Software Design Document

for

Sun SPOT Universal Monitoring System (SUMS)

Version 1.0
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Texas Christian University
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Table of Contents

Revision History

Date	Reason For Changes	Version
12/11/2008	Initial Version	1.0

Approvals

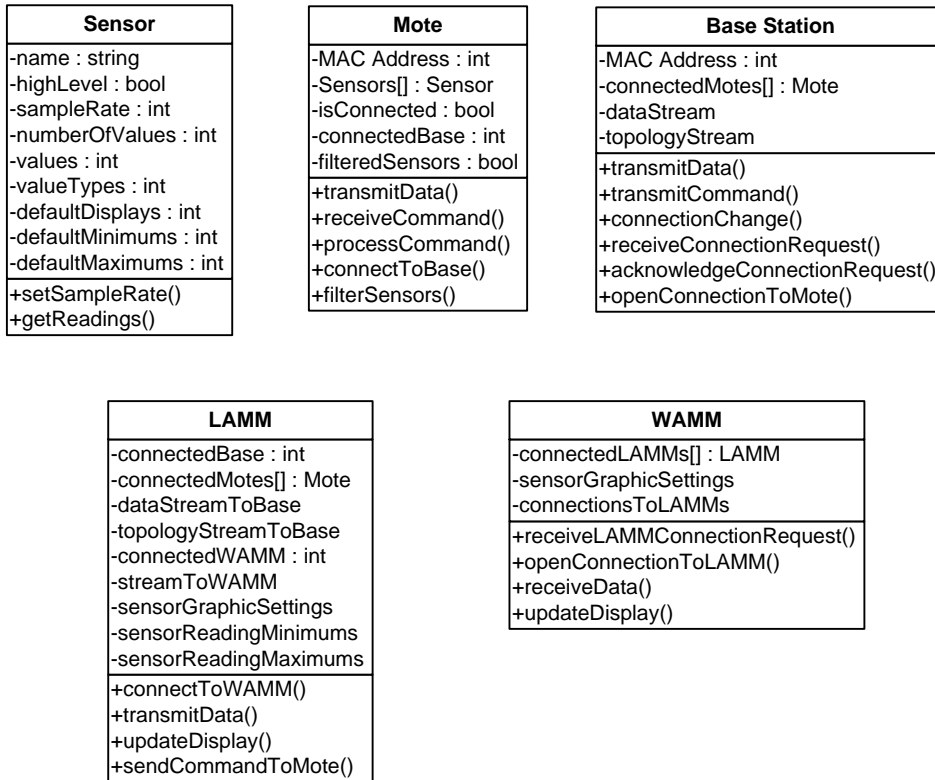| Print Name	Title	Signature	Date Approved
Brian Freeman	Project Manager		
Lei Jin	Physical Components Lead		
Anh Pham	Applications Lead		
Jamie Phelps	Front End Lead		
Edward Tran	Back End Lead		

