

**Title of the Thesis**

by

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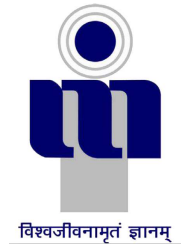
*A thesis submitted in partial fulfilment of the requirements for the  
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The final copy of this thesis has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline.

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## Abstract

## Dedication

## Acknowledgments

Here's where you acknowledge people who helped. But keep it short, i.e., no more than one page.

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## **Chapter 1**

### **Introduction**

This chapter presents an overview about the context as a part of MiCas (Micro satellite et Réseau de capteur sans fils) project in section 1.1. In section 1.2 the problems and motivations are presented. Next, in section 1.3, due to the presented motivations, a research work flow is introduced step by step. Finally, in section 1.4, the research objectives are presented.

#### **1.1 Context**

The internship work is a part of MiCas project (Micro Satellite et Réseau de Capteur sans fils) in LabSTICC, UBO. Micas project objective is develop and experiment solutions to coordinate systems which will exchange data as well as control information between several distributed wireless sensor networks (WSN) and several ground stations by using low cost micro satellites. The project focus on a specification, verification and simulation of related situations : several distant WSN have their gateways visited periodically by a mobile (satellite) on a static path.

#### **1.2 Problem/Motivation**

**Wireless sensor network and sensors :** Wireless sensor network (WSN) is a network which implements many autonomous sensors to monitor physical or environmental conditions and passes the collection data to a main location [5]. Inside the WSN, there are many devices, named sensor can detect events or changes from environment and provides corresponding output. There are several kinds of environment data that a sensor can detect: temperature, humidity, light...[6].

In recent years, WSN is very important in environment monitoring, such as: air pollution, forest fire detection, landslide detection...

**Distant WSN problem** : Most of the WSN projects is deployed in city (as example [7]), where communication systems are abundant. Otherwise, there are several WSN projects focus to the distant areas, such as shores, deserts, mountains, polar regions to monitor the environment changes. With this case, it is admitted that the radio connection from the sensor nodes to gateway can be lost or corrupted by effect of the environment. According to these problems, it is critical to propose a (several) solution(s) to collect data periodically to ensure the well operation of WSN.

**Opportunities in Satellite cooperation** : Obviously, with the advances in Satellites or Unmanned aerial vehicle (UAV) technologies, the solution to collect data periodically of WSN can be achieved by implement Satellite or UAV. Generally, most of the satellite systems are industrial systems and closed for the research purposes like MiCas project. Fortunately, the low earth orbit satellites (LEO satellites) [8] like CubeSat are deployed in recent years can replace the industrial satellites for the research projects i.e QB50 project, Outernet project [9, 10], Micas project because at least two reasons: energy budget and solution cost.

**Cooperation problem** : However, besides the advantages in cooperation between WSNs and CubeSat, there are several problems in data transaction:

- The correctly, reliable and adaptable protocols for data transaction between Satellite and WSN.
- An time event scheduler for WSN and satellite behaviors because they follow different sleeps and sampling periods.
- The limited buffering of the satellites to store and retrieve the data from ground stations.

**Research motivation** As the result, for the cooperation between CubeSat and WSN, it is critical to build an application level simulation to develop and experiment the potentials as well as the risks before real deploying in environment.

### 1.3 Objectives

The objective of research is to approach the geo-modelisation, communication protocol development and simulation for the interaction between CubeSat and WSN. This work also relates to system investigations, based on the simulation of thousand of nodes in distant area, where CubeSat visits them, collects data, connects to ground stations and controls sensing operations. Consequently, during the internship, there are several objectives need to be achieved:

**Geo-modelisation on QuickMap :** To model the geo location of WSN, CubeSat trajectory and the interactions between them. Moreover, in QuickMap, it allows to generate random network topology in specified area, to record satellite path based on tracked longitude, latitude from GPredict software (see chapter 2).

**Protocol developing in Occam environment** To develop the communication protocols, we propose to use Occam structure because it uses micro threads and blocking channels ([11]) which are suitable for mono and multi-processors simulation of WSN (as shown in [12]) (see chapter 3).

**Protocol implementing on GPGPU :** Meanwhile, the verified protocols will be implemented on GPGPU to simulate the sensing activity, the network activities, and interactions with satellites because GPGPU is attractive in synchronous message passing in WSN due to their Single Instruction Multiple Data - SIMD like architecture, shared memory (see chapter 4). In addition, it also useful to simulate the physical process due to the massive parallelism present in situations such as flooding, fires, pollution [13].

### 1.4 Research work flow

According to the research objectives, the report will describe the work flow as below:

**Step 1** Using a map browser, QuickMap [14], to manage geo location of WSN and satellite trajectories and to model the interaction between them. A satellite tracking software, GPredict (see [15]), is used as an external process to passed the satellite paths and information to QuickMap (chapter 2)

**Step 2** Using NetGen tool set [2] to generate the network topology from specification data of WSN fields and Satellite on QuickMap. The network topology can be generated into Occam structure or Compute Unified Device Architecture (CUDA) structure (chapter 2).

**Step 3** Developing and analyzing the distributed protocol algorithms for the cooperation between Satellite and WSN based on generated Occam structure (chapter 3).

**Step 4** Using these proposed algorithms to develop a simulation with CUDA architecture on General Purpose Graphic Processing Units (GPGPU) (chapter 4). Moreover, proposing a specific debugger interface which allows to manage the simulation execution at high level.

