

RIOT: Flood Gate Management System

May 2025

Introduction and Goals

This project aims to develop a system capable of monitoring the state of flood gates in the Hamburg Harbor, which are safety-critical infrastructure, and to partially digitalize the current analog workflow.

Requirements Overview

MVP Requirements

Nr.	Requirement	Description
MR01	Signal gate open/closed	The system shall be able to signal whether a gate is currently open or closed.
MR02	Request gate open/close to GateMate	The system shall allow the pilot to request a gate to open or close.
MR03	Visualize gate state	The system shall provide visual indication of the current gate state.
MR04	Manual state switch	The SenseMate shall be able to manually override the gate state when necessary.
MR05	Secure Communication	All communication regarding gate state shall be secured and encrypted.
MR06	State information exchange between Sense- and GateMate	The system shall facilitate state information exchange between SenseMate and GateMate.

Nr.	Requirement	Description
MR07	Periodic Server Update about the state of the gate	The Sense- and GateMate shall send periodic updates to the server about gate state.
MR08	Track state of a gate	The Server shall maintain a history of the current gate state and state changes.
MR09	Display gate information on SenseMate	The SenseMate component shall display relevant gate information to the workers.
MR10	Request gate open/close to SenseMate	The system shall allow the pilot to assign a SenseMate to open/close specific gates.

Table 1: Requirements for MVP

Optional Requirements

Nr.	Requirement	Description
OR01	Location Tracking of Sense- and GateMates	The system should be able to track and display the current location of the Sense- and GateMate.
OR02	Smart assignment	The system shall provide a smart assignment functionality for efficient closing workflow.
OR03	Battery State	The system shall be able to track and display the current battery state of the SenseMate.
OR04	Cycle-Change	The system should be able to adjust the update frequency from MR07.
OR05	Device Management	The system should be able to register/unregister devices dynamically.
OR06	Waterproof case for the GateMates	

Table 2: Optional Requirements

Quality Goals

Goal	Description	Metric	Value
Performance	The system must transmit gate status updates and operational commands with minimal latency to ensure timely response during flood events.	Transmission Time	$\geq 500ms$
Reliability	The system must accurately communicate flood gate statuses with high precision to prevent false alarms or missed critical states.	Error Rate	$\leq 0.1\%$
Scalability	The system should support automatic integration of new devices without requiring significant reconfiguration of the existing infrastructure.	Integration Time	$\leq 1hour$
Fault Tolerance	The system must detect malfunctioning components and provide alternative communication pathways when primary channels fail.	Recovery Time	$\leq 5minutes$
Availability	The system must maintain operational capability during emergency situations, including power outages and severe weather conditions.	Uptime	$\geq 99.99\%$
Efficiency	The system should minimize power consumption to extend battery life during work hours.	Battery life for SenseMate	$\geq 12hours$
Usability	The system interface must be intuitive enough for operators to use the dashboard and report gate state during different weather situations.	-	-

Table 3: Quality Goals for Flood Gate Management System

Stakeholders

Role/Name	Expectations
Pilot	The Pilot is one of the main stakeholders with the following expectations: <ul style="list-style-type: none">• Wants to know whether a gate has been closed or not• Wants to be able to monitor the current state of the gate• Wants to give instructions to close or open a gate
Worker	The Worker is another key stakeholder with the following expectations: <ul style="list-style-type: none">• Wants to know whether they have actually closed the gate• Wants an easy-to-use gadget• Wants to be able to manually transfer the status of a gate
Rescuemate	Wants a solution for monitoring floodgates in the harbor

