

Software solution for Oracle
Cloud Service control.

Cloud Control Performance Management



Cloud Control Performance Management represents a system that collects and stores real-time data on resource status in Oracle Cloud, monitors Oracle Cloud credit consumption, and serves for reporting, analysis, and prediction of consumption and system behavior.

The CCPM software system includes a module for notifying users about resource consumption and status based on predefined alarms and system behavior rules to prevent excessive consumption of Cloud credits.

The system consists of three modules:

Module for reporting and analyzing Cloud credit consumption and utilization of Cloud resources - **Cloud Control Consumption Management**

Module for system performance analysis - **Cloud Control Performance Management**

Module for controlling the usage of the Cloud environment with the ability to define security protocols that prevent excessive Cloud credit consumption - **Cloud Control Usage Management**

The modular architecture of this software solution allows the basic settings of the system, which relate to all three modules, to be configured in a unified administrative panel, significantly simplifying system administration and maintenance.

The administrative panel includes elements for:

User management

User management encompasses all operational tasks that can be performed on users (search, display, registration, viewing details, and managing user details - data modification, password change, access enablement, access rights definition).

System Settings Management (Administration):

System settings management involves defining and setting system configuration values.

Codebook Management:

Codebook management encompasses all operational tasks that can be performed on defined codebooks (search, display, input, viewing details, and managing details for defined codebooks - data modification, defining active codebook items).



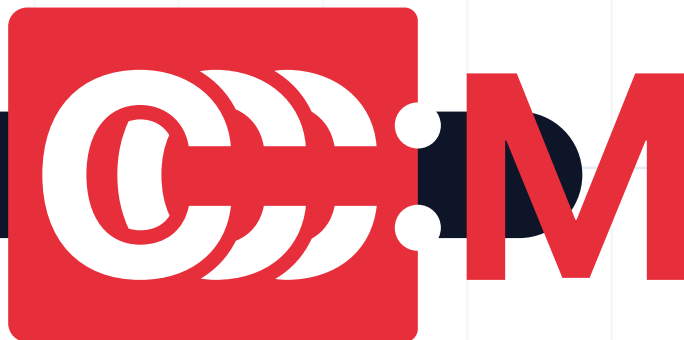
Module for reporting and analysis of Cloud credit consumption and utilization of Cloud resources



Cloud Control Consumption Management

It represents a system that collects and stores real-time data on Oracle Cloud credit consumption, while simultaneously serving for reporting, analysis, and prediction of their consumption. The collected consumption data is available to application users for analysis and report creation, which can be customized according to various parameters: time units, individual users, and individual resources. Special emphasis is placed on analyzing consumption trends over a predefined time period, ensuring consumption control and reducing unforeseen situations.

The primary objective of collecting data on Oracle Cloud credit consumption and their permanent storage is to enable system users to predict future costs, so they do not find themselves in a situation where they lack funds for minimum service operation.



The CCPM software system consists of several core and auxiliary components:

- Data collection services for Oracle Cloud credit consumption
- Subsystem for reporting and displaying data on Oracle Cloud credit consumption
- Reporting subsystem
- User notification subsystem

Service for collecting data on Oracle Cloud credit consumption:

Through specialized services that communicate with the Oracle Cloud infrastructure, data on credit status and consumption are collected at predefined intervals. These services rely on well-defined security protocols and procedures defined by the Oracle Cloud provider.

Subsystem for displaying data on Oracle Cloud credit consumption and user notification:

Accessed through a unified, intuitive, graphical user interface, the data collected via services defined in the previous point are displayed to users for analysis. The main objective of this system is to perform analysis, reporting, and simulate consumption for the subscription period (until its expiration) or Oracle Cloud credit consumption.

Based on defined rules, administrative settings, and trends derived from collected data, the system notifies users of increased consumption or unexpected behavior as needed. The aim of this subsystem is preventive action, which can lead to a reduction or complete elimination of unnecessary hazardous situations resulting in increased credit consumption or even additional unforeseen costs.

By leveraging an innovative management system, administrators have the ability to define appropriate settings for individual resources, including alarms, notification systems, and other consumption management services. Defined settings can be associated with one or more responsible individuals who will be notified via email.

