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niCE-life

INSTALATION AND TESTING OF TECHNICAL DEVICES AND APPLICATIONS

Deliverable D.T3.3.4

Version 1
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Table of Content

1. Introduction

This document, Installation and testing of technical devices and applications, presents the procedure of putting the AP-NURSE devices in operation in the Social Care Centre Petržalka as part of Output O.T3.2 – Pilot testing of AP-NURSE – persons suffering from Parkinson's disease in Care Centre Bratislava and deliverable D.T3.3.4. It starts with the selection of devices, including the AP-NURSE Home and AP-NURSE Care M5stack platforms, based on the specification and map provided by the representatives of Social Care Centre Petržalka. The next chapters are dealing with the detailed procedures of deploying and installing the AP-NURSE devices in dedicated locations and with the testing of the functionality of the installed devices. The last chapter is dealing with the registration of the installed devices to the Information System, assignment of devices to specific collections, configuration of notifications and testing the functionality of the whole system.

2. Selection of devices for testing

The pilot testing in Social Care Centre (SCC) Petržalka is focused on monitoring the patients suffering from Parkinson´s disease, Alzheimer´s disease, dementia and frail elderly. The Social Care Centre Petržalka is operated by the Petržalka district municipality and is located in Mlynarovičova street in Bratislava. The map of the SCC Petržalka is shown in **Figure 1**. The Center is in an enclosed area, has controlled entry, two floors and a garden, which is accessible for some of the clients. The pilot testing of AP-NURSE devices is performed inside the building of SCC Petržalka, on both floors. The garden of the centre is only accessible from the first floor. The map of the first and the second floor is shown in **Figure 2** and **Figure 3**.

Figure 1. Map of the Social Care Centre Petržalka

2.1. Areas of the Social Care Home

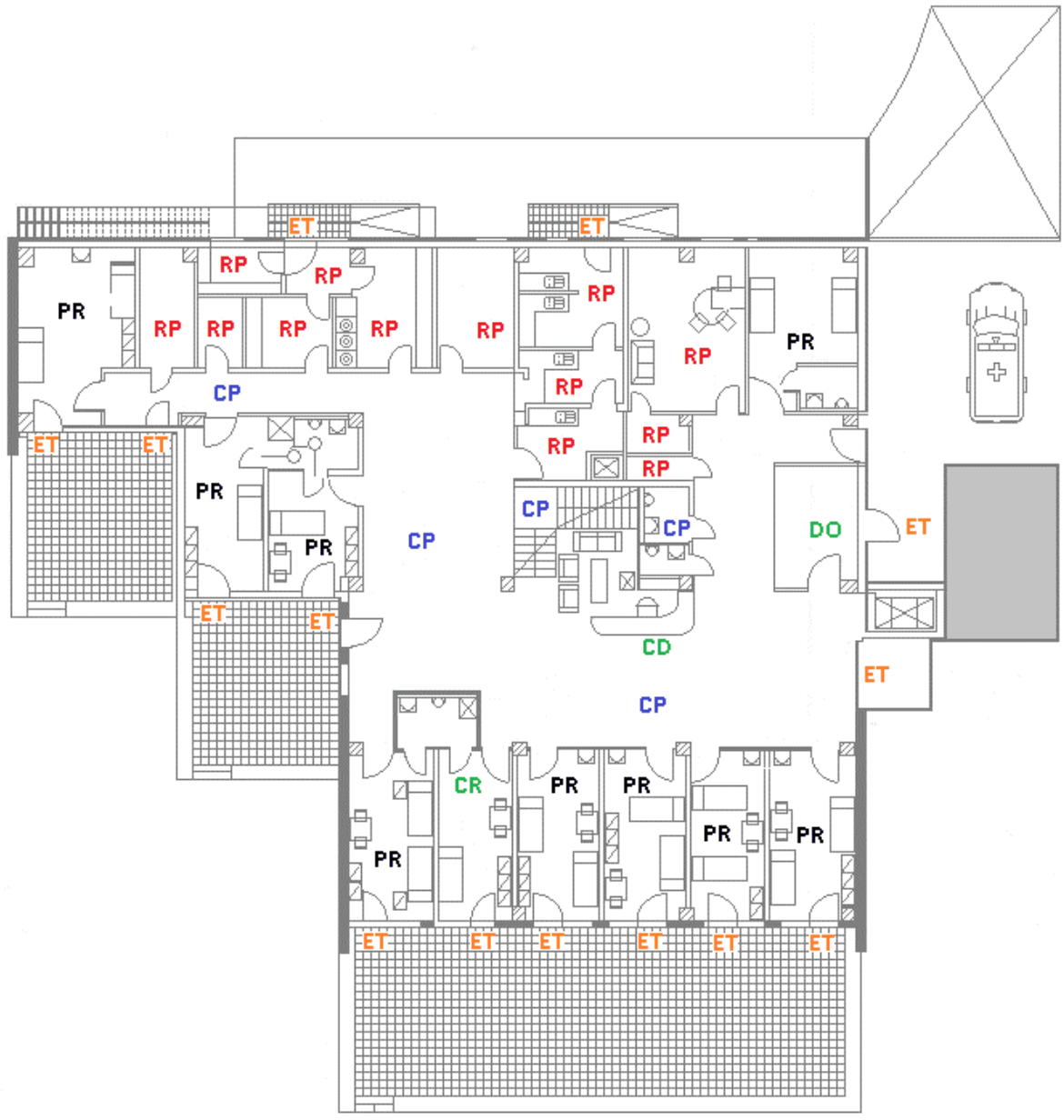


Figure 2. Layout of the Social Care Centre Petržalka - first floor (PR - patients´room, ET - exit, CP - common places for clients, RP - restricted places for clients, CR - caregiver´s room, CD - caregiver´s desk, DO - director´s office)

Figure 3. Layout of the Social Care Centre Petržalka - second floor

The Social Care Centre Petržalka consists of the following areas:

- Clients´ rooms
    - Rooms of mobile and immobile clients
    - With or without restrooms
    - One or two clients in the room
    - Black & white zone
- Common places for clients
    - Area where the movement of clients is not limited during the day
    - Both clients and caregivers may be present
    - This area includes the corridor, kitchen for clients, the staircases, and the saloon
    - Blue zone
- Restricted area for clients
    - Areas restricted for patients
    - Only caregivers and the personal of SCC Petržalka shell enter
    - This area includes the kitchen, laundry, washroom, warehouse and the maintenance area
    - Red zone
- Exit to outside premises
    - All doors to outside premises are restricted to clients
    - The doors to the garden may be accessed by clients upon approval of caregivers

- This area also includes the emergency exits
- Orange zones

- Other premises
  - Areas where the clients can access the caregivers
  - Caregivers´ desk - CD
  - Caregivers´room - CR
  - Director´s office - DO

2.2. Assignment of monitoring zones

Based on the above-mentioned classification of areas and the regime of patients and caregivers in the Social Care Centre Petržalka, the following monitoring zones were defined:

- **Monitoring of mobile clients in their room**
  - First floor
    - 3 rooms
    - 5 clients involved
    - monitoring of the patients in the bed or in the room
      - **AP1-H** - 3 devices
  - Second floor
    - 2 rooms
    - 4 clients involved
    - monitoring of the patient in the bed or in the room
      - **AP1-H** - 2 devices
    - monitoring the doors to the restroom
      - **AP2-H** - 2 devices
- **Monitoring of immobile clients in their room**
  - First floor
    - 1 room
    - 2 clients invovled
    - monitoring of the patient in the bed and potential movement in the room
      - **AP1-H** - 1 devices
  - Second floor
    - 2 rooms
    - 4 clients involved
    - monitoring of the patient in the bed and potential movement in the room
      - **AP1-H** - 2 devices