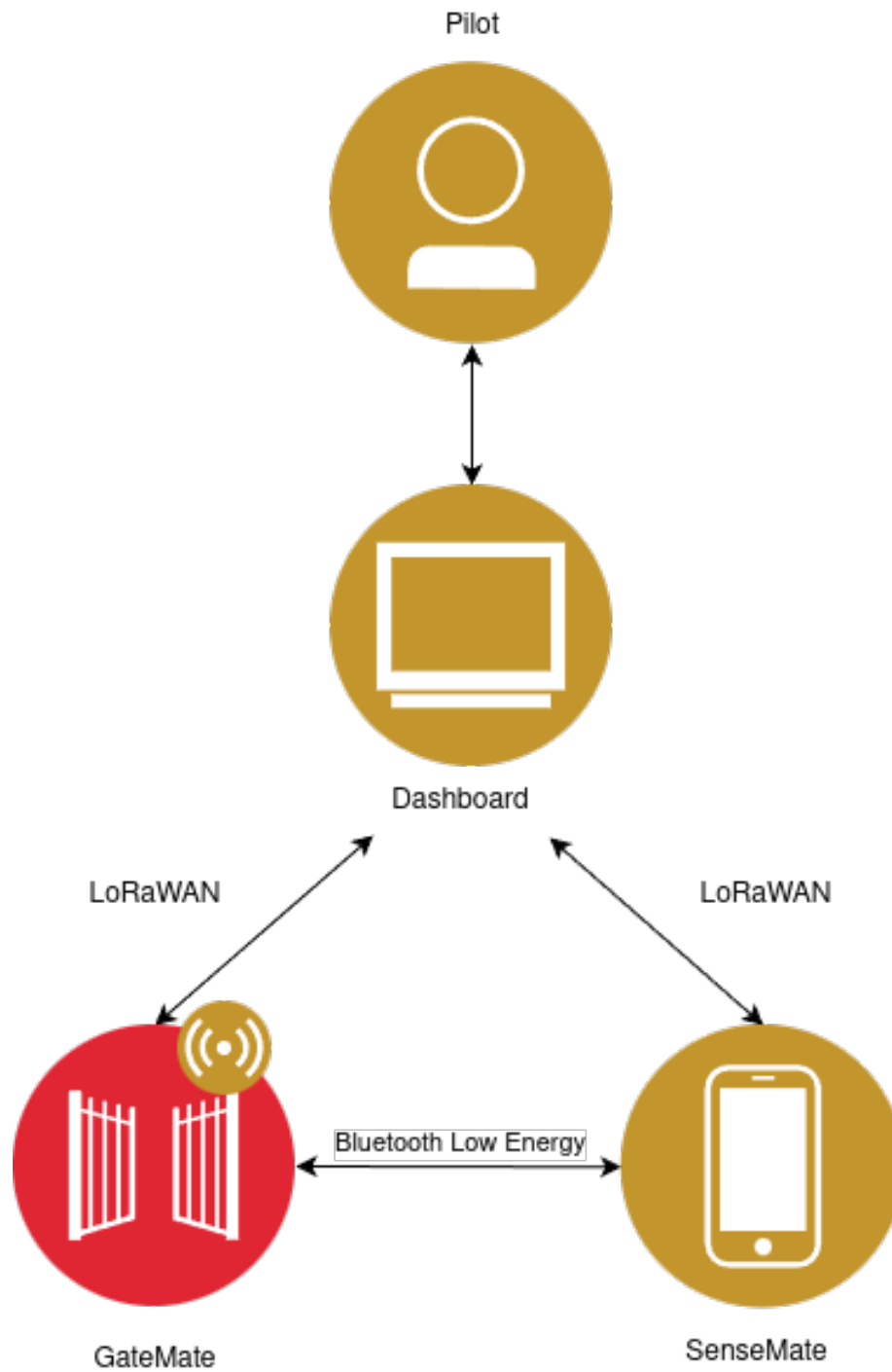
Table 4: Stakeholders

Architecture Constraints

Constraint	Description
feather-nrf52840 board	Microcontroller for the Sense- and GateMates.
LoRaWAN Communication	The communication between the Nodes and the Server shall be over LoRaWAN protocol.
BLE	The communication between the Nodes shall be over BLE.
RIOT	The software of the Nodes shall be based on RIOT OS.

Table 5: Constraints

Context and Scope



Business Context

Technical Context

Solution Strategy

Building Block View

Whitebox Overall System

<Overview Diagram>

Motivation *<text explanation>*

Contained Building Blocks *<Description of contained building block (black boxes)>*

Important Interfaces *<Description of important interfaces>*

<Name black box 1>

<Purpose/Responsibility>

<Interface(s)>

<(Optional) Quality/Performance Characteristics>

<(Optional) Directory/File Location>

<(Optional) Fulfilled Requirements>

<(optional) Open Issues/Problems/Risks>

<Name black box 2>

<black box template>

<Name black box n>

<black box template>

<Name interface 1>

...

<Name interface m>

Level 2

White Box *<building block 1>*

<white box template>

White Box <*building block 2*>

<*white box template*>

...

