06/2022

JOHANNES KEPLER
UNIVERSITÄT LINZ

PROJECT DOCUMENTATION

Smart Room Application

Team 1

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Markus Mühleder

Table of Contents

Version history

Version	Date	Creator	Changes
1.1	15.06.2022	Dobretsberger	added Req-Matrix
1.2	16.02.2022	Dobretsberger	overview User-Int.
1.3	17.06.2022	Dobretsberger	added Reports
1.4	01.07.2022	Dobretsberger	added graphics
1.5	04.07.2022	Dobretsberger	Updated Req-Matrix
1.6	04.07.2022	Herzog, Körper	Requirements
1.7	04.07.2022	Dobretsberger	Added Test-Descriptions
1.8	07.07.2022	Dobretsberger	Review

Table 1: Version history

1. Introduction

This document describes the most important parts of the smart room application in terms of design and the implementation of the requirements. Furthermore, it should help to understand the relationship between the used technologies and interfaces.

2. Implemented Requirements

All requirements have been implemented successfully within three sprints.
First of all, we have to point out that some prerequisites in terms of preparation where necessary to meet all requirements. These tasks were documented in zen-hub.
https://app.zenhub.com/workspaces/se-praktikum-62345aeefc8e8c00125ad915/board

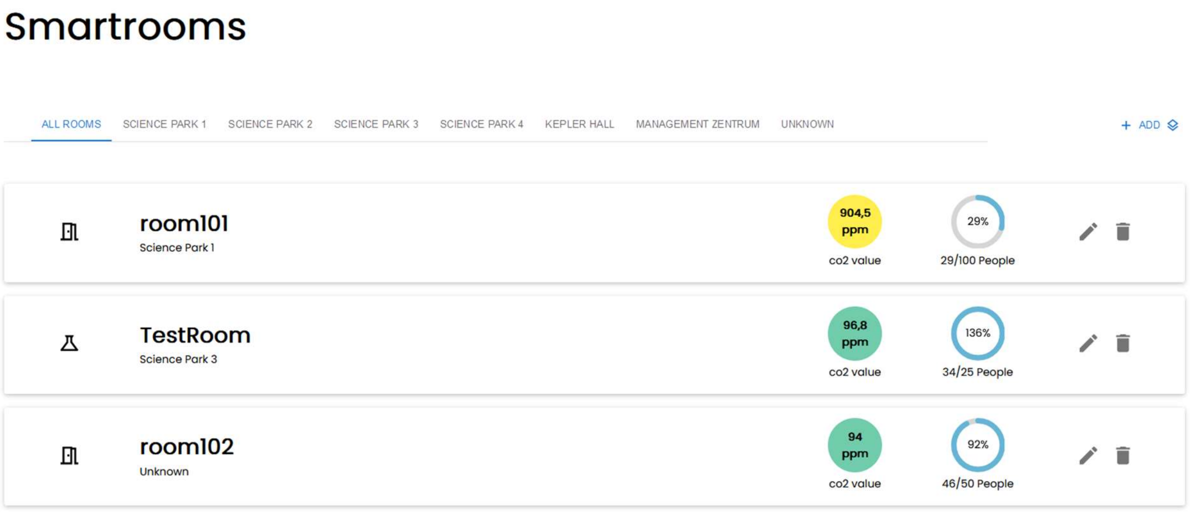
Nr.	Requirement	Responsible	Effort in SP
1	Basic: Import data from CSV to an Entity-Relationship database.	Markus Mühleder Florian Dobretsberger	BE #37 (21 SP)
2	Basic: Create/Update Rooms (id, size, available doors, windows, lights and fans).	ALL	FE #23 (13 SP) BE #49 (5 SP) BE #36 (8 SP) FE #47 (5 SP) FE #46 (5 SP)
3	Basic: Update and remove rooms.	ALL	FE #25 (3 SP) BE #49 (5 SP) FE #45 (3 SP)
4	Basic: Visualize available rooms.	Petra Körper Matthias Herzog	FE #24 (21 SP) FE #31 (3 SP) FE #22 (5 SP) FE #43 (5 SP)
5	Basic: Visualize static information for each room (id, size, available doors, windows, lights and fans).	Petra Körper Matthias Herzog	FE #32 (2 SP) FE #26 (8 SP)
6	Basic: Develop a line chart that shows real-time data regarding light/fan/window/door.	Petra Körper Matthias Herzog	FE #28 (13 SP)
7	Basic: Develop a line chart that shows the co2/temperature values and the number of people for each room over time.	Petra Körper Matthias Herzog	FE #29(3 SP) FE #30(5 SP)

8	Basic: Save rooms structure (rooms + static information) in a .csv file.	Markus Mühleder Florian Dobretsberger	BE #37 (21 SP)
9	Basic: Automatically add random values of co2/temperature/number of people for a specific room.	Markus Mühleder	BE #41 (13 SP)
10	Basic: Live update of visualizations for co2, temperature, and lights/ventilators/windows/doors status for each room.	Petra Körper Matthias Herzog	FE #48 (13 SP)
12	Remote Control: Allow to lock/unlock doors via the user interface.	Petra Körper Matthias Herzog	FE #27 (13 SP)
13	Remote Control: Allow to turn on/off lights via the user interface	Petra Körper Matthias Herzog	FE #27 (13 SP)
14	Remote Control: Allow to open/close windows via the user interface.	Petra Körper Matthias Herzog	FE #27 (13 SP)
15	Remote Control: Allow to turn on/off fans via the user interface.	Petra Körper Matthias Herzog	FE #27 (13 SP)
16	Security: Send alarm if temperature is above 70 degrees celsius.	Markus Mühleder Florian Dobretsberger	BE #59 (5 SP)
17	Security: Unlock all doors if temperature is above 70 degrees celsius.	Markus Mühleder Florian Dobretsberger	BE #59 (5 SP)
18	Energy Saving: Turn lights on if there are people in the room.	Markus Mühleder Florian Dobretsberger	BE #57 (5 SP)
19	Energy Saving: Lights should be turned off if the room is empty.	Markus Mühleder Florian Dobretsberger	BE #57 (5 SP)
20	Energy Saving: Turn off running devices if the room is empty.	Markus Mühleder Florian Dobretsberger	BE #57 (5 SP)
21	Air Quality: Open window + activate fan if co2 values are > 1000 parts per million (ppm).	Markus Mühleder Florian Dobretsberger	BE #58 (5 SP)

