Oracle® Communications Billing and Revenue Management

ECE Composable Services User's Guide

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Oracle Communications Billing and Revenue Management ECE Composable Services User's Guide, Release 15.2

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Contents

About This Content

This guide provides an overview of Oracle Communications Elastic Charging Engine composable services.

Audience

This guide is intended for analysts and others involved in charging.

1

ECE Composable Services Overview

Oracle Communications Elastic Charging Engine (ECE) composable services enable you to process and charge 5G events by using internal and external systems based on your business requirements. This document provides an overview of the available capabilities and system architecture.

Topics in this document:

About ECE Composable Services

The ECE Charging Manager (CHF) and Charging Gateway Function (CGF) composable services provide a charging and event processing solution that can be integrated with 5G network functions, ECE Cloud Native, Kafka, and downstream systems such as Oracle Communications Billing and Revenue Management (BRM). At a high level, the ECE CHF and CGF composable services act as a bridge between network and billing, revenue assurance, analytics, and similar systems.

You use the ECE CHF and CGF composable services to process 5G usage events, such as data sessions, SMS, and voice calls, generated by subscribers, and generate rated and unrated Call Detail Records (CDRs).

The ECE CHF and CGF composable services can do the following:

- **Generate Unrated 5G CDRs**: Transform unrated 5G usage events into unrated 5G CDRs for consumption by downstream systems.
- **Integrate the CHF composable service with ECE**: Enhance the charging capabilities of ECE by adding the ECE composable services and removing the dependency on CDR Gateway and CDR Formatter for unrated 5G CDR generation.
- **Integrate the CGF composable service for Rated CDR Publishing**: Improve the processing performance and scalability for generating rated CDRs with reduced dependency on Oracle Database.

The ECE CHF and CGF composable services make the CDR generation and the overall charging process more efficient, scalable, and highly available with features like CDR replication, duplicate CDR detection, sequencing, and CDR aggregation. They ensure that data loss is minimized, relevant details for each record are aggregated, and all generated CDRs are made available to their destinations in a standard format and in a timely manner.

You can deploy the ECE CHF and CGF composable services as a standalone architecture, or you can integrate it with ECE to combine their capabilities.

> **Note**
>
> The standalone ECE composable services architecture only supports 5G unrated CDR generation in this release. To use the ECE composable services for 5G online charging and for generating 4G and 5G rated CDRs in this release, the ECE composable services must be deployed and integrated with ECE.

For rated CDR generation, both ECE components and ECE composable services are part of the overall charging flow. The integrated architecture provides a more flexible and scalable mechanism for delivering CDRs from the charging environment to any external billing and mediation systems.

As an alternative to using the Oracle Database and the Rated Event Formatter (REF) to persist and transport rated CDRs, the ECE composable services allow using the Charging Gateway Function (CGF) for CDR processing and Kafka as the primary event transport layer.

The rated CDRs generated by the ECE CGF composable service are published to Kafka, where BRM or other rated CDR consumers consume them using Kafka-based consumers. The same event streams can also be consumed by third-party billing, mediation, or analytics systems by implementing their own Kafka consumers.

2

Generating 5G Unrated CDRs with CHF and CGF

Learn about the architecture, processing flow, and capabilities used to generate 5G unrated Call Detail Records (CDRs) in Oracle Communications Elastic Charging Engine (ECE) composable services.

Topics in this document:

About the 5G Unrated CDR Generation Process

The ECE Charging Manager (CHF) and Charging Gateway Function (CGF) composable services can generate unrated CDRs for 5G charging requests and make them available to downstream systems for charging, billing, analytics, mediation, and reporting. These charging requests can include activities such as data sessions, SMS usage, voice calls, or other 5G network options.

During request processing, the ECE CHF and CGF composable services capture charging information, such as subscriber details, session information, timestamps, usage metrics, and charging context. The ECE CHF and CGF composable services format this information as standardized 3GPP-compliant charging records to support consistency and interoperability with external systems.

The ECE CHF and CGF composable services can generate partial CDRs during an active session, final CDRs when a session closes, or both, depending on the deployment. The ECE CGF composable service aggregates related charging requests into complete session-based records and handles duplicate events, out-of-sequence messages, and missing sequence numbers during processing.

