Networking Swarm

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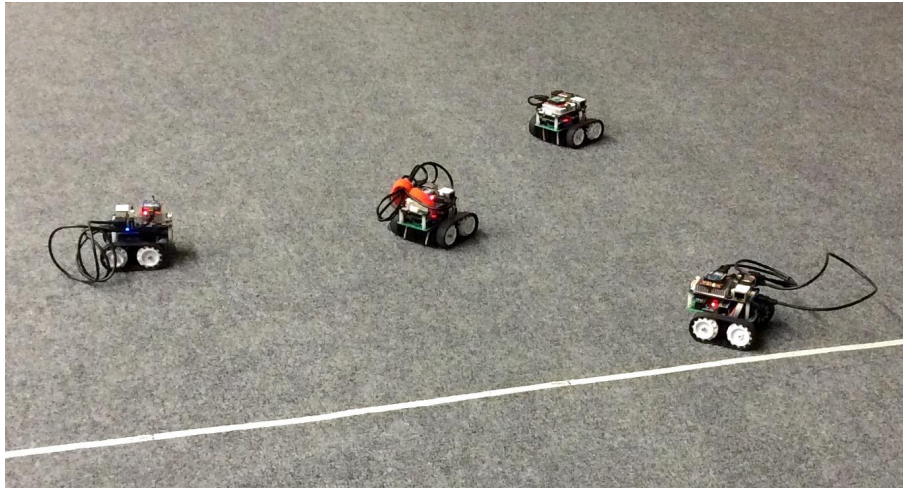


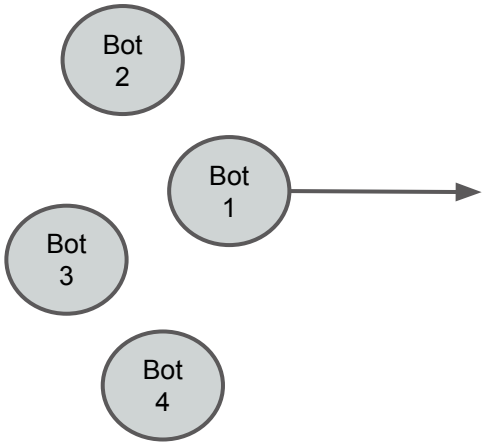
Agenda

- Objective
- Hardware
- RSSI
- Software Architecture
  - Gradient Ascend
  - Communication
- Video
- Application
- Future Work
- Acknowledgement
- Reference

Objective

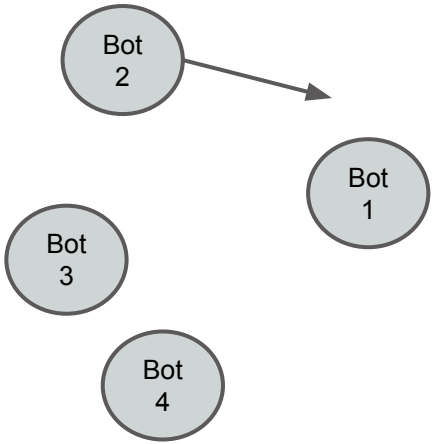
The objective of this project is to implement a swarm of robots that collaborate via network communication as well as low powered radio RSSI (Received Signal Strength Indicator) to coordinate their movements.

Objective



Gradient Descend

Objective



Gradient Ascend

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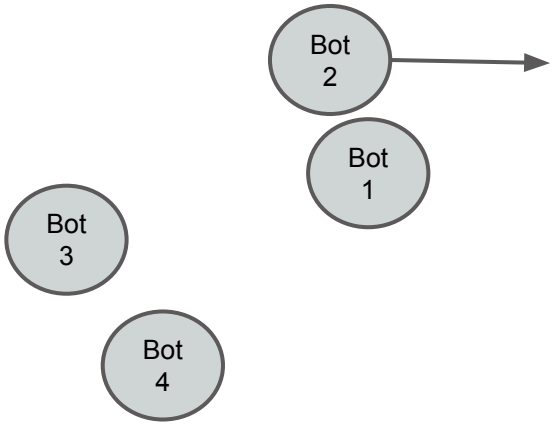
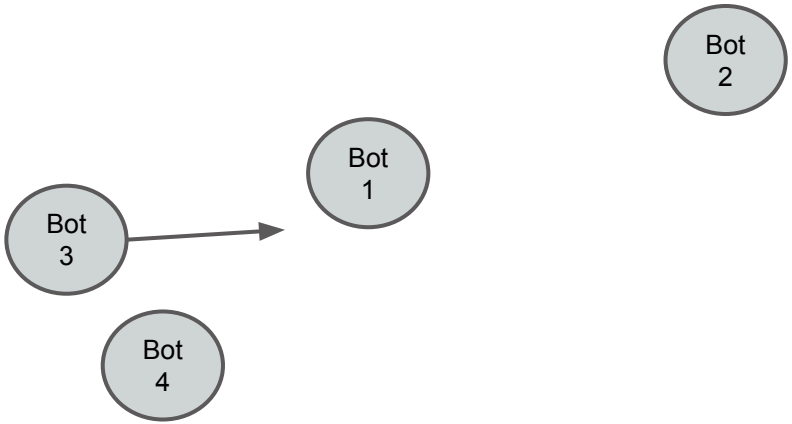


Gradient Descend

Objective



Gradient Ascend

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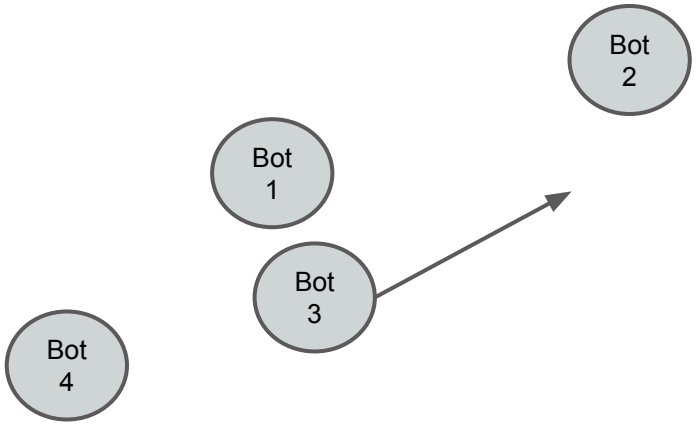

Gradient Ascend

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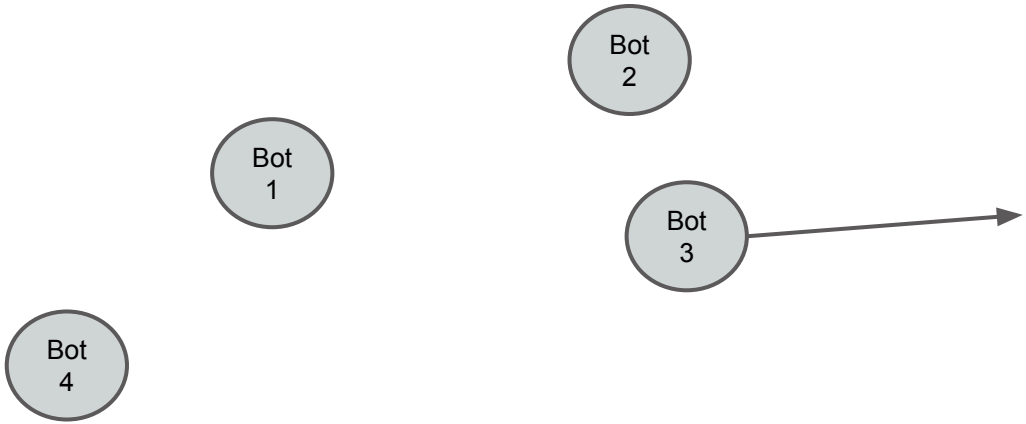

Gradient Descend

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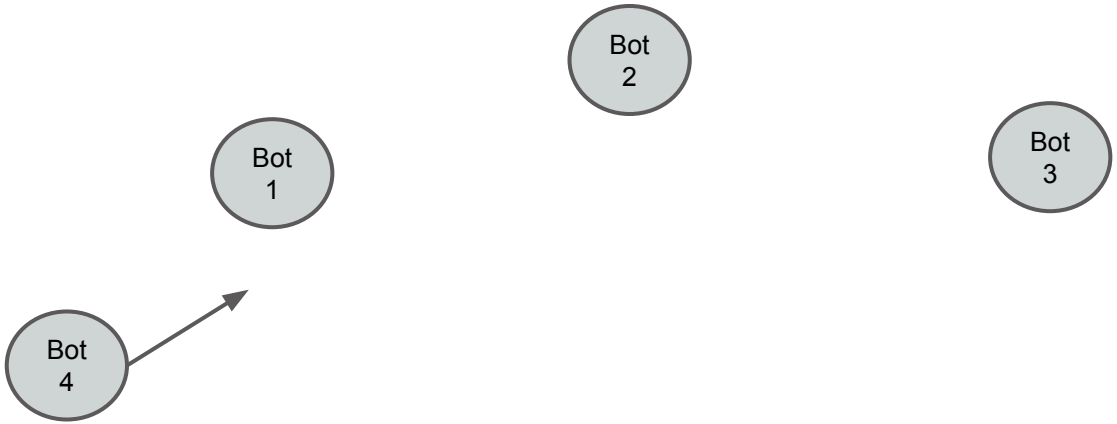

