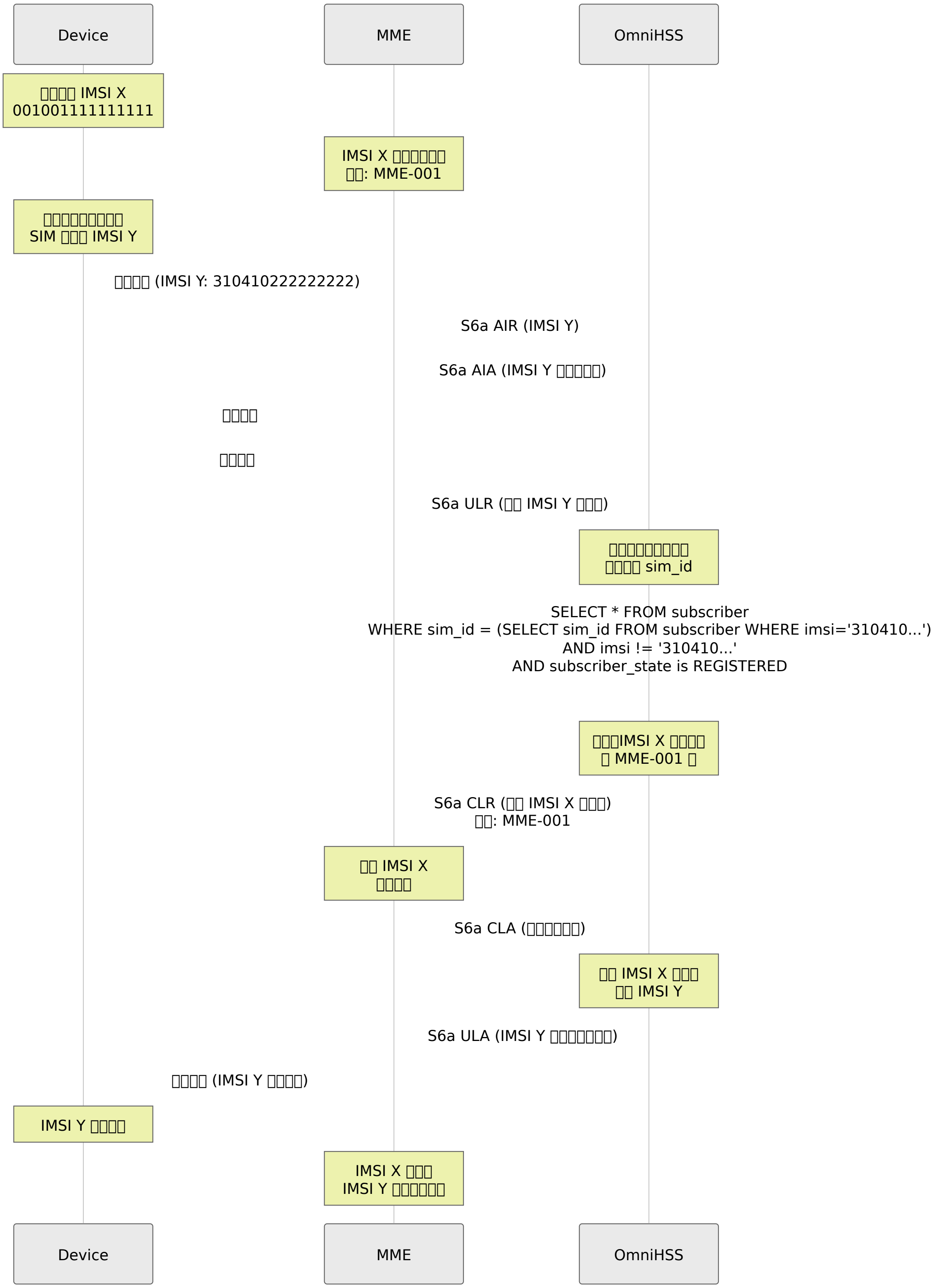
□□□□□ □□ SIM □□□□□□□□□IMSI□□□□□□□□□□□□□

- □□□□□ MME □□□□ **IMSI X**
- □□ HSS □□□□ **IMSI Y**□□□ IMSI X □□□ SIM □□□□□□□□□

- HSS □□□□□□ □□□□□□□ □□□ **IMSI X**

□□□□ IMSI □□□□□□□□□□□□□□□□□□

IMSI □□□□


Device
MME
OmniHSS
□□□□ IMSI X
001001111111111
IMSI X □□□□□□
□□: MME-001
□□□□□□□□□
SIM □□□ IMSI Y
□□□□ (IMSI Y: 310410222222222)
S6a AIR (IMSI Y)
S6a AIA (IMSI Y □□□□□)
□□□□
□□□□
S6a ULR (□□ IMSI Y □□□)
□□□□□□□□□
□□□□ sim_id
SELECT * FROM subscriber
WHERE sim_id = (SELECT sim_id FROM subscriber WHERE imsi='310410...')
AND imsi != '310410...'
AND subscriber_state is REGISTERED
□□□IMSI X □□□□
□ MME-001 □
S6a CLR (□□ IMSI X □□□)
□□: MME-001
□□ IMSI X
□□□□
S6a CLA (□□□□□□)
□□ IMSI X □□□
□□ IMSI Y
S6a ULA (IMSI Y □□□□□□□)
□□□□ (IMSI Y □□□□)
IMSI Y □□□□
IMSI X □□□
IMSI Y □□□□□□
Device
MME
OmniHSS

□□□□□□□

□□□□□□

- □□□□□□□□SIM□□□□□
- □□□□□□□□□□□□
- □□□□□□□□□□□

□□□□□□

- □□□□□□□□□□IMSI□□
- IMSI□□□□□□□□□□□
- □□□CDR□□□□□□□□□□

□□□□□

- □IMSI□MME□□□□□
- PDP□□□□□□□□□
- □□□□□□□□

IMSI□□□□□

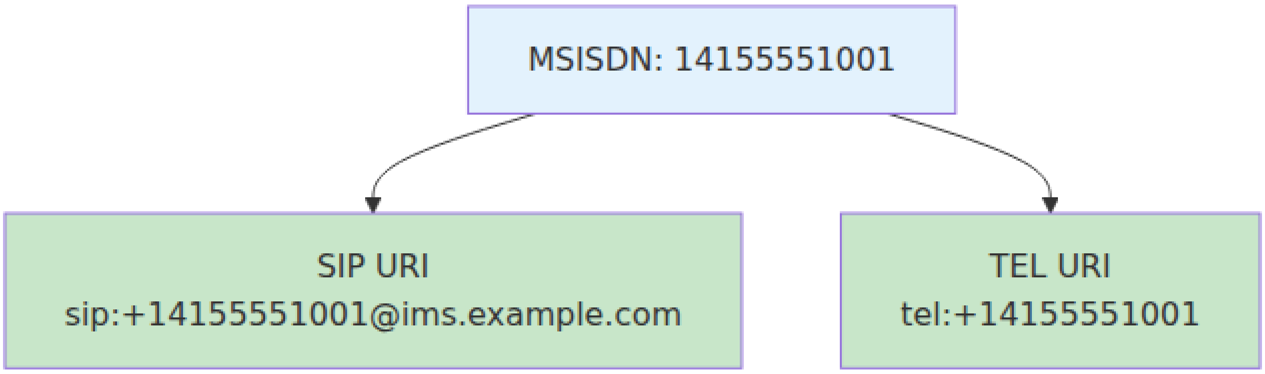
□□/SIM□□□□□□□□□□□□IMSI□

1. □□□□□
   - □□IMSI□□□□□
   - □□□□□□□□□IMSI
2. □□□□
   - □□□□□□□□
   - SIM□□□□□□IMSI
3. □□□□
   - SIM□□□□□□□□□□□□□□□□□□□□□IMSI□
   - □□MCC/MNC□□□□□
4. □□□□

  - □□□□□□□□□□IMSI
  - □□□□IMSI□□□□□□□

IMS□□□□

□□□□□□□□□□□□□□IMS□□□


MSISDN: 14155551001
SIP URI
sip:+14155551001@ims.example.com
TEL URI
tel:+14155551001

□□□□

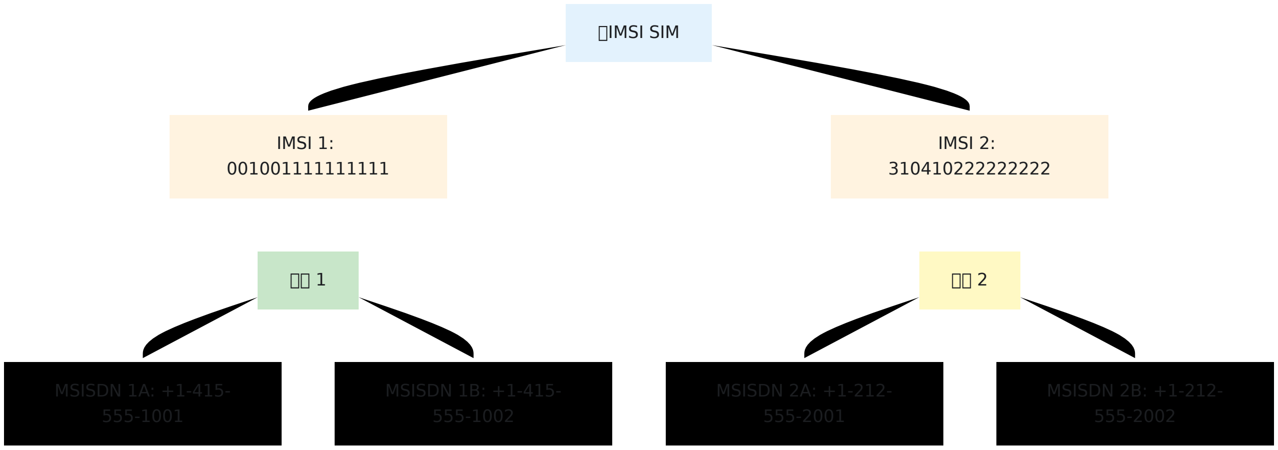
□□□□□□□

1. □□□□□□□ □IMSI□□□□□IMSI□□HSS□□□□“□□”□□□□□□□□
2. □□**SIM**□□□□□□□□ □IMSI SIM□□□□□□□□`sim_id`□□□□□□□□□□□□□□“□□”□□□
3. □□□□□ `subscriber_state`□□□□□IMSI□□□MME/SGSN□□IMSI□□□□□□□□□□□
4. □□□□□ □□□□□□□□□
   - □□□□□□□□□□IMSI
   - □□□□□□□□□□□□□IMSI
   - □□□□SIM□��□□IMSI□□□□□□

□□□□

□IMSI + □MSISDN

□□□□□□□□□□□□□SIM□□□□IMSI□□□IMSI□□□MSISDN□


□IMSI SIM
IMSI 1: 001001111111111
IMSI 2: 310410222222222
□□ 1
□□ 2
MSISDN 1A: +1-415-555-1001
MSISDN 1B: +1-415-555-1002
MSISDN 2A: +1-212-555-2001
MSISDN 2B: +1-212-555-2002

□□□□□

- **□□□□□IMSI 1□□**
    - □□□□□+1-415-555-1001
    - □□□□□+1-415-555-1002
- **□□□□□□□IMSI 2□□**
    - □□□□□+1-212-555-2001
    - □□□□□+1-212-555-2002

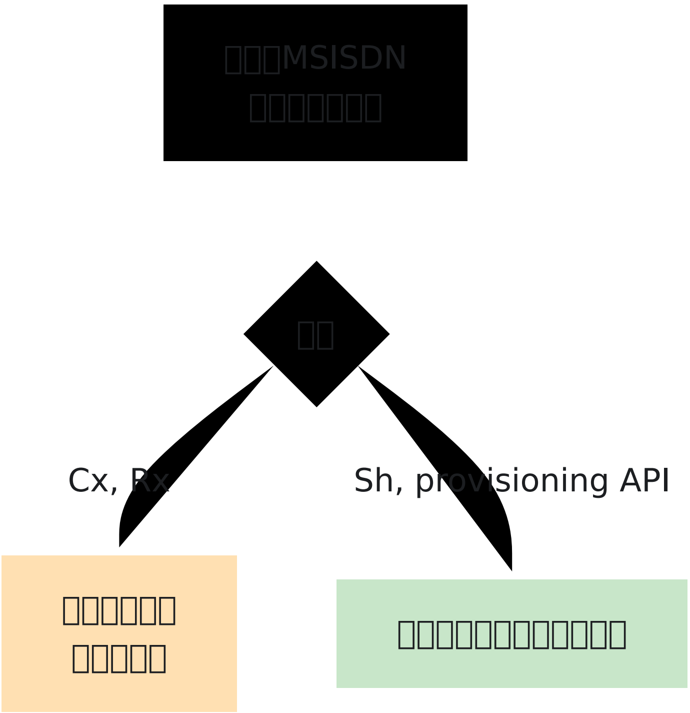
□□□□□□□□□□□□IMSI 1□□MSISDN□□□□□□□□□□□□IMSI 2□□□□MSISDN□□□□□□□□□

□□□□MSISDN□□

MSISDN□□□□□□□□□□□□□□□□□□□□□□MSISDN□□□IMSI□□□□□□□□□MSISDN□□□□□□□□□□□□IMSI□□□□□□□□□□□□□□□��□□□□□□□MSISDN□□□□□□□□□□

□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□MSISDN□□□MSISDN□□□□□□□□□□□ OmniHSS□□□□□□□□□□□□□□□□□□□□□□□□□□

[illegible]


[illegible]MSISDN
[illegible]
[illegible]
Cx, Rx
Sh, provisioning API
[illegible]
[illegible]
[illegible]

- [illegible] [illegible]**Cx**[illegible]**Rx**[illegible]
- [illegible] [illegible]**Sh**[illegible]API[illegible]

[illegible]

[illegible]	[illegible]…[illegible]	**[illegible]IMSI[illegible] MSISDN**	**[illegible]MSISDN[illegible]IMSI[illegible]**
Cx UAR, MAR	[illegible]IMSI[illegible]	[illegible]IMSI[illegible]	[illegible]IMSI[illegible]
Cx SAR	[illegible]	[illegible]IFC[illegible]MSISDN[illegible]	[illegible]���[illegible]IMSI[illegible]
Cx LIR	[illegible]	[illegible]	[illegible]S-CSCF[illegible]
Sh UDR, PUR, SNR	[illegible]MSISDN[illegible]	[illegible]	[illegible]UDR[illegible]PUR[illegible]
Rx AAR	[illegible]	[illegible]MSISDN[illegible]Subscription-Id[illegible]	[illegible]
API `GET /subscriber/msisdn/:msisdn`	MSISDN	[illegible]	[illegible]

[illegible]

- [illegible] IMS[illegible]Cx MAR, SAR, UAR[illegible]IMSI[illegible] IMSI[illegible]
- [illegible] [illegible]IMSI[illegible]MSISDN[illegible]Cx SAR[illegible]`sip:`[illegible] `tel:`[illegible]
- [illegible]**Cx**[illegible]**Sh**[illegible] [illegible]Cx LIR[illegible]HSS[illegible]S-CSCF[illegible]IMS[illegible]HSS[illegible]
- [illegible]**IMSI**[illegible]**ICCID**[illegible] [illegible]

[illegible]

[illegible]

[illegible]**IMSI**[illegible]**MSISDN**[illegible] 3GPP[illegible]

- [illegible]3GPP TS 23.008[illegible]2.1.3[illegible]HLR/HSS[illegible]MSISDN[illegible]MSISDN[illegible] MSISDN[illegible]VLR[illegible]SGSN[illegible]
- [illegible]**MSISDN**[illegible]**A-MSISDN**[illegible]3GPP TS 23.003[illegible]18.9[illegible]A-MSISDN[illegible]“[illegible]PS[illegible]MSISDN[illegible]s[illegible]”[illegible]“[illegible]IMSI”[illegible]

[illegible]**MSISDN**[illegible]**IMSI**[illegible] [illegible]IMSI[illegible]SIM[illegible]IMSI[illegible]IMSI-[illegible]MSISDN[illegible]MIMM[illegible]GSMA[illegible]GSMA IR.73 [illegible]eSIM[illegible]SGP.2x/SGP.32[illegible]3GPP[illegible]MSISDN[illegible]

- [illegible]**MSISDN**[illegible]**C-MSISDN**[illegible]3GPP TS 23.003[illegible]18.7[illegible]C-MSISDN“[illegible]IMSI[illegible]IMS[illegible]”[illegible]“[illegible]IMS[illegible]MSISDN”[illegible]C-MSISDN[illegible] SRVCC[illegible]IMSI[illegible]SRVCC[illegible]CS[illegible]

[illegible]

- Cx[illegible]MAR, SAR, UAR, LIR[illegible]3GPP TS 29.228[illegible]3GPP TS 29.229[illegible]
- Sh[illegible]UDR, PUR, SNR[illegible]3GPP TS 29.328[illegible]3GPP TS 29.329[illegible]

[illegible]	[illegible]	[illegible]
[illegible]IMSI[illegible] MSISDN	[illegible]	TS 23.008 §2.1.3[illegible]TS 23.003 §18.9[illegible]A-MSISDN[illegible]IMSI[illegible]
[illegible]MSISDN[illegible] IMSI	SIM[illegible]MIMM[illegible]	GSMA IR.73[illegible]TS 23.003 §18.7[illegible] MSISDN[illegible]C-MSISDN[illegible]

[illegible]

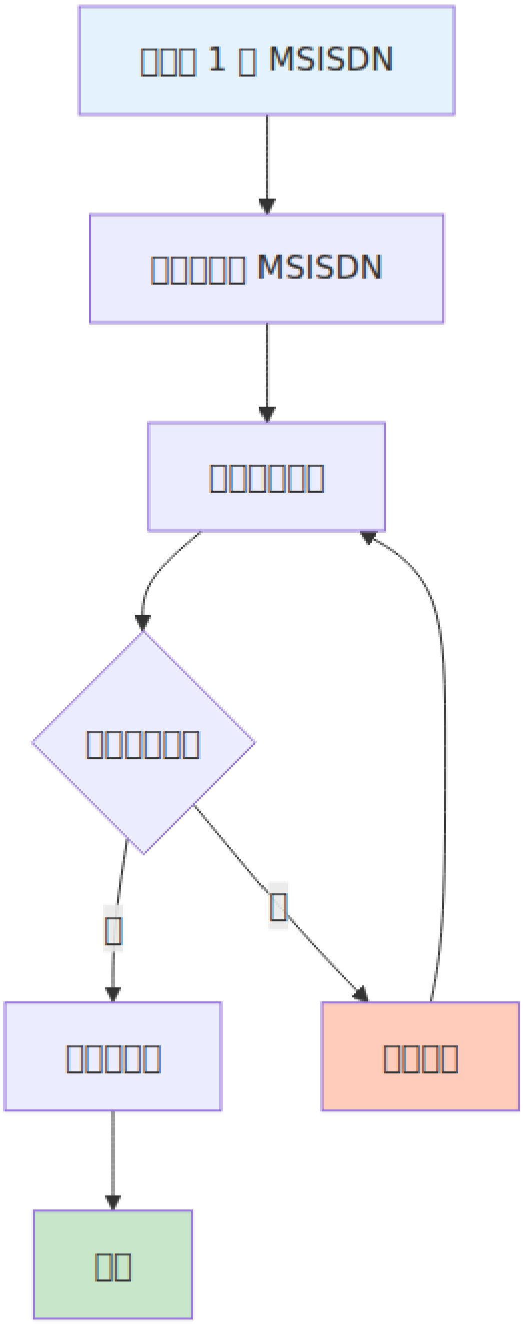
[illegible]SIM[illegible]**IMS**[illegible]3GPP[illegible]3GPP TS 23.228[illegible]IMPI[illegible]IMSI[illegible]S-CSCF[illegible]S-CSCF[illegible]

[illegible]IMS[illegible]S-CSCF[illegible]`ims_subscription`[illegible]S-CSCF[illegible]

[illegible]

- [illegible]`ims_subscription`[illegible]S-CSCF[illegible]`assigned_scscf`[illegible]
- [illegible]`ims_subscription_id`[illegible]
- [illegible]HSS[illegible]S-CSCF[illegible]Cx SAR[illegible]HSS[illegible]S-CSCF[illegible]S-CSCF[illegible]
- [illegible]S-CSCF[illegible]`selection_method: :pool_uri`[illegible]HSS[illegible]REGISTER[illegible]DNS[illegible]S-CSCF[illegible]
- [illegible]
- [illegible]S-CSCF[illegible]
- [illegible]Cx LIR[illegible]HSS[illegible]��[illegible]S-CSCF[illegible]
- Cx SAR[illegible]IMPI[illegible]S-CSCF[illegible]iFC[illegible]
- [illegible]Sh[illegible]`IMSPublicIdentity`[illegible]HSS[illegible]IMSI[illegible]`<IMSPrivateUserIdentity>`[illegible]MMTel TAS[illegible]1[illegible]

IMSI[illegible]AS[illegible]`<IMSPrivateUserIdentity>`[illegible]


1 MSISDN
MSISDN

[illegible]

[illegible]

```
# 1. □□IMS□□□□□□□□□ims_profile_id□□□□□□□□□□□□□□□□□
GROUP_ID=$(curl -k -X POST
https://hss.example.com:8443/api/ims_subscription \
  -H "Content-Type: application/json" \
  -d '{"name": "Smith family - shared number"}' | jq -r
'.response.id')

# 2. □□□□□□□□□□□□□□□□MSISDN□
curl -k -X PATCH
https://hss.example.com:8443/api/subscriber/$PHONE_SUBSCRIBER_ID \
  -H "Content-Type: application/json" \
  -d "{\"ims_subscription_id\": \"$GROUP_ID\", \"msisdns\":
[\"$SHARED_MSISDN_ID\"]}"

curl -k -X PATCH
https://hss.example.com:8443/api/subscriber/$WATCH_SUBSCRIBER_ID \
  -H "Content-Type: application/json" \
  -d "{\"ims_subscription_id\": \"$GROUP_ID\", \"msisdns\":
[\"$SHARED_MSISDN_ID\"]}"
```

□□□

□□	□□	□□	□□
`name`	□□□	□	IMS□□□□□□□□□□□□□□
`ims_profile_id`	UUID	□	□□□□□□□□□□□□□□□iFC□□□□□□□□□□□□□□□IMS□□□□□
`ims_subscription_id`	UUID	□	□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□S-CSCF□□□□□

□□□`assigned_scscf`□`last_seen_scscf_timestamp`□HSS□□□□□□□□□□□□□□□□□□

□□□□

- □□`ims_subscription_id`□□□□□□□□□□□□□□□□□□

- □□□□□□□MSISDN□□��□□□□□□□□□□□□□□□□□□□□□□□□
- □□□□□□□□□□□□□□`ims_subscription_id`□□□□□□□□□

□□□□

□□□MSISDN□□

□□□□□□□MSISDN□

```
□□API□□□GET /api/subscriber/imsi/:imsi
```

□□□□□□□□□MSISDN□

□□□□□IMSI

□□□□□□□□□**IMSI**□□□□□

1. □□□IMSI□□□□□□□□□□□□
2. □□key_set□□□□IMSI□□□□
3. □□EPC□□□□□□□□□□
4. □□□□□□□□□□□

□□□□□□□**IMSI**□

- □□□□□/SIM□□□□□□□□□HSS
- HSS□□□□□□□□IMSI
- □□□□IMSI□□□□

□□□□□MSISDN

□□□□□□□□□

1. □□MSISDN□□□□□□□□□
2. □□IMS□□□□□□□□□□`{{msisdns}}`□□

3. □□IMS□□□□□□□□□□
4. □□S-CSCF□□□□□□□□□

□□□□□□□□□□

- □□□□□□□□□□□□□□
- □□□□□□□□□□HSS
- HSS□□□□□□□□□□□

□□□□

□MSISDN□□

✓ □□SIM□□□□□□□
✓ □□□□□□□□□
✓ □□□□□□
✓ □□□□□□
✓ □□□□���□□□□□□□□
✓ □IMSI□□□□

□IMSI SIM□□

✓ □□□□□□
✓ □□□□□□
✓ □□□□□□□
✓ □□□□□□
✓ □□□□□□
✓ □□□□□□□□

□□□□

✓ □□□□□
✓ □□□□□□□□□□
✓ □□□□□□□□

✓ [illegible]
✓ [illegible]

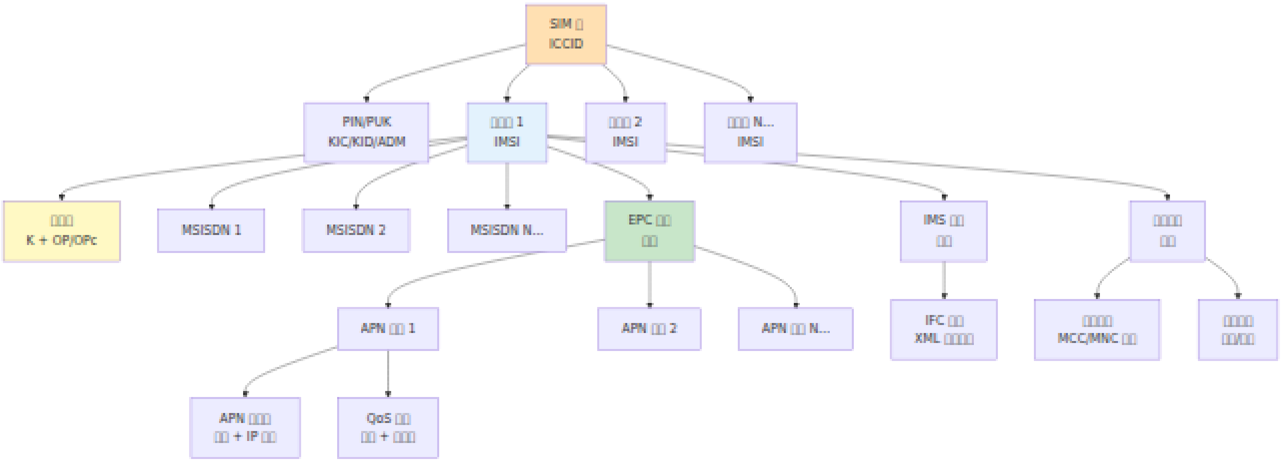
← [illegible]

OmniHSS [illegible]

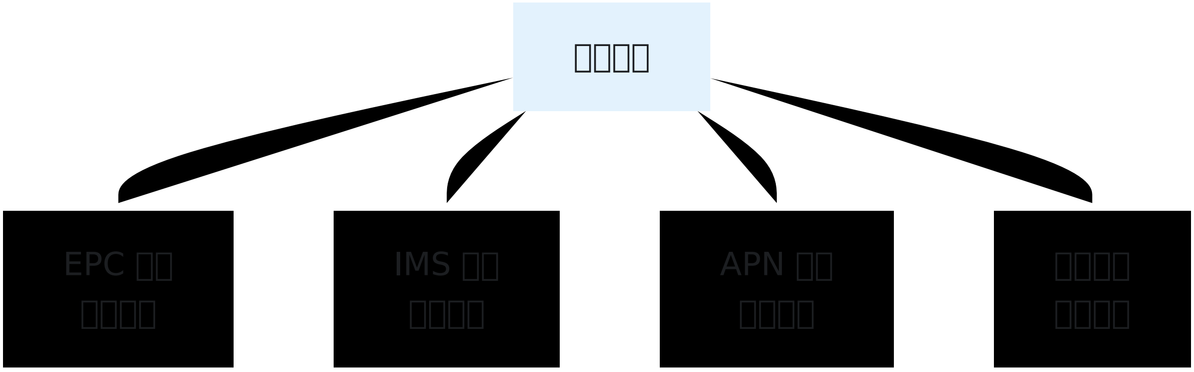
← [illegible]

[illegible]

OmniHSS [illegible]


SIM ICCID
PIN/PUK KIC/KID/ADM
1 IMSI
2 IMSI
N... IMSI
K + OP/OPc
MSISDN 1
MSISDN 2
MSISDN N...
EPC
IMS
APN 1
APN 2
APN N...
IFC XML
MCC/MNC
APN + IP
QoS +

[illegible]



EPC □□

EPC□□□□□□□□□□□□ LTE □□□□□□□□□□□

□□□□

□□	□□	□□□
`ue_ambr_dl_kbps`	□□□□□□	10,000 - 1,000,000 Kbps
`ue_ambr_ul_kbps`	□□□□□□	5,000 - 500,000 Kbps
`network_access_mode`	□□□□	"packet_only" □ "packet_and_circuit"
`tracking_area_update_interval_seconds`	TAU □□□	54 □□□□□

□□ EPC □□

```
curl -k -X POST https://hss.example.com:8443/api/epc/profile \
  -H "Content-Type: application/json" \
  -d '{
    "apn_profiles": [],
    "name": "Premium 100Mbps",
    "network_access_mode": "packet_only",
    "tracking_area_update_interval_seconds": 600,
    "ue_ambr_dl_kbps": 100000,
    "ue_ambr_ul_kbps": 50000
  }'
```

□□ EPC □□□□

□□□□□:

- □□: 10 Mbps (10,000 Kbps)
- □□: 5 Mbps (5,000 Kbps)

□□:

- □□: 50 Mbps (50,000 Kbps)
- □□: 25 Mbps (25,000 Kbps)

□□:

- □□: 100 Mbps (100,000 Kbps)
- □□: 50 Mbps (50,000 Kbps)

□□□:

- □□: 1 Gbps (1,000,000 Kbps)
- □□: 500 Mbps (500,000 Kbps)

IMS □□

IMS □□□□□□□□□□□□□□□ IFC□□□□□□□□□□□□□

IFC □□

IFC □□□□□ S-CSCF □□□□□□□ XML □□□

□□□□:

- `{{imsi}}` - □□□ IMSI
- `{{msisdns}}` - □□□□□□
- `{{mcc}}` - □□□□
- `{{mnc}}` - □□□□□

□□ IMS □□

```
curl -k -X POST https://hss.example.com:8443/api/ims/profile \
  -H "Content-Type: application/json" \
  -d '{
    "ims_profile": {
      "name": "Standard VoLTE",
      "ifc_template": "<InitialFilterCriteria>...
</InitialFilterCriteria>"
    }
  }'
```

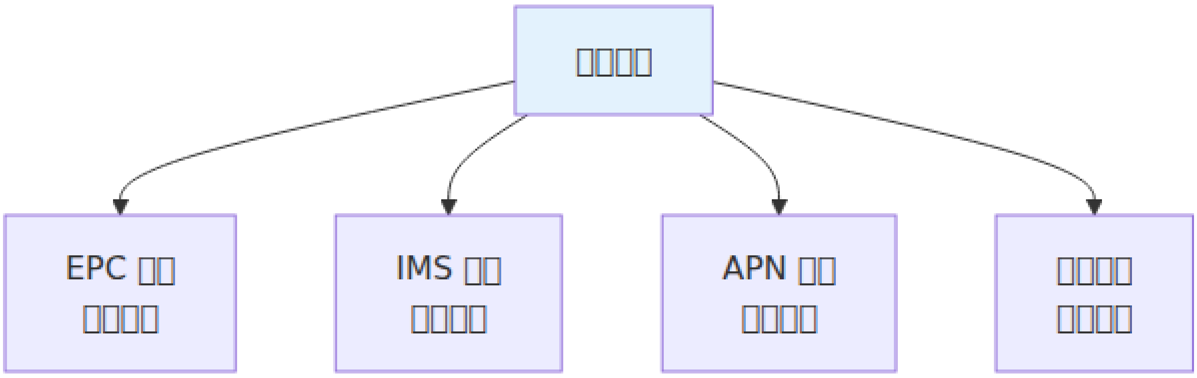
IFC □□□□

```
<ServiceProfile>
  <PublicIdentity>
    <Identity>sip:
{{imsi}}@ims.mnc{{mnc}}.mcc{{mcc}}.3gppnetwork.org</Identity>
  </PublicIdentity>
  <InitialFilterCriteria>
    <Priority>0</Priority>
    <TriggerPoint>
      <ConditionTypeCNF>0</ConditionTypeCNF>
      <SPT>
        <ConditionNegated>0</ConditionNegated>
        <Group>0</Group>
        <Method>INVITE</Method>
      </SPT>
    </TriggerPoint>
    <ApplicationServer>
      <ServerName>sip:as.ims.example.com</ServerName>
      <DefaultHandling>0</DefaultHandling>
    </ApplicationServer>
  </InitialFilterCriteria>
</ServiceProfile>
```

APN □□

APN□□□□□□□□□□□□□□□□□□□□□□

APN □□



APN □□□

□□ APN □□□ IP □□□□□

□□ APN:

- `internet` - □□□□□□□
- `ims` - IMS/VoLTE □□
- `mms` - □□□□□
- `vzwadmin` - □□□□□

IP □□□□:

- `"ipv4"`: □ IPv4
- `"ipv6"`: □ IPv6
- `"ipv4v6"`: IPv4v6□□□□
- `"ipv4_or_ipv6"`: IPv4 □ IPv6□□□□□□

APN QoS □□

□□□□□□□□□

QCI□□□□□□□□□□□□:

QCI	□□	□□	□□□
1	GBR	□□□□	□□
2	GBR	□□□□	□
4	GBR	□□□	□
5	□ GBR	IMS □□	□
9	□ GBR	□□□□□□□	□□

□□□□□□□□□□□:

APN QoS □□□□□□□ IP-CAN □□□□□□□□□□□□ Gx CCA-I □□□□ `Online`/`Offline` AVP □□□

□□	□□	□□	□□
`online_charging_enabled`	boolean	`null`	□□□□□□□□□ `Online` AVP □`true` = □□□`false` = □□□□□□ `null` □□PCRF □□ PGW □ CCR-I □□□□□□
`offline_charging_enabled`	boolean	`null`	□□□□□□□□□ `Offline` AVP □`true` = □□□`false` = □□□□□□ `null` □□PCRF □□ PGW □ CCR-I □□□□□□

□□□□□□□ AVP □□□□□□□ PCRF: □□□□□/□□□□□

□□□□□ APN □□

```
# 1. □□ APN □□□
APN_ID=$(curl -k -X POST
https://hss.example.com:8443/api/apn/identifier \
  -H "Content-Type: application/json" \
  -d '{"apn": "internet", "ip_version": "ipv4v6"}' \
  | jq -r '.response.id')

# 2. □□ APN QoS □□
QOS_ID=$(curl -k -X POST
https://hss.example.com:8443/api/apn/qos_profile \
  -H "Content-Type: application/json" \
  -d '{
    "name": "Best Effort",
    "allocation_retention_priority": 8,
    "apn_ambr_dl_kbps": 50000,
    "apn_ambr_ul_kbps": 25000,
    "pre_emption_capability": false,
    "pre_emption_vulnerability": true,
    "qci": 9
  }' | jq -r '.response.id')

# 3. □□ APN □□
curl -k -X POST https://hss.example.com:8443/api/apn/profile \
  -H "Content-Type: application/json" \
  -d "{
    \"apn_identifier_id\": \"$APN_ID\",
    \"apn_qos_profile_id\": \"$QOS_ID\",
    \"name\": \"Internet APN\"
  }"
```

□ APN □□□ EPC □□

APN □□ `join_epc_profile_to_apn_profile` □□ EPC □□□□□

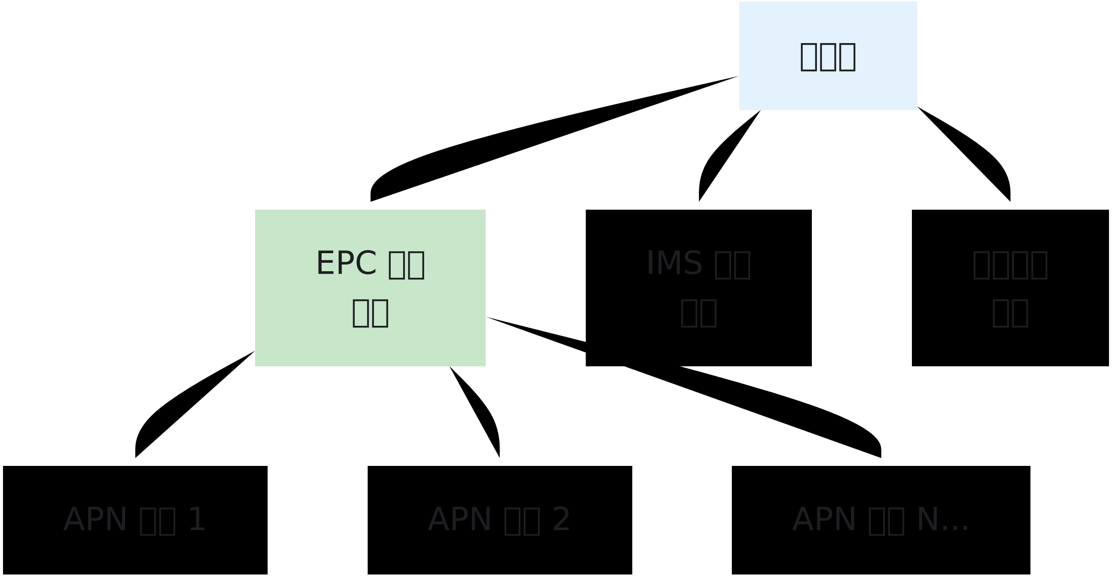
□□□□□□□□□□□□ APN □□ ID □□□ EPC □□ ID□□□ APN □□□□□□□□□ EPC □□□

[illegible]

[illegible] [illegible] [illegible]

[illegible]

[illegible]


[illegible]
EPC [illegible]
[illegible]
IMS [illegible]
[illegible]
[illegible]
[illegible]
APN [illegible] 1
APN [illegible] 2
APN [illegible] N...