22	Air Quality: Change room color in user interface based on co2 values. - green if c2o values are < 800 ppm - yellow if co2 values are between 800 and 1000 ppm - red if co2 values are above 1000 ppm	Petra Körper Matthias Herzog	FE #24 (21 SP) FE #26 (8 SP)

3. Overview of the System from the User´s Point of View

The Mainpage initially displays all rooms, which are available within the system. The user is able to switch between the buildings via the menu. Furthermore, the current co2 value and the capacity-state regarding the appropriate room are being displayed automatically.

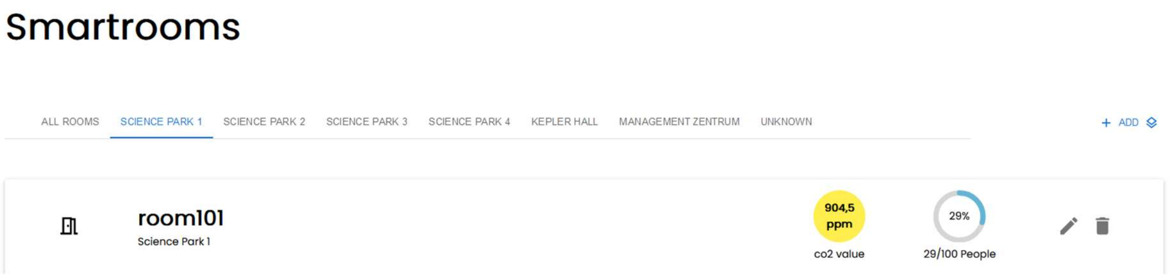


room101 Science Park 1 — 904,5 ppm co2 value — 29% 29/100 People

TestRoom Science Park 3 — 96,8 ppm co2 value — 136% 34/25 People

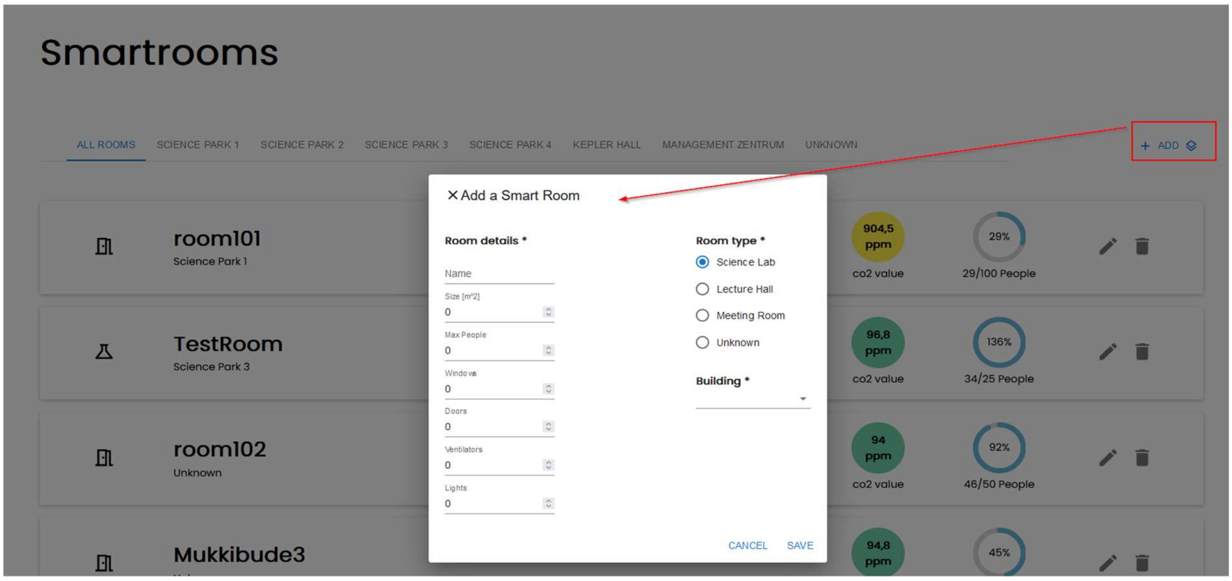
room102 Unknown — 94 ppm co2 value — 92% 46/50 People

Rooms filtered by building:



room101 Science Park 1 — 904,5 ppm co2 value — 29% 29/100 People

The User is able to create a new room via the ADD Button. A dialog appears and the user needs to fill in all necessary details regarding the room.



room101 Science Park 1	904,5 ppm co2 value	29%	29/100 People
TestRoom Science Park 3	96,8 ppm co2 value	136%	34/25 People
room102 Unknown	94 ppm co2 value	92%	46/50 People
Mukkibude3	94,8 ppm	45%	

✕ Add a Smart Room

Room details *

Name:

Size [m^2]: 0

Max People: 0

Windows: 0

Doors: 0

Ventilators: 0

Lights: 0

Room type *

● Science Lab

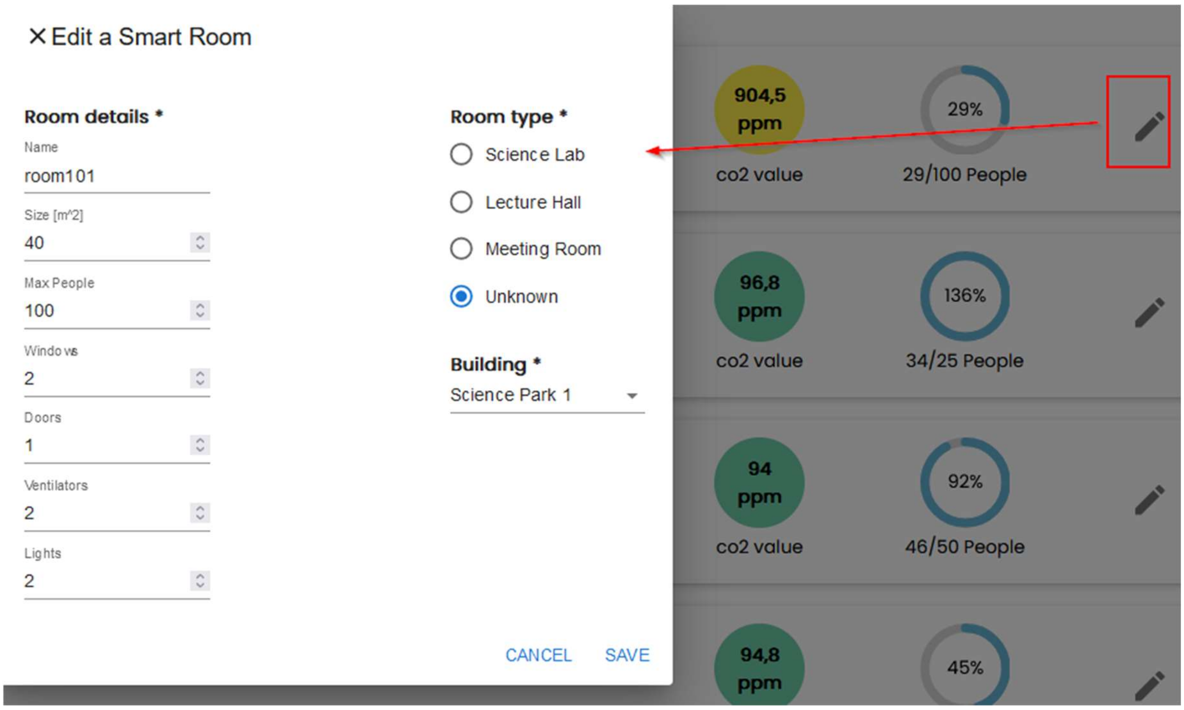
○ Lecture Hall

○ Meeting Room

○ Unknown

Building *

In case of wrong input, the user is notified in terms of the related error. The user is able to edit an existing room via the edit-button.



✕ Edit a Smart Room

Room details *

Name: room101

Size [m^2]: 40

Max People: 100

Windows: 2

Doors: 1

Ventilators: 2

Lights: 2

Room type *

○ Science Lab

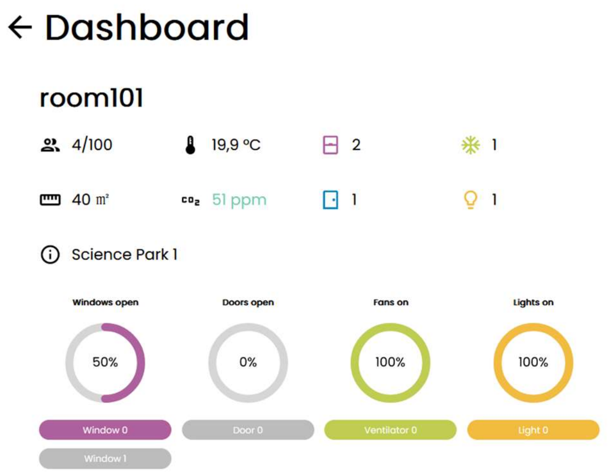
○ Lecture Hall

○ Meeting Room

● Unknown

Building *: Science Park 1

904,5 ppm co2 value	29%	29/100 People
96,8 ppm co2 value	136%	34/25 People
94 ppm co2 value	92%	46/50 People
94,8 ppm	45%	



