

Rainforest Data Accumulation and Monitoring System

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Abstract

- The Rainforest Data Accumulation and Monitoring System Project is designed to streamline the reception, storage and utilization of data received from the Bolivian-Amazon Rainforest.
- The project makes use of a satellite uplink and controllers to facilitate the reception and transmission of data. For the scope of this project, it focuses on the steps at and after the point of transmission rather than the data collection methods. At the point of reception, data is received via a microcontroller unit.
- Ground Control's Iridium Certus 100, the satellite uplink, makes use of a software called Cloudloop to help manage the reception of data. The data received from the sensors in the Bolivian-Amazon Rainforest will be sent to Cloudloop using a program called Node-Red which will create a pipeline between Cloudloop and our sensor. Cloudloop forwards the data along to Node-Red which will be able to move the data into the database server.
- Once the data is received at the server, a user platform that is exclusively used within the Karbon-X company is able to view and analyze the data. This completes the satellite transmission cycle which occurs approximately once every month with new data being transmitted and received.

Discussion

- The hardware and software used for this project has shown to be able to complete the process of satellite connection and data transfer. The system can be iterated and refined to meet new requirements. Additional data encryption and security measures have not been implemented in this project.
- Additional information will need to be gathered to calculate an accurate carbon mass. One piece of information required is the tree height. System tested using satellite in Calgary, not yet implemented in rainforest location.

Conclusions

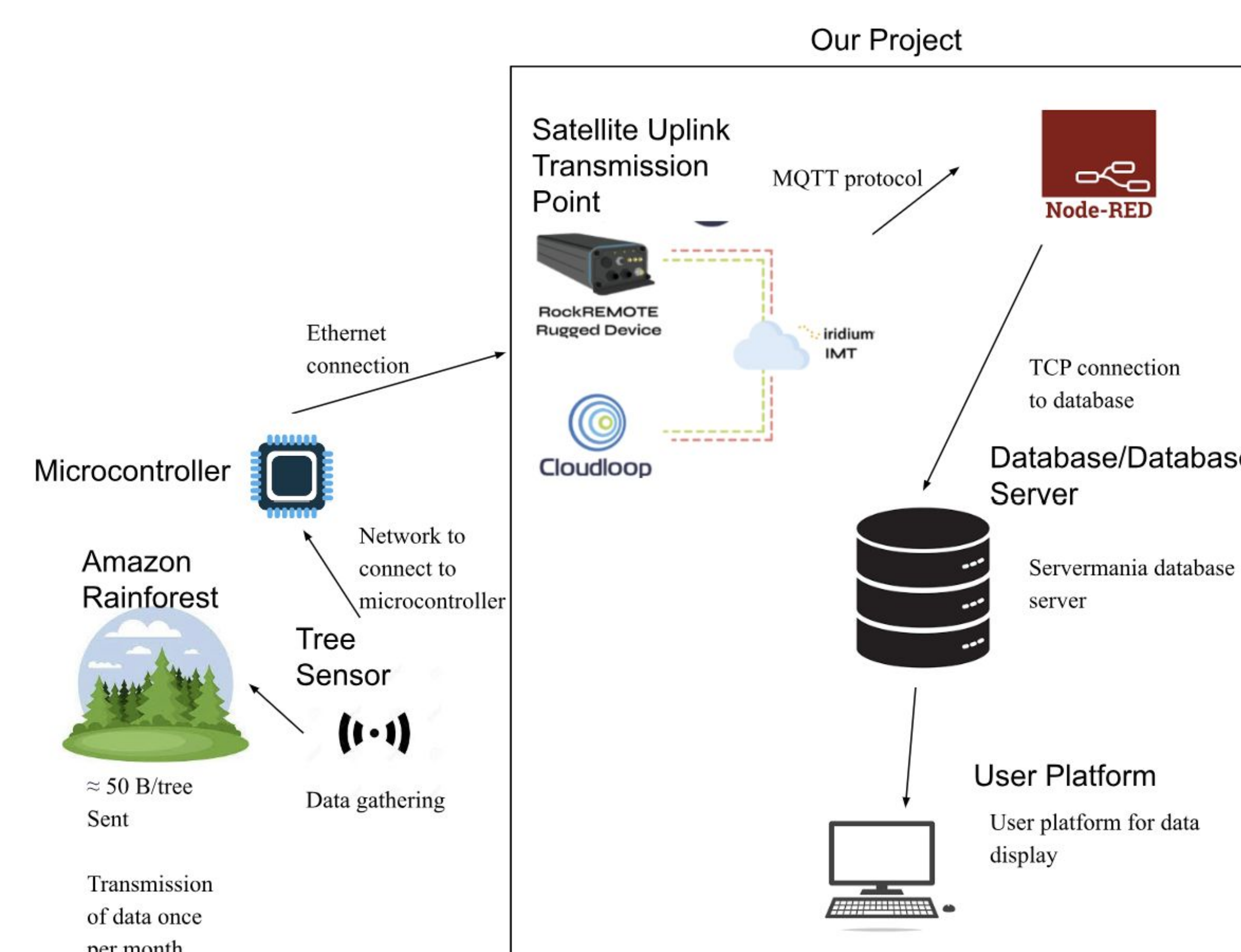
- The current system provides a starting point for the rainforest measurement and data collection process. The system currently supports one satellite uplink but can be scaled for the inclusion of more in the future.
- The Iridium Certus 100 satellite rock controller, the communication softwares of Cloudloop and Node-Red, and the data server of Servermania can all be built upon and scaled up for further use.