□□□□□□□□□

```
# □□□□□□□□□ EPC □ IMS □□
curl -k -X POST https://hss.example.com:8443/api/subscriber \
  -H "Content-Type: application/json" \
  -d '{
    "subscriber": {
      "imsi": "001001123456789",
      "key_set_id": "6ba7b810-9dad-41d1-80b4-00c04fd430c8",
      "epc_profile_id": "e58ed763-928c-4155-bee9-fdbaaadc15f3",
      "ims_profile_id": "7c9e6679-7425-40de-944b-e07fc1f90ae7",
      "roaming_profile_id": "9c858901-8a57-4791-81fe-4c455b099bc9"
    }
  }'

# □□□□□□□
curl -k -X PUT
https://hss.example.com:8443/api/subscriber/d290f1ee-6c54-4b01-
90e6-d701748f0851 \
  -H "Content-Type: application/json" \
  -d '{
    "subscriber": {
      "epc_profile_id": "f47ac10b-58cc-4372-a567-0e02b2c3d479"
    }
  }'
```

□□□□□□□□

□□□□

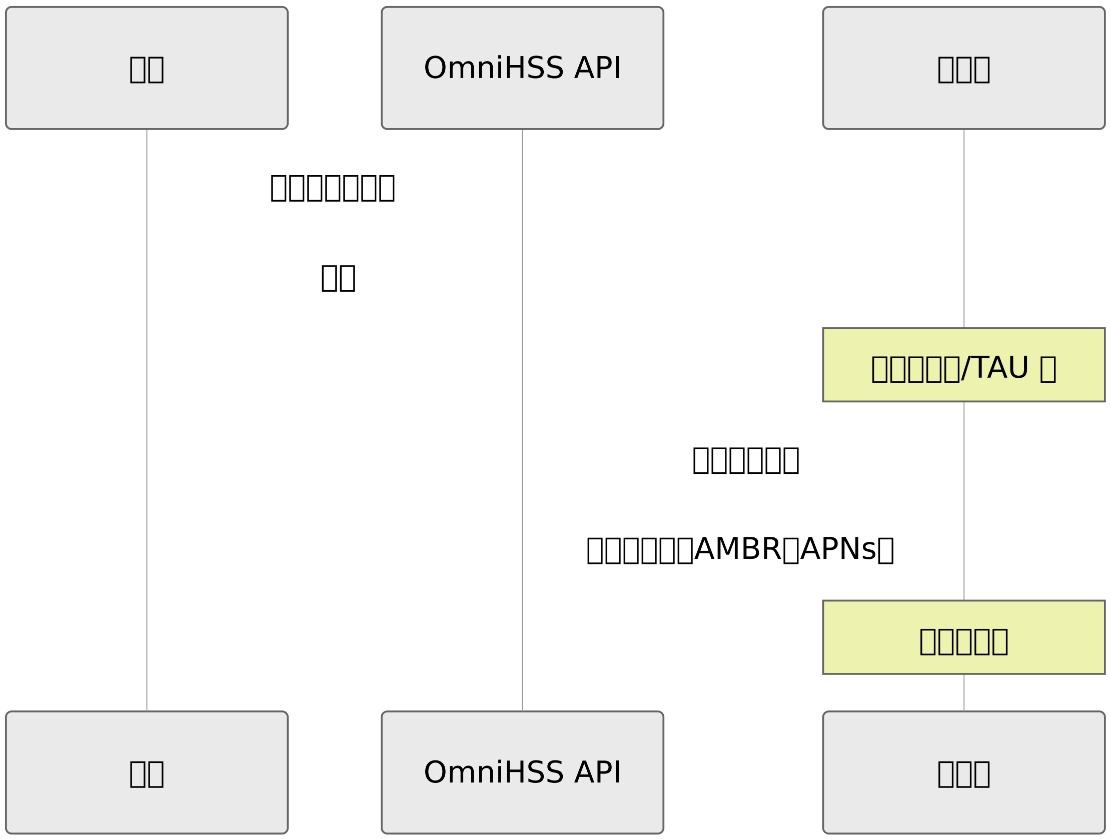
1. □□□□□□ - □□□□□□□□□□□□□□□□□□
2. □□□□ - □□□□□□□□□□□□□
3. □□□□ - □□□□□□
4. □□□□□ - □□□□□□□□□□□□□□□□□

□□□□□□

```
[□□□□]-[□□]-[□□]

□□:
- "Basic-10Mbps-Internet"
- "Premium-100Mbps-VoLTE"
- "Enterprise-1Gbps-MultiAPN"
```

□□□□

□□□□□□□□□□□□


□□
OmniHSS API
□□□
□□□□□□□
□□
□□□□□/TAU □
□□□□□□
□□□□□□AMBR□APNs□
□□□□□
□□
OmniHSS API
□□□

□□: □□□□□□□□□□□

- □□□□□□□TAU□
- □□
- IMS □□□□□ IMS □□□□□

[illegible]

[illegible]:

1. [illegible] EPC [illegible] AMBR [illegible]
2. [illegible] APN QoS [illegible] AMBR [illegible]
3. [illegible] MME/P-GW [illegible] QoS
4. [illegible]

IMS [illegible]:

1. [illegible] IMS [illegible]
2. [illegible] IFC [illegible] XML [illegible]
3. [illegible] S-CSCF [illegible] IFC [illegible]
4. [illegible] S-CSCF [illegible]

APN [illegible]:

1. [illegible] APN [illegible] EPC [illegible]
2. [illegible] APN [illegible]
3. [illegible] UE [illegible] PDN [illegible]

← [illegible] | [illegible]: [illegible] →

OmniHSS □□□□

← □□□□□□

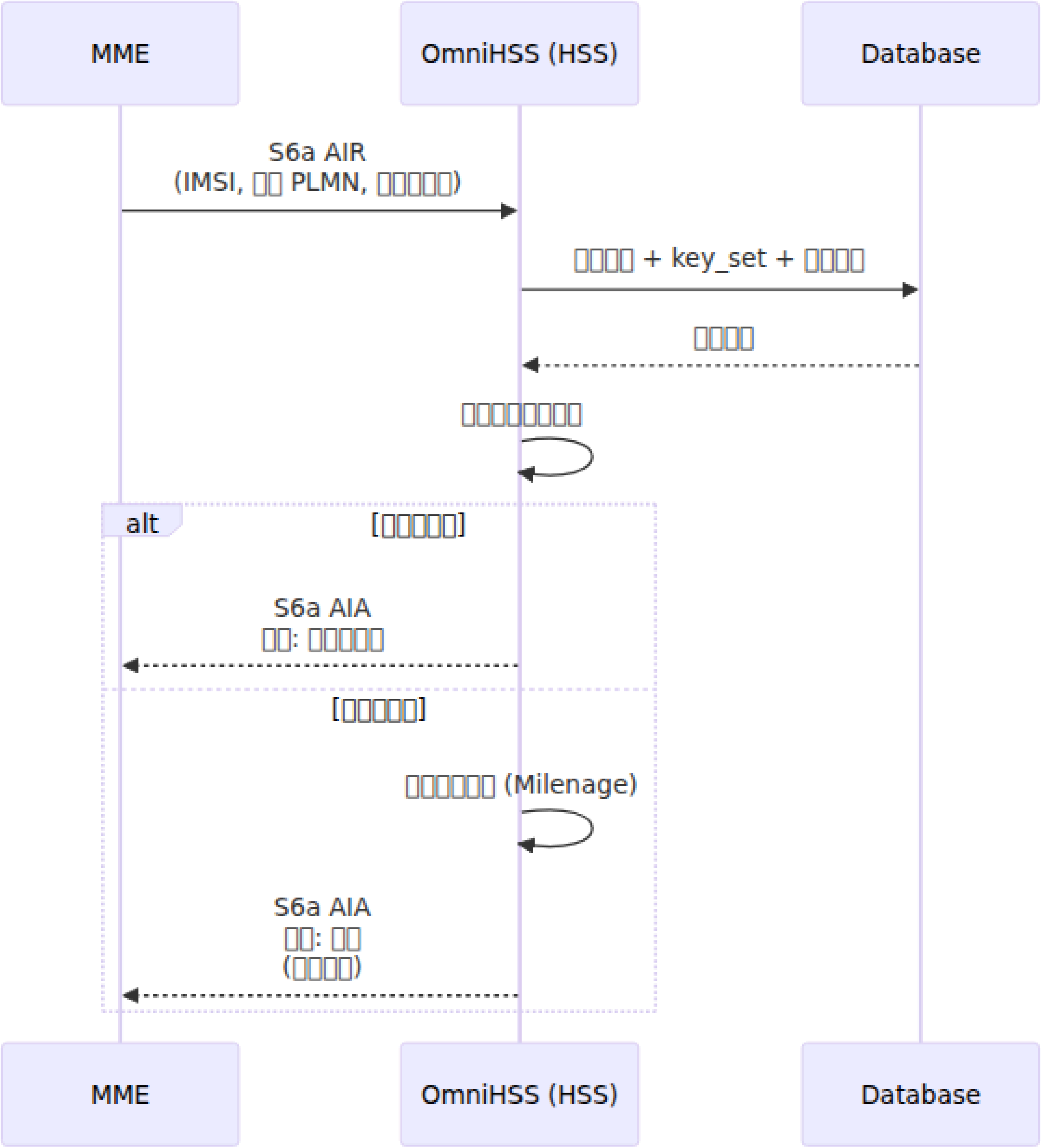
□□

□□□□□□□□□ OmniHSS □□□ Diameter □□□□□□□□□□□□□□□□□□□□□□□□□□□

S6a □□ (LTE/EPC)

□□□□□□ (AIR/AIA)

MME □□□□□□□□□□

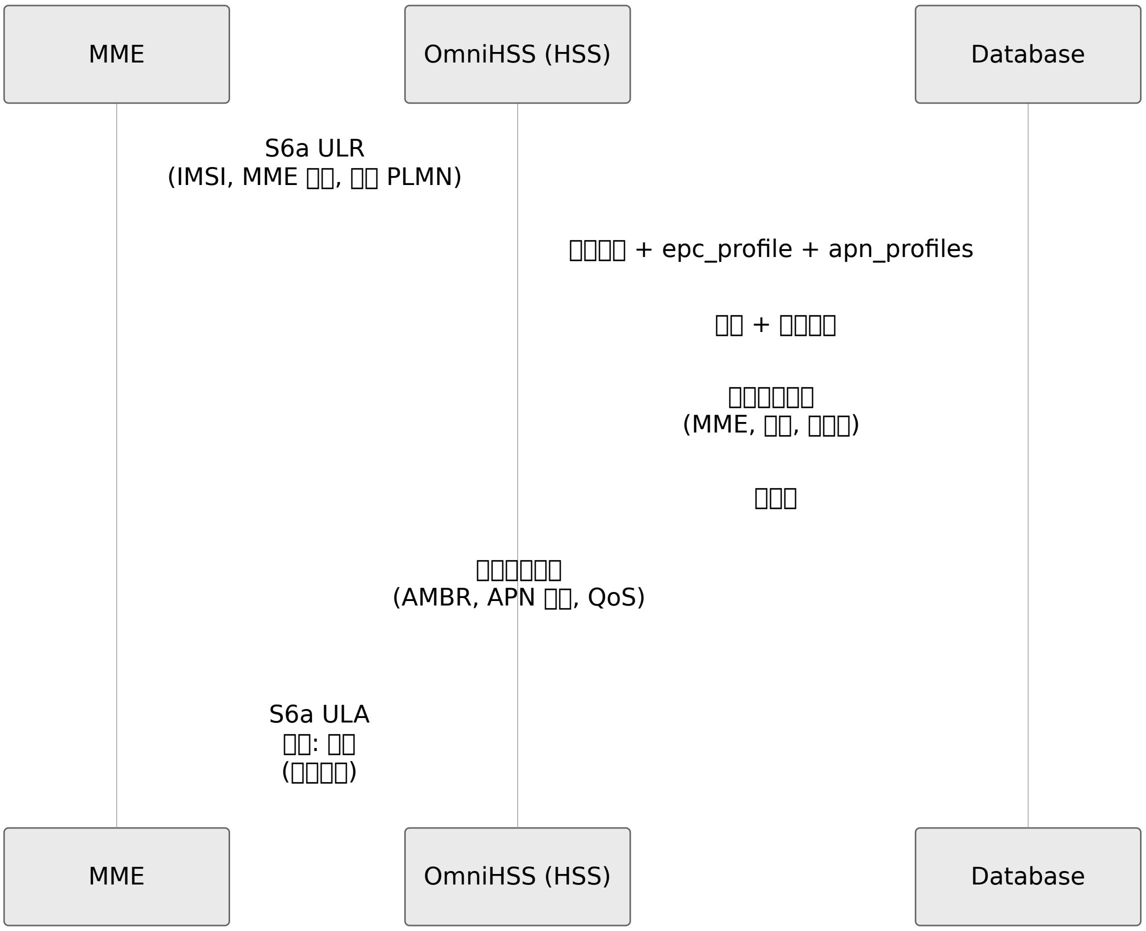

MME
OmniHSS (HSS)
Database
S6a AIR
(IMSI, □□ PLMN, □□□□□)
□□□□ + key_set + □□□□
□□□□
□□□□□□□□
alt
[□□□□□]
S6a AIA
□□: □□□□□
[□□□□□]
□□□□□□ (Milenage)
S6a AIA
□□: □□
(□□□□)
MME
OmniHSS (HSS)
Database

□□ AVP:

- □□: □□□ (IMSI), □□-PLMN-Id, □□□□□□□
- □□: □□□□ (RAND, AUTN, XRES, KASME)

□□□□□□ (ULR/ULA)

MME □□ HSS □□□□□□□□□□□□

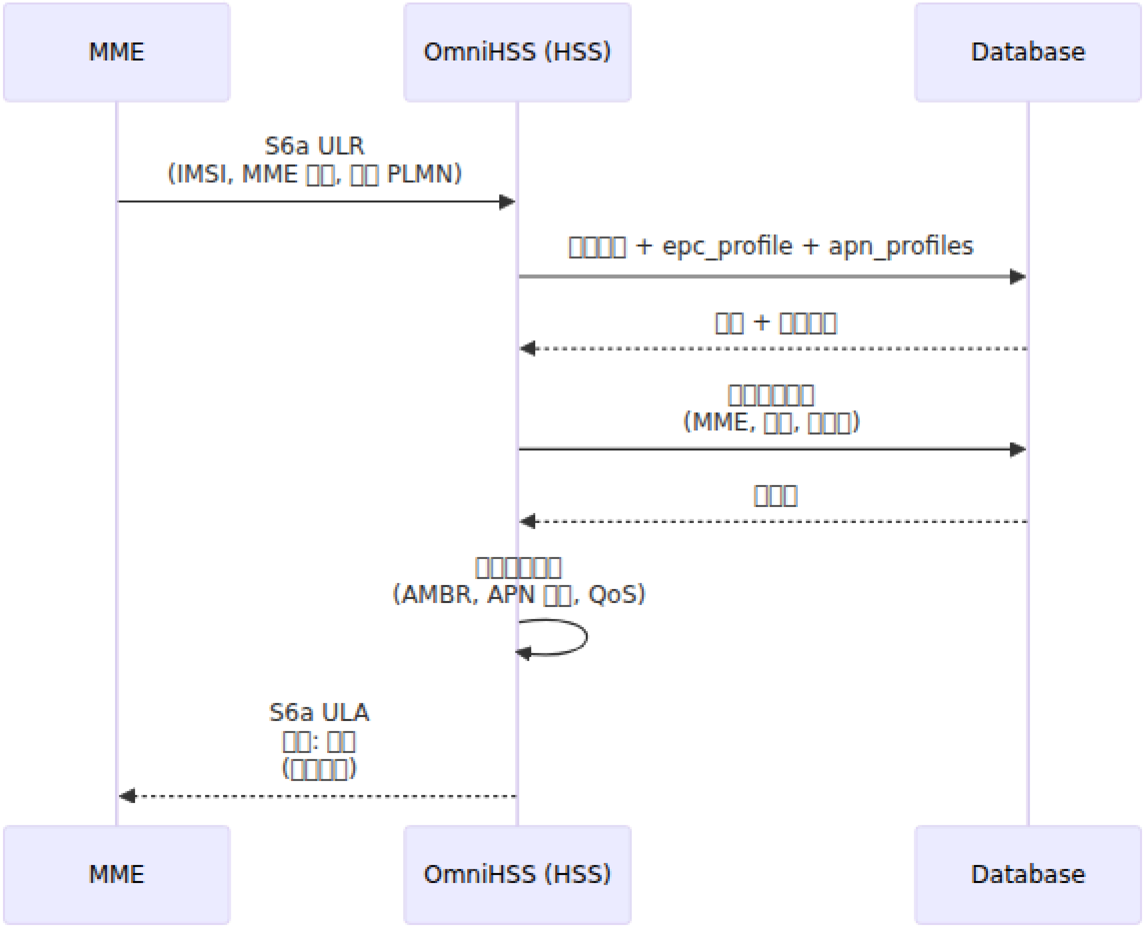

MME
OmniHSS (HSS)
Database
S6a ULR
(IMSI, MME □□, □□ PLMN)
□□□□ + epc_profile + apn_profiles
□□ + □□□□
□□□□□□
(MME, □□, □□□)
□□□
□□□□□□
(AMBR, APN □□, QoS)
S6a ULA
□□: □□
(□□□□)
MME
OmniHSS (HSS)
Database

□□ AVP:

- □□: □□□ (IMSI), RAT □□, ULR □□, □□-PLMN-Id, UE-SRVCC □□
- □□: □□□□ (AMBR, APN □□, □□□□□□)

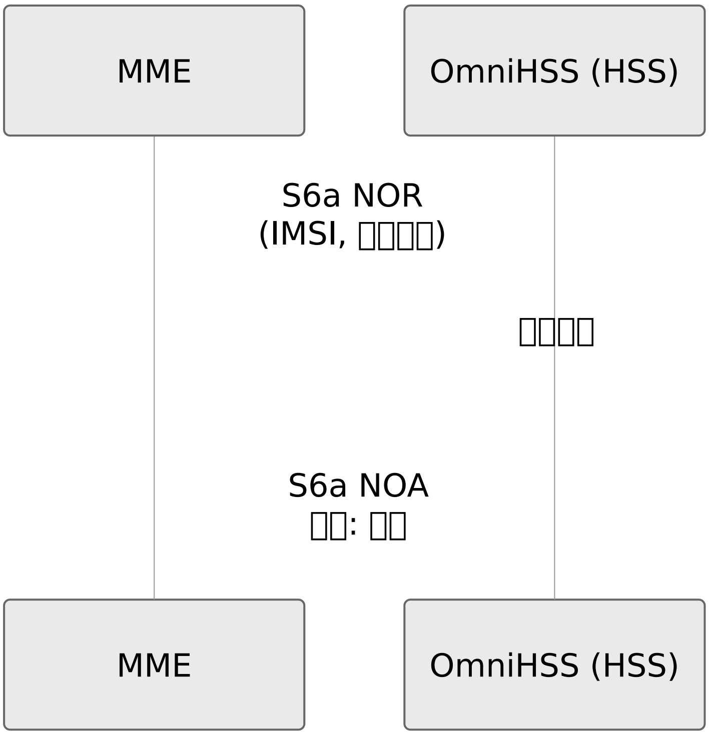
□□ UE □□ (PUR/PUA)

MME □□ HSS □□□□□□□□□□□


MME
OmniHSS (HSS)
Database
S6a ULR
(IMSI, MME □□, □□ PLMN)
□□□□ + epc_profile + apn_profiles
□□ + □□□□
□□□□□□
(MME, □□, □□□)
□□□
□□□□□□
(AMBR, APN □□, QoS)
S6a ULA
□□: □□
(□□□□)
MME
OmniHSS (HSS)
Database

□□□□ (NOR/NOA)

MME □□ HSS □□□□□

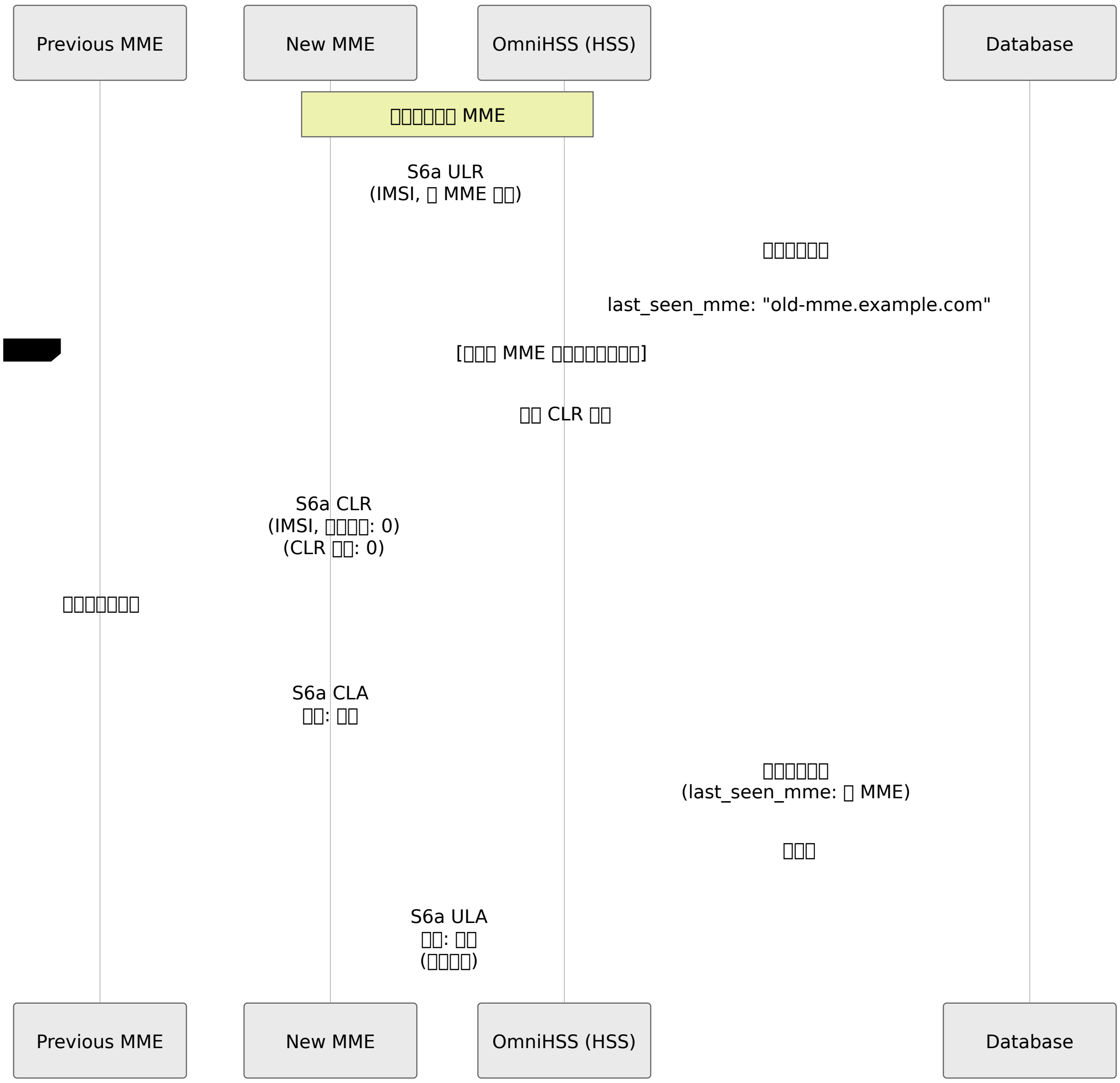

MME
OmniHSS (HSS)
S6a NOR
(IMSI, □□□□)
□□□□
S6a NOA
□□: □□
MME
OmniHSS (HSS)

□□□□□□ (CLR/CLA)

HSS □□□□□□□□□ MME □□□□□□□OmniHSS □□□□□□□□ CLR □□□

□□ CLR (MME □□)

□□□□□ MME □□□□□□□□□□OmniHSS □□□□□□ MME □□ CLR□□□□□□□□□□

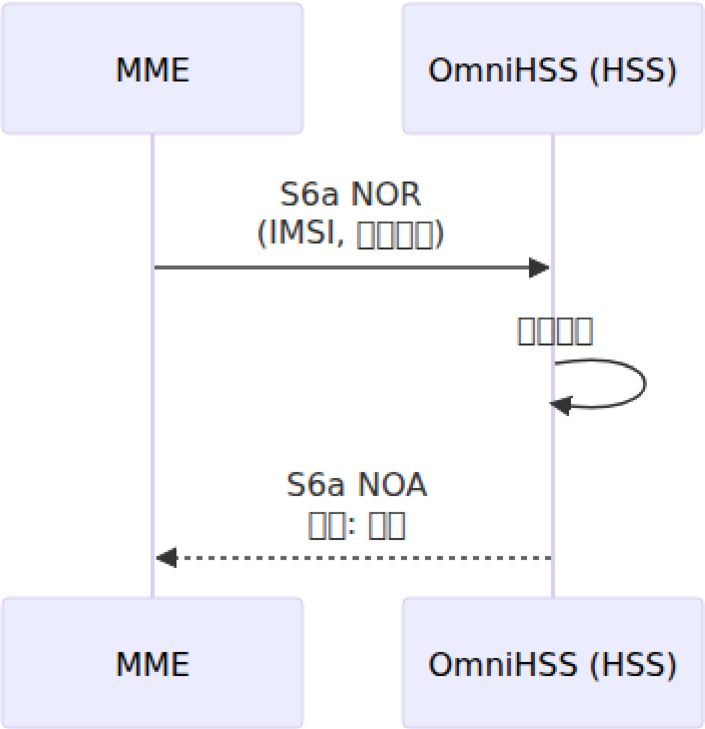

Previous MME
New MME
OmniHSS (HSS)
Database
□□□□□□ MME
S6a ULR
(IMSI, □ MME □□)
□□□□□□
last_seen_mme: "old-mme.example.com"
[□□□ MME □□□□□□□□]
□□ CLR □□
S6a CLR
(IMSI, □□□□: 0)
(CLR □□: 0)
□□□□□□□
S6a CLA
□□: □□
□□□□□□
(last_seen_mme: □ MME)
□□□
S6a ULA
□□: □□
(□□□□)
Previous MME
New MME
OmniHSS (HSS)
Database

□□ AVP (□□ CLR):

- □□□: □□□ IMSI
- □□□□: □□ MME □□□
- □□□: □□ MME □
- □□□□: 0 (MME □□□□)
- CLR □□: 0
- □□□□: □□□□□□���□□

□□□ CLR (API □□)

□□□□□□□□□□ API □□ CLR□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□


MME
OmniHSS (HSS)
S6a NOR
(IMSI, □□□□)
□□□□
S6a NOA
□□: □□
MME
OmniHSS (HSS)

□□ AVP (□□□ CLR):

- □□□: □□□ IMSI
- □□□□: □□□□□ MME □□□
- □□□: □□□□□ MME □
- □□□□: `:subscription_withdrawal` (□ 3GPP TS 29.272 □□□□□)
- CLR □□:
  - s6a_indicator: 1 (□□□□ S6a □□)
  - reattach_required: 1 (UE □□□□□□□□□□□□)

□□□□

OmniHSS □□□□□□□□□□□□ 3GPP TS 29.272□

[illegible]	[illegible]	[illegible]	[illegible]
MME [illegible]	0	[illegible] MME [illegible]	[illegible] MME [illegible] ULR
SGSN [illegible]	1	SGSN [illegible]	3G/2G [illegible]
[illegible]	2	[illegible]	[illegible] API [illegible]
[illegible] IWF	3	[illegible]	[illegible]
[illegible]	4	[illegible]	[illegible]

CLR [illegible]

CLR [illegible] AVP [illegible]

[illegible]	[illegible]	[illegible]
S6a/S6d [illegible]	0	1 = [illegible] S6a [illegible]
[illegible]	1	1 = UE [illegible]

[illegible] CLR [illegible]:

```
clr_flags: %{
  s6a_indicator: 1,        # [illegible] S6a [illegible]
  reattach_required: 1     # [illegible]
}
```

[illegible] IMSI [illegible]

OmniHSS [illegible] (IMSI) [illegible] MME [illegible] MSISDN[illegible] IMSI [illegible] CLR [illegible]

[illegible] 1: [illegible] MSISDN[illegible] IMSI

```
□□ A:
  - IMSI: 999000123456789
  - MSISDNs: ["+1234567890", "+9876543210"]
  - last_seen_mme: "mme01.operator.com"
```

□□□□□□□□ MME □□

- □□□□ **CLR** □ "mme01.operator.com"□IMSI □ 999000123456789
- □□ MSISDN □□□□□□□□□□□□□ SIM□
- □□□ AVP □□ IMSI□□□□ MSISDNs

□□ 2: □□□□□□□ IMSI□□□□ MSISDN

OmniHSS □□ □□ **MSISDN** □□□□□ MSISDN □□□□□□□□□□□□□□□□□□/□□□□□

```
□□ A:
  - IMSI: 999000111111111
  - MSISDN: "+1234567890"
  - last_seen_mme: "mme01.operator.com"

□□ B□□□□□:
  - IMSI: 999000222222222
  - MSISDN: "+1234567890"  # □□ MSISDN□□□ SIM/IMSI
  - last_seen_mme: "mme02.operator.com"
```

□□□ B □□□□

- □□□ **CLR**□□□ IMSI = □□□□□
- □□ A □□□ mme01 □□
- □□ B □ mme02 □□
- □□□□□□□□□□□□□□□□□□□□

□□ 3: □□□ CLR □□□ MSISDN □□

□□□

- □□□□ **CLR** □□□□ last_seen_mme
- □□ **MSISDN** □□ IMSI □□□□□□□□□□

- IMSI □□□ MME □□□□□

□□□□

1. **IMSI □□□:** CLR □□□□□ □ **IMSI**□□□□□ MSISDN□`subscriber_state` □□□□ (IMSI) □□ `last_seen_mme`□

2. □□□□**:** □□□□□□□□□□□□ MME □□���□□ CLR □□□□□□□□□□□□□□□

3. □□□□□□□ **MME □□□□ CLR:** □□ `last_seen_mme` □ `nil`□□□□□□□□□□ ULR □□□□□ CLR□

4. □□□□□□**:** □□ CLR□□ ULR □□□□□□□□ `Subscription-Data` AVP□□□□□ MME □□□□□ □□□

5. □□**:** CLR □□□□□□□□□□□□□□□ MME □ ULA □□□□□□□□ MME □ CLA□

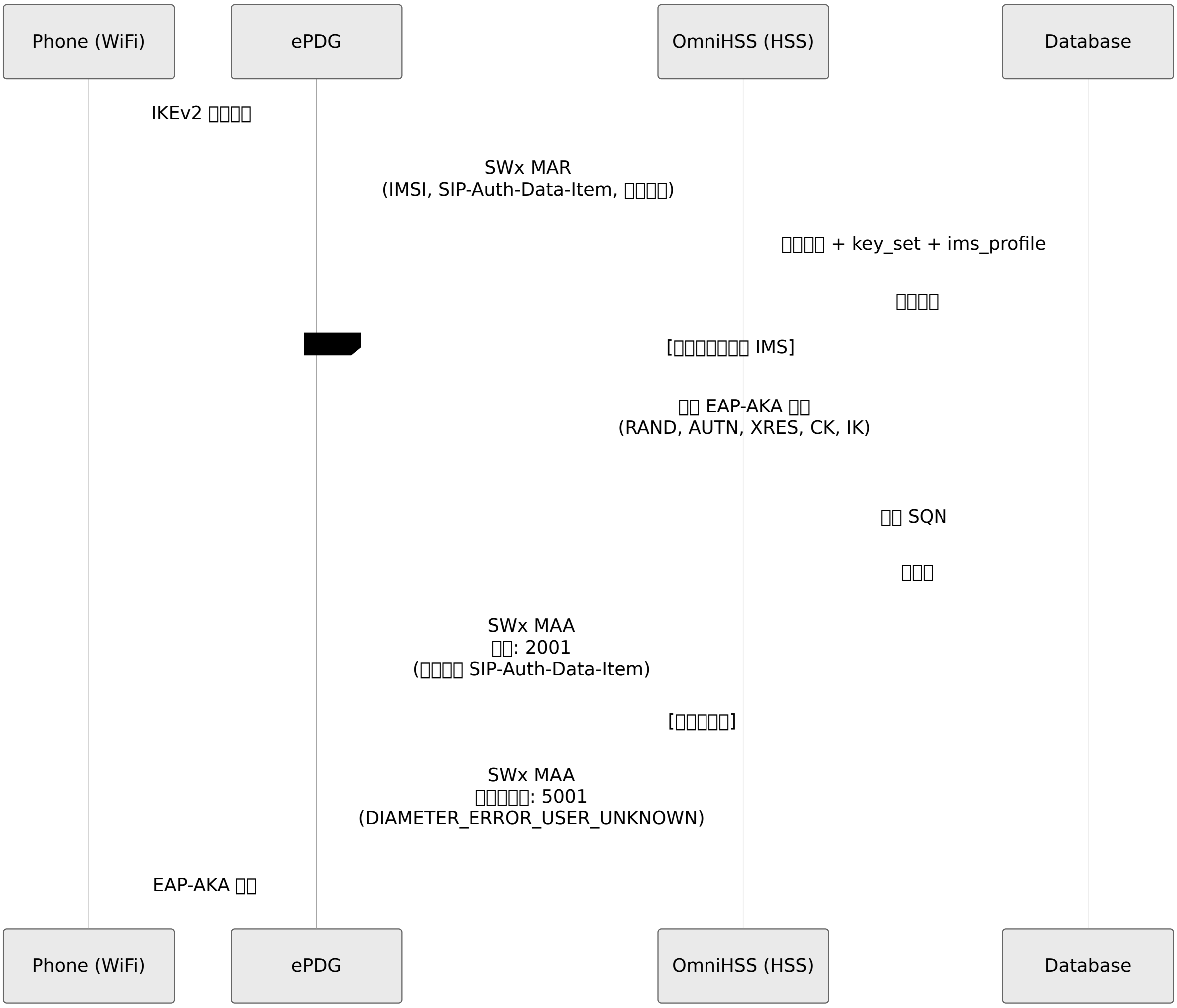
6. **CLA □□:** OmniHSS □□ CLA □□□□□□□□□□□□□□□□□□□□□□□□□□ HSS □□□

SWx □□ (□ 3GPP □□ / WiFi □□)

SWx □□□□□ ePDG□□□□□□□□□□□□ HSS□□□□□ 3GPP □□□□□□□□□□□□□□□□□□□ WiFi □□□

□□□□□□□ (MAR/MAA)

ePDG □□ WiFi □□□□□ EAP-AKA □□□□□


Phone (WiFi)
ePDG
OmniHSS (HSS)
Database
IKEv2 □□□□
SWx MAR
(IMSI, SIP-Auth-Data-Item, □□□□)
□□□□ + key_set + ims_profile
□□□□
[□□□□□□ IMS]
□□ EAP-AKA □□
(RAND, AUTN, XRES, CK, IK)
□□ SQN
□□□
SWx MAA
□□: 2001
(□□□□ SIP-Auth-Data-Item)
[□□□□□]
SWx MAA
□□□□□: 5001
(DIAMETER_ERROR_USER_UNKNOWN)
EAP-AKA □□
Phone (WiFi)
ePDG
OmniHSS (HSS)
Database

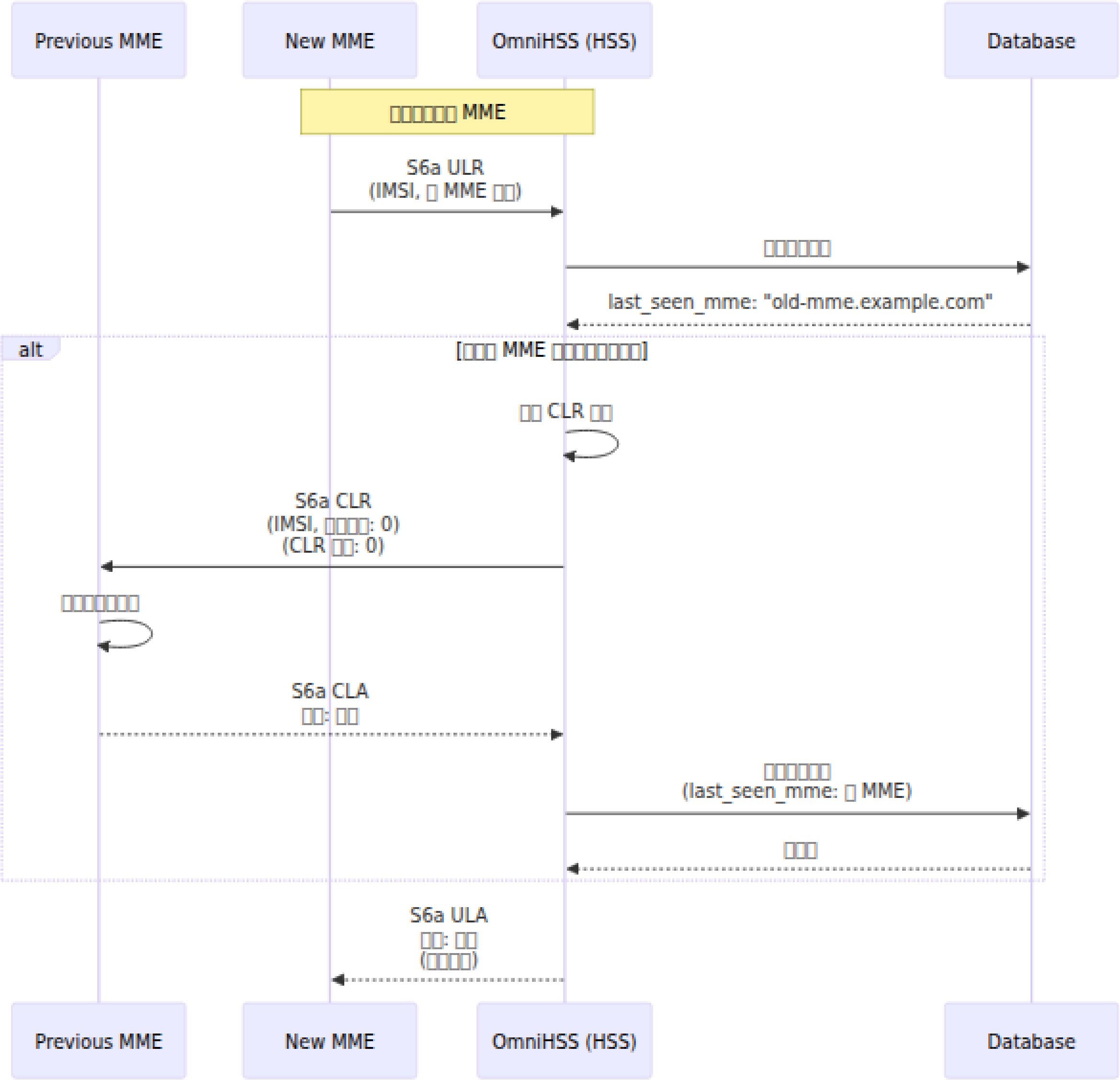
□□ AVP:

- □□: □□□ (IMSI □ IMSI@realm), SIP-Auth-Data-Item (□□□□), SIP-Number-Auth-Items
- □□: SIP-Auth-Data-Item (SIP-Authenticate, SIP-Authorization, □□□□, □□□□□)

SQN □□□□: □ UE □□□□□ SQN □□□□□□□□□□□□ePDG □ SIP-Authorization AVP □□□□□□□□□□OmniHSS □□□□□□□ AUTS□□□□ 3GPP TS 33.102 □□ IND □□□□□□□□□□ SQN□

□□□□□□□ (SAR/SAA)

ePDG □□□□□□□□□□ WiFi □□□□□


Previous MME
New MME
OmniHSS (HSS)
Database
□□□□□□ MME
S6a ULR
(IMSI, □ MME □□)
□□□□□□
last_seen_mme: "old-mme.example.com"
alt
[□□□ MME □□□□□□□□]
□□ CLR □□
S6a CLR
(IMSI, □□□□: 0)
(CLR □□: 0)
□□□□□□□
S6a CLA
□□: □□
□□□□□□
(last_seen_mme: □ MME)
□□□
S6a ULA
□□: □□
(□□□□)
Previous MME
New MME
OmniHSS (HSS)
Database

□□□□□□□:

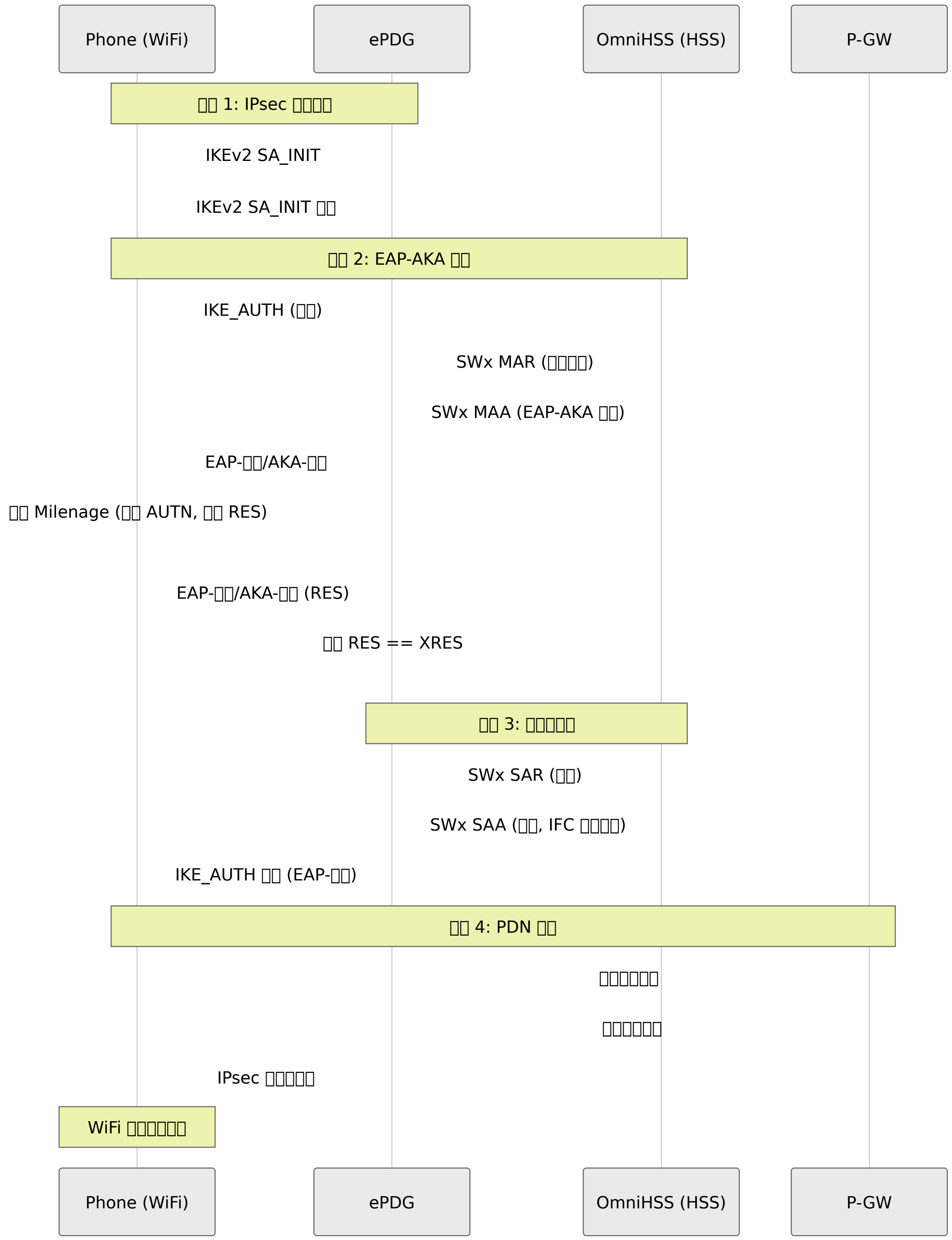
□□	□	□□
NO_ASSIGNMENT	0	□□□□□□□□□
REGISTRATION	1	□□ WiFi □□□□
RE_REGISTRATION	2	□□□□
UNREGISTERED_USER	3	□□□□□□□□
TIMEOUT_DEREGISTRATION	4	□□□□
USER_DEREGISTRATION	5	□□□□□□□
AUTHENTICATION_FAILURE	7	□□□□□□□□□
ADMINISTRATIVE_DEREGISTRATION	8	□□□□□□□□

□□ AVP:

- □□: □□□ (IMSI), □□□□□□□, □□□□□ (ePDG □□), □□□□ (APN)
- □□: □□□□ (IFC □□□□ XML), □ 3GPP □□□□

WiFi □□□□□□

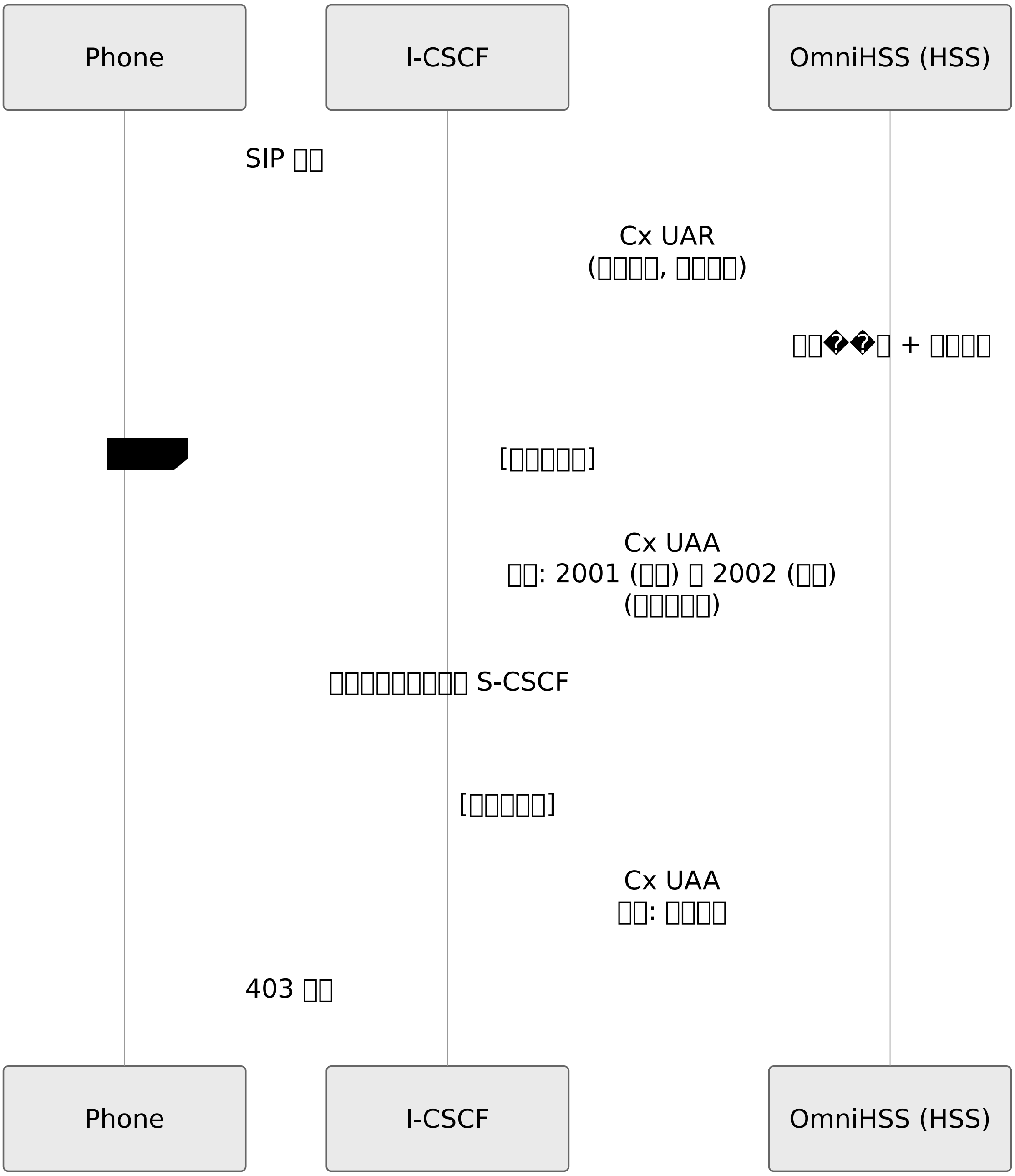
□□□□□□ WiFi □□□□□


Phone (WiFi)
ePDG
OmniHSS (HSS)
P-GW
□□ 1: IPsec □□□□
IKEv2 SA_INIT
IKEv2 SA_INIT □□
□□ 2: EAP-AKA □□
IKE_AUTH (□□)
SWx MAR (□□□□)
SWx MAA (EAP-AKA □□)
EAP-□□/AKA-□□
□□ Milenage (□□ AUTN, □□ RES)
EAP-□□/AKA-□□ (RES)
□□ RES == XRES
□□ 3: □□□□□
SWx SAR (□□)
SWx SAA (□□, IFC □□□□)
IKE_AUTH □□ (EAP-□□)
□□ 4: PDN □□
□□□□□□
□□□□□□
IPsec □□□□□
WiFi □□□□□□
Phone (WiFi)
ePDG
OmniHSS (HSS)
P-GW

Cx □□ (IMS)

