Cooperative Mining Robots

ISSUE RECORD				
Engineer	**Issue No.**	**Reason for Reissue**	**Page/Pages**	**Date**
Brooks Barrett Joe Galyean Tom Gauntner Shaun Heilmann Rob Lane Salman Mujahid John Nawrocki Kristen Radecsky Jason Salisbury Manon Skrzypecki Jeff Stofanak Andrew Thomas	1.04	Added Functional Block diagrams for each subsystem as well as made some changes according to review from Professor Gum. Also changed issue no. to correlate with version number in the footer of the document.	2 through 23	March 1, 2004

Description:
This document provides the functional block state requirements for all subsystems of the Cooperative Mining Robots. Defined within this document, one will notice that each subsystem defines its individual states as well as a brief explanation of what the subsystem will be accomplishing. This document serves as the preliminary for the detailed design.

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Supervisory Station Functional Block

Engineer:

Manon Skrzypecki
Shaun Heilmann
Brooks Barrett

Description:

This section provides state requirements for the Supervisory Station portion of the Cooperative Mining Robots.

Architecture:

The Supervisory Station is broken up into non-user, user and high-level states with the given inputs and outputs for the system

Non-user states:

- Initialize
- Idle
- Start-up Message
- Accept status from all robots
- Handshake with robots about map
    - If version number out of date, send new map
- Accept position reports
- Handshake with robots about mine assignment
- Respond to robots about shift status requests
- Send new mine assignments
- Send map change command
- Request and accept debug information from specific robot
- Receive error flags

User states:

- Create map in text
- Send text file
- Create mine assignments
- Display current map (include robot position on map)
- Display previous, current and future mine assignments (talk to Gum on Monday)
- Display robot status
- Display error flags

High Level

- Power on/off
- Menu Options based on HyperTerminal input
    - Create map
    - Create shift
        - Display current robots on system with current mine assignment status
        - Create/Edit mine assignments
        - Update option to update robot mine assignments

Inputs

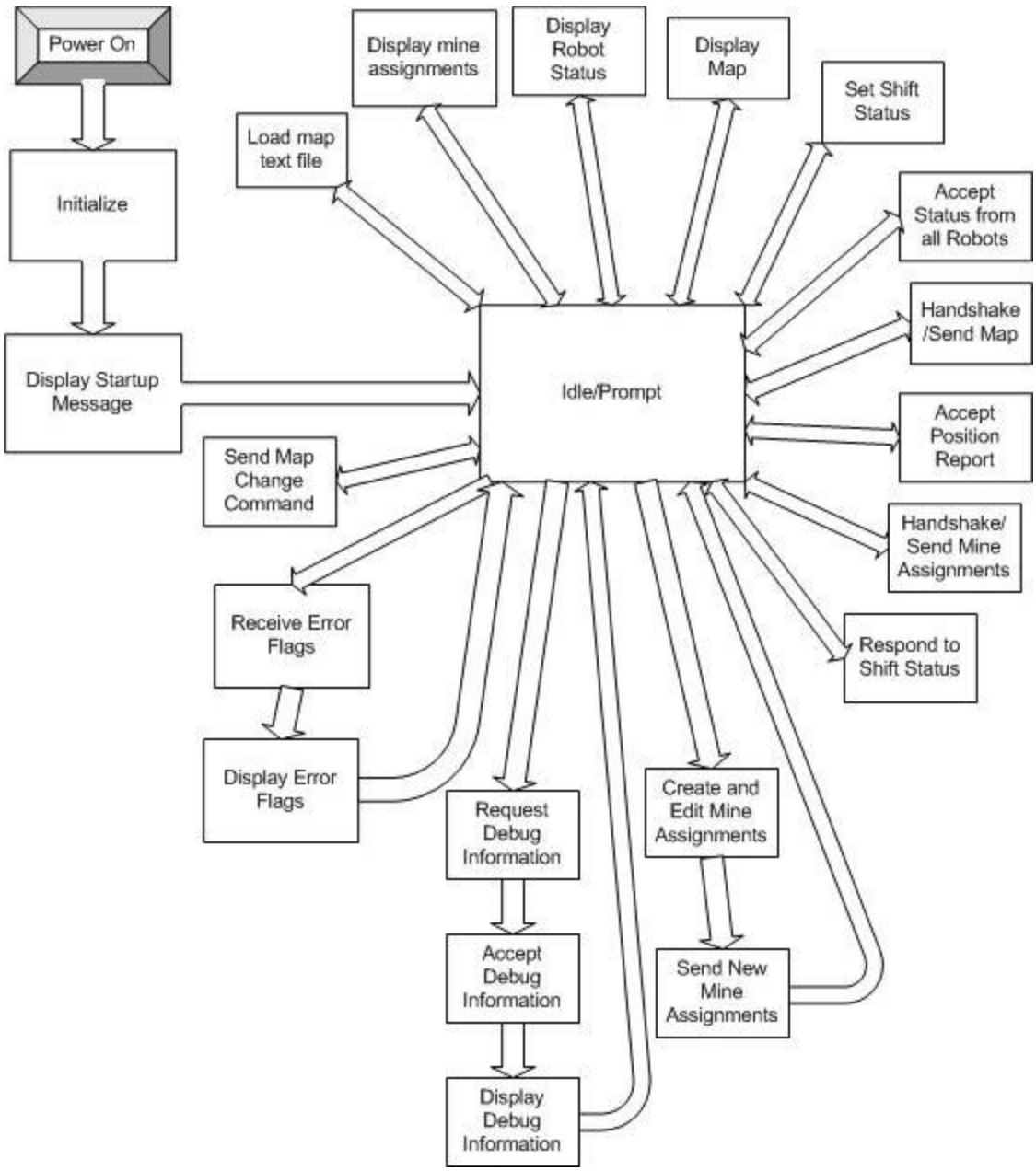
- *User*
    - Map configuration
    - Mine assignments
    - Update option to transmit info to robots
    - Begin and end shift
- *Non-user*
    - Robot location
    - Robot status
    - Robot error flags

