UNIVERSITY OF PUERTO RICO AT MAYAGÜEZ

MAYAGÜEZ, PUERTO RICO

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

WaveSphere: Progress Report #3

A PROGRESS REPORT SUBMITTED AS A PARTIAL REQUIREMENT OF THE
MICROPROCESSOR INTERFACING COURSE ICOM-5217

by

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1. Operating Charts

Operating charts describe the modes of operation and the flow of the system without much detail. Figure 1 shows the system's main flowchart, which depicts how the device goes in and out of each of its operating modes. A general but brief overview of the different modes of operation follows.

The following sections contain a more thorough explanation of each of the operating modes mentioned, along with a flowchart of its own to help explain what can be done in each one.

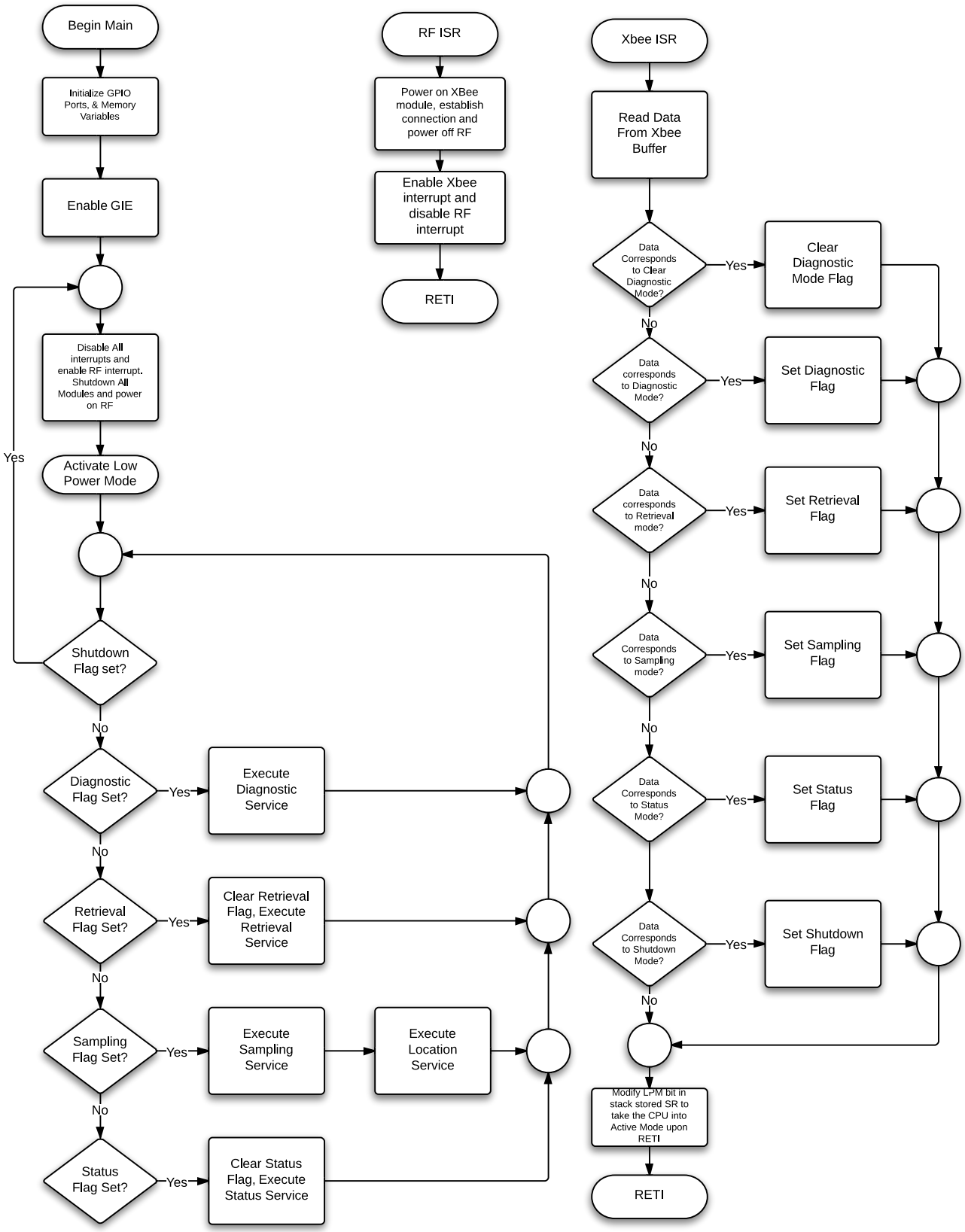

Figure 1: System Operating Chart

1.1 Diagnostic Event Service

On Diagnostic Mode the device maintains communication to the base station and sends real-time information of the different components to the base station, the user can then observe and verify that all components are taking measurements and data can be retrieved through the XBee.