1. Architecture

1.1 Topology Diagram
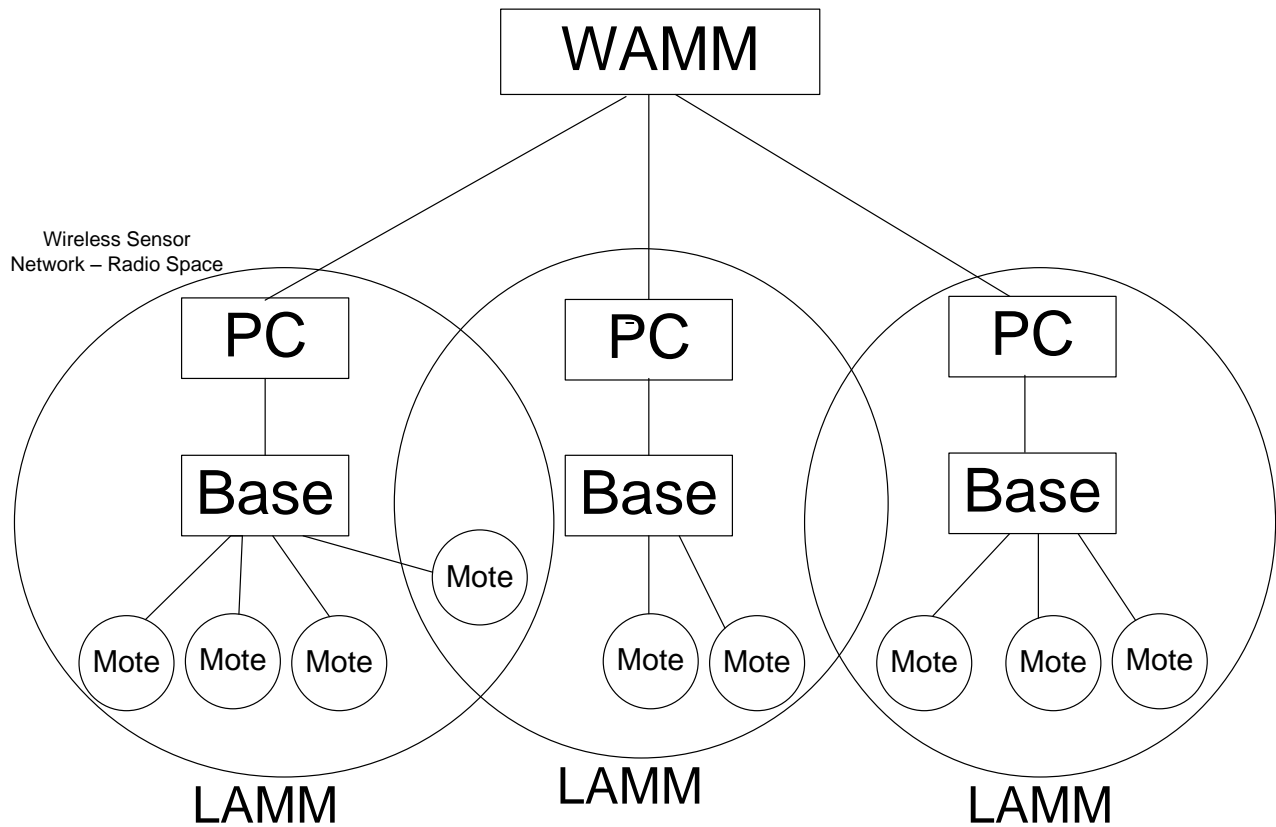
This maps the overall topology of SUMS. Sensor data is displayed on two levels: the WAMM and LAMM. The WAMM acts as a monitor that connects and displays information from LAMMs. Within the LAMM, there is the PC, base station, and motes. The PC is the display and control of the LAMM. The base station is the intermediary connection between the PC and the motes and creates the radio space of the LAMM. Motes connect to a single base station as long as it is in that base station's radio space. It then pushes sensor data through the rest of SUMS. Notice the distinct connection levels of the motes, base station, PC, and WAMM.

1.2 Class Diagram

Sensor
-name : string
-highLevel : bool
-sampleRate : int
-numberOfValues : int
-values : int
-valueTypes : int
-defaultDisplays : int
-defaultMinimums : int
-defaultMaximums : int
+setSampleRate()
+getReadings()

Mote
-MAC Address : int
-Sensors[] : Sensor
-isConnected : bool
-connectedBase : int
-filteredSensors : bool
+transmitData()
+receiveCommand()
+processCommand()
+connectToBase()
+filterSensors()

Base Station
-MAC Address : int
-connectedMotes[] : Mote
-dataStream
-topologyStream
+transmitData()
+transmitCommand()
+connectionChange()
+receiveConnectionRequest()
+acknowledgeConnectionRequest()
+openConnectionToMote()

LAMM
-connectedBase : int
-connectedMotes[] : Mote
-dataStreamToBase
-topologyStreamToBase
-connectedWAMM : int
-streamToWAMM
-sensorGraphicSettings
-sensorReadingMinimums
-sensorReadingMaximums
+connectToWAMM()
+transmitData()
+updateDisplay()
+sendCommandToMote()

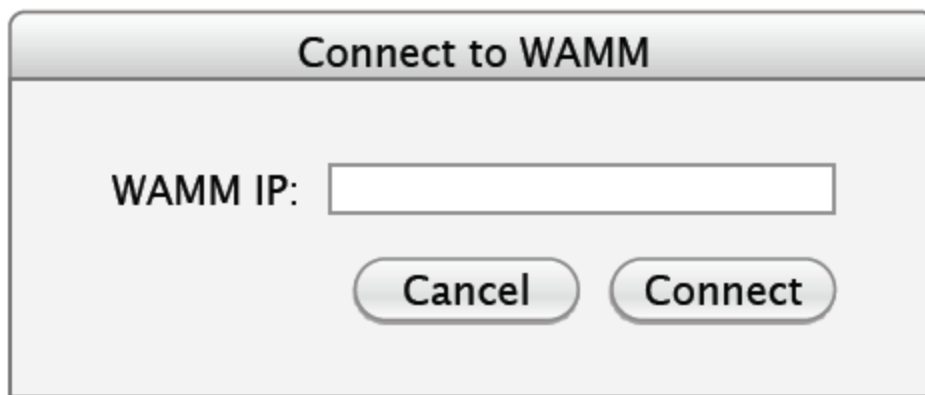| WAMM |
| --- |
| -connectedLAMMs[] : LAMM |
| -sensorGraphicSettings |
| -connectionsToLAMMs |
| +receiveLAMMConnectionRequest() |
| +openConnectionToLAMM() |
| +receiveData() |
| +updateDisplay() |

Five basic classes have been identified within SUMS. The classes encapsulate each other from the sensors to the WAMM level. A mote can be considered an array of sensors, a LAMM can be considered an array of motes, and a WAMM can be considered an array of LAMMs. Other variables are included for identification and connection purposes. Operations are better understood when looked at a use case perspective.