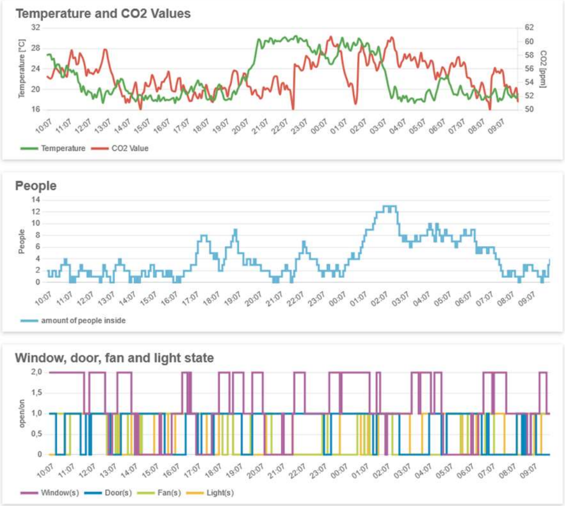
← Dashboard

room101

4/100 19,9 °C 2 1

40 m² 51 ppm 1 1

Science Park 1



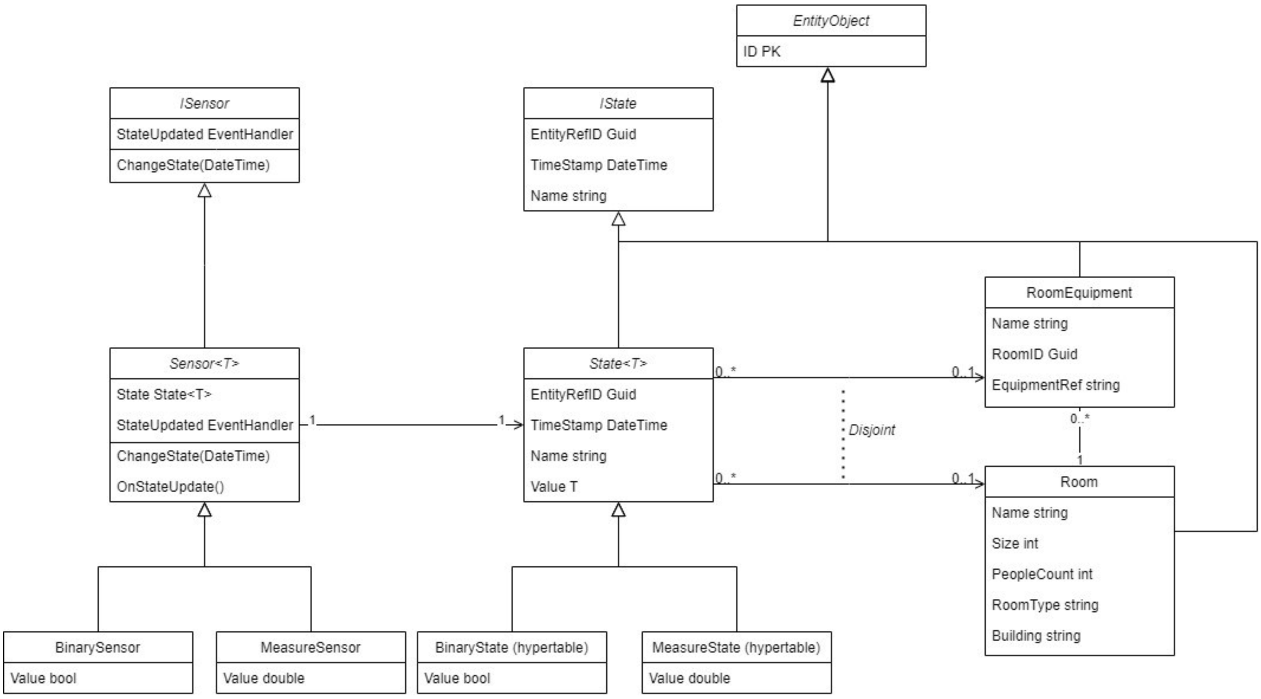
By clicking on a room-section on the overview the user gets a detailed page of the predefined properties. Moreover, the user can control the state of windows, doors, fans and light by clicking on the appropriate button.

4. Overview of the System from the Developer´s Point of View

4.1. Design

4.1.1. Overview of the System

UML Diagram with explanations
Design patterns used (e.g. Model-View-Controller)



4.1.2. Important Design Decisions

Decision: React Framework
Reason: well maintained (because facebook is the main contributor), experience within the team
Considered Alternatives: Angular, Vue.js
Assumptions: lightweight and freedom to choose fitting dependencies, faster development through experience in contrast to other frameworks.
Effect: it worked as expected

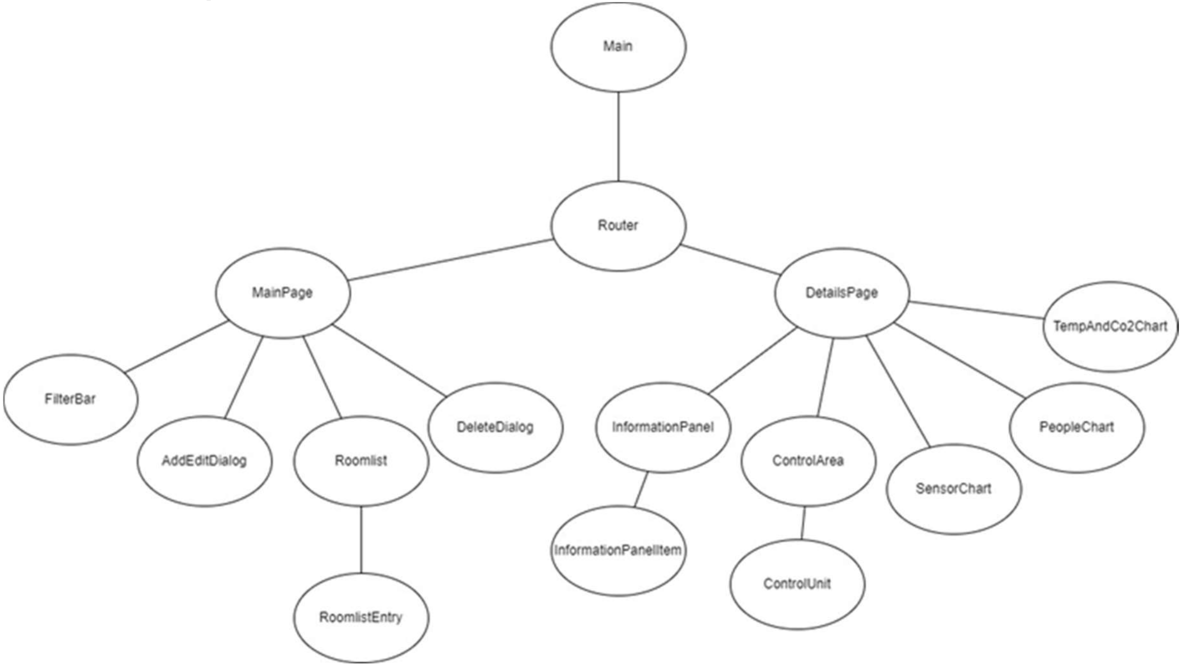
Decision: Material UI
Reason: up to date with the design, preconfigured components
Considered Alternatives: create the components by hand
Assumptions: easy to use and time saved for the other parts of the implementation
Effect: it worked as expected

Decision: .Net 6
Reason: pre-existing knowledge in C#, .NET 6 and needed frameworks for the project
Assumptions: saving time by using frameworks we know
Effect: we had time to focus on software architecture, tools, and project management

Decision: Micro Service Architecture
Reason: for a more efficient use of resources, an increase of availability and a reduction of dependencies between functionalities and project members
Assumptions: to get the maximum out of free cloud resources and make parallel working less complex
Effect: CI/CD got more complex, parallel working was more easy, fast deployment of smaller parts for the UI, better visibility of the progress

