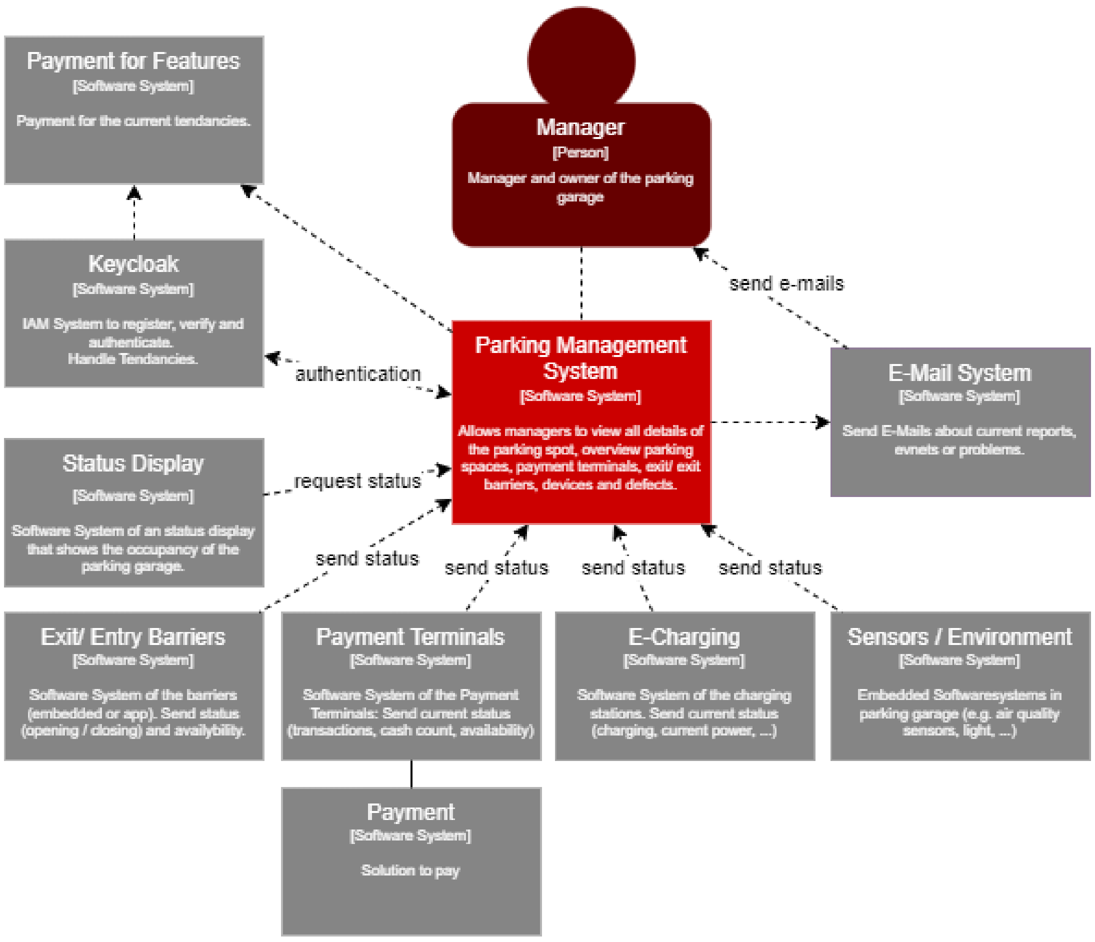