# 2. Interfaces

2.1 User Interface
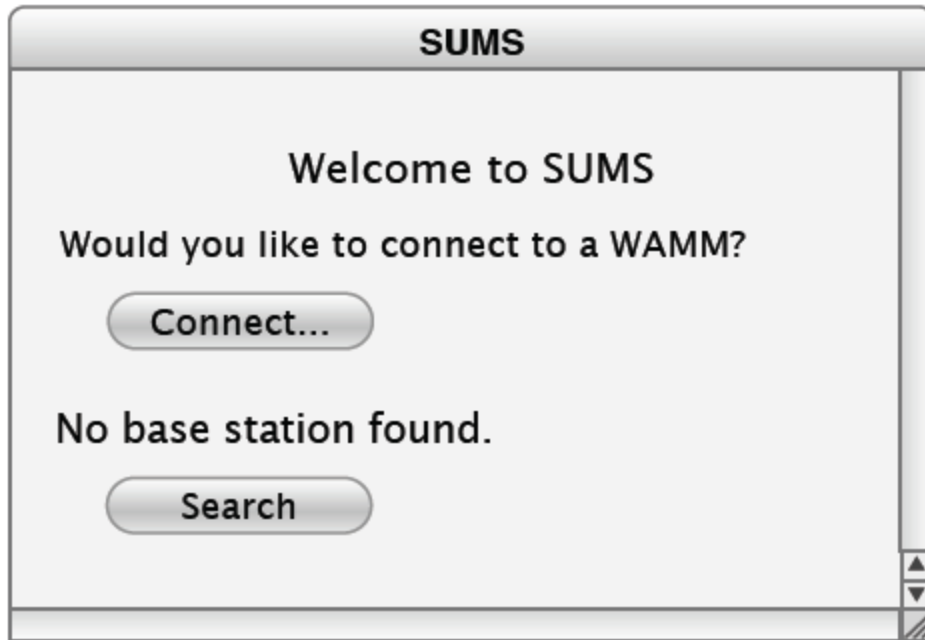
2.1.1   This is the default screen for the LAMM console. The LAMM console will search for a base at startup and display information about the LAMM similar to 2.1.4 if found. Otherwise, it allows the user to search for a base station that may have been recently connected.
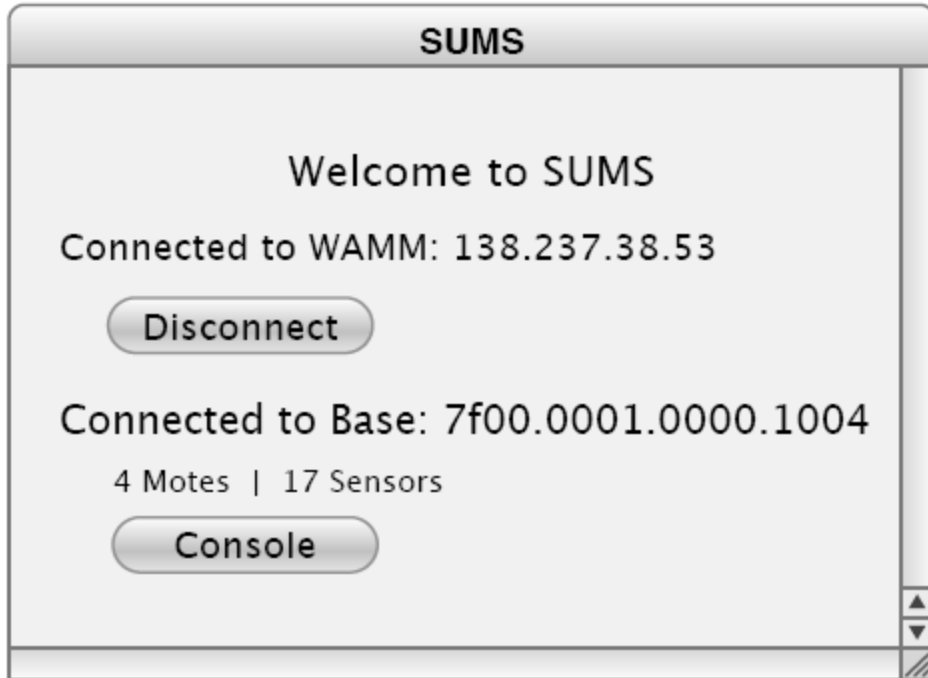