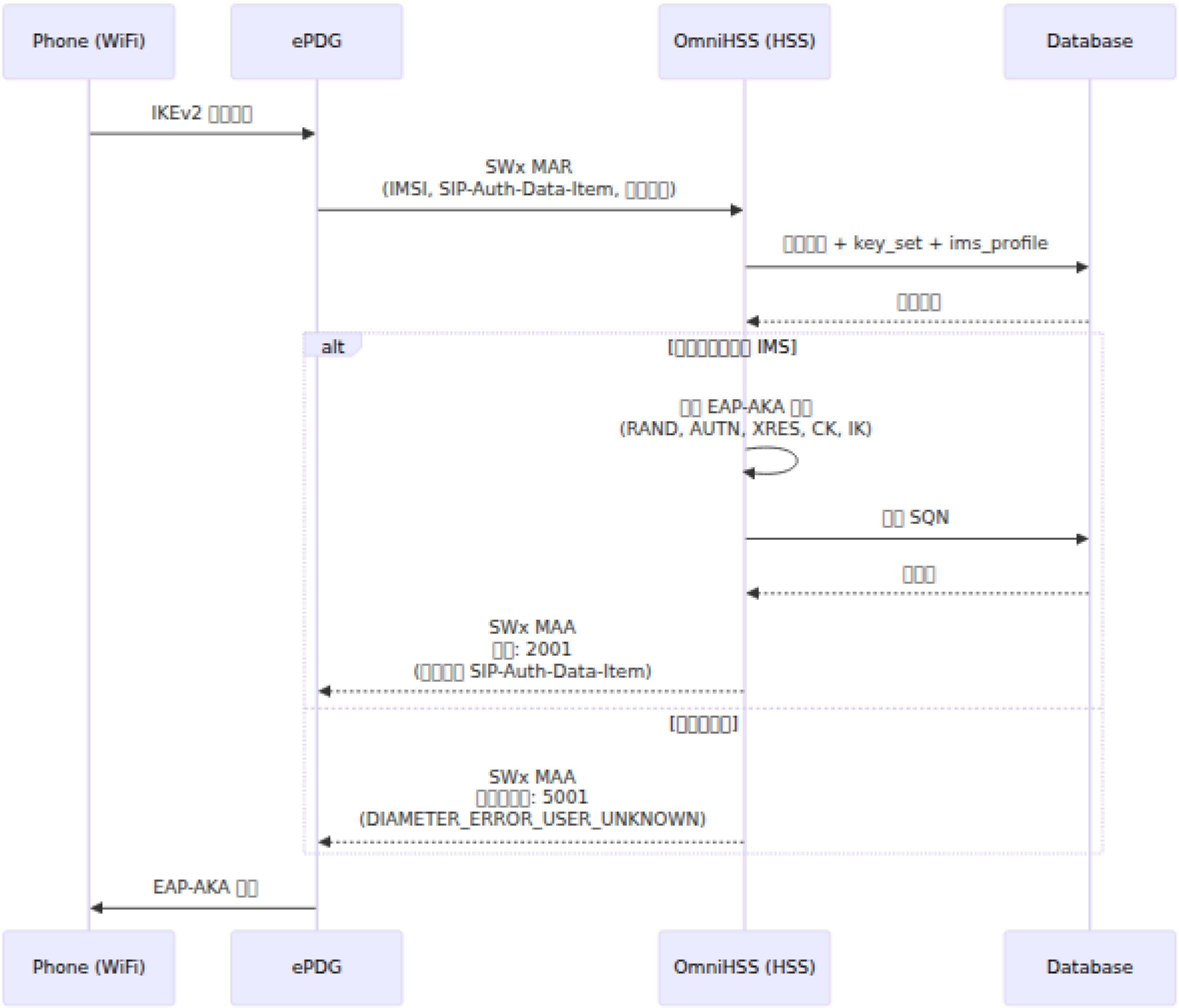
□□□□□□ (UAR/UAA)

I-CSCF □□□□□□□□□□□□□□□□□ S-CSCF□HSS □□□□ S-CSCF □□□□□ `Server-Name`□□□□□□□□□□□□□□□□□□ S-CSCF □□□□ □□□


Phone
I-CSCF
OmniHSS (HSS)
SIP □□
Cx UAR
(□□□□, □□□□)
□□��□ + □□□□
[□□□□□]
Cx UAA
□□: 2001 (□□) □ 2002 (□□)
(□□□□□)
□□□□□□□□□ S-CSCF
[□□□□□]
Cx UAA
□□: □□□□
403 □□
Phone
I-CSCF
OmniHSS (HSS)

□□□□□□□ (SAR/SAA)

S-CSCF □□/□□□□□□□ IMS □□□□□


Phone (WiFi)
ePDG
OmniHSS (HSS)
Database
IKEv2 □□□□
SWx MAR
(IMSI, SIP-Auth-Data-Item, □□□□)
□□□□ + key_set + ims_profile
□□□□
alt
[□□□□□□□ IMS]
□□ EAP-AKA □□
(RAND, AUTN, XRES, CK, IK)
□□ SQN
□□□
SWx MAA
□□: 2001
(□□□□ SIP-Auth-Data-Item)
[□□□□□□]
SWx MAA
□□□□□: 5001
(DIAMETER_ERROR_USER_UNKNOWN)
EAP-AKA □□
Phone (WiFi)
ePDG
OmniHSS (HSS)
Database

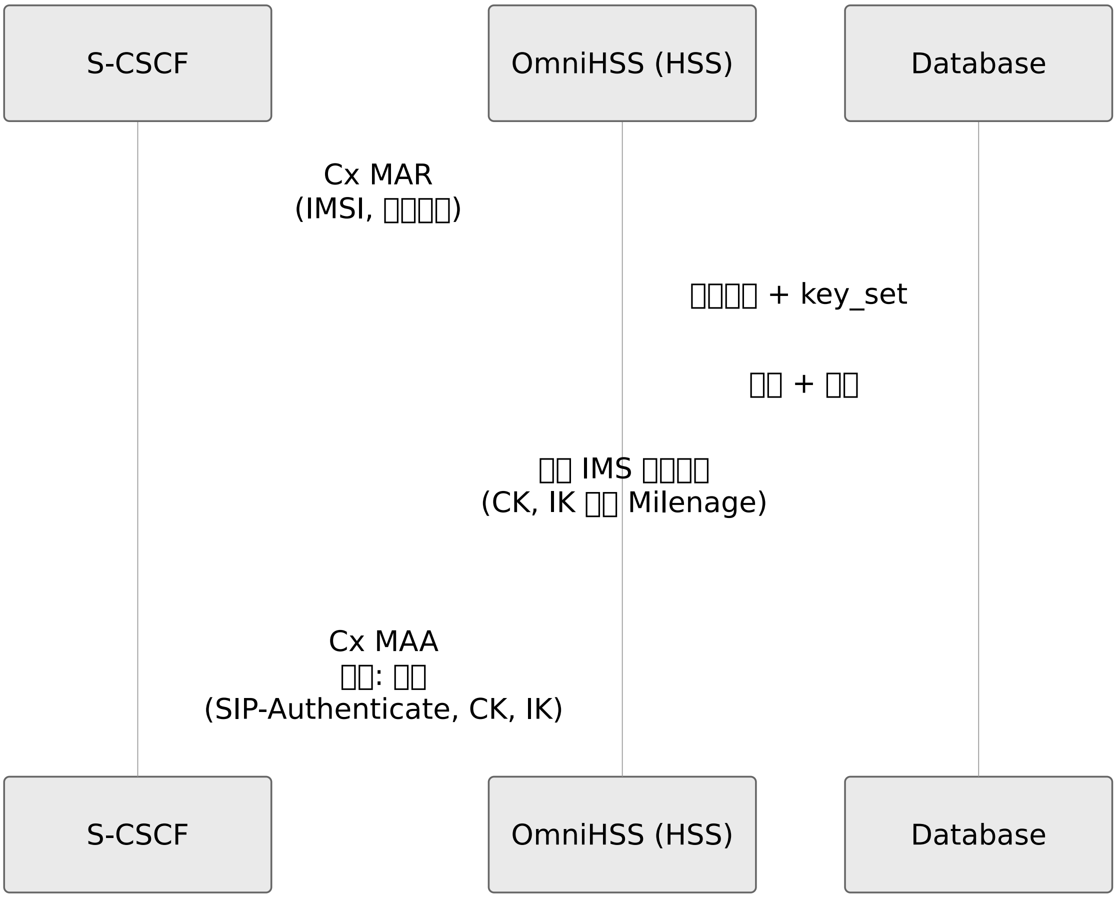
IFC □□□□:

- `{{imsi}}` → □□ IMSI
- `{{msisdns}}` → □□□□□□
- `{{mcc}}, {{mnc}}` → □□ PLMN □□

□□ SAR □□□□□□□□□□□□□□□□□□□□□□□□ `AUTHENTICATION_FAILURE` □ `AUTHENTICATION_TIMEOUT`□□□□ S-CSCF □□□□□

□□□□□□□□ (MAR/MAA)

S-CSCF □□ IMS □□□□□□□□


S-CSCF
OmniHSS (HSS)
Database
Cx MAR
(IMSI, □□□□)
□□□□ + key_set
□□ + □□
□□ IMS □□□□
(CK, IK □□ Milenage)
Cx MAA
□□: □□
(SIP-Authenticate, CK, IK)
S-CSCF
OmniHSS (HSS)
Database

S-CSCF □□□□

HSS □□□□□□□□□□□□ IMS □□□□□□□□□□□□□□□□□□□□□□ 3GPP TS 29.228 §3.1□

□□□□	□□□	□□□	□□
`assigned_scscf`	SAR □ □□□□□	SAR □□□□□□□/□□□□□□□□□□ □□□/□□□□□□□□□	□□□□ S-CSCF □□□□
`auth_pending_scscf`	MAR	SAR□□□□□□□□/□□□□UAR □ □□□ TTL □□	□ S-CSCF □□□ □□ IMS-AKA □ □□
`auth_pending_since`	MAR	□ `auth_pending_scscf` □ □	□□□□□□□□HSS □□□□□□□□□□□ □���□

MAR □□ S-CSCF □□□□□□□□□□□□□□□□ TS 29.228 §6.3□SAR □□□□□□□□□ TS 29.228 §6.1.2□

UAA S-CSCF □□□□□ □□□□ UAR□HSS □□□□ S-CSCF □□□□□□□□□□□□□□□□

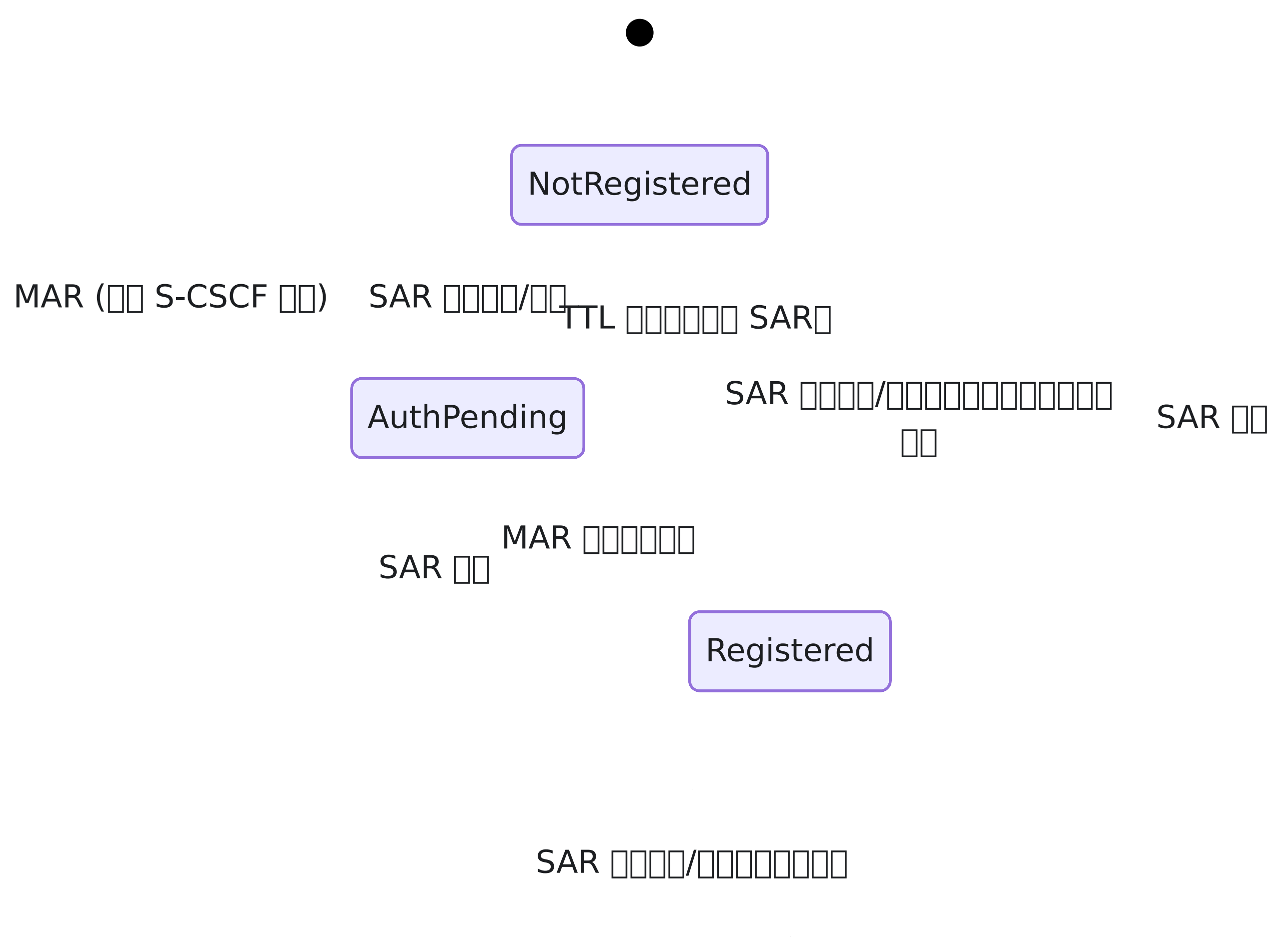
1. □□□□□□□□□□□□□□ S-CSCF□□□□□□□ `DIAMETER_SUBSEQUENT_REGISTRATION` (2002)□□ `auth_pending_scscf` □□□□ `auth_pending_since` □ `auth_pending_ttl_seconds` □□□□□□□□□□
2. `assigned_scscf` □□□□□□□ S-CSCF □□□□□□□□□ `DIAMETER_SUBSEQUENT_REGISTRATION` (2002)□
3. □□□□□□□□□□□□□ S-CSCF□□ S-CSCF □□□□□□□□ `DIAMETER_FIRST_REGISTRATION` (2001)□

□□ 2 □□□□□□□□□□ URI □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ URI□HSS □□□□ □□□□□□□□ 2001□□□□ SAR □□□□□□□□

□□□□□□□□□□ **S-CSCF**□ □□ 2 □□□□□□□□□□□□□□□□□□□□□□□□ UAR □□□□□ LIR □□□□□□□ HSS □□□□□□□□□□□�� URI□

HSS □□□□□□□□□ S-CSCF □□□ `assigned_scscf`□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ S-CSCF □□□□ □□□□

□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□ SAR □□□□□□□□□□□□□ S-CSCF □□□□□ SAR□□□□□□□□□□□□□□□HSS □□□□□ `auth_pending_ttl_seconds`□□□ 30 □□□□□□□□□ □□□□ TTL□□□□□□□□ MAR □□□ `assigned_scscf`□


NotRegistered
MAR (□□ S-CSCF □□)
SAR □□□□/□□
TTL □□□□□□ SAR□
AuthPending
SAR □□□□/□□□□□□□□□□□□ □□
SAR □□
MAR □□□□□□
SAR □□
Registered
SAR □□□□/□□□□□□□

Cx □□□□:

□□	□□	□□	□□
2001	DIAMETER_FIRST_REGISTRATION	□□□□□ S-CSCF□□□□□□□□□□	TS 29.229
2002	DIAMETER_SUBSEQUENT_REGISTRATION	□□□□□□ S-CSCF□HSS □□□□□□□□	TS 29.229

□□□□□□□□□□□□ (SAR):

□	□□	**HSS □□**
0	NO_ASSIGNMENT	□□ S-CSCF □□□□□□
1	REGISTRATION	□□□□□□□□□□□□□□□□□□
2	RE_REGISTRATION	□□□□□□□□□□□
4	TIMEOUT_DEREGISTRATION	□□ S-CSCF □□□□□□
5	USER_DEREGISTRATION	□□ S-CSCF □□□□□□
6	TIMEOUT_DEREGISTRATION_STORE_SERVER_NAME	□□□□□□□ S-CSCF □□□
7	USER_DEREGISTRATION_STORE_SERVER_NAME	□□□□□□□ S-CSCF □□□
8	ADMINISTRATIVE_DEREGISTRATION	□□ S-CSCF □□□□□□
9	AUTHENTICATION_FAILURE	□□□□□□□□□□□□□□□□□□□□□□□□□□□ S-CSCF □□□
10	AUTHENTICATION_TIMEOUT	□□□□□□□□□□□□□□□□□□□□□□□□□□□ S-CSCF □□□
11	DEREGISTRATION_TOO_MUCH_DATA	□□ S-CSCF □□□□□□

□□ 6 □ 7 □□□□□□□□ S-CSCF □□□□□ TS 29.228 §6.1.2□□□□□□□□□□□□□□□□□□□□□□□□□□□ UAR □□□□□□□

□□□□□□□□□□□□□ `AUTHENTICATION_FAILURE` □ `AUTHENTICATION_TIMEOUT` SAR □□□□□□□□□□□□□□□□□□□□□□□□ SAR □□□□□□□□□□ S-CSCF□□ I-CSCF □□□ REGISTER □□□□□□□□□□□□□□□□□□□□□□HSS □□□□□□□□□□□□□□□□□□□□□S-CSCF □□□□ □□□□□HSS □□□□□□□ UAR □□□□□□□□□ UE □□□□□ SAR □□□□□□□□□□□□□□□□

□□□ hss_cx_auth_abandon_total □□□□□□□□□□□□□□□□□□□□

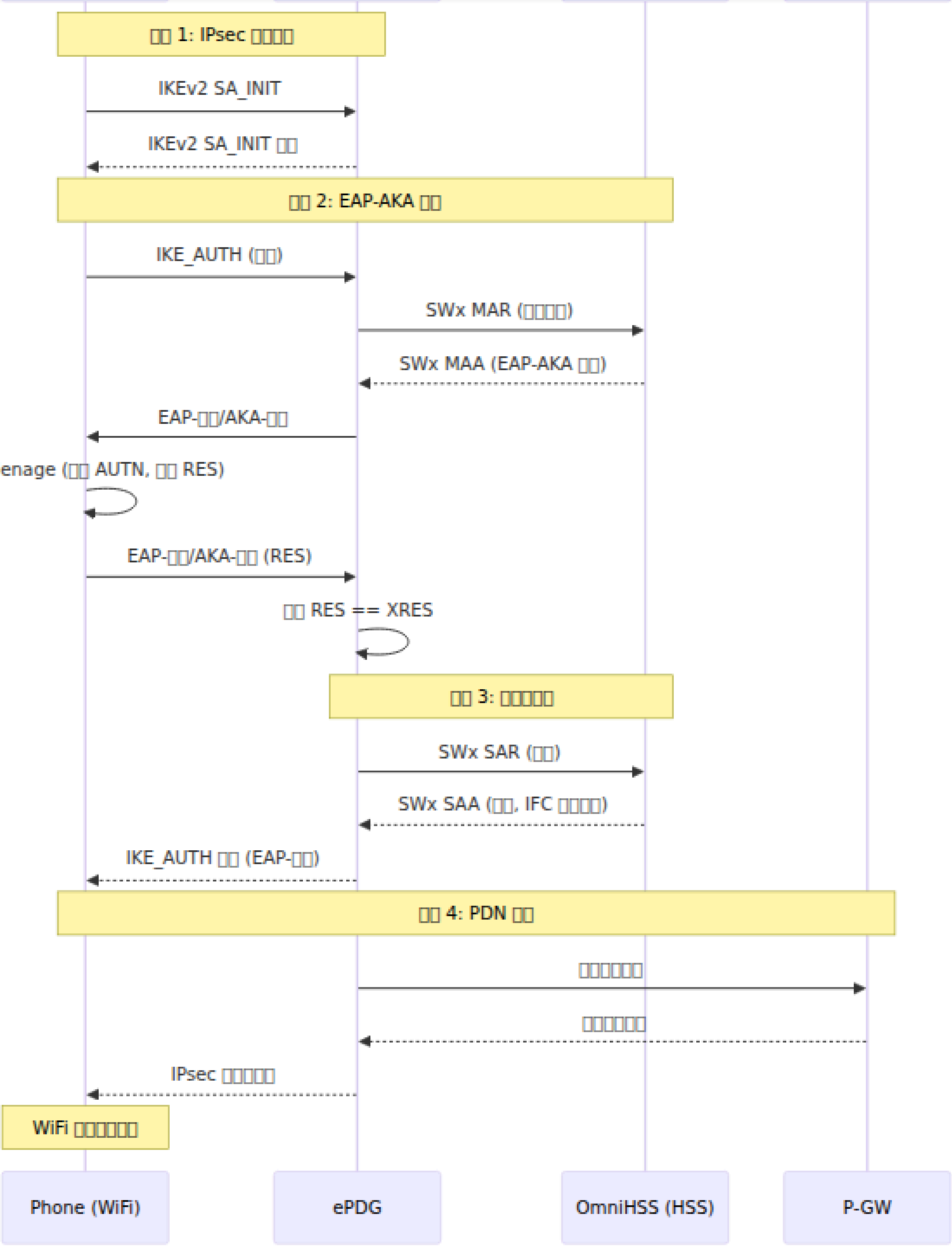
□□□□□□ S-CSCF

□□ IMS □□□□□ IMSI □□□ MSISDN □□□□□□□□□□ □ MSISDN □□ IMSI □□□□□□□□□□□□ S-CSCF □□□

HSS □ IMS □□□□□□□□□□ S-CSCF □□□□□□□

1. □□□□□□□□□□□□□□□□□ UAA □□□□□□□□□□ URI□□ `:random_peer` □□□□□□
2. □□□□□□□□□□□□□□□ SAR□HSS □□□□□□□□□□
3. □□□□□□□□□□□ UAA □□□□□□□□□□□□□□□□□□□□□ S-CSCF □□
4. □□□□□□□□□□□□□□□□□

HSS □□□□□ URI□□ URI □□□□□□□□□□□□ HSS □□ I-CSCF □□□□□□□□□□□□□□□□□□□□□□□□□ URI□□□□□ SAR □□□□□□□□□□□□□

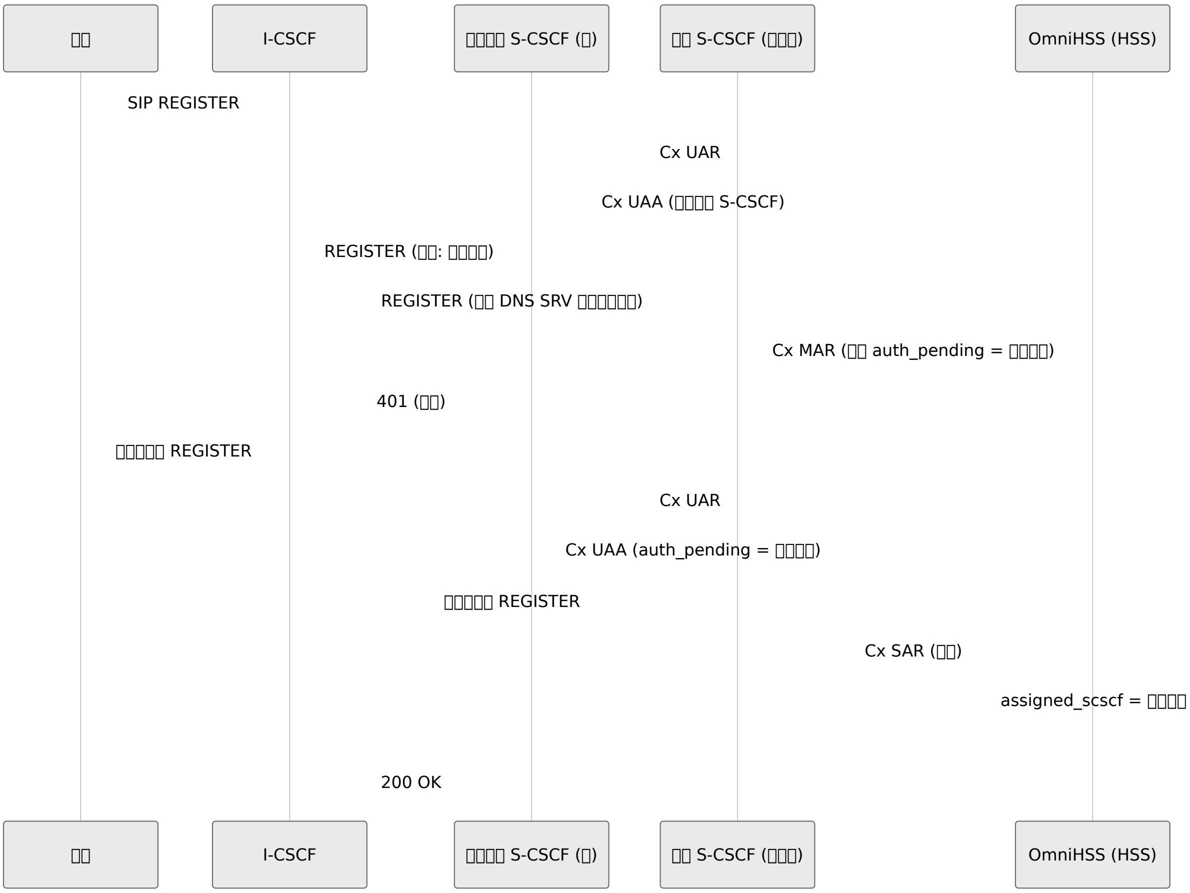

□□ 1: IPsec □□□□
IKEv2 SA_INIT
IKEv2 SA_INIT □□
□□ 2: EAP-AKA □□
IKE_AUTH (□□)
SWx MAR (□□□□)
SWx MAA (EAP-AKA □□)
EAP-□□/AKA-□□
□□ Milenage (□□ AUTN, □□ RES)
EAP-□□/AKA-□□ (RES)
□□ RES == XRES
□□ 3: □□□□□
SWx SAR (□□)
SWx SAA (□□, IFC □□□□)
IKE_AUTH □□ (EAP-□□)
□□ 4: PDN □□
□□□□□□
□□□□□□
IPsec □□□□□
WiFi □□□□□□
Phone (WiFi)
ePDG
OmniHSS (HSS)
P-GW

S-CSCF □□□□

□□□□□□□ S-CSCF □□□□□□I-CSCF □□ REGISTER □□□□□□ S-CSCF □□□□□□□□ S-CSCF □□□□□□□□□□□□□□□□ I-CSCF □□□□□□□ HSS `auth_pending_scscf` □□□□□□□□

□□□□□□□□□

□□□□	□□□□	□□
□□□□□ S-CSCF □□□HSS □□□□□□□□□□ □□	DNS □□ NXDOMAIN□ I-CSCF □□□□□□□□□□□ □□	I-CSCF □□□□□□ URI□DNS SRV □□□□□□ □ S-CSCF□
□□□□□ S-CSCF□S-CSCF □□□□□□	TCP □□□□□□□□□□□□	I-CSCF □□□□□□□□□□□□ URI□ `use_dst_blocklist` □ `use_dns_failover` □ DNS □□□□□□


□□
I-CSCF
□□□□ S-CSCF (□)
□□ S-CSCF (□□□)
OmniHSS (HSS)
SIP REGISTER
Cx UAR
Cx UAA (□□□□ S-CSCF)
REGISTER (□□: □□□□)
REGISTER (□□ DNS SRV □□□□□□)
Cx MAR (□□ auth_pending = □□□□)
401 (□□)
□□□□□ REGISTER
Cx UAR
Cx UAA (auth_pending = □□□□)
□□□□□ REGISTER
Cx SAR (□□)
assigned_scscf = □□□□
200 OK
□□
I-CSCF
□□□□ S-CSCF (□)
□□ S-CSCF (□□□)
OmniHSS (HSS)

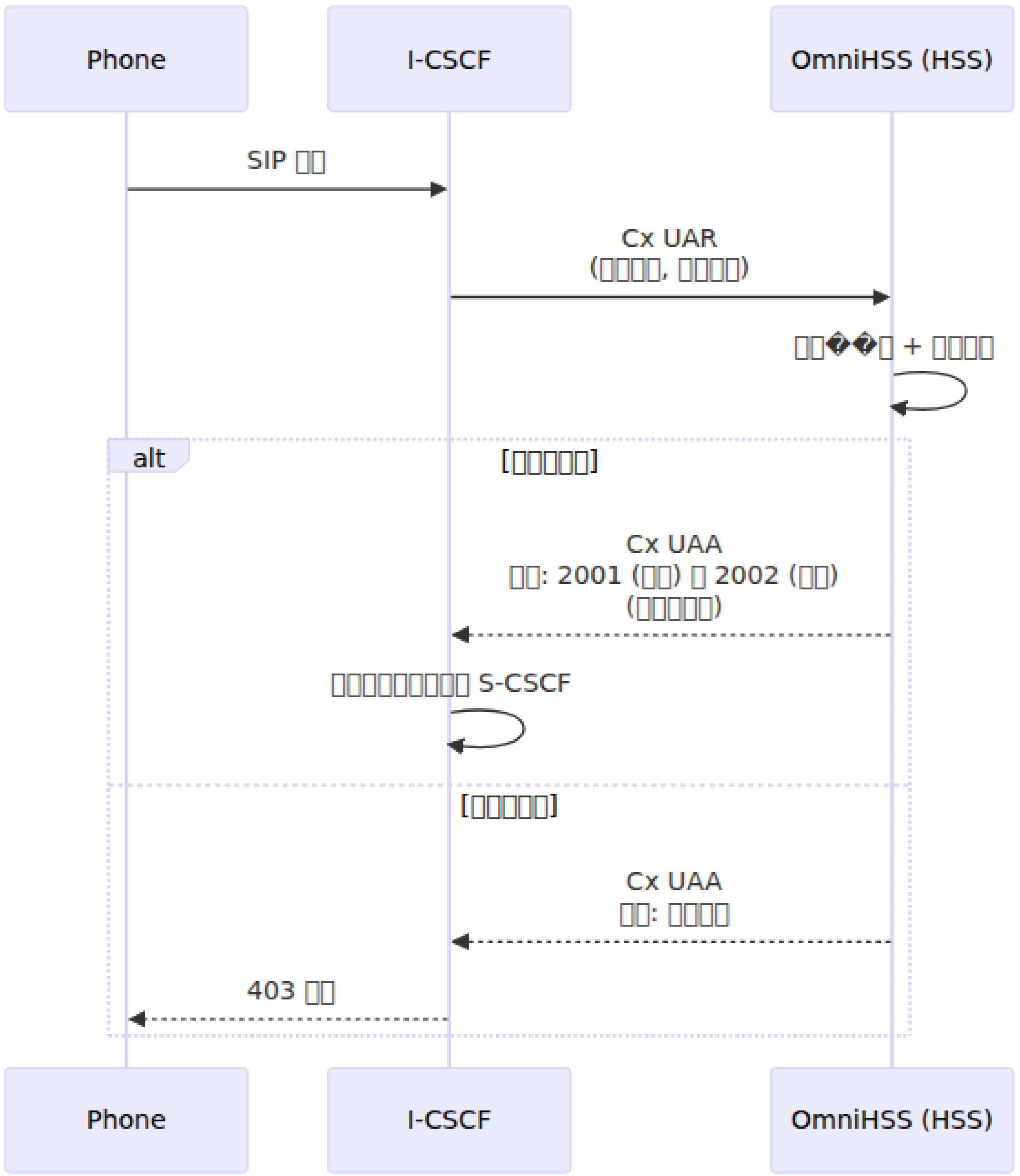
□□□□□□ REGISTER □□□□□□□□□□□□□□□□□ S-CSCF□UAA □□ `auth_pending_scscf` □□□□□□□ □□□□□□□□□□□□□□□□ MAR □□□□HSS □□□□□ UAR □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ REGISTER □□□□□□□□□□□□□□□□□□□□□□□

□□□□ □□ S-CSCF □ IMS-AKA □□□□□□□□□□□UE □□□□□ S-CSCF □□□□□□□□□□□□□UE □□□□□□□□□□ □□□□□□□□□□□□□□□□ S-CSCF □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ S-CSCF□

□□□□□□□□□□□□ `selection_method: :pool_uri`□□ S-CSCF □□□□□□□□□□ I-CSCF □□□□□□□

□□□□□□ (LIR/LIA)

I-CSCF □□□□ S-CSCF □□□□□□□□□□

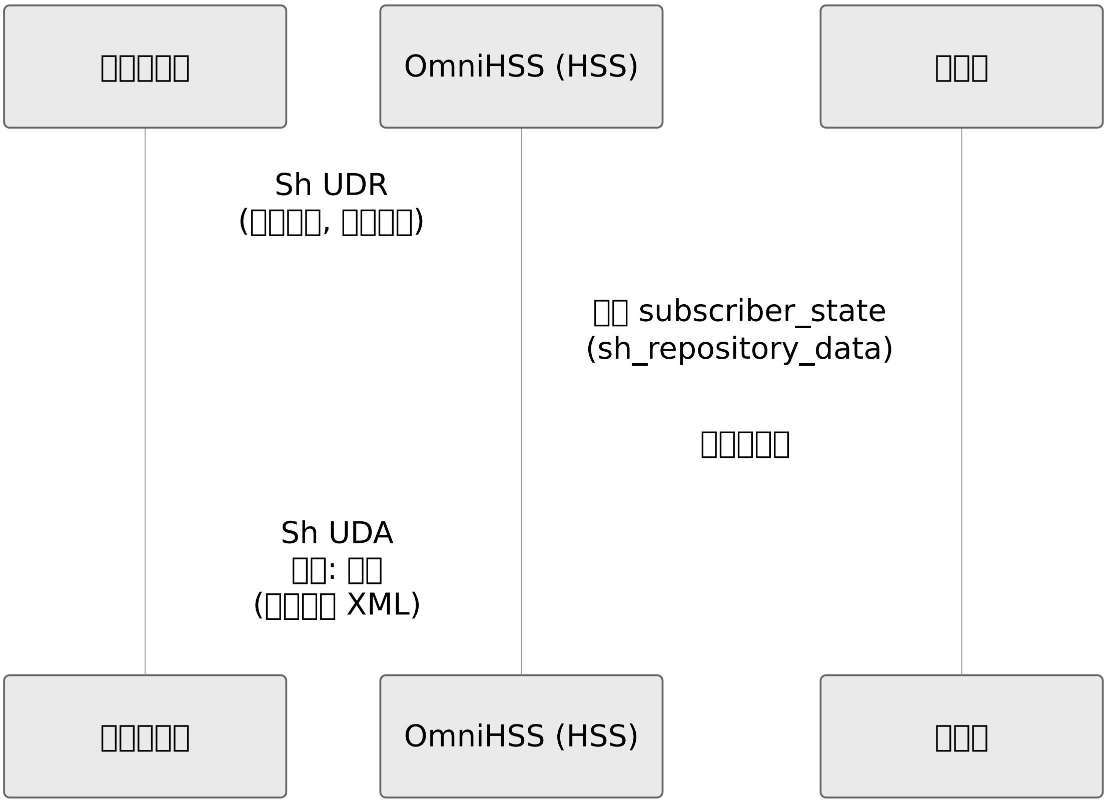

Phone
I-CSCF
OmniHSS (HSS)
SIP □□
Cx UAR
(□□□□, □□□□)
□□��□ + □□□□
alt
[□□□□□]
Cx UAA
□□: 2001 (□□) □ 2002 (□□)
(□□□□□)
□□□□□□□□□ S-CSCF
[□□□□□]
Cx UAA
□□: □□□□
403 □□
Phone
I-CSCF
OmniHSS (HSS)

Sh □□ (IMS □□□□)

□□□ Sh RepositoryData (□□□□) □□□□□□□□□□□/□□□□□□□ MMTEL □□ / IMS-ODB □□□□□ REST □□ API□

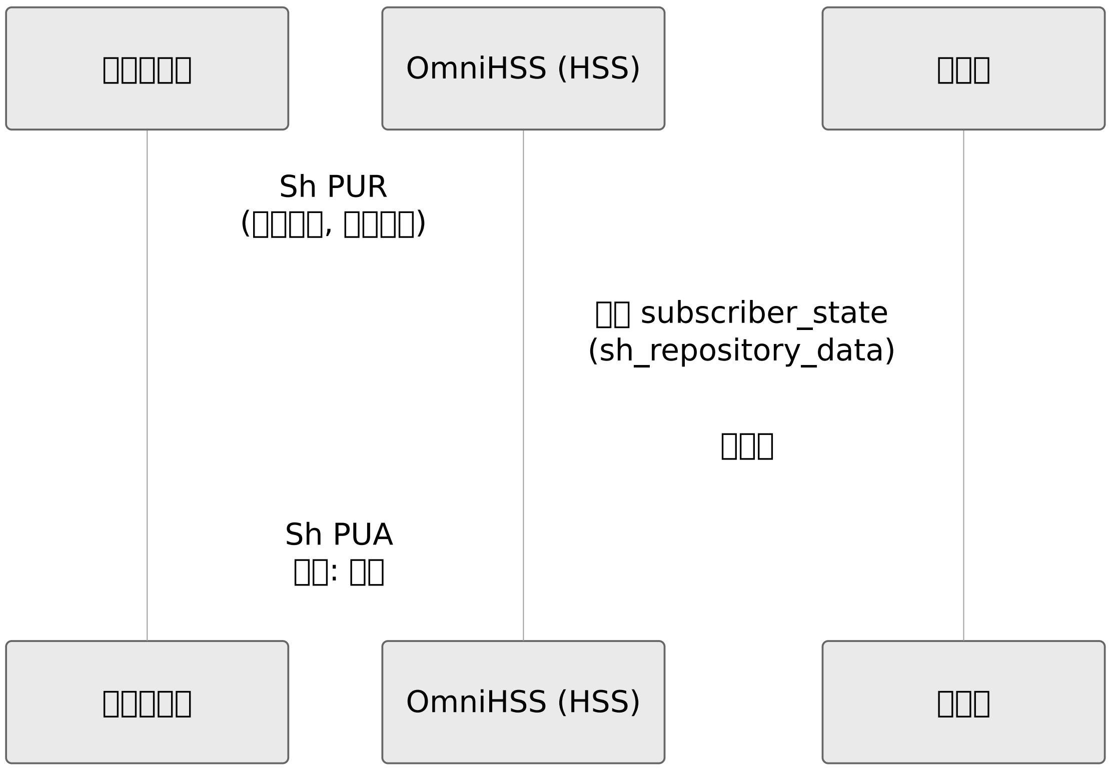
[illegible] (UDR/UDA)

[illegible]


[illegible]
OmniHSS (HSS)
[illegible]
Sh UDR
([illegible], [illegible])
[illegible] subscriber_state
(sh_repository_data)
[illegible]
Sh UDA
[illegible]: [illegible]
([illegible] XML)
[illegible]
OmniHSS (HSS)
[illegible]

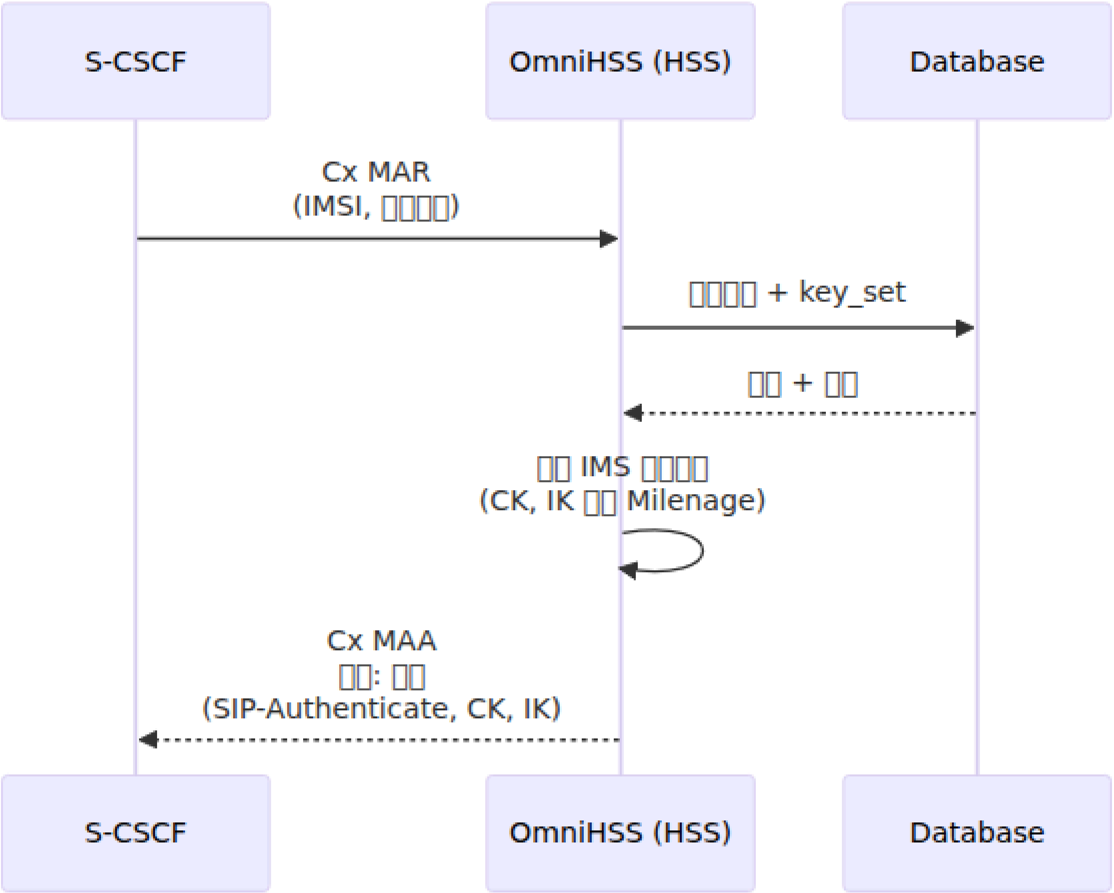
[illegible] (PUR/PUA)

[illegible]


□□□□□
OmniHSS (HSS)
□□□
Sh PUR
(□□□□, □□□□)
□□ subscriber_state
(sh_repository_data)
□□□
Sh PUA
□□: □□
□□□□□
OmniHSS (HSS)
□□□

□□□□□□ (SNR/SNA)

□□□□□□□□□□□□


S-CSCF
OmniHSS (HSS)
Database
Cx MAR
(IMSI, □□□□)
□□□□ + key_set
□□ + □□
□□ IMS □□□□
(CK, IK □□ Milenage)
Cx MAA
□□: □□
(SIP-Authenticate, CK, IK)
S-CSCF
OmniHSS (HSS)
Database