- **Monitoring of the corridors**
    - Second floor
    - Multiple clients and caregivers involved
        - Monitoring of activity patterns during the night – passage through the corridor or staircase
        - **AP4-M** – 2 devices
- **Monitoring of the kitchen**
    - Second floor
    - Multiple clients and caregivers involved
        - Monitoring of activity pattern during the night
        - **AP6-H** – 1 device
- **Monitoring of restricted areas**
    - First floor
        - Monitoring the passage of unauthorized personnel
        - Mainly caregivers involved
            - washroom
        - **AP6**-M – 1 device
    - Second floor
        - Monitoring the passage of unauthorized personnel
        - Mainly caregivers involved
            - cloakroom
        - **AP4**-M – 1 device

2.3. Devices used for deployment

Due to the type and structural diversity of premises in the SCC Petržalka, two AP-NURSE platforms were selected for testing, AP-NURSE Home and AP-NURSE Care M5stack, including AP1, AP2, AP4 and AP6 versions. The following section presents the used versions of AP-NURSE devices. **Figure 4** - **Figure 8** present the pictures of the device and a configuration of sensors.

2.3.1. AP-NURSE Home

2.3.1.1. AP1-H

AP-NURSE version	Sensor configuration					
	Mov.	Bar.	Force	Gas	Temp.	Light
AP1-H						
AP2-H						
AP4-H						
AP6-H						
AP7-H						

Figure 4. AP1-H device and configuration of sensors

2.3.1.2. AP2-H

AP-NURSE version	Sensor configuration					
	Mov.	Bar.	Force	Gas	Temp.	Light
AP1-H						
AP2-H						
AP4-H						
AP6-H						
AP7-H						

Figure 5. AP2-H device with PIR movement sensor

2.3.1.3. AP6-H

AP-NURSE version	Sensor configuration					
	Mov.	Bar.	Force	Gas	Temp.	Light
AP1-H						
AP2-H						
AP4-H						
AP6-H						
AP7-H						

Figure 6. AP6-H device with PIR movement sensor

2.3.2. AP-NURSE Care - M5stack

2.3.2.1. AP4-M

AP-NURSE version	Sensor configuration					
	Mov.	Bar.	Force	Gas	Temp.	Light
AP1-M						
AP2-M						
AP4-M						
AP6-M						

Figure 7. AP4-M device with PIR movement sensor

2.3.2.2. AP6-M

AP-NURSE version	Sensor configuration					
	Mov.	Bar.	Force	Gas	Temp.	Light
AP1-M						
AP2-M						
AP4-M						
AP6-M						

Figure 8. AP6-M device and configuration of sensors

3. Deployment of AP-NURSE devices

Based on the created monitoring zones of the Social Care Centre Petržalka, the deployment of AP-NURSE devices was performed separately for each zone, i.e. Clients´rooms, Common places for clients and Restricted areas for clients. The map of AP-NURSE devices installed in the SCC Petržalka is shown in **Figure 9** and **Figure 10**.

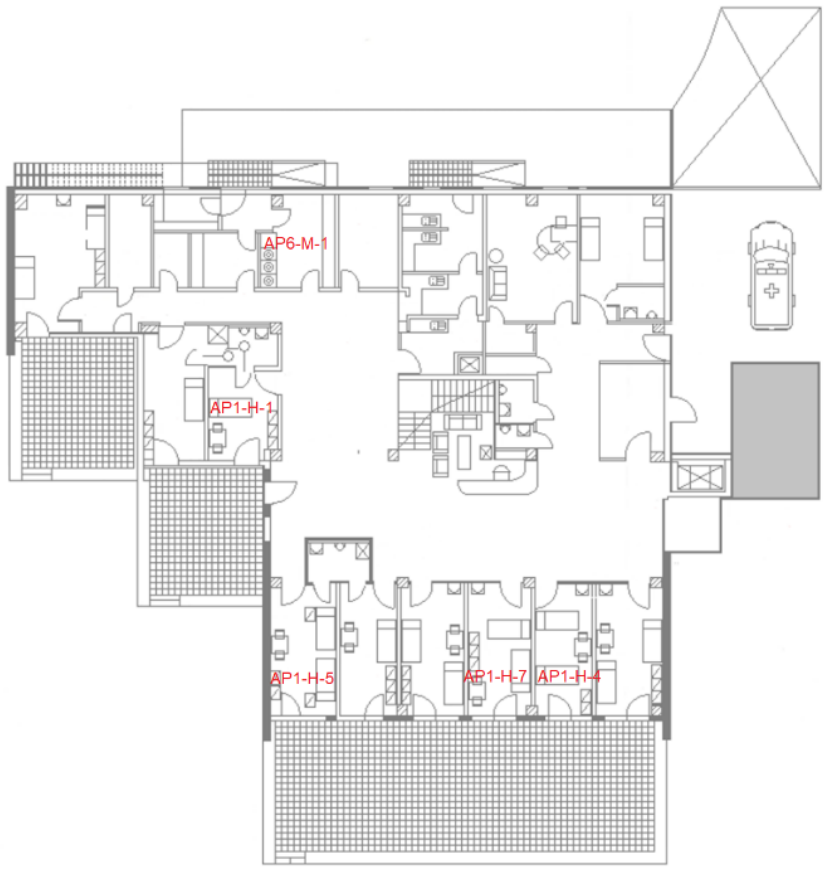


Figure 9. Map od of AP-NURSE devices installed on the first floor of SCC Petržalka

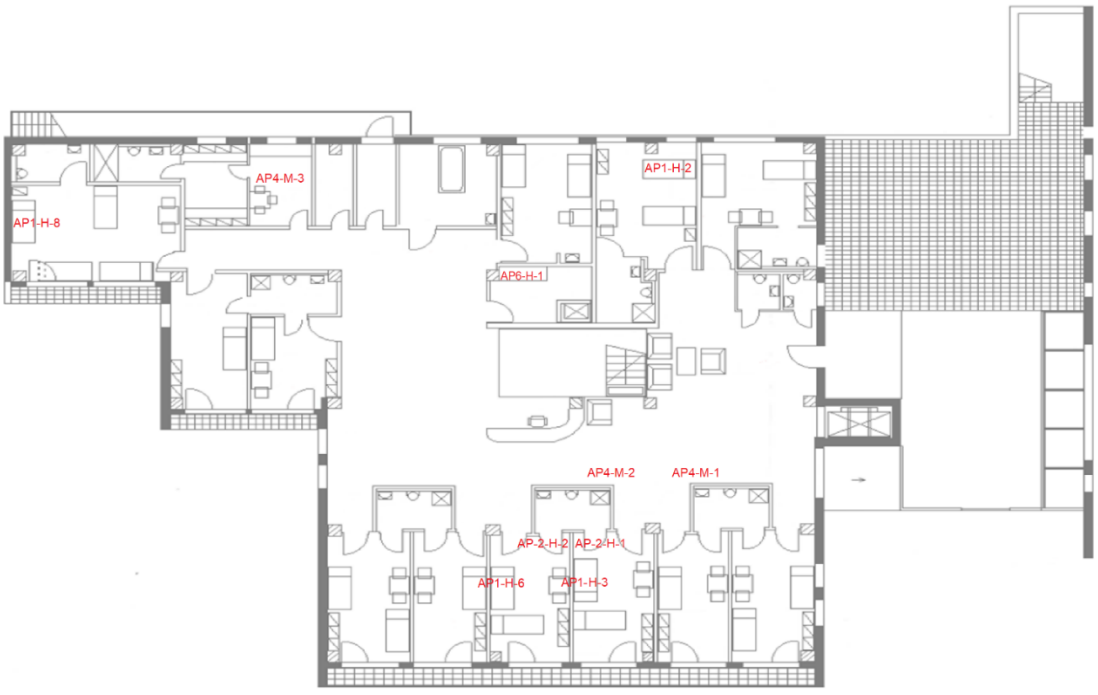


Figure 10. Map od of AP-NURSE devices installed on the second floor of SCC Petržalka