Gradient Ascend

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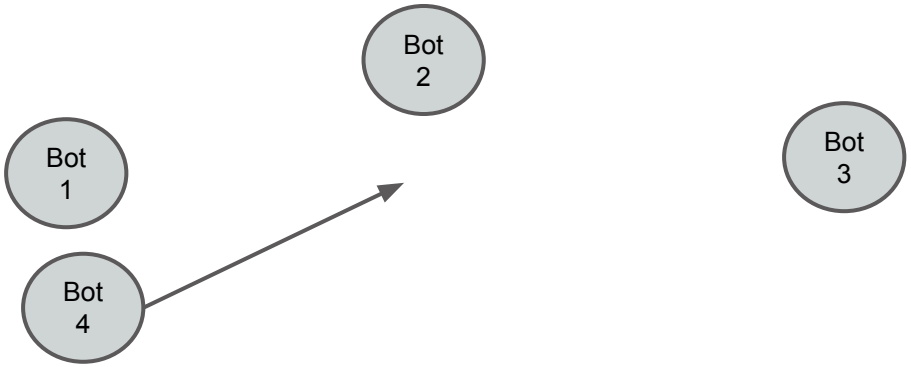

Gradient Ascend

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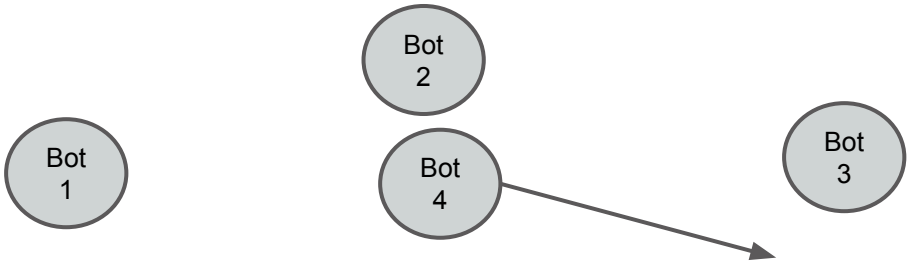

Gradient Ascend

Objective

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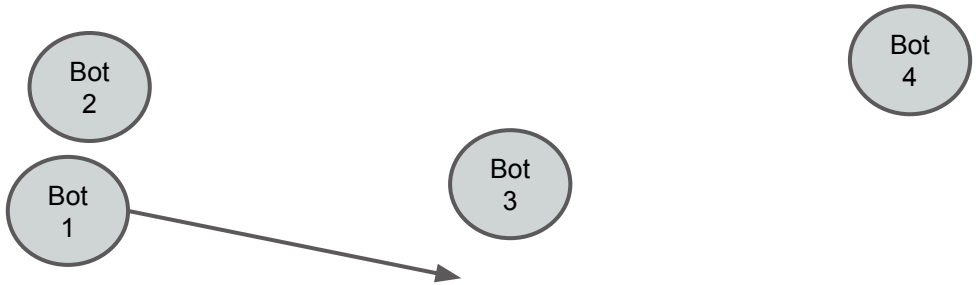

Gradient Ascend

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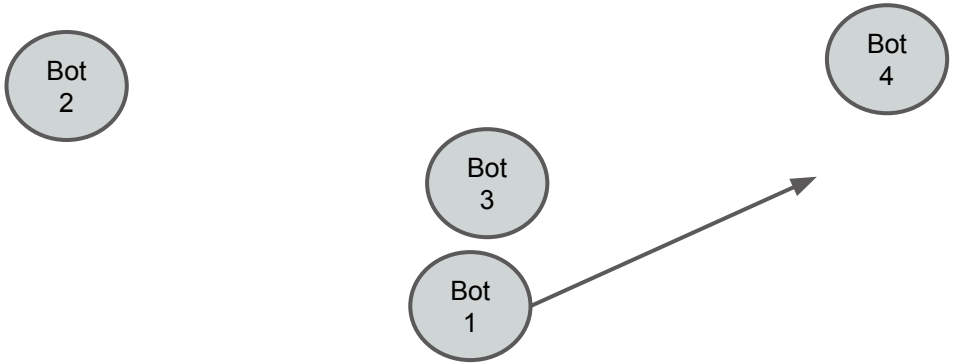

Gradient Ascend

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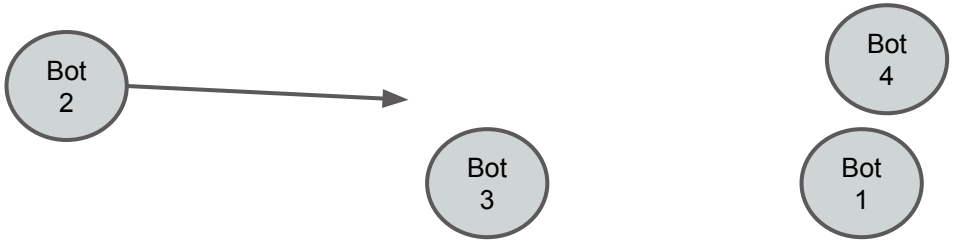

Gradient Ascend

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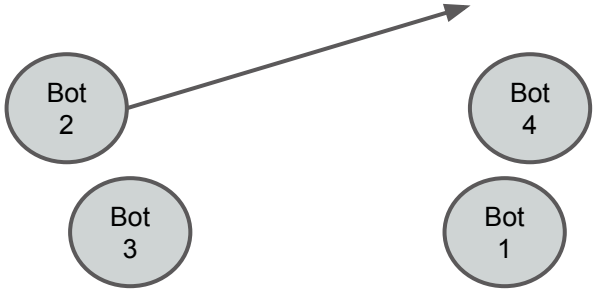

Gradient Ascend

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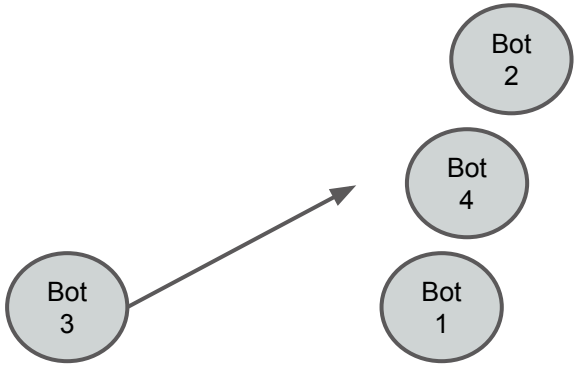

Gradient Ascend

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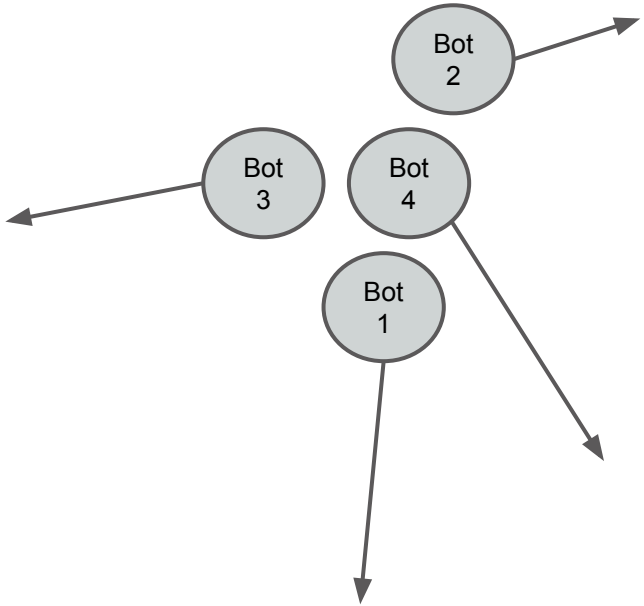