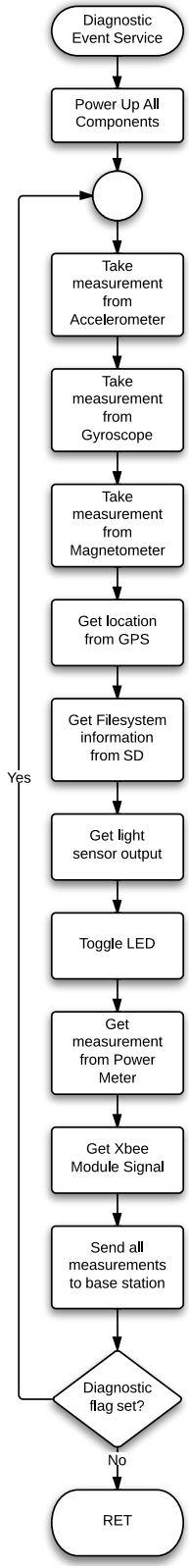

Figure 2: Flowchart for Diagnostic Event Service

1.2 Retrieval Event Service

Retrieval Mode is the operation mode of the device in which the system transfers the data collected while in Sampling Mode from the SD Card to the base station. Data is transferred trough the established ZigBee connection and once all data has been transferred it is erased from the SD card.

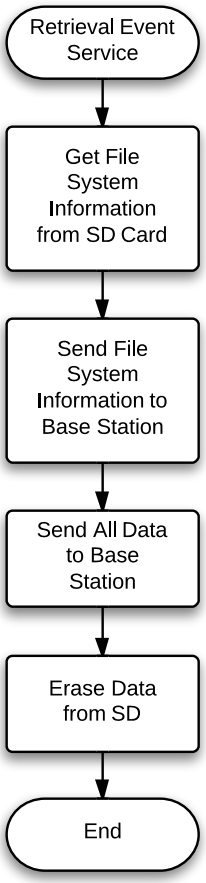

Figure 3: Flowchart for Retrieval Event Service

1.3 Sampling Event Service

On Sampling Mode the device captures data from the accelerometer, gyroscope and magnetometer. Data is captured for the duration of the previously specified time and data points are saved in the SD card, each with a time stamp from the time which they were captured.