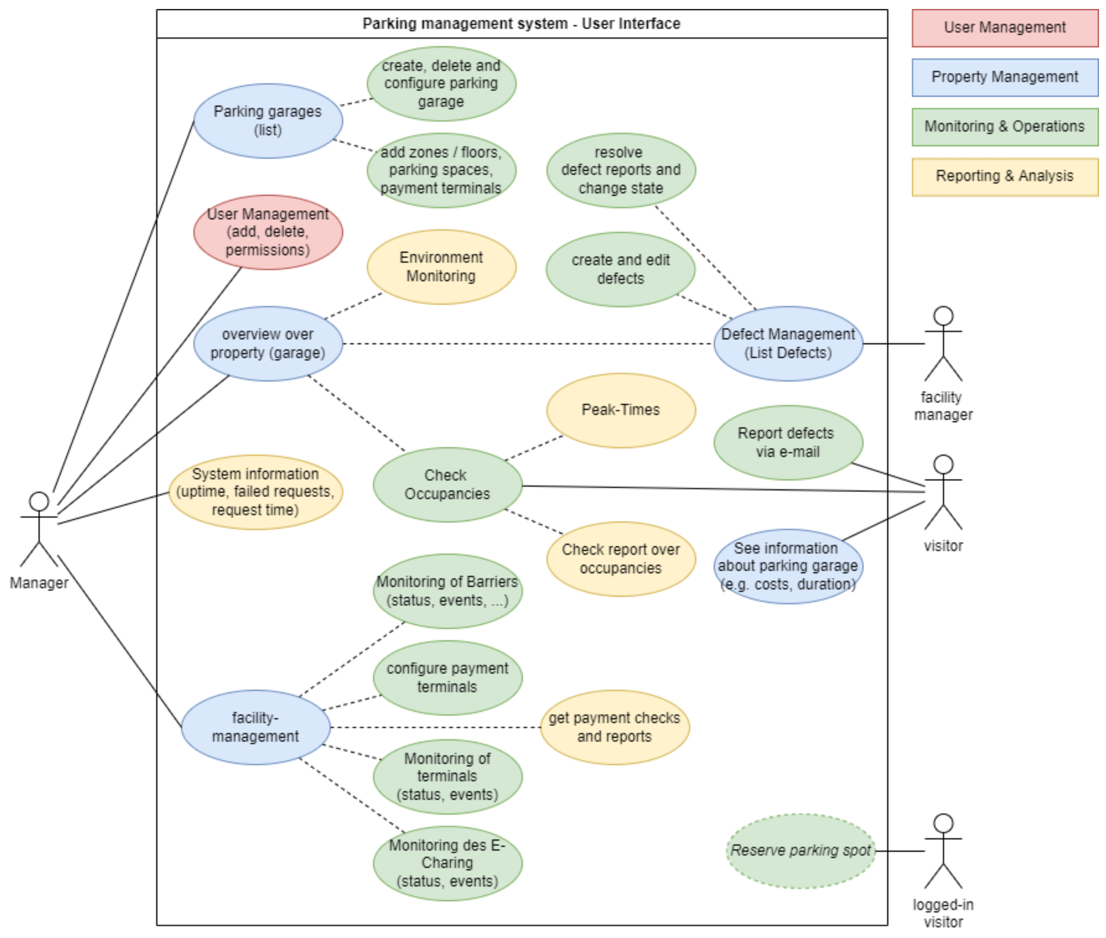
Architecture Description