Gradient Descend

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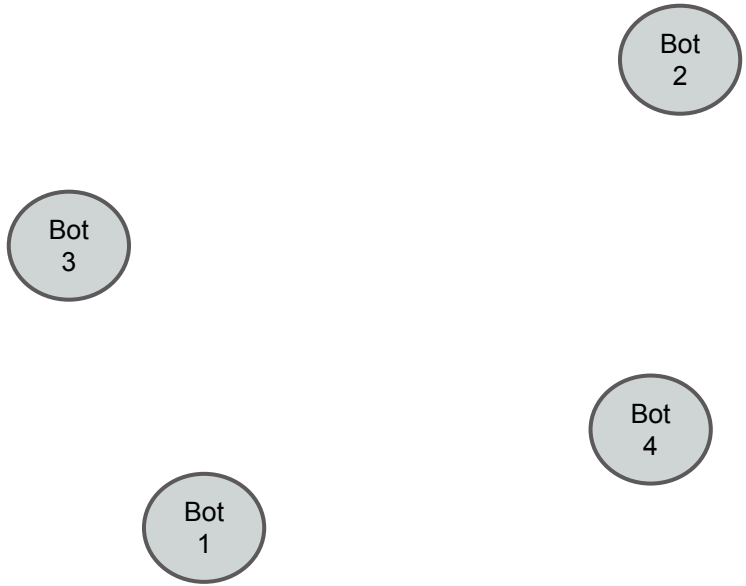
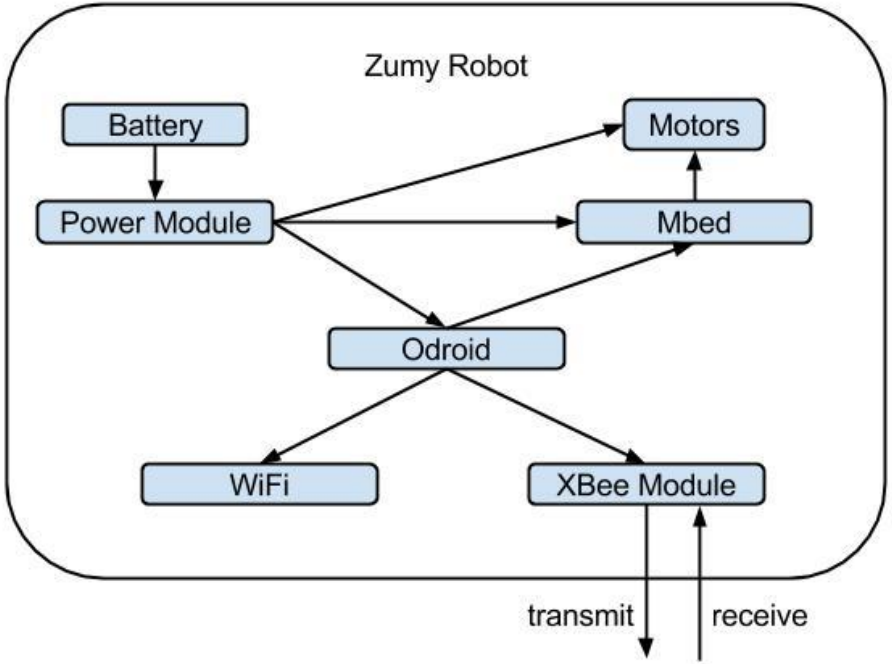
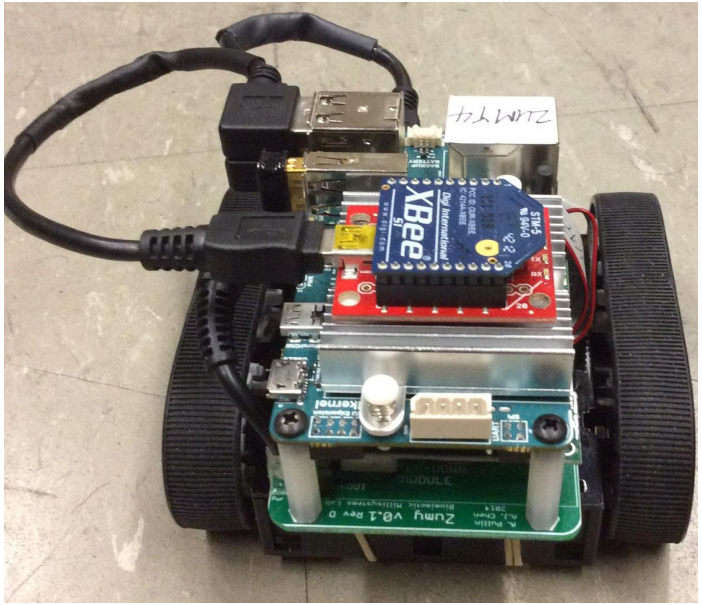