2.1.2   This is a simple window for the user to enter the IP address of a WAMM. It displays after the user clicks Connect... in 2.1.1.
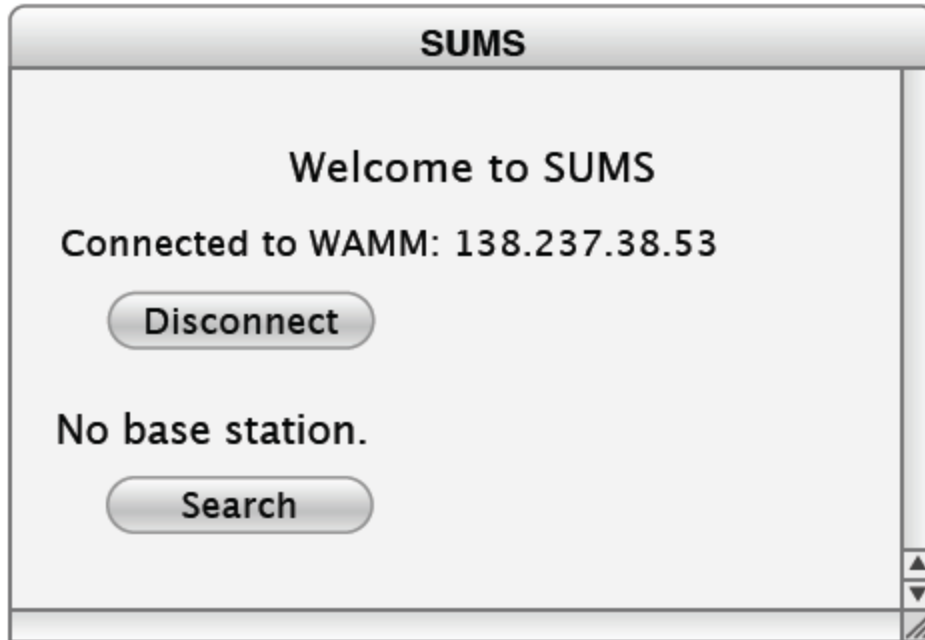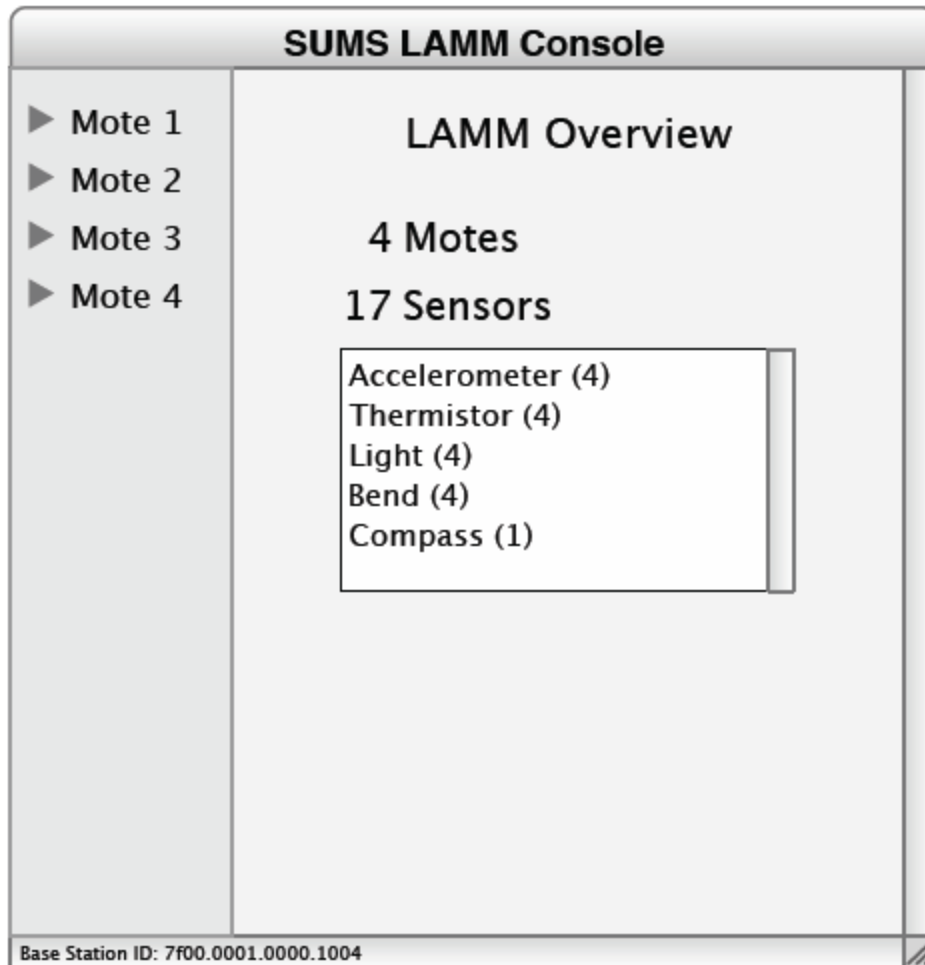
2.1.3 If a WAMM is connected, this is reflected and the IP is listed. The button now changes to "Disconnect".
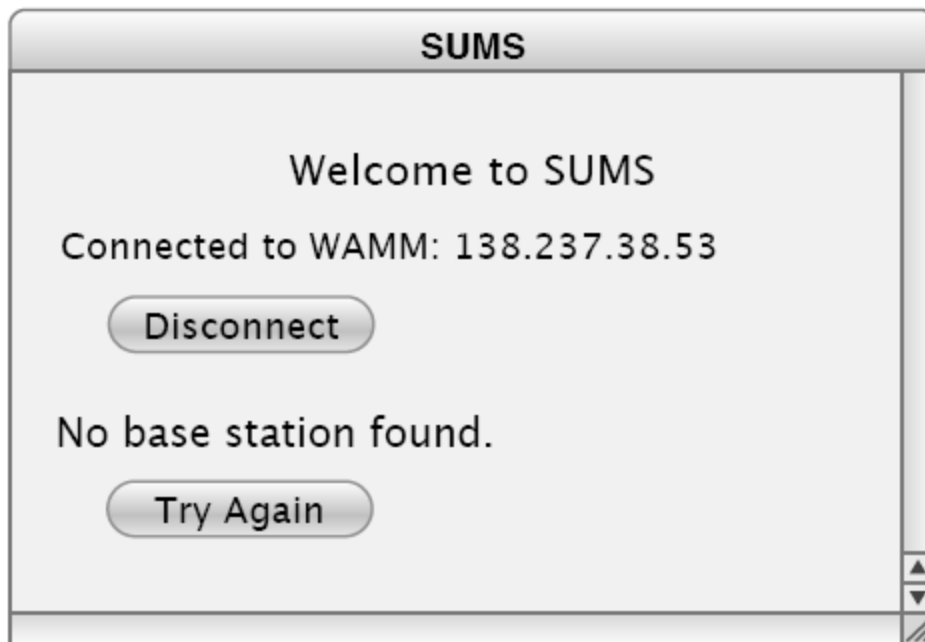

