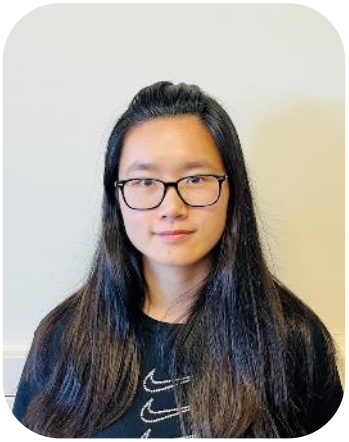
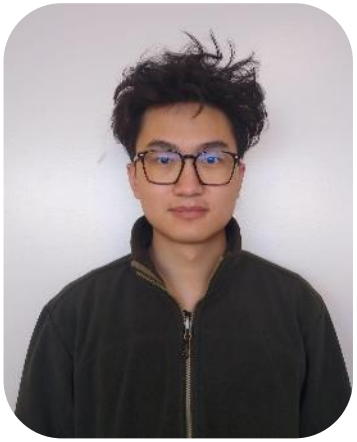
aerobot





Eric Buckland
Project Lead
UGV and Remote Station Hardware
Software Design and Integration

Angela Chen
Nordic Board Development and Integration
PCB Design
Communication Protocol

Kim Dang
Nordic Board Development and Integration
Communication Protocol

Tom Zu
Nordic Board Development and Integration
Serial Interaction

Our Thanks To

Phil Tokumaru
Tiziano Fiorenzani

Yogananda Isukapalli
Christopher Wimmel
Christopher Cheney
Brycen Westgarth

Problem Statement

- Uninterrupted connectivity for UGVs in disruptive environments
- Application of Ultrawide Bandwidth
- Relay nodes with radio module for stable communication

Project Overview

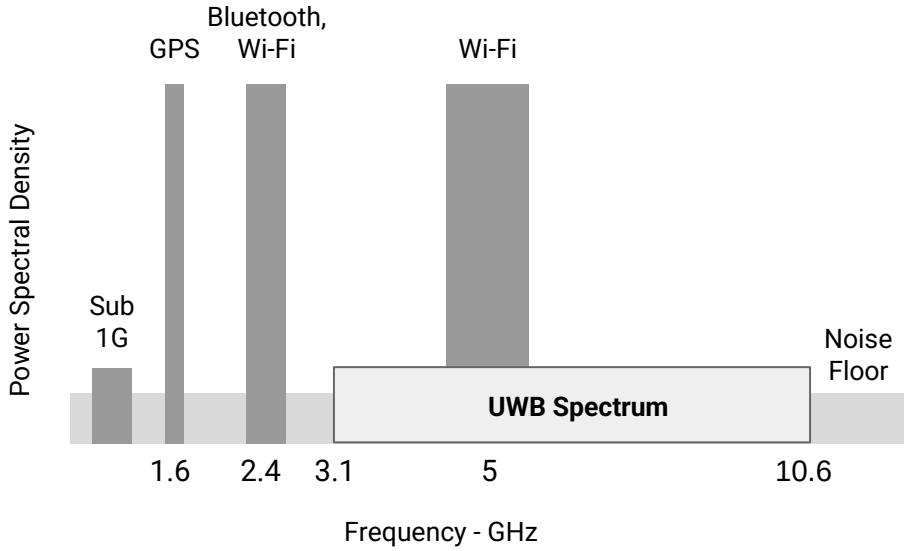
- Remote-controlled LiDAR SLAM-capable robot with camera feed
- Deploys RF and proximity aware nodes
- Uninterrupted connectivity in high-interference environments

Ultra-Wide Bandwidth

Uses narrow RF impulses

Frequency 3.1 GHz to 10.6 GHz

Bandwidth 500 MHz to 1.3 GHz



Why UWB?