Gradient Descend

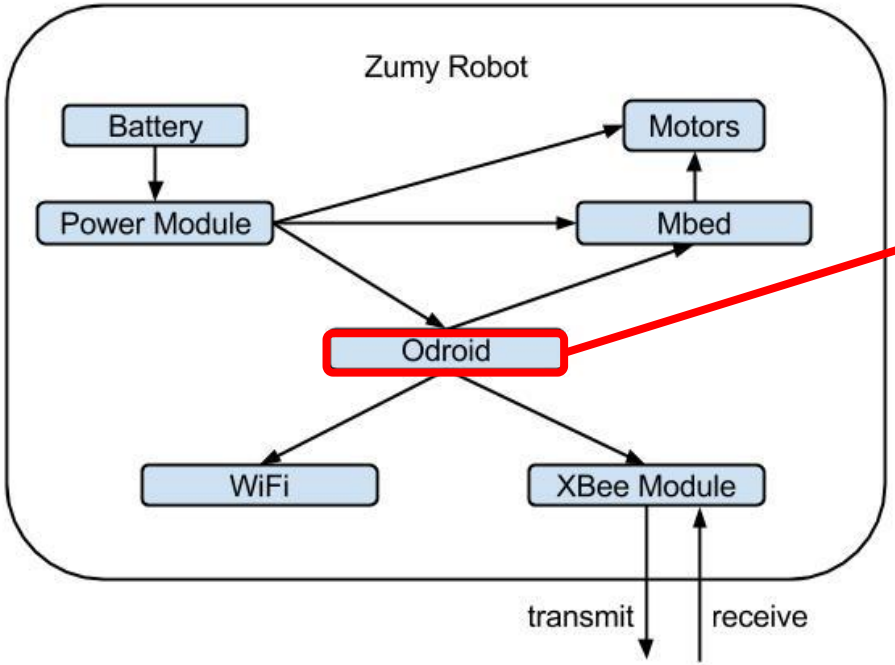
Hardware

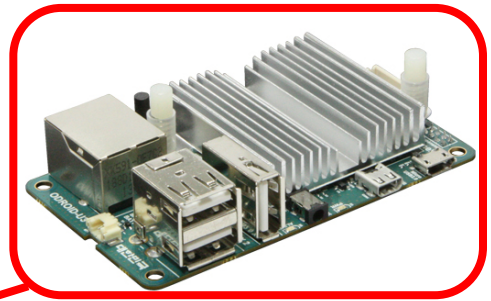




Biomimetic Millisystems Laboratory

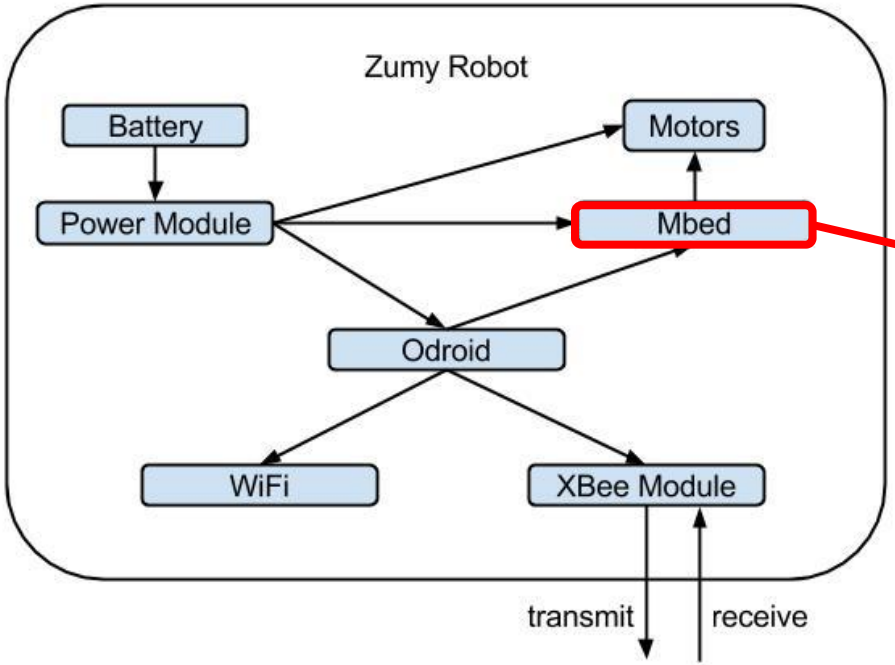
Hardware

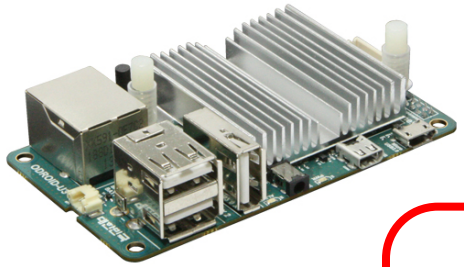


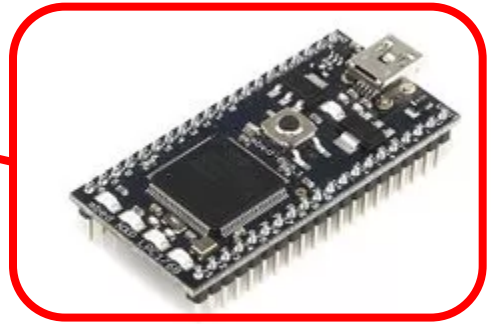


Odroid U3

Hardware

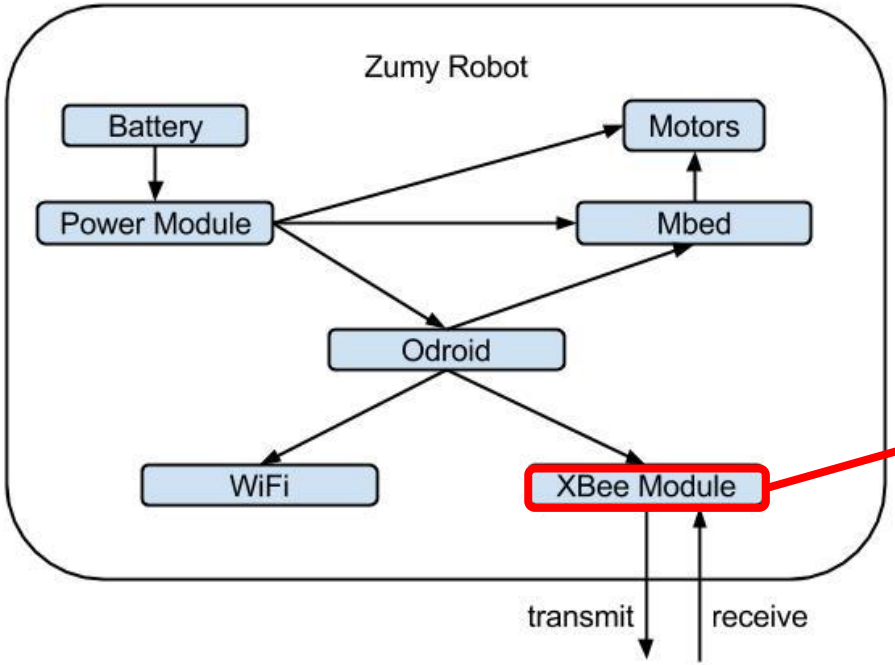


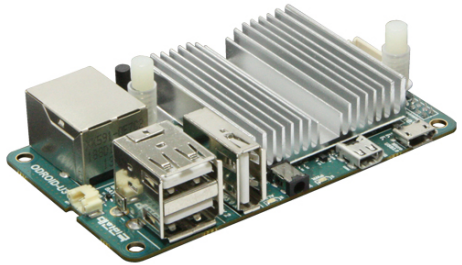




mbed LPC1768

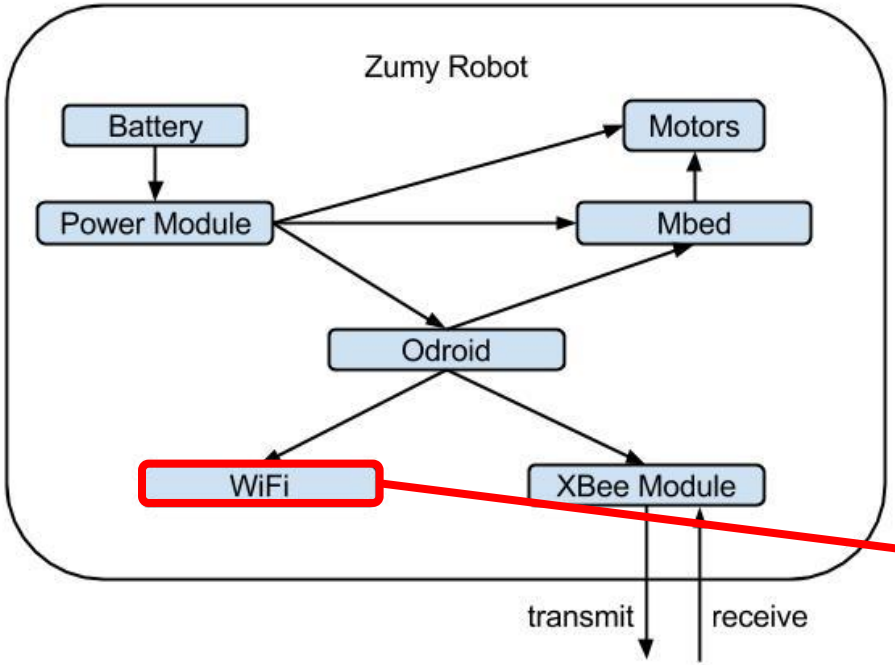
Hardware

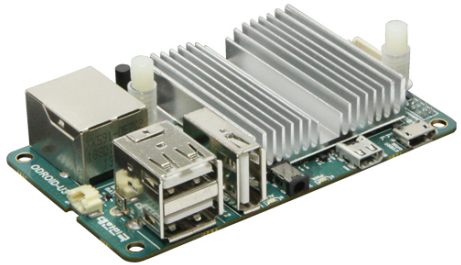




XBee Series 1
2.4 GHz
(802.15.4)