3.1. Clients´ rooms

In the clients´ rooms, the AP-NURSE devices were installed to monitor 8 rooms on both floors of the Social Care Centre Petržalka with a total number of 15 clients involved. Here, the AP1-H and the AP2-H versions of AP-NURSE were installed. The summary of the installed devices can be found in **Table 1**. The table also provides information about the accommodated patients in the room, including the list of their chronic diseases and level of mobility. In this table the AP-NURSE devices are presented using their shortcuts, following the logic that 1H4 stands for the AP1-H-004 device. In case of mobile patients accommodated in rooms with restrooms, two AP-NURSE devices were installed:

- AP1-H to monitor the bed or the presence of the patients in the room
- AP2-M to monitor the door to the restroom

In the case of double rooms, the AP1 devices were installed under one of the patient's beds. This device monitor movement of both patients since the beds are situated next to each other and the PIR movement sensor is aimed at the space between the beds. A combination of alerts from the FSR pressure sensors and PIR sensors may help to identify the patients, who move into the room. The AP2-H devices were directly attached to the door to the toilet and respond to the opening of the door. The deployment of AP1-H and AP2-H devices is shown in **Figure 11** and **Figure 12**.

Table 1. Summary of AP-NURSE devices installed in the patients´ rooms

Room ID	Location in the room	Gender / age	Characteristics of the monitored patient	Primary AP - NURSE unit	Secondary AP - NURSE unit
No. 2 (first floor)	Under the Bed	F/75	Alzheimer´s disease, Epilepsy – bed-ridden	*AP1-H-004 (1H4)*	-
	-	F/92	Stroke – bed-ridden	-	-
No. 3 (first floor)	Under the Bed	M/71	Lung cancer - walking	*AP1-H-007 (1H7)*	-
	-	M/68	Dementia – Wheel-chaired	-	-
No. 6 (first floor)	Under the Bed	F/78	Alzheimer´s disease - walking	*AP1-H-005 (1H5)*	-
	-	F/84	Cardiovascular disease – walking with the help	-	-
No. 7 (first floor)	Under the Bed	F/80	Parkinson´s disease, stroke – walking with the help	*AP1-H-001 (1H1)*	-
No. 13 (second floor)	Under the Bed	F/87	Alzheimer´s disease - walking	*AP1-H-003 (1H3)*	-
	-	F/91	Frail elderly - walking	-	-
	On the door to the restroom	N/A	-	-	*AP2-H-001 (2H1)*

No. 14 (second floor)	Under the Bed	F/63	Stroke – walking with help	*AP1-H-006 (1H6)*	-
	-	F/98	Frail elderly – walking with the help	-	-
	On the door to the restroom	N/A	-	-	*AP2-H-002 (2H2)*
No. 20 (second floor)	Under the Bed	M/80	Alzheimer´s disease, stroke, dementia – bed-ridden	*AP1-H-002 (1H2)*	-
	-	M/89	Recovering from surgery – bed-ridden	-	-
No. 22 (second floor)	Under the Bed	M/80	Dementia – wheel chaired	*AP1-H-008 (1H8)*	-
	-	M/89	Recovering from surgery – bed-ridden	-	-

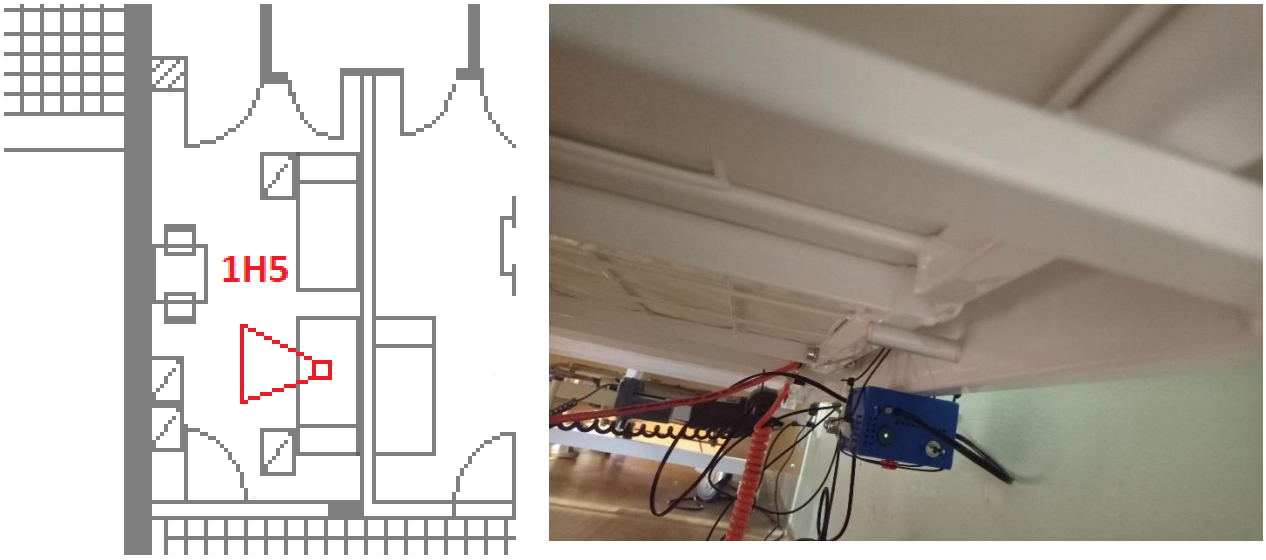


Figure 11. Deployment of the AP-NURSE AP1-H-005 (1H5) device

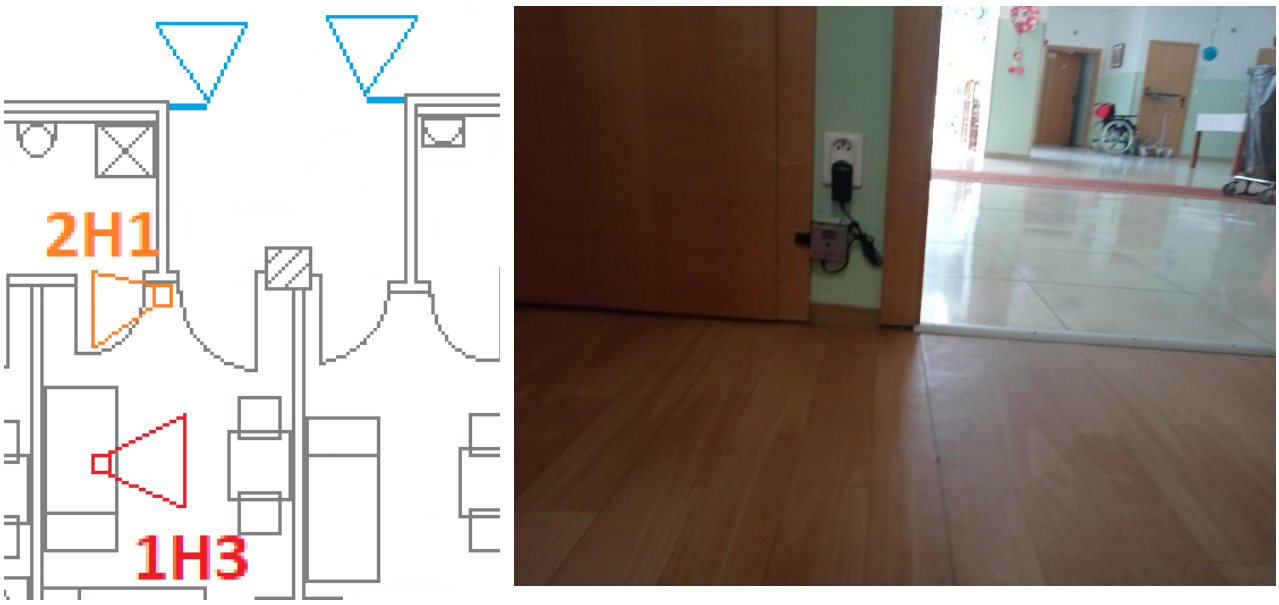


Figure 12. Deployment of the AP-NURSE AP1-H-003 (1H3) and AP2-H-001 (2H1) devices