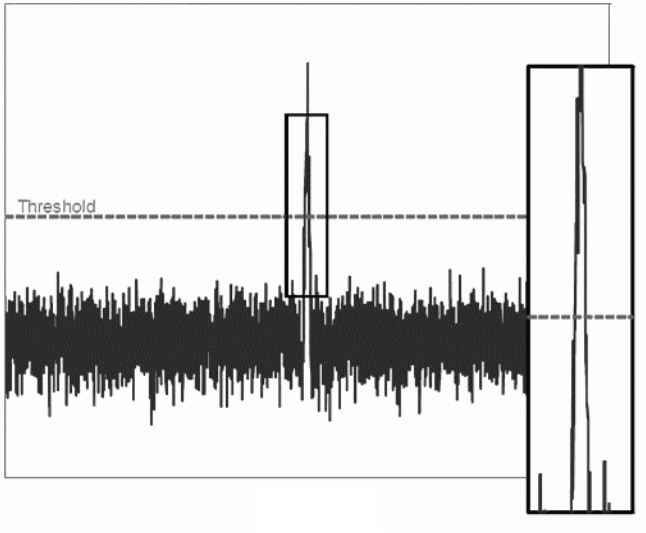
Low power and near noise floor

Resistance to multipath interference

Avoids commonly used frequencies

Data rates up to 27 Mbps

Ultrawide Bandwidth Signal vs Noise



UGV

Camera feed

LiDAR mapping

Remote control

Node deployment

Node

Deployable from robot

Links UGV and Station

Chain Topology

PIR sensor

Battery powered

Station

Camera display

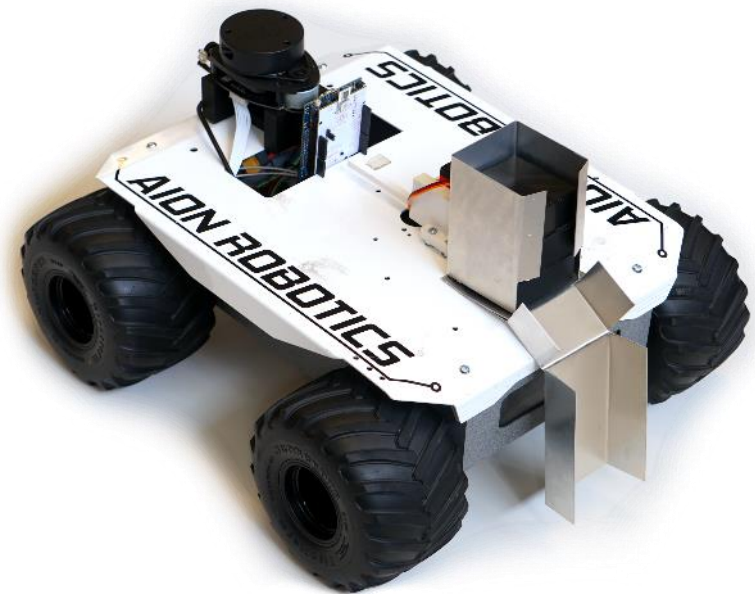
LiDAR map display

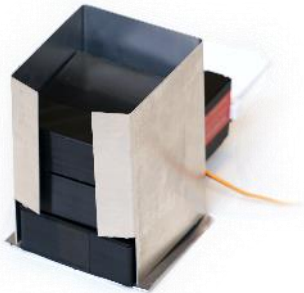
Node data display

Analog Control

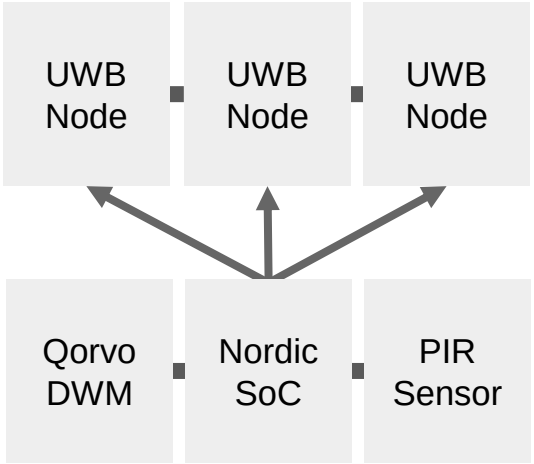
UGV

Drive Motors	Nordic SoC	Qorvo DWM
Robo-Claw Micro	Jetson TX2 ROS	LIDAR Hector Slam
Pololu Servo Control	Node Launch Servo	Night Vision Camera





