Towards a digital platform for the collection, storage and processing of heating installation data

Master thesis - Autumn semester 2022-2023

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HES-SO Master MSE

8th, March 2023

Context

- Environmental measures to reduce global warming
- Buildings needs to reduce their climate footprint
- Buildings optimizations
  - Choice of isolation material
  - Heating management

Context

- Heating installations must fully work all the time
- Caretakers and technicians perform periodic check-up
- Issue detected : technicians will resolve it as quick as possible
- Technicians cannot be everywhere at the same time

Problematic

How to monitor and perform remote maintenance on heating stations in order to optimize heating installations ?

Thesis objectives

- Build an IoT infrastructure to retrieve heating installation data
- Develop a high-level application targeting the technicians for remote monitoring capabilities and technical operations reporting capabilities
- Develop a high-level application targeting SG-Energies supervisors by generating performance reports

Contents

Introduction

State of the art

SG-Energies ecosystem

Technician application

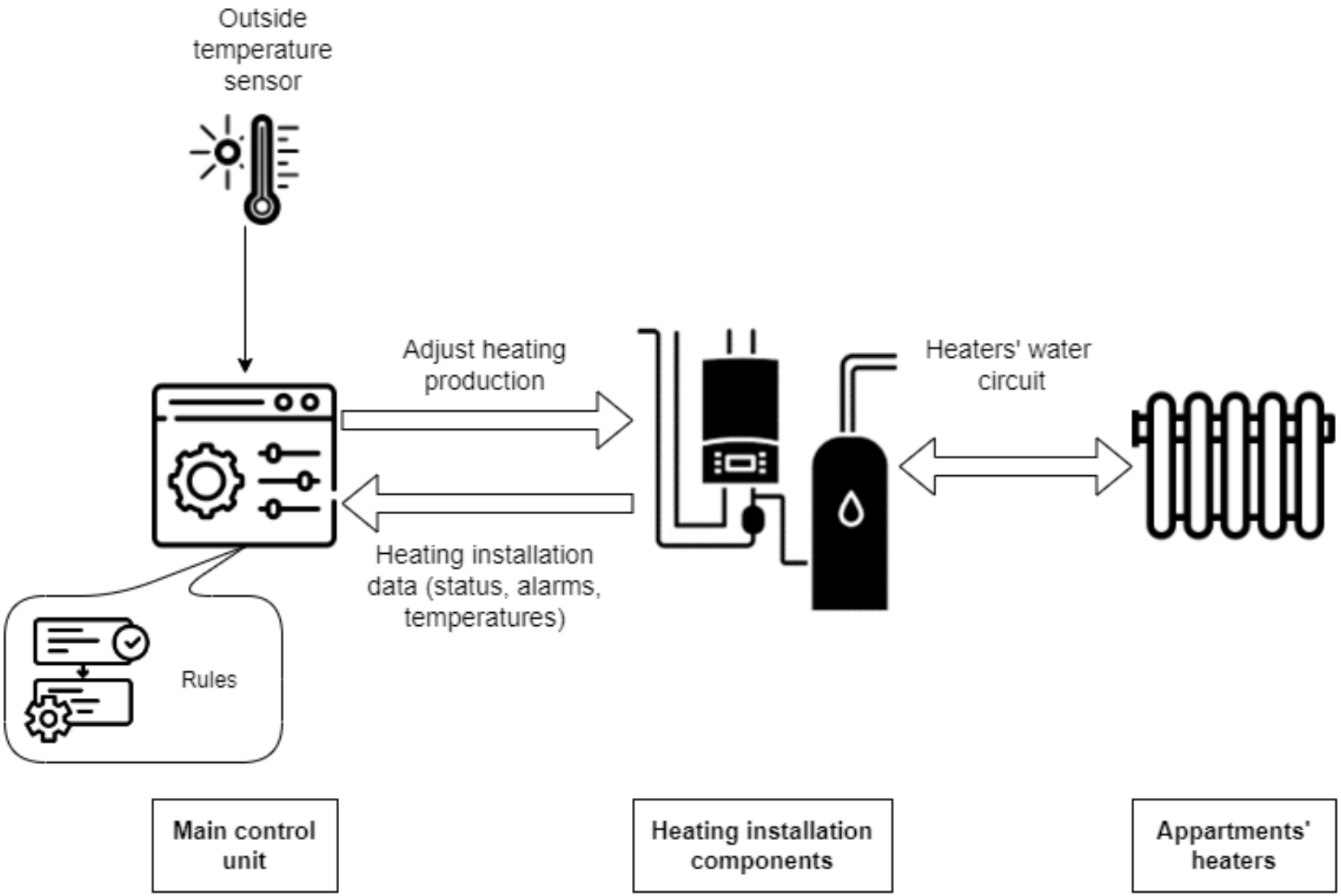
Reporting application

Conclusion

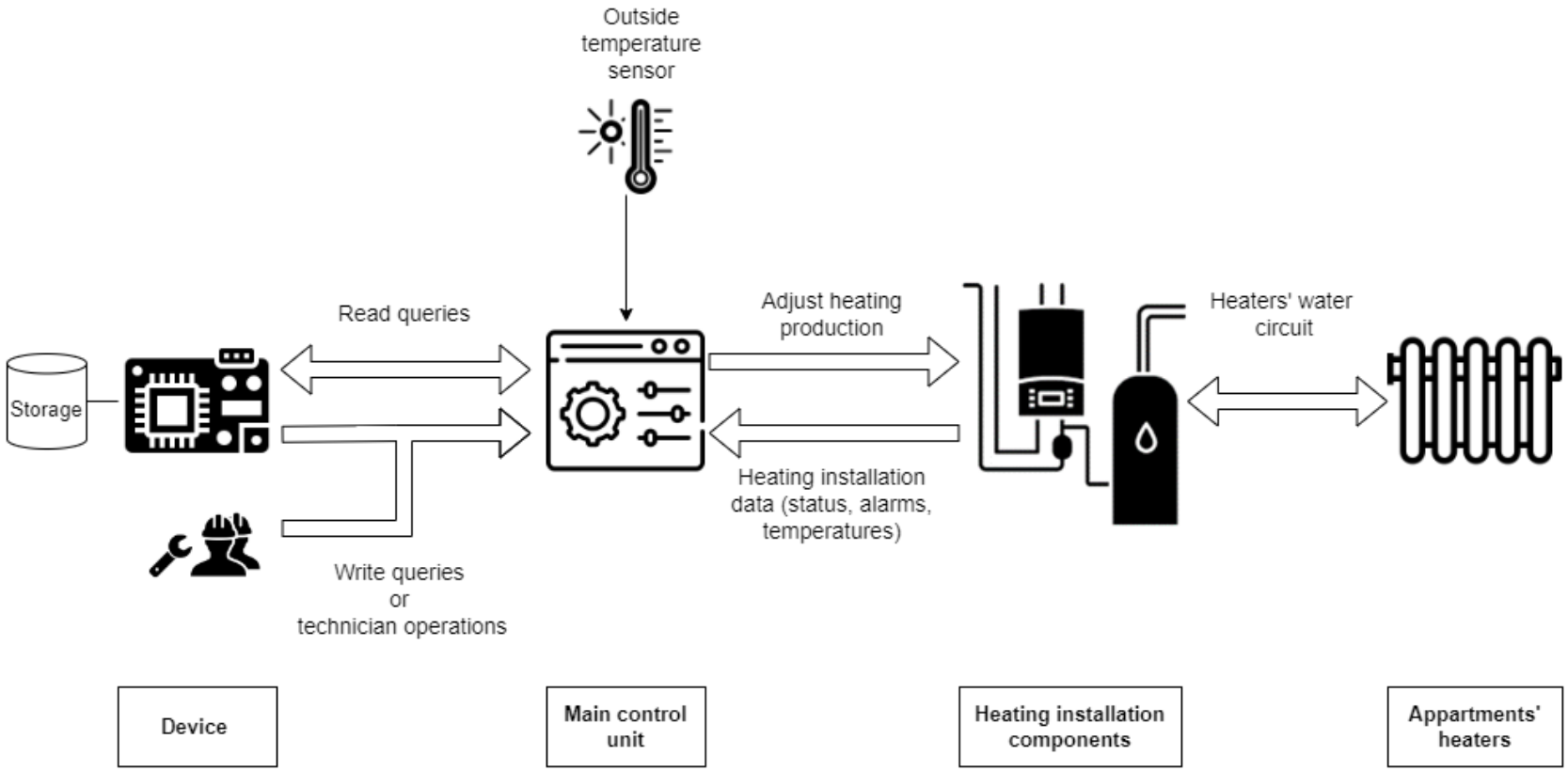