White Box <*building block m*>

<*white box template*>

Level 3

White Box <__building block x.1__>

<*white box template*>

White Box <__building block x.2__>

<*white box template*>

White Box <__building block y.1__>

<*white box template*>

Runtime View

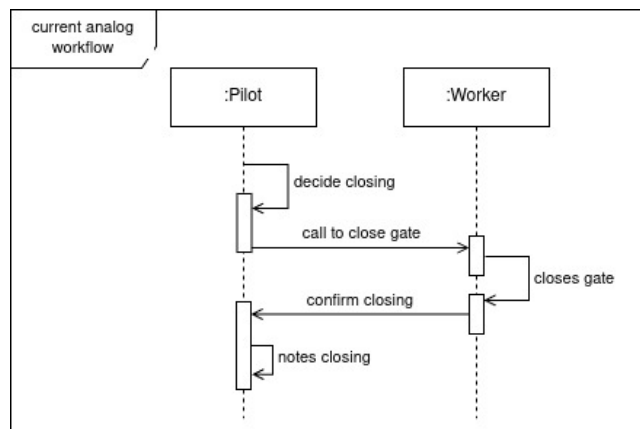


Figure 2: sequence diagram of the current workflows

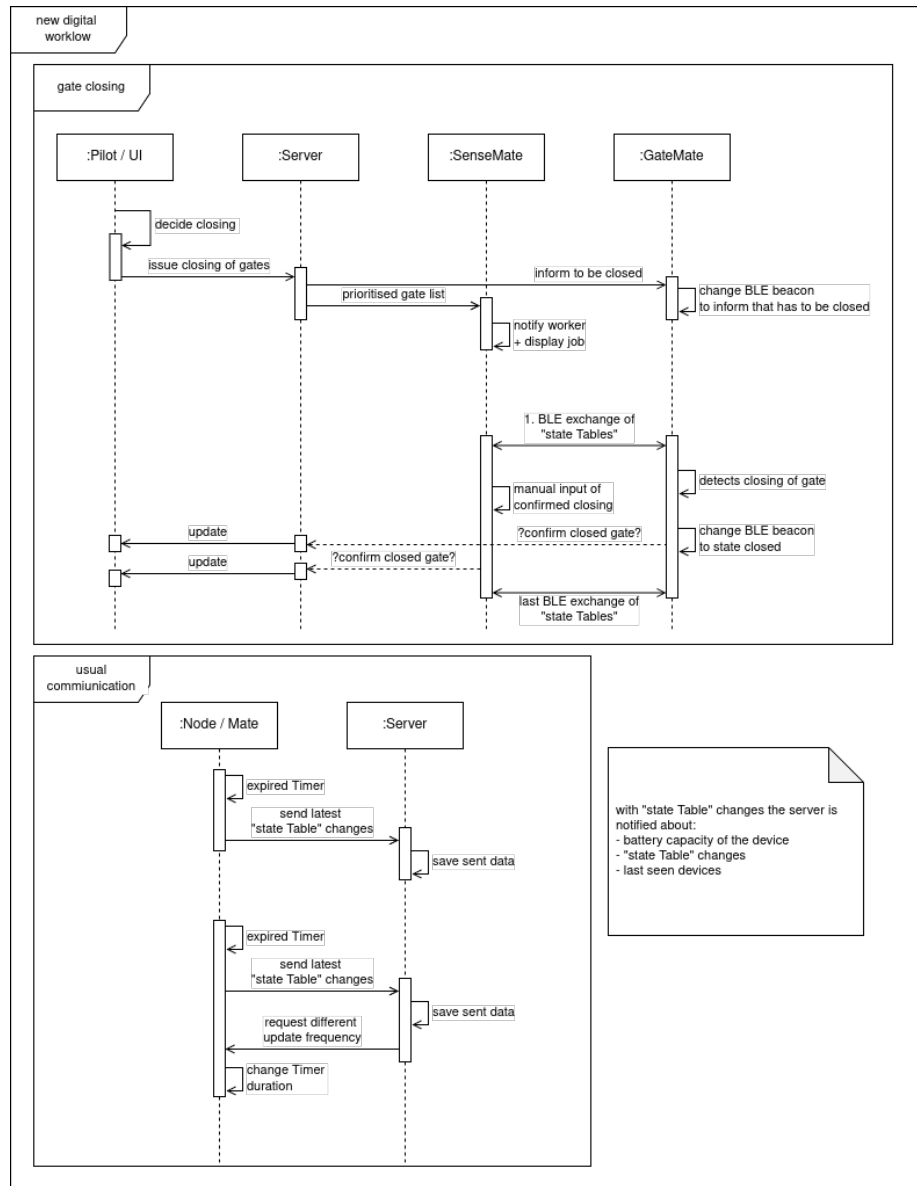


Figure 3: sequence diagram of the new workflows

<Runtime Scenario 1>

- <insert runtime diagram or textual description of the scenario>
- <insert description of the notable aspects of the interactions between the building block instances depicted in this diagram.>

<Runtime Scenario 2>

...

<Runtime Scenario n>

Deployment View

Infrastructure Level 1

<*Overview Diagram*>

Motivation <*explanation in text form*>

Quality and/or Performance Features <*explanation in text form*>

Mapping of Building Blocks to Infrastructure <*description of the mapping*>

Infrastructure Level 2

<*Infrastructure Element 1*>

<*diagram + explanation*>

<*Infrastructure Element 2*>

<*diagram + explanation*>

...

<*Infrastructure Element n*>

<*diagram + explanation*>

Cross-cutting Concepts

<*Concept 1*>

<*explanation*>

<*Concept 2*>

<*explanation*>

...

<*Concept n*>

<*explanation*>

Architecture Decisions

Quality Requirements

Quality Tree

Quality Scenarios

Risks and Technical Debts

Glossary

Term	Definition
SenseMate	Device carried by the workers.
GateMate	Device that is attached to the flood gates and is responsible for reporting the gate state.
Node	Could be SenseMate or GateMate.