

# Multi-Agent Decision Making Over Wireless Network

Martin Bullman

2nd Year BSc Computer Science Student (Intern)

University College Cork

[martinbullman@live.ie](mailto:martinbullman@live.ie)

## Abstract

*We developed a testbed for realtime decision making over wireless networks using multiple Intel Galileo embedded microcontrollers*

## 1. Introduction

Real time decision making based on heterogeneous data is becoming increasingly important in a wide range of industry sectors. For many applications, this involves gathering data from widely distributed sensors, making appropriate decisions, and transmitting them back out to remote actuators. This process of centralisation is often too slow for realtime decision making. Most existing research in distributed reasoning ignores the issues of wireless sensing, communication and actuation. The aim of this project is to construct a wireless testbed that will allow researchers to develop and test new protocols and algorithms.

## 2. Background

The need to consider wireless networks in distributed reasoning has been identified [1]. Intel have released Galileos [2], which are microcontroller boards based on the Intel Quark SoC X1000 application processor. The Intel Galileo also has wireless capabilities and are Arduino compatible. This is a step beyond traditional embedded microcontrollers, which were standalone.

## 3. Problem Statement

Construct a testbed using multiple Galileos which would demonstrate the principle of sensing, communication, actuation and coordination using wireless networks, (Fig 1), and which would allow researchers to implement and test new algorithms on this wireless platform.

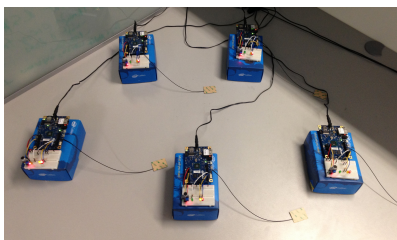


Figure 1: Intel Galileos connected to sound sensors used to demonstrate the application.

## 4. Solution

The proposed solution is to implement a network of devices which sense sounds and communicate with each other to determine which device is closest to the sound. This could then be extended to localize and track sound sources. Intel provided us with 5 Galileo units for us to use in our research. We extended the Galileos by adding microphones to each unit. For wireless communication we attached an Intel Centrino wireless-N35 Wi-Fi card to each board and configured the Galileos' cards to generate an ad-hoc Wi-Fi network which enabled wireless communication between all devices. To indicate the conclusion of the decision process we also added LEDs to each board. For the coordination protocol, any device that hears a sound above a threshold can initiate the process by broadcasting a message to all devices (usually, we assume a fully connected network). To visually indicate a device has detected a sound above the threshold the green LED will flash, all devices will then begin a synchronous communication sequence in which each device will broadcast its sound level. The node with the lowest ID will broadcast its sound level first, each node will then transmit in ID sequence until all nodes had broadcast their level. After the synchronous communication sequence was complete, each node could then decide who was the closest to the sound. We could then actuate and show the result by turning on a green LED for the node that had the highest sound level.

## 5. Evaluation

We successfully assembled an Intel Galileo wireless test bed on which researchers can now try to test and implement new protocols and algorithms. We also constructed a demonstration application on top of our wireless test bed to demonstrate issues in multi agent decision making over wireless networks. When we have a small number of devices (three or four) our protocol for sensing, communicating and actuation will work reliably but when we increase the number of devices and the speed at which they are communicating, packet loss will increase dramatically.

## 6. References

- [1] Mohamed Wahbi and Kenneth N. Brown "The impact of wireless communication on distributed constraint satisfaction" CP 2014, 20th Intl Conf on Principles and Practice of Constraint Programming, Lyon, September 2014.
- [2] Intel Galileo embedded Microcontroller Data Sheet: <https://communities.intel.com/docs/DOC-21835>