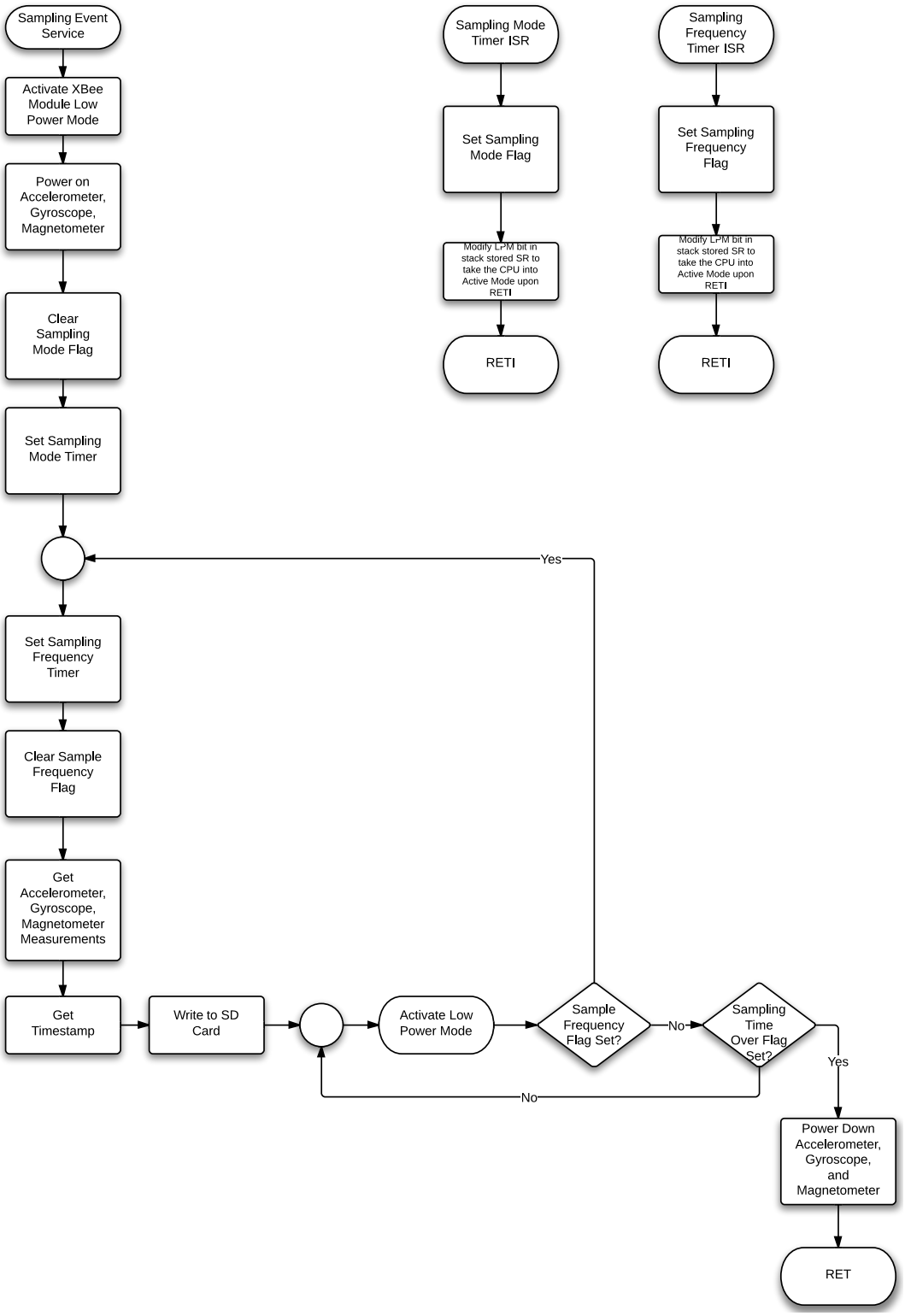

Figure 4: Flowchart for Sampling Event Service

1.4 Location Event Service

On Locate Mode the user is trying find and retrieve the device. The system turns on the XBee Module and the GPS and turns off all other components. The system then proceeds to establishing a ZigBee connection to the base station and get a GPS lock. Once the device gets its location using the GPS Module it will then broadcast the location to the base station through the ZigBee connection. If the on-board light sensor determines that it is dark, i.e. an experiment is being conduted when there is little or no sunlight, then a strobe LED will be flashed so as to facilitate the retrieval of the device.

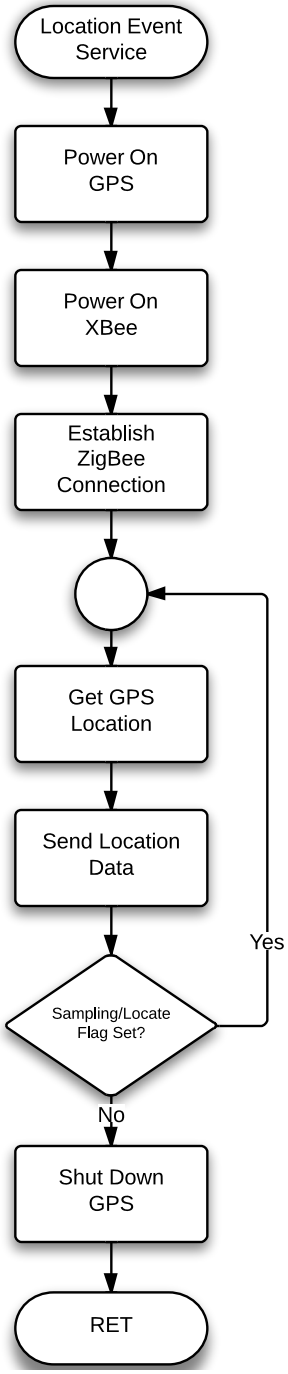

Figure 5: Flowchart for Location Event Service

1.5 Status Event Service

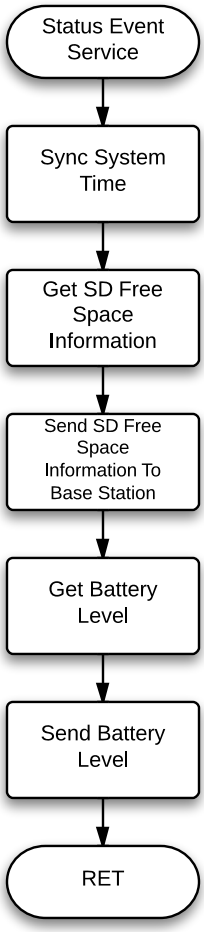

Figure 6: Flowchart for Status Event Service

2. Timing Analysis

Table 1 shows the frequency specifications for the components. Since the sample frequency will be 256Hz, there is complete compatibility between all components. Two timers are needed. The first timer will control the sample frequency for all the components. In order to have 256Hz, an external crystal with frequency of 32,768Hz will be used. The terminal count will be set to 128 and the prescaler to one. The second timer will control the sampling time (30s).