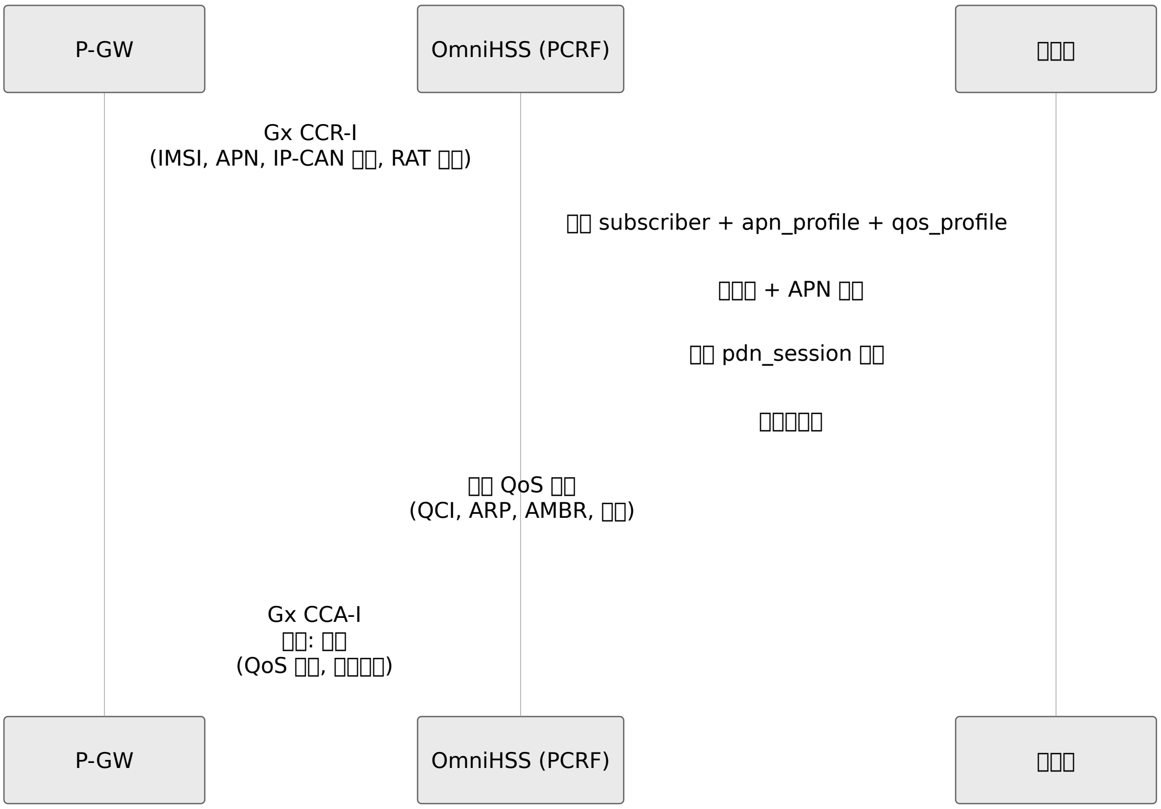
Gx □□ (□□□□)

OmniHSS □□ Gx □□□□ PCRF□□□□□□□□□□□□□□

□□□ **PCRF □□** □□□□□□□□□□□□□□ **QoS** □□□

□□□□□□ - □□ (CCR-I/CCA-I)

P-GW □ PDN □□□□□□□□□□□□

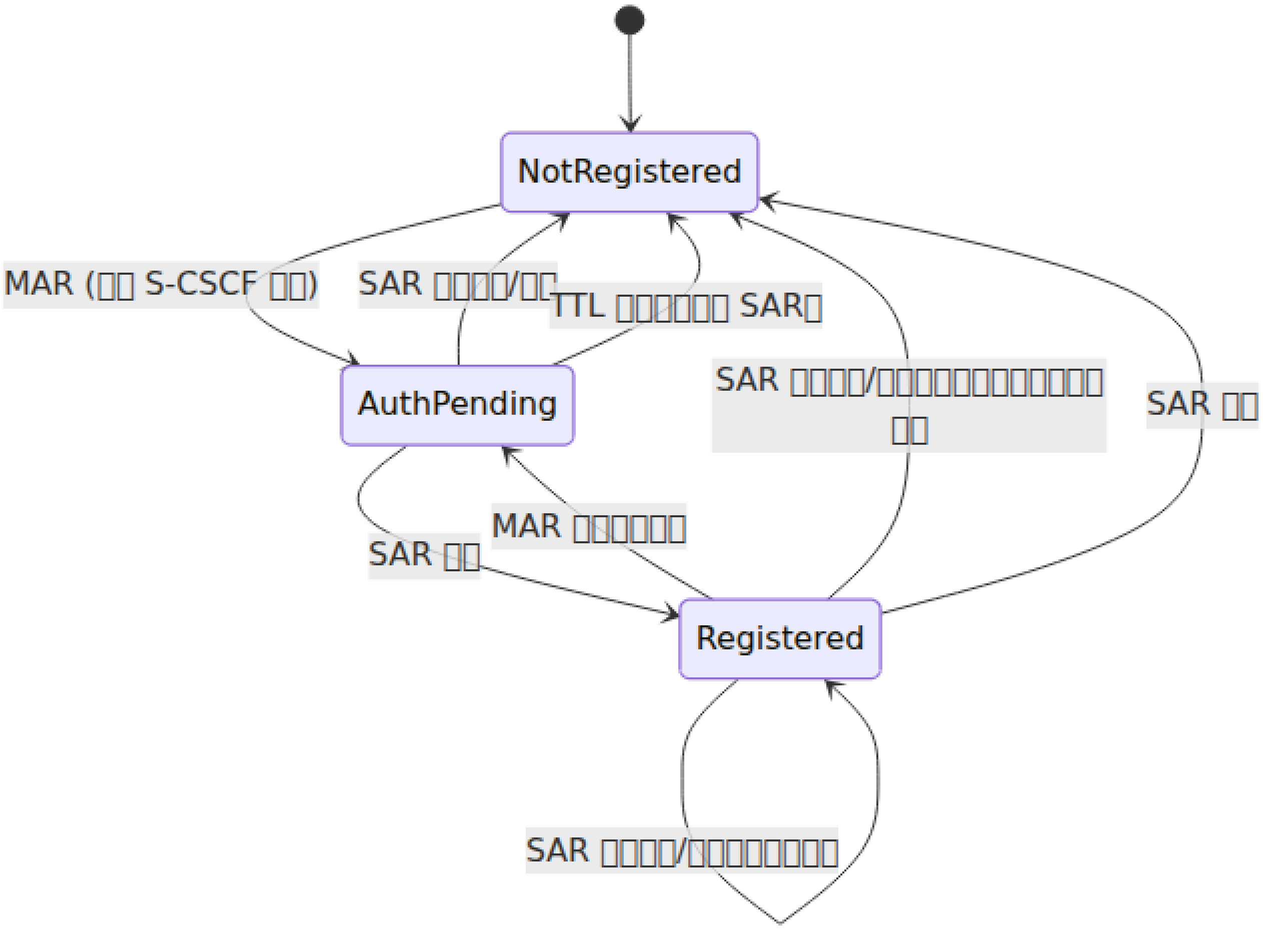

P-GW
OmniHSS (PCRF)
[illegible]
Gx CCR-I
(IMSI, APN, IP-CAN [illegible], RAT [illegible])
[illegible] subscriber + apn_profile + qos_profile
[illegible] + APN [illegible]
[illegible] pdn_session [illegible]
[illegible]
[illegible] QoS [illegible]
(QCI, ARP, AMBR, [illegible])
Gx CCA-I
[illegible]: [illegible]
(QoS [illegible], [illegible])
P-GW
OmniHSS (PCRF)
[illegible]

[illegible] AVP:

- [illegible]: Subscription-Id (IMSI), Called-Station-Id (APN), RAT-Type, IP-CAN-Type
- [illegible]: QoS-Information (QCI, ARP, AMBR), Charging-Rule-Install

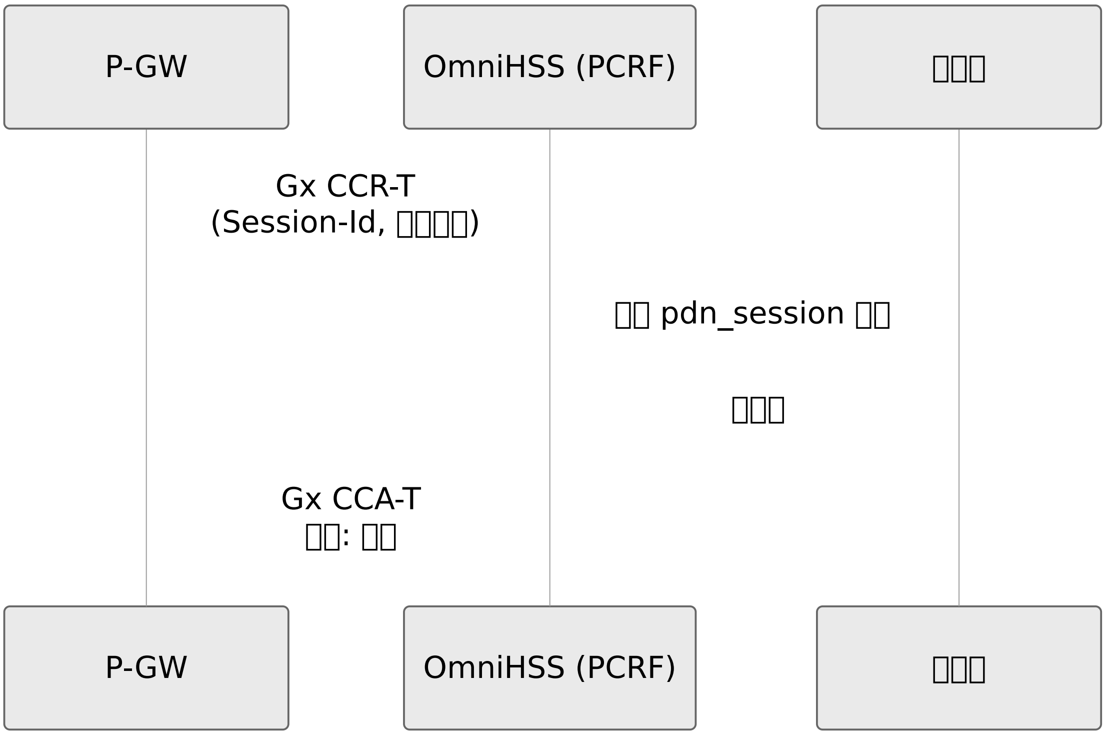
[illegible] - [illegible] (CCR-U/CCA-U)

P-GW [illegible]


NotRegistered
AuthPending
Registered
MAR (□□ S-CSCF □□)
SAR □□□□/□□
TTL □□□□□□□ SAR□
SAR □□□□/□□□□□□□□□□□□ □□
SAR □□
MAR □□□□□□
SAR □□
SAR □□□□/□□□□□□□□

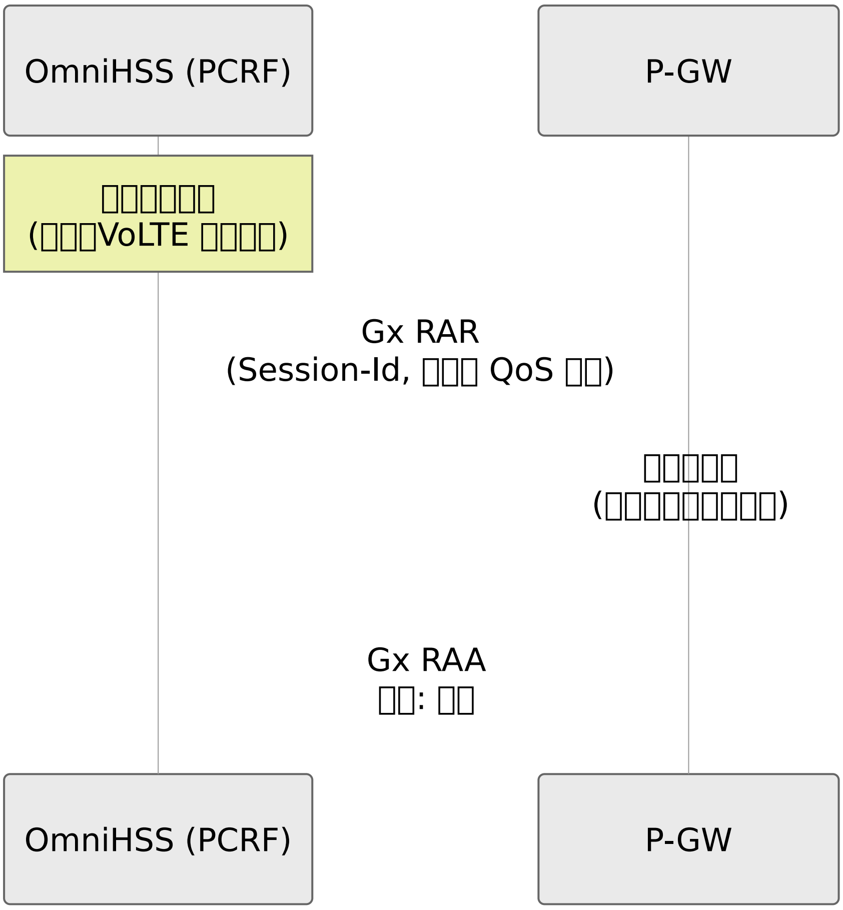
□□□□□□ - □□ (CCR-T/CCA-T)

P-GW □□ PDN □□□□□


P-GW
OmniHSS (PCRF)
□□□
Gx CCR-T
(Session-Id, □□□□)
□□ pdn_session □□
□□□
Gx CCA-T
□□: □□
P-GW
OmniHSS (PCRF)
□□□

□□□□□□ (RAR/RAA)

OmniHSS (PCRF) □ P-GW □□□□□□□


OmniHSS (PCRF)
P-GW
□□□□□□
(□□□VoLTE □□□□)
Gx RAR
(Session-Id, □□□ QoS □□)
□□□□□
(□□□□□□□□□)
Gx RAA
□□: □□
OmniHSS (PCRF)
P-GW

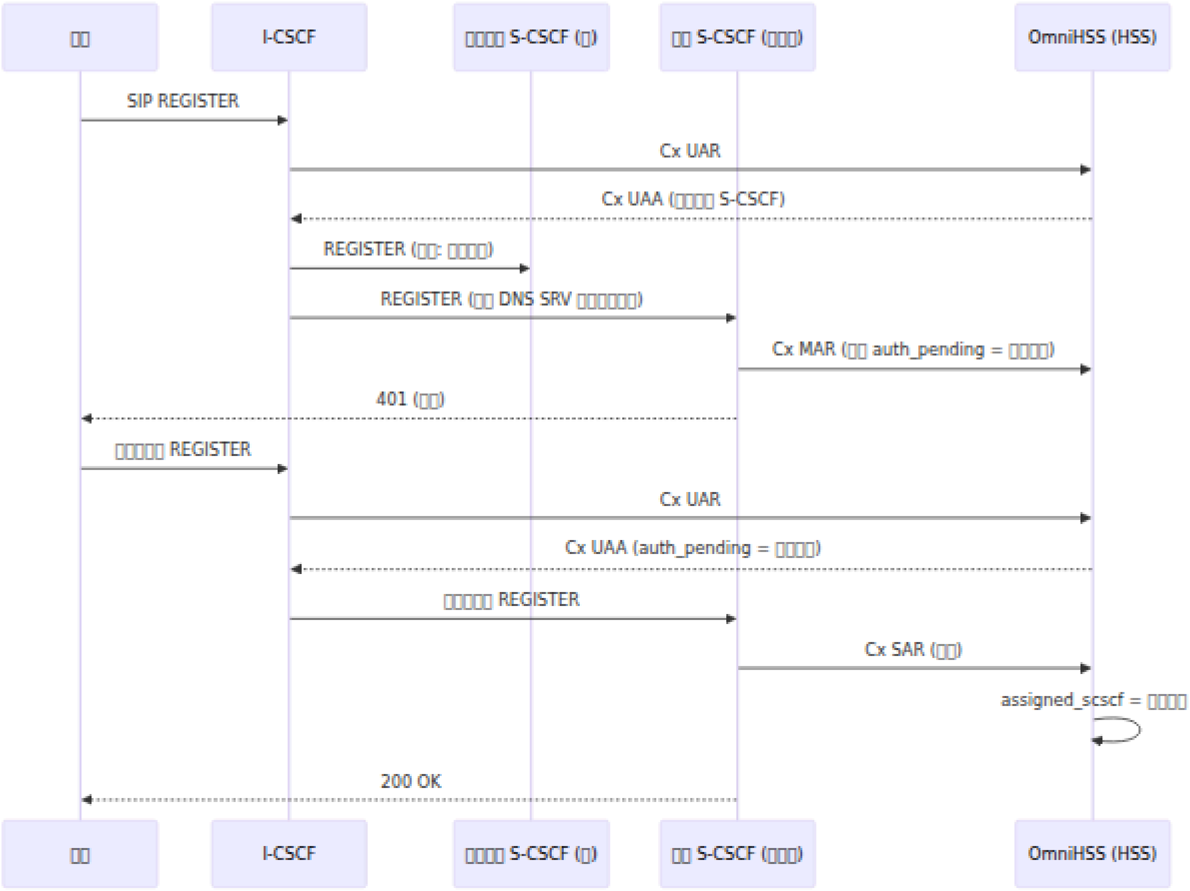
Rx □□ (IMS □□□□)

OmniHSS □□ Rx □□□□ PCRF □□□□□□ IMS □□□□□

□□□ **PCRF □□** □□□□□□ **VoLTE** □□□□□□□□□□

AA □□ (AAR/AAA)

P-CSCF □□ IMS □□□□□□□□

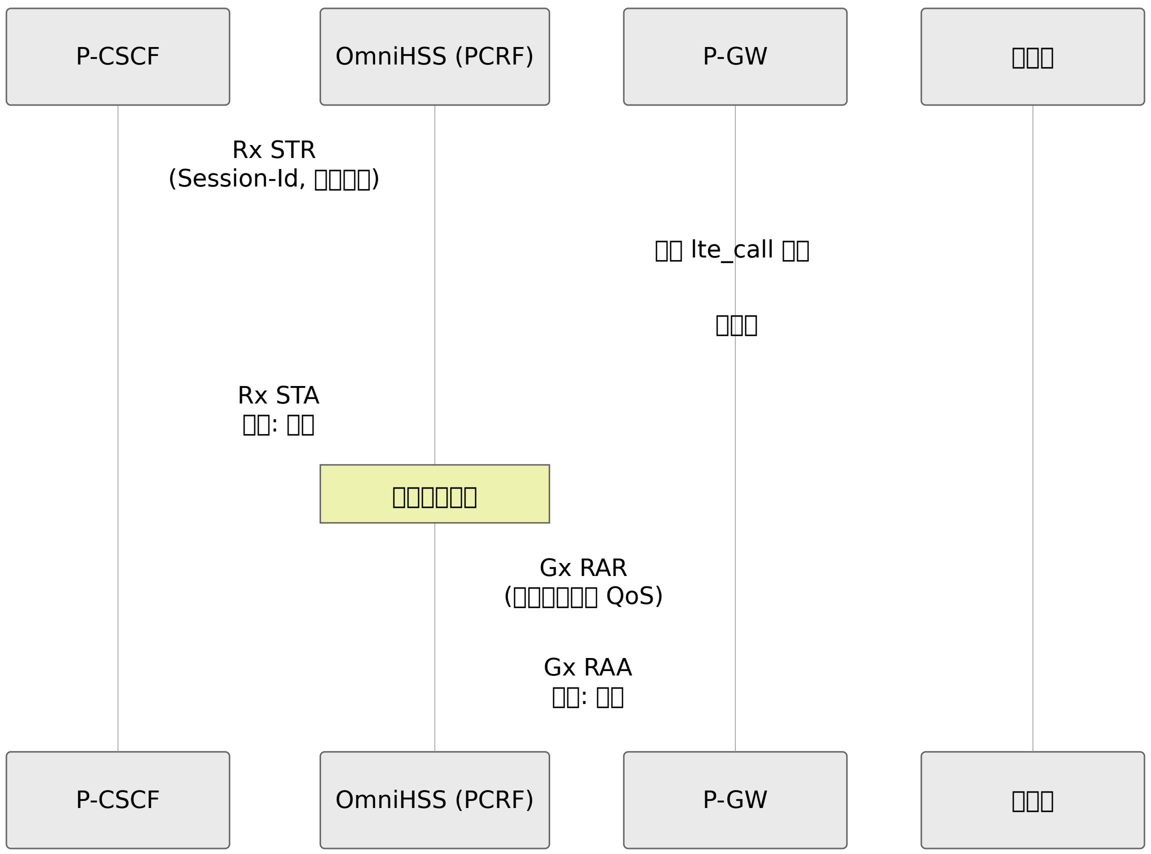

□□
I-CSCF
□□□□ S-CSCF (□)
□□ S-CSCF (□□□)
OmniHSS (HSS)
SIP REGISTER
Cx UAR
Cx UAA (□□□□ S-CSCF)
REGISTER (□□: □□□□)
REGISTER (□□ DNS SRV □□□□□□)
Cx MAR (□□ auth_pending = □□□□)
401 (□□)
□□□□□ REGISTER
Cx UAR
Cx UAA (auth_pending = □□□□)
□□□□□ REGISTER
Cx SAR (□□)
assigned_scscf = □□□□
200 OK

□□□□:

- □□ SDP □□□□□□□□□□
- □□□□□□ (□□/□□)
- □□□□□□ SDF □□□
- □□ Gx RAR □□□□□□

□□□□□□ (STR/STA)

P-CSCF □□ IMS □□□□□


P-CSCF
OmniHSS (PCRF)
P-GW
□□□
Rx STR
(Session-Id, □□□□)
□□ lte_call □□
□□□
Rx STA
□□: □□
□□□□□□
Gx RAR
(□□□□□□ QoS)
Gx RAA
□□: □□
P-CSCF
OmniHSS (PCRF)
P-GW
□□□

Sy □□ (□□□□□□)

OmniHSS □□ PCRF□□□ Sy □□□□□ OCS□□□□□□□□□□□□□□□□□□□□□□ Gx □□□□□□□□□□□ Sy □□□□□□ ID `16777302` (3GPP TS 29.219)□HSS □ Sy □□□□OCS □□□□□□□□ Sy □□ □□□□□□□□□□□□□□□□AVP□□□□□

□□□□□□ (SLR/SLA)

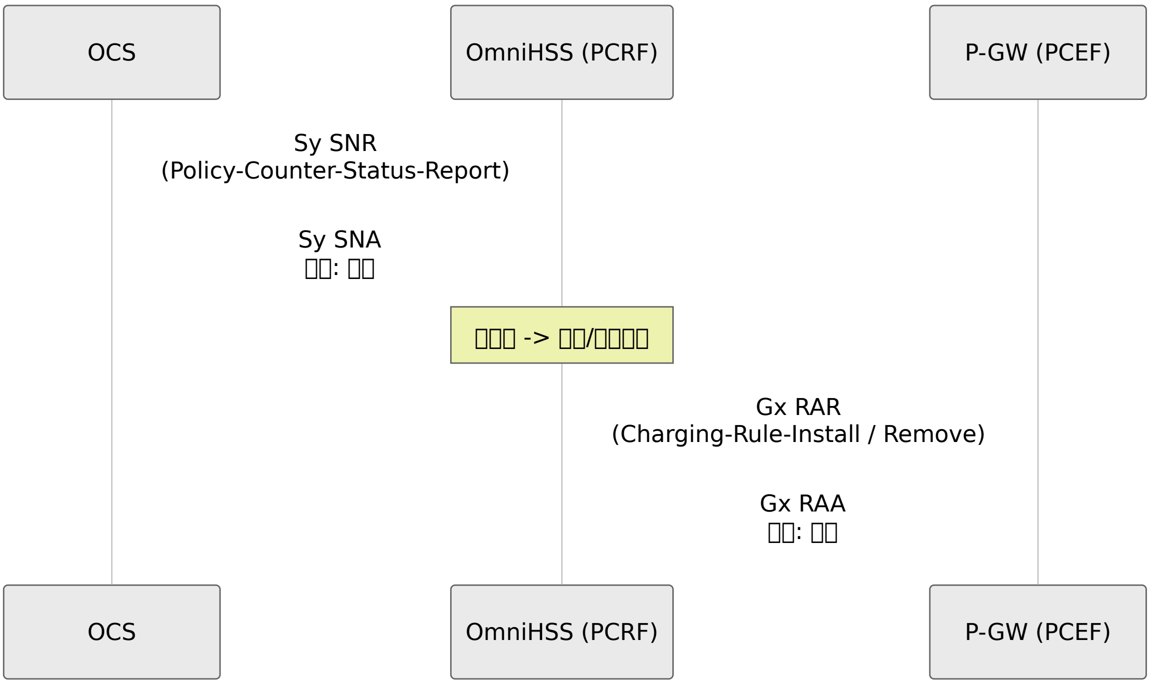
PCRF □□□□□□□□ Sy □□□□□ OCS □□□□□□□□□□□□□□□□□□□□□□□□□□□□ Gx CCA □□

Parse error on line 9: ...HSS: □□□□□□□□□□□□□□;<br/>□□□□□□/□□ H ------------------------^ Expecting 'SPACE', 'NEWLINE', 'create', 'box', 'end', 'autonumber', 'activate', 'deactivate', 'title', 'legacy_title', 'acc_title', 'acc_descr', 'acc_descr_multiline_value', 'loop', 'rect', 'opt', 'alt', 'par', 'par_over', 'critical', 'break', 'option', 'and', 'else', 'participant', 'participant_actor', 'destroy', 'note', 'links', 'link', 'properties', 'details', 'ACTOR', got 'INVALID'

□□

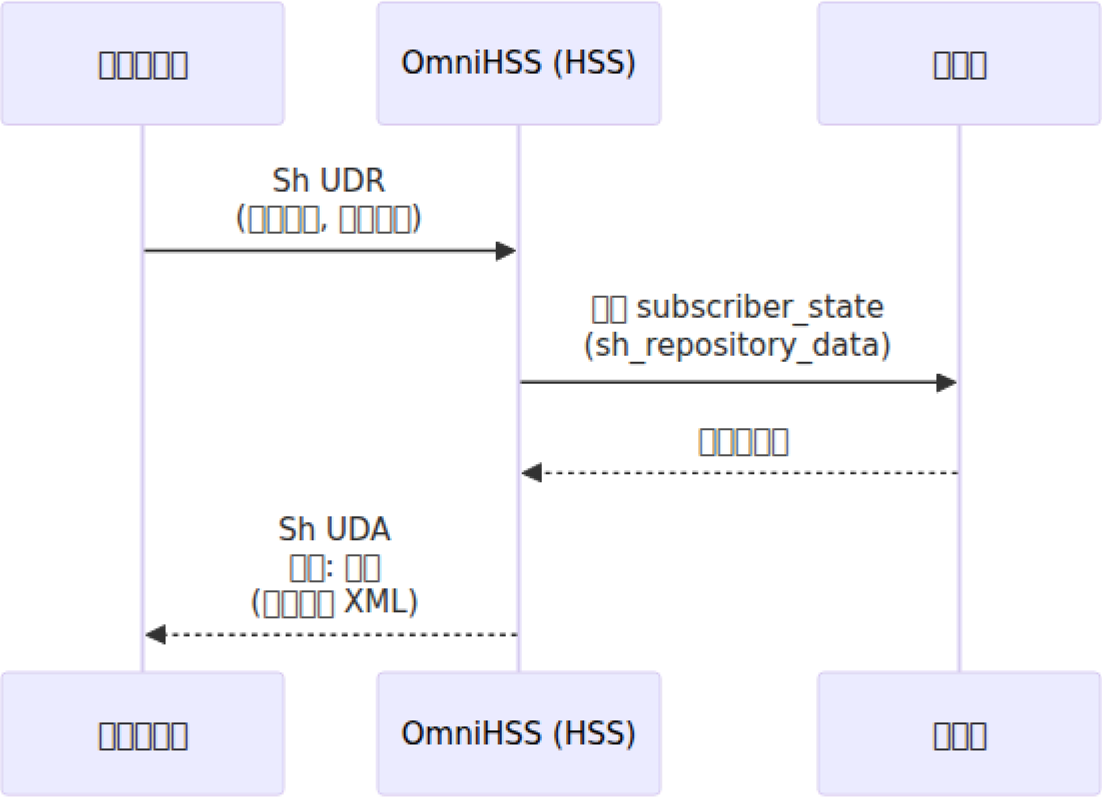
□□□□□□ (SNR/SNA)

□□□□□□□□□□□□□□□□□□□□□OCS □□ PCRF□PCRF □□ Gx RAR □□□□□□□□ PGW□


OCS
OmniHSS (PCRF)
P-GW (PCEF)
Sy SNR
(Policy-Counter-Status-Report)
Sy SNA
□□: □□
□□□ -> □□/□□□□
Gx RAR
(Charging-Rule-Install / Remove)
Gx RAA
□□: □□
OCS
OmniHSS (PCRF)
P-GW (PCEF)

□□□□ (STR/STA)

□□□□□□□□□□□□□□□□□□PCRF □□ Sy □□□


[illegible]
OmniHSS (HSS)
[illegible]
Sh UDR
([illegible], [illegible])
[illegible] subscriber_state
(sh_repository_data)
[illegible]
Sh UDA
[illegible]: [illegible]
([illegible] XML)
[illegible]
OmniHSS (HSS)
[illegible]

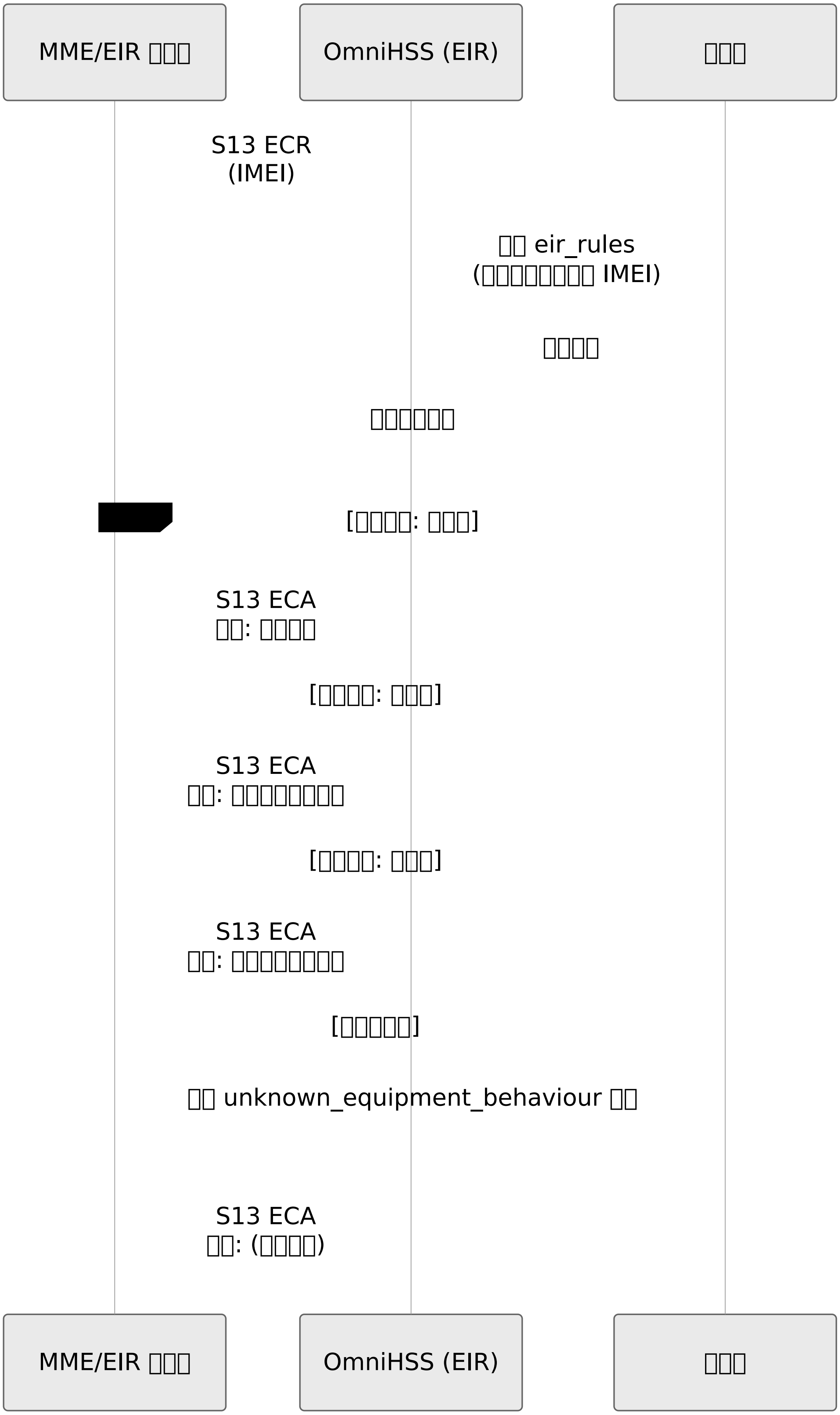
S13 [illegible] (EIR)

OmniHSS [illegible] S13 [illegible] EIR[illegible]

[illegible] **EIR [illegible]** [illegible]**IMEI** [illegible]

ME [illegible] (ECR/ECA)

[illegible] EIR [illegible] MME[illegible]


MME/EIR □□□
OmniHSS (EIR)
□□□
S13 ECR
(IMEI)
□□ eir_rules
(□□□□□□□□ IMEI)
□□□□
□□□□□□
[□□□□: □□□]
S13 ECA
□□: □□□□
[□□□□: □□□]
S13 ECA
□□: □□□□□□□□
[□□□□: □□□]
S13 ECA
□□: □□□□□□□□
[□□□□□]
□□ unknown_equipment_behaviour □□
S13 ECA
□□: (□□□□)
MME/EIR □□□
OmniHSS (EIR)
□□□

□□□□□:

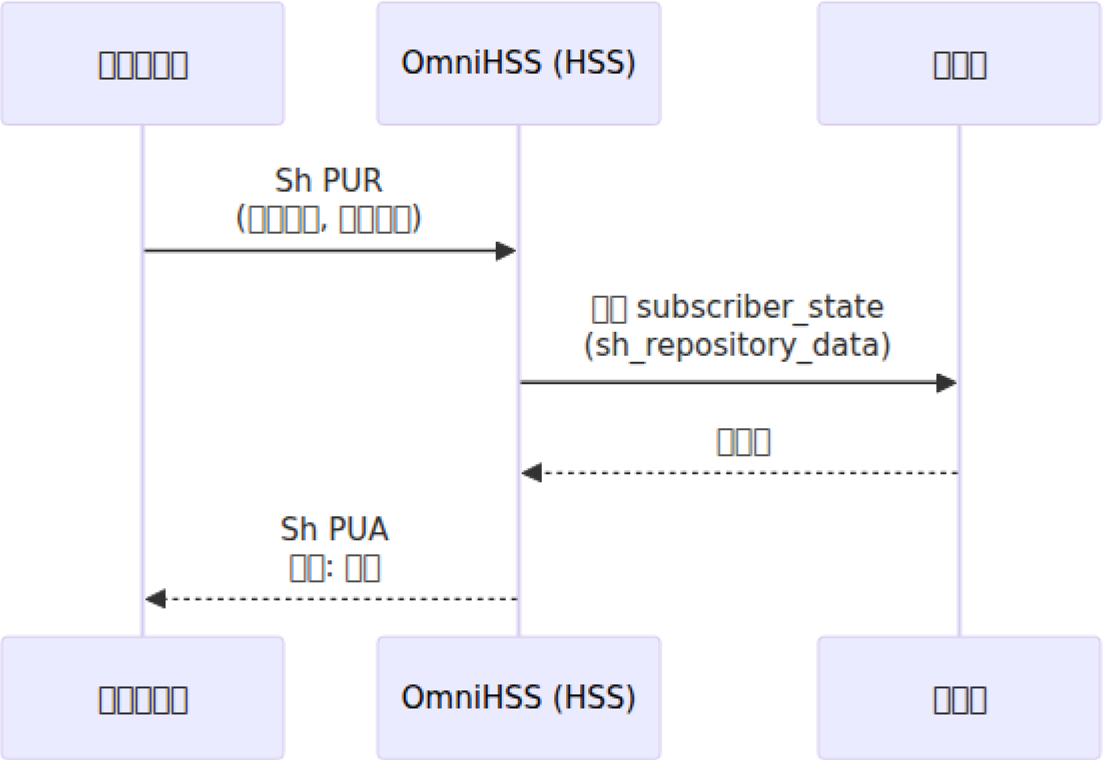
- **□□□□ (0)** - □□□□□□□□□
- **□□□□□□□□ (1)** - □□□□□
- **□□□□□□□□ (2)** - □□□□□□□□

SLh □□ (LCS / □□□□)

OmniHSS □□ SLh `LCS-Routing-Info-Request` (RIR)□□□ GMLC □□□ SLg □□□□□□□□□□□□□□□□□□□□ MME□□□□□□ MME □□ S6a □□□□□□□□□□□□□SLh □□□□□□ ID `16777291` (3GPP TS 29.173)□

LCS □□□□□□□ (RIR/RIA)

GMLC □□□□□□□□□□□


□□□□□
OmniHSS (HSS)
□□□
Sh PUR
(□□□□, □□□□)
□□ subscriber_state
(sh_repository_data)
□□□
Sh PUA
□□: □□
□□□□□
OmniHSS (HSS)
□□□

□□:

- IMSI □□ `□□□□`□MSISDN □□□□□□□

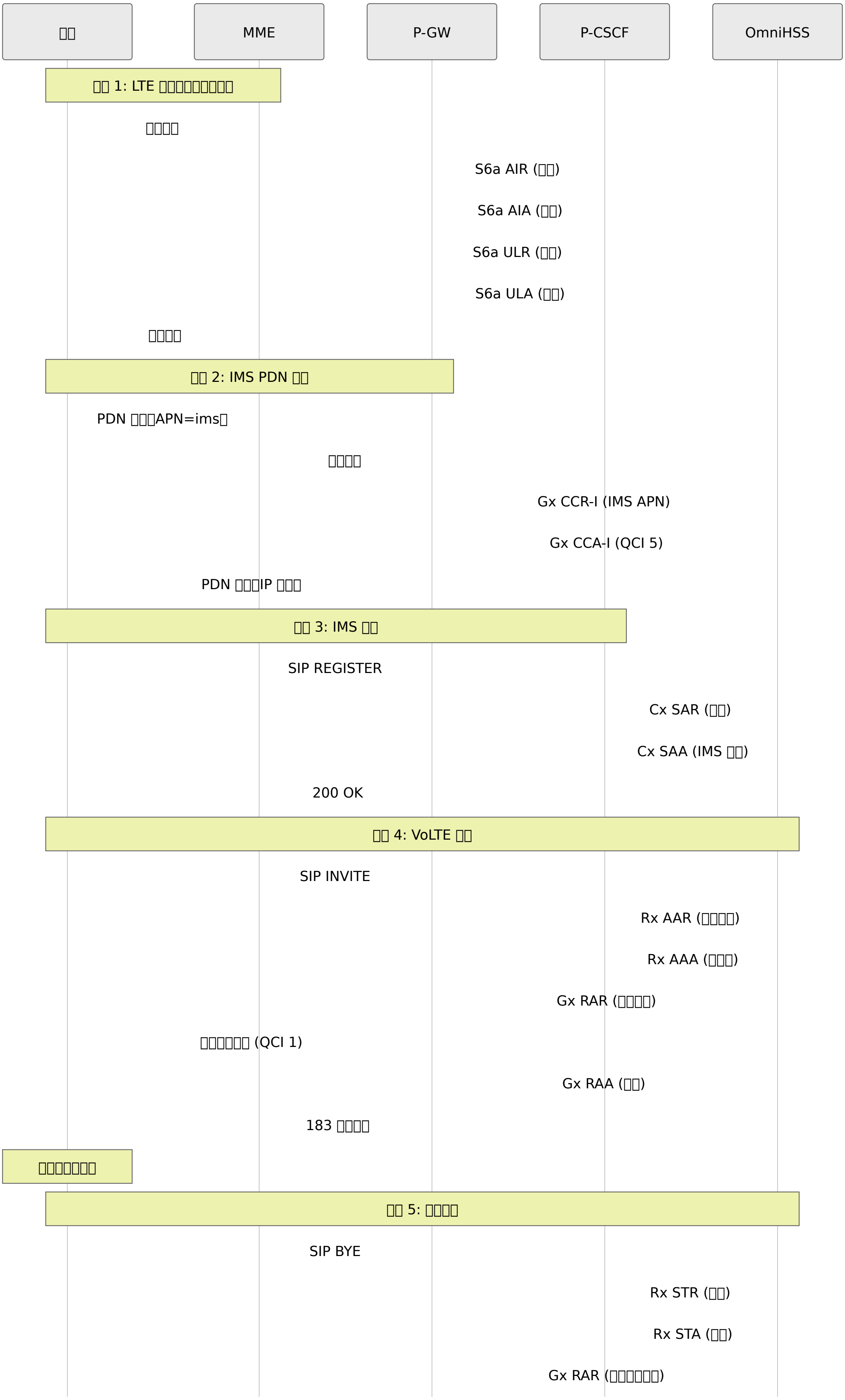
- □□□ `□□□□` □□ S6a AIR/ULR □□□□□□□□□ `MME □□`/`MME □`□`subscriber_state.last_seen_mme` / `last_seen_realm`□ - □□□□□□□
- GMLC □□□□□□ RIA □□□ SLg Provide-Location-Request □□□□ MME□

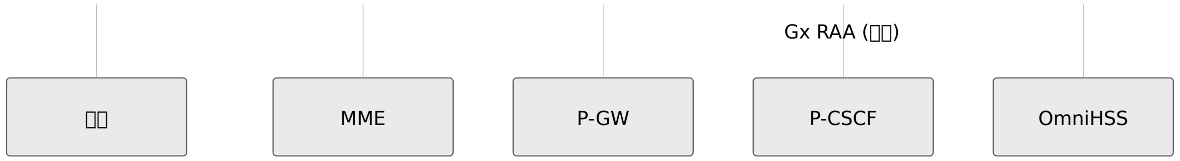
□□□□:

- **2001** - □□□□□ `□□□□`□
- **5001** - `DIAMETER_ERROR_USER_UNKNOWN`□IMSI/MSISDN □□□□
- **4201** - `DIAMETER_ERROR_ABSENT_USER`□□□□□□□□□□□□□□ MME□□□□□□□□□□□□□□□

□□□□□□: VoLTE □□

□□□ VoLTE □□□□□□□□□□□□


□□
MME
P-GW
P-CSCF
OmniHSS
□□ 1: LTE □□□□□□□□□
□□□□
S6a AIR (□□)
S6a AIA (□□)
S6a ULR (□□)
S6a ULA (□□)
□□□□
□□ 2: IMS PDN □□
PDN □□□APN=ims□
□□□□
Gx CCR-I (IMS APN)
Gx CCA-I (QCI 5)
PDN □□□IP □□□
□□ 3: IMS □□
SIP REGISTER
Cx SAR (□□)
Cx SAA (IMS □□)
200 OK
□□ 4: VoLTE □□
SIP INVITE
Rx AAR (□□□□)
Rx AAA (□□□)
Gx RAR (□□□□)
□□□□□□ (QCI 1)
Gx RAA (□□)
183 □□□□
□□□□□□□
□□ 5: □□□□
SIP BYE
Rx STR (□□)
Rx STA (□□)
Gx RAR (□□□□□□)