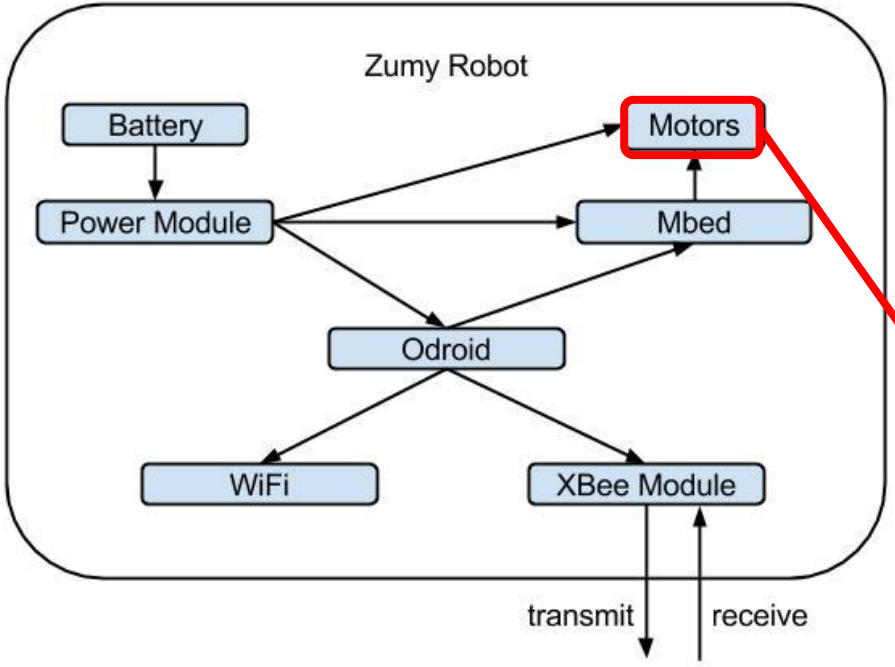
Hardware

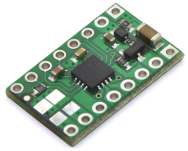




WiFi

Hardware

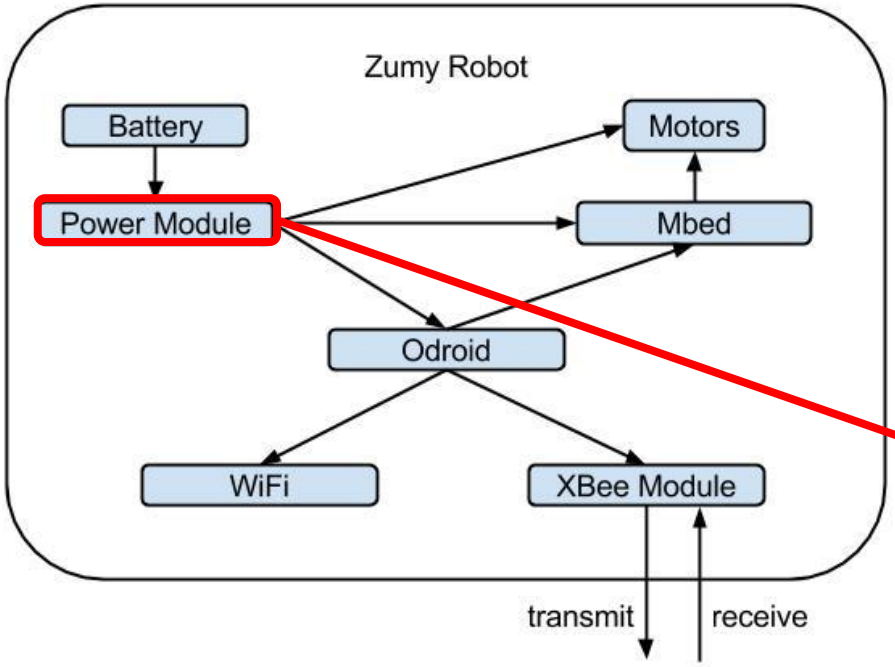


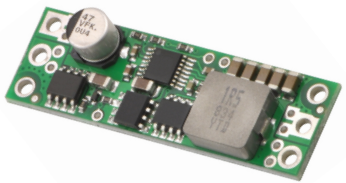


Pololu DRV8833 Dual Motor Driver Carrier

Zumo Robot Kit

Hardware

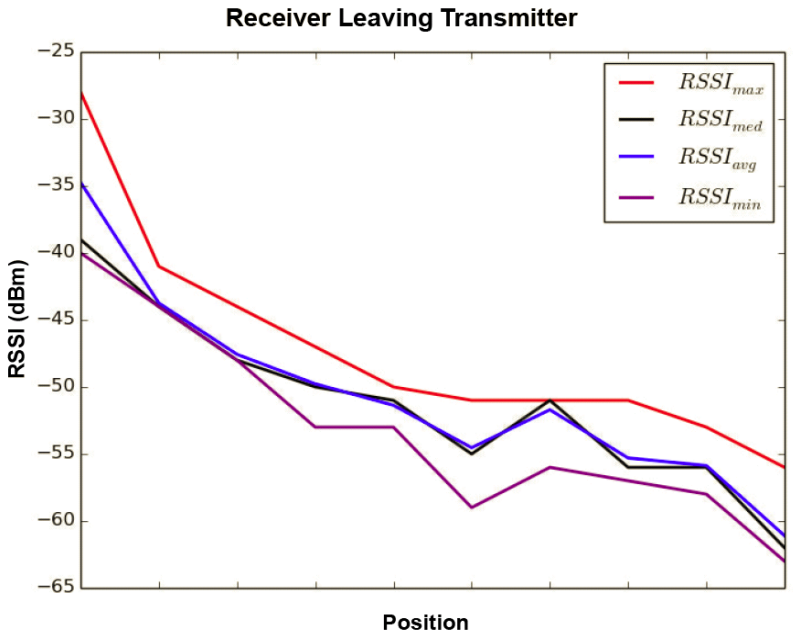




Pololu Step-Down Voltage Regulator

Received Signal Strength Indicator

- experiments investigating RSSI vs. distance
- fluctuate randomly over large distance but approx. linear within 1.5 m
- within this range, gradient ascend & descend is reasonably robust



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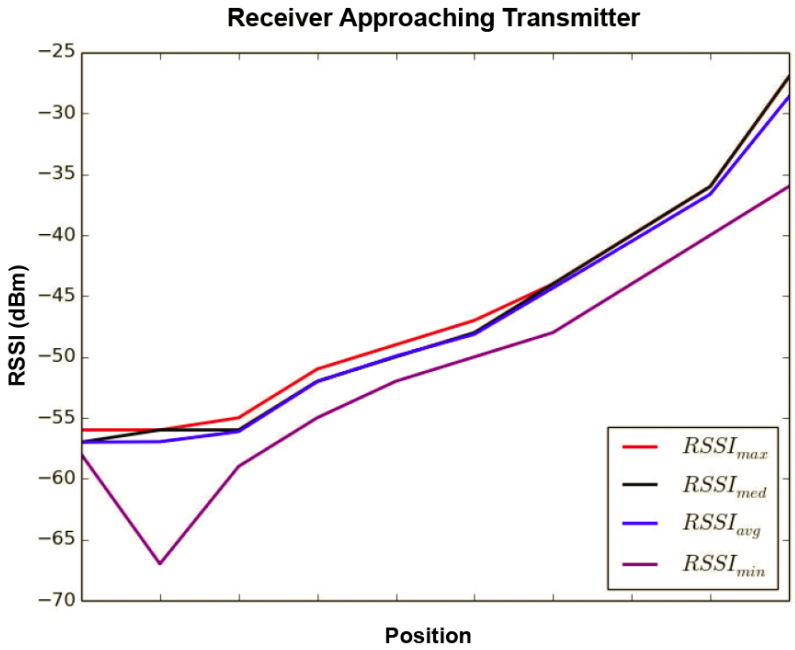
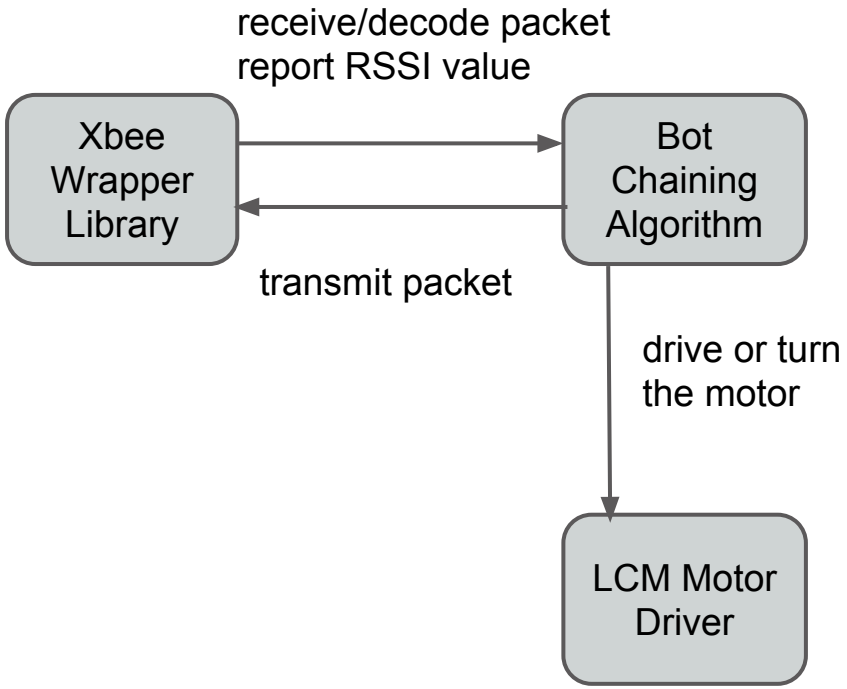
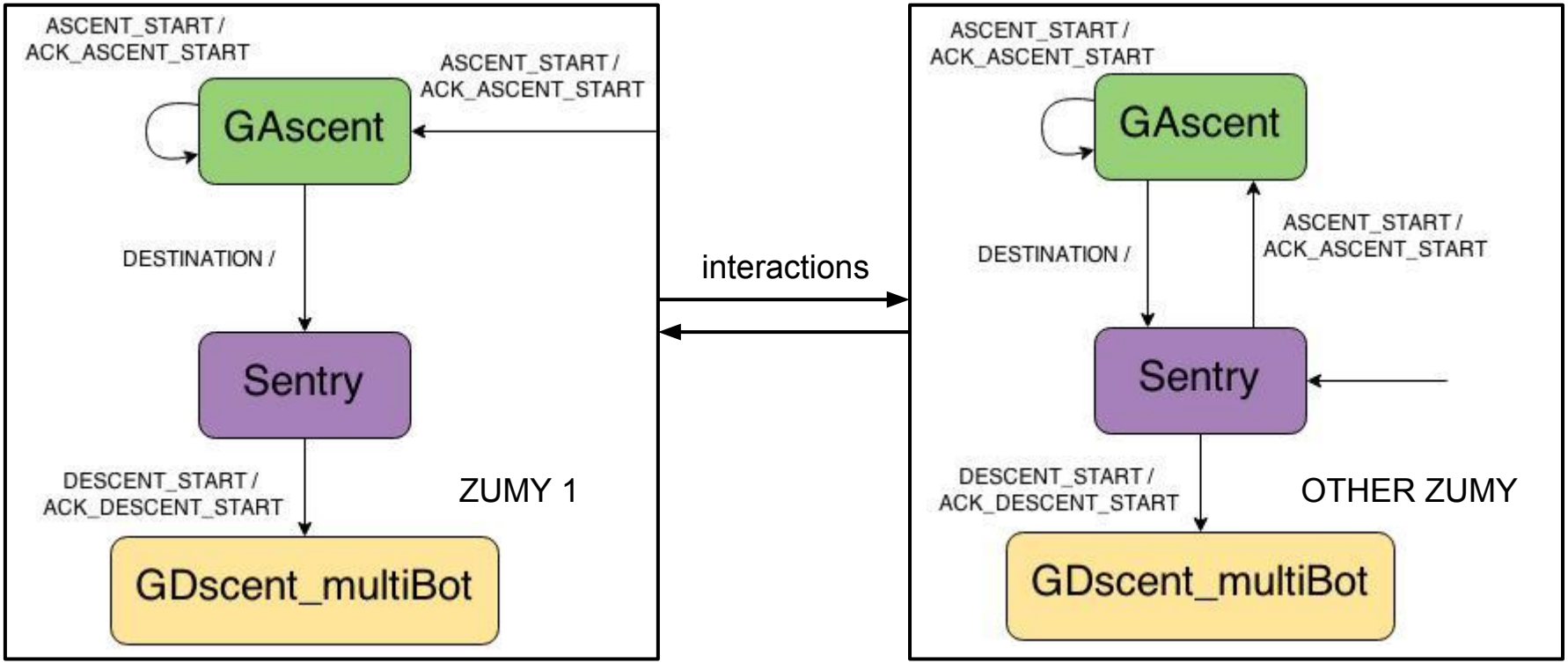