State of the art

Evaluate three market solutions based on five criteria

Heating installation without data retrieval



Heating installation with data retrieval



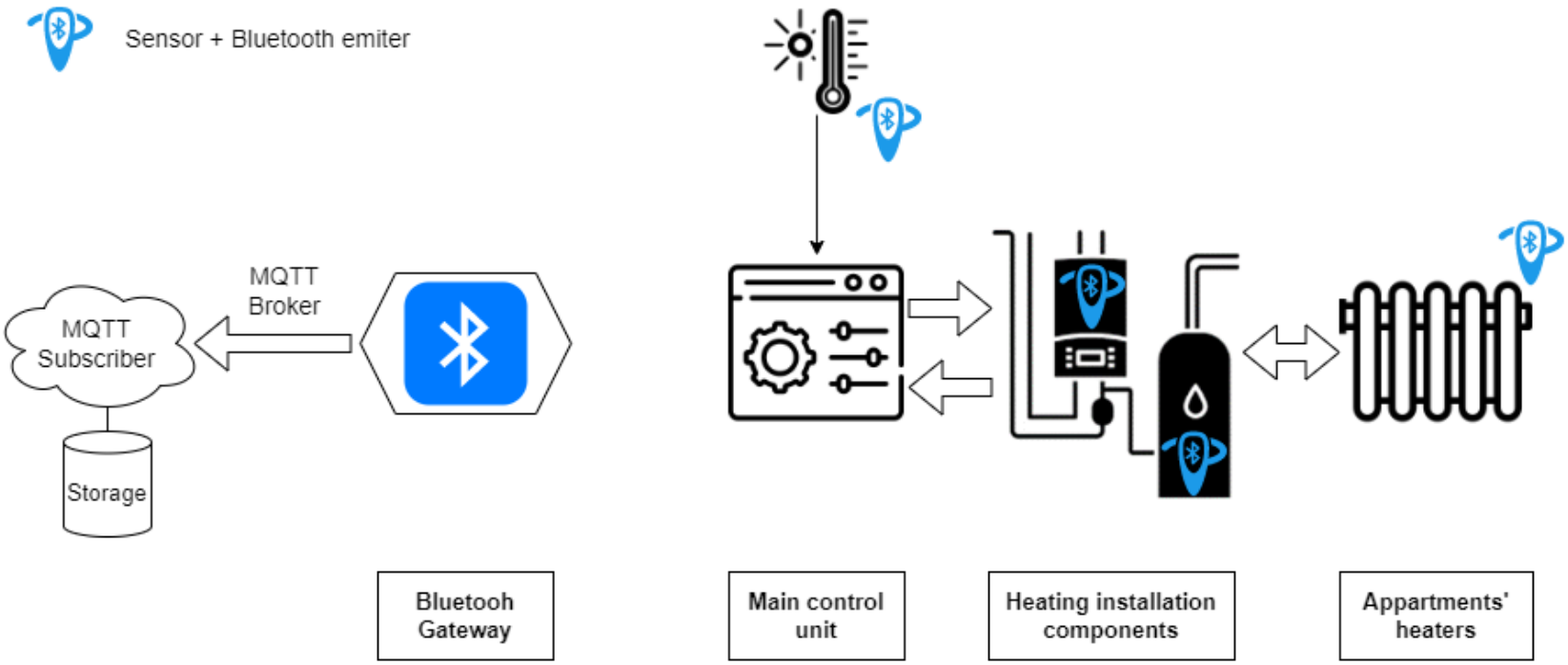
Comparison criteria

- Remote monitoring
- Remote maintenance
- Local storage
- Multiple heating room device supported
- Prediction

Elainnovation - Bluetooth gateway and sensors

- French company
- Beacons and sensors for identification, measurements and localization
- For heating installations : Bluetooth temperature probes and Bluetooth gateway

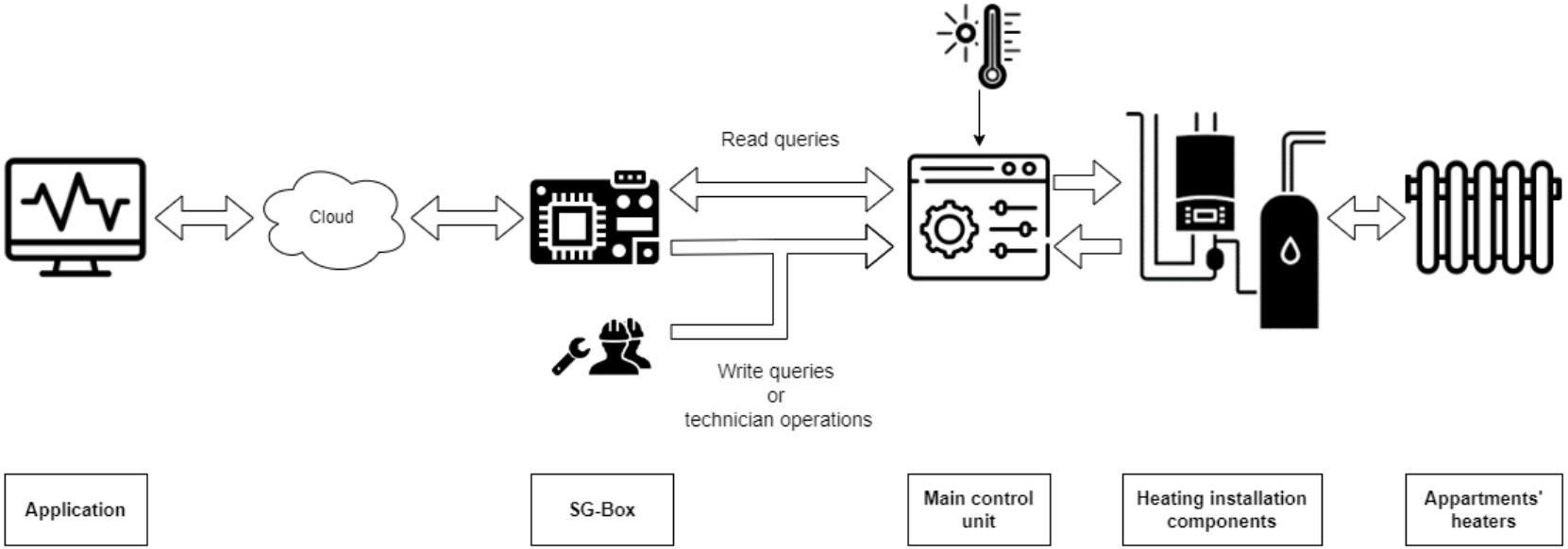
Elainnovation - Bluetooth gateway and sensors