Subsystem for system performance analysis



Cloud Control Performance Management

Undoubtedly, it can be said that the subsystem for monitoring and monitoring resources in cloud-based systems is one of the most significant elements for orchestrating and managing resources on the Oracle virtual infrastructure. The software solution Cloud Control Performance Management represents a system that collects and stores approximately real-time data on key virtual resources, such as CPU load, memory and storage utilization, and network traffic consumption.

The collected data on key resources are available to application users for analysis and report creation, which can be customized according to various parameters: time units, individual users, and individual resources. Special emphasis is placed on analyzing resource utilization over a predefined time period, ensuring control and preventive action for continuous operation and uninterrupted service delivery.

The software system consists of several core and auxiliary components:

- Service for collecting data on key virtual resources
- Display of resource utilization data
- Subsystem for reporting
- Subsystem for user notification

Service for collecting data on key virtual resources:

Through specialized services communicating with the infrastructure, data on the status and utilization of virtual resources are collected at predefined intervals. These services rely on well-defined security protocols and procedures defined by the Oracle Cloud provider.

Display of resource utilization data:

Data collected through the services defined in the previous point are accessed through a unified, intuitive, graphical user interface, providing users with display and analysis of collected information. The main objective of this system is to display the status and utilization of key virtual resources based on collected data, enabling subsequent trend analysis of each individual element.

Subsystem for user notification:

Based on defined rules, administrative settings, and trends derived from collected data, the system notifies users of unplanned behavior and increased consumption of key virtual resources due to objective and subjective circumstances as needed. The aim of this subsystem is preventive action, which can lead to a reduction or complete elimination of unplanned hazardous situations resulting in increased consumption or insecure operation of services utilizing virtual infrastructure.

By leveraging an innovative management system, administrators have the ability to define appropriate settings for individual virtual resources, including alarms, notification systems, and other services for managing the load on virtual infrastructure. Defined settings can be associated with one or more responsible individuals who will be notified via email.

Module for controlling the usage of the Oracle Cloud environment with the ability to define security protocols that prevent excessive Oracle Cloud credit consumption



Cloud Control Usage Management

Taking into account that Oracle Cloud systems, in addition to data protection, are also concerned with resource and credit consumption, the software system Oracle Cloud Control Usage Management enables the definition of security mechanisms aimed at preventing excessive resource and Oracle Cloud credit consumption.

Building upon previously defined modules, which aim at performance analysis, reporting, and analysis of Oracle Cloud credit consumption, this system provides a specific set of functionalities designed to safely stop critical virtual resources on the Oracle Cloud infrastructure.

The system, based on defined rules and administrative settings, as well as information collected through the services of previously defined software systems, notifies users and, according to predefined Oracle procedures, either through system administrators or automatically, halts virtual resources.

In this way, the system practices the application of best practices by protecting data and