Software Architecture

- Xbee Wrapper Library
- LCM Motor Driver
- Bot Chaining Algorithm

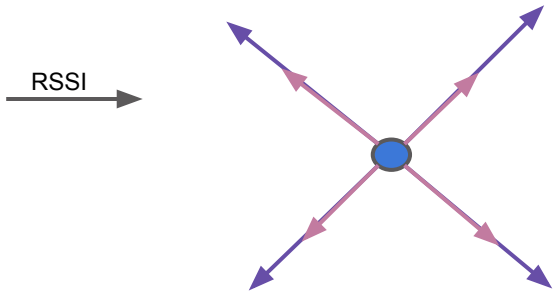


Bot Chaining Overall State Machines

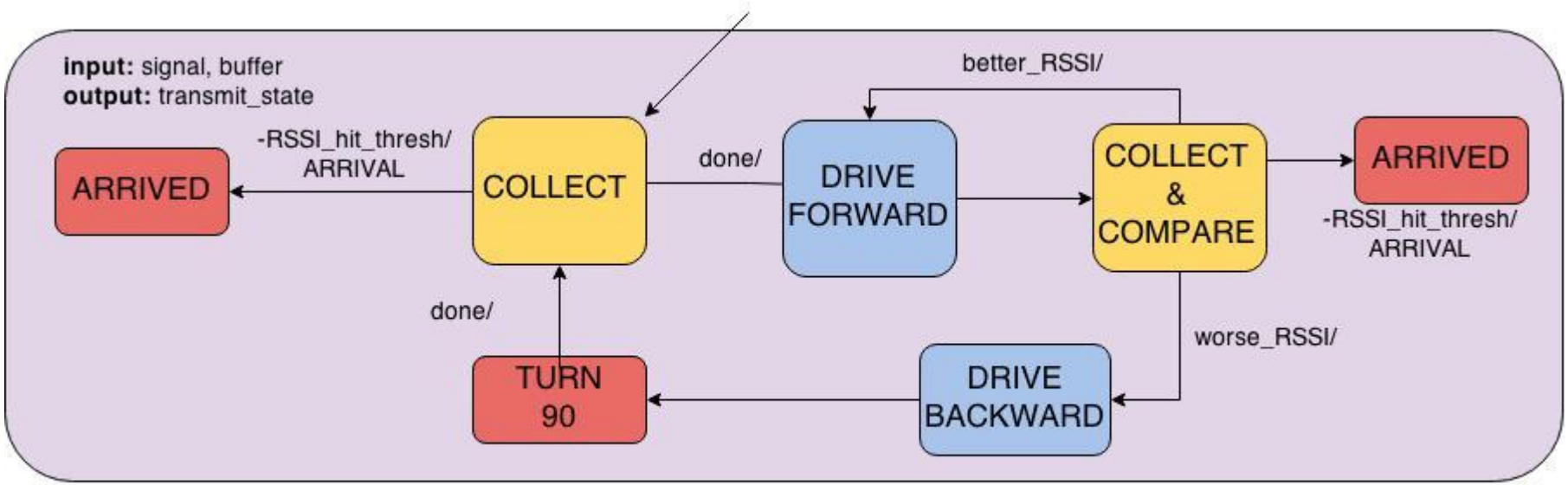


Gradient Ascend Algorithm

- Basic algorithm
- Ending RSSI: -38dB
- Drive time function
- Stage benefit



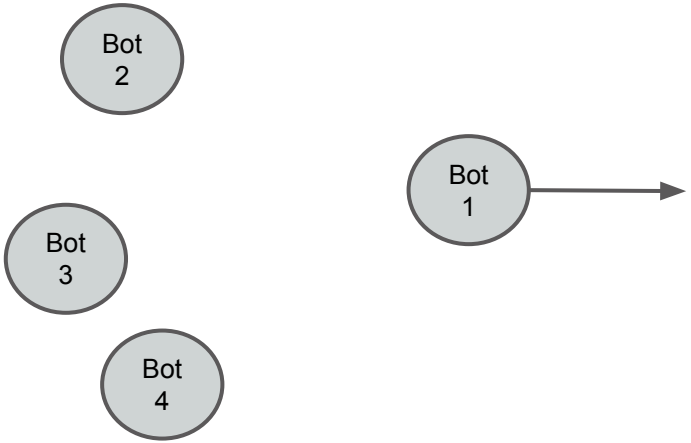
Gradient Ascend State Machine