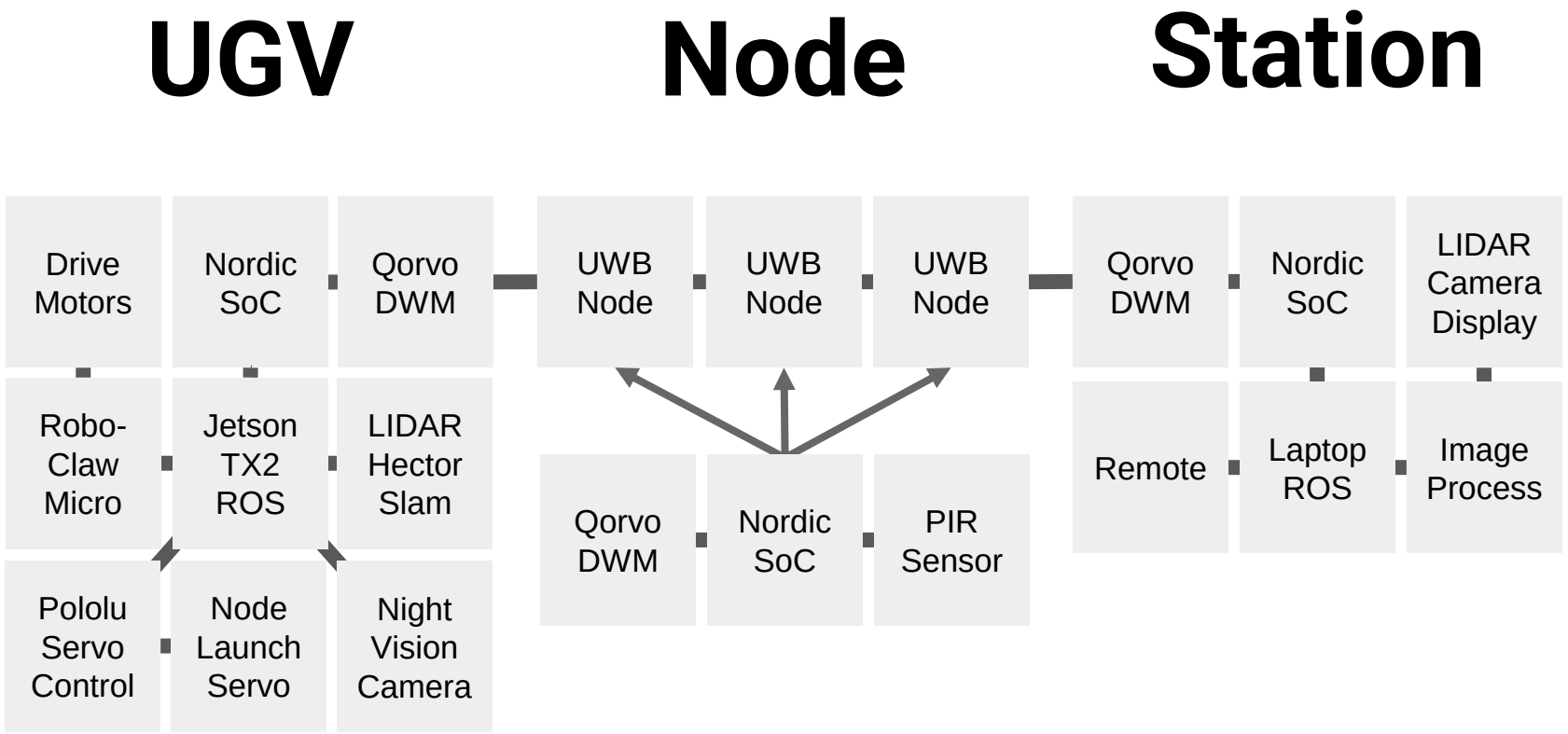
Node


UWB Node
UWB Node
UWB Node
Qorvo DWM
Nordic SoC
PIR Sensor

1004255 1.5 V LR6

Station

Qorvo DWM	Nordic SoC	LIDAR Camera Display
Remote	Laptop ROS	Image Process


UGV
Node
Station
Drive Motors
Nordic SoC
Qorvo DWM