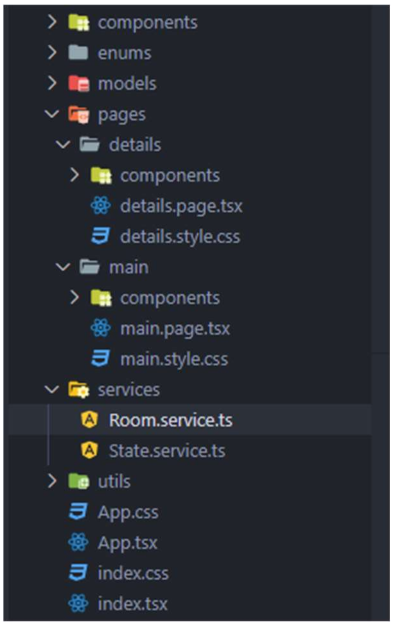
4.2. Implementation

Frontend Component-Tree:



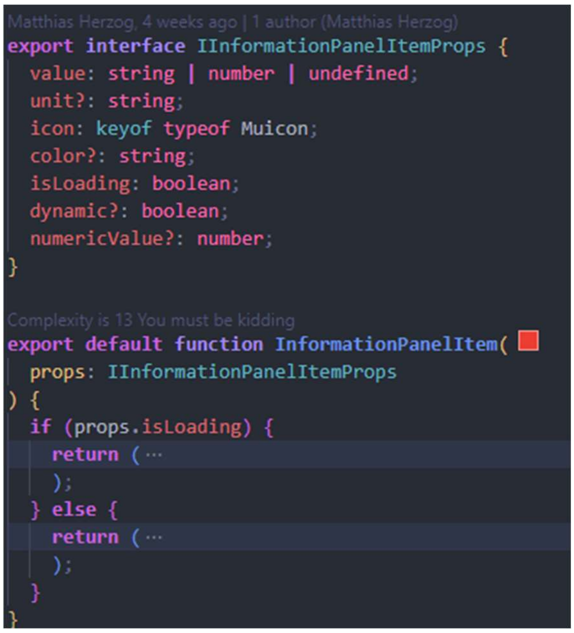
The implementation is based on the concept of a master detail page because the requirements stated the need for a list-based overview of the rooms. This page is represented through the main page which gives a basic overview of the rooms, every room links to the according details page. The details page contains the dashboard for the selected room and displays more specific information than the main page. Through this separation every page is clean and gives a better overview of the data.

Components which are used in the master and the details page are extracted, to avoid code duplication. Furthermore, functions which are used more than once are also extracted into a utils



```
> components
> enums
> models
v pages
  v details
    > components
      details.page.tsx
      details.style.css
  v main
    > components
      main.page.tsx
      main.style.css
v services
    Room.service.ts
    State.service.ts
> utils
  App.css
  App.tsx
  index.css
  index.tsx
```

folder, so they are accessible for every page. The communication with the backend is structured into two different services: room and state; which allows the use of the singelton pattern. Through the singelton pattern there are no inconsistencies.
With the help of props it is possible to customize one component as a template so it can be reused in different scenarios like the room-list-item, the control-unit and the information-panel-item. Props are like parameters in a function, they change the output.

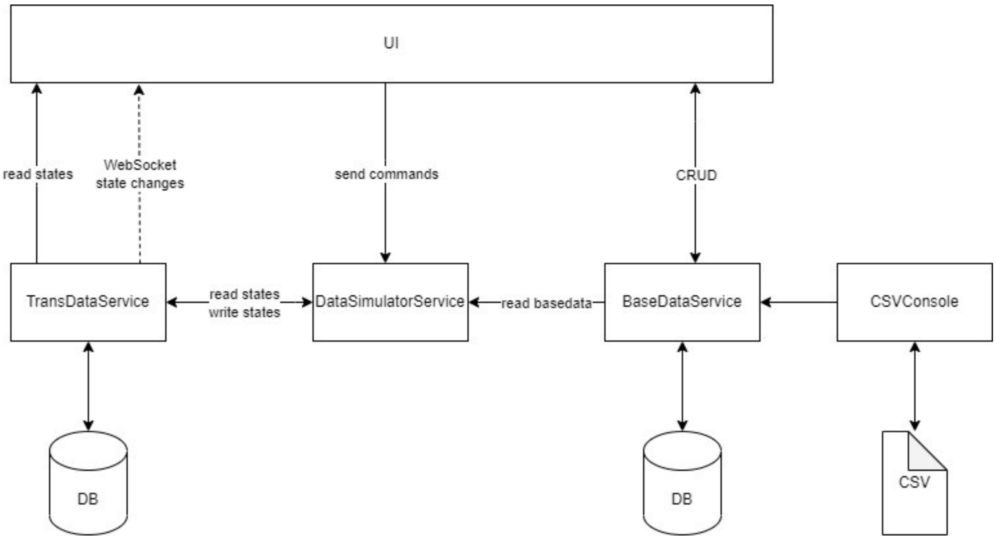


```
Matthias Herzog, 4 weeks ago | 1 author (Matthias Herzog)
export interface IInformationPanelItemProps {
  value: string | number | undefined;
  unit?: string;
  icon: keyof typeof Muicon;
  color?: string;
  isLoading: boolean;
  dynamic?: boolean;
  numericValue?: number;
}

Complexity is 13 You must be kidding
export default function InformationPanelItem(
  props: IInformationPanelItemProps
) {
  if (props.isLoading) {
    return (…
    );
  } else {
    return (…
    );
  }
}
```

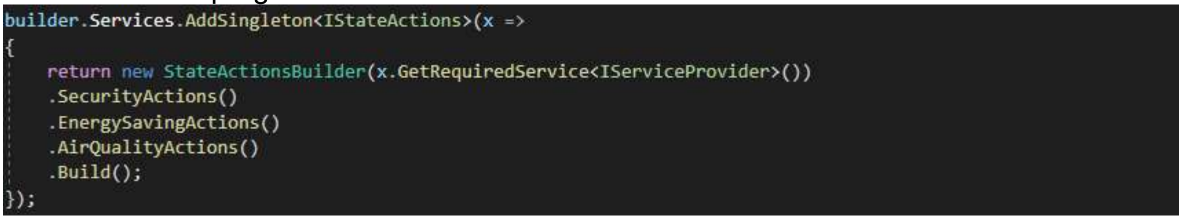
One might ask the question why this was not used with the charts as well. On the one hand there where restrictions from the backend, like what functions needed to be called, and on the other hand, due to the library which was used (Chart.js) and how it is designed, it would have resulted in too many props. Therefore, it is necessary to know when to generalize and when not to.

