IOWA STATE UNIVERSITY

Department of Electrical and Computer Engineering

Senior Design
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Internet of Machines

Introduction

Project Statement

The aim of our project is to develop a method to collect data from sensors on operational, in-service machines in the field. Compile that data into a cloud-based solution, and output the data into a readable and usable format that will show long term statistics about the machines. This will help both the owners and designers by providing data about the machines, leading to advances in part design and preventative maintenance schedules. Maximizing the cost effectiveness of running the machines, and leading to better designed components.

Project Requirements

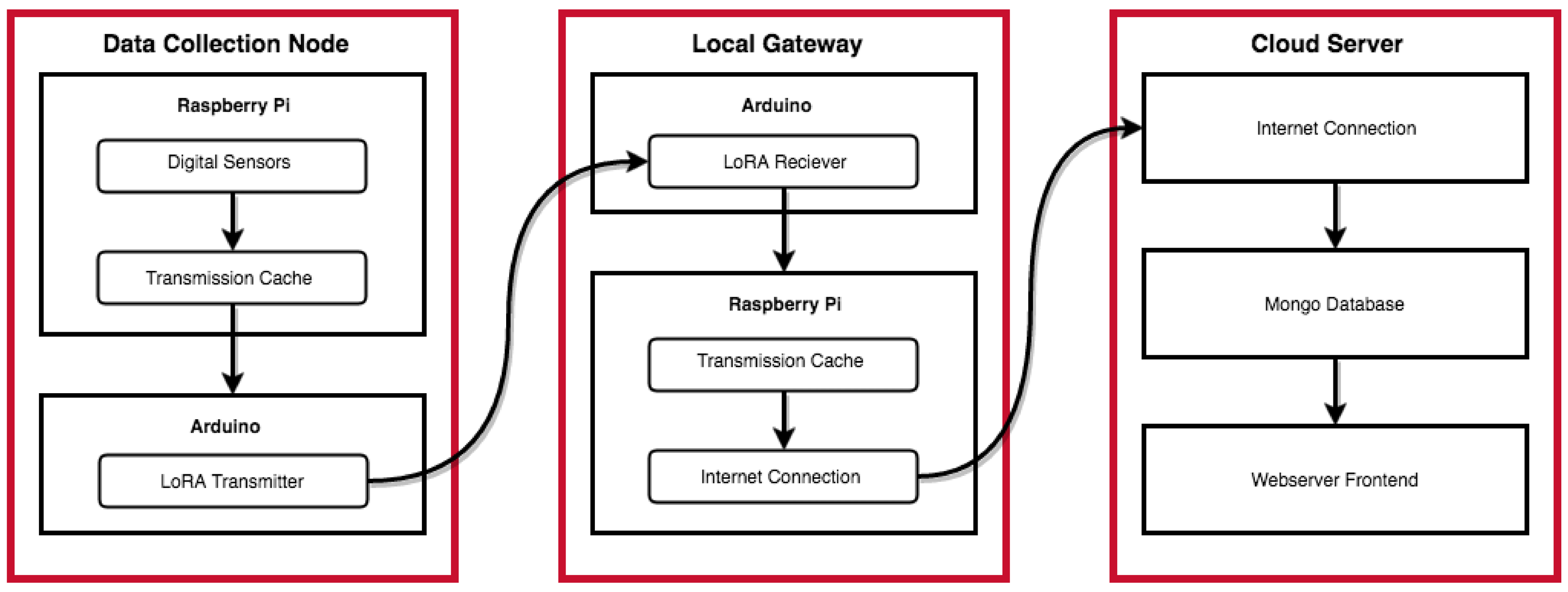
Functional	Non-Functional
• Retrieve data from a range of sensors	• Client portability (small size to fit on industrial machines)
• Connect over a great distance (1-5 miles)	• Expandable to be able to support a range of sensor hardware
• Server system must be able to host multiple clients	• Send data at a timely and stable rate
• Server must be able to distinguish clients	• Configurable associability of client and server hardware
• Server must host collected data and compile into a readable format	• Client must be structurally secure, and able to be attached to heavy machinery

