|  |  |  |
| --- | --- | --- |
|  |  |  |
|  | |  |  | | --- | --- | | |  | | --- | | **ESCUELA POLITÉCNICA SUPERIOR DE MONDRAGON UNIBERTSITATEA**  *MONDRAGON UNIBERTSITATEKO GOI ESKOLA POLITEKNIKOA*  MONDRAGON UNIVERSITY FACULTY OF ENGINEERING | | |  |
|  | **Trabajo presentado para la obtención del título de**  *Titulua eskuratzeko lana*  Final degree project for taking the degree of |  |
|  | **GRADO EN INGENIERÍA EN INFORMÁTICA** *INFORMATIKAKO INGENIARITZA GRADUA* DEGREE IN COMPUTER ENGINEERING |  |
|  |  |  |
|  | |  | | --- | | **Título del Trabajo** *Lanaren izenburua* Project Topic | | RUNTIME VERIFICATION FOR SPATIO-TEMPORAL PROPERTIES (WITH AGGREGATED OPERATORS) | |  |
|  |  |  |
|  |  |  |
|  | |  |  | | --- | --- | | **Autor** *Egilea* Author   **Curso** *Ikasturtea* Year | OIHANA GARCIA ANACABE   2021/2022 | | |

|  |
| --- |
| **Título del Trabajo** *Lanaren izenburua* Project Topic |
| **RUNTIME VERIFICATION FOR SPATIO-TEMPORAL PROPERTIES (WITH AGGREGATED OPERATORS)** |

**Nombre y apellidos del autor**   
*Egilearen izen-abizenak*   
Author's name and surnames   
GARCIA ANACABE, OIHANA   
  
**Nombre y apellidos del/los director/es del trabajo**   
*Zuzendariaren/zuzendarien izen-abizenak*   
Project director's name and surnames   
EZIO BARTOCCI   
ILLARRAMENDI, MIREN   
  
**Lugar donde se realiza el trabajo**   
*Lana egin deneko lekua*   
Company where the project is being developed   
TU WIEN   
  
**Curso académico**   
*Ikasturtea*   
Academic year   
2021/2022

**El autor/la autora del Trabajo Fin de Grado, autoriza a la Escuela Politécnica Superior de Mondragon Unibertsitatea, con carácter gratuito y con fines exclusivamente de investigación y docencia, los derechos de reproducción y comunicación pública de este documento siempre que: se cite el autor/la autora original, el uso que se haga de la obra no sea comercial y no se cree una obra derivada a partir del original.**

*Gradu Bukaerako Lanaren egileak, baimena ematen dio Mondragon Unibertsitateko Goi Eskola Politeknikoari Gradu Bukaerako Lanari jendeaurrean zabalkundea emateko eta erreproduzitzeko; soilik ikerketan eta hezkuntzan erabiltzeko eta doakoa izateko baldintzarekin. Baimendutako erabilera honetan, egilea nor den azaldu beharko da beti, eragotzita egongo da erabilera komertziala baita lan originaletatik lan berriak eratortzea ere.*

Abstract

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Laburpena

(Laburpen amaieran ipini dokumentuaren amaierarantz informazio gehiago dagoela euskaraz \*Erreferentzia bat sartu atal horretara)

Resumen

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Table of contents

[1. Introduction 4](#_Toc97049736)

[1.1. Objectives 4](#_Toc97049737)

[1.2. Project phases 5](#_Toc97049738)

[2. State of the art 5](#_Toc97049739)

[3. Product specifications and requirements 5](#_Toc97049740)

[3.1. Description of the service 5](#_Toc97049741)

[3.2. Resources and materials 5](#_Toc97049742)

[3.2.1. Hardware 5](#_Toc97049743)

[3.2.2. Software 5](#_Toc97049744)

[3.3. Tests and trials 5](#_Toc97049745)

[3.4. Conditions for the implementation of the project 5](#_Toc97049746)

[3.5. Legal aspects 5](#_Toc97049747)

[4. Objectives 5](#_Toc97049748)

[5. Use cases 5](#_Toc97049749)

[5.1. Office use case 5](#_Toc97049750)

[5.2. Wiener linien use case 5](#_Toc97049751)

[6. Development (subject to change) 6](#_Toc97049752)

[6.1. Middleware 6](#_Toc97049753)

[6.2. Design pattern 6](#_Toc97049754)

[6.3. Thingy 6](#_Toc97049755)

[7. Conclusions and future lines 6](#_Toc97049756)

[7.1. Conclusions 6](#_Toc97049757)

[7.2. Future lines 6](#_Toc97049758)

[8. Personal evaluation of the experience(?) and the project 6](#_Toc97049759)

[9. Sarrera, ondorioak eta etorkizuneko ildoak 8](#_Toc97049760)