3.2. Common places for clients and restricted areas

In addition to patients' rooms, the AP-NURSE devices were installed in common places for clients, which are accessible during the daytime and also in restricted areas. The common places include the staircase and the kitchen on the second floor. The restricted areas selected for monitoring are the cloakroom and the washroom. The purpose of installing AP-NURSE devices into common places is to monitor the potential wandering of clients during the night shift. The restricted areas, which are accessible only for the personnel, are monitored 24h a day. In these zones 3 AP4-M, 1 AP6-M and 1 AP-6 devices were installed. The summary of installed devices can be found in **Table 2**. The deployment of devices is shown in **Figure 13** - **Figure 16**.

Table 2. Assignment of devices to kitchens in the orange,green and red zone

Room ID	Type of the zone	Location in the room	Covered area	AP -NURSE unit
Staircase	Accessible for patients and caregivers	Attached to the wall, in front of the staircase	The top half of the staircase, part of the corridor between rooms of the second floor	*AP4-M-001 (4M1)* *AP4-M-002 (4M2)*
Kitchen	Accessible for patients and caregivers	Attached to the kitchen unit, close to the electric kettle	Area in front of the kitchen desk	*AP6-H-001 (6H1)*
Cloakroom	Restricted for patients, accessible for the staff	Attached to the wall on the left side of the room	The first room of the cloakroom, including the door to the second room	*AP4-M-003 (4M3)*
Laundry	Restricted for patients, accessible for the staff	Attached to the grounding of the wiring box	The first room of the laundry, including the door to the second room	*AP6-M-001 (6M1)*

Figure 13. Deployment of the AP-NURSE AP4-M-001 (4M1) and AP4-M-002 (4M2) devices