Outputs

- *User*
    - Display map with current robot locations
    - Display robot status
    - Display robot error flags
    - Display mine assignments
- *Non-user*
    - Send map to robots
    - Send mine assignments to robots
    - Send execution command to robots
    - Send shift status to robots

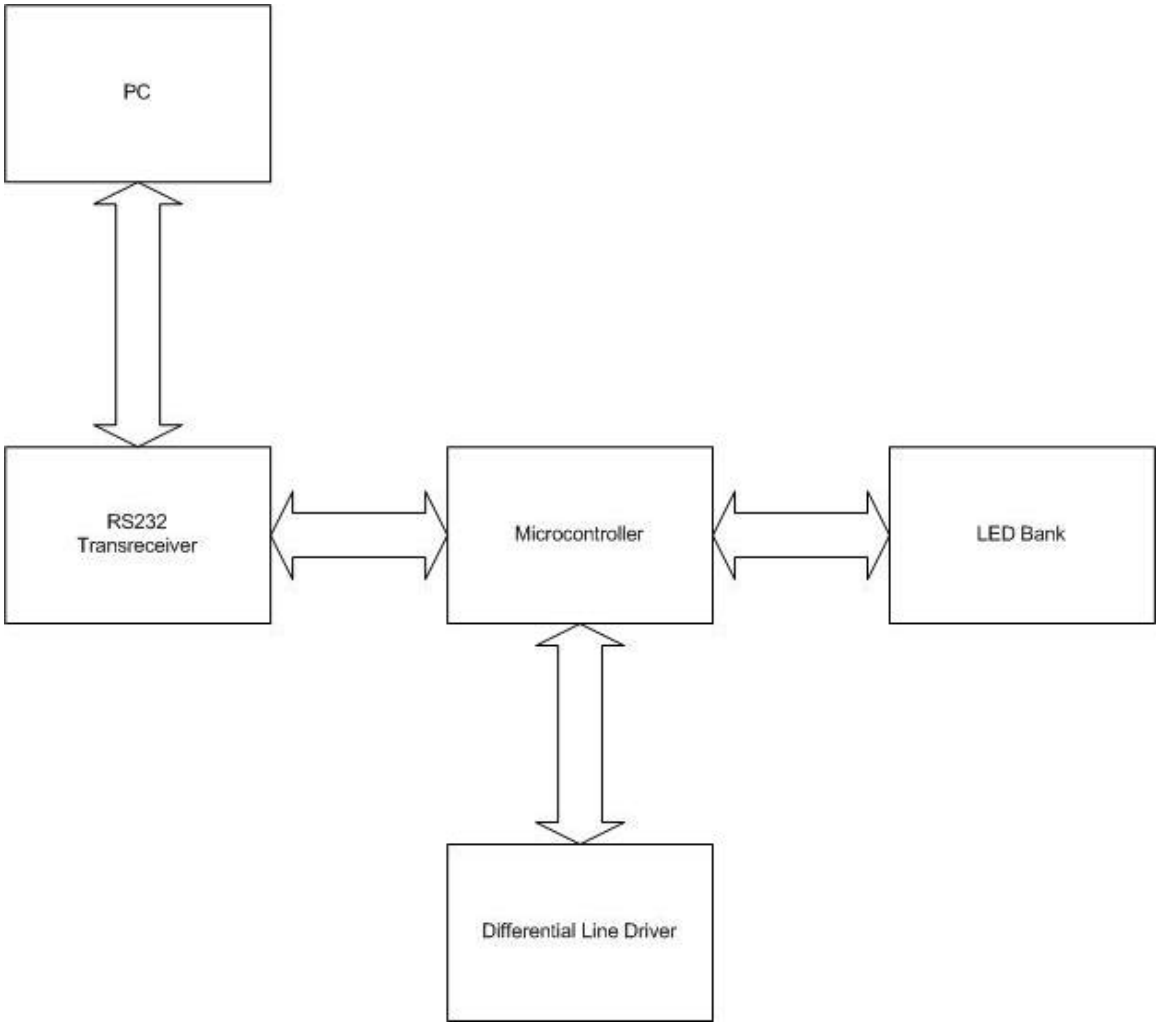
Supervisory Station Functional Block Diagram

Version 1.00



Supervisory Station Hardware Functional Block Diagram

Version 1.00



Wired Communication Functional Block

Engineer:

Shaun Heilmann
Joe Galyean
Tom Gauntner

Description:

This section provides state requirements for the wired communication portion of the Cooperative Mining Robots.

Architecture:

Communication:

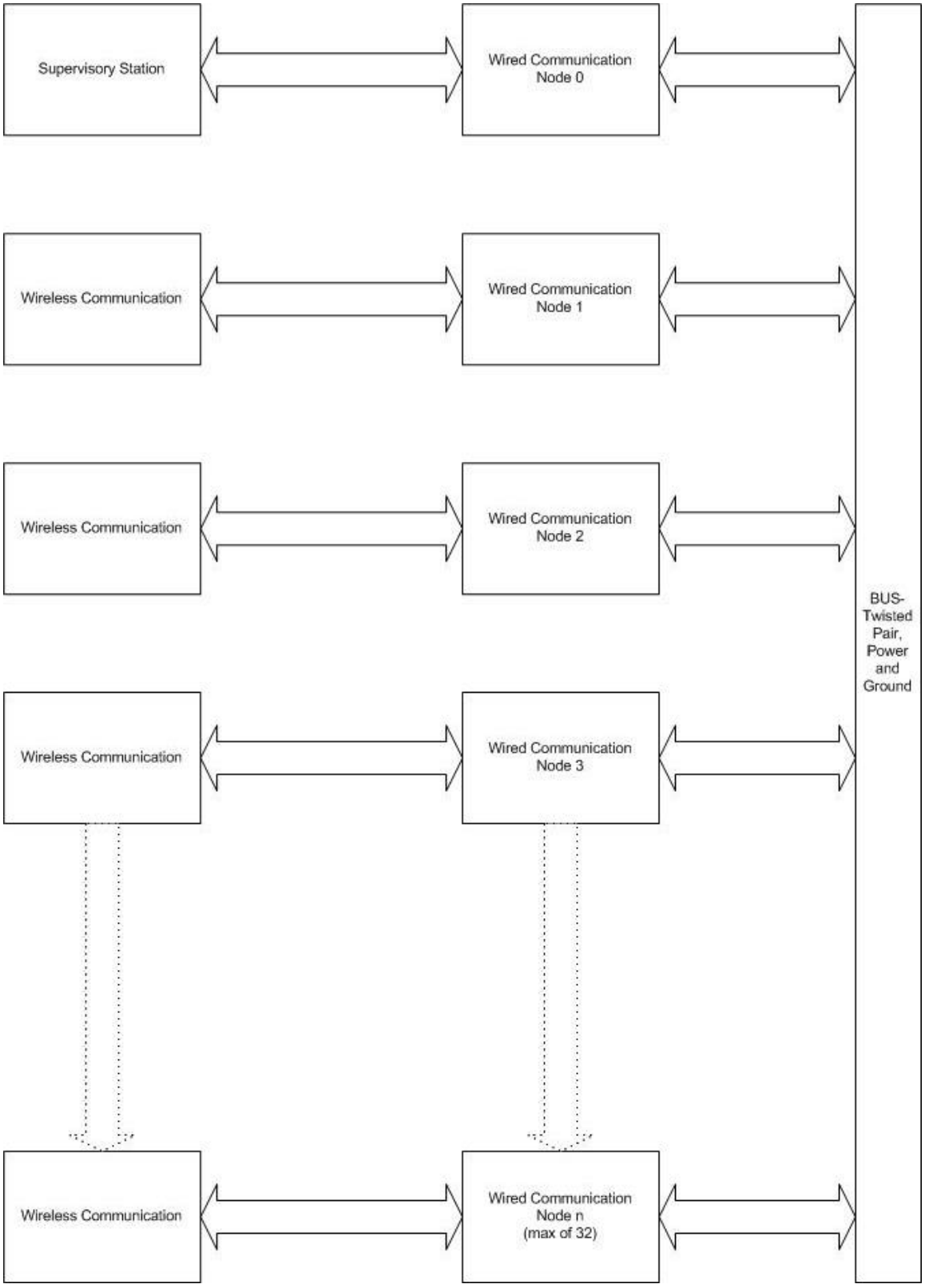
The Wired Communication function block provides a reliable communication link between the Wireless Communication, consisting of multiple robot nodes, and the Supervisory Station functional blocks. The Wired Communication shall provide the following states:

- Transmit to the Supervisory Station
- Receive from the Supervisory Station
- Notify Supervisory Station if received message was corrupt for retransmission
- Retransmit message to Supervisory Station if message was corrupt
- Transmit to all nodes of the Wireless Communication
- Receive from Wireless Communication
- Notify Wireless Communication if received message was corrupt for retransmission to guarantee reliability
- Retransmit message to Wireless Communication is message was corrupt
- Ping with the robot nodes to update location/position information

System shall be based on Ethernet protocol in which a maximum of 32 nodes shall be used for Wireless Communication link. Another node will be allocated to the supervisory station in order for direct communication.

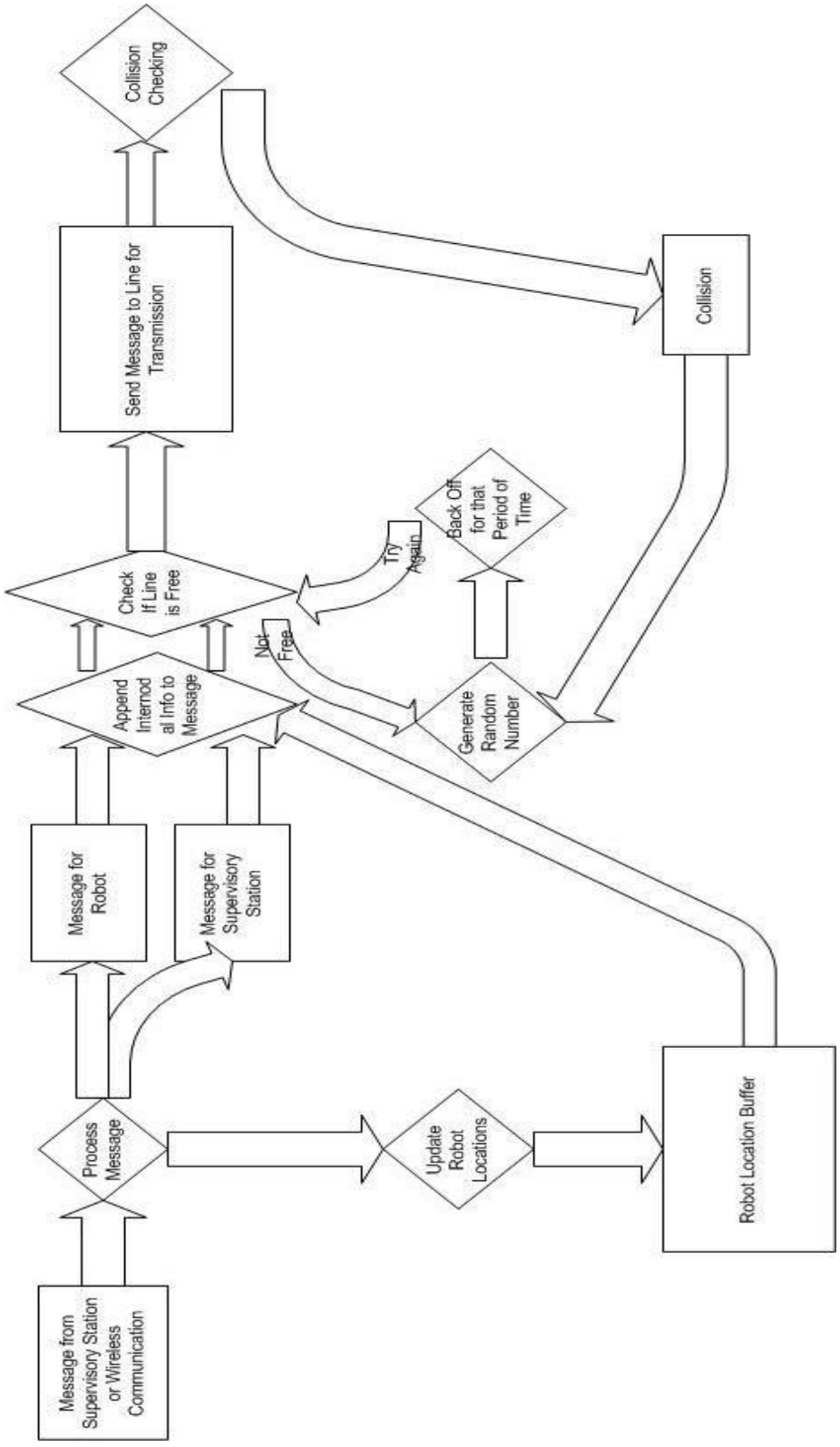
Wired Communication Functional Block Diagram