The ECE CHF and CGF composable services publish the generated CDRs to Kafka topics for downstream consumption. External systems can consume these CDR streams independently for further processing and integration.

Architecture Overview and Components

The ECE CHF and CGF composable services use a modular, event-driven architecture to support usage event intake, CDR generation, persistence, and downstream consumption. This architecture consists of independently deployable services running in a Kubernetes environment. This approach supports scalability, high availability, and flexible integration with external systems.

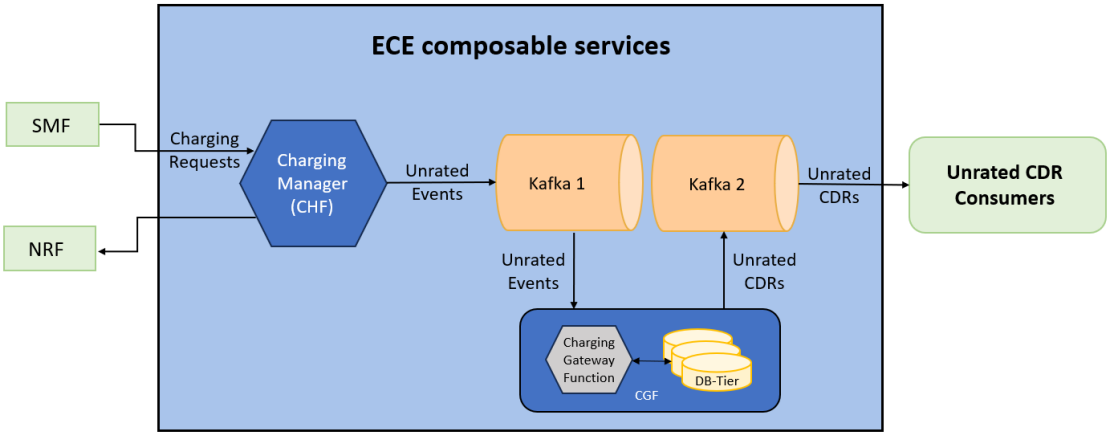
The key components of the architecture include:

- **Network functions**: External 5G components, such as the Session Management Function (SMF), that generate charging requests and interact with the charging system.

- **Charging Manager (CHF)**: Publishes received charging requests to Kafka as unrated events for downstream unrated CDR processing.
- **Event streaming layer (Kafka)**: Enables asynchronous communication and separates upstream and downstream components.
- **Charging Gateway Function (CGF)**: Consumes unrated events, generates and aggregates CDRs, and ensures data consistency.
- **Persistence layer (cnDBTier)**: A storage layer used for durability, intermediate data storage, and retry handling and georeplication of CDR data and CDR metadata.
- **Downstream consumers**: External systems such as billing, mediation, or analytics platforms that consume CDRs for further processing.

Figure 2-1 shows the high-level architecture of ECE composable services and their major components.

Figure 2-1 ECE Composable Services Architecture Overview



> **Note**
>
> In this architecture, Kafka 1 and Kafka 2 may be combined into a single Kafka deployment, or Kafka 2 may operate as an independent external component.

In Figure 2-1, you see how the ECE composable services transform charging requests into unrated 5G CDRs:

1. Network functions, like the SMF, generate charging requests and send them to the CHF.
2. The CHF processes these requests and produces unrated events.
3. The CHF publishes unrated events to Kafka.
4. The CGF consumes unrated events from Kafka and transforms them into structured CDRs.

   During this stage, the CGF performs aggregation of partial records, handles duplicate and out-of-sequence events, and ensures the completeness and accuracy of the data. The CGF may also interact with the cnDBTier to store intermediate records and support retry mechanisms for reliable processing.

5. After processing, the CGF publishes unrated CDRs back to Kafka, making them available to downstream systems.

   These systems consume the CDRs for purposes such as charging and billing.

About the Network Functions

Network functions are external 5G components that generate charging requests and interact with the charging system. In the ECE composable services architecture, the SMF generates charging requests associated with subscriber activities such as data sessions, session updates, and session termination requests. These requests are sent to the CHF composable service for charging and processing.