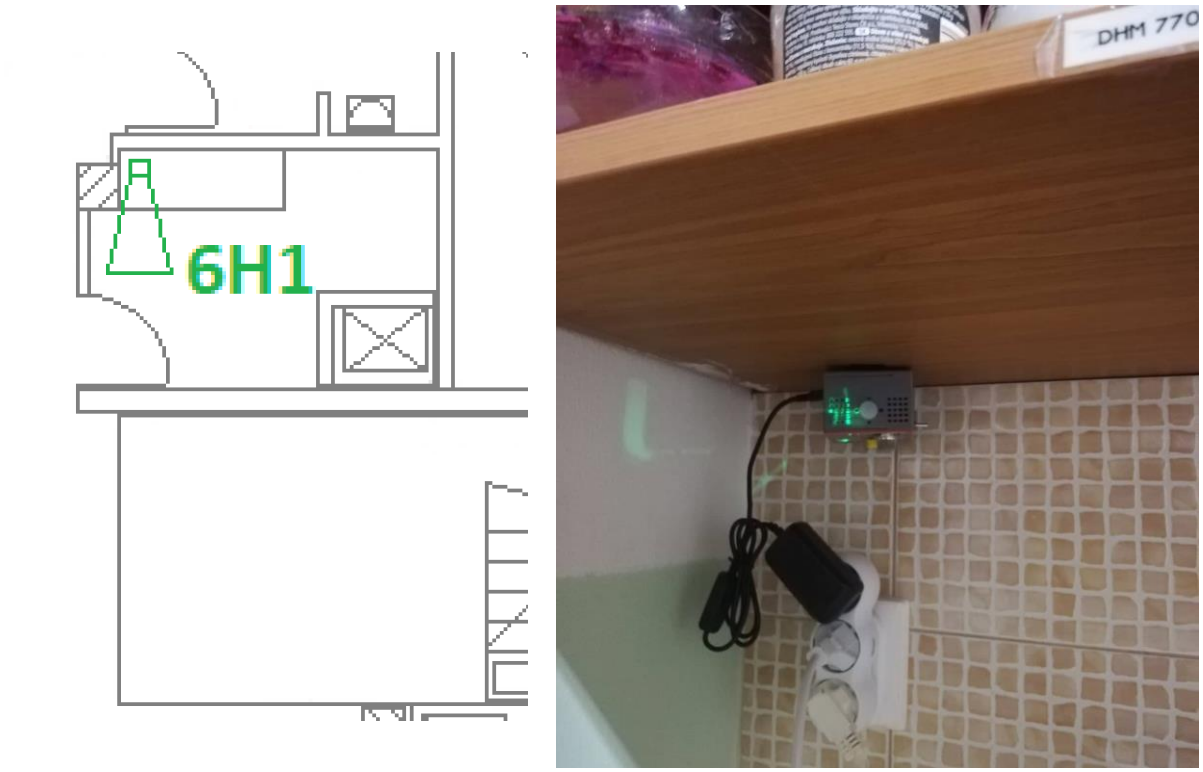


Figure 14. Deployment of the AP-NURSE AP6-H-001 (6H1) device

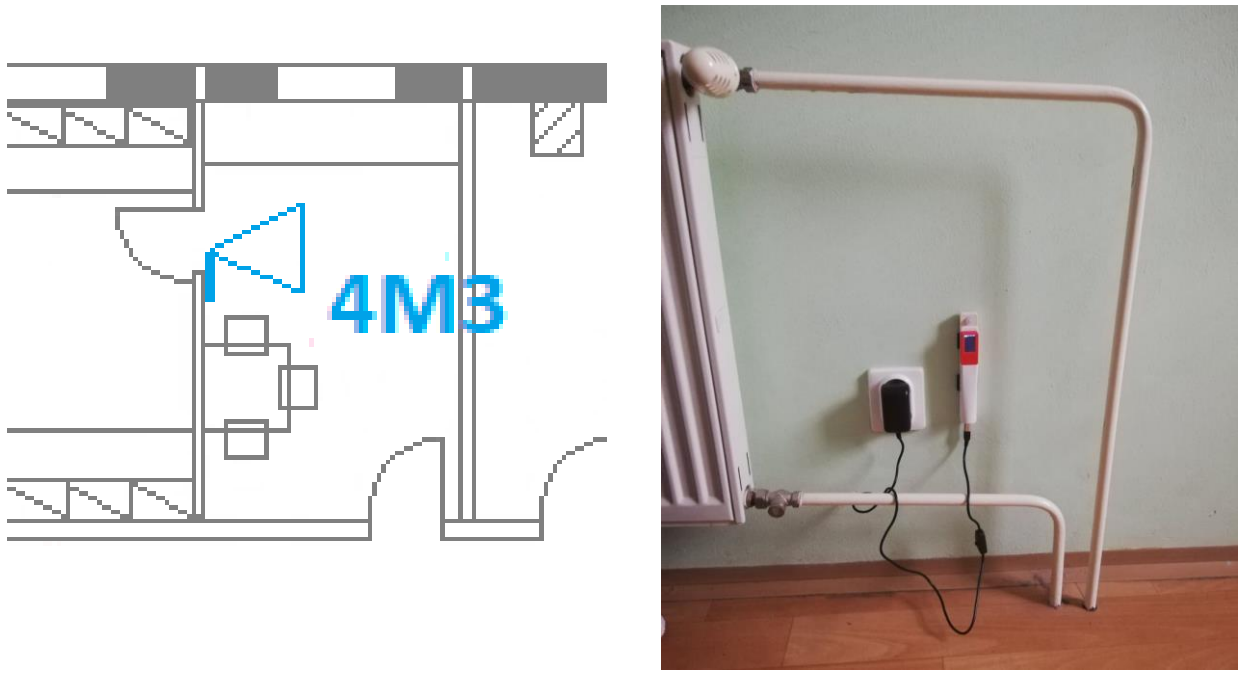


Figure 15. Deployment of the AP-NURSE AP4-M-003 (4M3) device

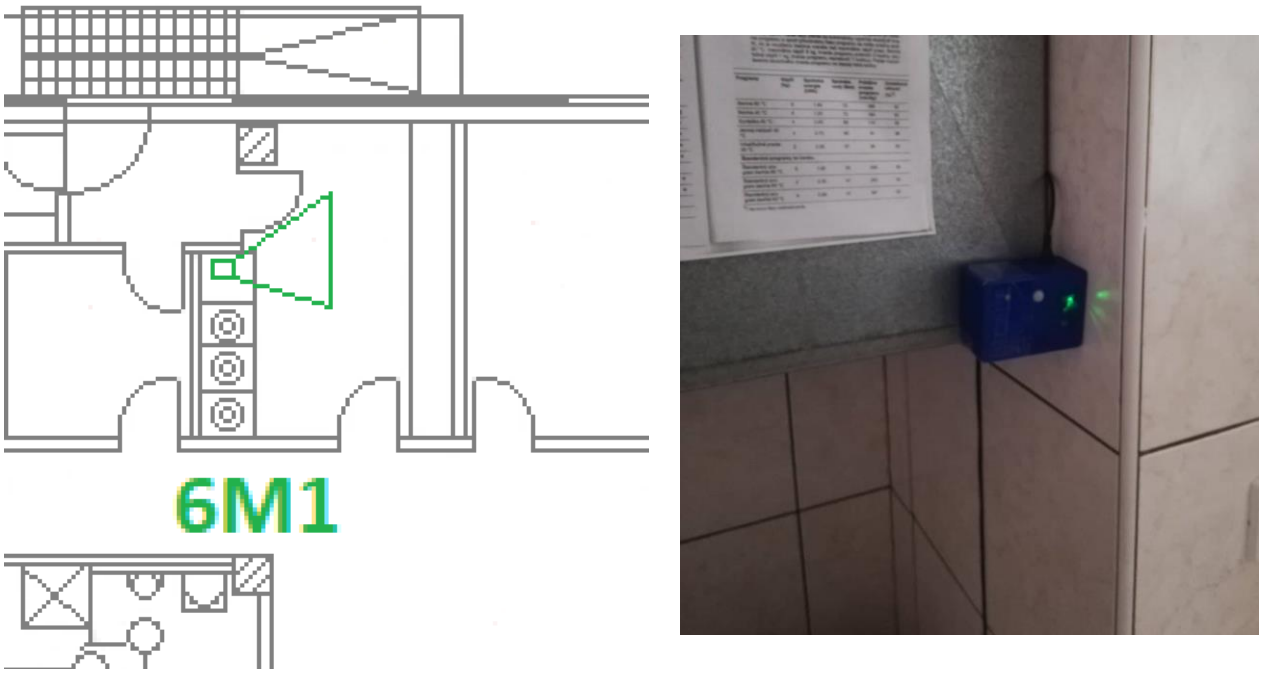


Figure 16. Deployment of the AP-NURSE AP6-M-001 (6M1) device

4. Installation and testing procedure

The installation and testing of the AP-NURSE devices was performed based on a specific procedure, consisting of the following steps:

1. Selection of the room for installation
2. Selection of the devices for the given room
3. Installation of devices
4. Testing of the functionality of the installed devices
5. Replacement or restart of malfunctioning device if necessary

4.1. Selection of rooms

Rooms for the installation of devices were picked by the personnel of SCC Petržalka. In the selection, the emphasis was on the behavior and health conditions of the patients. The selected rooms are presented in the figures in the previous section. Another important parameter influencing the selection of rooms is the strength of the WiFi signal. The WiFi signal must be appropriate for the devices to achieve a stable connection to the information system, which is used for data collection. If the WiFi coverage was insufficient, additional access points were installed or the rooms selected by the personnel were replaced.

4.2. Selection of devices

The selection procedure was influenced by the following facts:

1. Monitoring patterns related to the patients (movement, light etc.)
2. Possible location of the device in the room
3. Strength of the WiFi signal in the room

When the monitoring needs of the patient(s) are established, the initial – optimal – pick of the device(s) was made. This choice was changed when there was no suitable location for installation in the room and also if some parts of the room were not very well covered by WiFi signal.

4.3. Installation

Based on the above-mentioned procedure the selected final device(s) was/were installed in the rooms, common areas and restricted areas. In the patients´ rooms one or two devices were installed, the main devices under the patient's bed (AP1) and an auxiliary device (AP2) on the door to the toilet. The devices were physically attached to the bed structure using tapes, the pressure sensors were placed under the mattress and the PIR sensor was oriented to cover the bedside area. The AP2 devices were attached to the door or the wall next to the door, using two-sided tapes to not make construction intervention. The installation of the AP1 devices is illustrated in **Figure 17**.

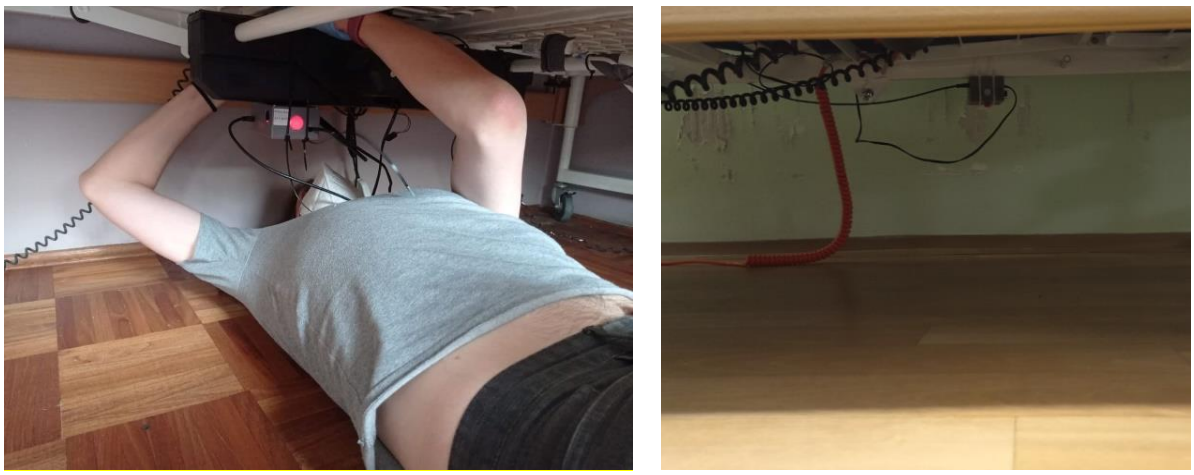


Figure 17. Installation of AP1 devices under the patient's bed

In the common areas and the restricted areas two types of devices were installed, AP4 to monitor potential movement and AP6 to monitor the kitchen and the washroom. In the corridors, the devices were installed in front of the staircase on the walls. In the kitchen, the AP6-H devices are attached to the kitchen unit, close to the electric kettle. In the cloakroom, the AP4-M unit is attached to the wall on the left side of the room and in the washroom, the AP6-M unit is mounted to the grounding of the wiring box. All AP4 and AP6 devices are supplied from the electric grid.