Version 1.00



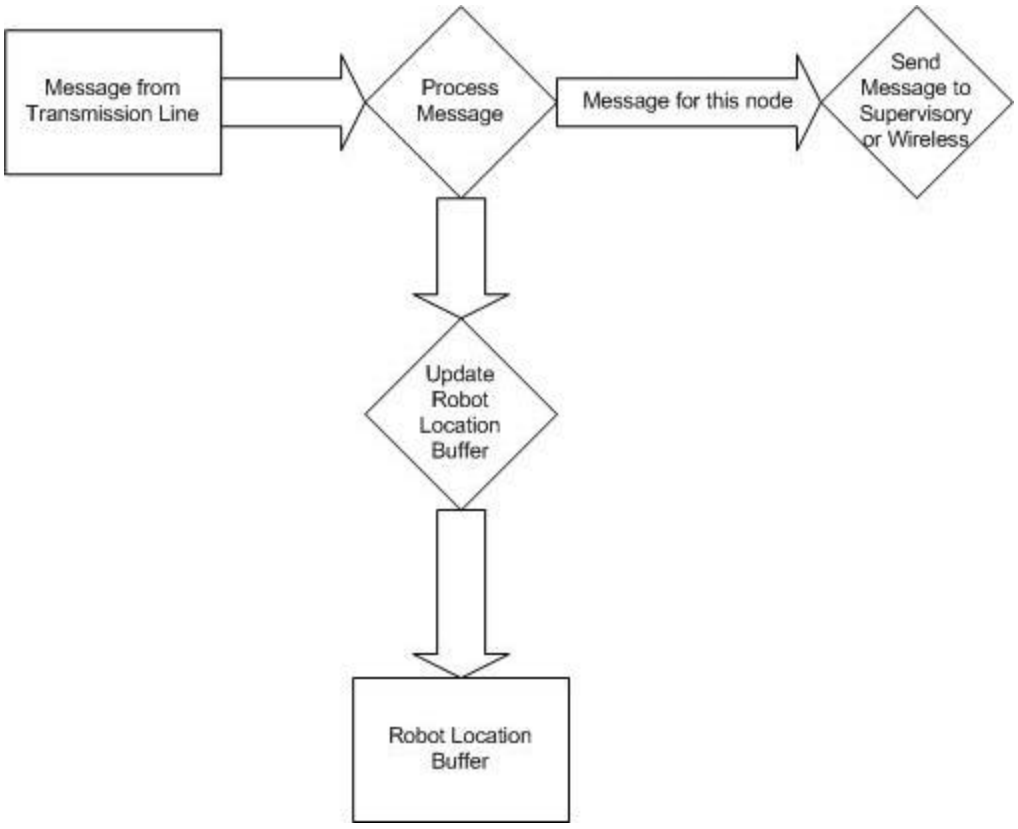
Wired Communication Detailed Functional Block Diagram

Version 1.00



Wired Communication Detailed-B Functional Block Diagram

Version 1.00



Wireless Communication Functional Block

Engineer:

Joseph Galyean
Rob Lane
Andrew Thomas

Description:

This section provides state requirements for the wireless communication portion of the Cooperative Mining Robots.

Architecture:

The Wireless Communication functional block provides a communication link between the Cooperative Mining Robot and the Wired Communication functional block. The Wireless Communication shall provide the following states:

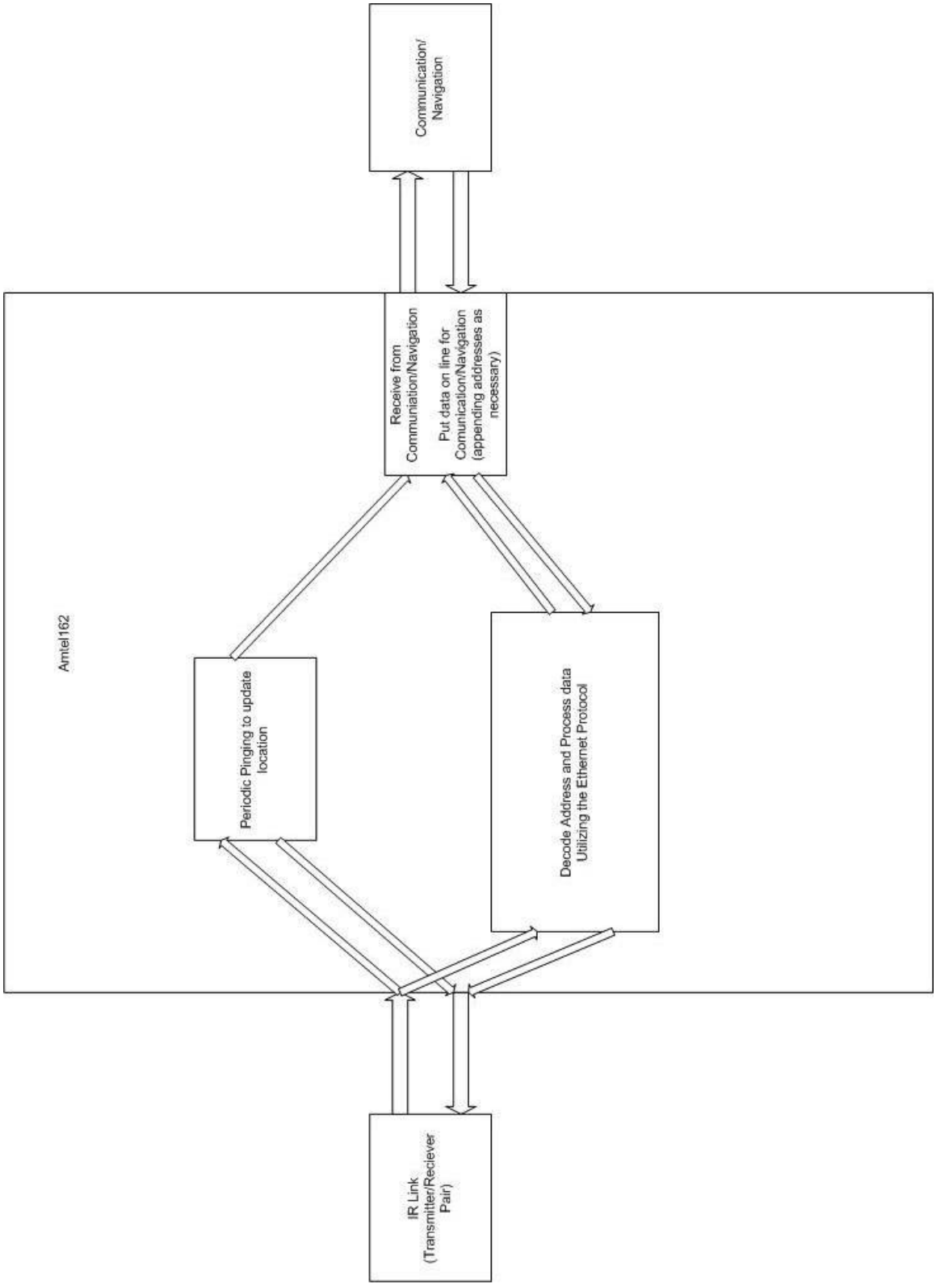
- Process and transmit message to Central Control
- Receive data for message from Central Control
- Transmit location to Navigation
- Receive location information from Navigation
- Transmit message to Wired Communication
- Receive message from Wired Communication
- Ping with ceiling nodes to update location/zone information

Transmit to and receive from Wired Communication states shall contain a handshaking routine to ensure the message is correctly transmitted or received.

The protocol for communication shall be based around an Ethernet system in with the other node being a ceiling node on one end and Central Control/Navigation on the other end.

Wireless Communication Functional Block Diagram

Version 1.00



Navigation Functional Block

Engineer:

Salman Mujahid
John Nawrocki
Jason Salisbury

Description:

This section provides state requirements for the navigation portion of the Cooperative Mining Robots.

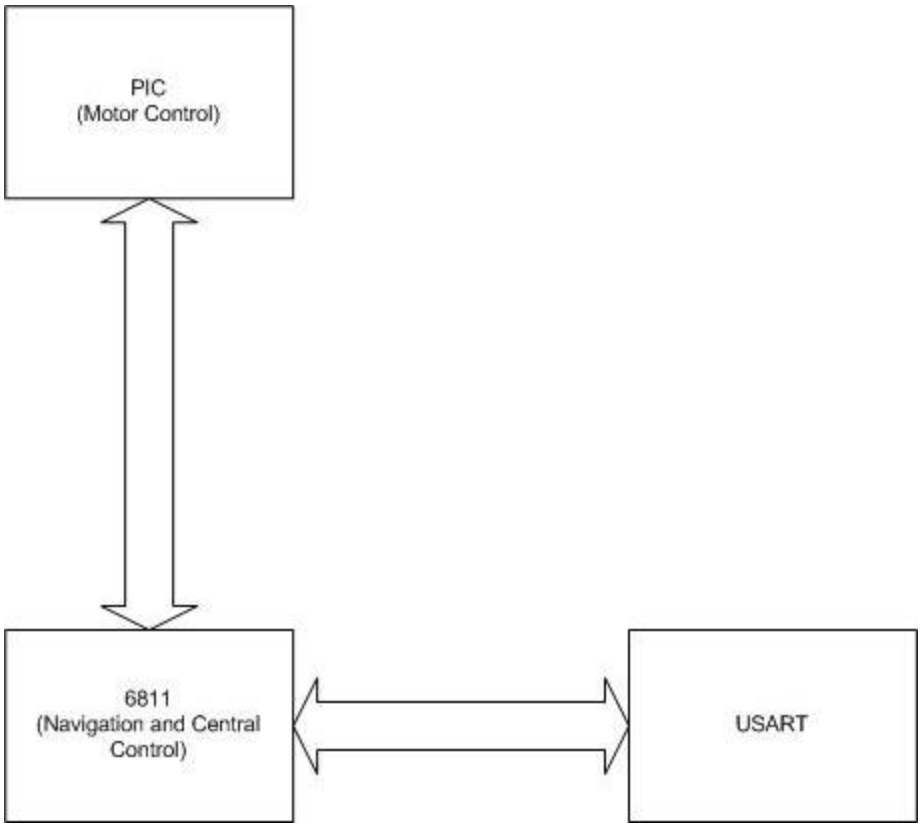
Architecture:

Navigation shall provide five [5] functions:

- Communicate with Central Control
  - This state will communicate with central control by receiving both map information and mine work orders. It will also send Error and debugging information back to central control.
  - Inputs – Map information or mine work orders
  - Outputs – Error and debugging information including that from Motor Control
- Communicate with Wireless
  - This state will communicate with wireless by receiving movement commands. It will also send the movement commands from its own robot to wireless.
  - Inputs – Movement commands from other robots
  - Outputs – Movement commands from this robot
- Communicate with Motor Control
  - This state will communicate with motor control by receiving completed tasks. It will also send the new tasks to motor control.
  - Inputs – Completed task information as well as error and debugging information
  - Outputs – Commands to perform new tasks
- Decide the path to take
  - This state will take the movement commands that were received from wireless and the mine work orders received from central control and will make a decision about the path to take. It will then issue the orders that will go to motor control, including the direction commands.
  - Inputs – Movement commands from other robots and mine work orders.
  - Outputs – The path the robot must take to reach it's destination including direction commands
- Idle (Wait for receive)

Navigation Functional Block Diagram

Version 1.00



Motor Control Functional Block

Engineer:

Rob Lane
John Nawrocki
Jason Salisbury
Jeff Stofanak

Description:

This section provides state requirements for the motor control portion of the Cooperative Mining Robots.

Architecture:

Motors:

The robot motor control shall track a tape, placed on the floor, with negligible error. The motor control shall provide five [5] functions:

- Straight
  - While in the straight state, the robot will receive feedback from the sensors in order to keep in online with the tape.
- Reverse
  - While in the reverse state, the robot will receive feedback from the sensors in order to keep in online with the tape.
- 180° turn
- Right turn
- Left turn

Each time the robot reaches a tick mark on the floor it will inform Navigation that it has finished the current task (straight, reverse, 180° turn, right turn, left turn) and it will receive a new task.

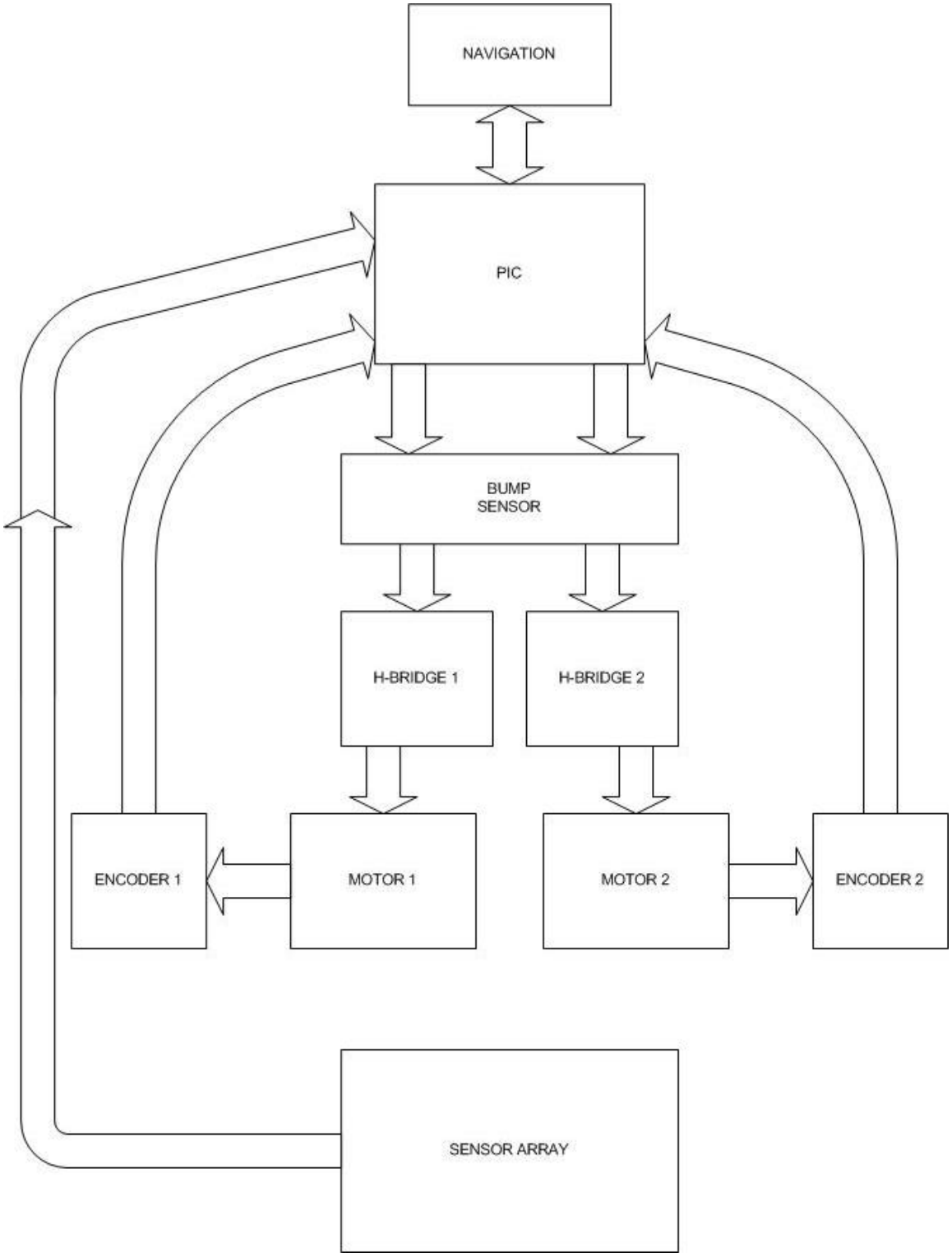
There shall be a panic state that will be activated when the bump sensor on the robot encounters an obstacle. The power to each motor will be interrupted until which time the Navigation sees fit to apply power again.