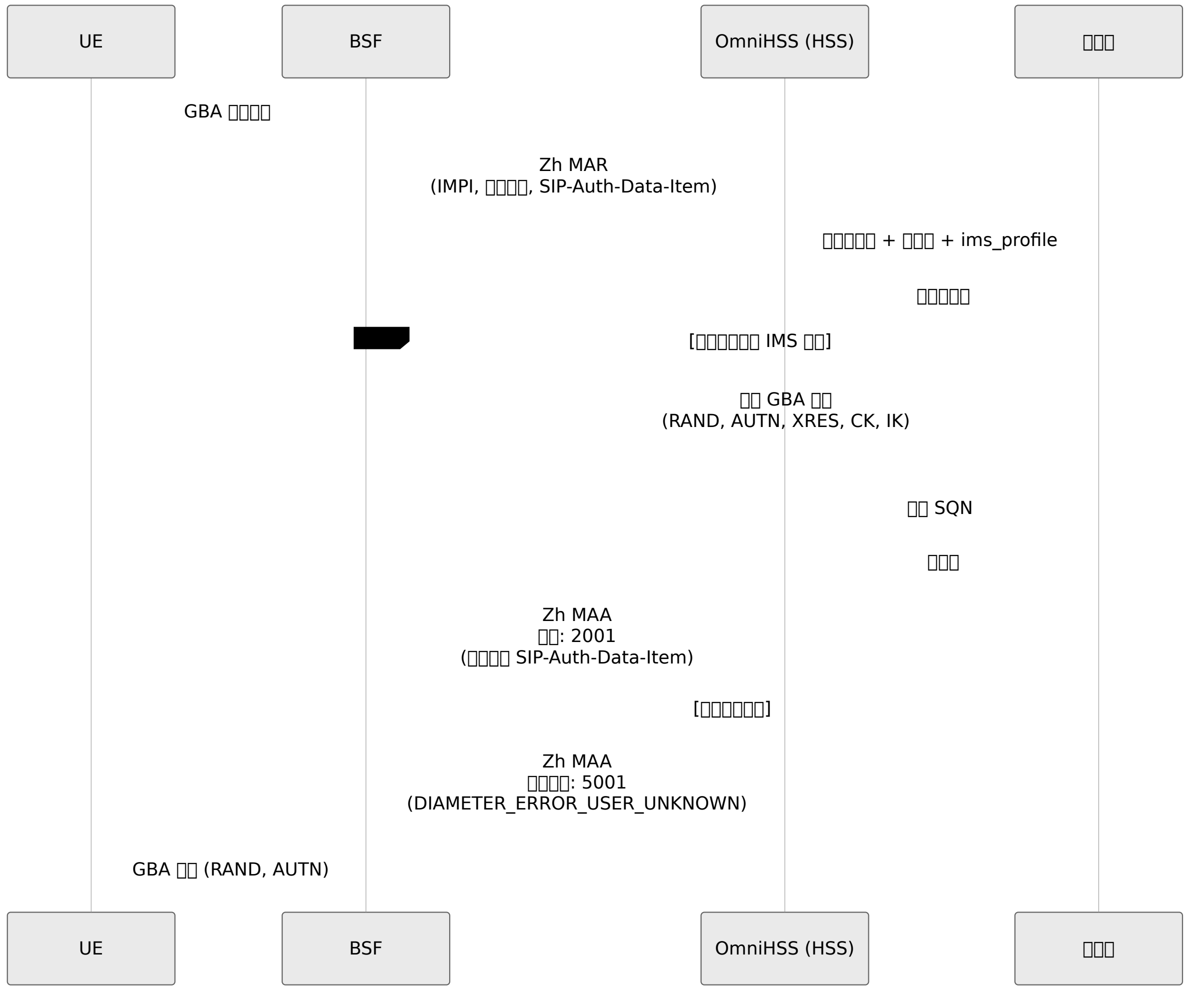

Gx RAA (□□)
□□
MME
P-GW
P-CSCF
OmniHSS

Zh □□ (□□□□□□□)

Zh □□□□□□□□□□□□□□BSF□□□□ HSS □□□□□□□□□□□□□□□□□□□□□□□□□□ (GBA)□

□□□□□□□ (MAR/MAA)

BSF □□ GBA □□□□□□□□□□


UE
BSF
OmniHSS (HSS)
□□□
GBA □□□□
Zh MAR
(IMPI, □□□□, SIP-Auth-Data-Item)
□□□□□ + □□□ + ims_profile
□□□□□
[□□□□□□ IMS □□]
□□ GBA □□
(RAND, AUTN, XRES, CK, IK)
□□ SQN
□□□
Zh MAA
□□: 2001
(□□□□ SIP-Auth-Data-Item)
[□□□□□□]
Zh MAA
□□□□: 5001
(DIAMETER_ERROR_USER_UNKNOWN)
GBA □□ (RAND, AUTN)
UE
BSF
OmniHSS (HSS)
□□□

□□ AVP:

- □□: User-Name (IMPI), Public-Identity, SIP-Auth-Data-Item (□□□□), Destination-Realm

- □□: SIP-Auth-Data-Item (SIP-Authenticate, SIP-Authorization, Confidentiality-Key, Integrity-Key), GBA-UserSecSettings

GBA □□□□:

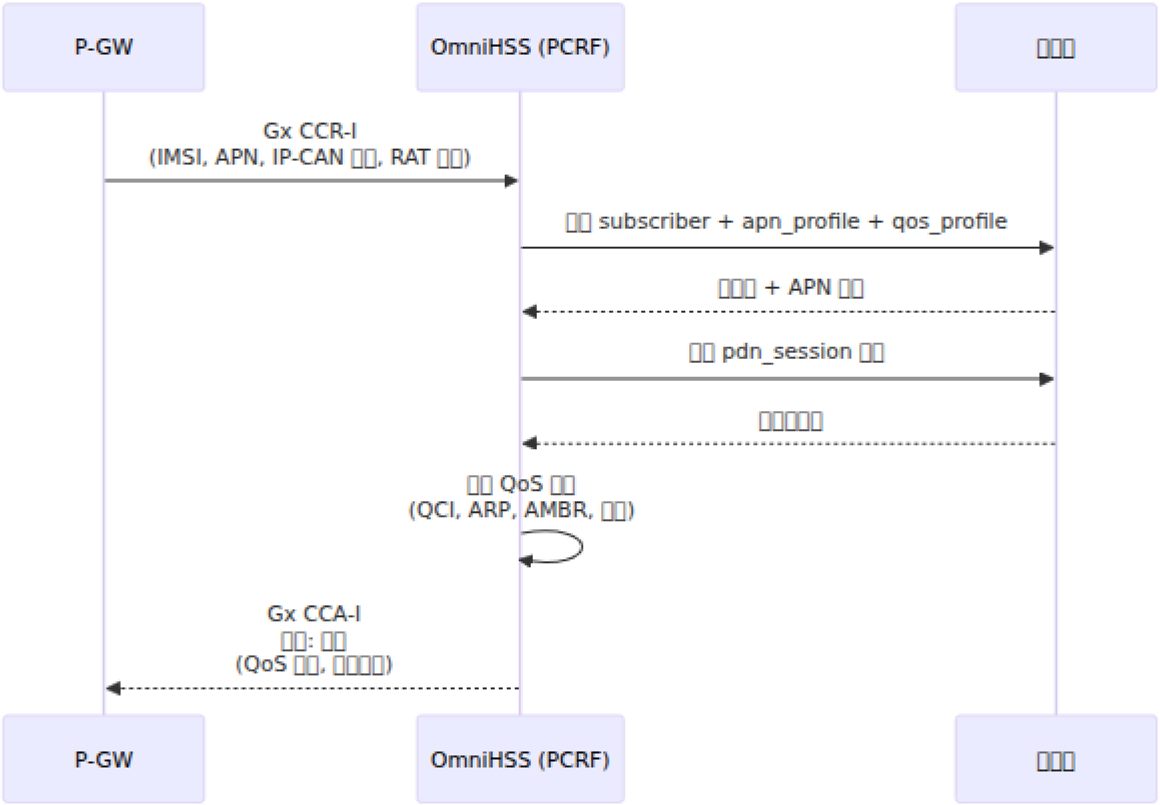
□□□□	□□
MBMS	□□□□□□□□□□□□□
HTTPS	□□ GBA □□□□□
NAF	□□□□□□□□□□
Presence	□□□□□□□□□□□

SWm □□□□□□□□□ 3GPP □□□

SWm □□□□□ 3GPP AAA □□□□□□ HSS□□□□□□□ 3GPP □□□□□□□□□□ ePDG □ WiFi□□□ EAP-AKA □□□

Diameter-EAP-Request (DER/DEA)

WiFi □□□ EAP □□□□□

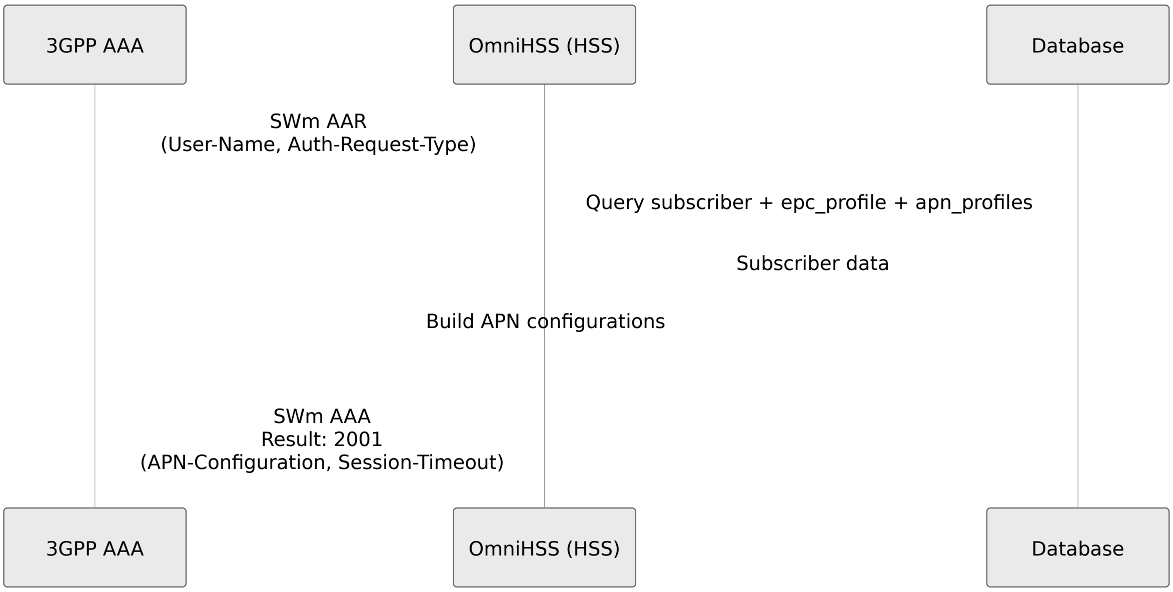

P-GW
OmniHSS (PCRF)
□□□
Gx CCR-I
(IMSI, APN, IP-CAN □□, RAT □□)
□□ subscriber + apn_profile + qos_profile
□□□ + APN □□
□□ pdn_session □□
□□□□□
□□ QoS □□
(QCI, ARP, AMBR, □□)
Gx CCA-I
□□: □□
(QoS □□, □□□□)
P-GW
OmniHSS (PCRF)
□□□

□□ AVP:

- □□: Session-Id, Auth-Application-Id, EAP-Payload, Auth-Request-Type, User-Name (□□)
- □□: EAP-Payload, EAP-Master-Session-Key (MSK), APN-Configuration, Session-Timeout

AA-Request (AAR/AAA)

□□ EAP □□□□□□□

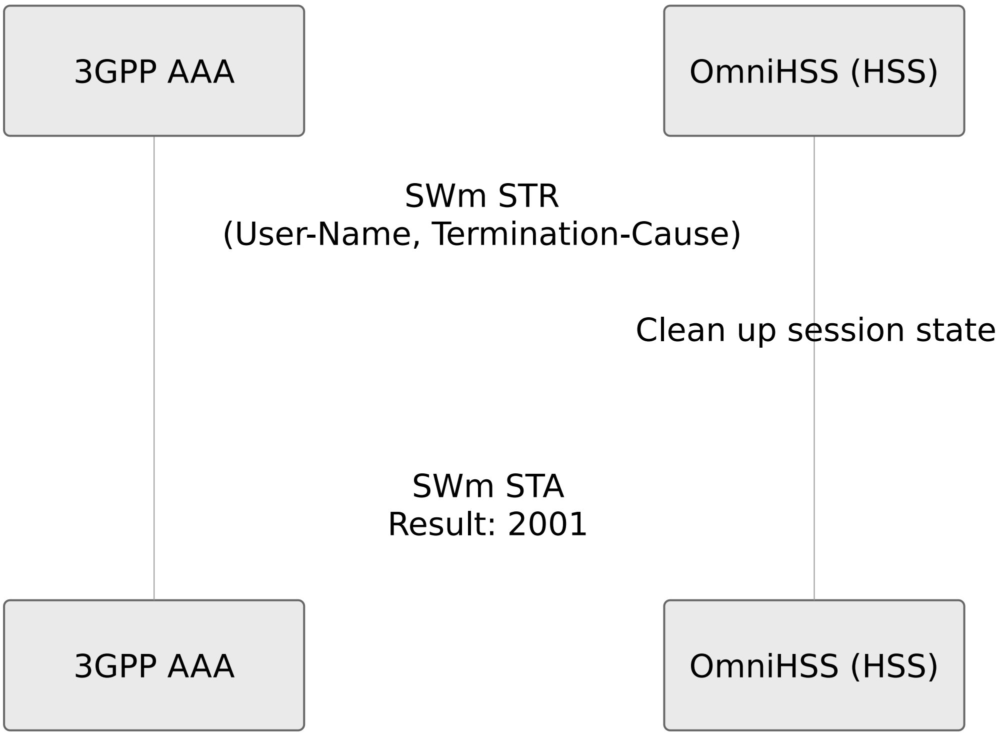

3GPP AAA
OmniHSS (HSS)
Database
SWm AAR
(User-Name, Auth-Request-Type)
Query subscriber + epc_profile + apn_profiles
Subscriber data
Build APN configurations
SWm AAA
Result: 2001
(APN-Configuration, Session-Timeout)
3GPP AAA
OmniHSS (HSS)
Database

□□ AVP:

- □□: Session-Id, Auth-Application-Id, User-Name, Auth-Request-Type, AAR-Flags
- □□: APN-Configuration, 3GPP-Charging-Characteristics, Session-Timeout

Session-Termination-Request (STR/STA)

WiFi □□□□□□□


3GPP AAA
OmniHSS (HSS)
SWm STR
(User-Name, Termination-Cause)
Clean up session state
SWm STA
Result: 2001
3GPP AAA
OmniHSS (HSS)

□□□□:

□□	□	□□
DIAMETER_LOGOUT	1	□□□□
DIAMETER_SERVICE_NOT_PROVIDED	2	□□□□□
DIAMETER_BAD_ANSWER	3	□□□□
DIAMETER_ADMINISTRATIVE	4	□□□□□
DIAMETER_LINK_BROKEN	5	□□□□
DIAMETER_AUTH_EXPIRED	6	□□□□
DIAMETER_USER_MOVED	7	□□□□□□□□□
DIAMETER_SESSION_TIMEOUT	8	□□□□

□□□□□□□□

□□□□ (S6a AIR)

□□:

1. □□□□□□□ (Ki, OPC, AMF)
2. SQN □□□□□□□□□□
3. □□□□□□□□□□□

□□□□□□ (S6a ULR)

□□:

1. EPC □□□□□□□□□□ APN

2. □□□□���□□□
3. MME □□□□□□

IMS □□□□ (Cx SAR)

□□:

1. IMS □□□□□□□□□□
2. IFC □□□□ XML
3. S-CSCF □□□□□
4. □□□□□□□□□□□□ MSISDN

PDN □□□□ (Gx CCR-I)

□□:

1. APN □ EPC □□□□□ APN □□□□□
2. APN QoS □□□□□□□
3. PDN □□□□□□□□□□□□□

← □□□□□□

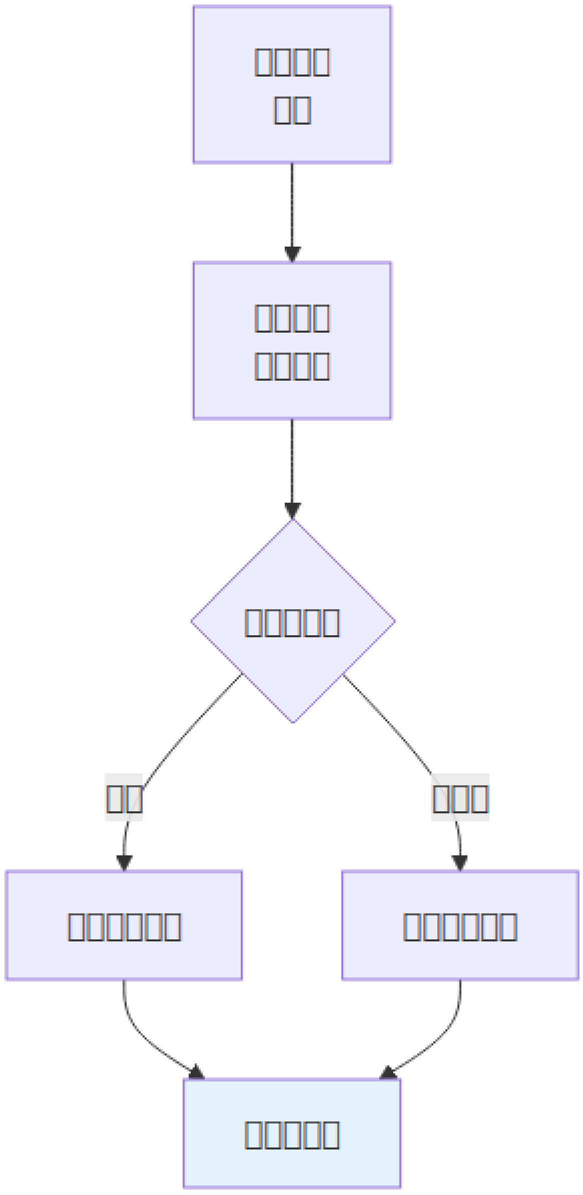
OmniHSS □□□□

← □□□□□□

□□

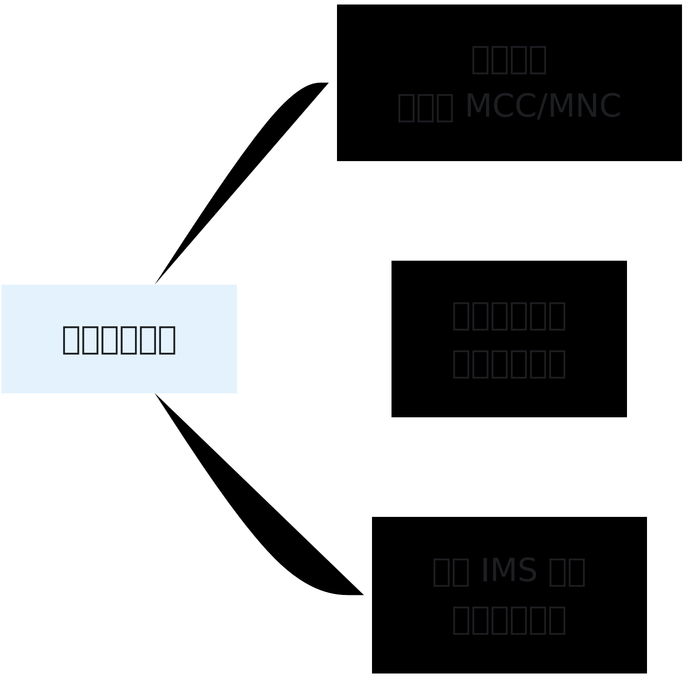
OmniHSS □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ IMS □□□

□□□□□□



□□□□□□□□

□□



□□□□

□□□□□□□□□□MCC/MNC □□□□□□□□

□□:

- `name` - □□□□□
- `mcc` - □□□□□□□3 □□□□
- `mnc` - □□□□□□□2-3 □□□□
- `data_action` - "allow" □ "deny"
- `ims_action` - "allow" □ "deny"

□□□□□□

□□□□□□□□□

□□:

- `name` - □□□□□□
- `data_action_if_no_rules_match` - "allow" □ "deny"
- `ims_action_if_no_rules_match` - "allow" □ "deny"

□□□□

□□□□□□

```
# □□□□□□□□□□□□□□□
curl -k -X POST https://hss.example.com:8443/api/roaming/profile \
  -H "Content-Type: application/json" \
  -d '{
    "roaming_profile": {
      "name": "□□□□",
      "data_action_if_no_rules_match": "allow",
      "ims_action_if_no_rules_match": "allow",
      "roaming_rules": []
    }
  }'
```

□□□□□□

```
# □□□□□□□□□□□□□□□
curl -k -X POST https://hss.example.com:8443/api/roaming/profile \
  -H "Content-Type: application/json" \
  -d '{
    "roaming_profile": {
      "name": "□□□□□",
      "data_action_if_no_rules_match": "deny",
      "ims_action_if_no_rules_match": "deny",
      "roaming_rules": []
    }
  }'
```

□□□□□□□□□□□

```
# □□ AT&T □□
RULE1=$(curl -k -X POST
https://hss.example.com:8443/api/roaming/rule \
  -H "Content-Type: application/json" \
  -d '{
    "roaming_rule": {
      "name": "□□ AT&T",
      "mcc": "310",
      "mnc": "410",
      "data_action": "allow",
      "ims_action": "allow"
    }
  }' | jq -r '.response.id')

# □□ Verizon □□
RULE2=$(curl -k -X POST
https://hss.example.com:8443/api/roaming/rule \
  -H "Content-Type: application/json" \
  -d '{
    "roaming_rule": {
      "name": "□□ Verizon",
      "mcc": "311",
      "mnc": "480",
      "data_action": "allow",
      "ims_action": "allow"
    }
  }' | jq -r '.response.id')

# □□□□□□□□□□□□□□□□
curl -k -X POST https://hss.example.com:8443/api/roaming/profile \
  -H "Content-Type: application/json" \
  -d "{
    \"roaming_profile\": {
      \"name\": \"□□□□□□□\",
      \"data_action_if_no_rules_match\": \"deny\",
      \"ims_action_if_no_rules_match\": \"deny\",
      \"roaming_rules\": [$RULE1, $RULE2]
    }
  }"
```

[illegible]

```
# [illegible] IMS [illegible]
curl -k -X POST https://hss.example.com:8443/api/roaming/rule \
  -H "Content-Type: application/json" \
  -d '{
    "roaming_rule": {
      "name": "[illegible] - T-Mobile",
      "mcc": "310",
      "mnc": "260",
      "data_action": "allow",
      "ims_action": "deny"
    }
  }'
```

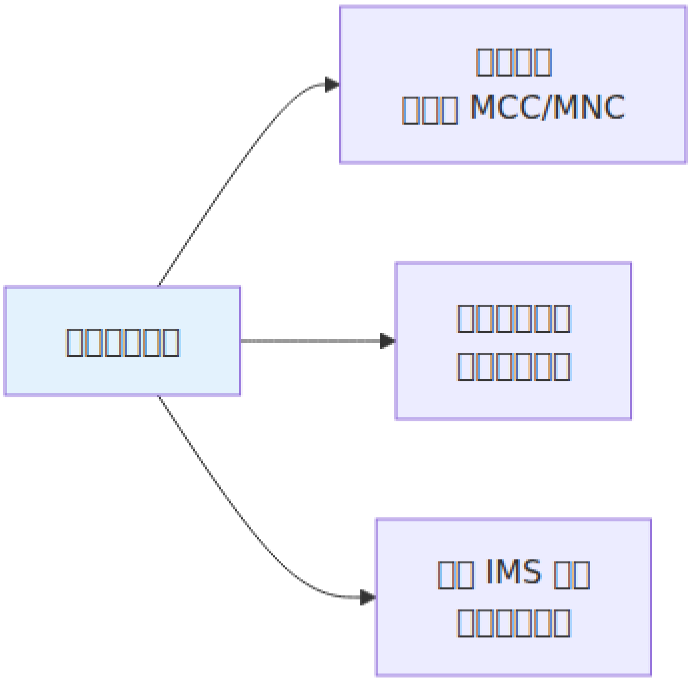
□□□□□□□□□□□

```
# □□□□□□□□□□□
RULE=$(curl -k -X POST
https://hss.example.com:8443/api/roaming/rule \
  -H "Content-Type: application/json" \
  -d '{
    "roaming_rule": {
      "name": "□□□□□□",
      "mcc": "206",
      "mnc": "01",
      "data_action": "deny",
      "ims_action": "deny"
    }
  }' | jq -r '.response.id')

# □□□□□□□□□□□
curl -k -X POST https://hss.example.com:8443/api/roaming/profile \
  -H "Content-Type: application/json" \
  -d "{
    \"roaming_profile\": {
      \"name\": \"□□□□□□\",
      \"data_action_if_no_rules_match\": \"allow\",
      \"ims_action_if_no_rules_match\": \"allow\",
      \"roaming_rules\": [$RULE]
    }
  }"
```

□□□□□□

□□ 1□□□□□□□

□□□□□□□□□□□□□□□□□□

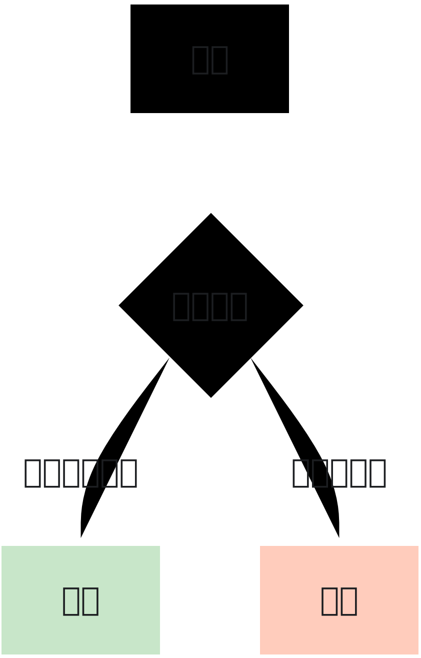


□□:

- □□□□□□□
- □□□□□□□□□ MCC □□□310, 311, 312, 313, 314, 315, 316□

□□ 2□□□□□□□□□

□□□□□□□□□□□□□□□□□□□□

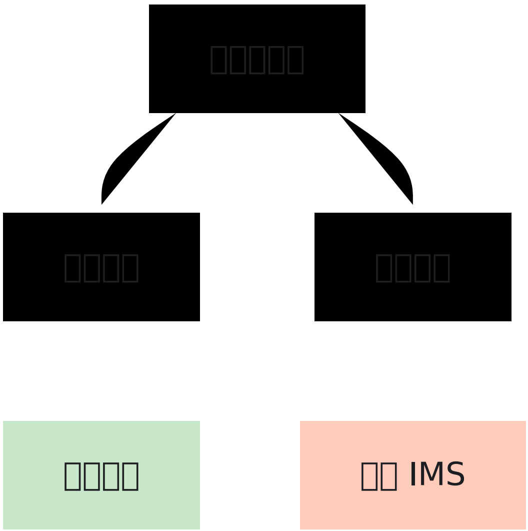


□□:

- □□□□□□□
- □□□□□□□□□□□□□□□□□ MCC/MNC□

□□ 3□□□□□□□□□□

□□□□□□□□□□□□□□□□□ WiFi □□□□□□□



□□:

- □□□`data_action: "allow"`□`ims_action: "deny"`

□□ 4□□□□□□

□□□□□□□□□□□□□□□□□

□□□ □□□□□□□□□ MME/□□□□□□□OmniHSS □□□□□□□□□□□□

MCC/MNC □□

□□□□□□□MCC□

MCC	□□	□□
310-316	□□	AT&T, Verizon, T-Mobile □
302	□□□	Rogers, Bell, Telus
234-235	□□	Vodafone, O2, EE
262	□□	Deutsche Telekom, Vodafone
208	□□	Orange, SFR, Bouygues
222	□□□	TIM, Vodafone, Wind
214	□□□	Movistar, Vodafone

□□□□□□□□MCC 310-316□

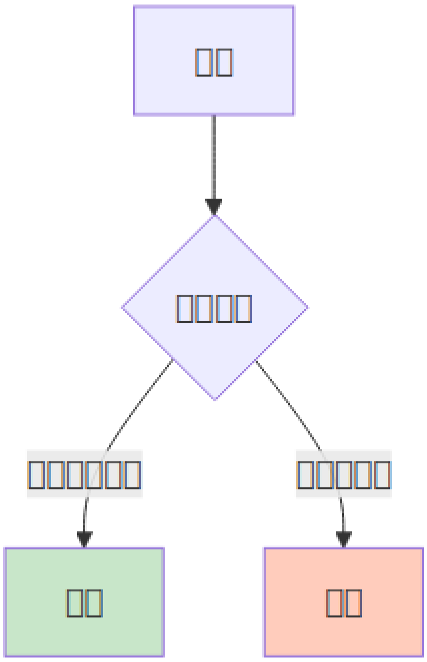
MCC	MNC	□□□
310	410	AT&T
311	480	Verizon
310	260	T-Mobile
310	120	Sprint
313	380	□□□□□□□□

□□□□□ □□□ ITU-T E.212 □ MCC/MNC □□□

[illegible]

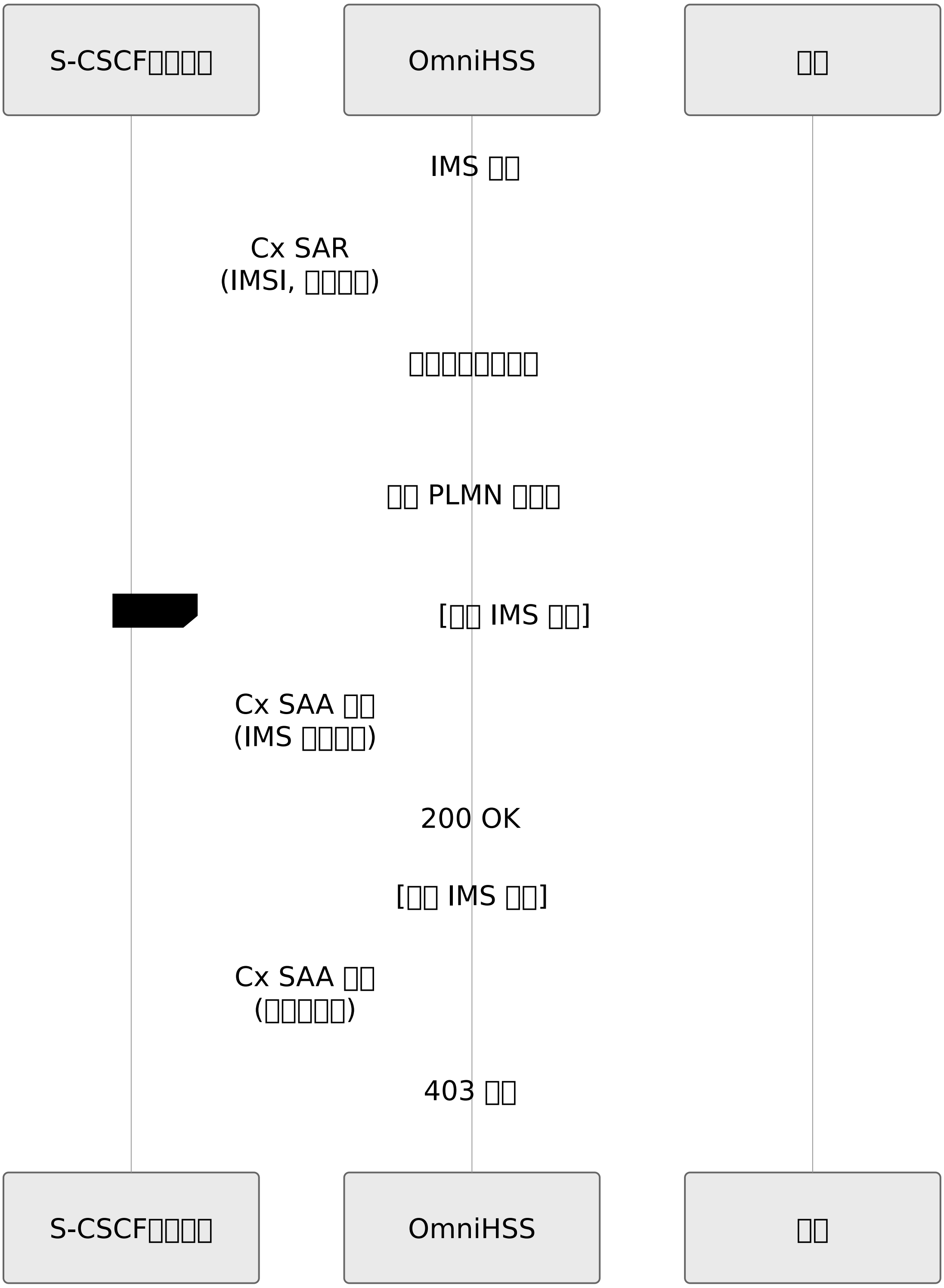
S6a [illegible]

[illegible]



Cx [illegible]IMS[illegible]

[illegible] IMS [illegible]


S-CSCF
OmniHSS
IMS
Cx SAR
(IMSI,)
PLMN
[IMS]
Cx SAA
(IMS)
200 OK
[IMS]
Cx SAA
403
S-CSCF
OmniHSS

[illegible]

[illegible]

[illegible]:

- [illegible]
- [illegible]

[illegible]:

- [illegible] MCC/MNC [illegible]
- [illegible]
- [illegible] data_action [illegible]

[illegible] IMS

[illegible] IMS [illegible]:

- [illegible]
- [illegible] data_action [illegible] ims_action [illegible]
- [illegible] IMS [illegible]

[illegible]

[illegible]:

```
[info] [illegible]: IMSI 001001123456789, [illegible] PLMN 310-410
[info] [illegible]: "[illegible] AT&T"
[info] [illegible]: [illegible], IMS [illegible]: [illegible]
```

[illegible]

[illegible]

1. [illegible] - [illegible]
2. [illegible] - [illegible]
3. [illegible] - [illegible]
4. [illegible] - [illegible]

[illegible]

1. [illegible] - "Allow-ATT-Data-Only" [illegible] "Rule1"
2. [illegible] **MCC/MNC** - [illegible]
3. [illegible] - [illegible] IMS
4. [illegible] - [illegible]

[illegible]

1. [illegible] - [illegible]/[illegible]
2. [illegible] - [illegible]
3. [illegible] - [illegible]
4. [illegible] - [illegible]

← [illegible] | [illegible] →

Sh RepositoryData (□□□□)

OmniHSS □□□□□□□ □□□□□□□□□□□□□ (AS) □ Sh □□ □□□□□□□□□□□□□ **MMTEL-Services**□□□□□/□□□□□□□□□□OIP/OIR□□□□□ **IMS-ODB-Information**□□□□□□□□□□□ □□□ AS □□□□ HSS □□□□□□□□□□□

“□□”□ 3GPP TS 29.328 □□□□□□□□HSS □ □□□□□ □□□□□□ □□□□□□□□□□ AS □□□□□□ XML□OmniHSS □ □□□ □□□□□□□□ `ServiceData` □□□□□□□□□□□□□□□□□□□□□□□AS □□□ □□□ etags □□□□□□□ XCAP/MMTel□□□□□□□□

□□□□□□□□□□ REST Provisioning API □□□/CRM □□□□□□□□□

□□

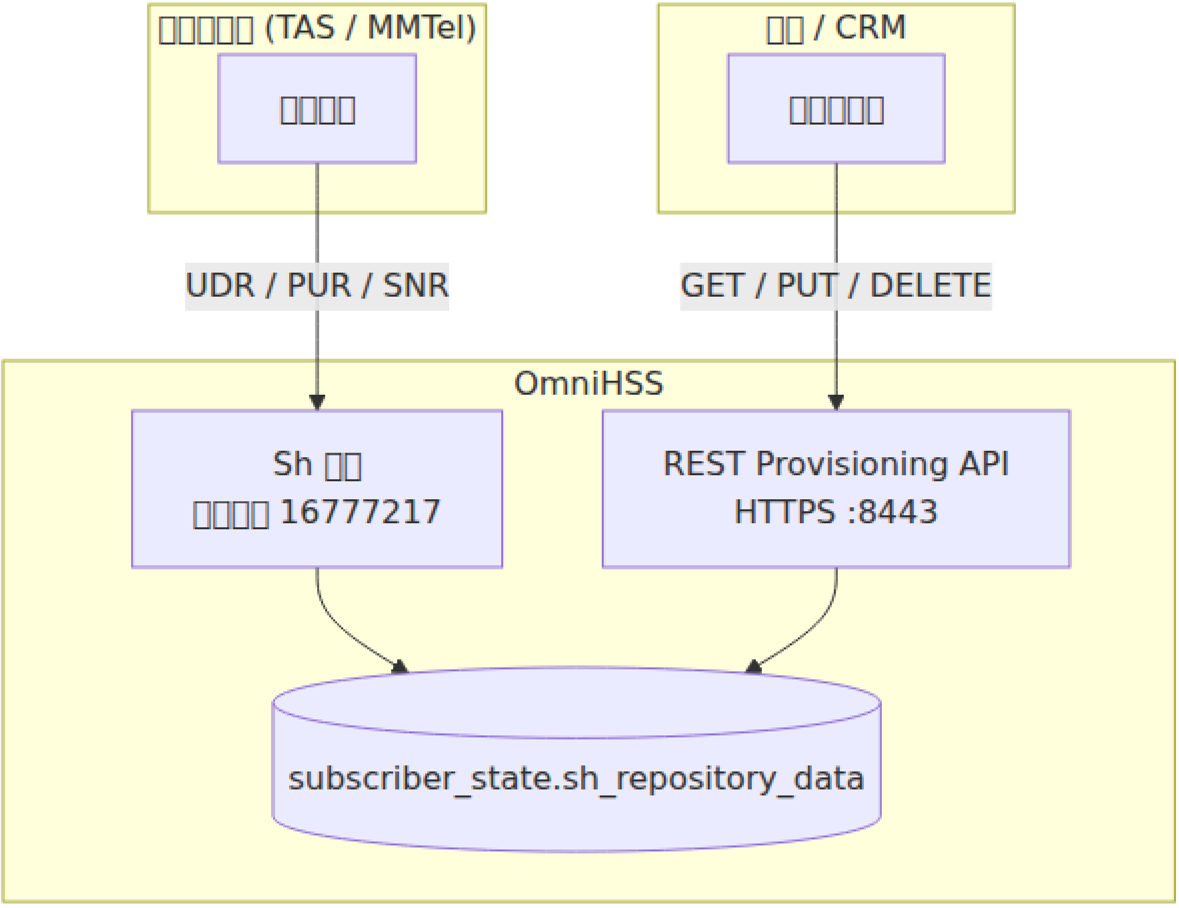
- □□
- □□□□
- Sh □□□
- SequenceNumber □□□
- REST Provisioning API
- □□□
- □□□□

□□

□□□□□□□□□□□□□□□□ □□□□□□□□□□ **Service-Indication**□“□□□”□□□□□□□□□□□□□

□□	□□□	□□
Service-Indication	HSS □□	□□□□□□□ `MMTEL-Services`□`IMS-ODB-Information`□□
SequenceNumber	HSS □□	□□□□□□□□□□□□□□□□ SequenceNumber □□□□
ServiceData	AS □□□□□□□	XML □□□□□□□□□□□□□□□

HSS □□□ Service-Indication □ SequenceNumber□`ServiceData` □□□□□□□□□□□□


□□□□□ (TAS / MMTel)
□□□□
□□ / CRM
□□□□□
UDR / PUR / SNR
GET / PUT / DELETE
OmniHSS
Sh □□
□□□□ 16777217
REST Provisioning API
HTTPS :8443
subscriber_state.sh_repository_data

□□□□

□□□□□□□□□□□□□□□□□□□ `subscriber_state.sh_repository_data` □□□□□□□□ Service-Indication □□□ JSON □□□□□□□□□□□□□□□□□□□□□□

```
{
  "MMTEL-Services":      { "sequence_number": "0", "service_data":
"<MMTelServices …>…</MMTelServices>" },
  "IMS-ODB-Information": { "sequence_number": "1", "service_data":
"<OdbForImsOrientedServices xmlns=\"odb.mmtel.omnitou.ch\"/>" }
}
```

[illegible]	[illegible]
`sequence_number`	[illegible] HSS [illegible] `UDA` [illegible]
`service_data`	[illegible] XML [illegible] AS [illegible] `ServiceData` [illegible] *[illegible]*[illegible]

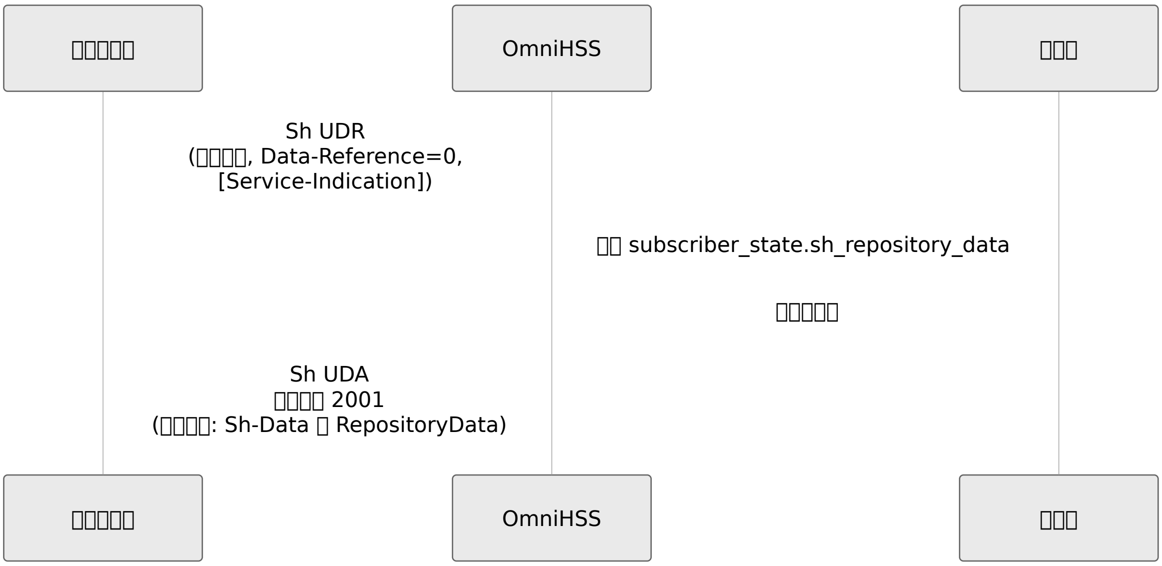
[illegible]HSS [illegible]

Sh [illegible]

RepositoryData [illegible] `Sh-Data` XML [illegible] `User-Data` AVP [illegible] **Data-Reference** [illegible] **0** [illegible] RepositoryData[illegible] **Service-Indication** AVP [illegible]

[illegible] (UDR/UDA)[illegible]