References

1. Woodall, C. W., Heath, L. S., Domke, G. M., & Nichols, M. C. (2011). (tech.). *Methods and Equations for Estimating Aboveground Volume, Biomass, and Carbon for Trees in the U.S. Forest Inventory, 2010*. Newton Square, PA: US Forest Service.
2. Jenkins, J. C., Chojnacky, D. C., Heath, L. S., & Birdsey, R. A. (2004). (tech.). *Comprehensive Database of Diameter-based Biomass Regressions for North American Tree Species*. Newtown Square, PA: USDA Forest Service.

Introduction

- The goal of the project is to facilitate the transmission of rainforest tree data from the Bolivian-Amazon Rainforest to a central database where the data can be accessed through an interface at the user platform.
- There are three major sections that make up the project, the satellite connection/transmission, database server/storage, and the frontend interface
- The satellite transmission makes use of a rock remote controller (Ground Control's Iridium Certus 100) as well as the Cloudloop and Node-Red softwares to transfer the data to the database server.
- The database is an SQL database that is hosted on a server through a service called Servermania. The data received from the satellite is organized into various tables of related data in the database.
- Only members of the Karbon-X company access the frontend interface, where they can view all the node data as well as the related charts and graphs



Results

- The resulting system includes all three major components (satellite connection, database storage, frontend interface). The system is able to transmit data from through the satellite controller into a database that can be accessed through a user interface.
- The data sent to the satellite controller is received through a program called Cloudloop. The data is temporarily stored before being sent to another program called Node-Red. Node-Red applies functions to extract and organize the data to be sent into the database server (Servermania)
 - Servermania is the server that stores the data through the use of an SQL database. The information is accessed from the frontend through the use of an API and SQL functions.
 - The frontend interface allows users to search and sort through nodes. Calculations are completed at the interface to calculate carbon mass from the data gathered. Currently there are two graphs, distribution of mean breast height diameter and distribution of carbon mass.

Methods and Materials

Reception from the satellite makes use of the MQTT (Message Queuing Telemetry Transport) Protocol v5 with TLS (Transport Layer Security). Connection is made from Node-Red to the database server using a TCP connection. Due to the model for the Bolivian-Amazon rainforest not being built yet, carbon mass calculations are computed using a model of North Central US states (KS, ND, NE, SD) and Ponderosa Pine as the species of tree.

- Data is received at the satellite controller from a Raspberry Pi microcontroller through an ethernet cable. The satellite controller sends the data to CloudLoop, and from there the data is sent from CloudLoop and received at Node-Red through the use of the MQTT protocol with TLS.
- From Node-Red, a TCP connection is made to connect with the IP associated with the database server and transfer the data into the tables in the database.
- Carbon Mass calculations completed using a model that included 4 North Central US States: Kansas, North Dakota, South Dakota, and Nebraska. Specifically for the Ponderosa Pine species of tree. Steps for the calculations are based on the methods in Woodall et al. (2011).

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