Design Considerations and Solution

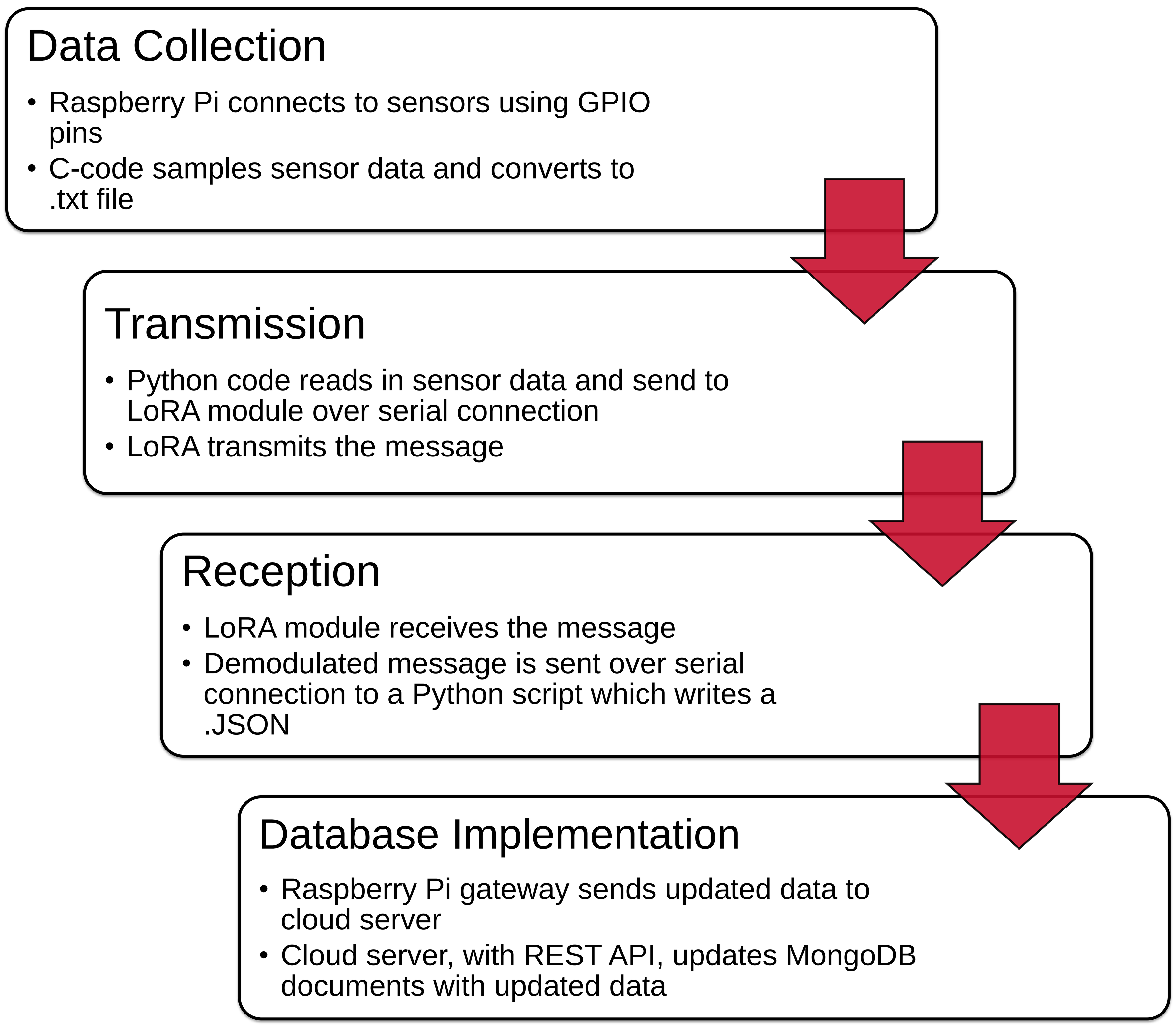
	2G	3G	LTE	WiFi	LoRA
Range	Long	Long	Long	< 200 m	> 10 km
Current	0.35 mA	1.2-3.5 mA	1.5-5.5 mA	1.1 mA	<0.005 mA
Module Cost	$12	$35-50	$40-80	$5-8	$5
Spectrum	License	Licensed	Licensed	Unlicensed	Unlicensed

To design the system, we will be using LoRa (**Lo**ng **Ra**nge) transmitters and receivers. A low-cost, low power and open source internet of things development platform. One of the biggest advantages is its unlicensed frequency band, which reduces operating costs for the modules.