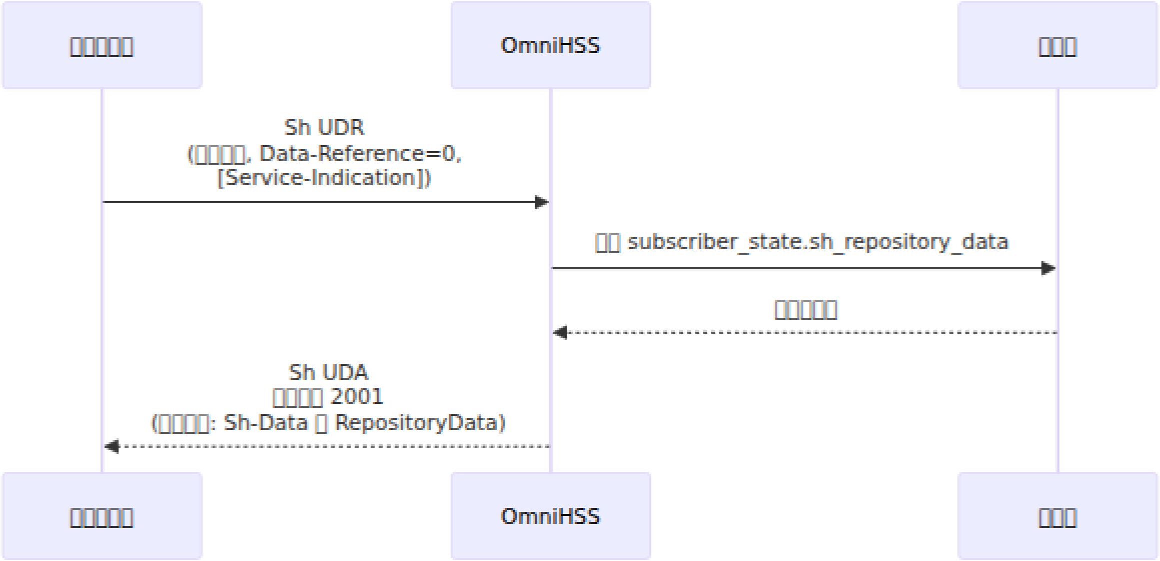
AS [illegible]���[illegible]���[illegible] Service-Indication [illegible] `<RepositoryData>` [illegible]


□□□□□
OmniHSS
□□□
Sh UDR
(□□□□, Data-Reference=0,
[Service-Indication])
□□ subscriber_state.sh_repository_data
□□□□□
Sh UDA
□□□□ 2001
(□□□□: Sh-Data □ RepositoryData)
□□□□□
OmniHSS
□□□

□□□□ IMS □□□□□□ **Experimental-Result 5001 (DIAMETER_ERROR_USER_UNKNOWN)**□

□□□□□□ (PUR/PUA)□□□

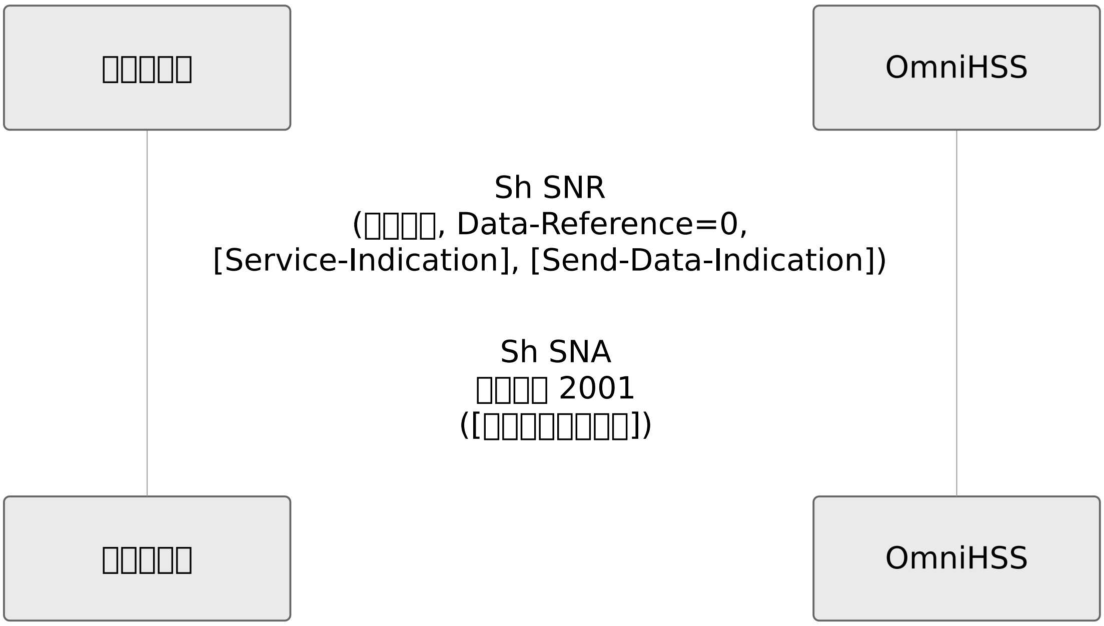
AS □□□□□□□□□□`ServiceData` □□□□□□□□□□□□ SequenceNumber □□□□□□□□□□□□□□□□


□□□□□
OmniHSS
□□□
Sh UDR
(□□□□, Data-Reference=0,
[Service-Indication])
□□ subscriber_state.sh_repository_data
□□□□□
Sh UDA
□□□□ 2001
(□□□□: Sh-Data □ RepositoryData)
□□□□□
OmniHSS
□□□

□ PUR □□

□□□□□□ (SNR/SNA)□□□

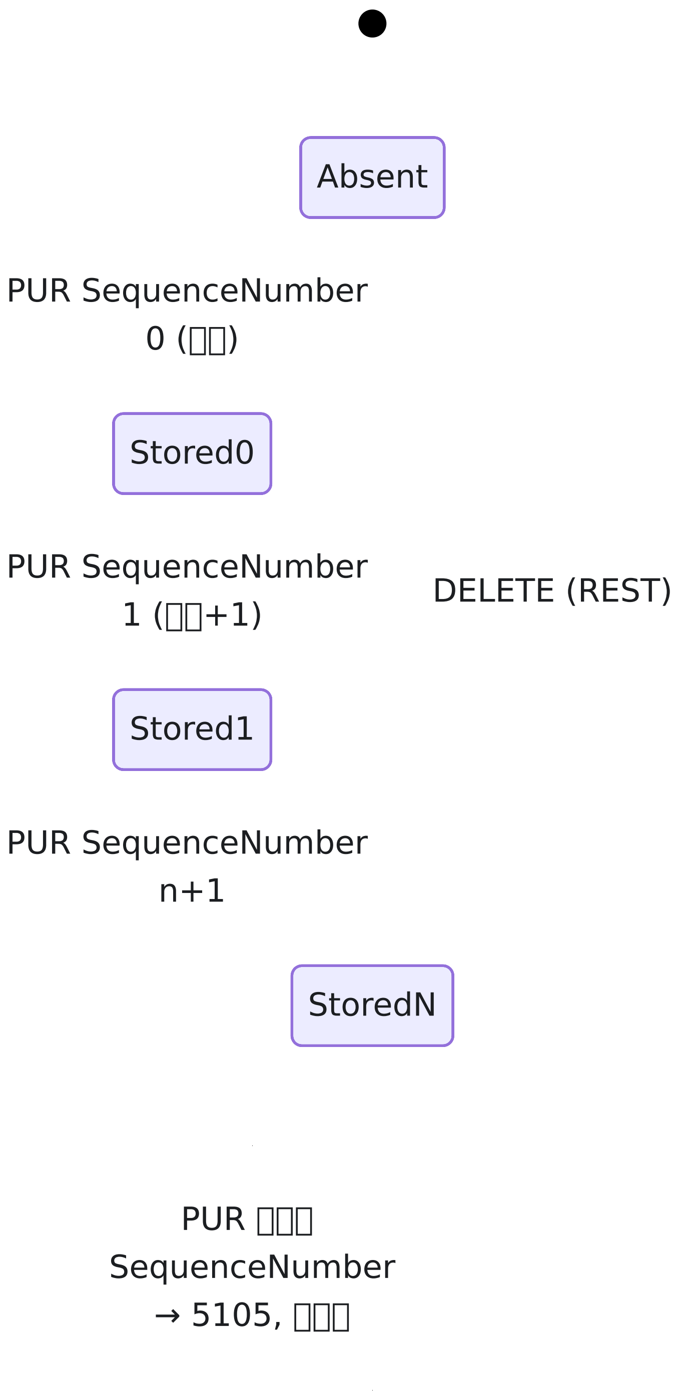
AS □□□□□□□□□□□□□□□□□□□□□`Send-Data-Indication`□□OmniHSS □□ SNR□□□□□□□□□□□ RepositoryData□


□□□□□
OmniHSS
Sh SNR
(□□□□, Data-Reference=0,
[Service-Indication], [Send-Data-Indication])
Sh SNA
□□□□ 2001
([□□□□□□□□])
□□□□□
OmniHSS

SequenceNumber □□□

SequenceNumber □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ 3GPP TS 29.328□

- □□ □□□□□ **SequenceNumber 0**□□ `0` □□□□□□□□□□□□□□
- □□ □□□□□□□□□□ SequenceNumber □ □□□□□□□ + 1□□
- □□□ □ **65535 □□□ 1**□□□□ 0□□□ 0 □□□□□□
- SequenceNumber □□□□□□□□□□□□□□□□ **Experimental-Result 5105 (DIAMETER_ERROR_TRANSPARENT_DATA_OUT_OF_SYNC)**□□□□□□□□□□□□□


Absent
PUR SequenceNumber 0 (□□)
Stored0
PUR SequenceNumber 1 (□□+1)
DELETE (REST)
Stored1
PUR SequenceNumber n+1
StoredN
PUR □□□ SequenceNumber → 5105, □□□

□□□ □□□□□□□ SequenceNumber `0`□□□ SequenceNumber `5` □ PUR □□□□□□ `5105`□□□□□□□□□□□ SequenceNumber `1` □ PUR □□□□□□□□□□□ `1`□

REST Provisioning API

□□□□□□□□□□□□/CRM □□□□□□□□□□□□ IMSI □□□□□□□□□□□ `service_indication` □□□□□□□□□□□□□□□□/□□□□□□□□□□□□□□□ `service_data` □□□□□□□□□ Sh □□□

□□□□□□□□ API □□□

```
{ "status": "success", "response": { } }
```

□ Sh □□□□□REST API □□□□□□□□□□□□□□ SequenceNumber □□□□□□□□□□□□□□□□

□□□□□□

□□□□□□□□□□□□

□□□ `GET /api/subscriber/repository_data/:imsi`

```
curl -k
https://hss.example.com:8443/api/subscriber/repository_data/00100112
```

```
{
  "status": "success",
  "response": {
    "MMTEL-Services":      { "sequence_number": "0",
"service_data": "<MMTelServices …/>" },
    "IMS-ODB-Information": { "sequence_number": "1",
"service_data": "<OdbForImsOrientedServices
xmlns=\"odb.mmtel.omnitou.ch\"/>" }
  }
}
```

□□□□□□

□□ Service-Indication □□□□□□□

□□□ `GET /api/subscriber/repository_data/:imsi?service_indication=:service_indication`

```
curl -k
"https://hss.example.com:8443/api/subscriber/repository_data/00100112
service_indication=MMTEL-Services"
```

```
{
  "status": "success",
  "response": { "sequence_number": "0", "service_data": "
<MMTelServices …/>" }
}
```

□□□□□□□

□□□□□□□□□□□□□□□□

□□□ `PUT /api/subscriber/repository_data/:imsi`

```
curl -k -X PUT
https://hss.example.com:8443/api/subscriber/repository_data/001001123
\
  -H "Content-Type: application/json" \
  -d '{
        "service_indication": "MMTEL-Services",
        "service_data": "<MMTelServices version=\"1\"/>",
        "sequence_number": "0"
      }'
```

□□	□ □	□ □	□ □	□□
`service_indication`	□ □ □	□	-	□□□/□□□□□□□□□□ `MMTEL-Services` □□
`service_data`	□ □ □	□	-	□□□□ XML □□□□□□□□□□□□□□□□□□□□ Service-Indication □ SequenceNumber□□
`sequence_number`	□ □ □	□	`0`	□□□□□□□□□

□□□□□□□□□□

```
{
  "status": "success",
  "response": { "sequence_number": "0", "service_data": "
<MMTelServices version=\"1\"/>" }
}
```

□□□□

□□ Service-Indication □□□□□□□

□□□ `DELETE /api/subscriber/repository_data/:imsi`

```
curl -k -X DELETE
https://hss.example.com:8443/api/subscriber/repository_data/001001123
\
  -H "Content-Type: application/json" \
  -d '{ "service_indication": "MMTEL-Services" }'
```

□□	□□	□□	□□	□□
`service_indication`	□□□	□	-	□□□□□□□

□□□□□□□□□□□□

□□□

Data-Reference □ (RepositoryData)

□	□□	□□	□□
0	RepositoryData	□ Service-Indication □□□□□□□□□	3GPP TS 29.328 §7.6

���[illegible]

[illegible]	[illegible]	[illegible]
2001	DIAMETER_SUCCESS	UDR/PUR/SN [illegible]
5001	DIAMETER_ERROR_USER_UNKNOWN	[illegible] I
5105	DIAMETER_ERROR_TRANSPARENT_DATA_OUT_OF_SYNC	[illegible] SequenceNu [illegible]

[illegible] ID

ID	[illegible]	[illegible]	[illegible]
16777217	Sh	AS ↔ HSS [illegible]	3GPP TS 29.329

[illegible] Service-Indications

Service-Indication	[illegible]
`MMTEL-Services`	MMTel [illegible]/[illegible]/[illegible]OIP/OIR[illegible] simservs XML
`IMS-ODB-Information`	[illegible] IMS [illegible]

> Service-Indication [illegible] XML [illegible]HSS [illegible]

□□□□

□□□□□□□□□□□ 5105

□□□ PUR □□□□ Experimental-Result `5105`□□□□□□□

□□□□□

- AS □□□□□ SequenceNumber���□□□□□□□ HSS □□□□□□□□□□□□□□□□□□
- □□□ AS □□□□□□□□ SequenceNumber□

□□□□□

1. □□ UDR □□□□□□□□□□□□□ SequenceNumber□
2. □□□□ PUR□SequenceNumber = □□ + 1□
3. □□□□□□□□□□ REST API □□□□ API □□□□□□□□

□□□ ServiceData □□□□□□

□□□ AS □□□□□□□ HSS □□□

□□□□□

- □□□□□□□OmniHSS □□□□□□□ `ServiceData`□□□□□□□□□□ AS □□□ XML □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

□□□□□

1. □ `UDA`/REST □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□
2. □□ AS □□□□□□□□□□□□ XML □□□□

□□ REST □□□□□

□□□ `GET …/repository_data/:imsi?service_indication=…` □□□□□

□□□□□

- □□□□□□□ Service-Indication □□□□

- IMSI □□□□□□□□□

□□□□□

1. □□ `GET /api/subscriber/repository_data/:imsi` □□□□□□□□□□□□□□□□
2. □□ □□ IMSI □□□□ □□ IMSI□

SRVCC - [illegible]

← [illegible]

[illegible]

SRVCC[illegible]LTE[illegible]VoLTE[illegible]2G/3G[illegible]CS[illegible]MME[illegible]**Sv**[illegible]TS 29.280[illegible]Sv PS[illegible]CS[illegible]MME[illegible]HSS[illegible]

AVP	[illegible]	[illegible]
`STN-SR`	1433	SRVCC[illegible]MSC-Server[illegible]E.164[illegible]TAS/S-CSCF[illegible]SIP REFER[illegible]VoLTE[illegible]CS[illegible]
`C-MSISDN`	1452	[illegible]MSISDN[illegible]TAS[illegible]STN-SR[illegible]

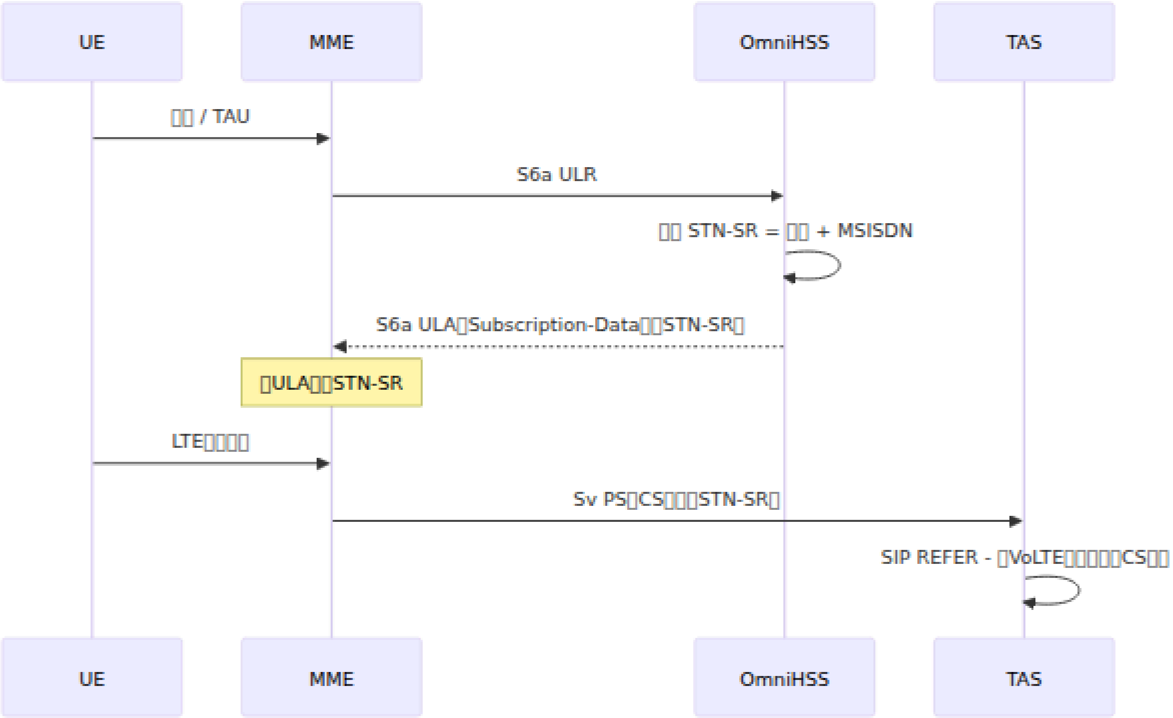
OmniHSS[illegible]S6a [illegible]ULA[illegible]`Subscription-Data` AVP[illegible]`STN-SR`[illegible]MME[illegible]ULA[illegible]Sv PS[illegible]CS[illegible]

[illegible]

[illegible]	[illegible]
TS 23.216	SRVCC PS[illegible]CS[illegible]
TS 29.272	S6a[illegible]STN-SR §7.3.89[illegible]Subscription-Data §7.3.2[illegible]
TS 23.003	STN-SR[illegible]§13.4[illegible]

□□□□

OmniHSS□□□□□□□□□□□□□□□□□□□□□STN-SR□□□HSS□ULA□□□□□□□□□□MSISDN□□□□□□□STN-SR□□□□□TBCD□□□□□`Subscription-Data`□□`STN-SR` AVP□□


UE
MME
OmniHSS
TAS
□□ / TAU
S6a ULR
□□ STN-SR = □□ + MSISDN
S6a ULA□Subscription-Data□□STN-SR□
□ULA□□STN-SR
LTE□□□□
Sv PS□CS□□□STN-SR□
SIP REFER - □VoLTE□□□□□CS□□
UE
MME
OmniHSS
TAS

□□□□□□□□□□□□□□□□HSS□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□SRVCC□

□□□□□□□OmniHSS□□□□`STN-SR` AVP□ULA□□□□□□□□□□SRVCC□□□□□□□□□

□□

□`srvcc`□□□`config/runtime.exs`□□`:hss`□□□□□□□

```
config :hss, :srvcc,
  stn_sr_prefix: "9"
```

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
`stn_sr_prefix`	[illegible]	[illegible]	[illegible]	[illegible]STN-SR[illegible]MSISDN[illegible]E.164 STN-SR[illegible]OmniHSS[illegible]ULA[illegible]`STN-SR` AVP[illegible]

STN-SR[illegible]

[illegible]STN-SR[illegible]

```
STN-SR = stn_sr_prefix + [illegible] MSISDN
```

[illegible]**TBCD**[illegible]TS 24.008 §10.5.4.7[illegible]`STN-SR` AVP[illegible]1433[illegible]10415[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	`9`
[illegible] MSISDN	`61412345678`
[illegible] STN-SR	`961412345678`

MSC-Server[illegible]`961412345678`[illegible]TAS[illegible]TAS[illegible]MSISDN[illegible]IMS[illegible]SIP REFER[illegible]CS[illegible]

[illegible]

[illegible]SRVCC

```
# config/runtime.exs

config :hss, :srvcc,
  # MSC-Server□□□□□□□□PSTN/CS□□TAS□
  # STN-SR = stn_sr_prefix + □□□ MSISDN□
  stn_sr_prefix: "9"
```

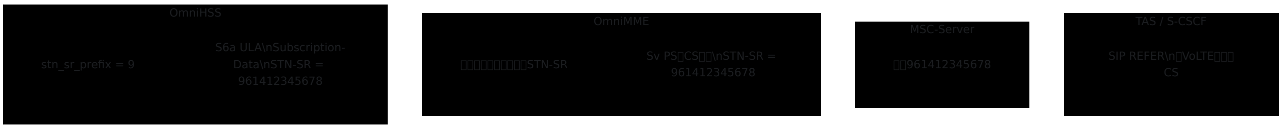
□□□□□ □□ULA□□□`Subscription-Data`□□□`STN-SR`□□□□□□□□□□□□MSISDN□□□TBCD□□□MME□□□���□□□□□SRVCC□□Sv PS□CS□□□□□□□

□□SRVCC□□□□

□`srvcc`□□□□`stn_sr_prefix`□□□□□OmniHSS□□□`STN-SR` AVP□ULA□□□□□□□□□□□□□□□SRVCC□□□□□□□□□

□MME□□□

MME□OmniMME□□ULA `Subscription-Data`□□□`STN-SR`□□□□□□□□□□□□□□□□□□□SRVCC□□□□□□□MSC-Server□Sv **PS□CS**□□□□□`STN-SR`□□□MME□□□□□□□□□□□□□Omnitouch/omnimme#426□


OmniHSS
stn_sr_prefix = 9
S6a ULA\nSubscription-Data\nSTN-SR = 961412345678
OmniMME
□□□□□□□□□□STN-SR
Sv PS□CS□□\nSTN-SR = 961412345678
MSC-Server
□□961412345678
TAS / S-CSCF
SIP REFER\n□VoLTE□□□CS

□□□□

ULA□□□□STN-SR

□□□ MME□□□□Sv PS□CS□□□SRVCC□□□□□

□□□□□

- `config/runtime.exs`□□□□`stn_sr_prefix`□

- HSS□□□□□□□□□□□□□□□

□□□□□

1. □□`config/runtime.exs`□□□□□`srvcc`□□□□`stn_sr_prefix`□□□
2. □□□□OmniHSS□□□□□□□□□□
3. □MME□□□□ULR□□□□□□□TAU□□□□ULA `Subscription-Data`□□□□`STN-SR`□

STN-SR□□□□

□□□ MSC-Server□□□□□□□□□□□□□□□□

□□□□□

- □□□□□□□□□□□□□
- □□□HSS□□□□□MSISDN□□□□□E.164□□□□□□□□`+`□□

□□□□□

1. □□API□□□□□□MSISDN□`GET /api/subscriber/imsi/:imsi`□□
2. □□□□□STN-SR□□`stn_sr_prefix`□□□□MSISDN□□□
3. □□MSC-Server□□□□□□□□□□□□

← □□□□□□

Sy [illegible]

[illegible]

Sy [illegible] HSS[illegible] **PCRF**[illegible] **OCS**[illegible] [illegible] PCRF [illegible] OCS [illegible] [illegible] [illegible]

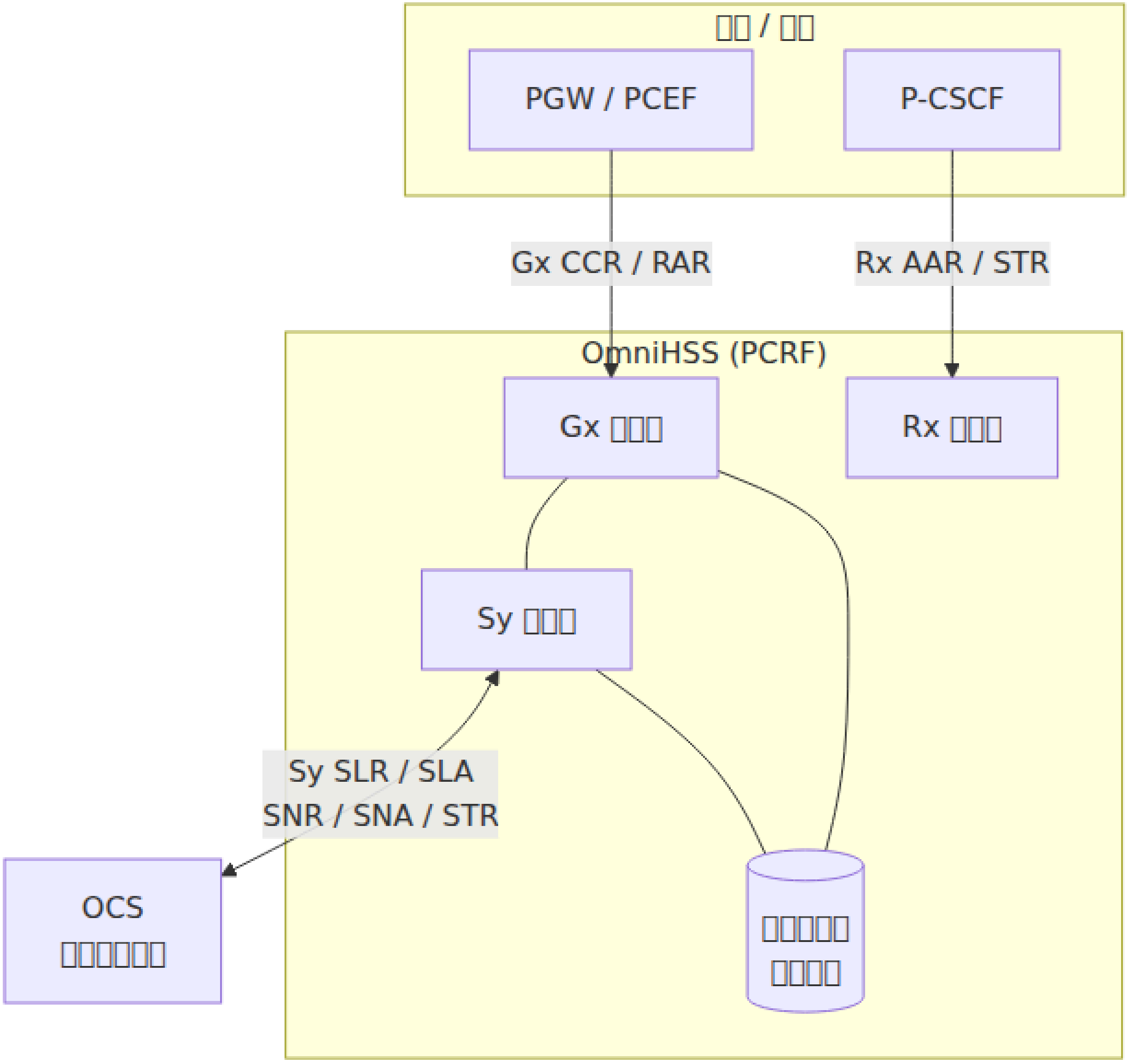
OmniHSS PCRF [illegible] Gx [illegible] QoS[illegible] Rx [illegible] IMS [illegible] Sy[illegible] OCS [illegible] Gx [illegible]

Sy [illegible] 3GPP TS 29.219[illegible] ID **16777302**[illegible]

[illegible]	[illegible]
[illegible] ID	16777302
[illegible]	3GPP TS 29.219
HSS [illegible]	PCRF[illegible]SLR/STR [illegible]SNR [illegible]
[illegible]	OCS[illegible]
[illegible]	TCP [illegible] SCTP[illegible] 3868

> **Sy** [illegible] **Gy** [illegible] Sy [illegible]Gy (TS 32.299) [illegible] PGW [illegible] OCS [illegible]Sy [illegible]**PCRF** [illegible] OCS [illegible] [illegible]OCS [illegible]

□□


□□ / □□
PGW / PCEF
P-CSCF
Gx CCR / RAR
Rx AAR / STR
OmniHSS (PCRF)
Gx □□□
Rx □□□
Sy □□□
Sy SLR / SLA
SNR / SNA / STR
OCS
□□□□□□
□□□□□
□□□□

HSS □ **Sy** □□□□□□□□□□□□□□□□□□□□□□□□ Sy □□□□□□□□□□□□□□□□□□□□□□□OCS □ **Sy** □□□□□□□□□□□□□□□□□□□□□□□□□□□ PCRF□□□□□□□ Gx □□□□□□□□

□□□□□□□□□□

OCS □□□□□���□□□□□□ □□□□□□□□□□□□□□

- □□□□□□□□□AVP 2901□ - □□□□□□□□□□□
- □□□□□□□□AVP 2902□ - □□□□□□□□□□□□□□□ `active`□`over_quota`□`throttled`□□ □□□□□□□□□ 3GPP □□□□□□□□ OCS □ PCRF □□□□□□TS 29.219 §3.1□□

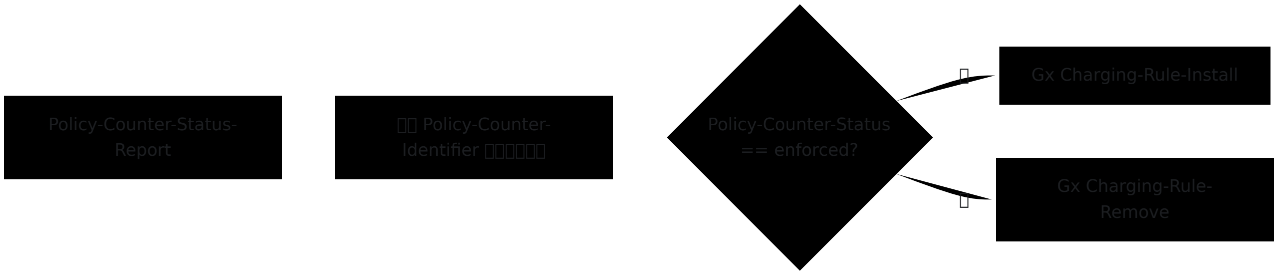
OmniHSS □□□□□□□□□□□□□□□□ □□□□□

Sy AVP	□□	□□□	□□
`Policy-Counter-Identifier` (2901)	□□ - □□□□□	HSS □□□□□ □□□□□	□□□□□□□□ *□□* □□□□
`Policy-Counter-Status` (2902)	□□ - □□□□□□	□□□□	□□□□□□□□ *□□□*□□□□□□□□□□□□□

□□□□□□□□□□□□□□□□□□□□□□□□□□□“□□□□”□“□□□□”□□□□□□□□□□□□□□□□□□□□□□□□□

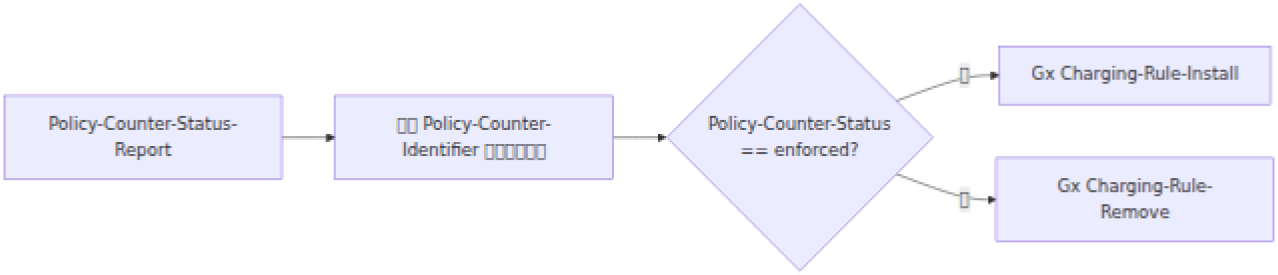
- □□□□ **`enforced`** □□□□□□□□□□□ Gx □□□ `Charging-Rule-Install`□□
- □□□□□□□□□□□□`Charging-Rule-Remove`□□

> **Sy** □□□□□□��□□□ Sy □□□□□□□QoS □□ AVP - □□□□□□ Gx □□□□□OCS □□□ PCRF □□□□□□□□□□ *□□* □□□□□□□□□□□□□□□ *□□* □□□□□□□□□□□□□□□□□□ HSS □□□□□□□□□ □□ `Policy-Counter-Identifier` □□□□□□□□□□□□□□ OCS □□□□□□□□□□□ `enforced` □□□□□□□□□□□□


Policy-Counter-Status-Report
□□ Policy-Counter-Identifier □□□□□□
Policy-Counter-Status == enforced?
□
Gx Charging-Rule-Install
□
Gx Charging-Rule-Remove

Sy □□□□□□

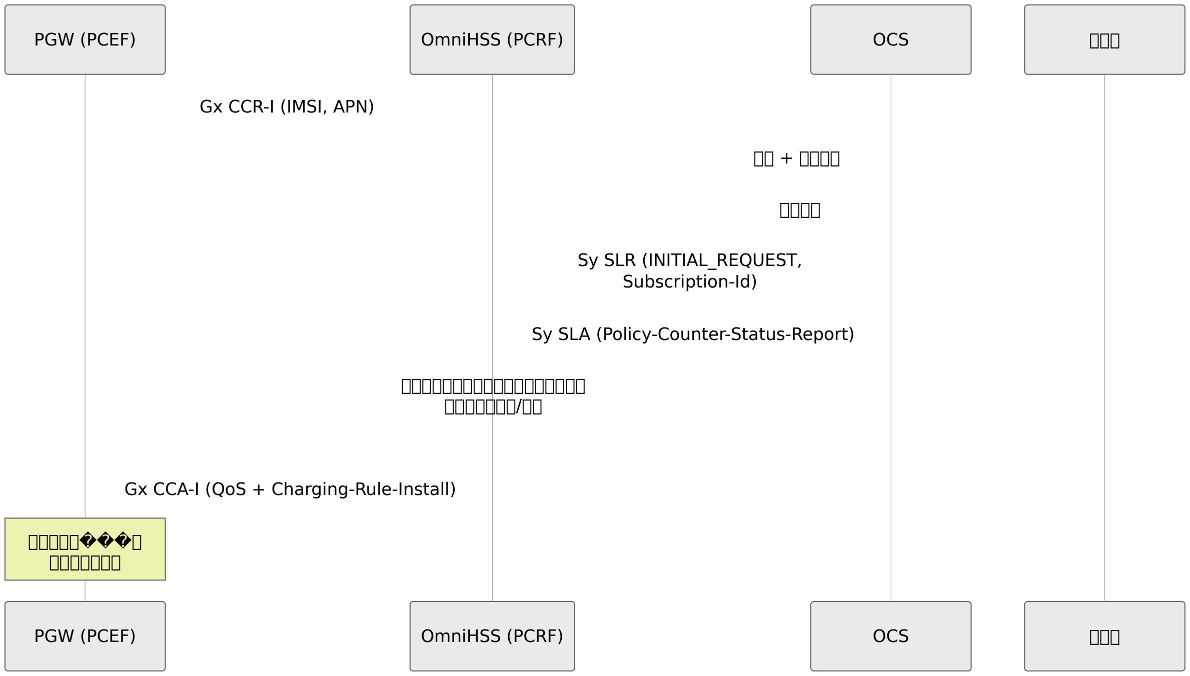
Sy □□□ □□□□□□□□□□□□□□□PCRF □□□□□□□ Sy □□□□□□□□ `Session-Id` □□□□□□□□□□□ □□□□□□□□□□□□□TS 29.219 §4.4.1□□


Policy-Counter-Status-Report
□□ Policy-Counter-Identifier □□□□□□
Policy-Counter-Status == enforced?
□
□
Gx Charging-Rule-Install
Gx Charging-Rule-Remove

- □□ **(SLR, INITIAL_REQUEST)**□ □□□□ Gx CCR-I □□□□□□□□□□□□□□□□□PCRF □□ Sy □□□□□□□□□□□□□□OCS □ SLA □□□□□□□□□□□□□
- □□ **(SLR, INTERMEDIATE_REQUEST)**□ □□ PCRF □□□□□□□□□□□□□□□□□□ Sy □□□□□□□□□□
- □□ **(SNR / SNA)**□ □□□□□□□□□□□OCS □□□□□□□□□□□PCRF □ SNA □□□□ Gx □□□□□□
- □□ **(STR / STA)**□ □□□□□□□□□□□□□□□□PCRF □□□□□□□□□ Sy □□□

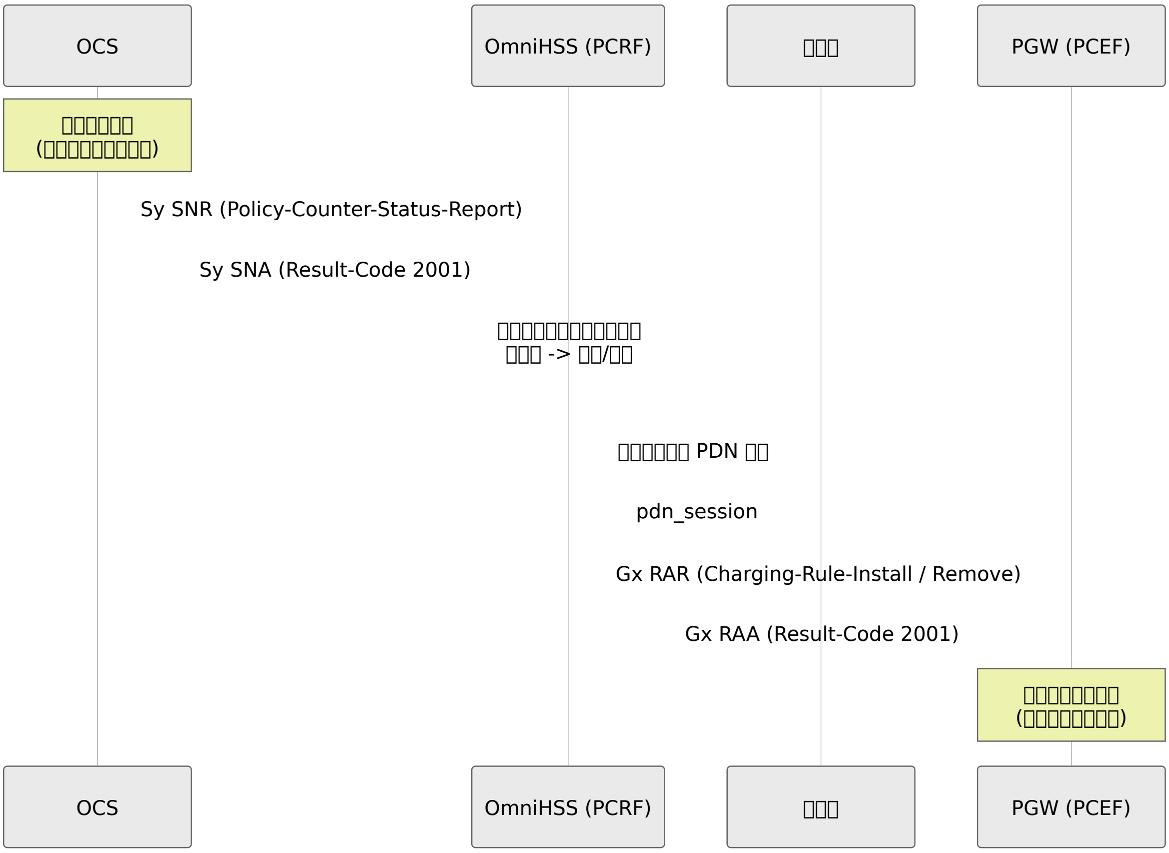
□□□

□□ 1□PDN □□□□□□□□□□□□


PGW (PCEF)
OmniHSS (PCRF)
OCS
□□□
Gx CCR-I (IMSI, APN)
□□ + □□□□
□□□□
Sy SLR (INITIAL_REQUEST, Subscription-Id)
Sy SLA (Policy-Counter-Status-Report)
□□□□□□□□□□□□□□□□□□□□
□□□□□□/□□
Gx CCA-I (QoS + Charging-Rule-Install)
□□□□□□��□
□□□□□□□
PGW (PCEF)
OmniHSS (PCRF)
OCS
□□□

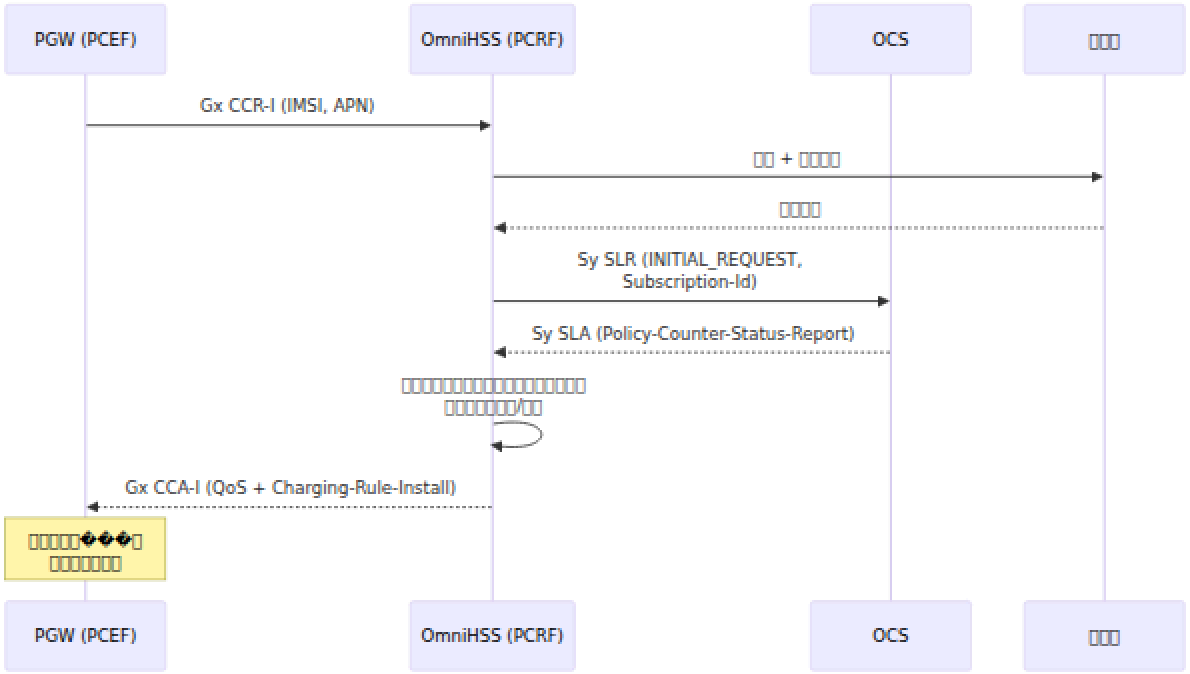
PCRF □□□□□□□□□□□□□□□ Gx □□□□□ □□ **CCA-I** □□□□ OCS □□□□□□□PCRF □□□□ APN □□□□□□□ Sy □□□□□□□□□

□□ 2□□□□□□□□OCS -> PCRF -> Gx RAR□


OCS
OmniHSS (PCRF)
□□□
PGW (PCEF)
□□□□□□
(□□□□□□□□□)
Sy SNR (Policy-Counter-Status-Report)
Sy SNA (Result-Code 2001)
□□□□□□□□□□□□
□□□ -> □□/□□
□□□□□□ PDN □□
pdn_session
Gx RAR (Charging-Rule-Install / Remove)
Gx RAA (Result-Code 2001)
□□□□□□□□
(□□□□□□□□)
OCS
OmniHSS (PCRF)
□□□
PGW (PCEF)

□□□□ PCRF □□□ Gx □□□□ □□ - □□ VoLTE □□□□□□□□□ - □□□□□□□□□□□□□ PGW□□□□□□□ □□ CCR□

□□ 3□Sy □□□□


PGW (PCEF)
OmniHSS (PCRF)
OCS
Gx CCR-I (IMSI, APN)
□□ + □□□□
□□□□
Sy SLR (INITIAL_REQUEST, Subscription-Id)
Sy SLA (Policy-Counter-Status-Report)
□□□□□□□□□/□□
Gx CCA-I (QoS + Charging-Rule-Install)