SG-Energies - SG-Box

- Swiss heating management company
- Manage heating installations around Geneva
- Technician oriented : remote monitoring and maintenance
- Retrieve heating data from the main control unit

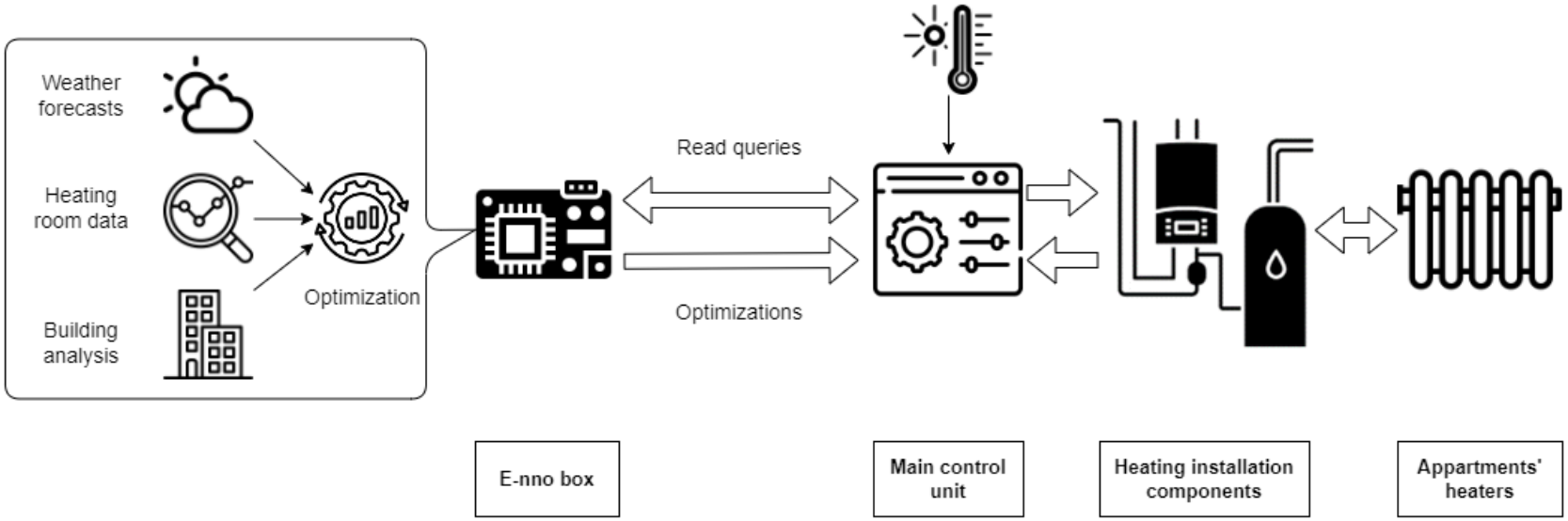
SG-Energies - SG-Box



E-nno - E-nno box

- Swiss heating optimization company
- Deploy machine learning and algorithms for building heating optimizations
- Building manager oriented
- Retrieve heating data from the main control unit

E-nno - E-nno box



Comparison

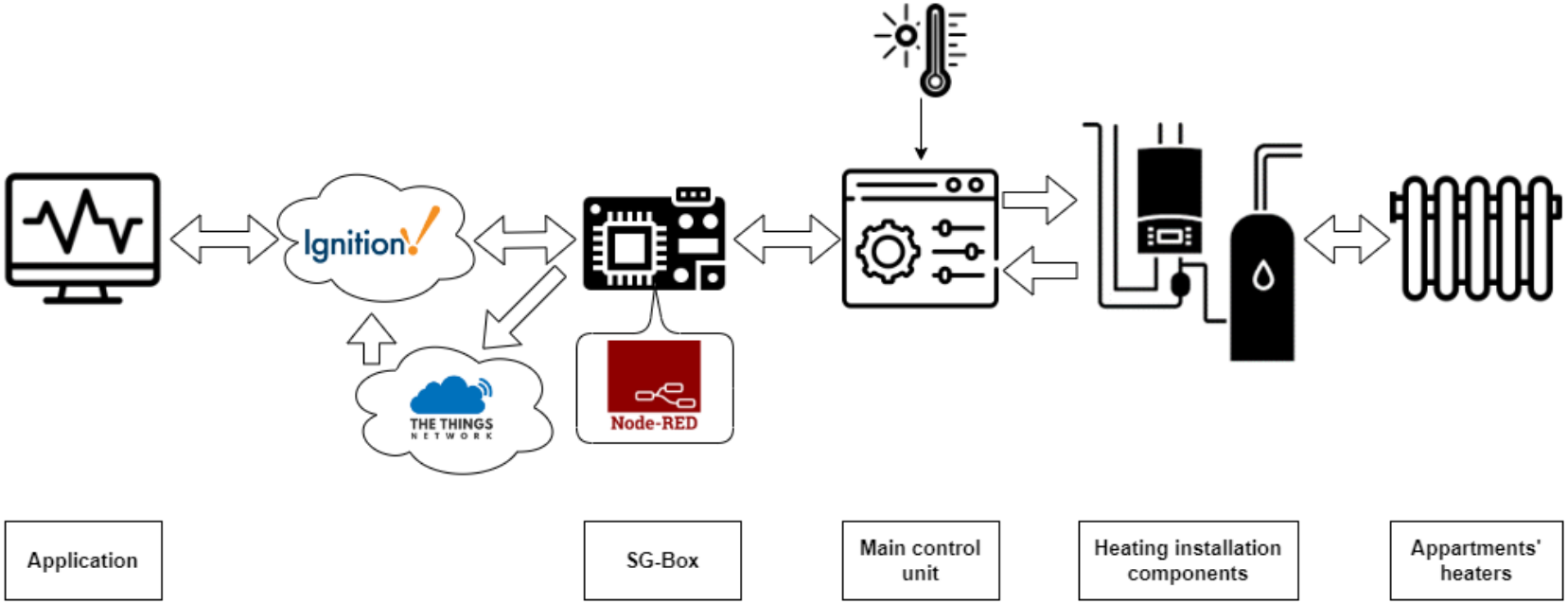
	Remote monitoring	Remote maintenance	Local Storage	Multiple device	Prediction
Elainnovation BLE Gateway	Yes	No	No	Yes	No
SG-Energies SG-Box	Yes	Yes (Planned)	No	Yes	No
E-nno E-nno box	Yes	Yes	Yes	Yes	Yes