UWB Node
UWB Node
UWB Node
Qorvo DWM
Nordic SoC
LIDAR Camera Display
Robo-Claw Micro
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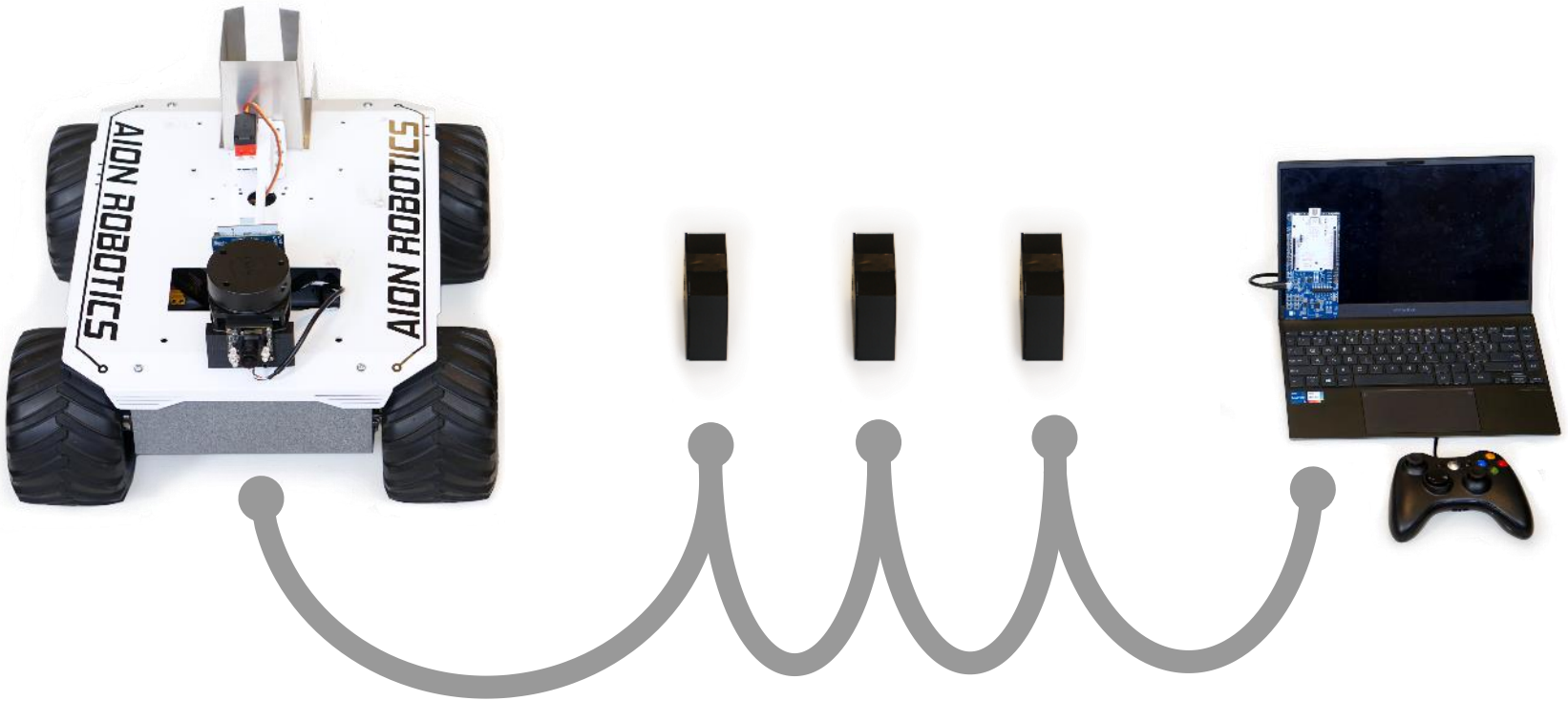
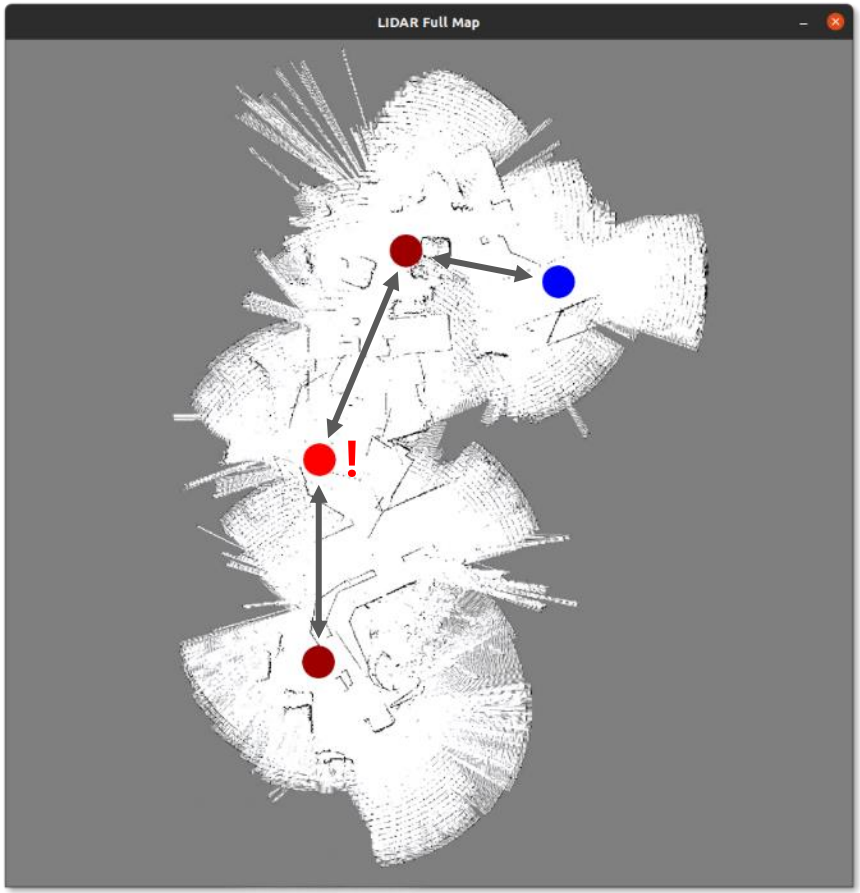
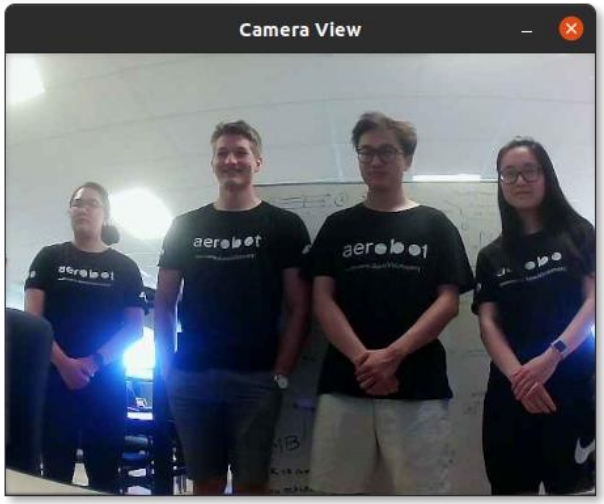