□□

Sy □□

Sy □□□ HSS □□□□□□□□□ Gx □ Rx □□□`config/runtime.exs`□□

```
%{
  application_name: :sy,
  application_dictionary: :diameter_gen_3gpp_sy,
  vendor_specific_application_ids: [
    %{vendor_id: 10415, auth_application_id: 16_777_302,
acct_application_id: nil}
  ]
}
```

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
`application_name`	Atom	[illegible]	-	[illegible] `:sy` Sy [illegible]
`application_dictionary`	Atom	[illegible]	-	[illegible] `:diameter_gen_3` [illegible]3GPP TS 29.219
`vendor_specific_application_ids`	List	[illegible]	-	[illegible] Sy [illegible]
`vendor_id`	Integer	[illegible]	-	[illegible] ID[illegible]3GPP [illegible] `1`
`auth_application_id`	Integer	[illegible]	-	[illegible] ID[illegible]Sy [illegible] `16_777_302`[illegible]
`acct_application_id`	Integer | nil	[illegible]	`nil`	[illegible] ID[illegible]Sy [illegible] ��� `nil`[illegible]

Sy [illegible]

Sy [illegible] `:hss, :sy` [illegible]`config/runtime.exs`[illegible]

```
config :hss,
  sy: %{
    enabled: false
  }
```

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
`enabled`	Boolean	[illegible]	`false`	[illegible] `true` [illegible]PCRF [illegible] Gx CCR-I [illegible] Sy [illegible] `false` [illegible]Sy [illegible]

□□□□□□□□□ `Policy-Counter-Status` □□□□□□ **`enforced`**□□□□□□□□□□□□□□□□□ OCS □□□□□□□□□□□□□

OCS □□

HSS □ □□ OCS □□□□□□□□□ SLR □ STR □□ HSS □ □□ `Destination-Realm`□□□□ `Destination-Host`□□□□□□□□ Sy □□ ID□16777302□□□□□□□□□□□□□□□ Sy □□□□□□□□ □□□□ - □□□ **DRA**□□□□□□□□□ OCS□□□□□ DRA □□ OCS □□□□□□□□□□□□□□□□□□□□□□□ OCS □□□□□□□

□□□□□□□□□□□□□□□□□□ Sy □□□□□□□□ DRA □□□□□□□□□□ HSS □□□ DRA □□□□□□□□□□ Sy □□□□□□□□

□□□□□□□

□□□□□□□□□□□□□□□□□□□□□□□ □□ □□□□□□

- □ **OCS** □□□□□□□□□□ `Policy-Counter-Identifier` □□□ HSS □□□□ □□□□ □□□ `name`□□□□□□□□□□□□□□□□□□□□ `enforced`□
- □ **HSS** □□□□□□□□□□□□□□□□□□

□□□ □□□□□□□□□□ □□□□□□□□

□□

Sy □□□ HSS □□□□□□□□ Prometheus □□□□ □□□□□□□

□□: `hss_sy_messages_total` □□: □□□ □□: □□□ Sy □□□□□□□□□□□□□□□ □□:

- `command` - `slr`□`sla`□`snr`□`sna`□`str`□□ `sta`
- `direction` - `incoming`□□ OCS □□□□ `outgoing`□□□□ OCS□
- `result` - `sent`□`received`□`success`□□ `error`

□□: `hss_sy_policy_updates_total` □□: □□□ □□: □ Sy □□□□□□□□□□ Gx □□□□□□□□□ □□□□□□□ □□:

- `action` - `install` □ `remove`

- `result` - `success` □ `error`□Gx RAR □ PGW □□□□

□□□□:

```
# □ OCS □ Sy □□□
rate(hss_sy_messages_total{command="snr", direction="incoming"}
[5m])

# □□□□□□□□□□/□□□□□□□
rate(hss_sy_policy_updates_total{action="install",
result="success"}[5m])

# Sy Gx RAR □□□□
sum(rate(hss_sy_policy_updates_total{result="error"}[5m]))
  / sum(rate(hss_sy_policy_updates_total[5m]))
```

□□

□□

□□	□□	□□	□□	□□
□□□□□□	SLR	8388635	PCRF -> OCS	□□□□□□□□□□□□□□
□□□□□□	SLA	8388635	OCS -> PCRF	□□□□□□□□□
□□□□□□□□	SNR	8388636	OCS -> PCRF	□□□□□□□□□
□□□□□□□□	SNA	8388636	PCRF -> OCS	□□□□
□□□□□□	STR	275	PCRF -> OCS	□□ Sy □□□□□□□□
□□□□□□	STA	275	OCS -> PCRF	□□□□□□

□□□□□□□□□ ID `16777302`□□□□□□ STR/STA (RFC 6733 □□□□)□

[illegible] AVPs

AVP	[illegible]	[illegible]	[illegible]
`Policy-Counter-Identifier`	2901	UTF8String	[illegible] OmniHSS [illegible]
`Policy-Counter-Status`	2902	UTF8String	��[illegible]
`Policy-Counter-Status-Report`	2903	Grouped	[illegible] + [illegible] (+ [illegible])[illegible]
`SL-Request-Type`	2904	Enumerated	[illegible] `INITIAL_REQUEST (0)` [illegible] `INTERMEDIATE_REQUEST (1)`[illegible]
`Pending-Policy-Counter-Information`	2905	Grouped	[illegible]
`Pending-Policy-Counter-Change-Time`	2906	Time	[illegible]
`SN-Request-Type`	2907	Unsigned32	SNR [illegible] 0 = [illegible] 1 = [illegible]OCS [illegible] Sy [illegible]
`Subscription-Id`	443	Grouped	[illegible]IMSI [illegible]/[illegible] MSISDN[illegible] SLR [illegible]

□□□□

□□	□□	□□
2001	DIAMETER_SUCCESS	□□□□□□
5030	DIAMETER_USER_UNKNOWN	OCS □□□□□□□Sy □□□□□
5570	DIAMETER_ERROR_UNKNOWN_POLICY_COUNTERS	□□□□□□□□□□□□□□ OCS □□□
4241	DIAMETER_ERROR_NO_AVAILABLE_POLICY_COUNTERS	OCS □□□□□□□□□□□

□□ 5570 □ 4241 □ Sy □□□□□□□□□□□TS 29.219 §5.5□□5030 □□ RFC 4006 □□□□

□□□□

- PCRF - Gx □ Rx □□□□□Sy □□□□
- □□□□ - □□ HSS □□□□□□
- □□ - □□ HSS □□

OmniHSS [illegible]

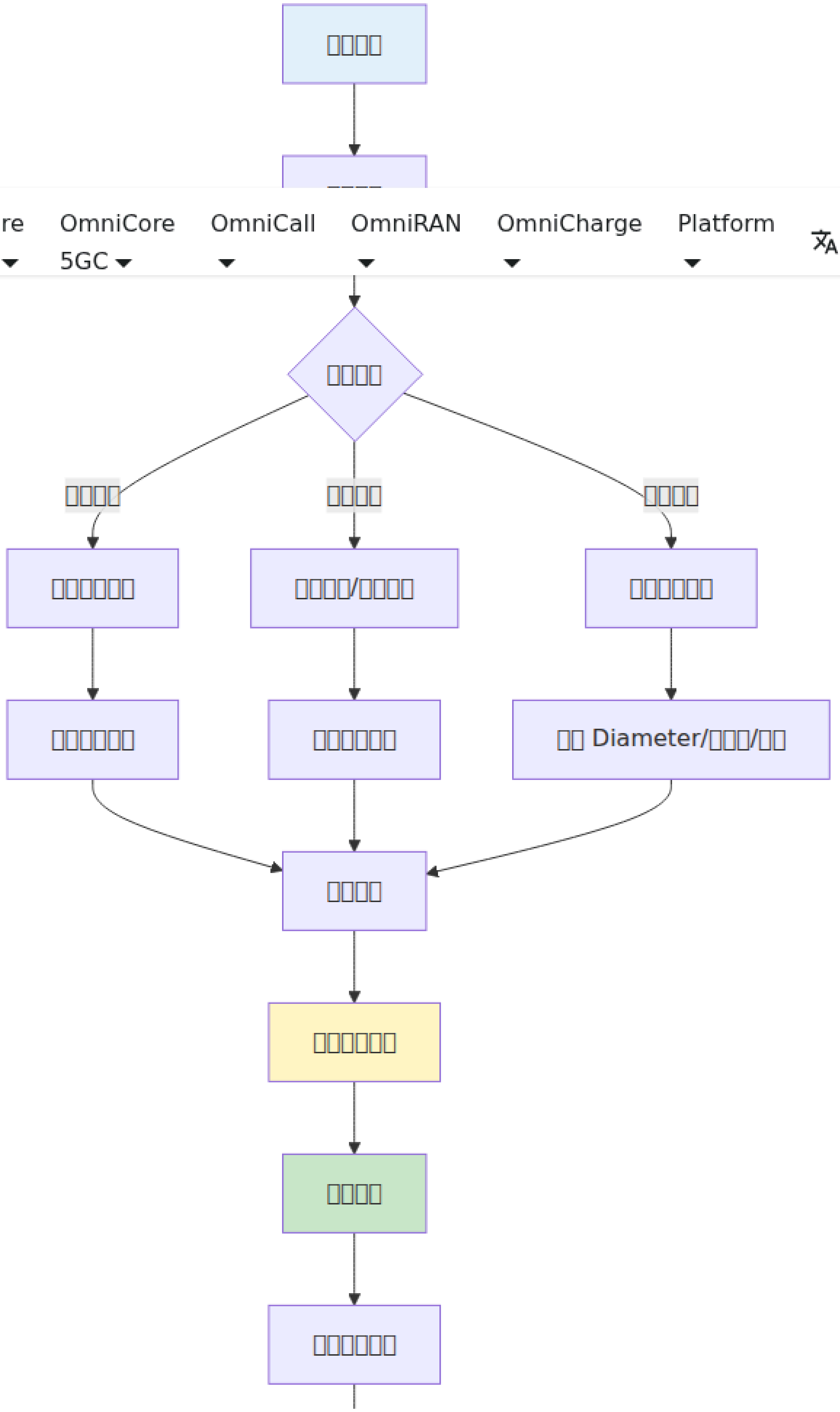
← [illegible]

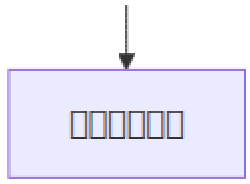
[illegible]

- [illegible]
- [illegible]
- Diameter [illegible]
- [illegible]
- EPC [illegible]
- IMS [illegible]
- VoLTE [illegible]
- [illegible]
- EIR [illegible]
- [illegible]
- [illegible]
- API [illegible]
- [illegible]

[illegible]

[illegible]


Diameter/ /



[illegible]

[illegible]

1. [illegible]
    - IMSI
    - MSISDN[illegible]
    - [illegible]
    - [illegible]
2. [illegible]
    - [illegible]
    - [illegible]
    - [illegible]
3. [illegible]
    - [illegible]
    - [illegible]
    - [illegible]/[illegible]
4. [illegible]
    - [illegible] [illegible] [illegible]
    - [illegible] Diameter [illegible]
    - [illegible]

□□□□

□□

- □□□□□□□□□
- "□□□□□" □□
- □□□□□□□

□□□□□□□□□

□□ 1□□□□□□□

□□□

- □□□□□□□□□□□
- □□□□□□□□□□□□□��□

□□□□□

1. □□□□□□□ key_set_id□

   ```
   curl -k https://hss.example.com:8443/api/subscriber/imsi/[IMSI]
   ```

2. □□□□□□□□□□□□□□□

   ```
   curl -k https://hss.example.com:8443/api/key_set/[KEY_SET_ID]
   ```

3. □ Ki □ OPC □□ SIM □□□□□□□

□□□□□

- □□□□□ □□□ □□□□
- □□□□□□□SIM □□□□□□

□□ 2□SQN□□□

□□□

- □□□□□□□□□□
- □□□“SQN □□□□”
- □□□□□

□□□□□

1. □□□□□□□□□□□ SQN □
2. □□□□□□ SQN □□□□
3. □□□□□□□□ SQN □

□□□□□

- SQN □□□□□ AUTS □□□□□□□□
- □□□□□□□□□□□□□□ SQN □□□ 0□□□□□□□□□□

□□□ □□ SQN □□□□□□□□□□□□□□□□□□□

□□ 3□□□□□□

□□□

- □□□□□□□
- □□□□□□□□

□□□□□

1. □□□□□□□□□

   ```
   curl -k https://hss.example.com:8443/api/subscriber/imsi/[IMSI]
   ```

2. □□ `enabled` □□□ `true`

□□□□□

- □□□���□

```
curl -k -X PUT https://hss.example.com:8443/api/subscriber/[ID]
\
  -H "Content-Type: application/json" \
  -d '{"subscriber": {"enabled": true}}'
```

□□ 4□□□ EPC □□□□

□□□

- □□□□□□□□□□□
- □□□“□□□ EPC □□□□”

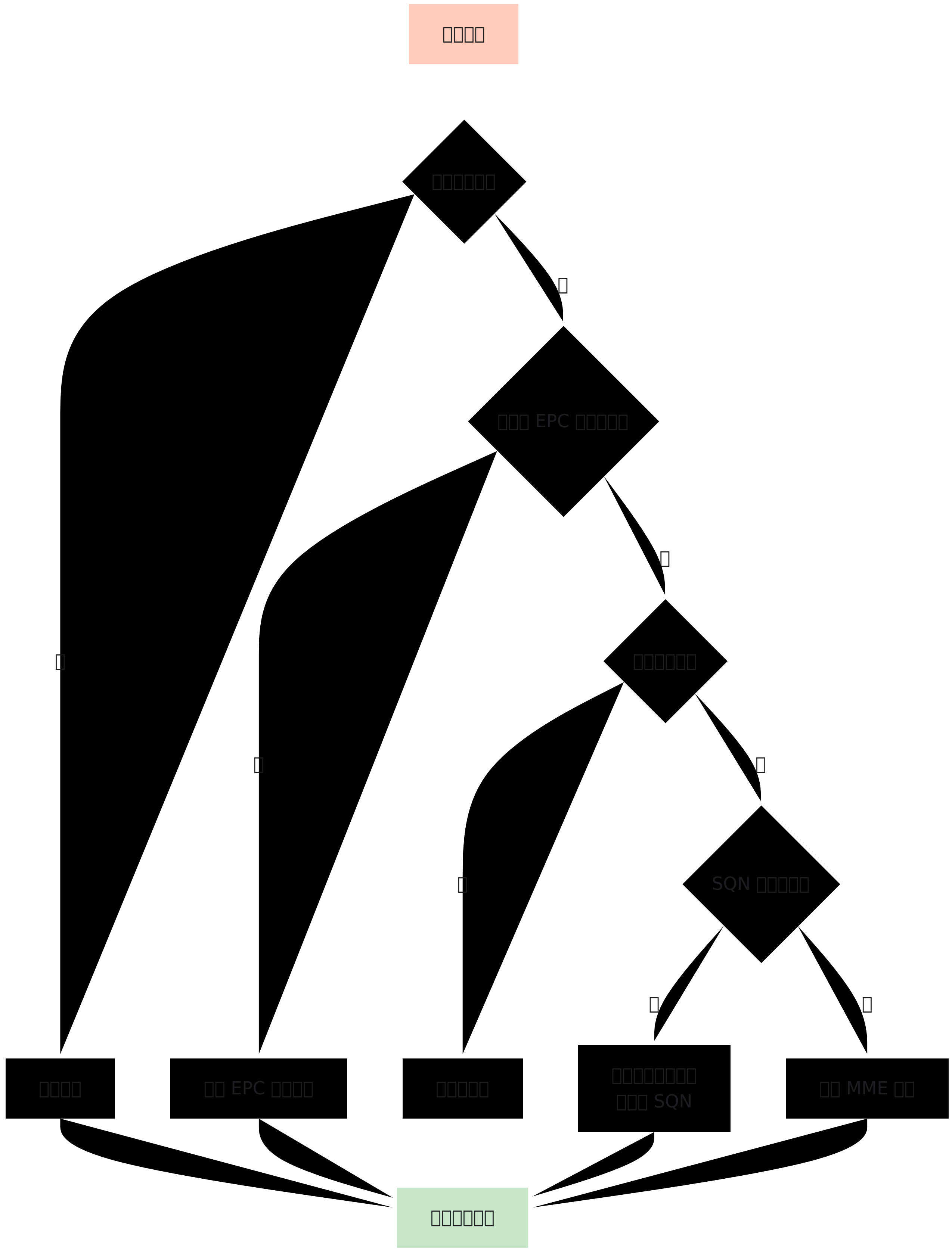
□□□□□

1. □□□□□ `epc_profile_id` □□
2. □□ EPC □□□□□□□
   ```
   curl -k
   https://hss.example.com:8443/api/epc/profile/[PROFILE_ID]
   ```

□□□□□

- □□□□ EPC □□□□ □□□□□

[illegible]


EPC
SQN
EPC
SQN
MME

Diameter [illegible]

[illegible]

- [illegible] [illegible] [illegible] Diameter [illegible]
- "[illegible]" [illegible]
- [illegible]

[illegible]

[illegible] 1[illegible]

[illegible]

- [illegible]
- [illegible]
- Ping [illegible]

[illegible]

1. [illegible] OmniHSS [illegible]

   ```
   ping [PEER_IP]
   ```

2. [illegible] Diameter [illegible]

   ```
   telnet [PEER_IP] 3868
   ```

3. [illegible] Diameter [illegible] 3868[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

□□ 2□Diameter □□□□□

□□□

- □□□□□□
- CER/CEA □□□□
- □□□□□□□

□□□□□

1. □□ runtime.exs □□ Diameter □□□

   - □□□□□ origin_host □□□□□□□□□□
   - □□ origin_realm □□
   - □□□□□ IP □□□□□□

2. □□□□□□ CER/CEA □□

3. □□□□□□□□□□□□ OmniHSS □ origin_host

□□□��□

- □□□□□ Diameter □□ □□ runtime.exs
- □□□□□□□□ OmniHSS
- □□□□□□□□□□□□□□

□□ 3□□□□□□TLS Diameter□

□□□

- □ TLS □□□□□□□□
- □□□□□□
- "□□□□" □ "□□□□" □□

□□□□□

1. □□ `priv/cert/` □□□□□□□

2. □□□□□□□

```
openssl x509 -in priv/cert/diameter.crt -noout -dates
```

3. [illegible]

4. [illegible] TLS

[illegible]

- [illegible]
- [illegible]
- [illegible] OmniHSS

[illegible] 4[illegible]

[illegible]

- [illegible]
- [illegible]
- "[illegible]" [illegible]

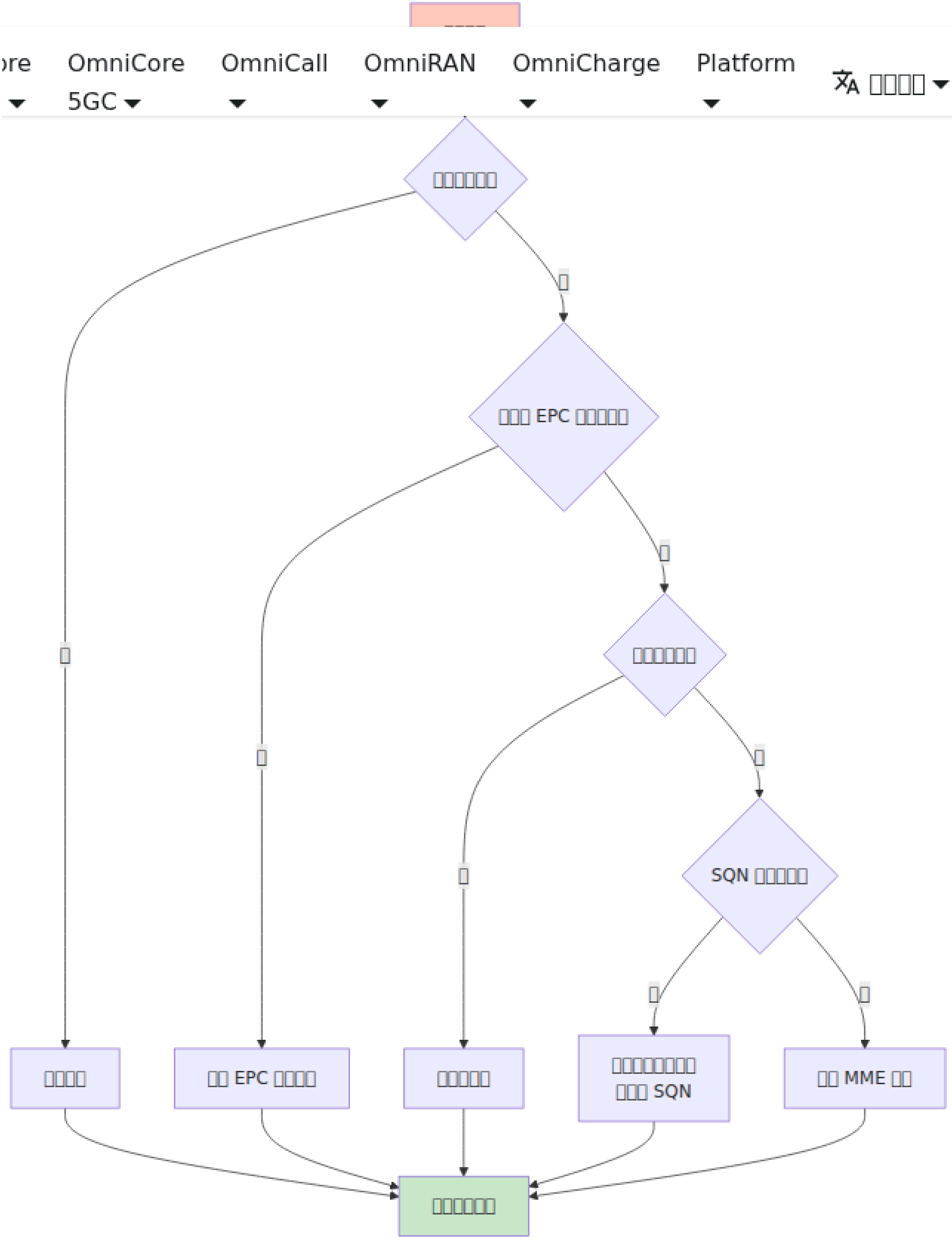
[illegible]

1. [illegible] [illegible] Diameter [illegible] [illegible]
2. [illegible]S6a[illegible]Cx[illegible]Sh [illegible]
3. [illegible] CER/CEA [illegible]

[illegible]

- [illegible] Diameter [illegible]
- [illegible]
  - MME [illegible] S6a[illegible]16777251[illegible]
  - S-CSCF [illegible]���[illegible] Cx[illegible]16777216[illegible]
  - P-GW [illegible] Gx[illegible]16777238[illegible]

Diameter □□□□□□□


□□□□
□□□□□□
□
□□□ EPC □□□□□
□
□□□□□□
□
SQN □□□□□
□
□
□
□
□
□□□□
□□ EPC □□□□
□□□□□
□□□□□□□□
□□□ SQN
□□ MME □□
□□□□□□

□□□□□

□□

- API □□ 500 □□
- □□□□□□□□
- "□□□□□□□" □□
- □□□□□□

□□□□□□□□□□

□□ 1□□□□□□□□□

□□□

- □□ API □□□□
- □□□□□□□□
- "□□□□□" □□

□□□□□

1. □□□□□□□□

   ```
   # □□□□□□
   psql -h [DB_HOST] -U [DB_USER] -d [DB_NAME]
   ```

2. □□□□□□□□□□□□□□□□□

3. □□□□□□□□□□□□□□

□□□□□

- □□□□□□□
- □□□□□□□□□□
- □□□□□□□□□□□□□□

□□ 2□□□□□□□□□

□□□

- "□□□□" □□
- OmniHSS □□□□□□□□

□□□□□

1. □□ runtime.exs □□□□□□□
2. □□□□□□□□□□□□□□
3. □□□□□□□□□

□□□□□

- □□ runtime.exs □□ □□□□□
- □□□□□□□□□□□□
- □□□□□□□□ OmniHSS

□□ 3□□□□□□

□□□

- □□□ 500 □□
- "□□□□□□" □□
- □□□□□□□□□

□□□□□

1. □□□□□□□□□□□□
2. □□ runtime.exs □□□□□□□□
3. □□□□□□□□□□□□□□□

□□□□□

- □ runtime.exs □□□□□□□□
- □□□□□□□□□□□□□□□
- □□□□□□□□□□□□□□□

[illegible] 4[illegible]

[illegible]

- API [illegible]
- [illegible]
- [illegible] CPU [illegible]

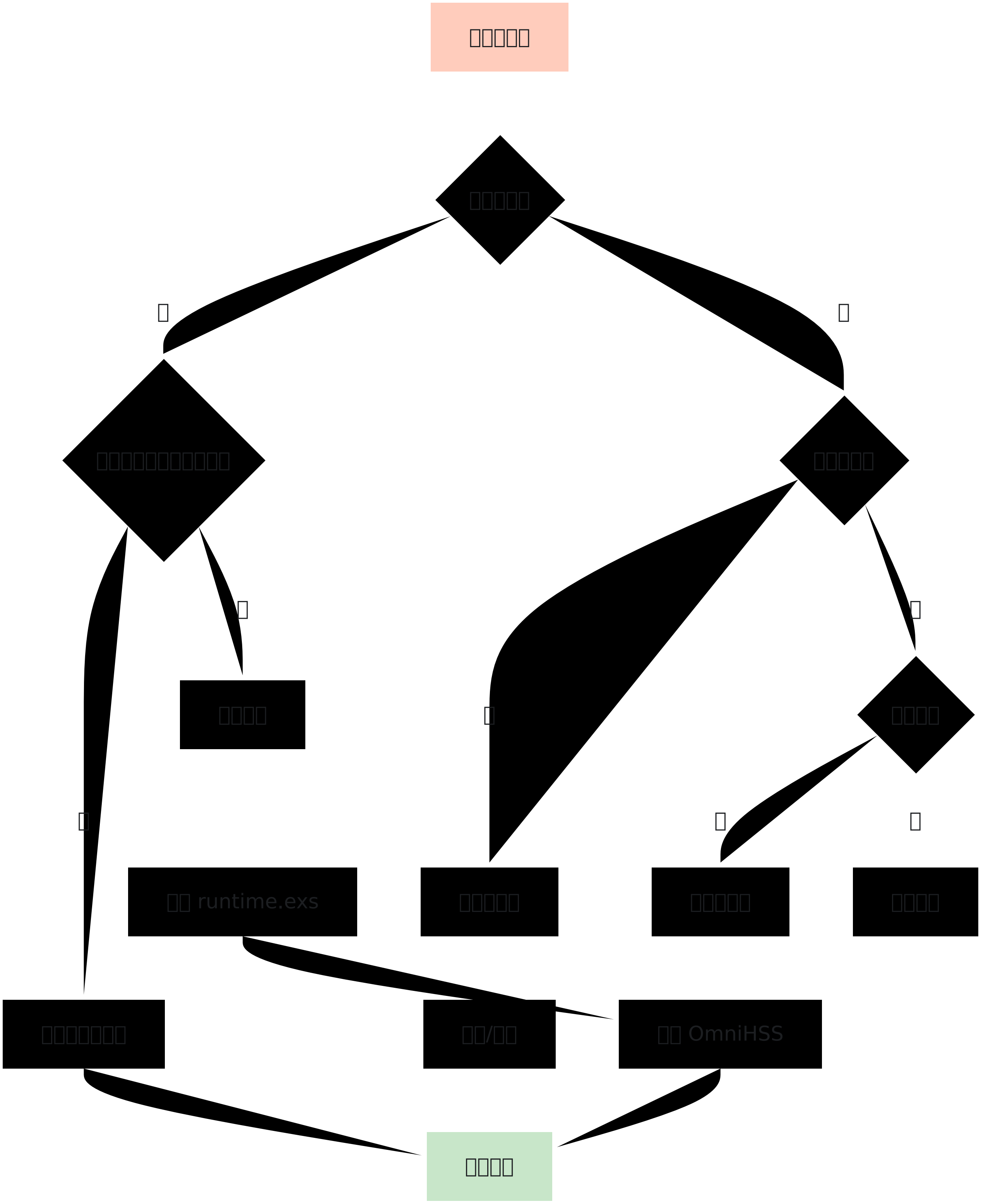
[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]


[illegible] runtime.exs
[illegible]/[illegible]
[illegible] OmniHSS

EPC [illegible]

[illegible]

- [illegible] LTE [illegible]
- MME [illegible]
- [illegible] PDN [illegible]

[illegible]

[illegible] 1[illegible]

[illegible]

- [illegible]���[illegible]
- "[illegible]" [illegible]
- [illegible]

[illegible]

1. [illegible] roaming_profile_id
2. [illegible]
3. [illegible] MCC/MNC
4. [illegible]

[illegible]

- [illegible] MCC/MNC [illegible] [illegible]
- [illegible]
- [illegible] [illegible] [illegible]

[illegible] 2[illegible] APN [illegible]

[illegible]

- [illegible] PDN [illegible]
- MME [illegible] "[illegible] APN" [illegible]

- □□□□□□□□□□

□□□□□

1. □□ EPC □□□□□□□□□ APN □□□□
2. □□ APN □□□□□□□□□□□□
3. □□ APN □□□□□□

□□□□□

- □ APN □□□□ □□□□□□ EPC □□□□
- □□ APN □□□□□□□□□
- □□ APN QoS □□□□□□□□

□□ 3□MME □□□

□□□

- □□□□□□□□
- □ MME □□□□
- Diameter □□□□□

□□□□□

1. □□ □□□□ Diameter □□
2. □□ MME □□□□□□ "□□□"
3. □□ MME □□□□ S6a □□□□

□□□□□

- □□□□ Diameter □□□□
- □□ MME □□
- □□ MME □□□

□□ 4□□□□□□□

□□□

- □□□□□□□□□□□□□□□□

- [illegible]
- [illegible]

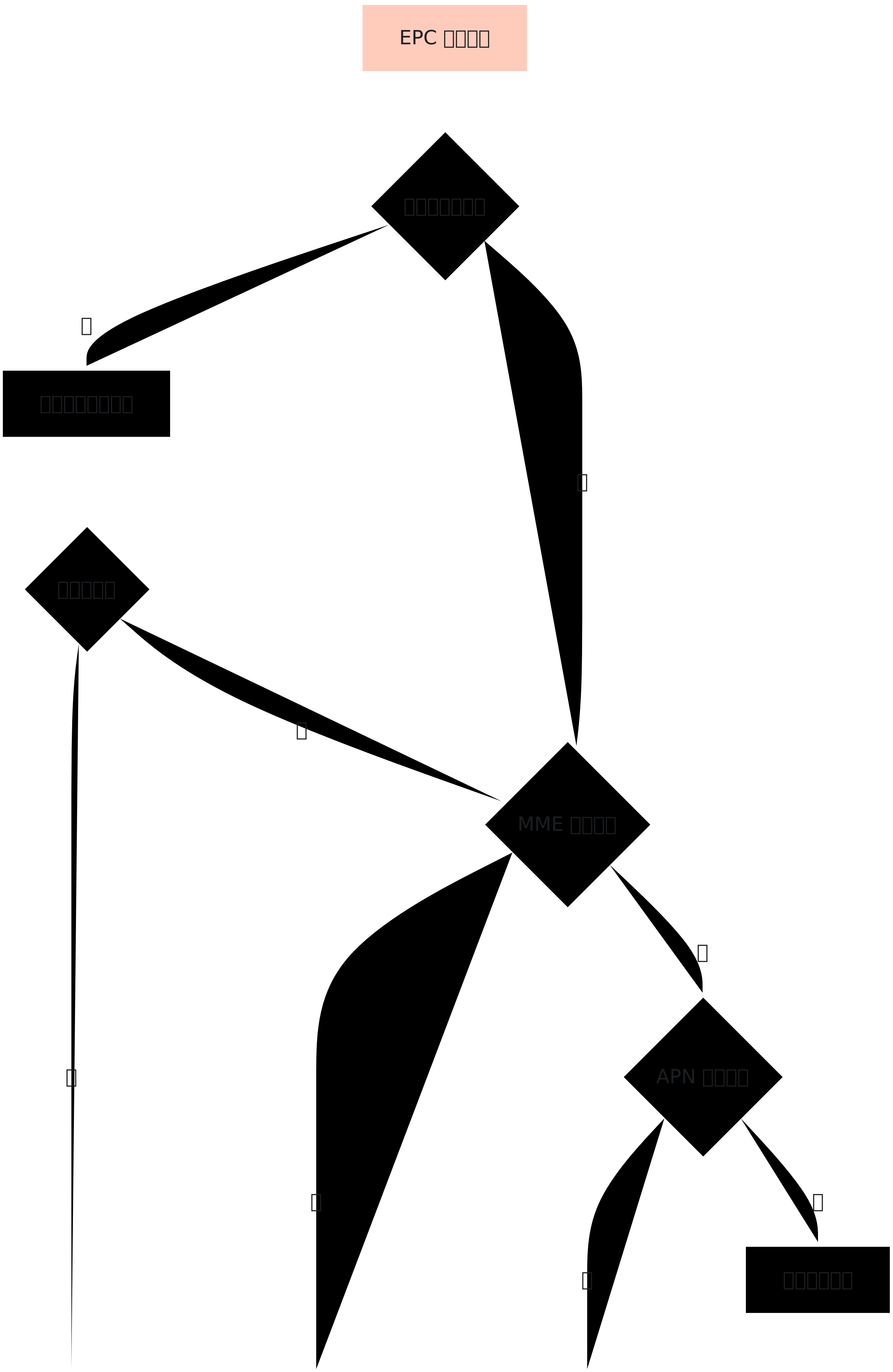
[illegible]

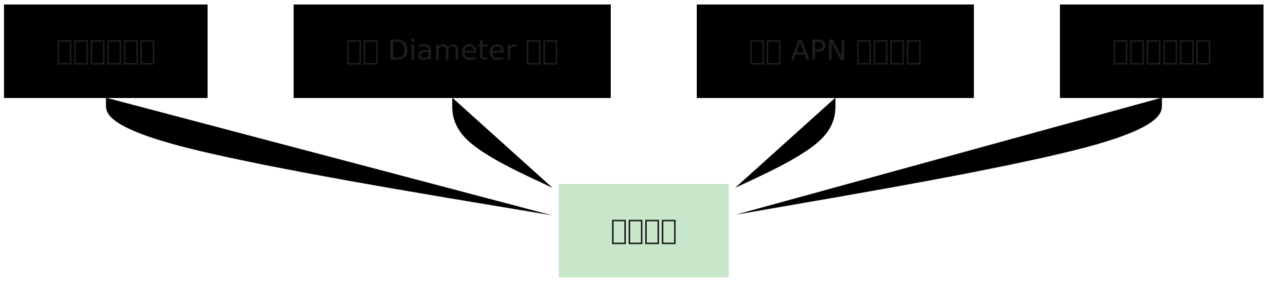
1. [illegible]
2. [illegible] MME [illegible]
3. [illegible]

[illegible]

- [illegible]
- [illegible] MME
- [illegible]

EPC [illegible]


EPC
MME
APN


□□□□□□
□□ Diameter □□
□□ APN □□□□
□□□□□□
□□□□

IMS □□□□

□□

- □□□□□□ VoLTE
- □□□□□ "IMS □□□□"
- □□□□□□□□□□

□□□□□□□□□

□□ 1□□□□□□ IMS

□□□

- □□□□□□□ IMS
- □□□□□□

□□□□□

1. □□□□□□□ `ims_enabled` □□
2. □□□□□□□□□ `ims_profile_id`

□□□□□

- □□□□□ IMS
- □□ IMS □□□□

□□ 2□S-CSCF □□□

□□□

- □□ IMS □□□□
- □□ IMS □□□ Diameter □□

□□□□□

1. □□ □□□□ Diameter □□
2. □□ S-CSCF □□□□□□
3. □□ S-CSCF □□□□ Cx □□□□

□□□□□

- □□□ S-CSCF □ Diameter □□□□
- □□ S-CSCF □□

□□ 3□□□□□□□ IFC □□

□□□

- □□□□□□□□□□□□
- □□□□□□ IFC □□□□□

□□□□□

1. □□□□□ IMS □□□□
2. □□ IFC □□□□□□
3. □□ IFC XML □□

□□□□□

- □□□□□ IFC □□□□ IMS □□□□
- □□ □□□□□□ □□ IFC □□

□□ 4□IMS □□□□□

□□□

- IMS □□□□□□□□
- □□□□□
- □□□□□□□ IMS □□

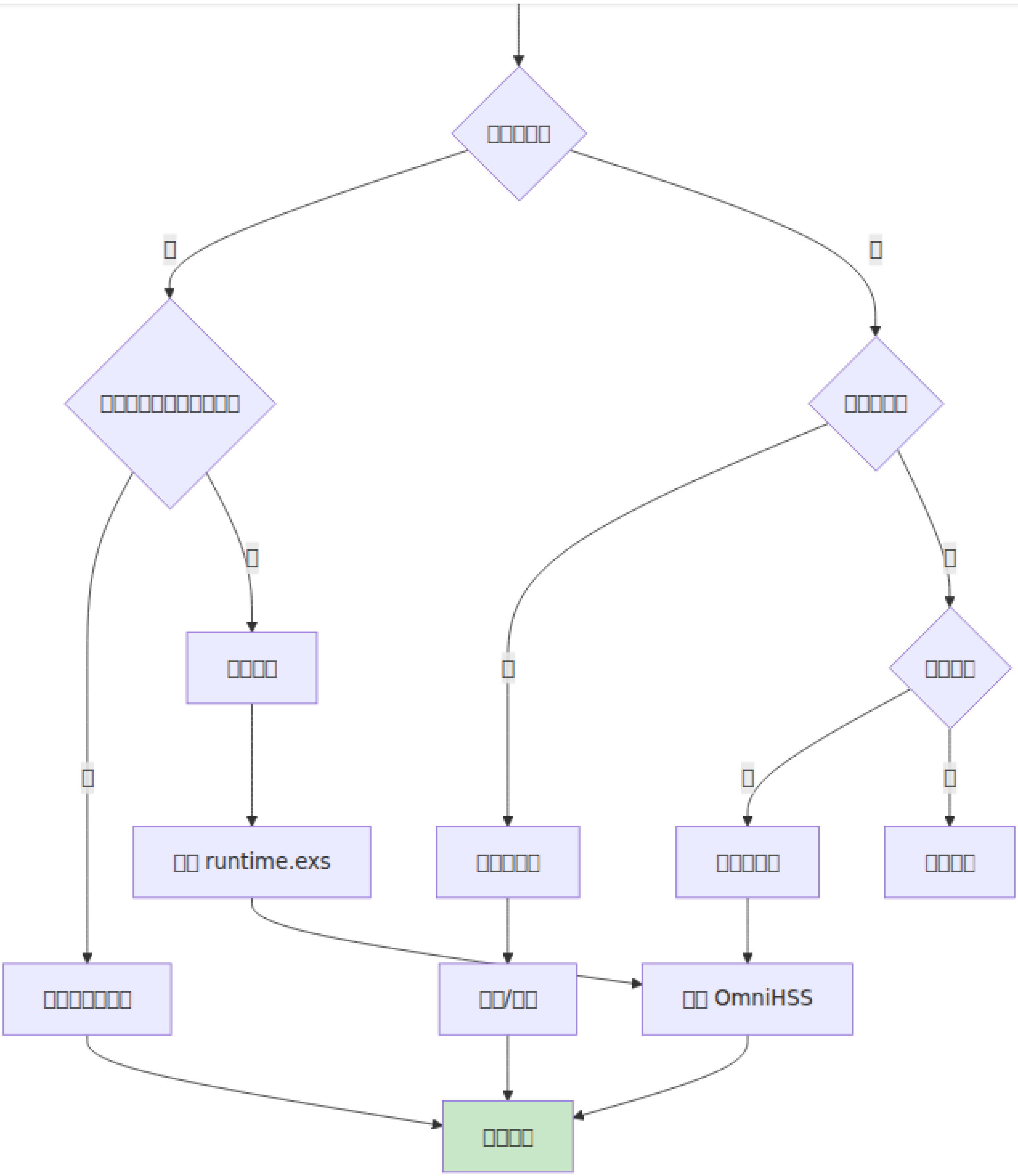
[illegible]

1. [illegible] IMS [illegible]
2. [illegible] `ims_action`

[illegible]

- [illegible] [illegible] [illegible] IMS
- [illegible] IMS [illegible]

IMS [illegible]


runtime.exs
/
OmniHSS

VoLTE [illegible]

[illegible]

- IMS [illegible]
- [illegible]
- [illegible]
- [illegible] "[illegible]" [illegible]

[illegible]

[illegible] 1[illegible]P-CSCF [illegible]

[illegible]

- [illegible]
- [illegible]

[illegible]

1. [illegible] [illegible] Diameter [illegible]
2. [illegible] P-CSCF [illegible]
3. [illegible] P-CSCF [illegible] Rx [illegible]OmniHSS PCRF [illegible]

[illegible]

- [illegible] P-CSCF [illegible] Diameter [illegible]
- [illegible] P-CSCF [illegible] OmniHSS [illegible] Rx

[illegible] 2[illegible]

[illegible]

- [illegible]
- AAR/AAA [illegible]
- Rx [illegible]

[illegible]

