ANDESITE

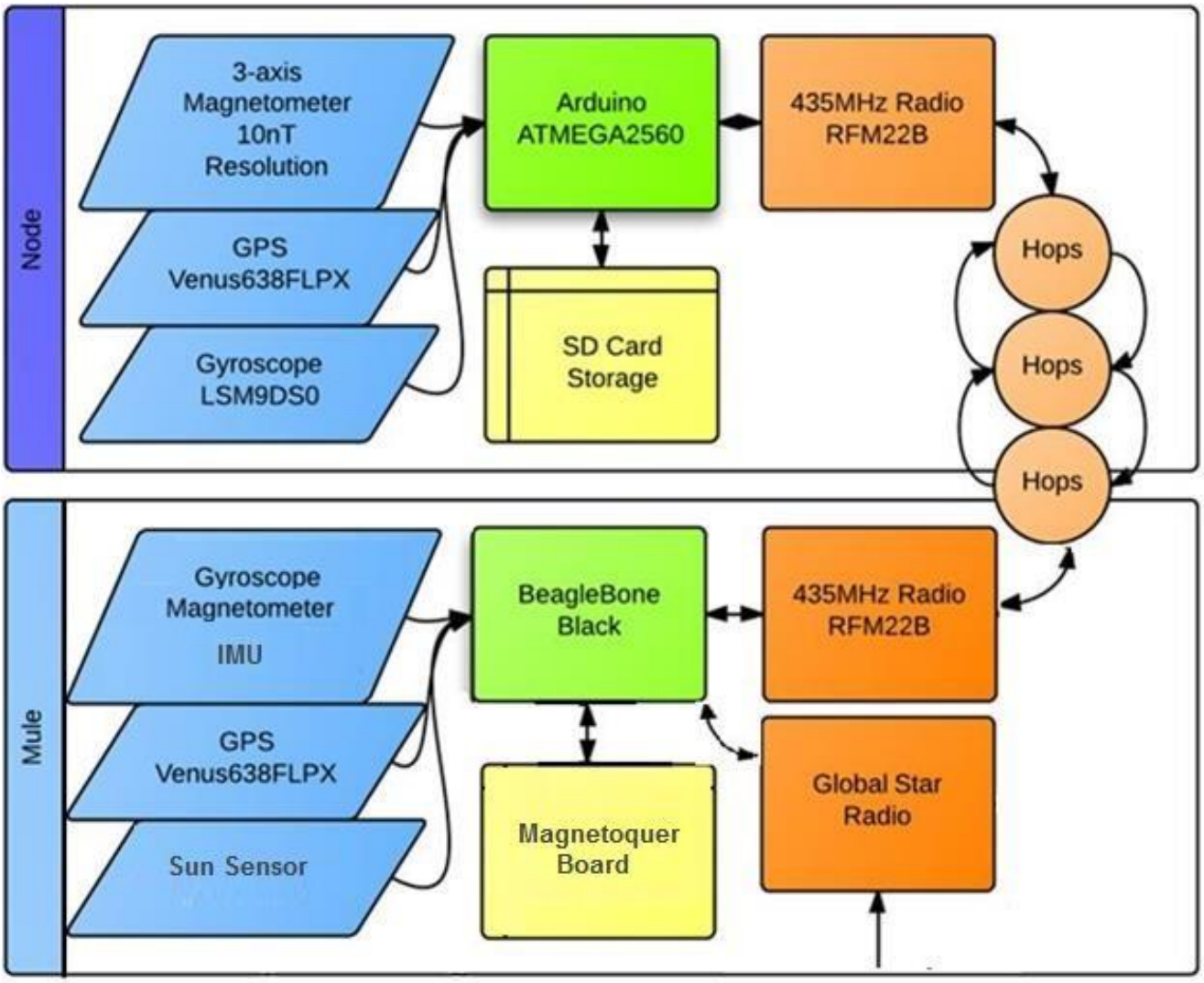
Boston University
CDH Subsystem
Internal Review