## Chapter 2

### Literature review

- 2.1 Background
- 2.2 Key related research
- 2.3 Analysis
- 2.4 Research gaps
- 2.5 Problem formulation
- 2.6 Conclusion

## **Chapter 3**

### **Methodology**

This section introduces the hypothesis and the analytical validation of the proposed solution.

- 3.1 Proposed hypothesis**
- 3.2 Mechanism/Algorithm**
- 3.3 Analytical validation**
- 3.4 Conclusion**



## **Chapter 4**

### **Experiments and results**

This section discusses the various experiments pertaining to the proposed hypothesis and their findings.

## **4.1 Experiment design**

### **4.1.1 Experiment 1**

#### **4.1.1.1 Parameter settings**

#### **4.1.1.2 Experiment description**

#### **4.1.1.3 Results and discussion**

#### **4.1.1.4 Conclusion**

### **4.1.2 Experiment 2**

#### **4.1.2.1 Parameter settings**

#### **4.1.2.2 Experiment description**

#### **4.1.2.3 Results and discussion**

#### **4.1.2.4 Conclusion**

### **4.1.3 Experiment 3**

#### **4.1.3.1 Parameter settings**

#### **4.1.3.2 Experiment description**

#### **4.1.3.3 Results and discussion**

#### **4.1.3.4 Conclusion**

## **4.2 Overall conclusion**

In this section, relate the conclusions obtained in the above experiments with the gaps identified in Chapter 2. Derive conclusion about how far the set gaps were met and if not, the reason for the deviation.

## **Chapter 5**

### **Discussions and conclusion**

In this chapter, the work is concluded and future plan is presented. Next, the research contribution are presented. Finally, limitation of the work and possible future extensions are described respectively.

#### **5.1 Contributions**

#### **5.2 Limitations**

#### **5.3 Future scope**

## Appendix A

### Weird Exam Answers

**About appendices:** Each appendix follow the same page-numbering rules as a regular chapter; the first page of a (multi-page) appendix is not numbered. By the way, the following are supposedly authentic answers to English GCSE exams!

- (1) The Greeks were a highly sculptured people, and without them we wouldnt have history.  
The Greeks also had myths. A myth is a female moth.
- (2) Actually, Homer was not written by Homer but by another man of that name.
- (3) Socrates was a famous Greek teacher who went around giving people advice. They killed him. Socrates died from an overdose of wedlock. After his death, his career suffered a dramatic decline.
- (4) Julius Caesar extinguished himself on the battlefields of Gaul. The Ides of March murdered him because they thought he was going to be made king. Dying, he gasped out: Tee hee, Brutus.
- (5) Nero was a cruel tyranny who would torture his subjects by playing the fiddle to them.
- (6) In midevil times most people were alliterate. The greatest writer of the futile ages was Chaucer, who wrote many poems and verses and also wrote literature.
- (7) Another story was William Tell, who shot an arrow through an apple while standing on his sons head.

- (8) Writing at the same time as Shakespeare was Miguel Cervantes. He wrote Donkey Hote. The next great author was John Milton. Milton wrote Paradise Lost. Then his wife died and he wrote Paradise Regained.
- (9) During the Renaissance America began. Christopher Columbus was a great navigator who discovered America while cursing about the Atlantic. His ships were called the Nina, the Pinta, and the Santa Fe.
- (10) Gravity was invented by Issac Walton. It is chiefly noticeable in the autumn when the apples are falling off the trees.
- (11) Johann Bach wrote a great many musical compositions and had a large number of children. In between he practiced on an old spinster which he kept up in his attic. Bach died from 1750 to the present. Bach was the most famous composer in the world and so was Handel. Handel was half German half Italian and half English. He was very large.
- (12) Soon the Constitution of the United States was adopted to secure domestic hostility. Under the constitution the people enjoyed the right to keep bare arms.
- (13) The sun never set on the British Empire because the British Empire is In the East and the sun sets in the West.
- (14) Louis Pasteur discovered a cure for rabbis. Charles Darwin was a naturalist who wrote the Organ of the Species. Madman Curie discovered radio. And Karl Marx became one of the Marx brothers.

## Appendix B

### Ode to Spot

**(Data, Stardate 1403827)** (A one-page chapter — page must be numbered!) Throughout the ages, from Keats to Giorchamo, poets have composed “odes” to individuals who have had a profound effect upon their lives. In keeping with that tradition I have written my next poem . . . in honor of my cat. I call it . . . Ode . . . to Spot. (Shot of Geordi and Worf in audience, looking mystified at each other.)

Felus cattus, is your taxonomic nomenclature  
 an endothermic quadruped, carnivorous by nature?  
 Your visual, olfactory, and auditory senses  
 contribute to your hunting skills, and natural defenses.  
 I find myself intrigued by your sub-vocal oscillations,  
 a singular development of cat communications  
 that obviates your basic hedonistic predilection  
 for a rhythmic stroking of your fur to demonstrate affection.  
 A tail is quite essential for your acrobatic talents;  
 you would not be so agile if you lacked its counterbalance.  
 And when not being utilized to aid in locomotion,  
 It often serves to illustrate the state of your emotion.

(Commander Riker begins to applaud, until a glance from Counselor Troi brings him to a halt.)  
 Commander Riker, you have anticipated my denouement. However, the sentiment is appreciated.  
 I will continue.

O Spot, the complex levels of behavior you display  
 connote a fairly well-developed cognitive array.  
 And though you are not sentient, Spot, and do not comprehend  
 I nonetheless consider you a true and valued friend.