2.1.4 If the user searches for a base and the LAMM console is not able to find it, the user is informed and the button changes to "Try Again".

2.1.5 After successfully connecting to a base, gathering topology information, and connecting to a WAMM.

2.1.6 This is the LAMM Overview screen. The user will see a hierarchical representation of the topology of the LAMM in the sidebar on the left and summary information about the LAMM including the number of motes, the number of sensors, and the kinds of sensors and their counts.
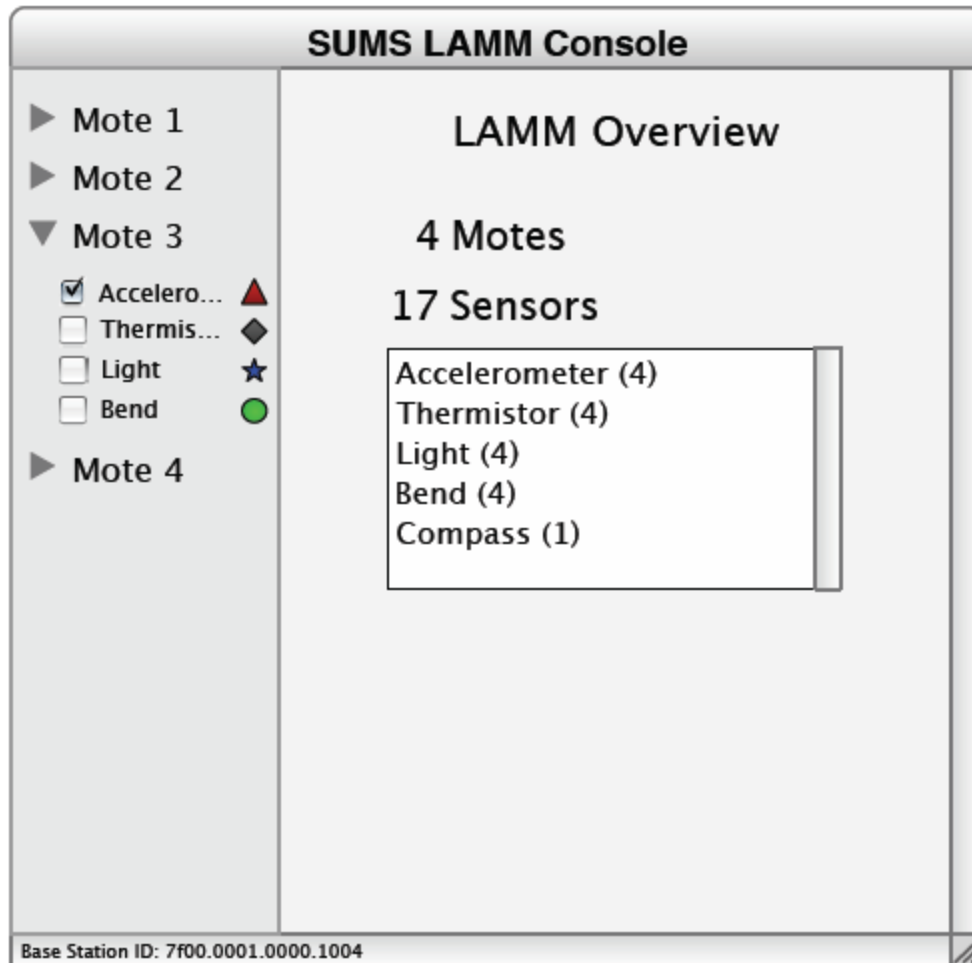
2.1.7 This is the same screen as 2.1.6 except the user has expanded one of the motes to display the sensors. Each sensor has a checkbox and an icon to reflect the sensor type since the name of the sensor might not reflect the sensor type. For instance, "Index Finger" might be the name of a bend sensor in a glove application, but the icon will inform the user of the sensor's type in a consistent way.
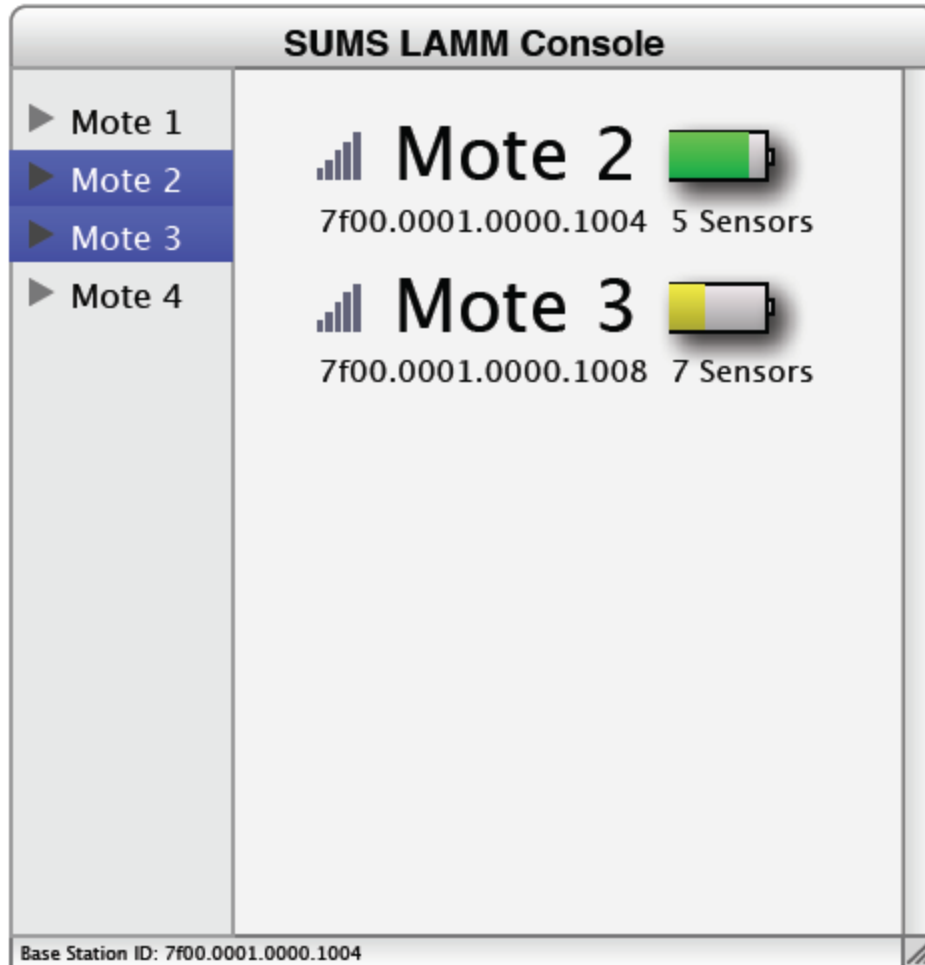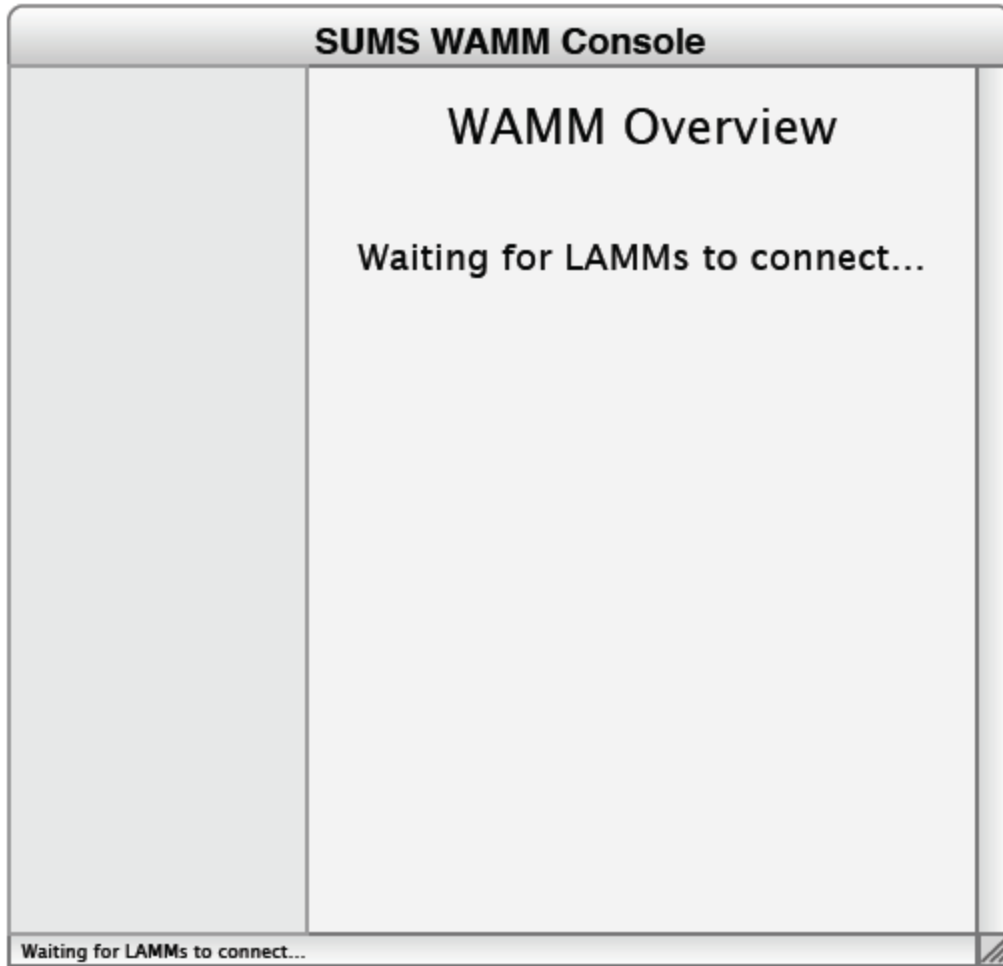