The NRF supports service discovery and communication between network services within the 5G environment.

About the CHF Composable Service

The CHF composable service receives charging requests from 5G network functions and publishes the request information for downstream unrated CDR processing.

About the Kafka Layer

The Kafka layer acts as the messaging backbone for transporting unrated events and unrated CDRs across the system. It enables asynchronous communication between components and allows upstream and downstream services to scale independently while maintaining reliable message delivery.

After processing charging requests, the CHF publishes unrated events to Kafka for downstream CDR processing. The CGF consumes these events, generates unrated CDRs, and publishes the resulting records back to Kafka for consumption by downstream systems.

Downstream systems can subscribe to these CDR streams for billing, mediation, analytics, and reporting purposes.

ECE composable services also support flexible deployment topologies by allowing unrated events and unrated CDR streams to use either shared or separate Kafka clusters, depending on deployment requirements.

About the CGF Composable Service

The CGF composable service processes charging requests received from Kafka and generates standardized CDRs for downstream consumption. The CGF aggregates related charging requests into session-based records, detects duplicate events, handles out-of-sequence messages, and manages missing sequence numbers.

The CGF also provides durable retry capabilities to help prevent data loss during temporary infrastructure or communication failures. After processing completes, the CGF publishes the unrated CDRs to Kafka for consumption by downstream systems.

About the cnDBTier

The cnDBTier provides storage support for charging and CDR processing operations. It stores intermediate records, supports retry mechanisms, maintains processing state, and ensures reliable message handling during failures.

It helps prevent data loss when publishing or downstream communication errors occur. The CGF interacts with the cnDBTier to temporarily store CDR-related information during processing and retry operations.

The cnDBTier can also store session-related or processing metadata required for event handling. Background cleanup operations remove expired records after a configurable retention period to ensure efficient database management while still supporting late-arriving or duplicate events.

CDR Processing Capabilities

The ECE CHF and CGF composable services provide capabilities that improve the reliability, accuracy, and scalability of CDR processing in a 5G environment. These capabilities help ensure consistent processing even when records arrive as partial events, arrive out of order, are duplicated, or are affected by temporary infrastructure failures.

The ECE CHF and CGF composable services support these capabilities through advanced CDR processing features implemented primarily within the CGF and supported by the Kafka messaging and database persistence layers. This includes CDR aggregation, sequencing support, duplicate detection, operational monitoring, and durable retry to help prevent data loss. Together, these features improve the consistency and reliability of downstream billing, mediation, analytics, and reporting systems.

About CDR Aggregation

The ECE CHF and CGF composable services support CDR aggregation to combine partial records into consolidated and complete CDRs. Aggregation helps produce accurate records that represent the complete lifecycle of a subscriber session and reduces downstream processing complexity by providing consolidated records instead of fragmented usage events.

Since charging data can arrive as complete events or in multiple partial events over time, the CGF supports the following aggregation modes:

- DEFAULT Aggregation Mode

  In DEFAULT mode, the CGF combines partial records into a single aggregated CDR. This mode is useful when multiple updates belong to the same subscriber session, such as session initiation, usage updates, and session termination events.

- INDIVIDUAL Aggregation Mode

  In INDIVIDUAL mode, the CGF processes each record independently without aggregation. This mode is useful when each event must remain separate.

You can configure the aggregation mode based on your deployment requirements. See "Setting Up the CGF Worker Messaging Service" in *ECE Composable Services Installation and Administration Guide* for more information.

About Improved Sequencing

The ECE CHF and CGF composable services offer sequencing capabilities that help maintain the correct order of charging events and records during processing. In distributed systems, events may arrive in the wrong order due to component or network failures, network delays, retries, or asynchronous processing.

The CGF can detect out-of-order arrivals and correctly reconstruct the charging session using invocation sequence numbers. The system can detect gaps in sequence numbers, track out-of-sequence records, and identify when missing records are later received.

These capabilities ensure that charging records are assembled and processed in the correct order, improving the accuracy and reliability of downstream billing operations. The ECE CHF and CGF composable services also expose metrics related to sequence gaps and gap recovery for operational visibility.