AION ROBOTICS
AION ROBOTICS

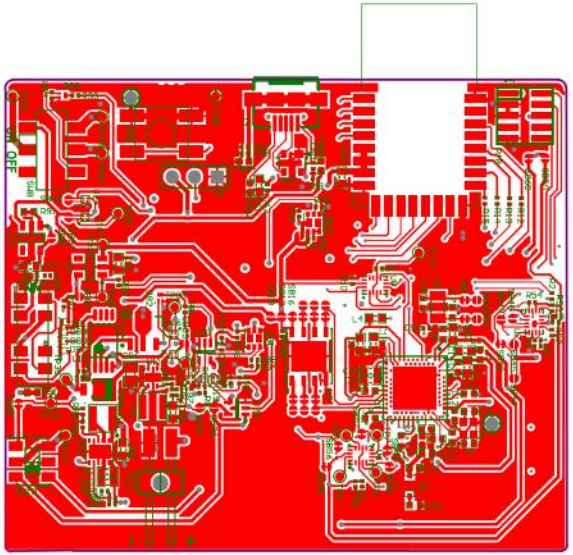
remot...

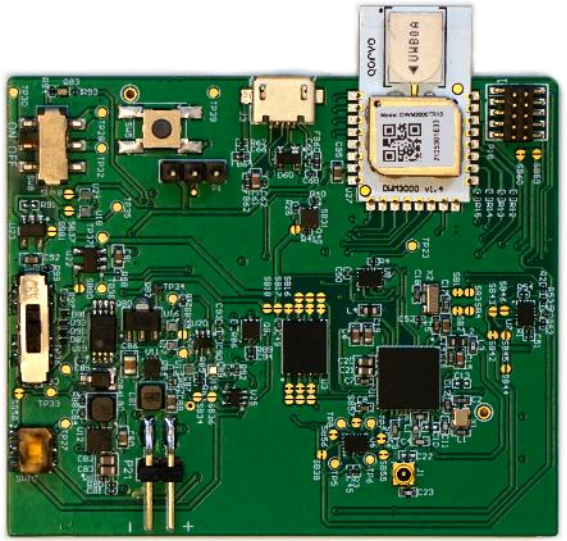
```
[INFO] [1652658986.640470]:


    Remote Station Status

Sent Control Data :
    Linear : 1.0
    Angular : -0.7828367352485657
    Deploy Node : False

Updates Received : 69
Round Trip Time : 0.9650027751922607
Nodes Online : 2

Passive Infrared Sensors :
    Node 1 : Not Triggered
    Node 2 : Triggered
    Node 3 : Not Triggered
```





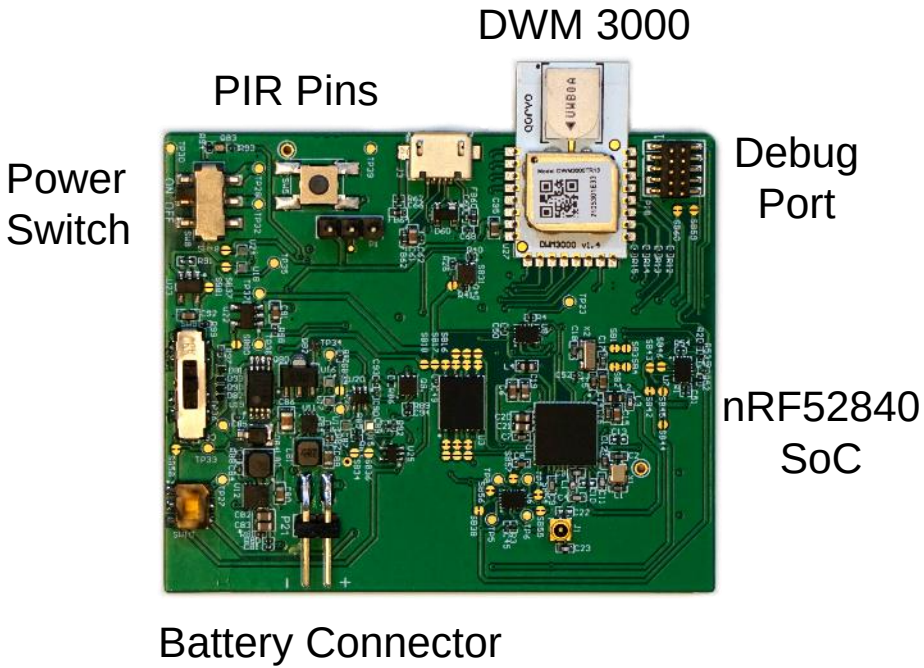
Printed Circuit Board





Printed Circuit Board

- 4 Layers (2.5” x 2.5”)
- On-board RF module
- Worked the 1st iteration!

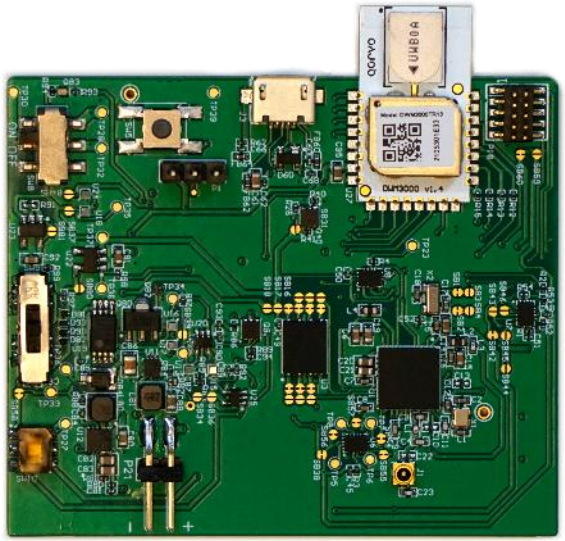


DWM3000 (UWB Module)