4.4. Testing of the functionality

After all devices were physically installed, they were registered in the Information System. All the devices were programmed to automatically connect to the information system. If the connection was not successful, a manual connection was carried out. Basic sensor functionality (without notifications and alerts) was tested on-site right after the installation. Every sensor in the room was tested before standard operation. If all sensor tests were passed, the devices were ready to use.

4.5. Replacing malfunctioning devices

If the outputs from the sensors in the information system were not corresponding to the test inputs (movement, sitting on the bed, etc.), the following corrective measures took place:

- Changing the position of the device in the room (if possible)
- Replacing the device to a new unit
- Changing type of the device
- Removing the device from the room

In some cases, due to various reasons, all sensor tests could not be reached. It means that the system was unable to monitor some changes in the environment, which, in the worst-case scenario, led to removing the device from the room. In the majority of the cases changing the position or type of the device was sufficient to improve the test results.

5. Data management of the AP-NURSE devices

The monitoring system is working through the internal Wi-Fi network of SCC Petržalka. The simplified scheme of the data management is shown in **Figure 18**. The monitoring devices of the AP-NURSE technology are connected to the internal network through the specific Wi-Fi SSID. The Wi-Fi routers are connected to the ethernet network and all measured data with the certified signature of the devices are sent to the bridge server. The security of the measured data is ensured by the ciphered communication with the servers of the information system. The bridge server handles all the communication within the measuring devices and transfers the data to the main servers of the information system with the necessary certification of the communication. The main server is an online server and is located at STU. It handles the obtained data and provides notifications to the caregivers logged in to this system through the PC placed at the caregiver´s desk. The server also stores data, which can be used for further data analysis.

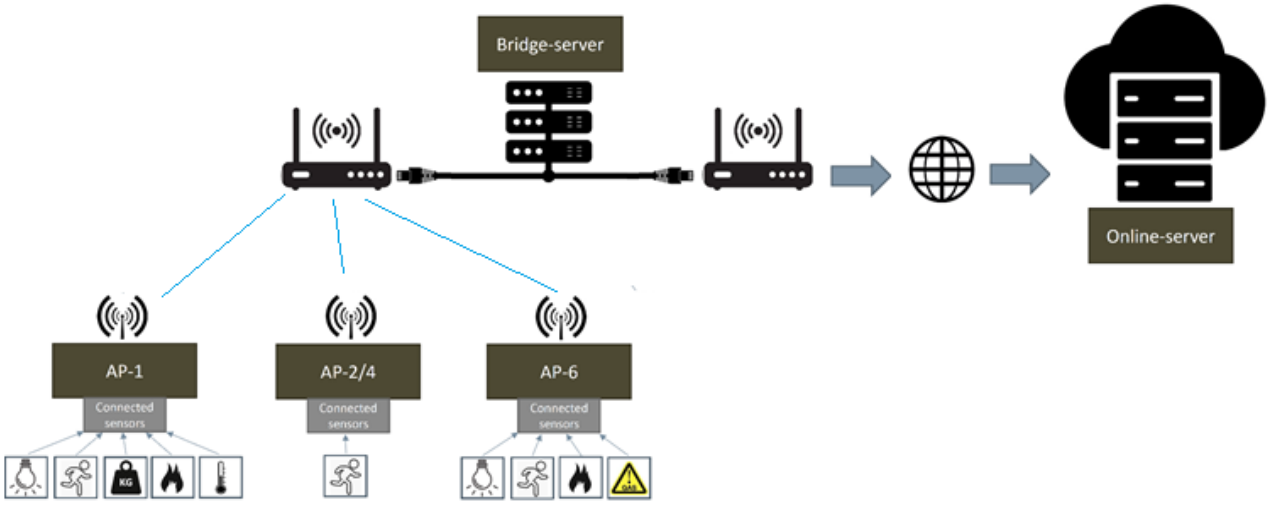


Figure 18. Schematics of the data management

5.1. Registration and connection of devices to the information system

After the physical installation of the AP-NURSE devices in dedicated rooms and corridors of SCC Petržalka, the devices are connected to the internal network through WiFi connection. If the SSID (Service Set Identifier) and the password are not set, the AP-NURSE devices create a local WiFi hotspot, where it is possible to connect and set up the correct SSID and password of the internal network for further communication. The setup of the network in the device can be accessed through the web browser through the following IP address: 192.168.4.1. After successful connection of the device to the internal network, it is necessary to add the device to the information system. The information system can be accessed through the URL: https://esim.fei.stuba.sk . After login to the information system, the device can be registered in the *Device tab* (*Zariadenia*) through the + *Add device* (*Pridat zariadenie*) button **Figure 19**.

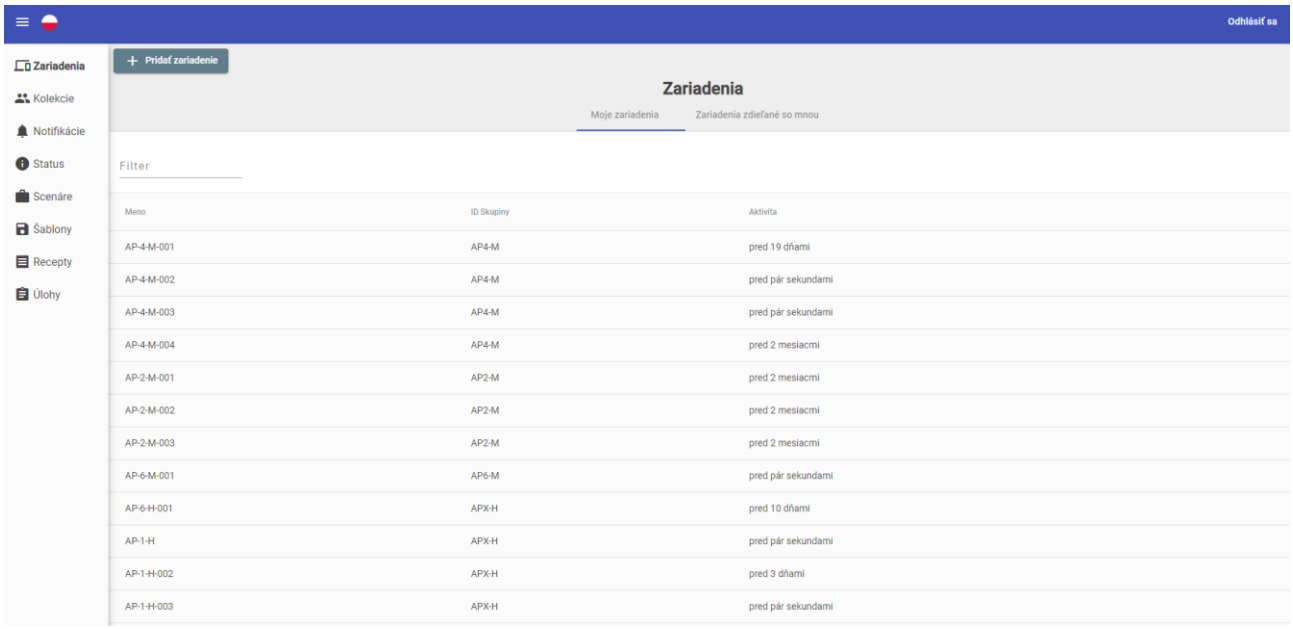


Figure 19. Add device function in the information system

Based on the unique *Registration key* (*Registračný kľúč*), the device can be added to the information system (**Figure 20**). This unique key is generated when the administrator of the information system is registering the device into the back-end of the server. After clicking next, the *Device* (*Zariadenie*) name can be entered in the information system together with the *collection* (*Kolekcia*), as shown in **Figure 21**. The collection field may be left in the *Default* option and this option can be changed later in the information system if necessary. The next option is the selection of the *Template* (*Šablóna*) for the device if the template was previously defined in the information system. Based on the type of the device, a proper template can be selected (**Figure 22**).This option can be also left in the *Default* setup and can be manually changed later. The last stage of the device registration is the summary tab, where it is possible to check all the input parameters of the device and the whole process is finished after clicking the *Confirmation* (Potvrdenie) button (**Figure 23**).