Tracking and Monitoring Events

The ECE CHF and CGF composable services can monitor and track the health and status of charging and CDR processing operations. The system exposes metrics related to request processing, message consumption, publishing activity, processing failures, duplicate detection, sequence gaps, and closed CDR counts.

These metrics can be integrated with monitoring platforms such as Grafana and Prometheus to provide real-time visibility into system behavior. These metrics are essential for identifying processing bottlenecks, detecting failures, monitoring throughput, and troubleshooting charging-related issues. The ECE CHF and CGF composable services also standardize error handling and response mapping to improve operational consistency and diagnostics.

Detecting Duplicate CDRs

The ECE CHF and CGF composable services provide duplicate detection capabilities to prevent the generation and downstream distribution of duplicate charging records. In distributed systems, duplicate events are common. Sometimes the same charging record is sent multiple times due to retries, network failures, or repeated submissions from upstream systems. The CGF includes logic to detect these records and avoid processing them repeatedly.

The CGF identifies duplicate charging events using identifiers, sequence information, and session context during processing. Duplicate detection metrics are also exposed to support operational monitoring and analysis.

Avoiding Data Loss

The CGF composable service provides durable processing and retry mechanisms to prevent data loss during charging and CDR publishing operations. A background retry process periodically attempts to republish failed records until successful delivery is achieved.

This durability mechanism ensures reliable event delivery even during temporary infrastructure outages or communication failures. The persistence layer maintains retry metadata, timestamps, and processing state required for recovery operations. The CGF composable service also supports cleanup policies to remove expired records after configurable retention periods, ensuring efficient long-term storage management while preserving processing reliability.

Establishing Security for Kafka Communication

The ECE CHF and CGF composable services support secure communication with Kafka brokers using TLS-based authentication and encryption. This ensures that charging events, unrated events, and generated CDRs are transmitted securely between processing components and messaging infrastructure. Secure Kafka communication helps protect sensitive subscriber and charging data from unauthorized access or interception during transport.

To establish secure communication, the ECE CHF and CGF composable services integrate with Kafka deployments configured with TLS authentication, such as Strimzi-based Kafka clusters. A Kafka user is created within the Kafka deployment environment. This process

generates the required user certificates and cluster Certificate Authority (CA) certificates. These certificates are then provided to the ECE CHF and CGF composable services through Kubernetes Secrets or local configuration files.

The Kafka client configuration includes secure communication properties such as the security protocol, TrustStore location, KeyStore location, and associated passwords. During deployment, the ECE CHF and CGF composable services mount the required certificate Secrets into the application containers and use them to establish encrypted connections with Kafka brokers. When secure communication is enabled, the messaging layer uses SSL/TLS for both authentication and encryption of all Kafka traffic.

3

Integrating Composable Services with ECE Cloud Native

Learn about integrating the 5G charging capabilities of the Oracle Communications Elastic Charging Engine (ECE) Charging Manager (CHF) and Charging Gateway Function (CGF) composable services with an existing ECE cloud native deployment.

Topics in this document:

About Composable Services for 5G Charging

The ECE CHF and CGF composable services process 5G charging requests and generate charging records for downstream systems. They support session-based and event-based charging, online and offline charging flows, session management, charging request mediation, and CDR generation and processing within a scalable, event-driven architecture.

When integrated with an ECE Cloud Native deployment, the CHF and CGF composable services extend the existing charging system and provide processing, mediation, event streaming, and CDR handling capabilities while preserving the existing ECE charging environment.

Integrating Composable Services with ECE for 5G Charging

You can integrate the ECE CHF and CGF composable services into an existing ECE deployment to support real-time rating, quota management, spending limit control, and charging-event processing for 5G charging scenarios.

In this deployment model, the ECE CHF composable service serves as the public-facing Nchf endpoint for 5G converged charging and spending limit control requests. The CHF receives charging requests from 5G network functions, applies mediation and request-processing logic, evaluates online charging requirements, and routes eligible requests to the ECE Elastic Charging Server (ECS) component for rating and policy enforcement.

The integration also provides request and response mediation, session-aware charging request handling, Kafka-based event streaming, and unrated CDR generation through the ECE CGF composable service. ECS continues to serve as the primary charging engine responsible for real-time rating, quota management, balance management, and spending limit enforcement.