2.1.8 This screen shows that the user has selected two motes in the sidebar. Selecting a mote that is collapsed displays summary information about the mote including signal strength, battery life, IEEE identifier, and the number of sensors.
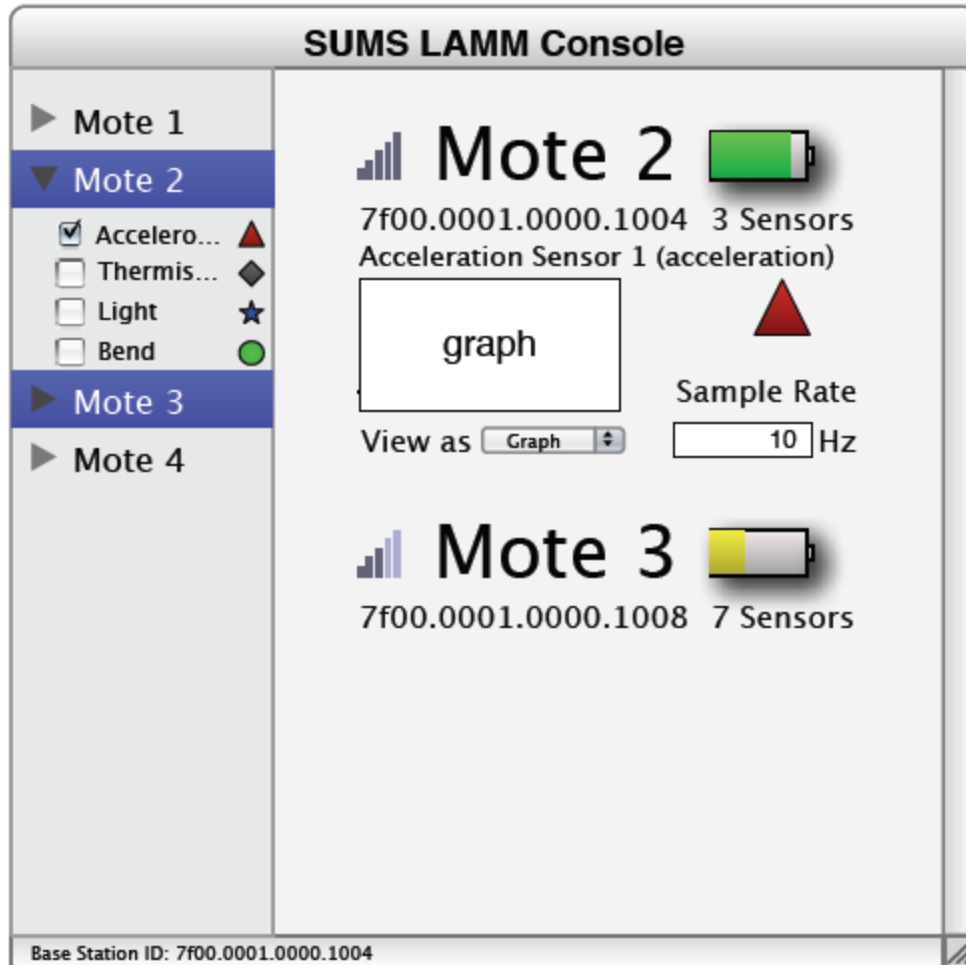
2.1.9 This screen is similar to 2.1.8, but Mote 2 has been expanded and an accelerometer sensor is selected. As a result, the mote's details are expanded to include information about the selected sensor. Mote 3 is not expanded in the sidebar, so it continues to display only summary information.