Communication:

Input - Motor control shall receive commands from Navigation to perform a function.
Output - Motor control shall inform Navigation each time it has completed a specific function

Motor Control Functional Block Diagram

Version 1.00



Central Control Functional Block

Engineer:

Brooks Barrett
Kristen Radecsky
Andrew Thomas

Description:

This section provides state requirements for the Central Control portion of the Cooperative Mining Robots.

Architecture:

High Level

1. Power on / reset
2. Check previous status
   Finds out if it were reset, and if so why. (Check non-volatile)
3. Check for coherent response from all subsystems indication the system is operational.
4. Broadcast status
   Send its state to other bots and supervisory station.
5. Ask for Map
6. Broadcast a request for everyone to send a position report and wait a little to receive.
7. Feed map with current positions to navigation.
8. Broadcast confirmation map is loaded.
9. Ask for Mine Assignment from supervisory station.
10. Send Navigation specific mine to work from
11. Perform Tasks (defined below)

SPECIAL STATES
ERRORS – random and interrupting (defined below)
Sanity Check – automatic and periodic

11. Perform Tasks

a. Check shift status.

If shift has not yet started, wait.

If shift started, tell navigation to proceed.

If shift over, tell navigation go to maintenance shaft.

b. Check each subsystem's states for normal operation via polling

Poll each subsystem for error flag – Triggers ERROR state with flag

c. Receive Supervisor command

Accept new mine designation

Send Navigation specific mine to work

If command is a map change, store condition in the non-volatile, trigger reset.

Debugging information requested

Dump debug info to supervisor.

d. Deal with request for position report

Halt report sending until confirmation of map loaded from requesting robot.

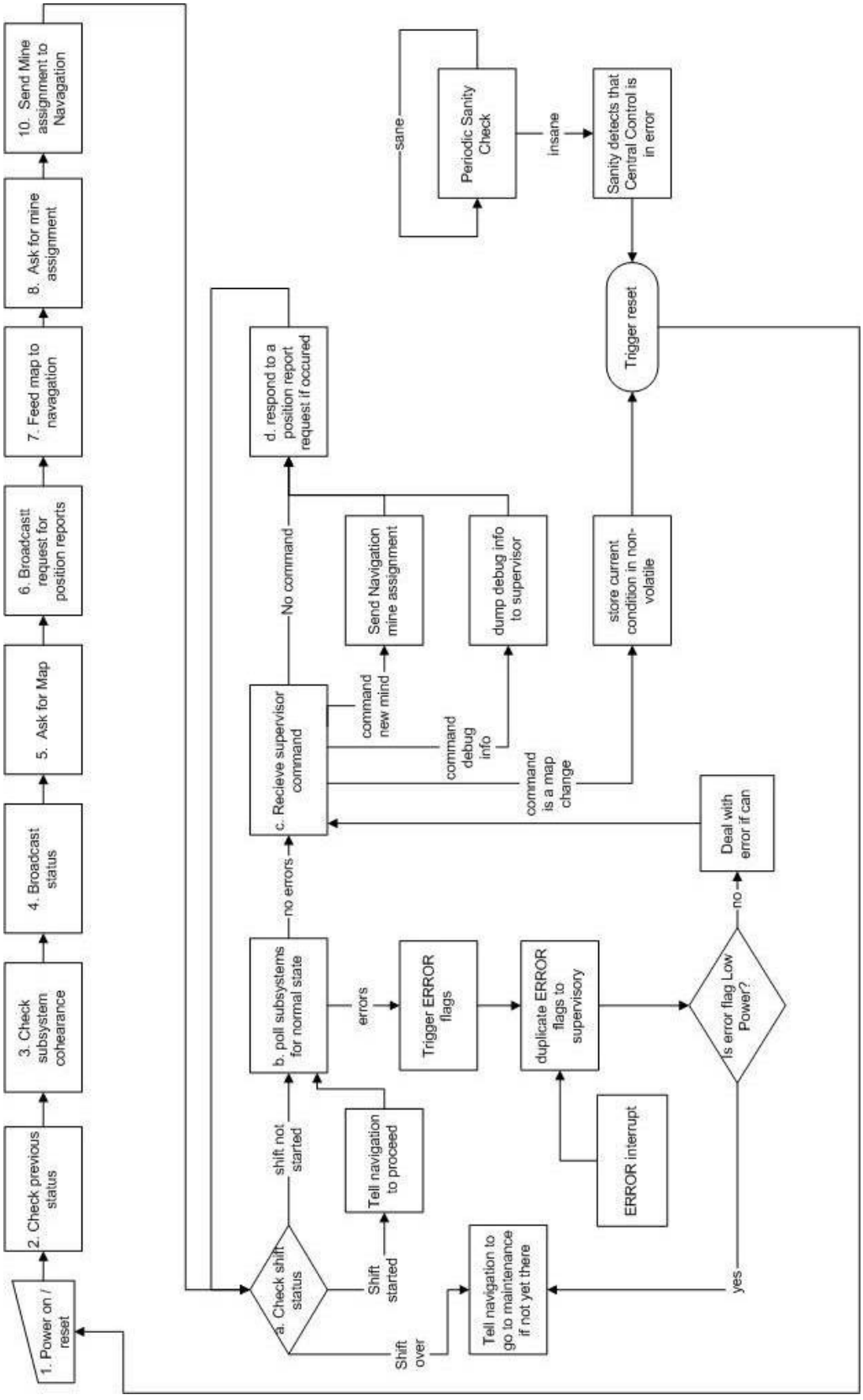
ERRORS

Duplicate error flag(s) to supervisor.