Architecture Overview

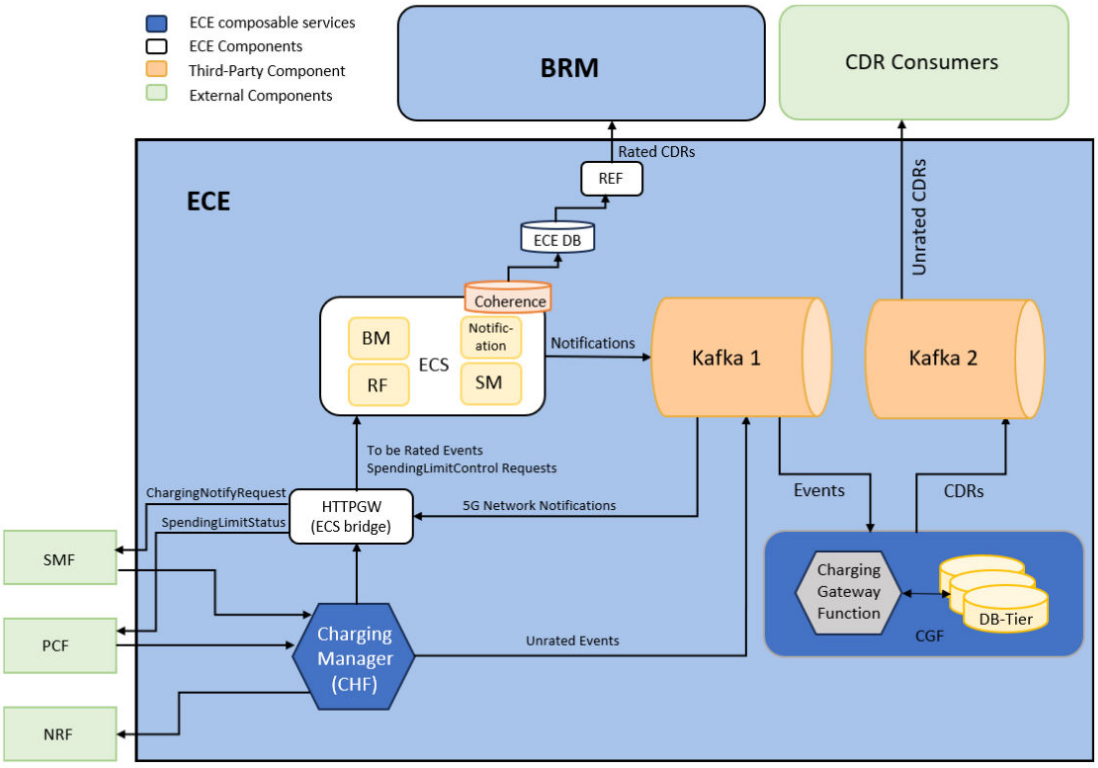
The key components of the integrated architecture for 5G charging functionality include:

- **CHF**: Provides the public Nchf interfaces, performs request mediation and orchestration, evaluates online charging requirements, and routes charging requests to ECS.
- **HTTP Gateway**: Provides the ECS bridge layer for request routing and asynchronous notification delivery.
- **ECS**: Performs real-time rating, balance management, quota management, charging-session processing, and spending limit enforcement.
- **Kafka**: Provides asynchronous event streaming and event distribution for charging workflows.
- **CGF**: Consumes Kafka unrated events and generates unrated 5G CDRs.

  When enabled, it also consumes rated events and generates 4G and 5G rated CDRs. See "Integrating Composable Services with ECE for Rated Event Publishing" for more information.
- **NRF Management Agent**: Registers CHF services with the Network Repository Function (NRF) and manages service discovery and health reporting.

Figure 3-1 shows the integrated architecture for the ECE CHF and CGF composable services and an existing ECE deployment for 5G charging functionality.

Figure 3-1 Integrated Architecture for 5G Charging



> **Note**
>
> In this architecture, Kafka 1 and Kafka 2 may be combined into a single Kafka deployment, or Kafka 2 may operate as an independent external component.