August 1st 2016

CDH requirements

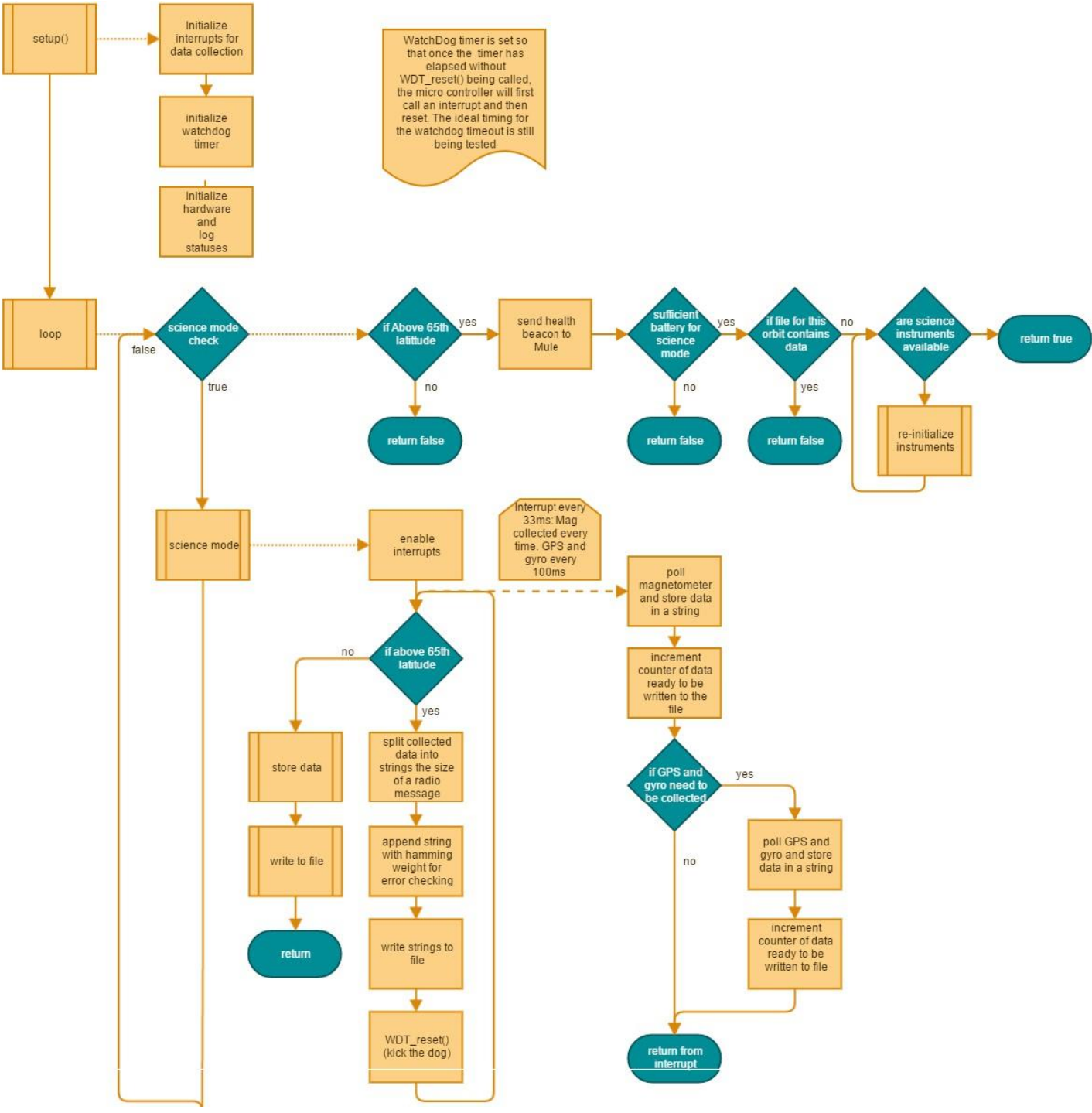
Requirement	Description
CDH-1 Tests: 1.0-1.6, 4.0, 5.0, 6.0	The mule and sensor node C&DH subsystem shall handle the collection and transmission of magnetometer, GPS, and gyroscope data.
CDH-1.1 Test: 3.0	The sensor node C&DH subsystem shall collect magnetometer data at a minimum rate of 30 hertz.
CDH-1.2 Test: 3.0	The sensor node C&DH subsystem shall process GPS and gyroscope readings at a minimum rate of 10 hertz.
CDH-2 Test: 2.0	Each sensor node shall transmit data to the mule at a minimum rate of 1,212 bits per second.
CDH-3 Test: 8.0	The sensor nodes shall enter low power mode if power drops beneath a pre- determined threshold.
CDH-3.1 Test: 8.1	The sensor node C&DH subsystem shall exit low power mode once the batteries have been charged to 3.7v.
CDH-4 Test: 1.5	The C&DH mule shall be operable throughout all powered modes of the spacecraft.
CDH-5	The C&DH mule shall have bi -directional communication with the sensor nodes and the GlobalStar network.
CDH-8 Test: 1.5	The mule C&DH shall temporarily store all data for at least 2 days while communication with an authorized ground station is not possible.