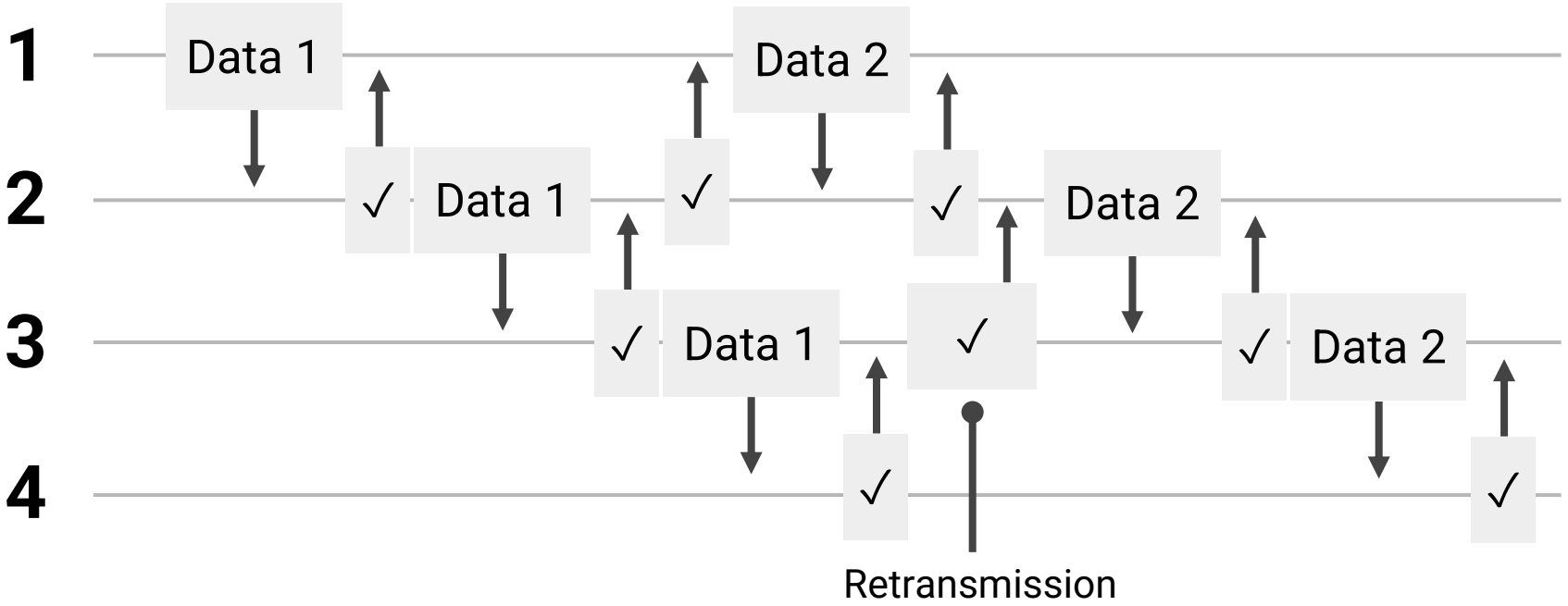
0.4 Inch Width, 0.9 Inch Height

Low Power, High Reliability

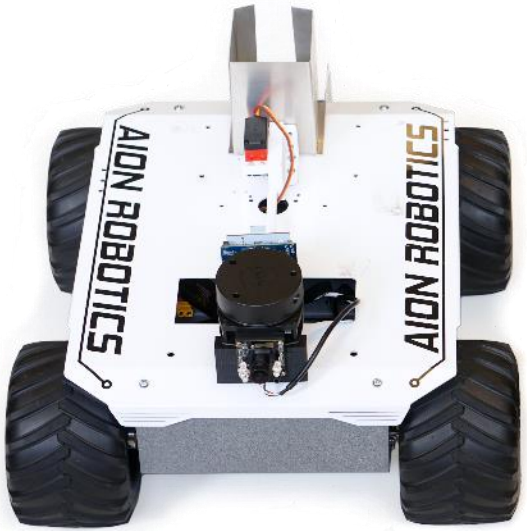
Released in 2020



Node Transmission Protocol

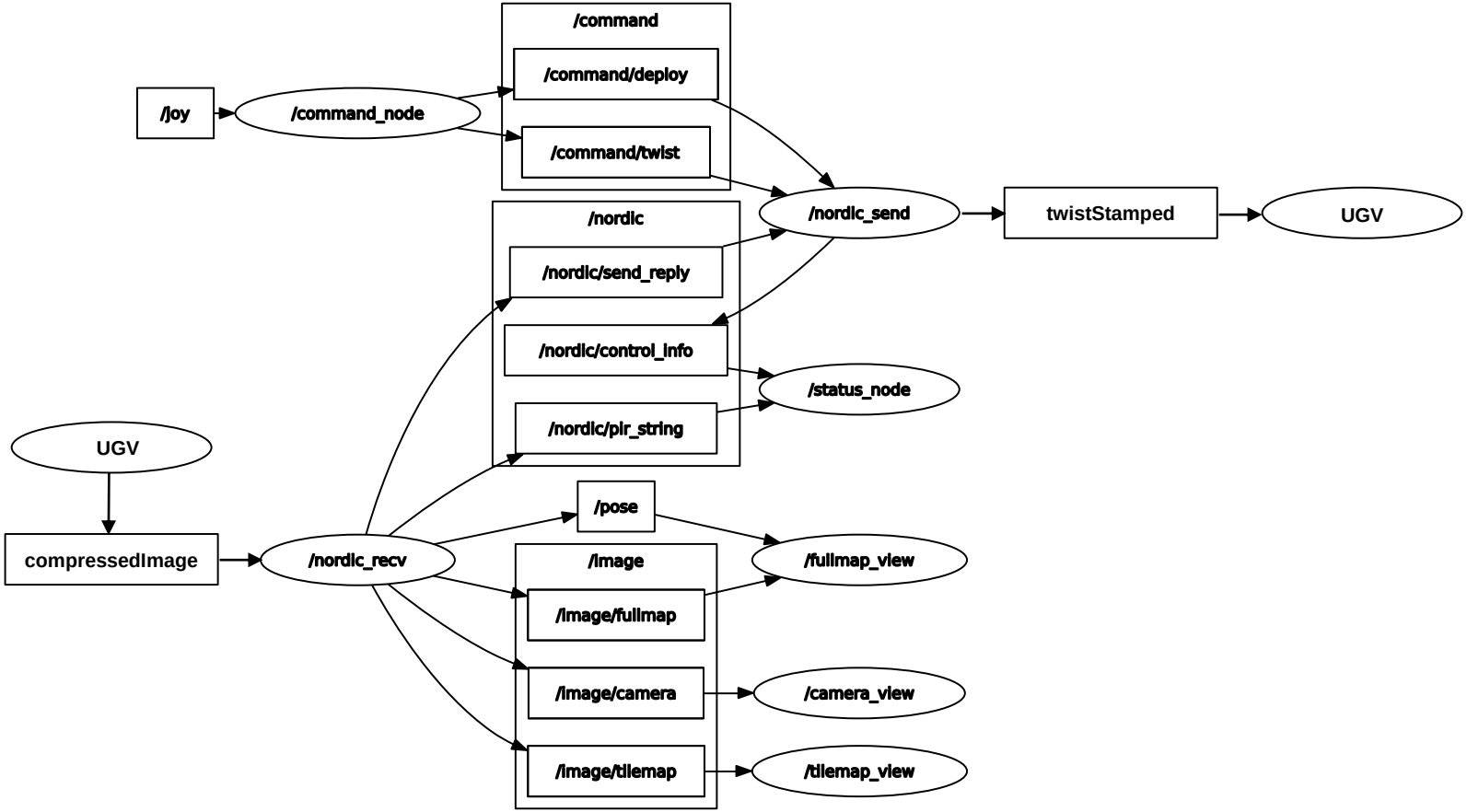


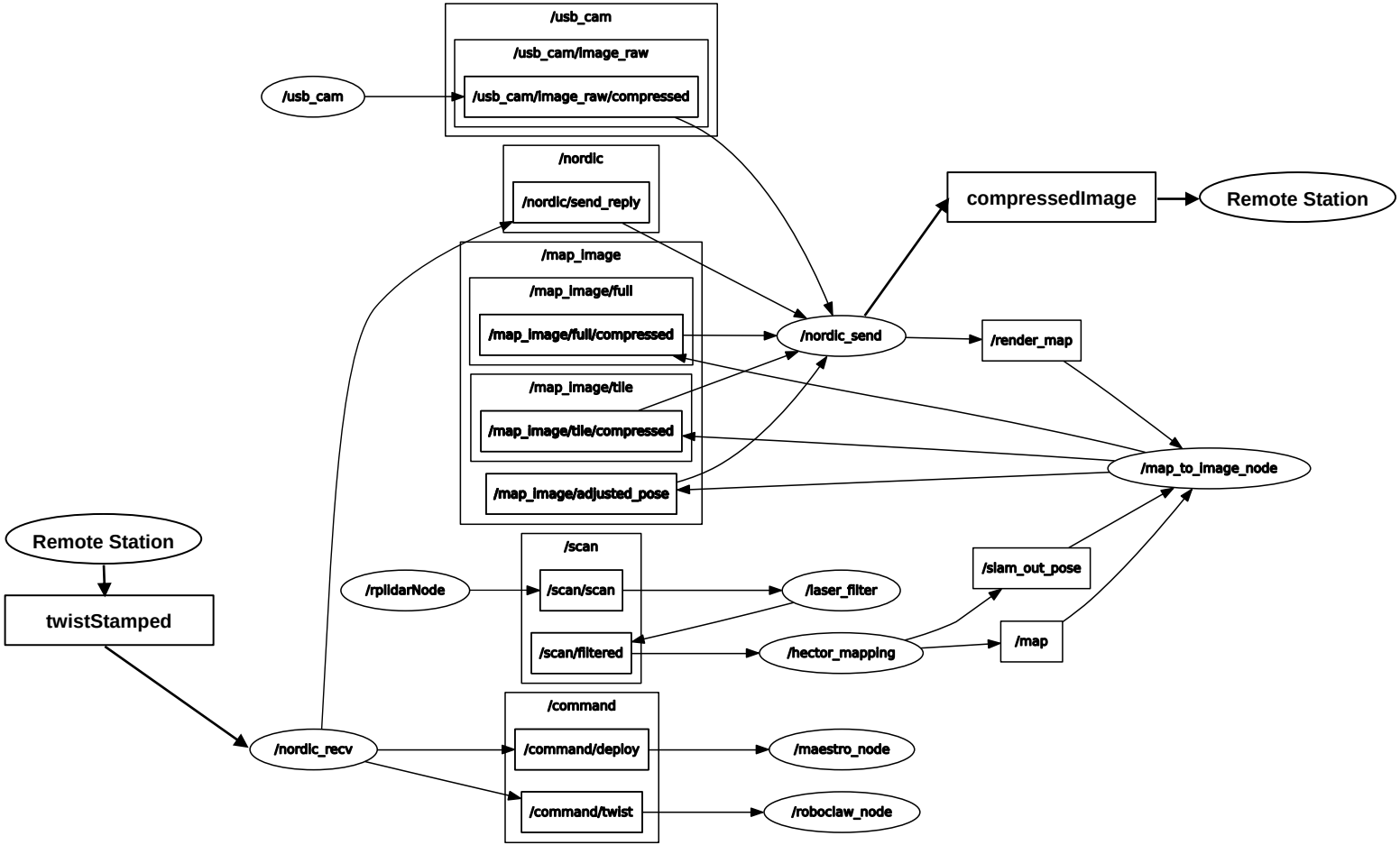
Serial Interface

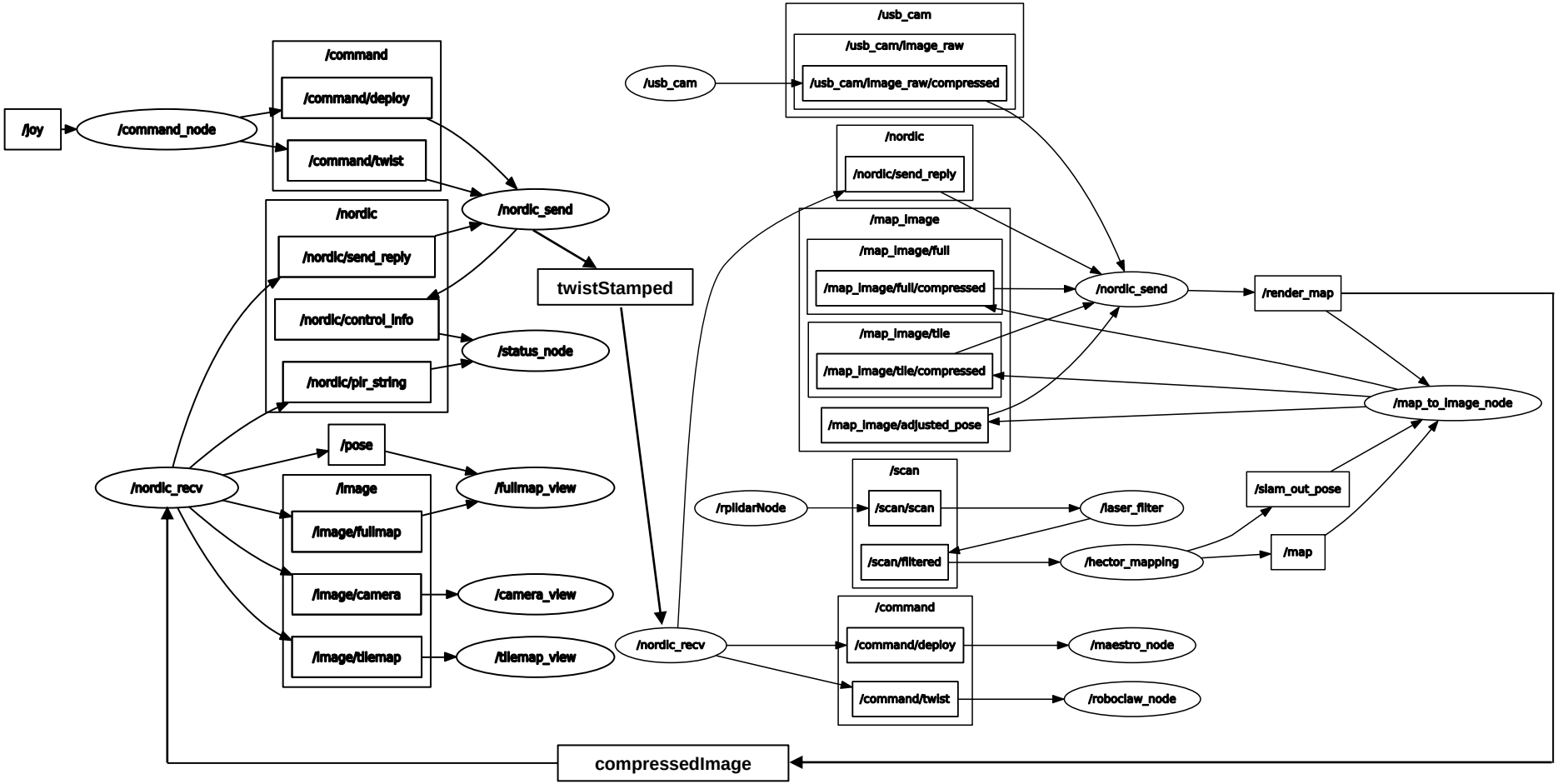


Challenges

- Node Coordination using Half-Duplex Communication
- Speed vs. Reliability Tradeoff
- ROS Implementation on UGV and Remote Station


/command
/command/deploy
/command/twist
/joy
/command_node
/nordic_send
twistStamped
UGV
/nordic
/nordic/send_reply
/nordic/control_info
/nordic/pir_string
/status_node
UGV
compressedImage
/nordic_recv
/pose
/image
/image/fullmap
/fullmap_view
/image/camera
/camera_view
/image/tilemap
/tilemap_view


/usb_cam
/usb_cam/image_raw
/usb_cam
/usb_cam/image_raw/compressed
/nordic
/nordic/send_reply
compressedImage
Remote Station
/map_image
/map_image/full
/map_image/full/compressed
/nordic_send
/render_map
/map_image/tile
/map_image/tile/compressed
/map_to_image_node
/map_image/adjusted_pose
Remote Station
/scan
/slam_out_pose
/rplidarNode
/scan/scan
/laser_filter
twistStamped
/scan/filtered
/hector_mapping
/map
/command
/nordic_recv
/command/deploy
/maestro_node
/command/twist
/roboclaw_node


/joy
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/command/deploy
/command/twist
/nordic_send
/nordic
/nordic/send_reply
/nordic/control_info
/nordic/pir_string
/status_node
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/nordic_recv
/image
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/image/camera
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compressedImage

Future Applications

- Multi-band OFDM UWB solution for IEEE 802.15.3a WPANs
- 802.15.4z Enhanced UWB PHY Layers and Associated Ranging
- Low Probability of Detection and Interception