OmniRoam

OmniRoam is Omnitouch's comprehensive wholesale revenue management solution for roaming operators. It handles the complete lifecycle of roaming data CDRs (Call Detail Records), from ingestion through rating to TAP3 file generation and reporting.
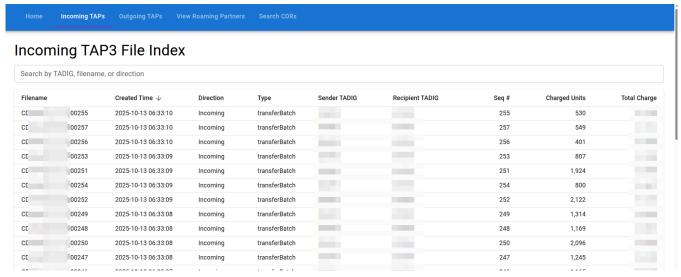
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Overview

OmniRoam processes roaming CDRs from mobile network operators, rates them using the OmniCharge rating engine, generates GSMA-compliant TAP3 files for billing, and provides comprehensive monitoring and reporting capabilities.

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Incoming TAP3 File Index

Search by TADIG, filename, or direction

Filename	Created Time ↓	Direction	Type	Sender TADIG	Recipient TADIG	Seq #	Charged Units	Total Charge
CD 00255	2025-10-13 06:33:10	Incoming	transferBatch			255	530	
CD 00257	2025-10-13 06:33:10	Incoming	transferBatch			257	549	
CD 00256	2025-10-13 06:33:10	Incoming	transferBatch			256	401	
CD 00253	2025-10-13 06:33:09	Incoming	transferBatch			253	807	
CD 00251	2025-10-13 06:33:09	Incoming	transferBatch			251	1,924	
CD 00254	2025-10-13 06:33:09	Incoming	transferBatch			254	800	
CD 00252	2025-10-13 06:33:09	Incoming	transferBatch			252	2,122	
CD 00249	2025-10-13 06:33:08	Incoming	transferBatch			249	1,314	
CD 00248	2025-10-13 06:33:08	Incoming	transferBatch			248	1,169	
CD 00250	2025-10-13 06:33:08	Incoming	transferBatch			250	2,096	
CD 00247	2025-10-13 06:33:08	Incoming	transferBatch			247	1,245	

CDR Import and Rating Process

TAP3 Export Process

Operations Guide

Running TAP3 Export

```
# Export for specific partner
python3 export_TAP3.py VZW_Live

# Interactive mode (prompts for partner)
python3 export_TAP3.py
```

The export process:

1. Queries CDRs from last 30 days (GSMA requirement)
2. Filters out CDRs marked as already processed
3. Excludes CDRs with end time less than 1 hour ago (prevents incomplete sessions)
4. Groups CDRs by roaming partner
5. Generates TAP3 file per partner
6. Marks CDRs as processed in database
7. Increments sequence counter
8. Pushes metrics to InfluxDB

Monitoring & Reporting

OmniRoam pushes real-time metrics to InfluxDB for monitoring and analytics.

Metrics Collected

Raw CDR Metrics Pushed during the CDR import and rating process:

- **operator**: Roaming partner identifier
- **input_file**: Source CSV filename
- **apn**: Access Point Name (data service identifier)
- **cellId**: Cell tower identifier
- **imsi**: Subscriber identity
- **tac**: Tracking Area Code
- **sGWAddress**: Serving Gateway IP address
- **pGWAddress**: PDN Gateway IP address
- **chargeableUnits**: Total bytes of usage
- **chargedUnits**: Calculated cost

TAP Export Metrics Pushed during the TAP3 file generation process:

- **operator**: Roaming partner identifier
- **filename**: Generated TAP3 filename
- **totalcharge**: Total charge in TAP3 file
- **totalconsumed**: Total bytes in TAP3 file
- **cdr_count**: Number of CDRs in TAP3 file

Dashboard Queries

Example InfluxDB queries for monitoring:

Revenue by Operator

```
SELECT sum("totalcharge")
FROM "tap_cdr"
```

```
WHERE time > now() - 30d
GROUP BY "operator"
```

Data Usage by TAC

```
SELECT sum("chargeableUnits")
FROM "raw_cdr"
WHERE time > now() - 7d
GROUP BY "tac"
```