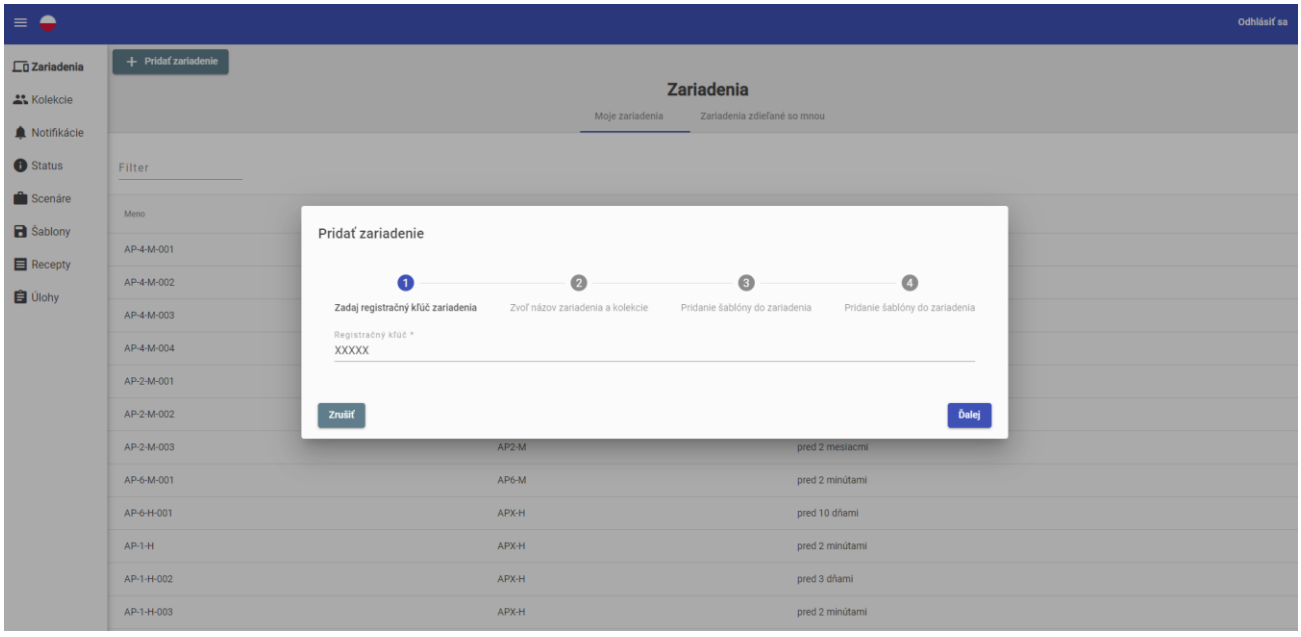


Figure 20. Entering of the device registration key in the information system

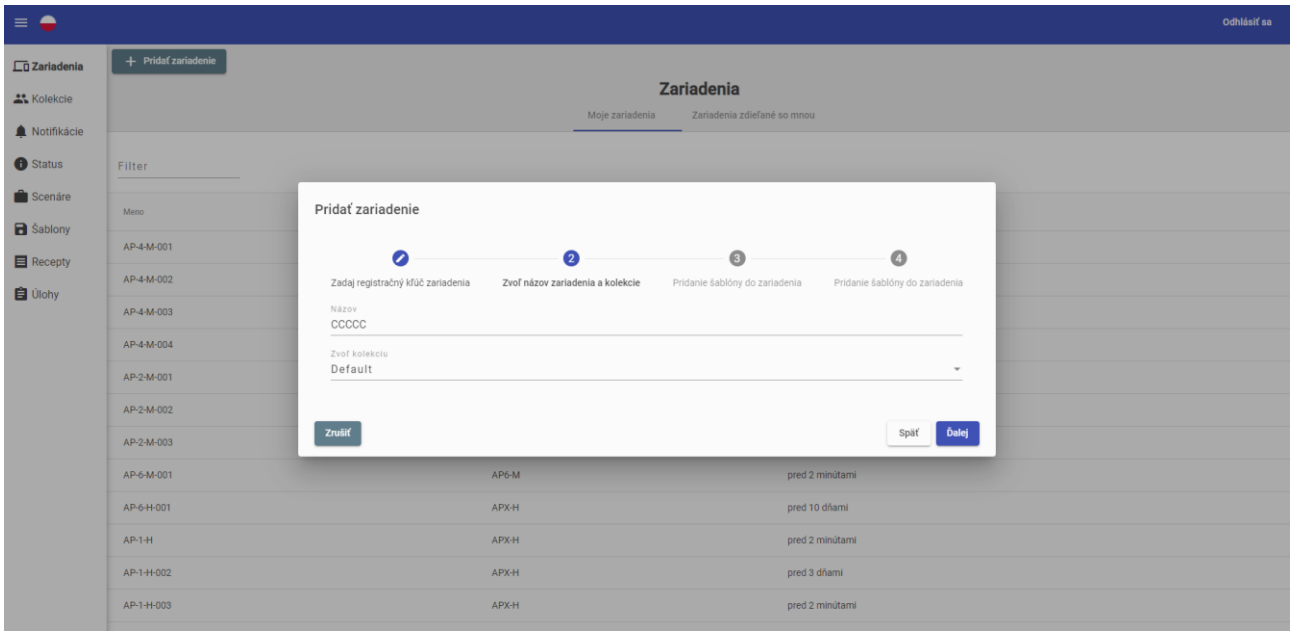


Figure 21. Selection of the device name and template in the information system

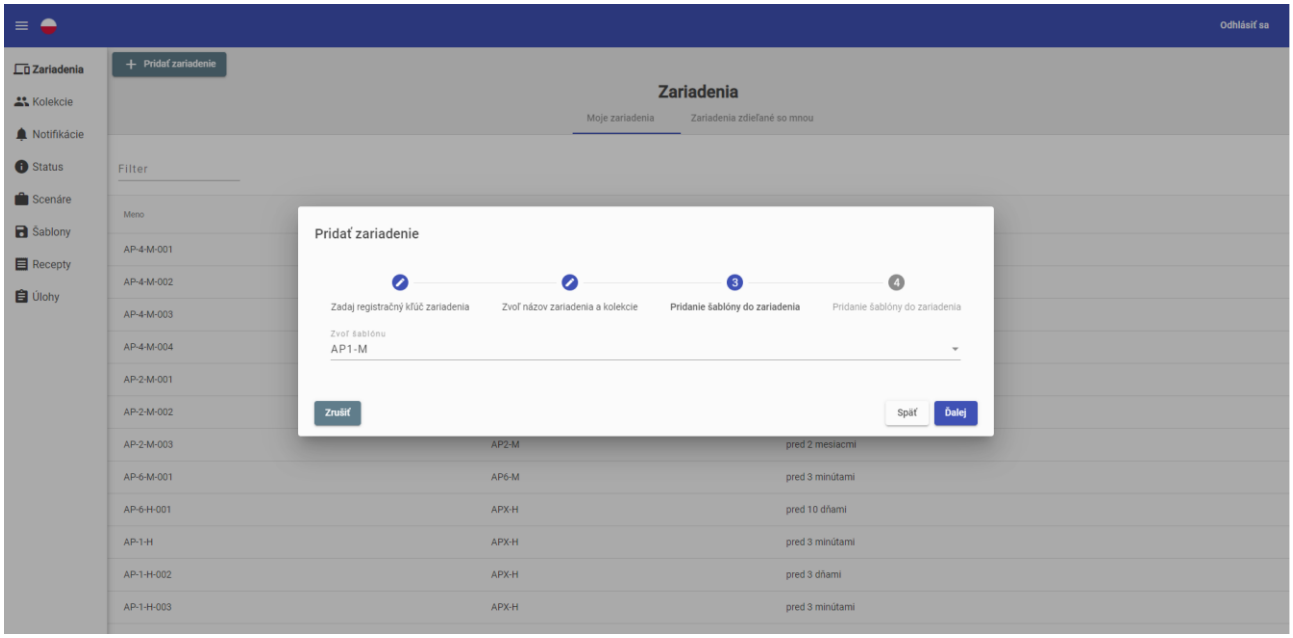


Figure 22. Template selection for newly registered device in the information system

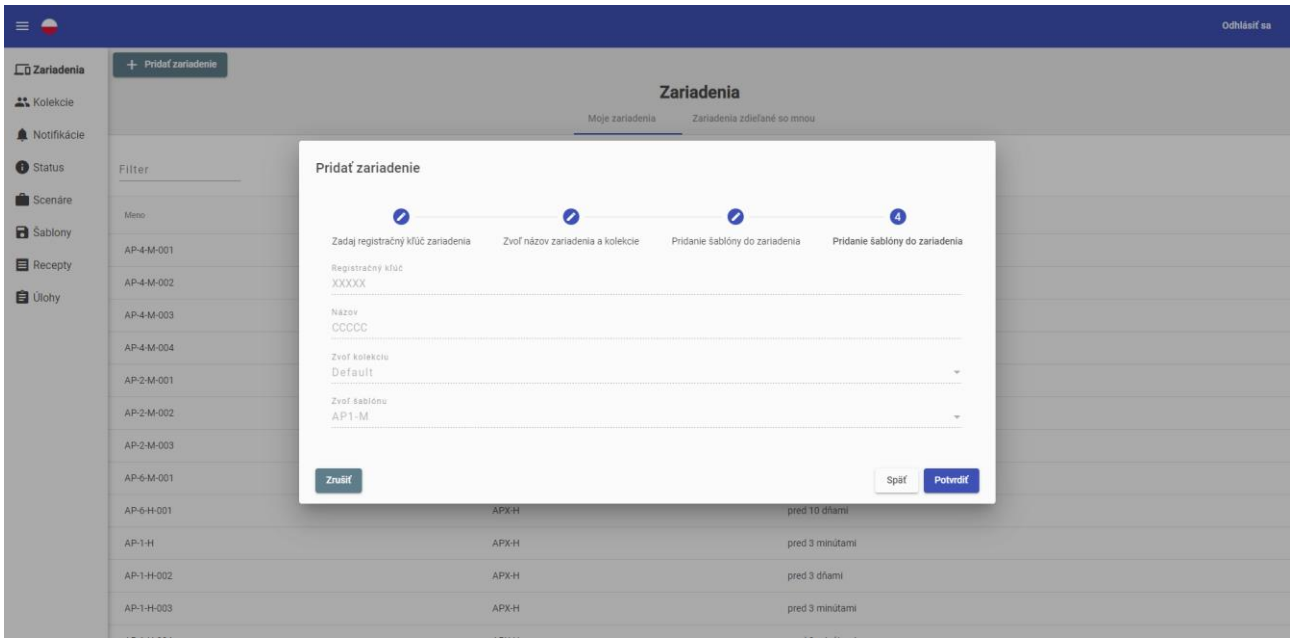


Figure 23. Device registration summary and confirmation in the information system

6. Conclusion

This deliverable summarizes the findings from the installation of AP-NURSE devices in the Social Care Centre Petržalka, as part of the Output O.T3.2 – Pilot testing of AP-NURSE – persons suffering from Parkinson's disease in Care Centre Bratislava. It covers the selection of devices for testing, deployment of devices, installation and testing procedure as well as the data management of devices. The devices were installed in the patients' rooms, on the corridors, kitchen, cloakroom and washroom at SCC Petržalka. In overall, 15 devices were installed, among which 11 are AP-NURSE Home and 4 are AP-NURSE Care M5stack. **Table 3** summarises the installed devices. This table also serves to update the status of devices during the testing. All installed devices were connected to the local WiFi network, which serves to deliver the data to the bridge server which subsequently provides the data for the main servers of the information system. The notifications from the connected devices are shown in the information system, which is accessible for the caregivers through their PC, tablet or mobile device. Two portable computers with monitors were installed in the Social Care Centre Petržalka (one on the first floor and one on the second floor) to support access of caregivers to