Service-Architecture:



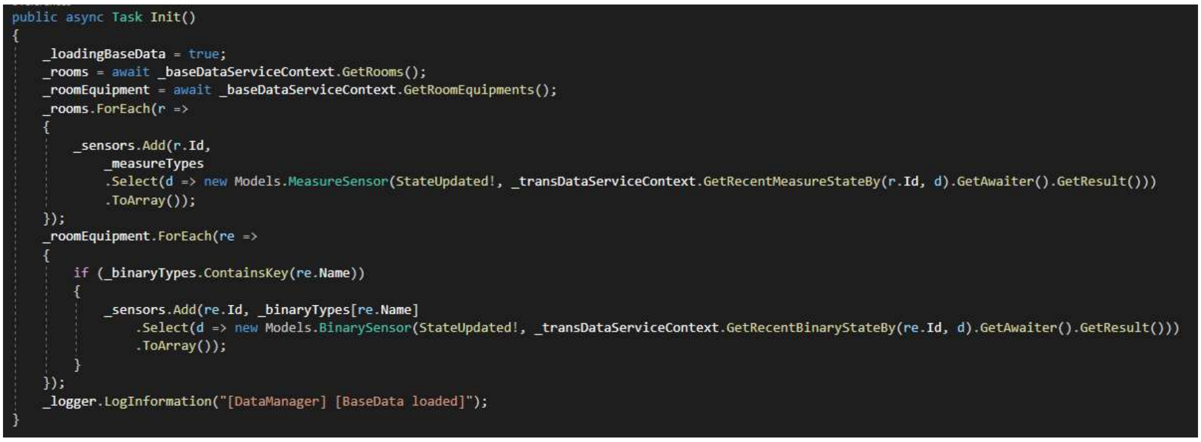
The illustration above shows the data flow between our services. We divided our backend into 4 services.

- The **TransDataService** handles all sensor data which we call trans data. The Service provides a read and write interface, aggregated queries included. Also a web socket is implemented with SignalR, so the frontend can subscribe to the data changes and alarms. For the different mechanisms like air quality, we have implemented a builder pattern for a clean decapsulation. As the following snippet show the builder was easy to use in the main program:



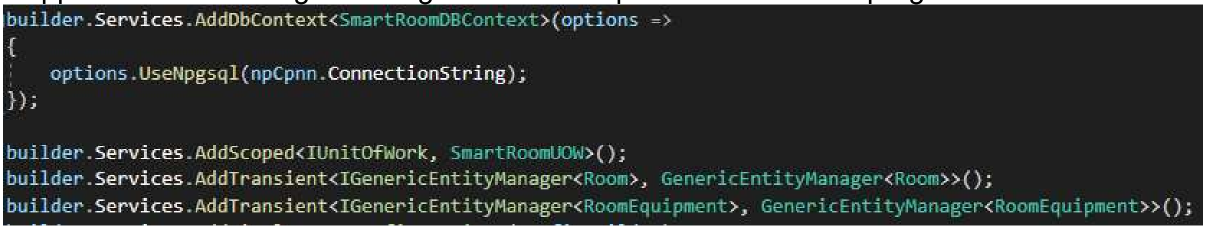
```
builder.Services.AddSingleton<IStateActions>(x =>
{
    return new StateActionsBuilder(x.GetRequiredService<IServiceProvider>())
    .SecurityActions()
    .EnergySavingActions()
    .AirQualityActions()
    .Build();
});
```

- The DataSimulatorService simulates real sensors and actors. The services supply interfaces to trigger actors and to check the status of the simulator. For the data generation the simulator reads at the start the latest trans data and base data and creates sensor instances. These instances generate data random between 0.01 and 1 minute. If the data gets updated, the service sends the new data to the TransDataService. The Following code snippet shows the method which creates the instances of the sensors.



```
public async Task Init()
{
    _loadingBaseData = true;
    _rooms = await _baseDataServiceContext.GetRooms();
    _roomEquipment = await _baseDataServiceContext.GetRoomEquipments();
    _rooms.ForEach(r =>
    {
        _sensors.Add(r.Id,
            _measureTypes
            .Select(d => new Models.MeasureSensor(StateUpdated!, _transDataServiceContext.GetRecentMeasureStateBy(r.Id, d).GetAwaiter().GetResult()))
            .ToArray());
    });
    _roomEquipment.ForEach(re =>
    {
        if (_binaryTypes.ContainsKey(re.Name))
        {
            _sensors.Add(re.Id, _binaryTypes[re.Name]
                .Select(d => new Models.BinarySensor(StateUpdated!, _transDataServiceContext.GetRecentBinaryStateBy(re.Id, d).GetAwaiter().GetResult()))
                .ToArray());
        }
    });
    _logger.LogInformation("[DataManager] [BaseData loaded]");
}
```

- The BaseDataServcie provides the CRUD operations for static data (rooms, room equipments, …). This service uses a small Postgres SQL instance. The Following code snippet shows the usage of our generic CRUD pattern in the main program.