Main Features and Scope

System Context


Payment for Features
[Software System]
Payment for the current tendancies.
Manager
[Person]
Manager and owner of the parking garage
Keycloak
[Software System]
IAM System to register, verify and authenticate. Handle Tendancies.
authentication
Parking Management System
[Software System]
Allows managers to view all details of the parking spot, overview parking spaces, payment terminals, exit/ exit barriers, devices and defects.
send e-mails
E-Mail System
[Software System]
Send E-Mails about current reports, evnets or problems.
Status Display
[Software System]
Software System of an status display that shows the occupancy of the parking garage.
request status
send status
send status
send status
send status
Exit/ Entry Barriers
[Software System]
Software System of the barriers (embedded or app). Send status (opening / closing) and availability.
Payment Terminals
[Software System]
Software System of the Payment Terminals: Send current status (transactions, cash count, availability)
E-Charging
[Software System]
Software System of the charging stations. Send current status (charging, current power, ...)
Sensors / Environment
[Software System]
Embedded Softwaresystems in parking garage (e.g. air quality sensors, light, ...)
Payment
[Software System]
Solution to pay

Use Case Diagram - Frontend Parking Management


Parking management system - User Interface
User Management
Property Management
Monitoring & Operations
Reporting & Analysis
Parking garages (list)
create, delete and configure parking garage
add zones / floors, parking spaces, payment terminals
resolve defect reports and change state
User Management (add, delete, permissions)
Environment Monitoring
create and edit defects
overview over property (garage)
Defect Management (List Defects)
facility manager
Peak-Times
Report defects via e-mail
System information (uptime, failed requests, request time)
Check Occupancies
visitor
Manager
Check report over occupancies
See information about parking garage (e.g. costs, duration)
Monitoring of Barriers (status, events, ...)
configure payment terminals
facility-management
get payment checks and reports
Monitoring of terminals (status, events)
Monitoring des E-Charing (status, events)
Reserve parking spot
logged-in visitor

Actors

- **Manager**: Owner and Manager of the parking garage. This person wants a good overview of the parking garage, its occupancy and the different devices.
- **Facility Manager**: Wants to know about problems, devices and defects inside of the parking garage.
- **Visitor**: Wants to know about the occupancy of the parking garage.

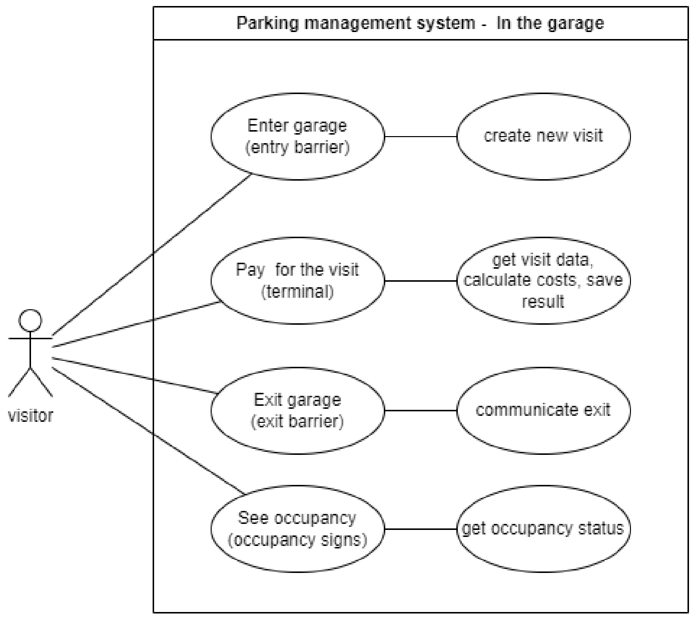
User Stories

1. As Manager, I want to get an overview of my parking garages. I want to be able to see all of them, add new parking garages to the current management and add rooms, parking spaces and similar things to the parking garage.
2. As Manager, I want to handle users of my parking management system. I want to add new ones and grant permissions.
3. As Manager, I want to get a good overview of all my properties. Additionally, I want to see if there are defects.
4. As Manager, I want to get information about the system (e.g. uptime, failed requests, request time).
5. As Facility Manager, I want to get an overview of the defects and resolve them.
6. As Manager, I want to see all parking spaces, the current occupancy (including peak times and reports) and reserve, manage or configure the spaces.
7. As Manager, I want to get an overview of the exit / entry barriers and see the current status and usage amount.
8. As Manager, I want to see my payment terminals, their status and of course the earned money. Additionally, I want to configure my terminals.
9. As Manager, I want to see the E-Charging terminal list and the current status.

10. As a Visitor, I want to see the costs of the parking garage and the current occupancy.
11. As a Visitor, I want to be able to report defects.
12. As a logged-in Visitor, I want to reserve parking spots.

Use Case Diagram - In the Parking Garage

Inside of the parking garage, there are other "users". The visitor itself, who is a person that wants to park inside the garage, and a lot of facilities, that communicate with the parking management software, to manage the user.