CDR Volume by Hour

```
SELECT count("chargeableUnits")
FROM "raw_cdr"
WHERE time > now() - 24h
GROUP BY time(1h)
```
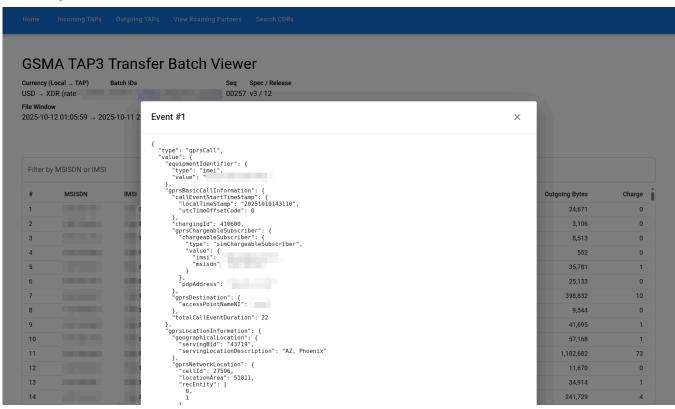
Revenue by APN

```
SELECT sum("chargedUnits")
FROM "raw_cdr"
WHERE time > now() - 7d
GROUP BY "apn"
```

Grafana Integration

Create Grafana dashboards using these metrics for:

- Real-time revenue monitoring
- Traffic pattern analysis
- Partner performance tracking
- Network resource utilization
- Anomaly detection
- Billing reconciliation

Troubleshooting

CDR Import Issues

Check logs at `/tmp/import_CDR_Logger_Marben_*.log`

Common issues:

- Invalid IMSI format
- Missing required fields
- Timezone conversion errors
- Duplicate charging IDs

TAP3 Export Issues

Check logs at `/tmp/tap3_export_*.log`

Common issues:

- No CDRs in last 30 days
- Missing TAC configuration
- Invalid sequence number
- Database connection errors

OmniCharge Rating Errors

Review OmniCharge logs for:

- Missing rate plans
- Account not found
- Invalid usage values
- Currency conversion errors

InfluxDB Connection Issues

Verify:

- InfluxDB URL reachable
- Valid authentication token
- Bucket exists
- Network connectivity

Support & Maintenance

Log Locations

- CDR Import: /tmp/import_CDR_Logger_Marben_*.log
- TAP Export: /tmp/tap3_export_*.log

Key Configuration Files

- config.yaml - Main configuration (partner rates, network settings, InfluxDB connection)
- counters.yaml - TAP3 file sequence counters

Regular Maintenance Tasks

1. **Monitor sequence counters** - Ensure they don't exceed 99999
2. **Archive old TAP files** - Move files older than retention period
3. **Monitor InfluxDB disk usage** - Configure retention policies
4. **Review rate configurations** - Update when partner rates change
5. **Backup configuration files** - config.yaml and counters.yaml
6. **Monitor CDR backlog** - Ensure timely processing

System Architecture

High-Level Architecture

CDR Import Process

OmniRoam uses a two-stage import process with Cache as a temporary aggregation layer for assembling partial CDR records into complete, billable CDRs.

Understanding Partial CDRs

Mobile network elements (S-GW/P-GW) don't generate a single CDR for a data session. Instead, they produce **multiple partial CDR records** throughout the session lifecycle:

- **Start Record**: Generated when the data session begins
- **Update Records**: Generated periodically during the session (e.g., every 15 minutes or every 100 MB of data usage)
- **Stop Record**: Generated when the session ends

Each partial record contains incremental usage data. For accurate billing, OmniRoam must:

1. **Identify** which partial records belong to the same data session
2. **Aggregate** the usage data from all partial records
3. **Calculate** the total session duration
4. **Assemble** one complete CDR representing the entire session

Why Cache for CDR Aggregation?

Cache serves as a high-performance temporary holding area where partial CDRs accumulate until the session is complete. Cache provides:

- **Fast key-value lookups** - Instantly find existing partial CDRs for a session
- **In-memory storage** - High-speed read/write operations for real-time aggregation
- **Atomic operations** - Safe concurrent updates from multiple import processes
- **Persistence** - CDRs survive system restarts during the aggregation window

Two-Stage Import Architecture

Stage 1: CSV Parsing and Partial CDR Aggregation

The first stage continuously reads CSV files from S-GW network elements and aggregates partial CDRs in Cache.

How Partial CDRs Are Identified and Matched

OmniRoam must determine which partial records belong to the same data session. Each session is uniquely identified by a composite **Session ID** consisting of:

- **Charging ID**: Unique session identifier from the network element
- **IMSI**: Subscriber identity (mobile number identifier)
- **Date**: Session date in the serving network's timezone
- **P-GW IP Address**: Gateway that handled the session
- **TAC**: Tracking Area Code (cell tower location)
- **QCI**: Quality of Service class

This combination ensures that all partial records from the same data session are grouped together, even when multiple files arrive out of order.