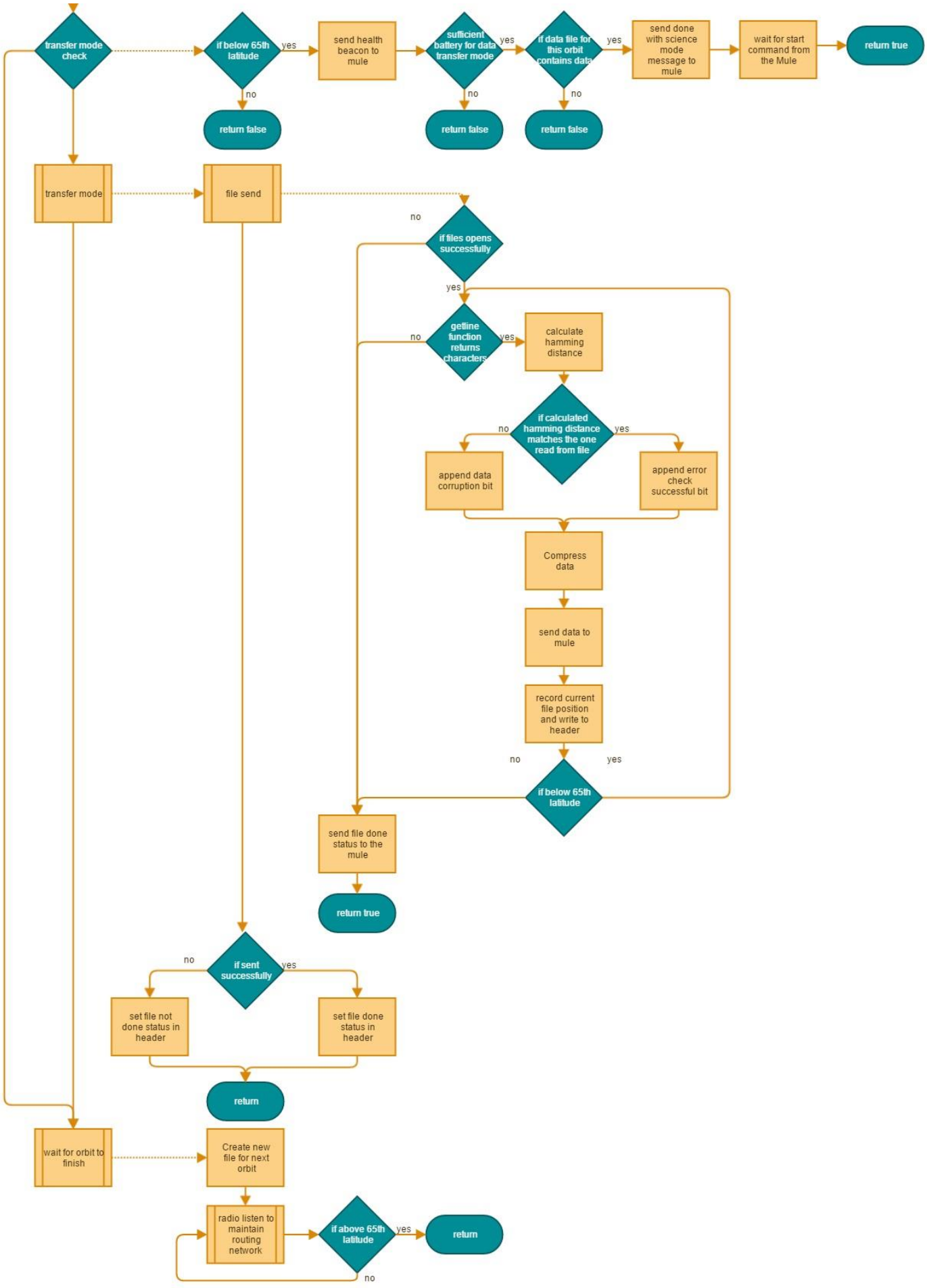
CDH Dataflow Design



WSN Flowchart Design

(EPS Integration missing)




transfer mode check
if below 65th latitude
yes
no
send health beacon to mule
sufficient battery for data transfer mode
yes
no
if data file for this orbit contains data
yes
no
send done with science mode message to mule
wait for start command from the Mule
return true
return false
return false
return false
transfer mode
file send
no
if files opens successfully
yes
no
getline function returns characters
yes
calculate hamming distance
no
if calculated hamming distance matches the one read from file
yes
append data corruption bit
append error check successful bit
Compress data
send data to mule
record current file position and write to header
no
yes
if below 65th latitude
send file done status to the mule
return true
no
if sent successfully
yes
set file not done status in header
set file done status in header
return
wait for orbit to finish
Create new file for next orbit
radio listen to maintain routing network
if above 65th latitude
yes
return
no

Mule Overview - Threading Design

Executive Thread – Maintaining state machine of Satellite and routing messages for thread communications

Worker Threads:

GPS Thread - Constant monitoring of the GPS location of the satellite, making the information available to all threads

EPS Thread - Monitoring and maintaining health status of batteries and performing low power mode operations

ADC Thread - Performing detumbling and pointing routines when required (determined based on a “orientation” mutex lock)

Deployment Thread - Performing deployment when required (determined based on a “deployment” mutex lock)