Parking management system - In the garage
visitor
Enter garage (entry barrier)
create new visit
Pay for the visit (terminal)
get visit data, calculate costs, save result
Exit garage (exit barrier)
communicate exit
See occupancy (occupancy signs)
get occupancy status

In this case, the visitor wants to do the following things:

1. As a visitor, I want to be able to enter the garage and receive a ticket from the entry barrier. Therefore, my visit needs to be stored within the parking management service.
2. As a visitor, I want to be able to pay for my visit. Therefore, the spent time and the resulting costs need to be calculated, I have to pay and the result will be stored in the database.
3. As a visitor, I want to leave the parking garage after my visit. Therefore, my ticket needs to be checked.
4. As a visitor, I want to see the current occupancy of the parking garage on a display.

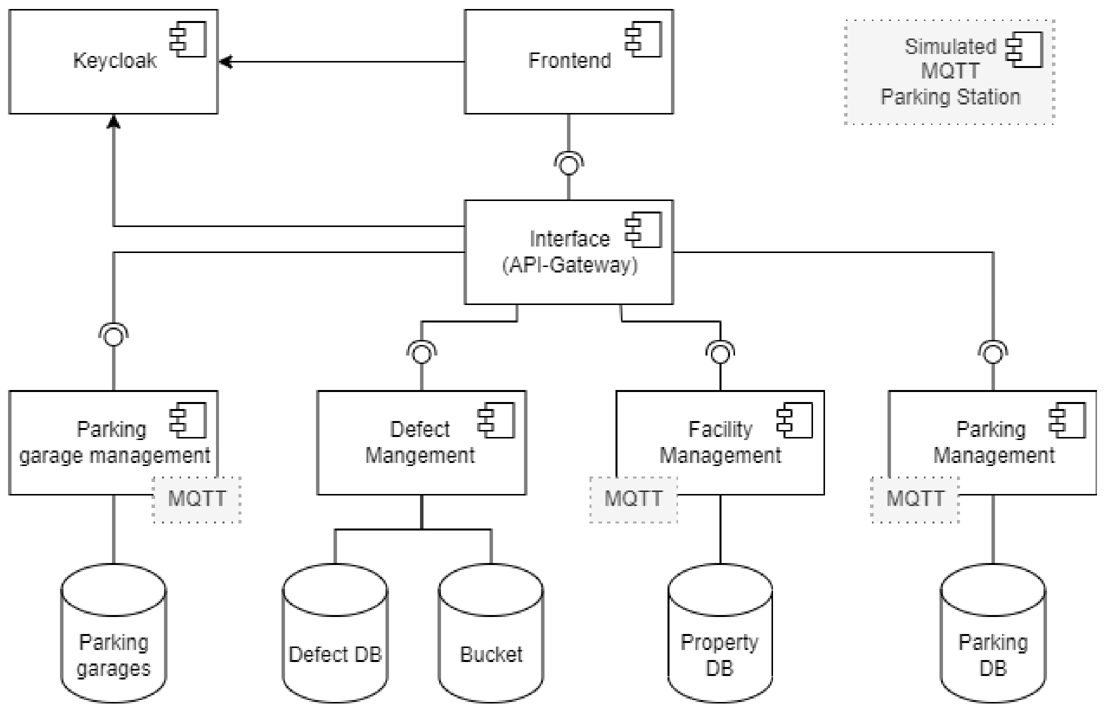
Additional requirements

1. Authentication and Authorization
2. Self-Registration of Tenants with tenant management
3. Customization for each Tenant
4. Pricing models for the tenants (goal: dynamic pricing for the tenants)
5. Security with IAM (e.g. one service account per tenant/service)
6. CI/CD-Pipeline
7. Separate Staging and productive environment

Architecture

Components

In the following diagram, all services are listed.