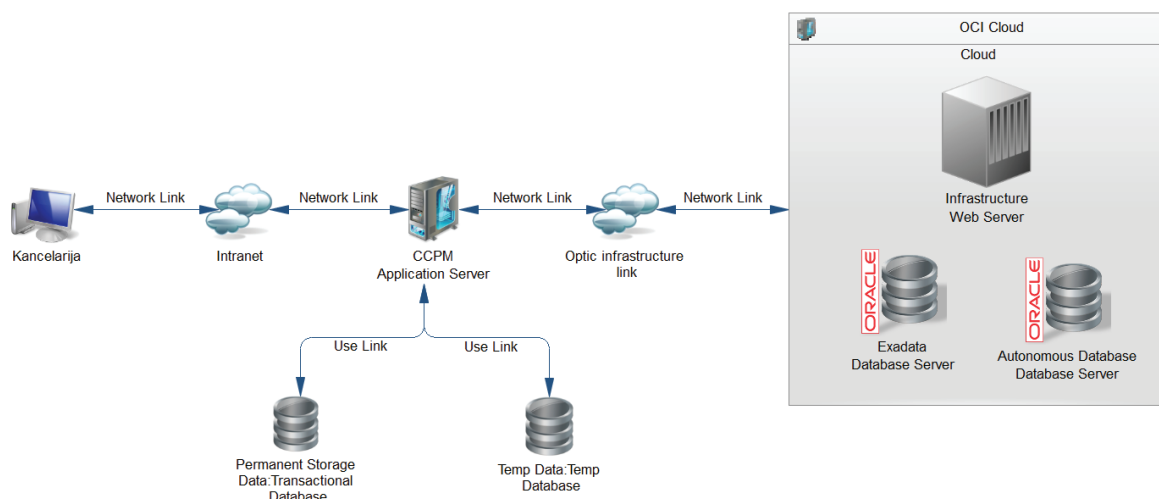
CCPM system architecture

The system architecture at the highest level of abstraction is divided into:

- Services that collect metadata about ORACLE resources:
 - Resource metrics
 - COST files used for Cloud credit consumption analysis
 - Current state of resources
 - Notification to users about the status of virtual resources and credit consumption.
- Web application that displays and analyzes collected data to end-users.

Figure 1 displays the Enterprise architecture of the system, which includes:

- End-user of the system (The Office for Information Technologies and eGovernment)
- CCPM - a system that collects and stores real-time data on resource status in Oracle Cloud
- Oracle Cloud – with internal resources controlled by CCPM
- Infrastructure links connecting architecture elements (network links, Intranet, and/or Internet communication).



Slika 1. Enterprise arhitektura sistema

Services communicating with the Oracle Cloud infrastructure, based on Java technologies, have built-in mechanisms capable of communicating with the API services defined by Oracle as the Oracle Cloud solution vendor. Service configuration is accessible through the user Web interface, where settings can be defined for each individual virtual resource depending on its role in the virtual infrastructure. As previously mentioned, services rely on well-defined security protocols and procedures defined by the Oracle Cloud provider.

The basic division of services is into services that:

1. Collect data on metrics and status of virtual resources, and
2. Services that collect data on Oracle Cloud credit consumption.

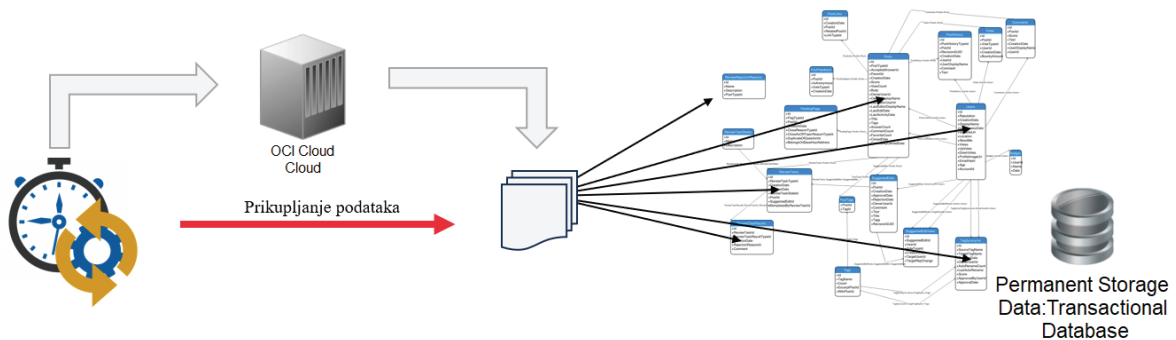
Basic services are accompanied by special user notification services about:

- The status of virtual resources,
- Oracle Cloud credit consumption.

A special service deals with communication with virtual resources aiming to shut them down or temporarily suspend services in case of exceeding Oracle Cloud credits or hazardous, unexpected behavior of any of the virtual resources. The goal of this service is to, depending on the system settings, with the assistance of system administrators or in a fully automated manner, stop a specific virtual resource. Services recognize three basic resources in the virtual infrastructure: virtual machine, autonomous database, and Exadata, which can be managed.