In Figure 3-1, you see how the ECE CHF and CGF composable services and an existing ECE deployment work together for 5G charging:

1. The SMF and PCF generate charging and spending limit control requests and notifications, while the NRF supports service discovery for charging-related network functions.
2. The CHF processes these requests.

   The CHF acts as the public-facing Nchf endpoint and processes charging and spending limit control requests by validating subscriber information, managing session lifecycle operations, applying charging logic, and generating unrated events.

   The CHF also integrates mediation and transformation capabilities to normalize ingress charging and spending limit control requests and responses before further processing.
3. The HTTP Gateway component acts as a bridge between the CHF and the ECS, forwarding charging requests requiring rating as well as spending limit control requests to ECS.
4. The ECS processes these requests and generates charging decisions and 5G network notifications.
5. The Kafka layer transports unrated events and 5G network notifications to downstream processing components.
6. The HTTP Gateway bridge and Kafka messaging layer deliver the 5G network notifications to network functions, supporting asynchronous notification handling within the system.
7. The CGF consumes the unrated events generated by the CHF and transforms them into structured CDRs.

   The CGF also interacts with the cnDB-Tier persistence layer to support durable processing, retry handling, and reliable message delivery.
8. After processing, the CGF publishes generated unrated CDRs back to Kafka, making them available to downstream CDR consumer systems.

About ECS

ECS is the core real-time charging and rating engine in ECE. ECS processes high-volume charging requests, performs real-time rating, manages balances and quotas, and enforces spending limit control policies.

In an integrated CHF and ECE architecture, ECS processes charging and spending limit control requests that CHF forwards through the HTTP Gateway.

About the ECS Bridge

The ECS Bridge provides the integration layer between CHF and ECS. It uses the HTTP Gateway component to route eligible charging requests and spending limit control requests from the CHF to ECS for rating and charging.

The ECS Bridge allows CHF to provide 5G charging capabilities while continuing to use ECS as the primary real-time charging and rating engine.

In addition to request routing, HTTP Gateway supports asynchronous delivery of charging and spending limit notifications generated by ECS. It distributes notifications through Kafka-based event processing and delivers them to external 5G network functions by using the notification URIs associated with the charging or spending limit sessions.

4

Integrating Composable Services with ECE for Rated Event Publishing

Learn about integrating Oracle Communications Elastic Charging Engine (ECE) Charging Gateway Function (CGF) composable service and Kafka-based rated event publishing with an existing ECE cloud native deployment.

Topics in this document:

About ECE Composable Services Rated Event Publishing

The CGF composable service supports rated event publishing by using Kafka to stream rated events and rated CDRs to downstream systems. ECS can be optionally configured to publish rated events to Kafka, where the CGF composable service processes the events and publishes rated CDRs for BRM and other consumers.

The CGF composable service also supports publication of TMF and 3GPP-aligned rated CDR formats, improving interoperability and enabling standardized downstream processing. This integration reduces dependency on the Oracle database and removes the need for ECE Rated Event Formatter.

Integrating the CGF Composable Service for Rated Event Publishing

You can integrate the ECE CGF composable service and Kafka into an existing ECE deployment to enable Kafka-based rated event publication.

In the existing ECE publication architecture, ECS publishes rated events through the Rated Event Formatter (REF). REF processes rated events and stores the resulting rated records in the ECE database for downstream systems such as BRM.