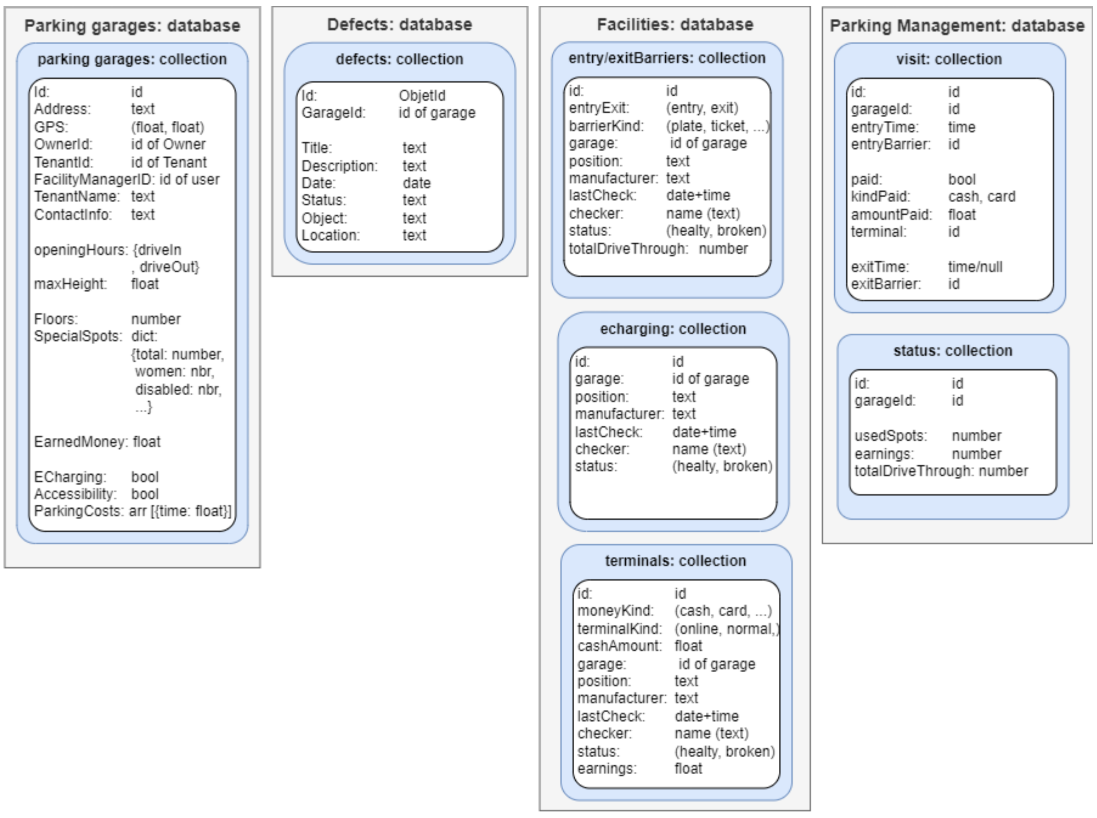


The components are:

- **Keycloak**: Authentication Service to manage the tenants, users and authorization
- **Frontend**: User Interface that presents all important components and artefacts
- **Interface / API-Gateway**: Service to check the requests, validate the tokens and grant access to the services behind.
- **Parking garage management**: Property Management for the entire garage. A lot of information can be requested (e.g. location, name, parking spaces, ...)
- **Defect Management**: Management of Defects and problems. Important for the facility manager
- **Facility Management:** Facilities within the building, e.g. exit/entry barriers, terminals or occupancy signs
- **Parking Management**: Current state, ticket management and parking management.