1. □□□□□□ Rx Diameter □□
2. □□□□□□ AAR□AA-□□□
3. □□ AAA□AA-□□□□□

□□□□□

- □□ P-CSCF □□□□ AAR □□□□□□
- □□ OmniHSS Rx □□□□□□
- □□□□□□□□□□□□ IMS □□

□□ 3□QoS/□□□□

□□□

- □□□□□□□□□
- □□□□
- □□□□

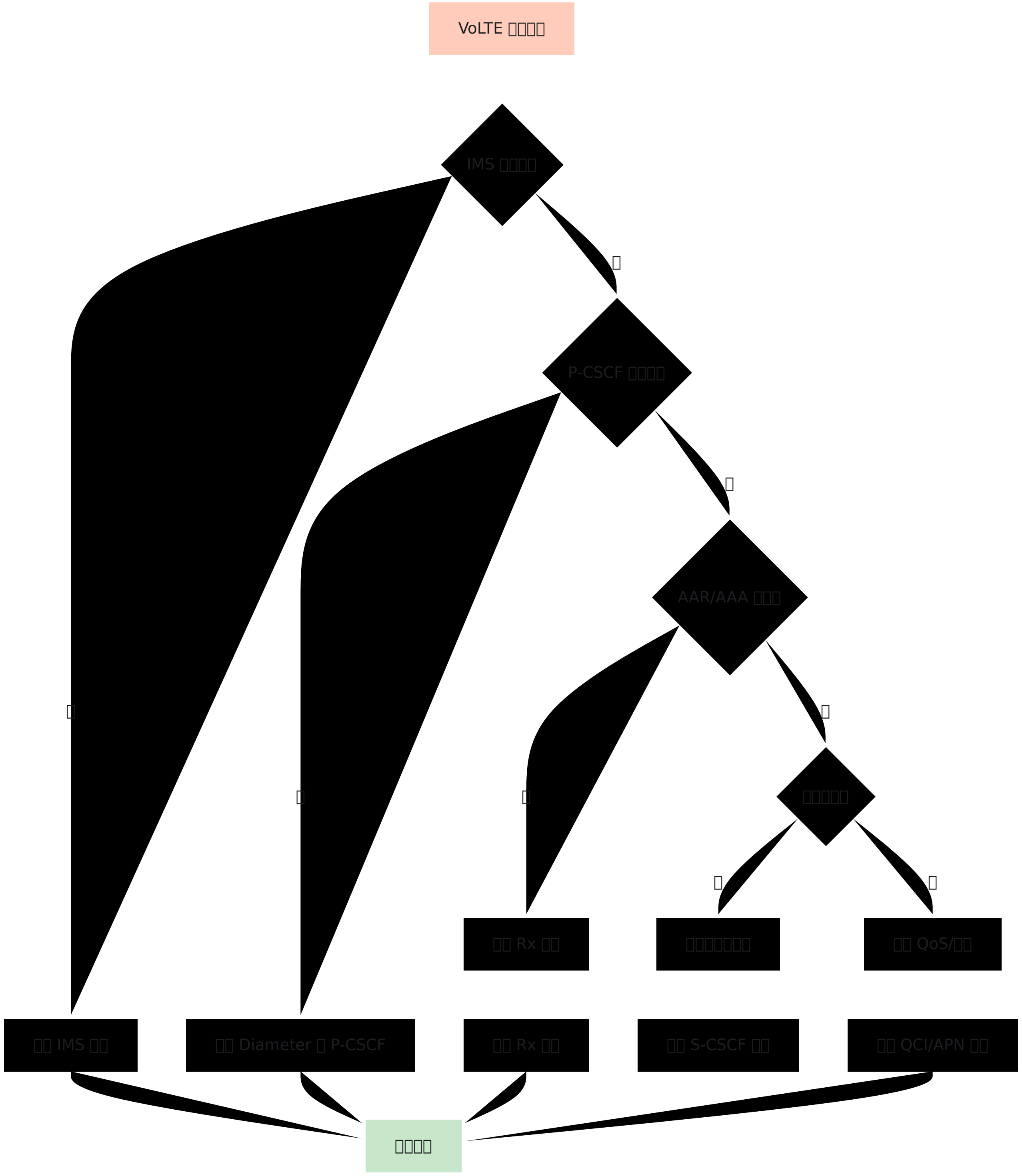
□□□□□

1. □□□□ APN □ APN QoS □□□□
2. □�� QCI □□□□□□□□□□□□ QCI 1□
3. □□ P-GW □□□□ Gx□PCRF □□□

□□□□□

- □□ APN QoS □□□□ □□□□□ IMS APN
- □□□□□□□□□ QCI 1
- □□□□□□□□ P-GW □ Diameter □□□□

VoLTE [illegible]


VoLTE
IMS
P-CSCF
AAR/AAA
Rx
QoS/
IMS
Diameter
P-CSCF
Rx
S-CSCF
QCI/APN

□□□□

□□

- □□□□□□□□□□□□□□
- □□□□□□□□□□□□□
- □□□□□□□□□□□□□□□□

□□□□□□□□□

□□ 1□□□□□□□□□□

□□□

- □□□□□□
- □□□□□□□□

□□□□□

1. □□□□□ `roaming_profile_id`
2. □□□□□□□ null

□□□□□

- □ □□□□□□ □□□□□

□□ 2□□□□□□□

□□□

- □□□□□□□□□□□□
- □□□□□□□□

□□□□□

1. □□□□□□ MME □□□□□□□ MCC/MNC
2. □□□□□□□□□□□
3. □□□ MCC/MNC □□□□□□□

4. □□□□□□□□□□□

□□□□□

- □□ □□□□ □□□□□□□□□

  ```
  curl -k -X POST https://hss.example.com:8443/api/roaming/rule \
    -H "Content-Type: application/json" \
    -d '{
      "roaming_rule": {
        "name": "Allow Visited Network",
        "mcc": "310",
        "mnc": "410",
        "data_action": "allow",
        "ims_action": "allow"
      }
    }'
  ```

□□ 3□□□□□□ IMS □□

□□□

- □□□□□□
- □□/IMS □□□□
- □□□□□□□

□□□□□

1. □□□□□□□□□□□
2. □□ `data_action` □ `ims_action` □
3. □□□□□□□□□□□□□

□□□□□

- □□□□□□□□□ IMS□
  - □□ `ims_action: "allow"`
- □□□□□□□□ `ims_action_if_no_rules_match` □ `"allow"`

□□□ □□□□ □□□□□□□□

EIR [illegible]

[illegible]

- [illegible]
- [illegible]
- EIR [illegible]

[illegible]

[illegible] 1[illegible] IMEI [illegible]

[illegible]

- [illegible]/[illegible]
- [illegible]

[illegible]

1. [illegible] EIR [illegible]
2. [illegible]
3. [illegible] IMEI
4. [illegible]/[illegible]

[illegible]

- [illegible] EIR [illegible]
- [illegible]
- [illegible]

[illegible] 2[illegible]MME [illegible] S13 [illegible]

[illegible]

- EIR [illegible]
- [illegible]

[illegible]

1. □□ MME □□□□□□□ S13 □□
2. □□ MME Diameter □□□□□□□
3. □□ S13 □□□□
4. □□ MME □□

□□□□□

- □□ MME □□ S13 □□ EIR □□
- □□ Diameter □□□□□ S13 □□ (16777252)
- □□□□□□□□ MME □□□

□□ 3□□□□□□□

□□□

- □□□□□□□□□□□□□□

□□□□□

1. □□□□ EIR □□
2. □□□□□□□□□□□□
3. □□□□□□

□□□□□

- □□□□□□□□ `.*` □□□□□□□□□□ IMEI
- □□□□□□□□□□□□□□□□
- □□□□□□□□□□□□□□□□□

□□□□

□□

- API □□□□
- Diameter □□□□
- CPU □□□□□□□

- [illegible]

[illegible]

[illegible] 1[illegible]

[illegible]

- [illegible]
- [illegible] CPU [illegible]
- [illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible] [illegible]

[illegible] 2[illegible]

[illegible]��[illegible]

- [illegible]��[illegible]
- [illegible]
- [illegible]

[illegible]

1. [illegible]

2. [illegible]
3. [illegible]
4. [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible] 3[illegible]Diameter [illegible]

[illegible]

- Diameter [illegible]
- [illegible]
- [illegible]

[illegible]

1. [illegible] [illegible] Diameter [illegible]
2. [illegible]
3. [illegible]
4. [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible] Diameter [illegible]

[illegible] 4[illegible]

[illegible]

- OmniHSS [illegible]

- □□□□□□
- □□□□□□□

□□□□□

1. □□□□□□□ OmniHSS □□□□□□
2. □□□□□□
3. □□□□□□
4. □□ Erlang VM □□

□□□□□

- □□ OmniHSS □□□□□□□
- □□□□□□□□□□□□□□□□
- □ runtime.exs □□□ Erlang VM □□□□
- □□□□□□□□□□□□□

□□□□□��

□□

- □□□□□□□□□□□□□□
- □□□□□□
- □□□□□□□
- □□□□□□

□□□□□□□□□□□□

□□ 1□MME □□/□□

□□□

- □□□□□□ MME □□ MME □□□□□□
- □□□ MME □□□□□□□
- □□□□

[illegible]

1. [illegible] MME
2. [illegible] MME [illegible]
3. [illegible] MME [illegible]

[illegible]

- [illegible]
- [illegible]
- MME [illegible] Cancel-Location

[illegible] 2[illegible]

[illegible]

- [illegible]
- PDN [illegible]
- [illegible]

[illegible]

1. [illegible] last_seen [illegible]
2. [illegible]
3. [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible] 3[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]

[illegible]

- [illegible]���[illegible]
- [illegible]
- [illegible]

API [illegible]

[illegible]

- API [illegible]
- API [illegible]
- [illegible]/[illegible]
- 500 [illegible]

[illegible]

[illegible] **1**[illegible]

[illegible]

- 400 [illegible] 422 [illegible]
- [illegible]
- [illegible]

[illegible]

1. [illegible]
2. [illegible] API [illegible]

3. [illegible]
4. [illegible]

[illegible]

- [illegible] API [illegible]
- [illegible]
- [illegible] ID [illegible]

[illegible] 2[illegible]

[illegible]

- [illegible]
- [illegible]“key_set_id [illegible]”
- [illegible]

[illegible]

1. [illegible]
2. [illegible]
    - key_set_id → [illegible]
    - epc_profile_id → EPC [illegible]
    - ims_profile_id → IMS [illegible]

[illegible]

- [illegible]
- [illegible] ID
- [illegible] [illegible]

[illegible] 3[illegible]

[illegible]

- 500 [illegible]
- [illegible] API [illegible]
- [illegible]

[illegible]

- [illegible] [illegible]

[illegible]

[illegible]

1. [illegible]
   - URL: `https://[hostname]:7443/overview`
   - [illegible]
2. **Diameter** [illegible]
   - URL: `https://[hostname]:7443/diameter`
   - [illegible]
3. [illegible]
   - URL: `https://[hostname]:7443/application`
   - [illegible]

API [illegible]

[illegible]

```
curl -k https://hss.example.com:8443/api/status
```

[illegible]

```
# □ IMSI
curl -k
https://hss.example.com:8443/api/subscriber/imsi/001001123456789

# □ MSISDN
curl -k
https://hss.example.com:8443/api/subscriber/msisdn/14155551234

# □ ID
curl -k https://hss.example.com:8443/api/subscriber/d290f1ee-6c54-
4b01-90e6-d701748f0851
```

□□□□□□□

```
curl -k https://hss.example.com:8443/api/subscriber
```

□□□□□□□□□

```
# EPC □□□□
curl -k https://hss.example.com:8443/api/epc/profile/e58ed763-
928c-4155-bee9-fdbaaadc15f3

# IMS □□□□
curl -k https://hss.example.com:8443/api/ims/profile/7c9e6679-
7425-40de-944b-e07fc1f90ae7

# □□□□□□
curl -k https://hss.example.com:8443/api/roaming/profile/9c858901-
8a57-4791-81fe-4c455b099bc9
```

□□□□□□

□□ Diameter □□□□□□

```
telnet [PEER_IP] 3868
```

□□ TLS □□□

```
openssl s_client -connect [hostname]:8443 -showcerts
```

□□□□□□□□□

```
psql -h [DB_HOST] -U [DB_USER] -d [DB_NAME] -c "SELECT COUNT(*)
FROM subscriber;"
```

□□□□

□□□□□□□□ IMSI□

```
grep "001001123456789" /var/log/omnihss/omnihss.log
```

□□□□□□□□□

```
grep "authentication.*fail" /var/log/omnihss/omnihss.log
```

□□ Diameter □□□□□□

```
grep "Diameter peer" /var/log/omnihss/omnihss.log
```

□□□□□□□□

```
grep -i "database.*error" /var/log/omnihss/omnihss.log
```

□□□□

□□□□

□□□□□□□□□□□□□□/□□□□□□

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]

[illegible]

[illegible]

1. [illegible] - [illegible]
2. [illegible] - [illegible]
3. [illegible] - [illegible]
4. [illegible] - runtime.exs [illegible]
5. [illegible] - OmniHSS [illegible]
6. [illegible] - [illegible]
7. [illegible] - [illegible] IMSI

[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]

□□□□□□□□

□□□□□□

□□□□	□□	□□□□
"□□□□□□□□□□"	□□□□□□□□□	□□ □□□□□
"SQN □□□□"	SQN □□□	□□□□□□
"□□□□□"	□□□ IMSI	□□ IMSI□□□□□
"□□□□□"	enabled=false	□□□□

Diameter □□

□□□□	□□	□□□□
"Diameter □□□□□□□"	□□□□	□□□□□□
"CER/CEA □□□□"	□□□□□	□□ Diameter □□
"□□□□□□□□"	□□□□□□□□□□□	□□□□□□□
"TLS □□□□"	□□□□	□□□□

□□□□□

□□□□	□□	□□□□
"□□□□□"	□□□□□	□□□□□
"□□□□□□"	□□□□	□□□□
"□□□□□□"	□□□	□□□□□
"□□□□"	□□□	□□□□

API □□

□□□□	□□	□□□□
"key_set_id □□□"	□□□□□	□□□□□□□
"IMSI □□□□"	□□□ IMSI	□□□□□ IMSI □□□□□□
"□□□□"	□□□□	□□□□□□□□□

← □□□□□□ | □□□□API □□ →

OmniHSS Webhook [illegible]

← [illegible]

[illegible]

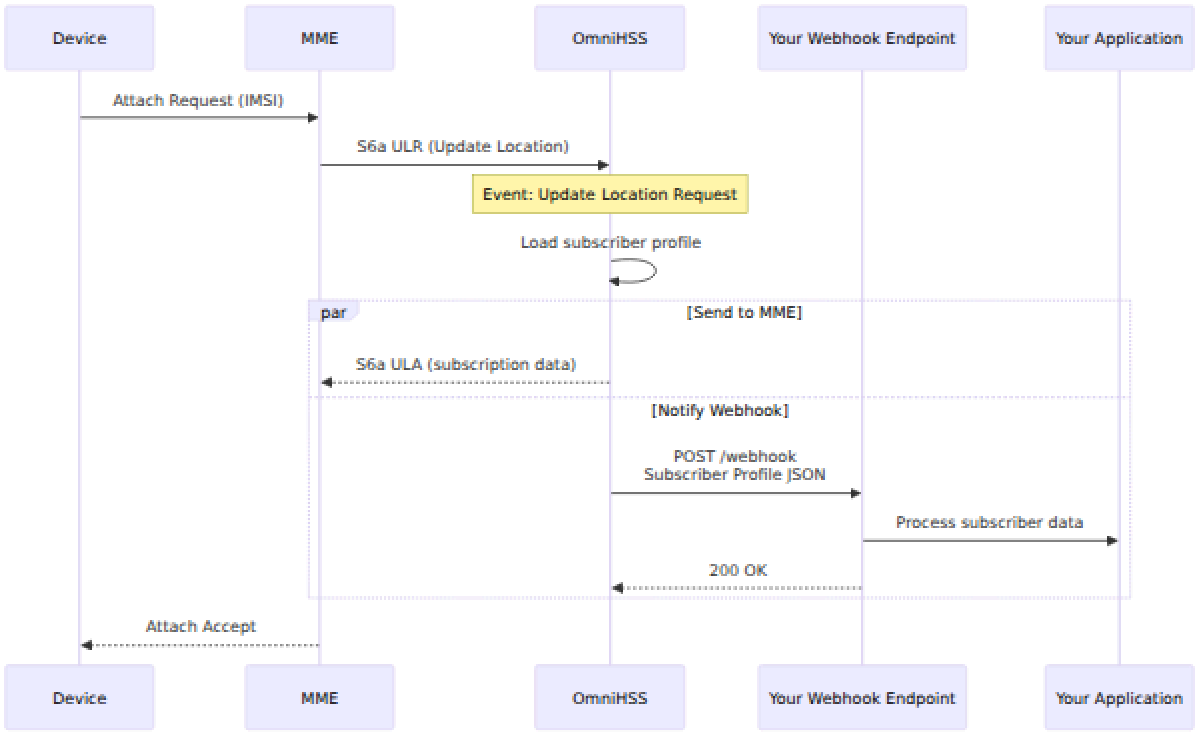
- [illegible]
- Webhook [illegible]
- Webhook [illegible]
- Webhook [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

OmniHSS [illegible] **webhooks** [illegible] IMS [illegible]OmniHSS [illegible] webhook [illegible] HTTP POST [illegible]

[illegible] Webhooks[illegible]

Webhooks [illegible] HTTP [illegible] OmniHSS [illegible] HSS API [illegible]


Device
MME
OmniHSS
Your Webhook Endpoint
Your Application
Attach Request (IMSI)
S6a ULR (Update Location)
Event: Update Location Request
Load subscriber profile
par
[Send to MME]
S6a ULA (subscription data)
[Notify Webhook]
POST /webhook
Subscriber Profile JSON
Process subscriber data
200 OK
Attach Accept
Device
MME
OmniHSS
Your Webhook Endpoint
Your Application

[illegible]

- [illegible] - [illegible]
- [illegible] - [illegible] webhook [illegible] `GET /api/subscriber` [illegible]
- [illegible] - [illegible]
- [illegible] - [illegible] API [illegible]
- [illegible] - [illegible] OmniHSS [illegible]

Webhook [illegible]

[illegible]

1. [illegible] - [illegible]IMS [illegible]
2. **HSS [illegible]** - OmniHSS [illegible] Diameter [illegible]/[illegible]
3. **Webhook [illegible]** - [illegible] webhook[illegible]HSS [illegible] HTTP POST
4. [illegible] - Webhook [illegible] JSON
5. [illegible] - [illegible] HTTP 200-299 [illegible]

□□□□

- □□□□□□□ - Webhooks □□□□□□□□□□□□□□□
- □□ - Webhook □□□ 5 □□□□
- □□□ - □□□□□□□□□□□□□□□□□□□□ webhook
- □□□□□ - □□□□□□□□□□□□□□□

□□□ □□□□□□□□□□□□□□□□□□□□ webhook □□□□□□□□ webhook □□□□□□□□□□□□□□□□

Webhook □□

OmniHSS □□□□□□□□□ webhooks□

EPC/LTE □□

□□	□□	□□
`update_location_request`	S6a ULR	□□□□□□□□□□□□□□
`authentication_information_request`	S6a AIR	□□□□□□□□□□□□□□
`purge_request`	S6a PUR	MME □□□□□□□□□□□□□□□□□
`cancel_location_answer`	S6a CLA	MME □□□□□□□

IMS □□

□□	□□	□□
`ims_registration`	Cx SAR	□□□□□ IMS/VoLTE □□
`ims_deregistration`	Cx SAR (de-reg)	□□□□□ IMS
`ims_profile_request`	Sh UDR	□□□□□□□□□□ IMS ��□□□

□□□□ (PCRF)

□□	□□	□□
`policy_request`	Gx CCR	P-GW □□□□□□□□□□□□
`media_authorization`	Rx AAR	P-CSCF □□ IMS □□□□□□□

□ IMSI □□

□□	□□	□□
`imsi_switch`	ULR for different IMSI on same SIM	□□□□ IMSI SIM □□□□□□□ IMSI

Webhook □□

□□□□

□□□□□□□OmniHSS □□□□□ webhook URL □□ HTTP POST □□□

```
POST /your-webhook-endpoint HTTP/1.1
Host: your-server.com
Content-Type: application/json
X-OmniHSS-Event: update_location_request
X-OmniHSS-Event-ID: 550e8400-e29b-41d4-a716-446655440000
X-OmniHSS-Timestamp: 2025-01-15T14:30:00Z

{
  "event": "update_location_request",
  "event_id": "550e8400-e29b-41d4-a716-446655440000",
  "timestamp": "2025-01-15T14:30:00Z",
  "subscriber": {
    "id": "d290f1ee-6c54-4b01-90e6-d701748f0851",
    "imsi": "001001123456789",
    "enabled": true,
    "ims_enabled": true,
    "msisdns": [
      {"id": "16fd2706-8baf-433b-82eb-8c7fada847da", "msisdn":
"14155551001"},
      {"id": "27ae3807-9cbf-4a4c-93fc-9d8afdb958eb", "msisdn":
"14155551002"}
    ],
    "sim": {
      "id": "3f2504e0-4f89-41d3-9a0c-0305e82c3301",
      "iccid": "8991101200003204510",
      "is_esim": false
    },
    "key_set": {
      "id": "6ba7b810-9dad-41d1-80b4-00c04fd430c8",
      "amf": "8000"
    },
    "epc_profile": {
      "id": "e58ed763-928c-4155-bee9-fdbaaadc15f3",
      "name": "Premium 100Mbps",
      "ue_ambr_dl_kbps": 100000,
      "ue_ambr_ul_kbps": 50000
    },
    "ims_profile": {
      "id": "7c9e6679-7425-40de-944b-e07fc1f90ae7",
      "name": "Standard VoLTE"
    },
    "roaming_profile": {
      "id": "9c858901-8a57-4791-81fe-4c455b099bc9",
      "name": "International Roaming Allowed"
    },
    "subscriber_state": {
      "mme_host": "mme-01.example.com",
      "mme_realm": "epc.mnc001.mcc001.3gppnetwork.org",
      "visited_plmn": "001001",
      "last_update": "2025-01-15T14:30:00Z"
    },
    "custom_attributes": {
      "account_type": "premium",
      "billing_plan": "unlimited"
    }
  },
  "event_context": {
    "visited_plmn": "310410",
    "mme_host": "mme-roaming.example.com",
    "location_update_type": "initial_attach"
  }
}
```

□□□□

□□	□□	□□
`event`	string	□□□□□□□□`update_location_request`□
`event_id`	string	□ webhook □□□□□ UUID
`timestamp`	string	□□□□□□ ISO 8601 □□□
`subscriber`	object	□□□□□□□□□□□□ `GET /api/subscriber/:id` □□□
`event_context`	object	□□□□□□□□□□□□

□□□□□□□

`event_context` □□□□□□□□□□□□

□□ `update_location_request`:

```
{
  "visited_plmn": "310410",
  "mme_host": "mme-roaming.example.com",
  "mme_realm": "epc.mnc410.mcc310.3gppnetwork.org",
  "location_update_type": "initial_attach"
}
```

□□ `imsi_switch`:

```
{
  "previous_imsi": "001001111111111",
  "new_imsi": "310410222222222",
  "sim_id": "3f2504e0-4f89-41d3-9a0c-0305e82c3301",
  "previous_mme_host": "mme-home.example.com",
  "new_mme_host": "mme-roaming.example.com"
}
```

□□ `ims_registration`:

```
{
  "scscf_host": "scscf-01.ims.example.com",
  "public_identities": [
    "sip:001001123456789@ims.mnc001.mcc001.3gppnetwork.org",
    "sip:+14155551001@ims.example.com",
    "tel:+14155551001"
  ]
}
```

HTTP [illegible]

[illegible]	[illegible]	[illegible]
`Content-Type`	[illegible] `application/json`	`application/json`
`X-OmniHSS-Event`	[illegible]	`update_location_request`
`X-OmniHSS-Event-ID`	[illegible]	UUID
`X-OmniHSS-Timestamp`	[illegible]	ISO 8601 [illegible]
`User-Agent`	OmniHSS [illegible]	`OmniHSS/1.0`

[illegible]

[illegible] Webhooks

Webhooks [illegible] OmniHSS API [illegible]

[illegible] Webhook

```
curl -k -X POST https://hss.example.com:8443/api/webhook \
  -H "Content-Type: application/json" \
  -d '{
    "webhook": {
      "url": "https://your-server.com/omnihss-webhook",
      "events": [
        "update_location_request",
        "ims_registration",
        "imsi_switch"
      ],
      "enabled": true,
      "description": "□□□□□□ webhook"
    }
  }'
```

□□:

```json
{
  "data": {
    "id": "4e5d6c7b-8a9f-4b0c-8d1e-2f3a4b5c6d7e",
    "url": "https://your-server.com/omnihss-webhook",
    "events": [
      "update_location_request",
      "ims_registration",
      "imsi_switch"
    ],
    "enabled": true,
    "description": "□□□□□□ webhook",
    "created_at": "2025-01-15T14:00:00Z"
  }
}
```

□□ Webhooks

```
curl -k https://hss.example.com:8443/api/webhook
```

□□ Webhook

```
curl -k -X PUT https://hss.example.com:8443/api/webhook/4e5d6c7b-
8a9f-4b0c-8d1e-2f3a4b5c6d7e \
  -H "Content-Type: application/json" \
  -d '{
    "webhook": {
      "enabled": false
    }
  }'
```

□□ Webhook

```
curl -k -X DELETE
https://hss.example.com:8443/api/webhook/4e5d6c7b-8a9f-4b0c-8d1e-
2f3a4b5c6d7e
```

Webhook □□□□

□□ webhook □□□□□

1. □□ **POST** □□□□□ `Content-Type: application/json`
2. □□□□ - □ 5 □□□□ HTTP 200-299
3. □□□□ - □□□□□□□□□
4. □□ **HTTPS** - □□□□□□□ TLS/SSL □□□□□□
5. □□□□ - □□□□□□ OmniHSS□□□□□□□□□

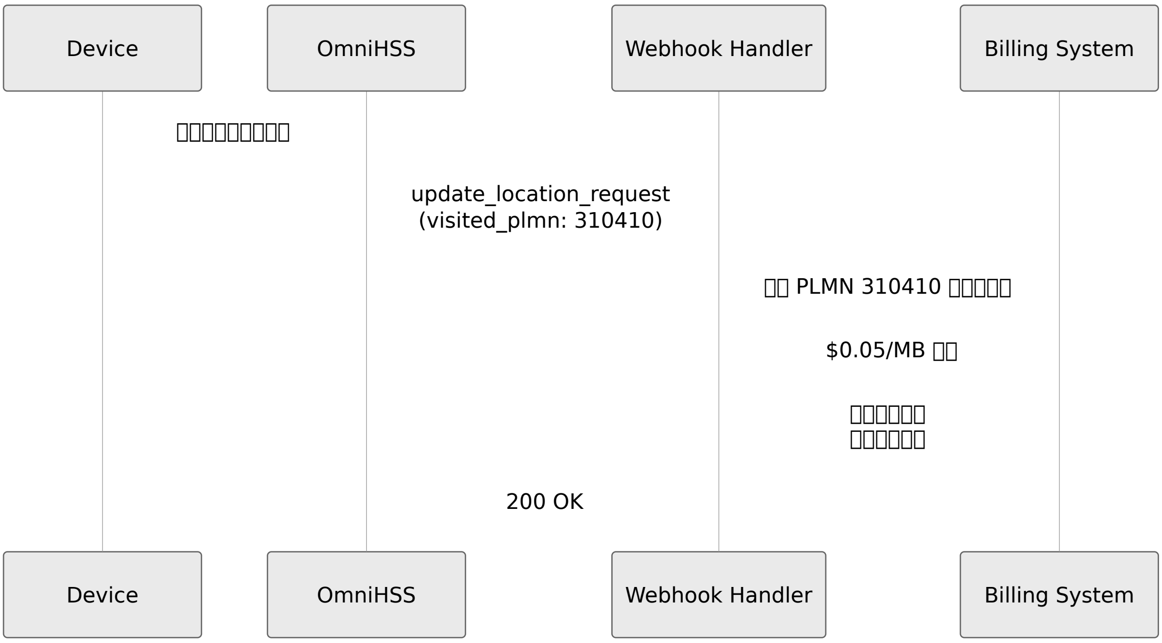
□□ Webhook □□□□ (Node.js/Express):

```javascript
const express = require('express');
const app = express();

app.post('/omnihss-webhook', express.json(), (req, res) => {
  const { event, subscriber, event_context } = req.body;

  console.log(`□□□□: ${event}`);
  console.log(`□□□ IMSI: ${subscriber.imsi}`);

  // □□□□□□□
  // ... □□□□□□□□□ ...

  // □□□□□□□□□
  res.status(200).json({ received: true });

  // □□□□□□□□□□
  processWebhook(req.body).catch(console.error);
});

async function processWebhook(payload) {
  // ���□□□□□□□
  // □□□□□□□□□□□□□□□
}

app.listen(3000);
```

□□

1. □□□□□□□□□

□□□□□□□□□□□□□□□□□□□□□□□


Device
OmniHSS
Webhook Handler
Billing System
[illegible]
update_location_request
(visited_plmn: 310410)
[illegible] PLMN 310410 [illegible]
$0.05/MB [illegible]
[illegible]
[illegible]
200 OK
Device
OmniHSS
Webhook Handler
Billing System

[illegible]:

- [illegible]
- [illegible]
- [illegible]/[illegible]
- [illegible]

2. [illegible]

[illegible]

[illegible]: [illegible]

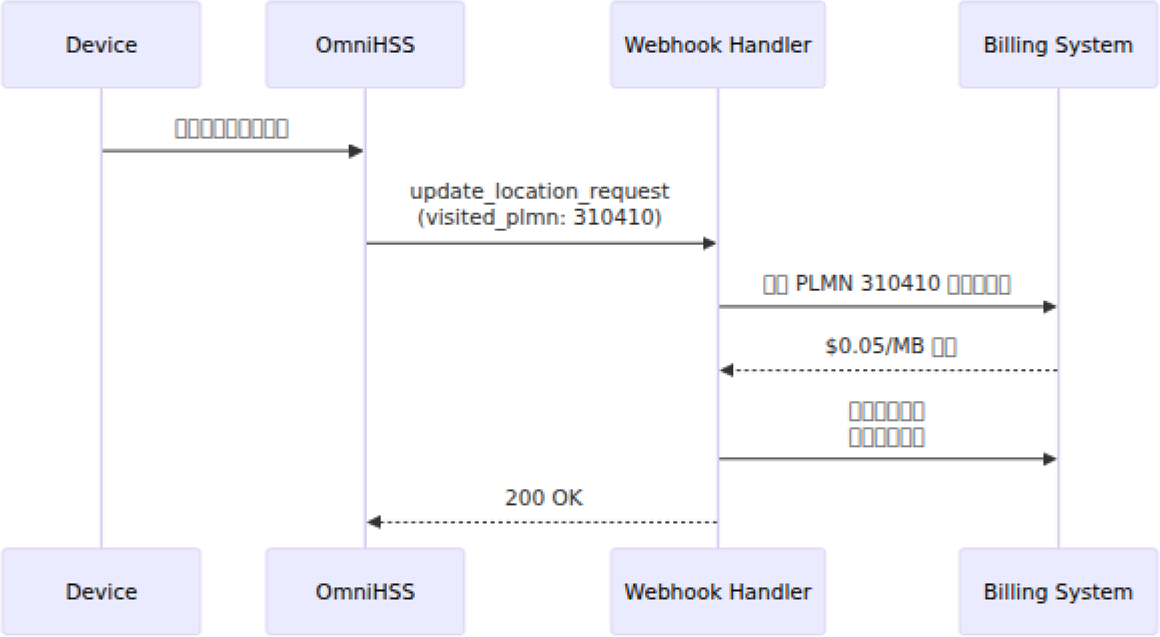
```
// Webhook [illegible]
app.post('/omnihss-webhook', async (req, res) => {
  const { event, subscriber, event_context } = req.body;

  if (event === 'update_location_request') {
    await analytics.track({
      event: 'subscriber_location_update',
      imsi: subscriber.imsi,
      visited_plmn: event_context.visited_plmn,
      timestamp: req.body.timestamp,
      profile: subscriber.epc_profile.name
    });
  }

  res.status(200).send();
});
```

[illegible]:

- [illegible] MME [illegible]
- [illegible]
- [illegible]
- IMS [illegible]

3. [illegible]

[illegible]


Device
OmniHSS
Webhook Handler
Billing System
□□□□□□□□□
update_location_request
(visited_plmn: 310410)
□□ PLMN 310410 □□□□□
$0.05/MB □□
□□□□□□
□□□□□□
200 OK
Device
OmniHSS
Webhook Handler
Billing System

□□□□□□:

1. □□□□□□
   - □□□□ A □□□
   - 30 □□□□□ B □□□□□□□□□□□
   - □□: □□□□□□□□□□□□□□
2. **IMSI** □□□□
   - □□ SIM □□□□□ IMSI □□
   - □□□ SIM □□□□□□□□□ IMSI □□
   - □□: □□ SIM □□□□ IMSI□□□□□□□
3. □□□□□□□
   - □□□□□□□□□□□□□□□□□□□□□
   - □□: □□□□□□□□□□□□□□

□□□□:

```
@app.route('/omnihss-webhook', methods=['POST'])
def webhook_handler():
    data = request.json
    subscriber = data['subscriber']
    event_context = data.get('event_context', {})

    if data['event'] == 'update_location_request':
        visited_plmn = event_context.get('visited_plmn')

        # □□□□□□□□
        if visited_plmn in BLOCKED_PLMNS:
            disable_subscriber(subscriber['imsi'])
            alert_security_team(subscriber, '□□□□□□□ PLMN')

        # □□□□□□□□
        if is_impossible_travel(subscriber['imsi'], visited_plmn):
            flag_for_review(subscriber['imsi'])
            alert_fraud_team(subscriber, '□□□□□□□□□')

    return jsonify({'status': 'ok'}), 200
```

4. □□□□□

□□□□□□□□□□□□□□□□□□□

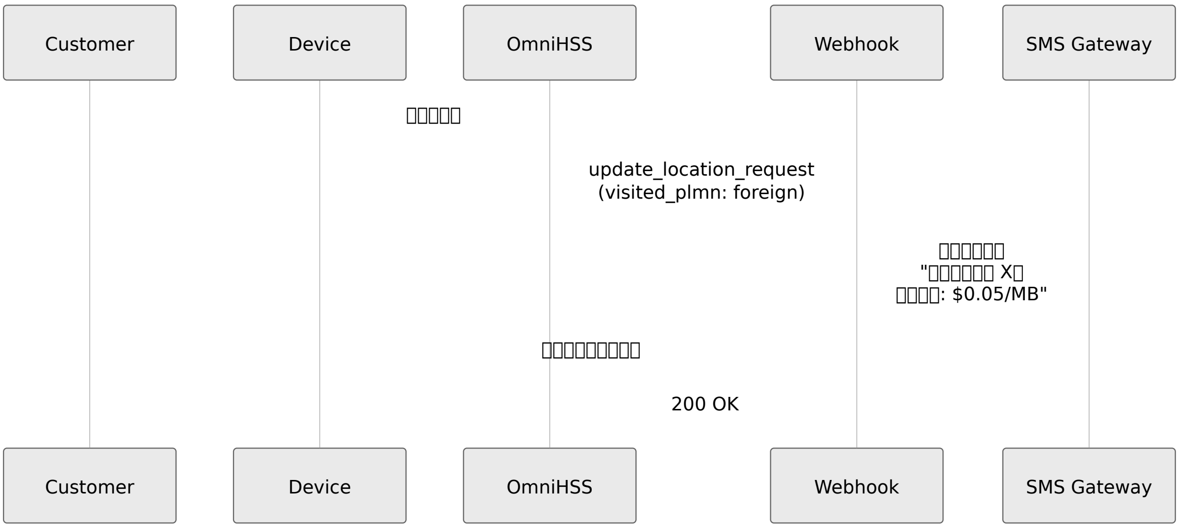
□□: □□□□□□□□ VoLTE □□□□□ IMS

```
app.post('/omnihss-webhook', async (req, res) => {
  const { event, subscriber } = req.body;

  if (event === 'ims_registration' && !subscriber.ims_enabled) {
    // □□ IMS □□ - □□□□ IMS
    await omnihss.updateSubscriber(subscriber.id, {
      ims_enabled: true,
      custom_attributes: {
        ...subscriber.custom_attributes,
        volte_activated_at: new Date().toISOString()
      }
    });

    // □□ CRM
    await crm.updateCustomer(subscriber.imsi, {
      features: ['volte']
    });
  }

  res.status(200).send();
});
```

5. □□□□

□□□□□□□□□□□□□□□□

□□: □□□□□□□□□□□□


Customer
Device
OmniHSS
Webhook
SMS Gateway
□□□□□
update_location_request
(visited_plmn: foreign)
□□□□□□
"□□□□□□ X□
□□□□: $0.05/MB"
□□□□□□□□□
200 OK
Customer
Device
OmniHSS
Webhook
SMS Gateway

□□□□:

- "□□□□ [□□]□□□□□□□□"
- "□□□□ 80% □□□□□"
- "□□□□□□□□ VoLTE □□"
- "□□□□□□□□□□□"

6. □ IMSI SIM □□

□□□□□□□□ IMSI SIM □□□□□□□□□□ IMSI □□□□□□

```
app.post('/omnihss-webhook', async (req, res) => {
  const { event, subscriber, event_context } = req.body;

  if (event === 'imsi_switch') {
    const { previous_imsi, new_imsi, sim_id } = event_context;

    // □□ IMSI ��□□□□□□
    await db.logImsiSwitch({
      sim_id,
      from_imsi: previous_imsi,
      to_imsi: new_imsi,
      timestamp: req.body.timestamp
    });

    // □□□□□□
    await billing.endSession(previous_imsi);
    await billing.startSession(new_imsi);

    // □□□□□□□□□□□□□□□□□□□□□
    const switchCount = await db.getSwitchCount(sim_id, '24h');
    if (switchCount > 10) {
      await alertFraudTeam(`□□ IMSI □□: SIM ${sim_id}`);
    }
  }

  res.status(200).send();
});
```

7. □□□□□□□

□ OmniHSS □□□□□□□□□□□□□□

□□□□:

- **CRM □□** - □□□□□□□□□□□□□□□
- **□□□□** - □□□□□□□□□□□□□□
- **□□□□** - □□□□□□□□□□
- **□□□□** - □□□□□□□□□□□□□
- **□□□□** - □□□□□□□□□□□□□□□□□

□□□□

Webhook □□/□□

□□□□ webhooks □□ OmniHSS□□□□□□□□□

```
# □□□□□□ webhook
curl -k -X POST https://hss.example.com:8443/api/webhook \
  -H "Content-Type: application/json" \
  -d '{
    "webhook": {
      "url": "https://your-server.com/omnihss-webhook",
      "events": ["update_location_request"],
      "secret": "your-secret-key-here"
    }
  }'
```

OmniHSS □□□□□ `X-OmniHSS-Signature` □□

```
X-OmniHSS-Signature:
sha256=5d7a8f9b2c1e3a4d6f7e8b9c0a1b2c3d4e5f6a7b8c9d0e1f2a3b4c5d6e7f8a
```

□□□□:

```
const crypto = require('crypto');

function verifyWebhook(req) {
  const signature = req.headers['x-omnihss-signature'];
  const secret = process.env.WEBHOOK_SECRET;
  const payload = JSON.stringify(req.body);

  const expectedSignature = 'sha256=' +
    crypto.createHmac('sha256', secret)
      .update(payload)
      .digest('hex');

  return crypto.timingSafeEqual(
    Buffer.from(signature),
    Buffer.from(expectedSignature)
  );
}

app.post('/omnihss-webhook', (req, res) => {
  if (!verifyWebhook(req)) {
    return res.status(401).json({ error: '□□□□□' });
  }

  // □□ webhook...
  res.status(200).send();
});
```

□□□□

1. □□ **HTTPS** - □□□ webhook □□□□ TLS
2. □□□□ - □□ webhook □□□□□□□
3. □□□□ - □ webhook □□□□□□□□□
4. **IP** □□□ - □□ webhook □□ OmniHSS IP □□
5. □□□□ - □□ webhook □□□□□□□
6. □□□□ - □□□□□□□□□□ webhook □□
7. □□□□ - □□□□□□□□ webhook □□□□□□□□□□□□□□

[illegible]

Webhook [illegible] [illegible]

- IMSI[illegible]
- MSISDN[illegible]
- [illegible] PLMN[illegible]MME[illegible]
- [illegible]

[illegible]

- **GDPR** - [illegible] webhook [illegible] GDPR
- [illegible] - [illegible]
- [illegible] - [illegible] webhook [illegible]
- [illegible] - [illegible] webhook [illegible] TLS
- [illegible] - [illegible] webhook [illegible]

[illegible]

Webhook [illegible]

[illegible]:

- [illegible] webhook [illegible]
- Webhook [illegible]

[illegible]:

1. **[illegible] webhook [illegible]:**

   ```
   curl -k https://hss.example.com:8443/api/webhook
   # [illegible] "enabled": true
   ```

2. **[illegible] webhook [illegible]:**

    - □□□□□□□□□ webhook □ `events` □□□
    - □□: □□□□□ `ims_registration` □□□□□□□□□□□□□□□

3. □□ **HSS** □□□

    - □□ webhook □□□□
    - □□□□□□□□
    - □□□□ DNS □□□□

4. □□□□□□□□□

    ```
    curl -X POST https://your-server.com/omnihss-webhook \
      -H "Content-Type: application/json" \
      -d '{"test": true}'
    ```

Webhook □□

□□□

- HSS □□□□ webhook □□□□
- Webhook □□□□□□□□ HSS □□□□□

□□□□□

1. □□□□□

    - □ 5 □□□□ HTTP 200
    - □□□□□□□□□□

2. □□□□□□□

```
// [illegible] - [illegible]
app.post('/webhook', (req, res) => {
  processData(req.body); // [illegible] 10 [illegible]
  res.status(200).send();
});

// [illegible] - [illegible]
app.post('/webhook', (req, res) => {
  res.status(200).send(); // [illegible]
  processData(req.body); // [illegible]
});
```

[illegible] Webhooks

[illegible]

- [illegible]
- [illegible] `event_id` [illegible]

[illegible]

- [illegible] OmniHSS [illegible]
- [illegible] webhook

[illegible]

��[illegible] `event_id` [illegible]

```
const processedEvents = new Set();

app.post('/omnihss-webhook', (req, res) => {
  const eventId = req.body.event_id;

  if (processedEvents.has(eventId)) {
    // □□□□□□
    return res.status(200).json({ status: 'duplicate' });
  }

  processedEvents.add(eventId);

  // □□ webhook...
  processWebhook(req.body);

  res.status(200).json({ status: 'processed' });
});
```

Webhook □□□□

□□□

- □□□□ HTTP 4xx □ 5xx
- HSS □□ webhook □□□□

□□□□□

1. **401 Unauthorized** - □□□□□□
   - □□ webhook □□□□□□□□□
   - □□□□□□□□
2. **400 Bad Request** - □□□□
   - □□ webhook □□□□
   - □□□□ Content-Type □
3. **500 Internal Server Error** - □□□□
   - □□□□□□□□

    - [illegible]

[illegible]

[illegible]

```
app.post('/omnihss-webhook', async (req, res) => {
  try {
    // [illegible]
    if (!verifyWebhook(req)) {
      return res.status(401).json({ error: 'Invalid signature' });
    }

    // [illegible]
    if (!req.body.event || !req.body.subscriber) {
      return res.status(400).json({ error: 'Invalid payload' });
    }

    // [illegible] webhook
    await processWebhook(req.body);

    res.status(200).json({ status: 'ok' });

  } catch (error) {
    console.error('Webhook processing error:', error);
    // [illegible] 200 [illegible]��[illegible]
    res.status(200).json({ status: 'error', message: error.message
});
  }
});
```

[illegible]

[illegible]

- [illegible] webhook [illegible]
- [illegible] null [illegible]

[illegible]

1. [illegible] - [illegible]IMS[illegible]

2. [illegible] - [illegible] webhook [illegible]

[illegible]

[illegible]

```
const { subscriber } = req.body;

// [illegible]
const imsProfile = subscriber.ims_profile || { name: 'No IMS' };
const roamingProfile = subscriber.roaming_profile || { name: 'No
Roaming' };

// [illegible] MSISDN
const msisdns = subscriber.msisdns || [];
```

[illegible]

Webhook [illegible]

[illegible] webhook [illegible]

[illegible]

- Webhook [illegible]
- Webhook [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]**Prometheus/Grafana**[illegible]

```
# Webhook □□□
rate(omnihss_webhook_success_total[5m]) /
rate(omnihss_webhook_attempts_total[5m])

# Webhook □□
histogram_quantile(0.95, omnihss_webhook_duration_seconds)
```

Webhook □□

□□□□□ webhook □□□□□□□□□□□□

□□□□□

```
{
  "timestamp": "2025-01-15T14:30:00Z",
  "level": "info",
  "component": "webhook",
  "event_id": "550e8400-e29b-41d4-a716-446655440000",
  "webhook_id": "4e5d6c7b-8a9f-4b0c-8d1e-2f3a4b5c6d7e",
  "event_type": "update_location_request",
  "subscriber_imsi": "001001123456789",
  "endpoint": "https://your-server.com/omnihss-webhook",
  "http_status": 200,
  "duration_ms": 145,
  "error": null
}
```

← □□□□□□ | □□□□□API □□ →