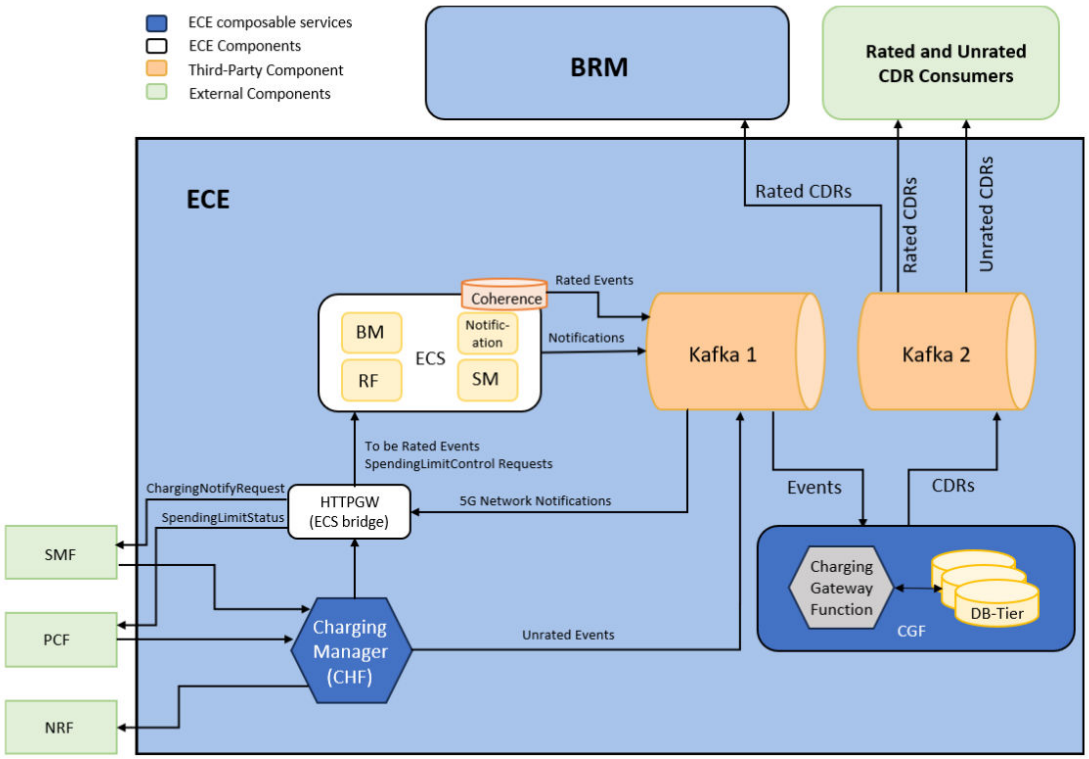
In the integrated CGF and ECE architecture, ECS publishes rated events to Kafka. CGF consumes the rated events, processes them, and publishes rated CDRs to Kafka, where they can be consumed by BRM and other downstream consumers.

> **Note**
>
> ECE includes a configuration entry for switching between Kafka-based publication and REF-based publication.

Architecture Overview

Figure 4-1 shows the architecture for Kafka-based rated event publication in an integrated ECE and ECE composable services environment.

Figure 4-1 Architecture for ECE Composable Services Rated Event Publication



> **Note**
>
> In this architecture, Kafka 1 and Kafka 2 may be combined into a single Kafka deployment, or Kafka 2 may operate as an independent external component.

In Figure 4-1, you see how ECE and ECE composable services work together for rated event publication:

1. The Session Management Function (SMF) and Policy Control Function (PCF) generate charging and spending limit control requests and notifications, while the NRF supports service discovery for charging-related network functions.
2. The CHF acts as the public ingress point for 5G network traffic, forwarding requests requiring rating or spending limit control processing to ECS through the ECS bridge.
3. ECS processes these requests and generates rated events and charging-related notifications to Kafka.
4. The CGF consumes rated events from Kafka and transforms them into structured CDRs.

The CGF also interacts with the persistence layer to store rated CDR metadata for deduplication.

5. Once processed, the CGF publishes rated CDRs back to Kafka, making them available to BRM and other downstream systems.
6. These downstream systems consume the CDRs for purposes such as charging and billing.

> **Note**
>
> For guidelines on BRM consumption of Kafka rated events, see *BRM Loading Rated Events*.

5

Implementing Georedundancy with Multisite CGF Deployments

Learn about the georedundancy capability of Oracle Communications Elastic Charging Engine (ECE) composable services through multi-site deployments of the Charging Gateway Function (CGF) composable service.

About Multisite CGF Support

Multisite CGF support helps with georedundancy by providing continuity in service for your customers and guarding against data loss if a system fails. This capability involves supporting Active-Active deployment, configuring two or more active production sites at different geographical locations. If one production site fails, other production sites can take over the traffic from the failed site. This minimizes operational impact on downstream billing, mediation, and analytics systems in the case of infrastructure failure.