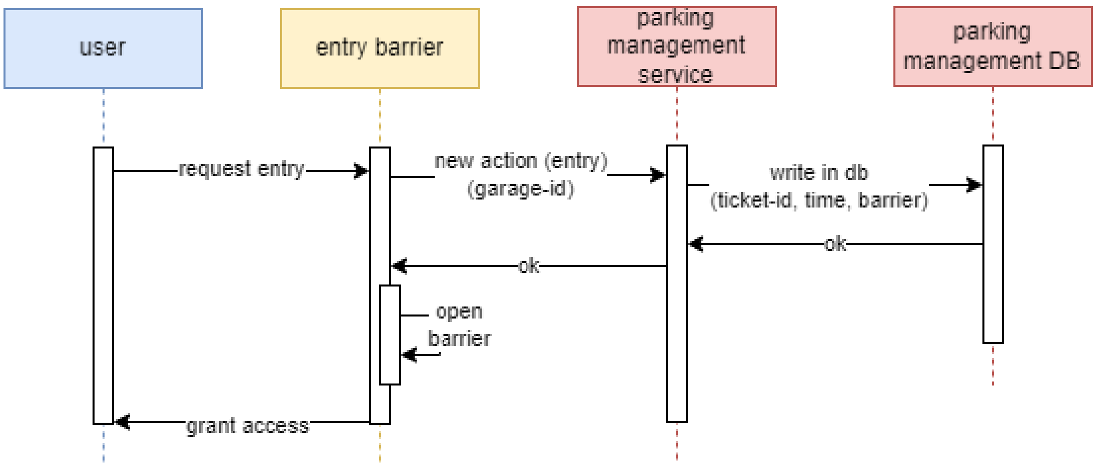
Data Management

Each microservice has a plan for data structure and stored data in the database. Reference the image below for detailed information.