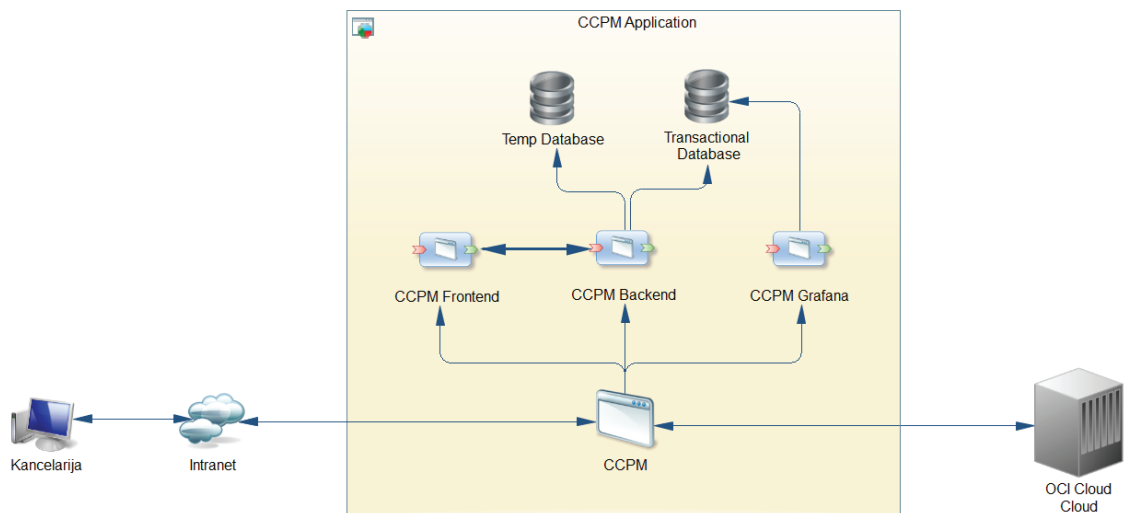
The described software system increases efficiency, manages, monitors, optimizes operations, and prevents overload of virtual resources and excessive consumption of Oracle Cloud credits. Considering this fact, the system relies on a set of services that follow the microservices paradigm in their architecture, where one service is divided into multiple microservices, each performing its own business logic.

Based on the information provided, we can conclude that the described services aim to collect and store data from Oracle Cloud Infrastructure, while specialized services are dedicated to notifying users about the status of virtual resources and Oracle Cloud credit consumption. Additional functionality delegated to specialized services involves processing the collected resource data to populate entities (operational tables and codebooks) in the database. This functionality is developed to enrich system behavior reports, facilitate system administration, and conduct additional analysis of collected data. Depending on the module, system elements will retrieve information from Oracle Cloud Infrastructure through time-defined background processes and perform processing and preparation for input into the operational database.



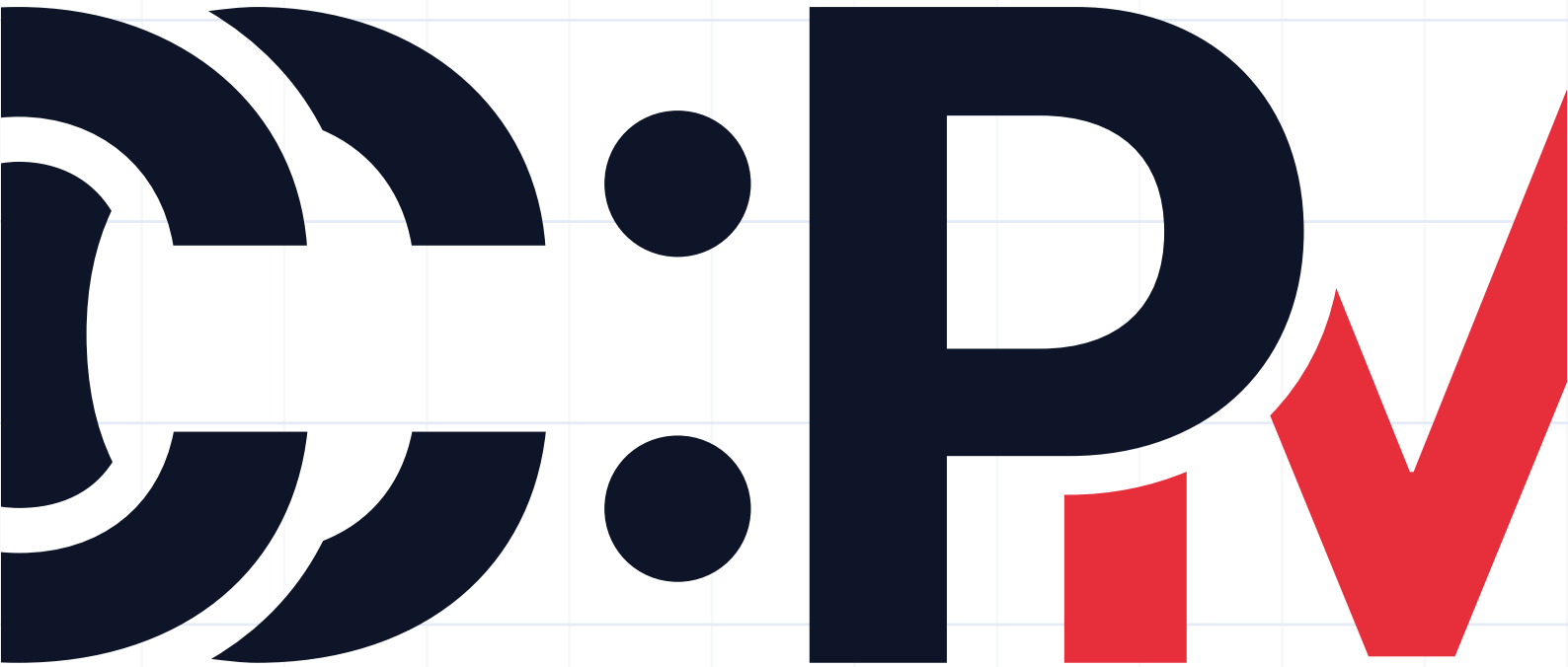
Slika 2. Bremenski definisani pozadinski procesi za prikupljanje informacija