[9.1. Sarrera 8](#_Toc97049761)

[9.2. Ondorioak 8](#_Toc97049762)

[9.3. Etorkizuneko ildoak 8](#_Toc97049763)

[10. Appendix A STREL 9](#_Toc97049764)

[11. Appendix B MQTT 10](#_Toc97049765)

[12. Appendix C REST 11](#_Toc97049766)

[13. Appendix D CoAP 12](#_Toc97049767)

[14. Appendix E Gantt chart 13](#_Toc97049768)

[15. Bibliography 14](#_Toc97049769)

# Introduction

This is a bachelor thesis about the monitoring of spatio-temporal properties over IoT networks. Lan honen nondik norakoak adierazi (…)

#### Internet of Things

IoT (…)

#### Cyber Physical Systems

In our lives, we are surrounded by CPSs and SoCPSs due to an increasing number of intelligent systems that involve safety, life and business-critical requirements in domains such as transportation, healthcare or home equipment.

“Cyber-Physical Systems are engineering, physical and biological systems whose

operations are integrated, monitored, and/or controlled by a computational

core. Components are networked at every scale. Computing is deeply embedded

into every physical component, possibly even into materials. The computational

core is an embedded system, usually demands real-time response, and is most

often distributed. The behavior of a cyber-physical system is a fully-integrated

hybridisation of computational (logical) and physical action."

(Helen Gill, US National Science Foundation)

Diagrama

Descripción generada automáticamente

Figure 1‑A Cyber-Physical Systems

#### Runtime Verification

Monitoring information related to the internal status of the CPSs at runtime can anticipate the occurrence of failures. This makes it possible to take corrective actions earlier and prevent faulty scenarios.

## Objectives

Dfsdf

## Project phases

#### Spatio-temporal properties

STREL…

# State of the art

# Product specifications and requirements

The scope of the work is monitoring spatio-temporal properties using logic-based specification languages. The goal of the student work is to evaluate existing technologies for Runtime Verification of Spatio-Temporal properties over smart cities such as SaSTL. Further, to identify best practices and implement a demonstration methodology based on one of the use-cases defined in the project. Lastly, the method will be tested in order to establish a grade of improvement compared to earlier and state-of-the-art techniques. Writing a technical report on the work performed and the achieved results.

## Description of the service

## Resources and materials

### Hardware

sdfghj

### Software

sdfgh

## Tests and trials

## Conditions for the implementation of the project

## Legal aspects

General Data Protection Regulation (GDPR):

# Objectives

# Use cases

## Office use case

## Wiener linien use case

# Development (subject to change)

## Middleware



Egin horrelako zerbait nire adibidea erabiliz

<https://docs.oracle.com/cd/E21764_01/core.1111/e10103/intro.htm#ASCON110>

## Design pattern

Builder 🡪 <https://refactoring.guru/>

## Buffer

Collecting binary data bits into groups that can then be operated on as a unit,

automatic buffering.

It helps devices to manipulate data before sending or receiving.

## Thingy

Kconfig Json importatu ahal izateko 🡪 zephyrrena

CMakeList

Prj.conf 🡪 sensoreak enable egin ahal izateko

<https://github.com/google/eddystone/blob/master/protocol-specification.md>

# Conclusions and future lines

This is thechnical

## Conclusions

a. Reflexiones técnicas: relacionadas con los objetivos del proyecto b. Reflexión sobre las implicaciones sociales, de salud y seguridad, medioambientales, económicas e industriales   c. Reflexión sobre la aplicación de conocimientos relativos a cuestiones económicas, organizativos de gestión (gestión del riesgo y del cambio) en el contexto industrial y comercial.

## Future lines

“Smart Home Automation System Using on IoT” dokumentuan rosas dagoenari begirada bat bota /!\

# Personal evaluation of the experience(?) and the project

Proiektua egiten nola sentitu naizen aipatu

Esperientziari dagokionez: A) Unibertsitatea: nola sentitu naizen, IoTko kurtsoak, astero egiten diren hitzaldietara joaten utzi… B) Beste herrialde batera joan: Leku berriak ezagutu, bertoko kulturatik ikasi, bakarrik bizitzea eta independentzia.

# Sarrera, ondorioak eta etorkizuneko ildoak

Atal honetan sarrera, ondorioak eta etorkizuneko ildoak atalen laburpen bat egingo da euskaraz.

## Sarrera

## Ondorioak

## Etorkizuneko ildoak

# Appendix A **STREL**

Titulua aldatzerako orduan kontuz! Formatua galdu gabe/!\ Aurkibidean polit ikusteko

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Tabla A1 …

# Appendix B **MQTT**

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

# Appendix C **REST**

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

# Appendix D **CoAP**

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

# Appendix E **Gantt chart**

# Bibliography