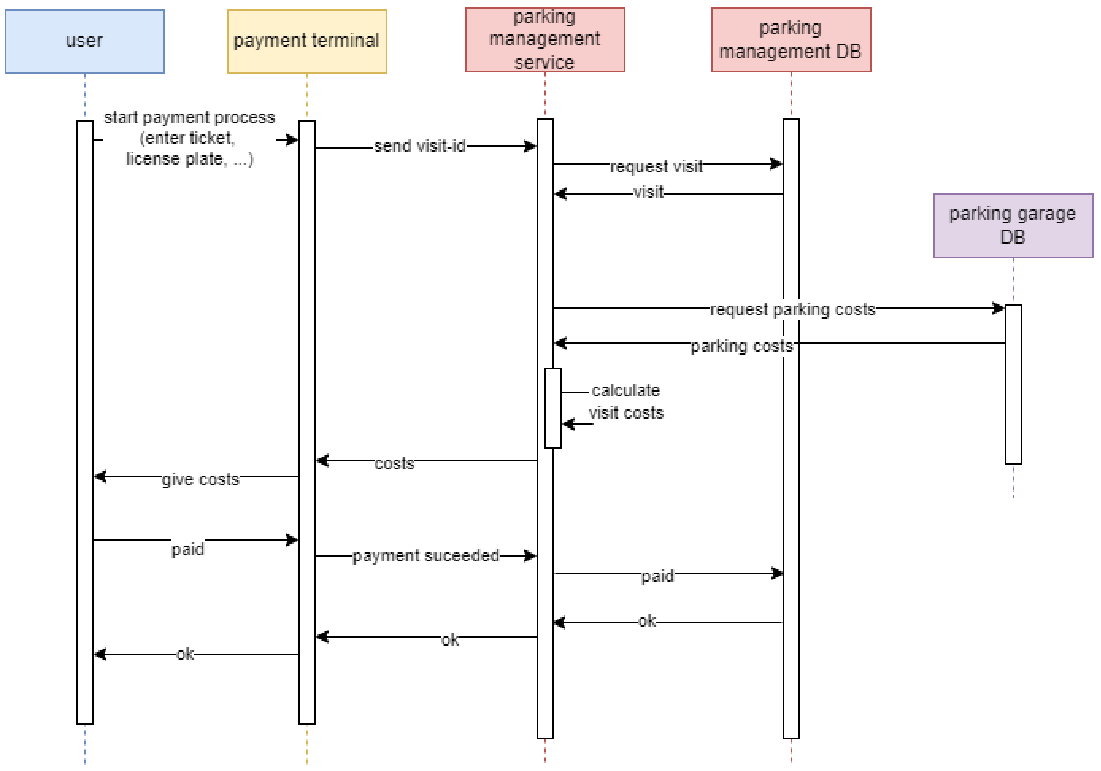


Sequence

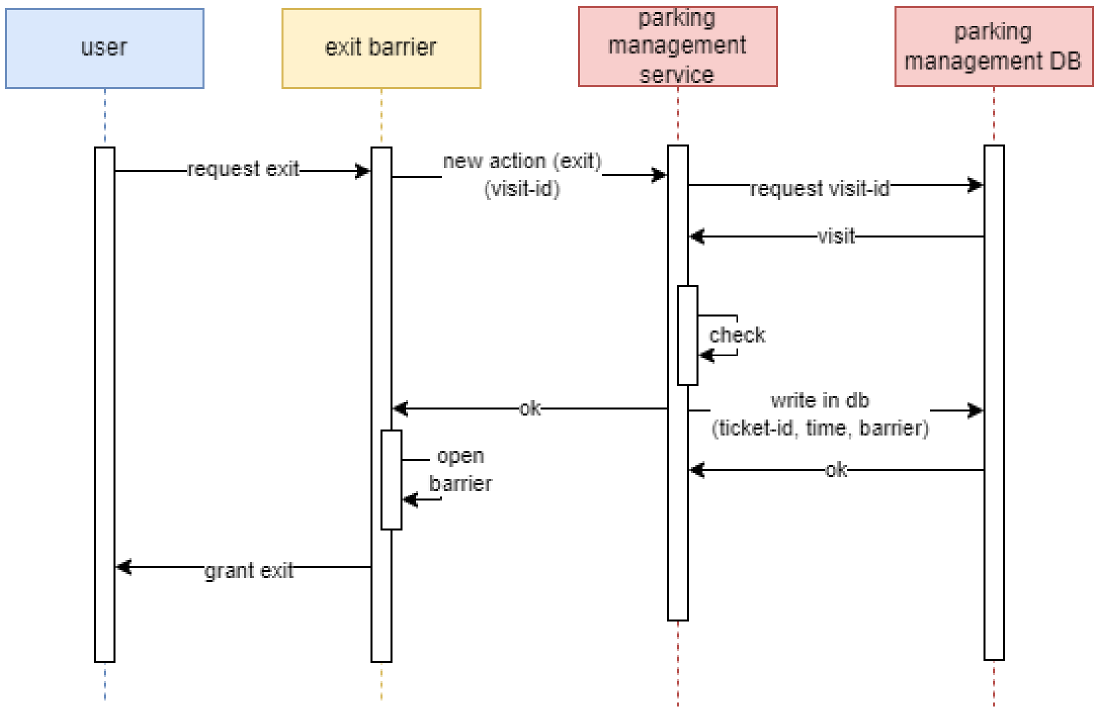
User enters parking garage


user
entry barrier
parking management service
parking management DB
request entry
new action (entry) (garage-id)
write in db (ticket-id, time, barrier)
ok
ok
open barrier
grant access

User uses the terminal



User leaves the parking garage



Multi Tenancy

Tenant Types

There are three types of tenants with different features

- **Free**: No Price, Best Effort, No Customization, Shared
- **Standard**: Attractive Price, SLA, Few Customization, Shared/Pooled
- **Enterprise**: Premium Price, SLA, Highly Customizable, High Isolation