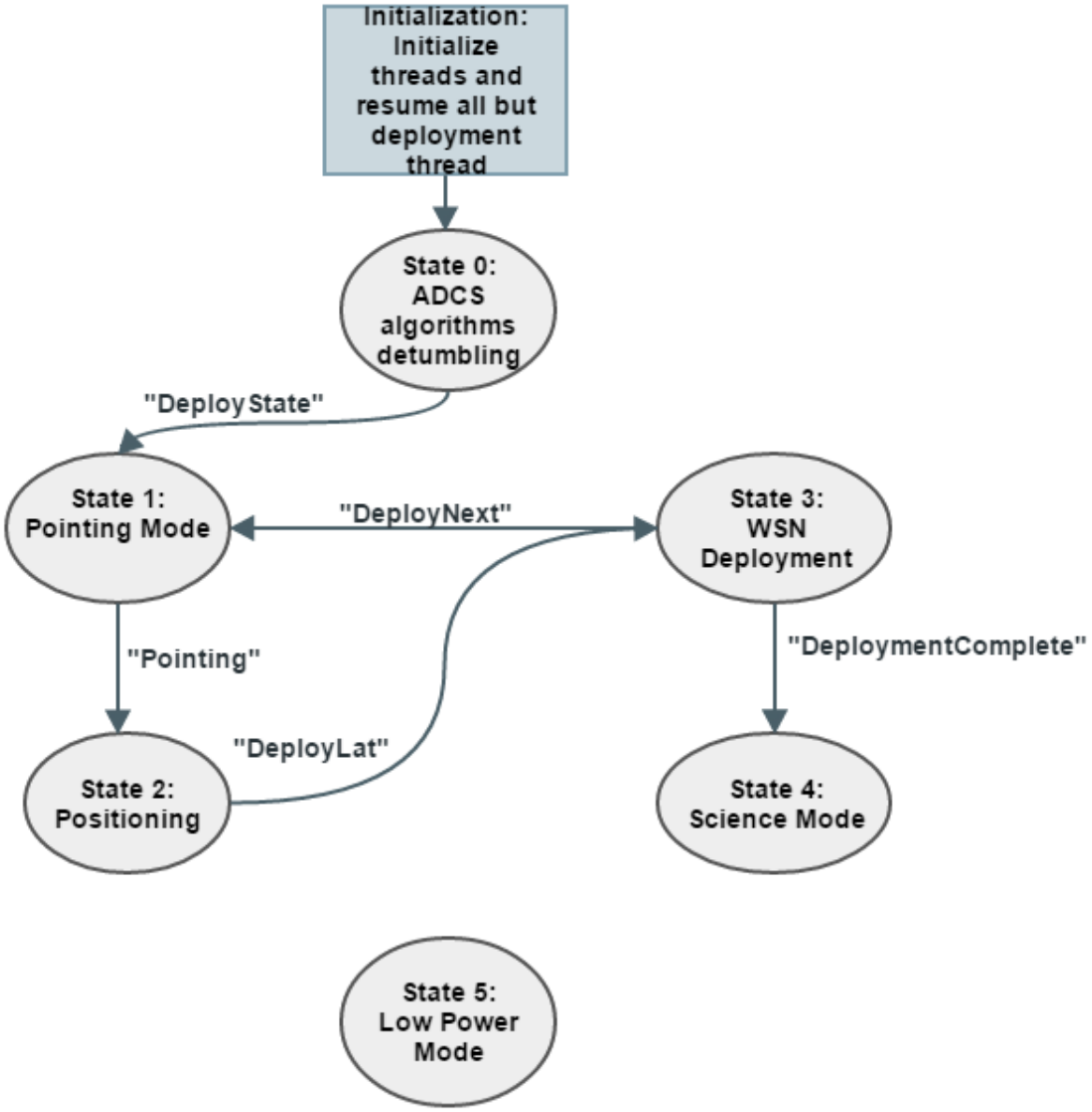
GlobalStar Thread - Transmitting messages stored in a buffer received from the RFM22B thread

RFM22B Thread - Receiving messages from the sensor nodes and placing parsed messages in GlobalStar transmission buffer

Worker Thread Design

- Worker Threads are initialized in the beginning of the Executive Thread state machine
- Once initialized Worker Threads are designed to follow and “Init” and “Loop” program design.
    - “Init” function is made to be re-run to reconfigure hardware
    - “Loop” function is made to run periodically with a configurable timing scheme.
- 5 Worker Threads
    - Globalstar, Power, and RFM22B threads are run constantly
    - ADCS and Deployment threads are run only when required