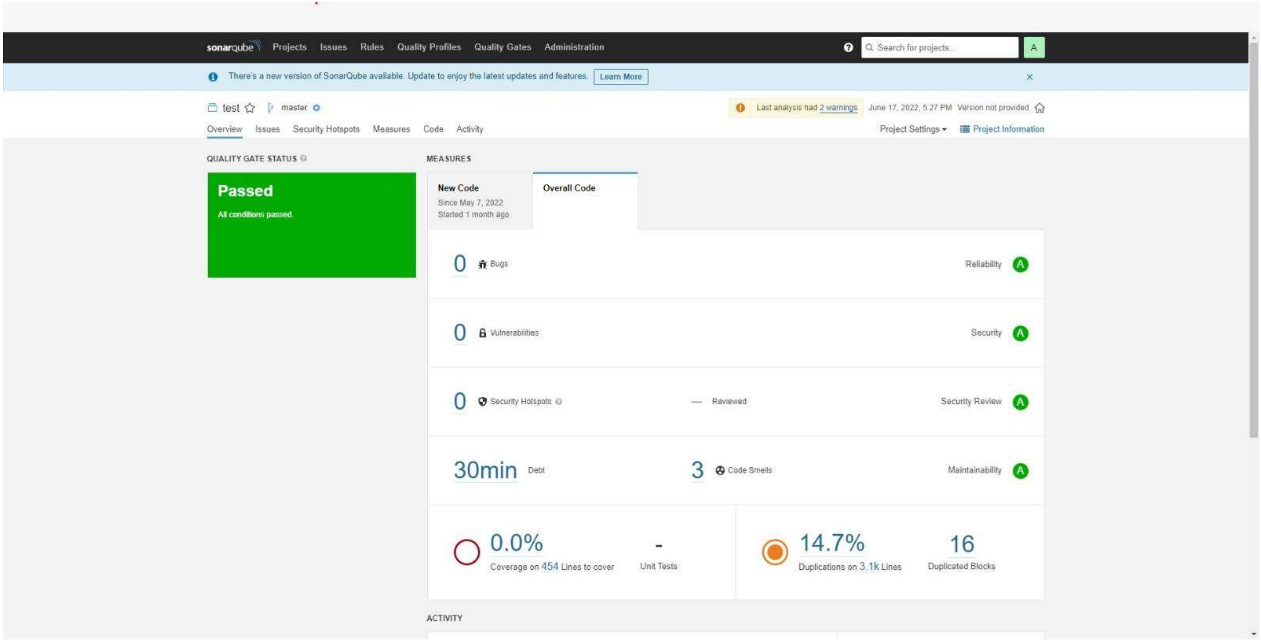
```
builder.Services.AddDbContext<SmartRoomDBContext>(options =>
{
    options.UseNpgsql(npCpnn.ConnectionString);
});

builder.Services.AddScoped<IUnitOfWork, SmartRoomUOW>();
builder.Services.AddTransient<IGenericEntityManager<Room>, GenericEntityManager<Room>>();
builder.Services.AddTransient<IGenericEntityManager<RoomEquipment>, GenericEntityManager<RoomEquipment>>();
```

- The CSVConsole is a console application which im- and exports the static data.

4.3. Code Quality

Code Quality Frontend



There's a new version of SonarQube available. Update to enjoy the latest updates and features.

test master

Last analysis had 2 warnings June 17, 2022, 5:27 PM Version not provided

QUALITY GATE STATUS

Passed

All conditions passed.

MEASURES

New Code Since May 7, 2022 Started 1 month ago | Overall Code

0 Bugs — Reliability A

0 Vulnerabilities — Security A

0 Security Hotspots — — Reviewed — Security Review A

30min Debt — 3 Code Smells — Maintainability A

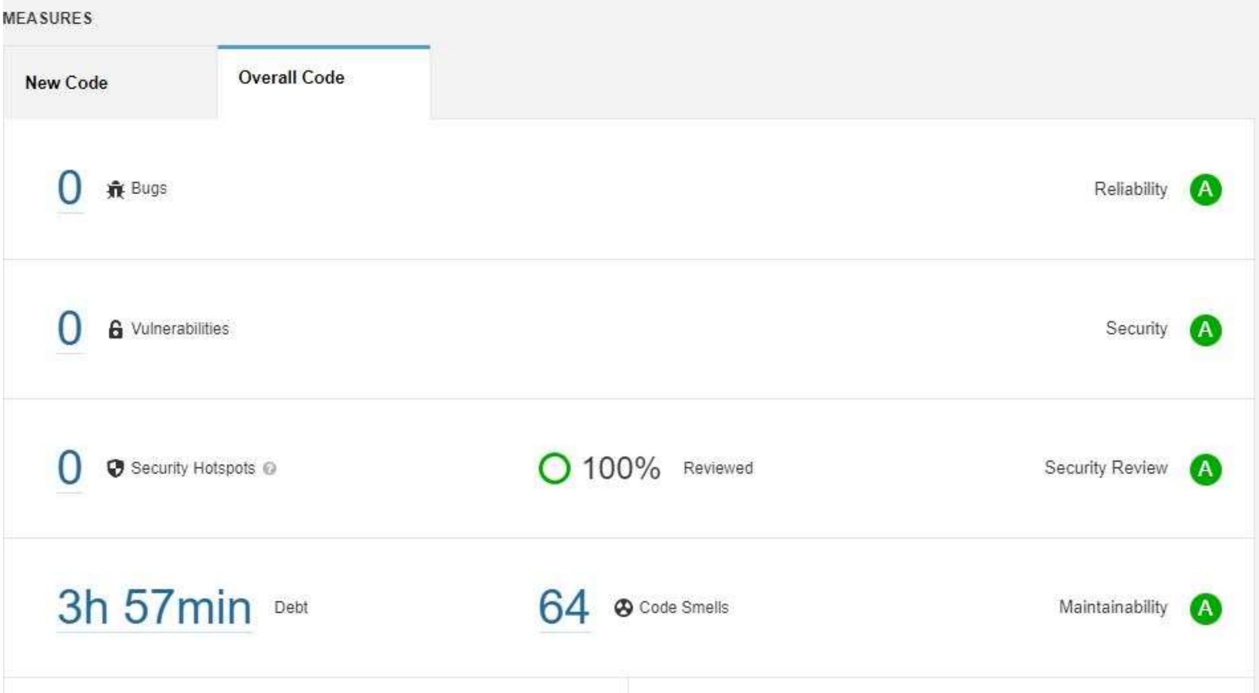
0.0% Coverage on 454 Lines to cover — - Unit Tests

14.7% Duplications on 3.1k Lines — 16 Duplicated Blocks

ACTIVITY

Due to the inner workings of Sonarqube there is a high amount of code duplication. This comes from the import statements and the HTML elements which are used more than once. Additionally, there were a few code smells which have been fixed easily. As an example, “use different variable names for different scopes”. This is not mandatory in JavaScript but it is considered bad practice.