SG-Energies ecosystem

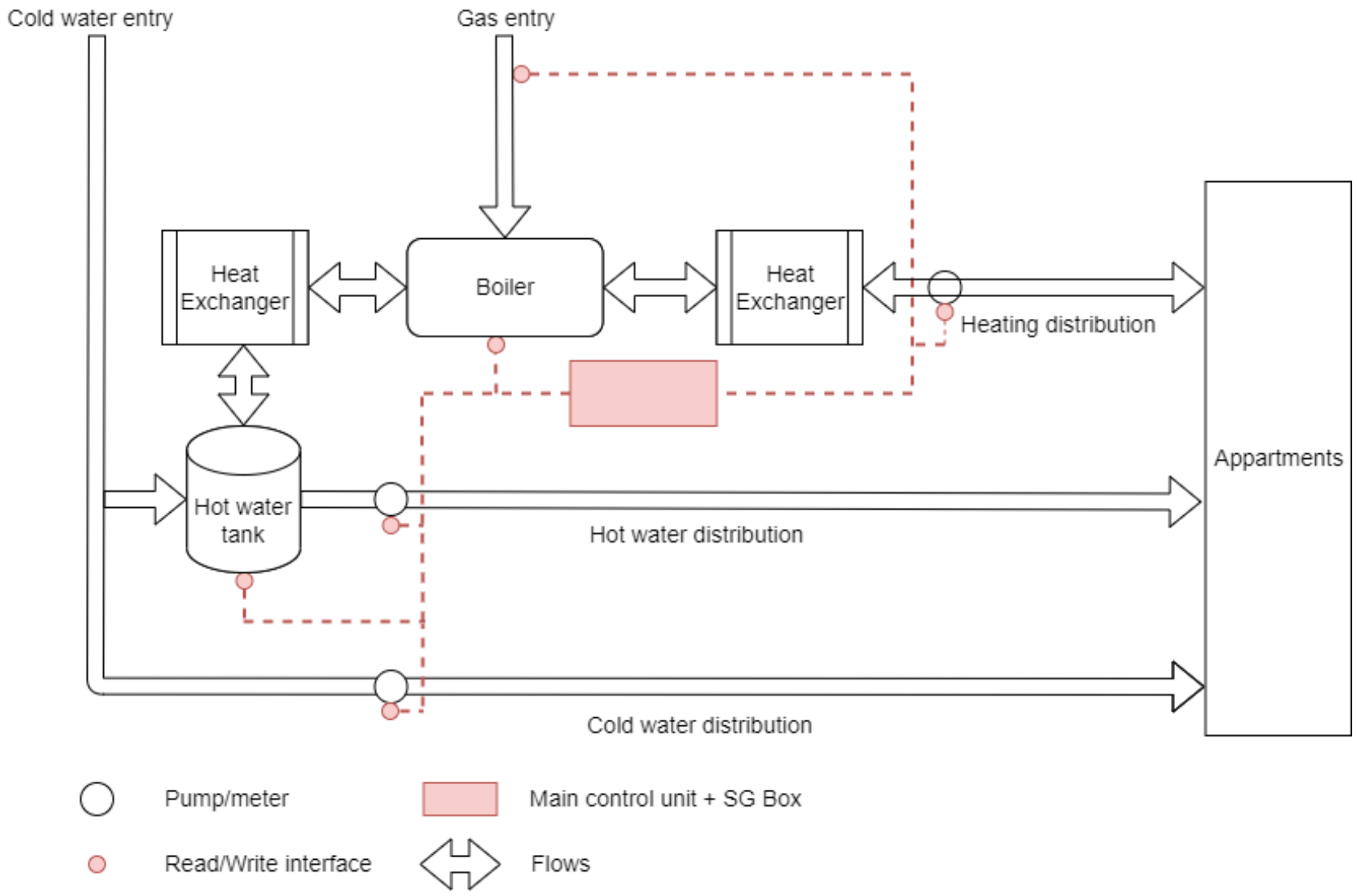
SG-Energies project

- SG-Energies : STEP project
- Reduce the frequency and duration of breakdowns
- Limit the unnecessary on-site visit of technicians
- Add a device to the heating station : SG-Box