Executive Thread State Machine

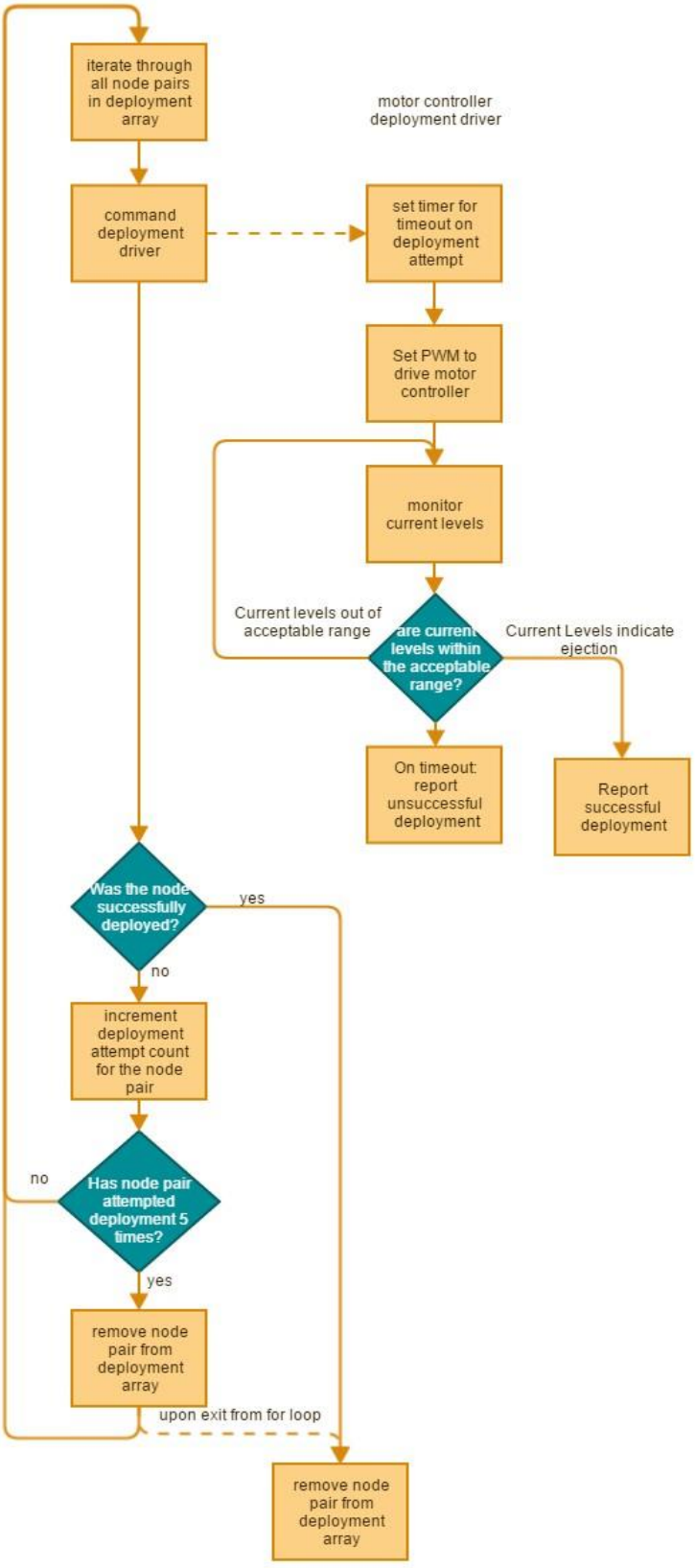


*Connections between all states and Low Power Mode based on “LowPowerMode” command and WSN deployment mode based on “DeployNow” command

Thread Communication

- Each thread routes messages to the executive thread
- Priority Queue data structure
    - FIFO – first in first out
    - Each message has a priority – higher priority messages such as low power mode and node deployment make it to the front of the queue
- Process scheduling techniques to avoid starvation of processes to be implemented – priority increases with time?