the Information System and to notifications. For each device a specific monitoring scenario was set up. Examples of monitoring scenarios are shown in **Figure 24**. In these scenarios the time period during which monitoring is provided depends on the specific device. There are two types of events:

- Abnormal condition (orange alert)
    - Motion alert in the cloakroom
        - 10 PM – 5 AM
    - Motion alert in the washroom
        - 10 PM – 5 AM
    - Motion alert in the kitchen
        - 0:50 PM – 10 PM
    - Light alert in the room
        - 10 PM – 5 AM

- Motion alert in the room
  - 10 PM – 5 AM
- Critical condition (red alert)
  - Motion on the corridor
    - 10 PM – 5 AM
  - Motion alert in the room of an immobile patient
    - 10 PM – 5 AM
  - Stuck at the toilet
    - 10 PM – 5 AM

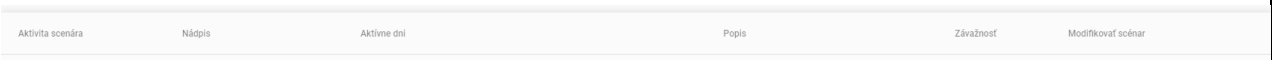
Since the information system requires user authentication, 3 user (riaditelka.ssspetrzalka@gmail.com, mlynarovicova.sestry@gmail.com, srenkelova.petrzalka@gmail.com) and one administrator accounts (nice.life.sss.petrzalka@gmail.com) were created for the caregivers of the Social Care Home. The user accounts have limited functions, while the administrator account allows operative changes in the system.

Staircase

Cloakroom

Laundry

Kitchen



Patient´s room

Patient´s room with toilet

Figure 24. Examples of monitoring scenarios

Table 3. Summary of installed devices

Device ID	Status 15/05/2021	Status 30/06/2021	Status 31/07/2021	Status 31/08/2021
AP1-H-001	OK	OK		
AP1-H-002	OK	NA		
AP1-H-003	OK	OK		
AP1-H-004	OK	OK		
AP1-H-005	OK	OK		
AP1-H-006	OK	OK		
AP1-H-007	OK	OK		
AP1-H-008	OK	OK		
AP2-H-001	OK	OK		
AP2-H-002	OK	OK		
AP4-M-001	OK	NA		
AP4-M-002	OK	OK		
AP4-M-003	OK	OK		
AP6-H-001	OK	NA		
AP6-M-001	OK	OK		
Operation rate	100%	80%		