Workflow


Ignition
THE THINGS NETWORK
Node-RED
Application
SG-Box
Main control unit
Heating installation components
Appartments' heaters

Workflow

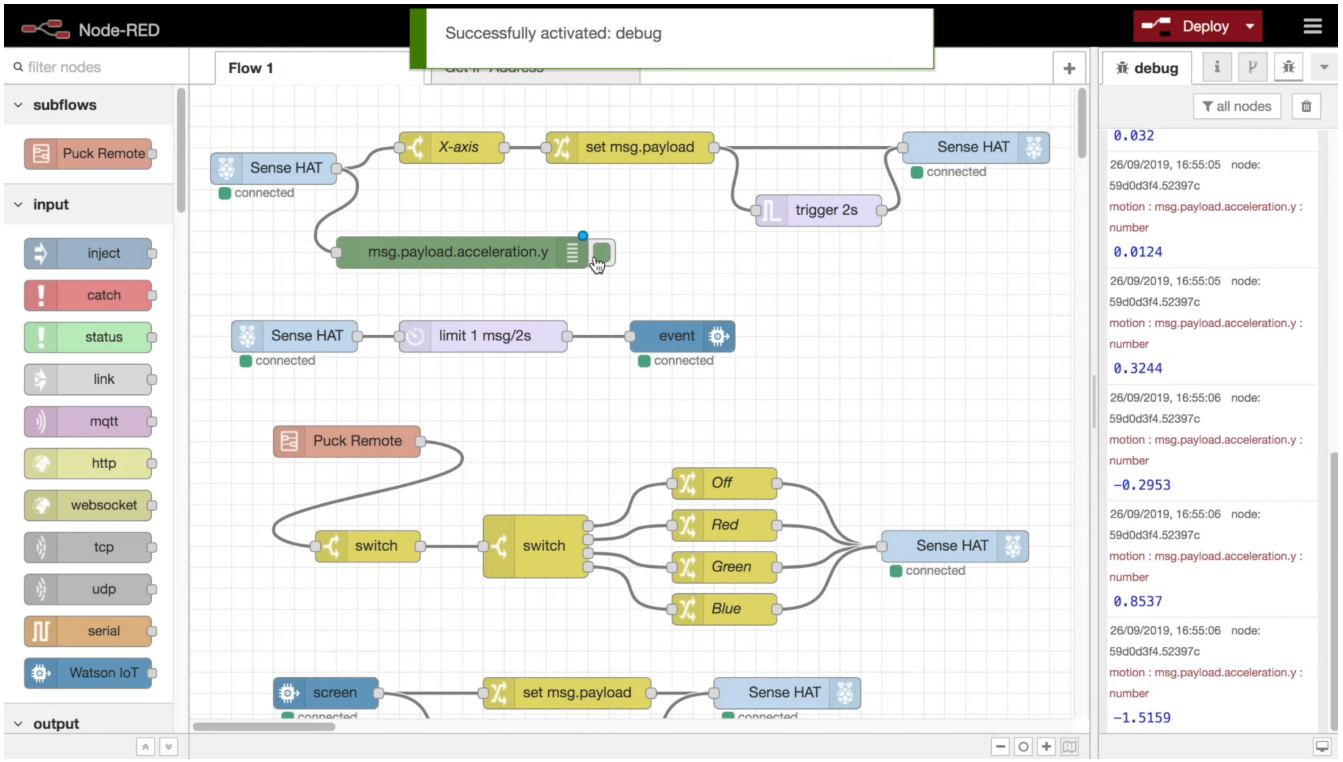

Cold water entry
Gas entry
Heat Exchanger
Boiler
Heat Exchanger
Heating distribution
Appartments
Hot water tank
Hot water distribution
Cold water distribution
Pump/meter
Main control unit + SG Box
Read/Write interface
Flows

Edge Device : SG-Box

- Based on Raspberry Compute Module 4
- Core component of the system
- Query the main control unit