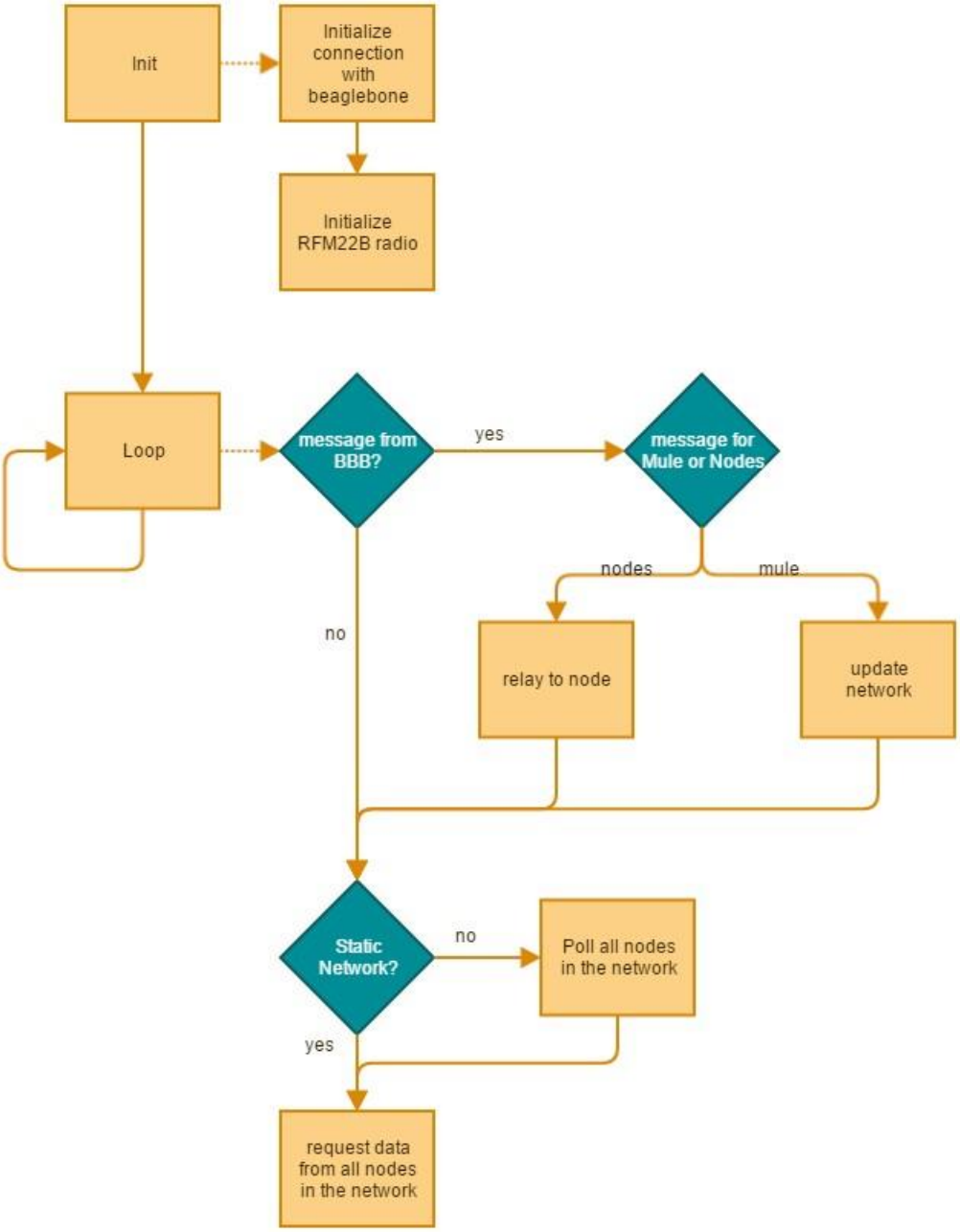
Deployment Thread



Data Flow on Mule

- GlobalStar Thread (transmission) & RFM22B Thread (reception)
- RFM22B Thread
    - RFM22B radio driver (Arduino)
    - Setup - network initialization
    - Loop - network management and message receiving and processing.
    - Processed messages are relayed to the transmission buffer for the GlobalStar Thread to transmit
- GlobalStar Thread
    - GlobalStar radio driver (class on BeagleBone)
    - Setup - initialization of connection
    - Loop - constant checking for received messages or messages in transmission buffer

Network Management (Arduino radio driver)



*Implement tx power rate, retry scheme, and data rate determined from the communication tests

Communication Tests

- Long Range and Mesh Network Tests being scheduled
- Uses for information retrieved from these tests
    - Updated link budget
    - Determine best TX power for radio transmissions
    - Radio transmission and reception timeout and retry scheme
    - Most reliable data rate
    - Expected range of RF mesh network
- Globalstar driver acceptance test
    - Interfacing with NearSpace Launch to get Globalstar radio activated

* Projected deadline of **Sept. 2016**

Integration with Other Subsystems

- ADCS integration - Projected End Date: **Jan. 2017**
    - Communication scheme with microcontroller sampling IMU, GPS and sunsensor
    - Magnetorquer board interface
    - Interface with ADCS algorithm
- EPS integration: Projected End Date: **Dec 2016**
    - Mule
        - Testing EPS driver
        - Implement hardware restart schemes
        - Implement Low Power Mode
    - WSN
        - Reading current from solar panels
        - Monitoring voltages from batteries
        - Implementing Low Power Mode
- Communication Integration: Projected End Date: **Oct. 2016**
    - Globalstar
        - Health beacons
        - Packetizing data for transmission
    - RFM22B
        - Tx power rates, data rate, retry/timeout scheme
        - Update network management

Current Status Summation