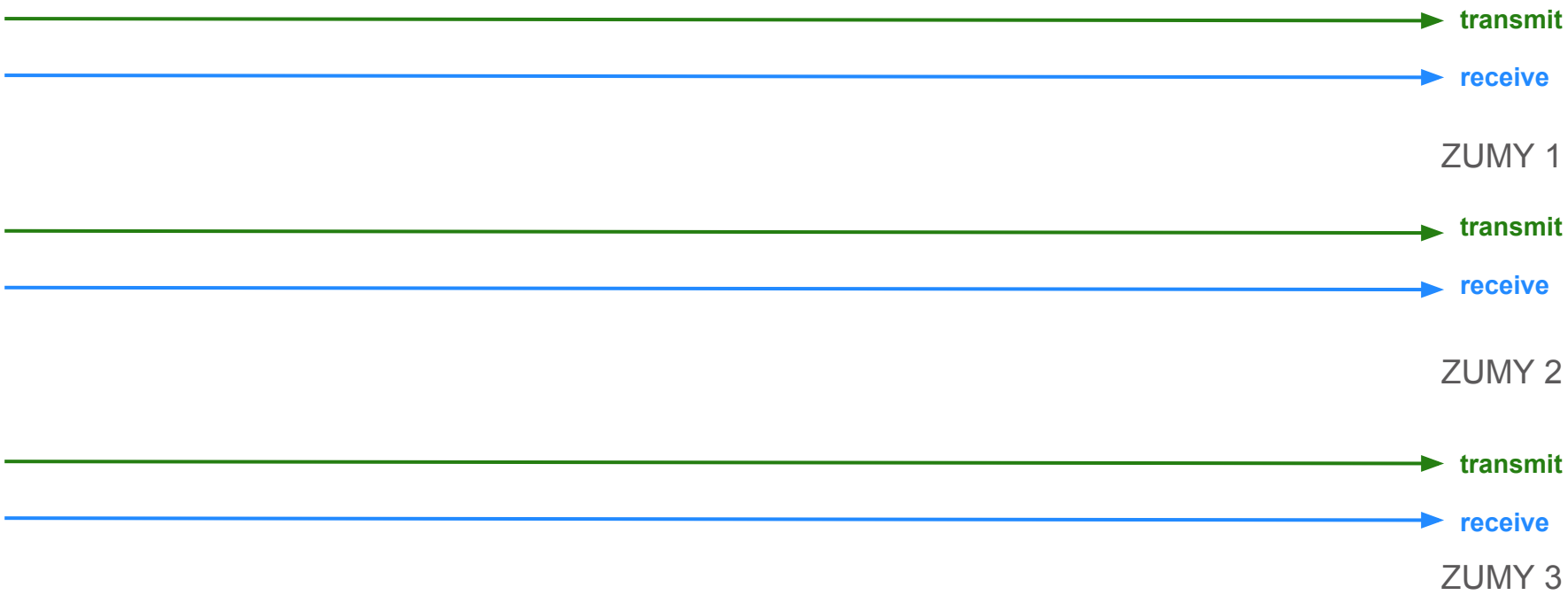
Gradient Ascend

Gradient Descend Algorithm

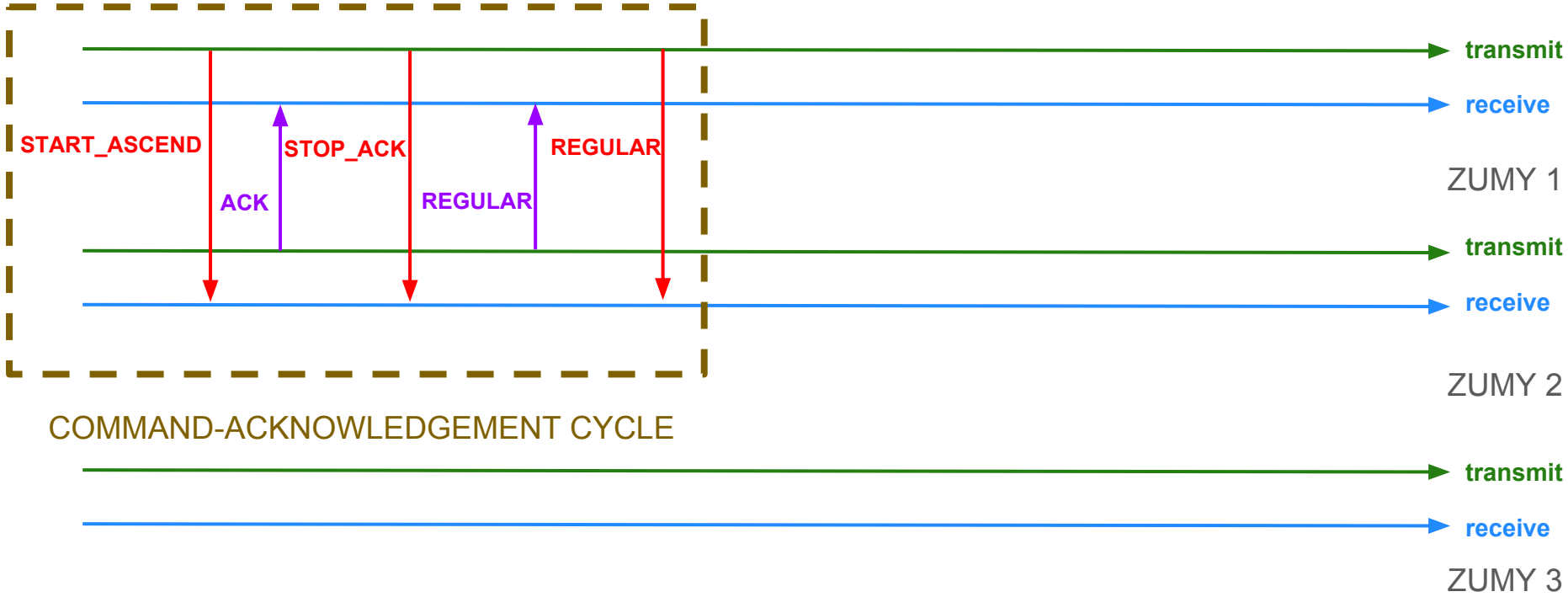
- Basic algorithm
- Multiple Zumy Bots



Communication Threads



Communication Threads



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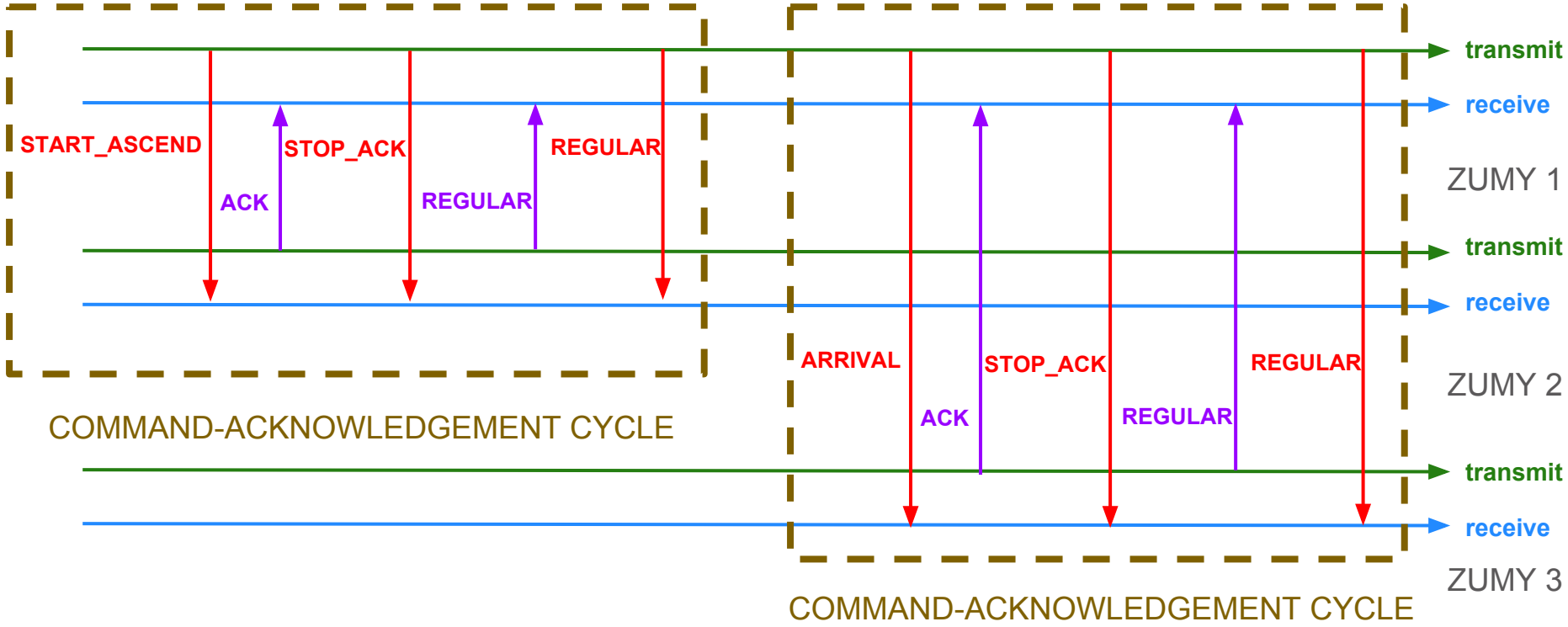
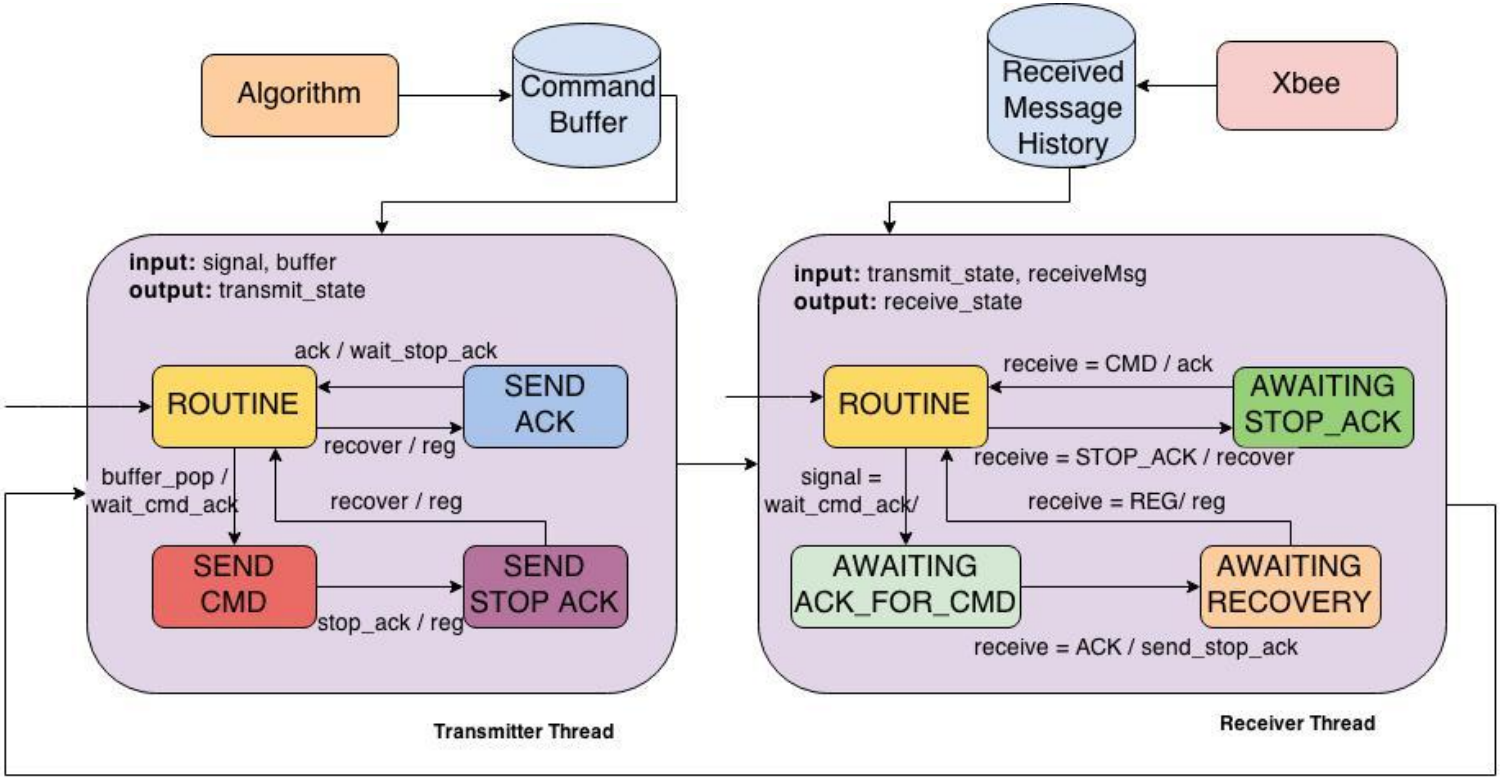
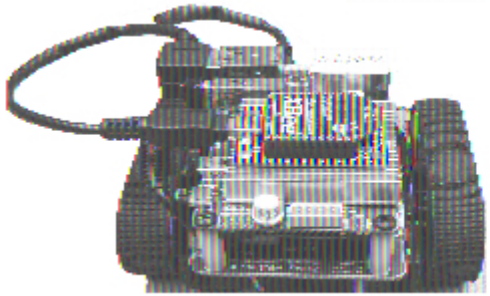