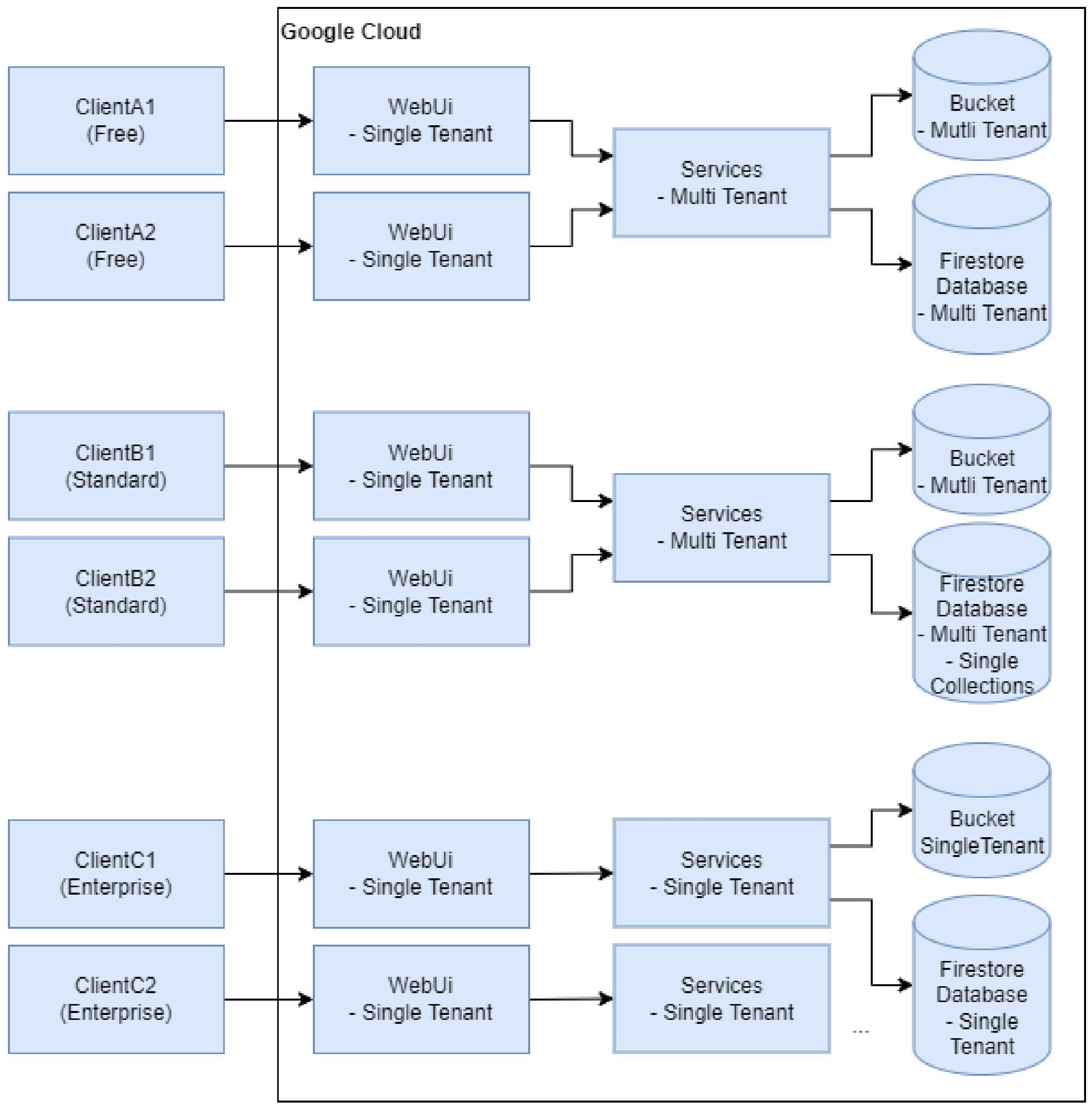
Access and Features by Tenant Type

Feature	**Free**	**Standard**	**Enterprise**
Number of parking garages	1	5	unlimited
Number of parking spaces	max. 1000	unlimited	unlimited
Type of parking spaces	no special parking spaces	Standard, Women, Family, Disabled, E-Parking	configurable
Hardware APIs	limited	most supported	all supported
E-Charging	-	possible	possible
Defect management	-	no status no comments no user feedback	unlimited
Reports	-	limited	unlimited
Roles	no Facility Manager	all	all
Landing-page prioritization	none	medium	high
Advertising	a lot	none	none

Customization			
Parking prices	one price	day/night	fully customizable
Color scheme	fixed	color selection	unlimited

Hardware			
Databases	one collection (per service) for all customers	one collection (per tenant)	dedicated database
Scaling	barely scaled	scaled	very well scaled
Shared resources	all	all, except databases have dedicated collections	none

Tenants in Hardware


Google Cloud
ClientA1 (Free)
ClientA2 (Free)
WebUi - Single Tenant
WebUi - Single Tenant
Services - Multi Tenant
Bucket - Mutli Tenant
Firestore Database - Multi Tenant
ClientB1 (Standard)
ClientB2 (Standard)
WebUi - Single Tenant
WebUi - Single Tenant
Services - Multi Tenant
Bucket - Mutli Tenant
Firestore Database - Multi Tenant - Single Collections
ClientC1 (Enterprise)
ClientC2 (Enterprise)
WebUi - Single Tenant
WebUi - Single Tenant
Services - Single Tenant
Services - Single Tenant
Bucket SingleTenant
Firestore Database - Single Tenant
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