Node-RED

- Flow-based development tool

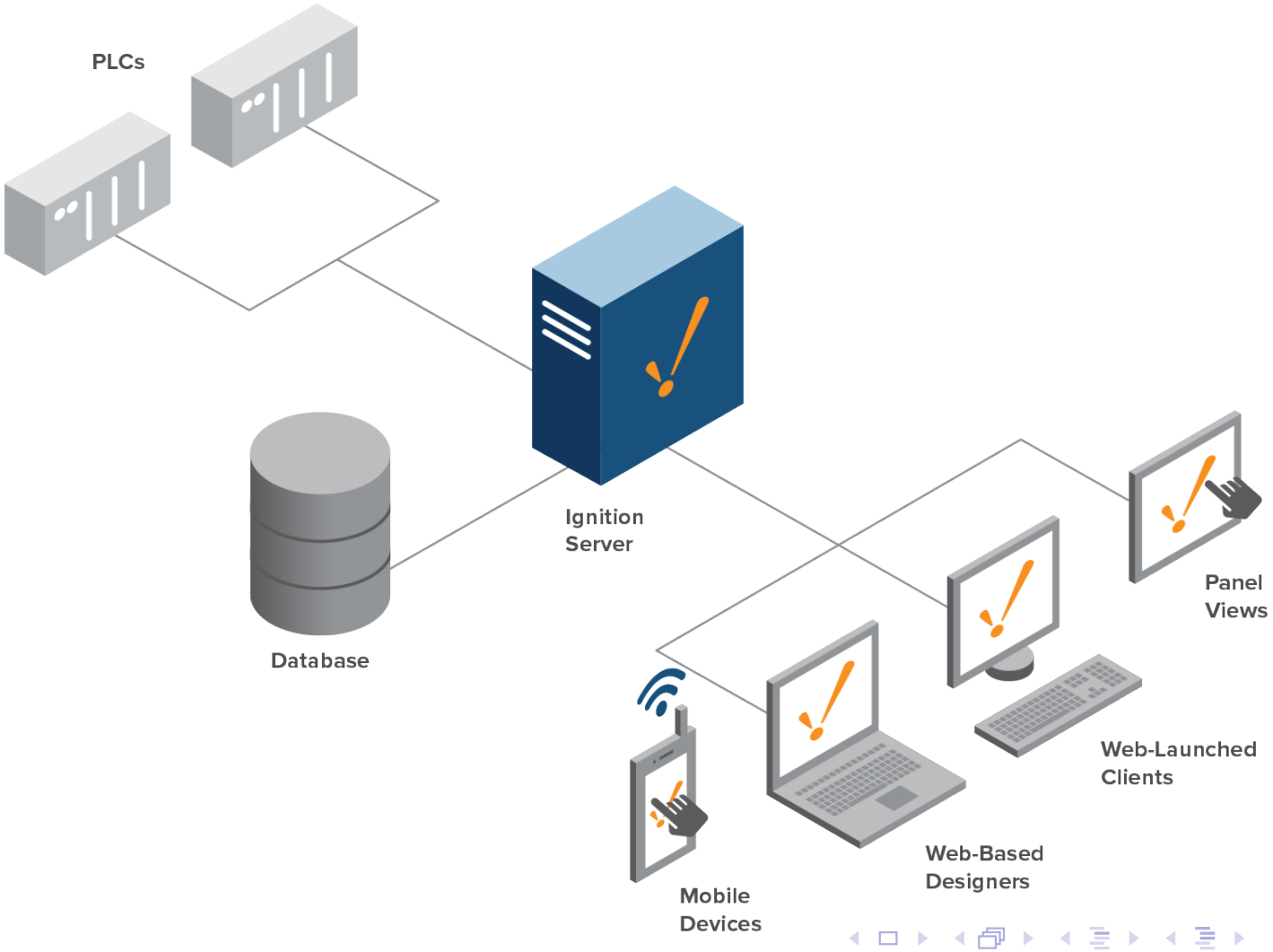


Node-RED

- Flow-based development tool
- Deployed on SG-Box
- Responsible to query main control units
- Send retrieved data to Ignition Server

Ignition

- Supervisory control and data acquisition software



Ignition

- Supervisory control and data acquisition software
- Store the SG-Box data
- Tools to develop interface to visualize data

ModBUS vs BACnet

Criterion	ModBUS	BACnet
Year of creation	1979	1995
Countinuous maintenance	No	Yes
Area of use	Programmable logic controllers of any type	Building automation and control systems
Typing	Boolean or Integer 16 bits	Many types available
Data availability	Value only	Value + many optional fields
Command priorization	No	Yes

Deployments

- ModBUS
  1. Vernier : Viessmann
  2. Chancy (Bellegarde road) : Froeling
- BACnet
  1. Geneva (Yvoy Boulevard) : Sauter