If error flag is Low Power, tell navigation to go to maintenance shaft.

Central Control Functional Block Diagram

Version 1.00



Sanity Functional Block

Engineer:

Manon Skrzypecki
Kristen Radecsky
Jeff Stofanak

Description:

This section provides state requirements for the Sanity portion of the Cooperative Mining Robots.

Architecture:

1. Power on
2. Handshake with Central Control
   This includes sending and receiving a specified pattern of bits. Shall occur continuously as long as there is no problem.
3. Error exchange in handshaking once.
4. Error exchange in handshaking twice.
5. Error exchange in handshaking three times.
6. Sanity declares a reset on central control as well as motor control.

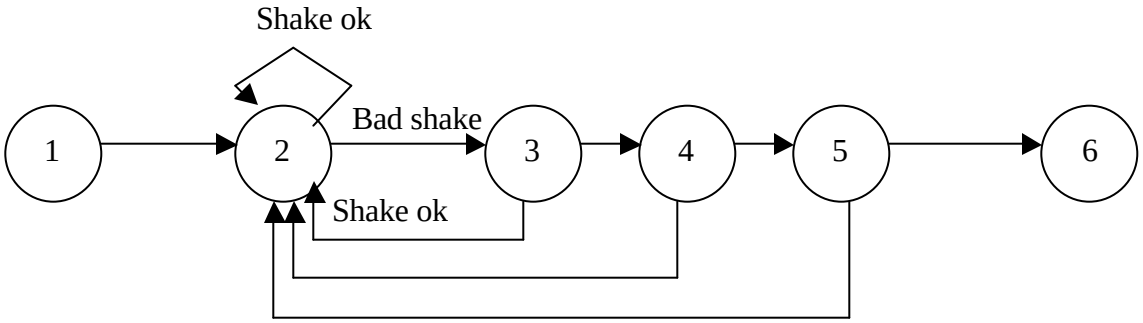
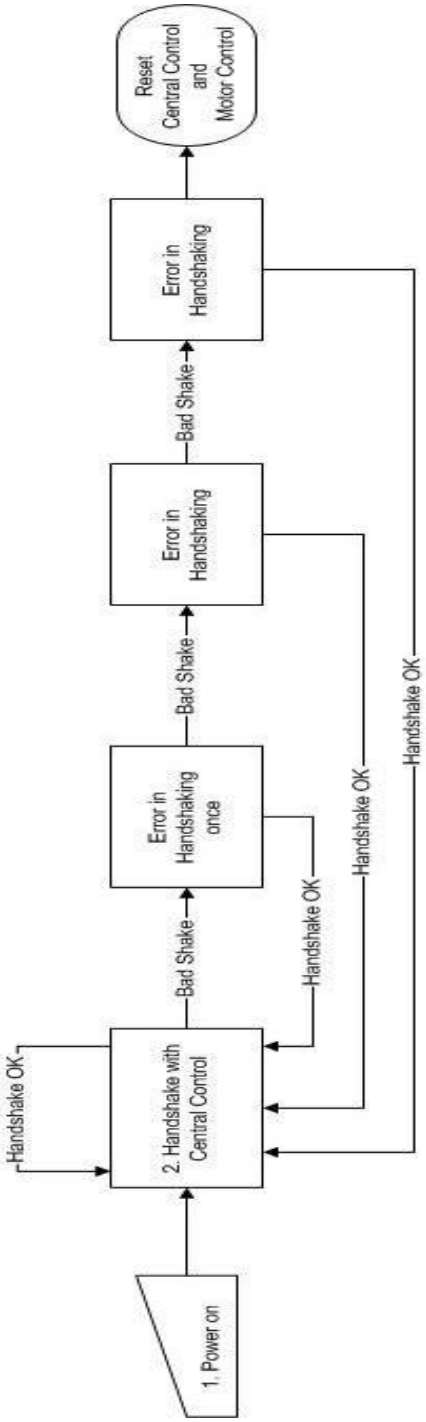


Figure 1.1

Sanity Functional Block Diagram

Version 1.00



Power Functional Block

Engineer:

Salman Mujahid
Tom Gauntner
Jeff Stofanak

Description:

This section provides state requirements for the power portion of the Cooperative Mining Robots.

Architecture:

Power Monitoring:

The Power Monitoring module shall be responsible for monitoring the battery level triggering an alarm when the low battery threshold is reached. The low battery threshold shall be determined when the system current is better understood. Thus this unit shall have two [2] states.

1. Functioning with adequate power from the battery and the low voltage alarm is not activated.
2. The battery voltage level has dropped below the low voltage threshold and the low voltage alarm is activated.

Power Distribution:

The Power Distribution module shall be responsible for allocating the required power to the five functional blocks on the robot, namely

1. Wireless Communication
2. Navigation
3. Motor Control
4. Central Control
5. Sanity.

Power Distribution shall be responsible for reporting current a overdraw alarm (i.e. a tripped Motor Control breaker). This unit will have two [2] states.

1. Normal operation, the system is functioning normally with all power requirements met and no current overdraw (no breakers tripped).
2. Over current operation, the system activates the current overdraw alarm sending the appropriate signal to central control.

Power Distribution shall also have a means of cutting power to all functional blocks by way of a switch.

Recharging:

- There shall be a means, namely a mechanical switch, of disconnecting the battery from the functional blocks of the robot in order to charge the battery and protect the electronics within the robot.

Power Functional Block Diagram

Version 1.01