The feature enables CGF to continue processing rated and unrated charging events even when a site, network connection, or CGF component becomes unavailable. There is replication of CGF Call Detail Record (CDR) data and metadata between sites, allowing either site to assume processing responsibilities when failures occur.

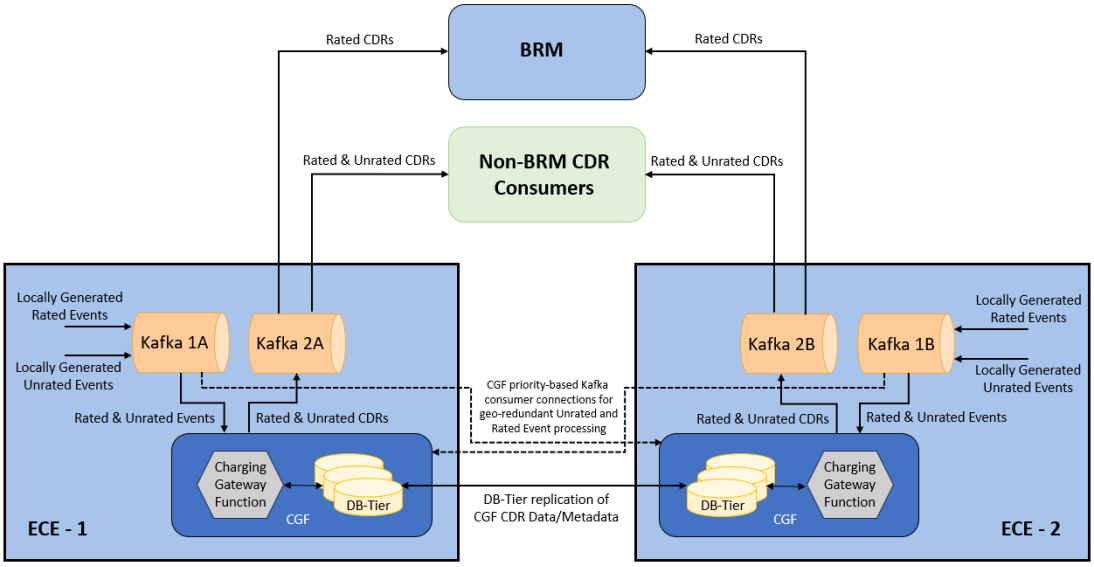
CGF multisite support also offers priority-based Kafka consumption of unrated events generated by the Charging Manager (CHF) and rated events generated by the Elastic Charging Server (ECS). This ensures that CDR generation can continue without interruption when the CGF composable service at a site is unable to process its local unrated and/or rated events.

Additionally, you can apply business logic and operational procedures that govern failure, fallback, recovery, and synchronization scenarios in a multisite environment.

Architecture Overview

Figure 5-1 shows the architecture for multisite CGF support in ECE composable services deployments.

Figure 5-1 Architecture for Multisite CGF Support



> **Note**
>
> In this architecture, Kafka 1 and Kafka 2 at each ECE site may be combined into a single Kafka deployment, or Kafka 2 may operate as an independent external component.

In Figure 5-1, you see how the CGF supports CDR generation in a two-site Active-Active deployment.

1. Each site contains an independent ECE deployment, Kafka messaging layer, Charging Gateway Function (CGF), and DB-Tier persistence layer. Both sites can generate rated and unrated events locally and publish them to their respective Kafka environments.
2. The Kafka layer receives locally generated rated and unrated events and delivers them to the CGF, which transforms them into structured CDRs.

   The CGF also interacts with the persistence layer to store rated CDR metadata for deduplication.
3. The DB-Tier persistence layers in both sites replicate CGF CDR data and metadata between each other.

   This replication enables either site to continue processing charging records if the alternate site becomes unavailable and supports graceful failover and fallback operations.
4. Once processing is complete, the CGF publishes rated and unrated CDRs back to Kafka, making them available to BRM and other downstream consumer systems.
5. If the CGF at an ECE fails or is unable to process the unrated and/or rated events from Kafka 1 at its local ECE site, one or more CGFs at other ECE sites are able to take over processing of the unrated and/or rated events at the site using CGF's priority-based Kafka consumption capability.