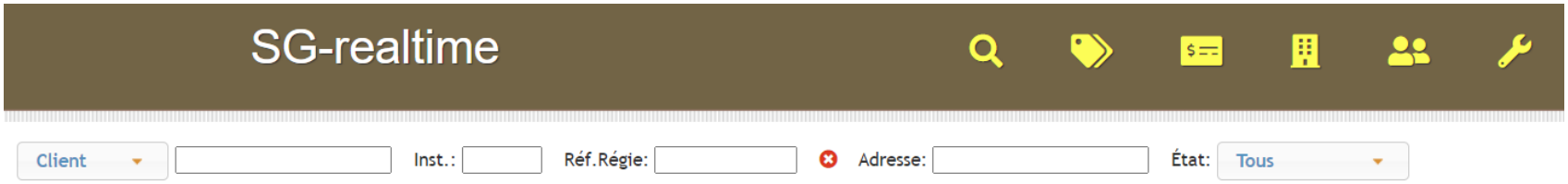
Technician application

Main requirements

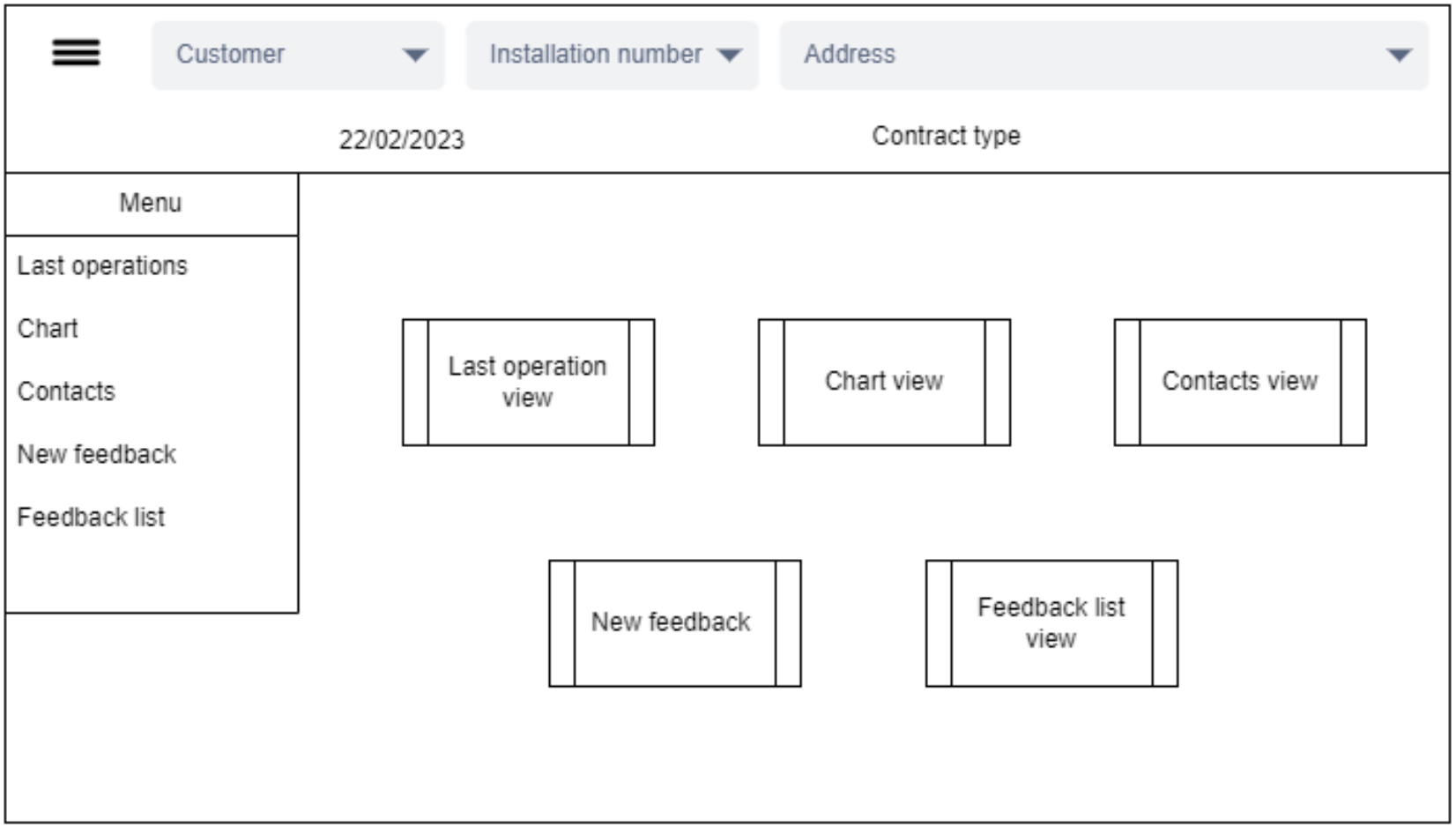
- Search
- Installation history and information
- Data visualization
- Intervention reports ("Feedback") creation and management

Design

- Same user experience from the "Realtime" application



Design


Customer
Installation number
Address
22/02/2023
Contract type
Menu
Last operations
Chart
Contacts
New feedback
Feedback list
Last operation view
Chart view
Contacts view
New feedback
Feedback list view

Technician application demonstration

Reporting application

Main requirements

- Base for creating multiple types of reports
- Create a report from a template : VeriSol
- Export the report as a PDF

Reporting application demonstration

Users tests

- Positive feedbacks
- Each view tested in real-life situation
- Feeling of time saving and better work quality

Conclusion

- Entire workflow is operational
- Technicians can use the app on all installations
- Non-closed application to allow the addition of new modules or templates

Future perspectives

- Expand protocol compatibility
- New templates for reports
- Centralize more processes in the same application

Auto-Evaluation

- Development of all the workflow
- Concrete project

- Improve quality of documentation along the project
- Keep enhancing my English writing level