Communication Threads



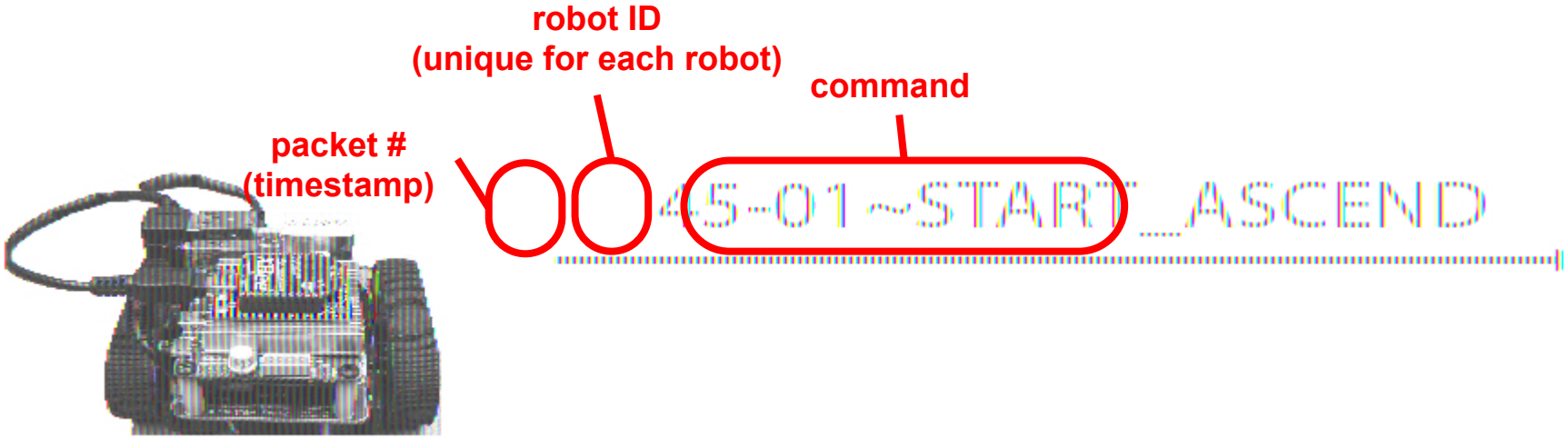
Communication Packet



45-01~START_ASCEND

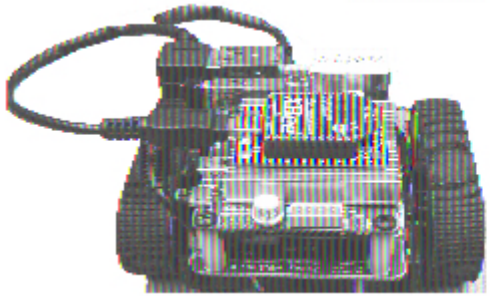
start gradient ascend

Communication



start gradient ascend

Communication

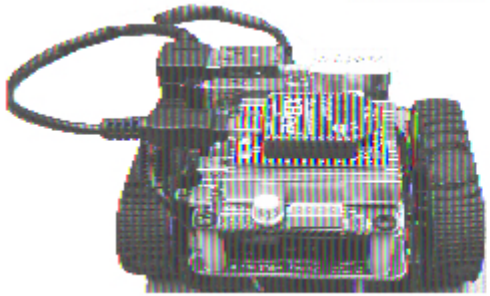


45-01~START_ASCEND

32-02~ACK=START_ASCEND

acknowledge gradient ascend

Communication



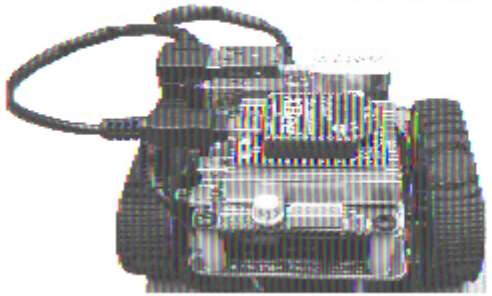
45-01~START_ASCEND

32-02~ACK=START_ASCEND

intended recipient

acknowledge gradient ascend

Communication



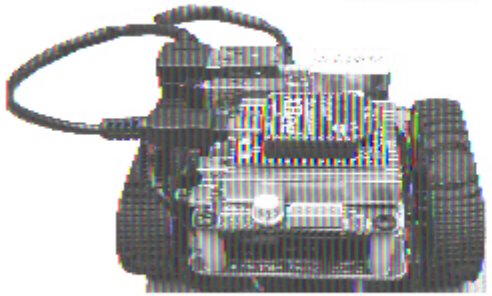
46-01~STOP_ACK=START_ASCE

45-01~START_ASCEND

32-02~ACK=START_ASCEND

stop acknowledgement

Communication



46-01~STOP_ACK=START_ASCE

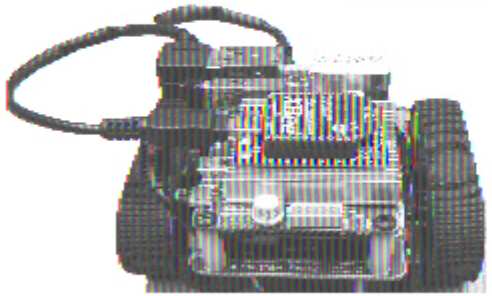
45-01~START_ASCEND

32-02~ACK=START_ASCEND

33-03~

go back to normal mode

Communication



47-01~

46-01~STOP_ACK=START_ASCE

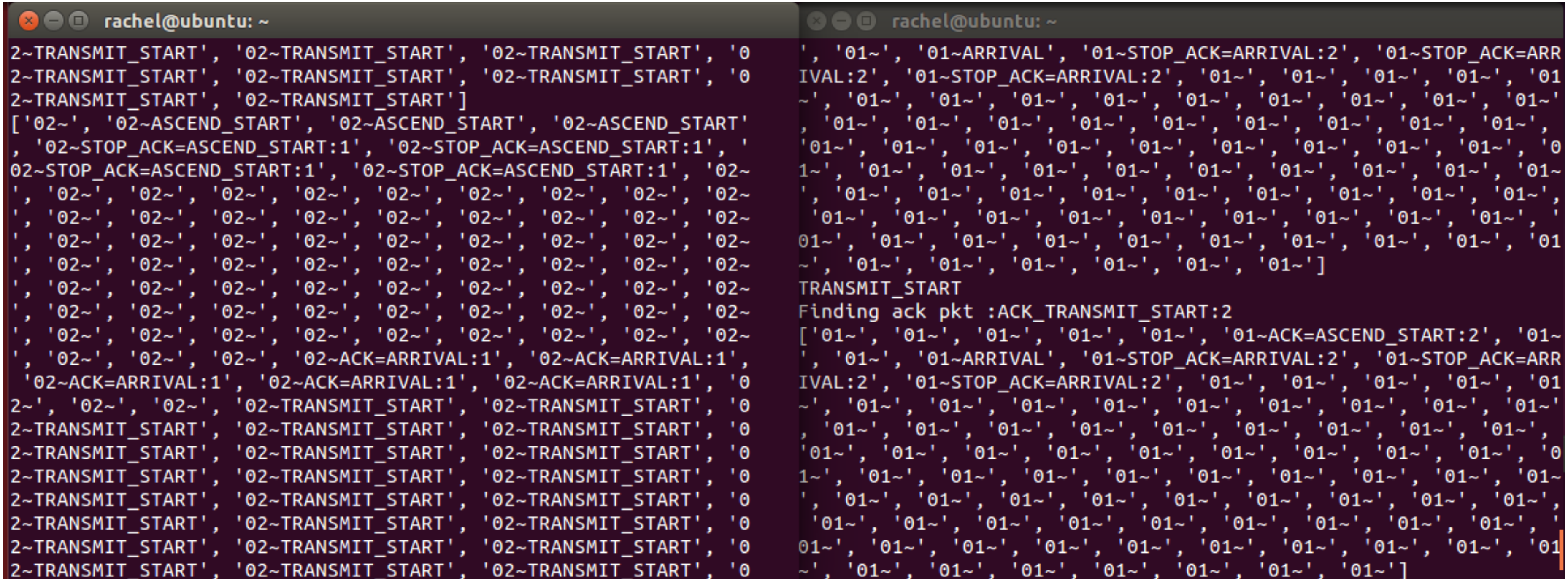
45-01~START_ASCEND

32-02~ACK=START_ASCEND

33-03~

go back to normal mode

Communication



Video

https://www.youtube.com/watch?v=NIDYIy6H6Tw

Final Touch

- Analyze runtime of
  - gradient ascend/descend
  - command-acknowledgement cycle

Application

- Exploration in hazardous environment
- Environment mapping
- Monitoring system

Future Work

- Append with Laser Range Finder
- Measuring RSSI in motion
- Automatic bot chaining
- Automatic motion coordination by neighbor bots
- Localization

Acknowledgement

Special thanks to:

Prof. Edward Lee

Prof. Alberto L. Sangiovanni-Vincentelli

Prof. Rob Fearing

Matt Weber

Ben Zhang

Antonio Ianopollo

Austin Buchan

Andrew Pullin

References

XBee Python Library by Paul Malmsten, Greg Rapp, and Brian.
https://github.com/blalor/python-xbee

Zumy Library by Andrew Chen.
https://github.com/andrewjchen/zumy