In terms of system architecture, CCPM is based on Docker and Kubernetes technologies, which are becoming standard in modern software development. Docker allows isolating individual services and their dependencies into separate containers, while Kubernetes serves as a platform for container management and orchestration, enabling automated deployment, scaling, and management of containers. The internal architecture of the CCPM system is depicted in Figure 3.



Slika 3. Unutrašnja arhitektura sistema

Dizajn web aplikacije



Cloud Control Performance Management

Special attention is given to the architecture of the user web application, which displays and analyzes collected data to end-users. Additionally, through the administrative panel, it is possible to configure system settings for all three modules. A multi-layered architecture is applied, involving separate layers (physical and/or logical) executing a set of functionalities unique to their position, while access to them is provided through developed interfaces. By using a multi-layered architecture, dynamic configuration of the system architecture is enabled, greatly enhancing flexibility, functional encapsulation, ease of maintenance, and scalability of the system.

Identified layers in the solution include:

Data layer and Data Access

Ensures data stored in related tables and the relationships between them, based on business models.

Business Layer

The data access layer and business layer are closely related. In certain cases, the business layer will execute on the service layer to achieve business transformations and logic. The business layer will contain entities defining domain models and procedures executed on these entities such as recording, updating, and deleting records from a specific entity.

Data validation will occur at the business layer as well as the user interface. The functionalities of the business layer will vary depending on the specific part of the system.



Service Layer

The service layer encapsulates the functionalities of the business layer and provides access to an arbitrary number of heterogeneous clients to the system.

Presentation Layer

Users will access the application through a web interface. To increase productivity, the application will contain additional graphical components such as user dialogs and explanations of expected data for each field, as well as processing notifications about successful/unsuccessful system transactions.

Security and Access

Access to the information system is based on role-based access control (RBAC), allowing each end user to only see a set of data permitted by defined access rights. The security model will be hierarchical, and user roles assigned with specific security privileges will be able to inherit security privileges from other roles. Changing user information is possible, except for the username.

User Authentication and Authorization

The system is accessed through a web portal or service, using security protocols (HTTPS protocol relying on SSL certificates issued by a valid central certificate authority for authorization). The web portal provides an intuitive interface for administrators and other users.

As part of the software solution, it is necessary to provide a user authentication and authorization system for accessing the system, ensuring access and checks that must be restricted according to user rights in all segments. However, the goal is to provide access to the system and all functionalities allowed by access rights for the given user through a single verification process.

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