How Partial CDRs Are Aggregated

When the CSV parser processes each partial CDR:

1. **Generate Session ID** from the CDR fields
2. **Check Cache** to see if this session already exists
3. **If session exists in Cache**:
   - Retrieve the accumulated CDR data
   - Verify this file hasn't been processed before (prevents duplicates)
   - Add the new usage data: incoming bytes + outgoing bytes
   - Update the session duration using the earliest and latest timestamps
   - Store metadata about this partial record for audit purposes
   - Save the updated CDR back to Cache
4. **If new session**:
   - Create a new CDR entry in Cache
   - Initialize usage counters and session metadata
   - Record the first partial record's timestamp

Audit Trail and Metadata

Every partial record that contributes to a CDR is tracked with comprehensive metadata:

- **Source filename**: Which CSV file contained this partial record
- **Timestamp**: When the network element generated this record
- **Processing time**: When OmniRoam received and processed it
- **Usage contribution**: How much data this partial added (incoming/outgoing bytes)
- **Event type**: Whether this was a start, update, or stop record
- **Serving network timezone**: For accurate timestamp conversion

Why metadata is critical for accounting:

This audit trail allows OmniRoam to trace a single charge end-to-end through every processing stage, which is essential for:

- **Dispute resolution**: When partners challenge a charge, operators can show exactly which source files contributed to it
- **Revenue reconciliation**: Verify that all billable usage was captured and nothing was missed or duplicated
- **Regulatory compliance**: Demonstrate proper handling of billing records for auditing purposes
- **Debugging**: Quickly identify issues in the CDR aggregation process by tracing the complete data flow
- **Financial accuracy**: Ensure every dollar charged can be traced back to specific network events

Session Duration Calculation

The total session duration is calculated by finding:

- **Earliest timestamp** across all partial records (session start)
- **Latest timestamp** across all partial records (session end)
- **Duration** = Latest - Earliest

For sessions where only update records exist (missing start/stop), the duration defaults to 24 hours.

Stage 2: CDR Assembly and Rating

The second stage periodically scans Cache for completed sessions, assembles the final CDRs, and submits them to OmniCharge for rating.

How Complete CDRs Are Selected from Cache

The CDR Assembly Process runs continuously and examines all sessions stored in Cache:

1. **Scan Cache** for all accumulated CDR sessions
2. **Process in batches** of 1,000 sessions at a time
3. **For each session**:
   - Extract the session date from the Session ID
   - **Skip if too old** (> 30 days): Delete from Cache (prevents stale data buildup)

- **Skip if too recent** (< 24 hours): Leave in Cache for more partial records to arrive
- **Load the complete CDR** with all accumulated data

The 24-Hour Waiting Period

Why does OmniRoam wait 24 hours before rating a CDR?

- **Partial records arrive out of order**: Network congestion can delay CSV file delivery by hours
- **Sessions span midnight**: A session starting at 11:50 PM generates files on two different dates. The same charging ID can span multiple days, with partial records dated differently
- **Update records are delayed**: Periodic update records may arrive well after the session ends
- **Asynchronous file generation**: Different network elements export files on different schedules
- **Long-running sessions**: Data sessions can last hours or days, with update records trickling in throughout

By waiting 24 hours, OmniRoam ensures all partial records have arrived and the CDR is truly complete before billing.

CDR Validation and Enrichment

Before rating, each assembled CDR goes through validation and enrichment:

1. **Validate completeness**:
   - Check if start/stop records are present
   - If only update records exist, set duration to 24 hours (default)

2. **Discard invalid CDRs**:
   - Zero usage sessions are deleted (no billable activity)

3. **Calculate final usage**:
   - Sum all incoming and outgoing bytes
   - Apply partner-specific rounding rules (e.g., round up to nearest 1 KB)

4. **Enrich with location data**:
   - Map TAC (Tracking Area Code) to serving network location
   - Add timezone information for accurate timestamps
   - Add geographic location description

5. **Submit to OmniCharge**:
   - Send the complete, enriched CDR for rating
   - Receive back the calculated charge

6. **Store and clean up**:
   - Save the rated CDR to Database database
   - Push metrics to InfluxDB for reporting
   - Delete the processed CDR from Cache

CDR Data Structure

Each aggregated CDR contains:

- **Subscriber Information**: IMSI, MSISDN, IMEI
- **Network Information**: Serving Gateway (S-GW), PDN Gateway (P-GW), Cell ID, TAC (Tracking Area Code)
- **Session Details**: Start/End timestamps, Duration, APN (Access Point Name)
- **Usage Data**: Data Volume Incoming/Outgoing, Total Chargeable Units
- **Location Information**: Serving BID (Network ID), Geographic Location
- **QoS Information**: QCI (QoS Class Identifier)

Data Processing Rules

Usage Rounding

CDRs are rounded based on partner-specific configuration in config.yaml:

```yaml
partners:
  Example_Live:
    round_up_to: 1024  # Round usage to nearest 1KB
```

The system:

1. Calculates total usage: `dataVolumeIncoming + dataVolumeOutgoing`
2. Rounds up to the configured unit (e.g., 1024 bytes)
3. Preserves original values for auditing

TAC-Based Localization

The system determines serving network location based on TAC (Tracking Area Code):

```yaml
config:
  tac_config:
    Global:
      tac_list: ['1101', '10000', '10100']
      servingBid: 72473
      servingLocationDescription: 'Smallville USA'
      timezone: 'America/Smallville'
```

This enables:

- Proper timezone conversion for timestamps
- Geographic location assignment
- Serving network identification

OmniCharge Rating Engine

OmniRoam sends CDRs to **OmniCharge**, the powerful rating engine that calculates charges based on configurable rate plans.

GSMA TAP3 Transfer Batch Viewer

Currency (Local → TAP)	Batch IDs	Seq	Spec / Release
USD → XDR (rate 1.37392)	Sender: ▓▓▓▓ / Recipient: ▓▓▓▓	00257	v3 / 12

File Window	Call Window	Events / Total Charge
2025-10-12 01:05:59 → 2025-10-11 22:22:23	2025-10-10 01:45:41 → 2025-10-11 22:22:23	549 events 178,055 (TAP) USD: $2.45

Filter by MSISDN or IMSI

#	MSISDN	IMSI	PDP Addr	Start	Duration (ms)	Incoming Bytes	Outgoing Bytes	Charge
1	▓▓	▓▓	100.86.1.122	2025-10-10 14:31:10	22	14,583	24,671	0
2	▓▓	▓▓	100.85.29.146	2025-10-10 17:32:36	84847	394	3,106	0
3	▓▓	▓▓	100.85.31.70	2025-10-10 17:34:46	59	10,231	8,513	0
4	▓▓	▓▓	100.86.1.14	2025-10-10 14:45:22	16260	0	552	0
5	▓▓	▓▓	100.85.31.73	2025-10-10 14:45:23	16259	44,403	35,781	1

Rating Process

Rate Configuration

Rates are configured per roaming partner in the configuration file:

```
partners:
  Example_Live:
    imsi_prefixes:
      - 99901
    rates:
      unit_price: 0.000476800  # Price per unit
      unit_bytes: 1024         # Unit size in bytes
    batch_info:
      sender: AUSIE
      recipient: AAA00
      accountingInfo:
        localCurrency: 'USD'
        tapCurrency: 'USD'
        roundingAction: 'Simple'
        tapDecimalPlaces: 5
```

IMSI Prefix Matching

OmniRoam matches CDRs to roaming partners using **IMSI prefix matching with longest-match-first logic**. This allows operators to create specific configurations for test SIMs while maintaining general configurations for production traffic.

How Prefix Matching Works

When rating a CDR, OmniRoam:

1. **Extracts the IMSI** from the CDR (e.g., 310410123456789)
2. **Evaluates all partner configurations** in order
3. **Finds the longest matching prefix**
4. **Applies that partner's rates and configuration**

Example: Test SIM Configuration

This feature is particularly useful for TADIG/IREG testing where test SIMs need different handling:

```
partners:
  Demo_Test:
    imsi_prefixes:
      - 0010112345123  # Test SIM range (9-digit prefix)
    rates:
      unit_price: 0.0  # No charge for test traffic
    batch_info:
      sender: AUSIE
      recipient: AAA00TEST

  Demo_Production:
    imsi_prefixes:
      - 001011  # Production range (6-digit prefix)
    rates:
      unit_price: 0.000476800
    batch_info:
      sender: AUSIE
      recipient: AAA00
```

Matching behavior:

- IMSI 00101123451234 → Matches `Demo_Test` (9-digit prefix is longer)
- IMSI 00101023456789 → Matches `Demo_Production` (6-digit prefix)

This ensures test traffic goes to test TAP files with test TADIG codes, while production traffic is billed normally with production TADIG codes.