Code Quality Backend



MEASURES

New Code | Overall Code

0 Bugs — Reliability A

0 Vulnerabilities — Security A

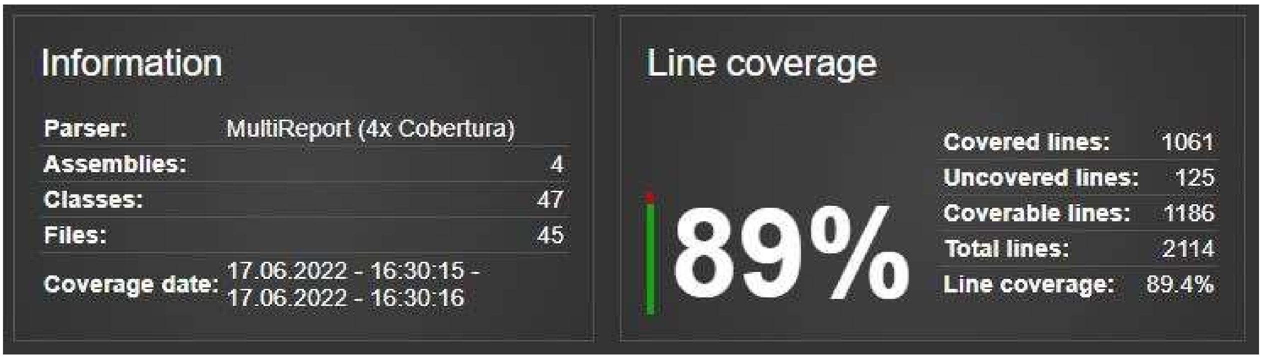
0 Security Hotspots — 100% Reviewed — Security Review A

3h 57min Debt — 64 Code Smells — Maintainability A

4.4. Testing

The detailed coverage report can be displayed under https://github.com/jku-win-se/teaching.ss22.prse.digitaltwin.team1/blob/main/Backend/SmartRoom/CoverageReport/index.html

For excecution: https://github.com/jku-win-se/teaching.ss22.prse.digitaltwin.team1/blob/main/Backend/SmartRoom/StartCodeQualityReport.bat
Hint: Following can not be testet therefore, it is excluded.
/p:ExcludeByFile="**/*migrations/*.cs" /p:ExcludeByFile="**/program.cs"



Information

Parser:	MultiReport (4x Cobertura)
Assemblies:	4
Classes:	47
Files:	45
Coverage date:	17.06.2022 - 16:30:15 - 17.06.2022 - 16:30:16

Line coverage

89%

Covered lines:	1061
Uncovered lines:	125
Coverable lines:	1186
Total lines:	2114
Line coverage:	89.4%

Example #1:

Test Case ID	`Ctor_ValidFileName_GetFileName()`
Designed by	Florian Dobretsberger
Execute on	24.06.2022
Carried out by	Florian Dobretsberger
Tested Requirement	Check if constructor `GenericCSVWriter<Object>` initializies a new csv-file
Requirement	Creating a new csv-file
Test steps	`var writer = new GenericCSVWriter<Object>(new List<Object>(), "Test.csv");`
Test data	Test.csv
Expected result	`Filename exists: Assert.Equal("Test.csv", writer.FileName);`
Post condition	CSV file with example data
Status	Test passed
Comments	-

Example #2:

Test Case ID	`Room_PropertyNames_Exist(string name)`
Designed by	Markus Mühleder
Execute on	08.06.2022
Carried out by	Florian Dobretsberger
Tested Requirement	Check if room properties are existing and names have not changed.
Requirement	Visualize static information for each room (id, size, available doors, windows, lights and fans)
Test data	“”

Test steps	`[Theory]`
	`[InlineData("Name")]`
	`[InlineData("PeopleCount")]`
	`[InlineData("Size")]`
	`[InlineData("RoomType")]`
	`[InlineData("Building")]`
	`[InlineData("RoomEquipment")]`
	`[InlineData("Id")]`
	
	`public void Room_PropertyNames_Exist(string name)`
	`{`
	
	`Assert.NotNull(typeof(Room).GetProperties().First(p`
	`=> p.Name.Equals(name)));`
	`}`

Expected result	All properties are not null.
Post condition	Unchanged
Status	Test passed
Comments	Important to visualize changes at the web interface

Example #3:

Test Case ID	`Decrypt_ValidEncString_ExpDecryptedString()`
Designed by	Markus Mühleder
Execute on	26.05.2022
Carried out by	Florian Dobretsberger
Tested Requirement	Test encryption and decryption
Requirement	Correct decyption of encypted data.

Test steps	`public void Decrypt_ValidEncString_ExpDecryptedString()`
	`        {`
	`            var cypher = new Aes256Cipher(_key);`
	`            var encrString =`
	`"XrOYnGAPkoTh4lB5zRdAAMWOEwZMgqD6kq7tXdI9JB5NhkL9khk/O6klzgBLLs9h";`
	
	`            Assert.Equal(_decrString, cypher.Decrypt(encrString));`
	`        }`

Test data	`"XrOYnGAPkoTh4lB5zRdAAMWOEwZMgqD6kq7tXdI9JB5NhkL9khk/O6klzgBLLs9h"`
Expected result	Correct decryption.
Post condition	String has changed to the excepted decrypted string

Status	Test passed
Comments	-

5. Installation guide

https://github.com/jku-win-se/teaching.ss22.prse.digitaltwin.team1/tree/main/Frontend/smart-home-ui

https://github.com/jku-win-se/teaching.ss22.prse.digitaltwin.team1/tree/main/Backend