Table 1: Component Frequencies

Component	Frequency
MCU	1, 2.667, 3.5, 4, 5.333, 7, 8, 16 MHz
Crystal	32,768 Hz
Accelerometer	Analog, ADC 200ksps, 1000Hz max bandwidth
Battery Gauge	I^2C, 10-100kHz and 400kHz
GPS	UART, 9,600 baud (std), from 4,800 to 921,600 baud. 9,600 baud selected
Gyroscope	SPI, up to 10MHz
Magnetometer	I^2C, up to 100kHz std, 400kHz fast
RF Wakeup	SDI (SPI) - 2MHz
SD card	0-25MHz std, up to 50Mhz max.
Xbee	SPI, no specification

In order to make sure that the Real Time Clock (RTC) will be precise, the external crystal, with frequency of 32,768 will be used.

3. Software Plan

This section contains the pseudocode of the embedded software of the system. Algorithm 1 contains the Main function of the system. After the Main, Interrupt Service Routines (ISRs) and Sub-Routines are found in order of appearance.

4. References

Algorithm 1: Main

```
Initialize GPIO Ports;
Initialize Memory Variables;
Enable GIE;
while true do
    Disable All Interrupts;
    Enable RF Interrupt;
    Shutdown All Modules;
    Power on RF module;
    Activate Low Power Mode;
    while Shutdown Flag Cleared do
        if Diagnostic Flag Set then
            Execute Diagnostic Service;
        else if Retrieval Flag Set then
            Clear Retrieval Flag;
            Execute Retrieval Service;
        else if Sampling Flag Set then
            Execute Sampling Service;
            Execute Location Service;
        else if Status Flag Set then
            Clear Status Flag;
            Execute Status Service;
    end
end
```

Algorithm 2: RF ISR

```
Power On Xbee Module;
Establish Connection;
Power Off RF;
Enable Xbee Interrupt;
Disable RF Interrupt;
Return from Interrupt;
```

Algorithm 3: Xbee ISR

```
Read Data From Xbee Buffer;
if Data corresponds to Clear Diagnostic Mode then
    Clear Diagnostic Mode Flag;
else if Data corresponds to Diagnostic Mode then
    Set Diagnostic Mode Flag;
else if Data corresponds to Retrieval Mode then
    Set Retrieval Mode Flag;
else if Data corresponds to Sampling Mode then
    Set Sampling Mode Flag
else if Data corresponds to Status Mode then
    Set Status Mode Flag;
else if Data corresponds to Shutdown Mode then
    Set Shutdown Mode Flag;
Modify LPM bit in stack stored SR to take the CPU into Active Mode;
Return from Interrupt;
```

Algorithm 4: Diagnostic Event Service

```
Power Up All Components;
repeat
    Take measurement from Accelerometer;
    Take measurement from Gyroscope;
    Take measurement from Magnetometer;
    Get location from GPS;
    Get file system information from SD Card;
    Get Light Sensor Output;
    Toggle LED;
    Get measurement from Power Meter;
    Get Xbee Module Signal;
    Send Measurements to Base Station;
until Diagnostic Flag Cleared;
Return;
```

Algorithm 5: Retrieval Event Service

```
Get file system information from SD Card;
Send file system information to base station;
Send all data to base station;
Erase data from SD Card Return;
```

Algorithm 6: Sampling Event Service

```
Activate Xbee Module Low Power Mode;
Power on Accelerometer;
Power on Gyroscope;
Power on Magnetometer;
Clear Sampling Mode Flag;
Set Sampling Mode Timer;
while SamplingTimeOver Flag Cleared do
    Set Sampling Frequency Timer;
    Clear Sample Frequency Flag;
    Get Accelerometer measurement;
    Get Gyroscope measurement;
    Get Magnetometer measurement;
    Get Timestamp;
    Write to SD Card;
    Activate Low Power Mode;
end
Power Down Accelerometer;
Power Down Gyroscope;
Power Down Magnetometer;
Return;
```

Algorithm 7: Sampling Mode Timer ISR

```
Set Sampling Mode Flag;
Modify LPM bit in stack stored SR to take the CPU into Active Mode;
Return from Interrupt;
```

Algorithm 8: Sampling Frequency Time ISR

```
Set Sampling Frequency Flag;
Modify LPM bit in stack stored SR to take the CPU into Active Mode;
Return from Interrupt;
```

Algorithm 9: Location Event Service

```
Power On GPS;
Power On Xbee;
Establish Zigbee Connection;
repeat
    Get GPS Location;
    Send Location Data;
until Sampling/Location Flag is Cleared;
Shut Down GPS;
Return;
```

Algorithm 10: Status Event Service

Sync System Time;
Get SD Free Space Information;
Send SD Free Space Information To Base Station;
Get Battery Level;
Send Battery Level;

Appendices