Rating Calculation

For each CDR:

1. **Match Partner**: Identify roaming partner by IMSI prefix
2. **Calculate Units**: totalBytes / unit_bytes
3. **Apply Rate**: units × unit_price = charge
4. **Apply Rounding**: Round based on roundingAction (Up/Down/Simple)
5. **Convert to TAP Units**: Multiply by 1000 for TAP3 format

Example:

```
Usage: 52,428,800 bytes (50 MB)
Unit Size: 1024 bytes
Units: 51,200
Rate: $0.000476800 per 1KB
Charge: 51,200 × $0.000476800 = $24.41
TAP Units: 24,410 (24.41 × 1000)
```

QCI-Based Call Type Assignment

Quality of Service Classes (QCI) are mapped to TAP3 Call Type Levels:

```
call_type_level:
  qci_1: 20  # Conversational (Voice)
  qci_2: 22  # Conversational (Video)
  qci_3: 23  # Real-time Gaming
  qci_4: 24  # Buffered Streaming
  qci_5: 20  # IMS Signaling
  qci_6: 26  # Interactive (Browsing)
```

```
    qci_7: 27   # Interactive (Gaming)
    qci_8: 28   # Background
    qci_9: 29   # Background (Low Priority)
    default: 20
```

TAP3 File Generation

After CDRs are rated by OmniCharge, OmniRoam generates GSMA-standard TAP3 files for wholesale billing.

TAP3 Export Flow

TAP3 File Structure

File Naming Convention

TAP3 files follow GSMA naming standards:

```
<FileType><Sender><Recipient><SequenceNumber>

Examples:
CDAUSIEAAA0000001  - Commercial Data file from AUSIE to AAA00, sequence 1
TDAUSIEAAA0000001  - Test Data file from AUSIE to AAA00, sequence 1
```

Where:

- **FileType**: CD (Commercial) or TD (Test)
- **Sender**: 5-character TADIG code
- **Recipient**: 5-character TADIG code
- **SequenceNumber**: 5-digit sequence (from counters.yaml)

Configuration Guide

Partner Configuration

Add roaming partners in config.yaml:

```yaml
partners:
  ONS_Live:
    imsi_prefixes:               # List of IMSI prefixes for this partner
      - 505057
    accessPointNameOI: mnc057.mcc505.gprs
    rates:
      unit_price: 0.000476800    # Price per unit in dollars
      unit_bytes: 1024           # Number of bytes per unit
    batch_info:
      sender: AUSIE              # Your TADIG code
      recipient: AAA00           # Partner TADIG code
      specificationVersionNumber: 3
      releaseVersionNumber: 12
      accountingInfo:
        localCurrency: 'USD'
        tapCurrency: 'USD'
        roundingAction: 'Simple'  # Up/Down/Simple
        tapDecimalPlaces: 5
    round_up_to: 1024            # Round usage to nearest N bytes
    call_type_level:            # QCI to Call Type Level mapping
      qci_1: 20
      qci_2: 22
      default: 20
```

Sequence Counter Configuration

Initialize sequence counters in counters.yaml:

```yaml
AAA00:
  CD: 1      # Commercial Data sequence
  TD: 1      # Test Data sequence
AAA01:
  CD: 1
  TD: 1
```

Sequences auto-increment with each TAP file generated.

Network Configuration

Configure TAC-to-location mappings:

```yaml
config:
  tac_config:
    LocationName:
      tac_list: ['1101', '10000']
      servingBid: 72473
      servingLocationDescription: 'Network Location'
      timezone: 'America/New_York'
```

InfluxDB Configuration

Configure InfluxDB connection in config.yaml:

```yaml
config:
  influx_db:
    influxDbUrl: 'http://10.3.0.135:8086'
    influxDbOrg: 'omnitouch'
    influxDbBucket: 'Omnicharge_TAP3'
    influxDbToken: 'your-token-here'
```

Output Paths

Configure file output locations:

```yaml
config:
  tap_output_path: '/etc/pytap3/OutputFiles'
  tap_human_readable_output_path: '/etc/pytap3/OutputFiles_Human'
  tap_in_path: '/home/user/TAP_In/'
```

Architecture Decisions

Why OmniCharge?

OmniCharge provides:

- Powerful rating engine with flexible rate plans
- Real-time rating capabilities
- CDR deduplication
- Comprehensive audit trails
- API-based integration

Why InfluxDB?

Advantages:

- Time-series optimized for CDR metrics
- High write throughput
- Efficient storage with compression
- Built-in downsampling
- Native Grafana integration

Workflow Summary

OmniRoam - Professional roaming revenue management by Omnitouch.