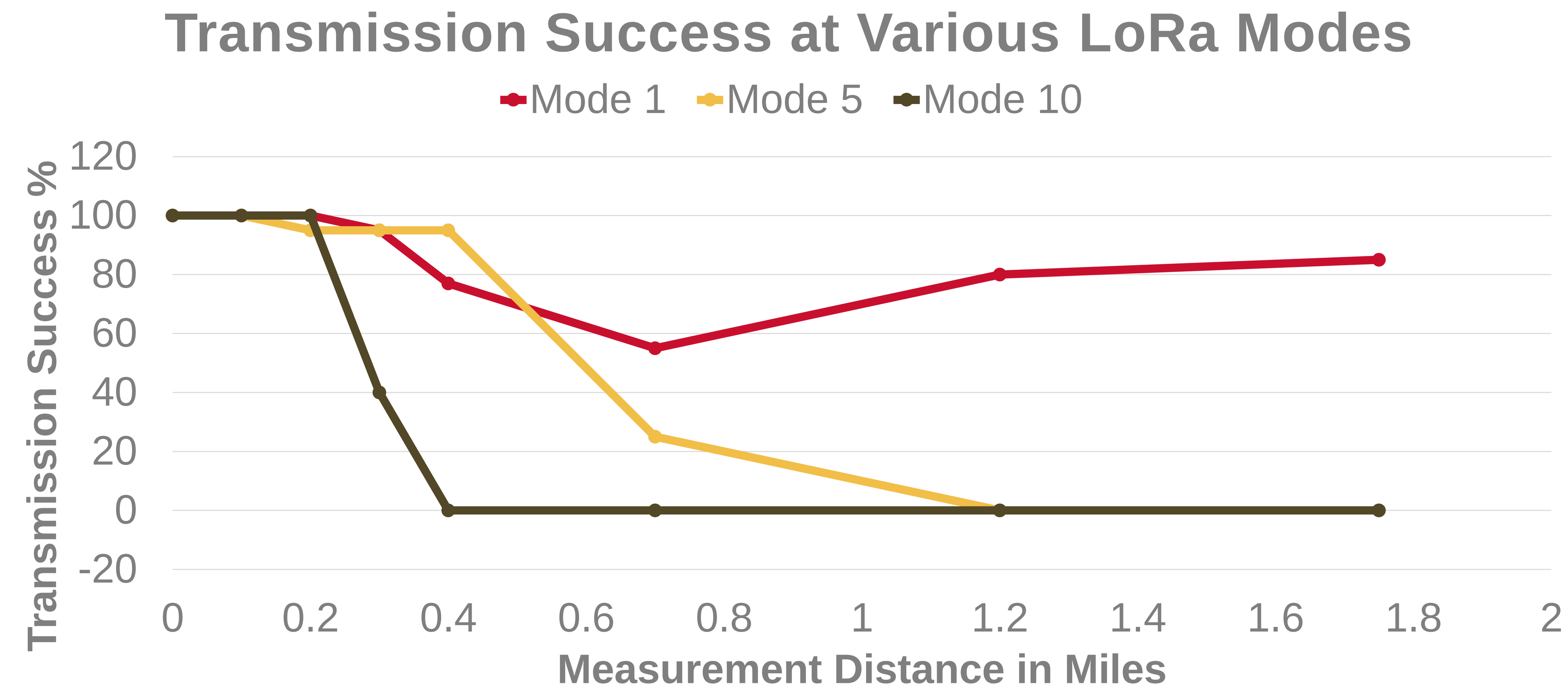
Concept Sketch



Functional Modules



Testing and Evaluation



In order to test the transmission distance of the LoRa module we ran a series of tests in line of sight on different modes. The three modes that we tested were 1 (BW 125, CR 4/5, SF 12), 5(BW 250, CR 4/5, SF 10) and 10(BW 500, CR 4/5, SF 7) where BW is bandwidth, CR is coding rate and SF is spreading factor, generally estimated to give us the highest and lowest transmission distance, and one in between. For each mode we tested the signal 20 times, and figured the percentage of successful transmissions at that distance. To ensure line of sight, we stationed the receiver on a hill on a dirt road outside of Ames, and used our cars odometers to figure mileages.

	0 Mi	0.1 Mi	0.2 Mi	0.3 Mi	0.4 Mi	0.7 Mi	1.2 Mi	1.8 Mi
Mode 1	100%	100%	100%	95%	77%	55%	80%	85%
Mode 5	100%	100%	95%	95%	95%	25%	0%	0%
Mode 10	100%	100%	100%	40%	0%	0%	0%	0%