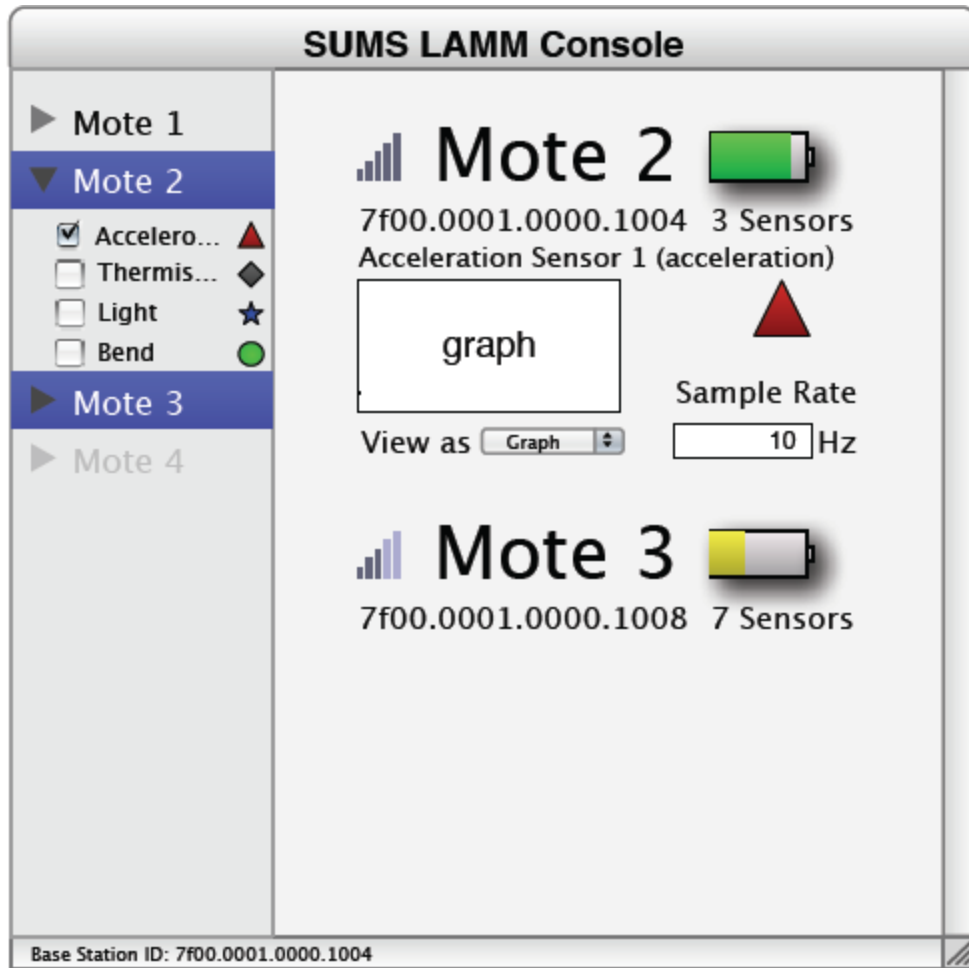
2.1.10   This screen is the same as 2.1.9, but Mote 4 has left the radio space of the LAMM. This is reflected in the screen as a disabled sidebar entry. The disabled entry remains for a brief period before being removed from the sidebar entirely.

SUMS WAMM Console

WAMM Overview

### Waiting for LAMMs to connect...

Waiting for LAMMs to connect...

2.1.11 This screen is the default startup screen for the WAMM console. Since the WAMM is passive, it simply waits for connection to be initiated from one or more LAMMs.
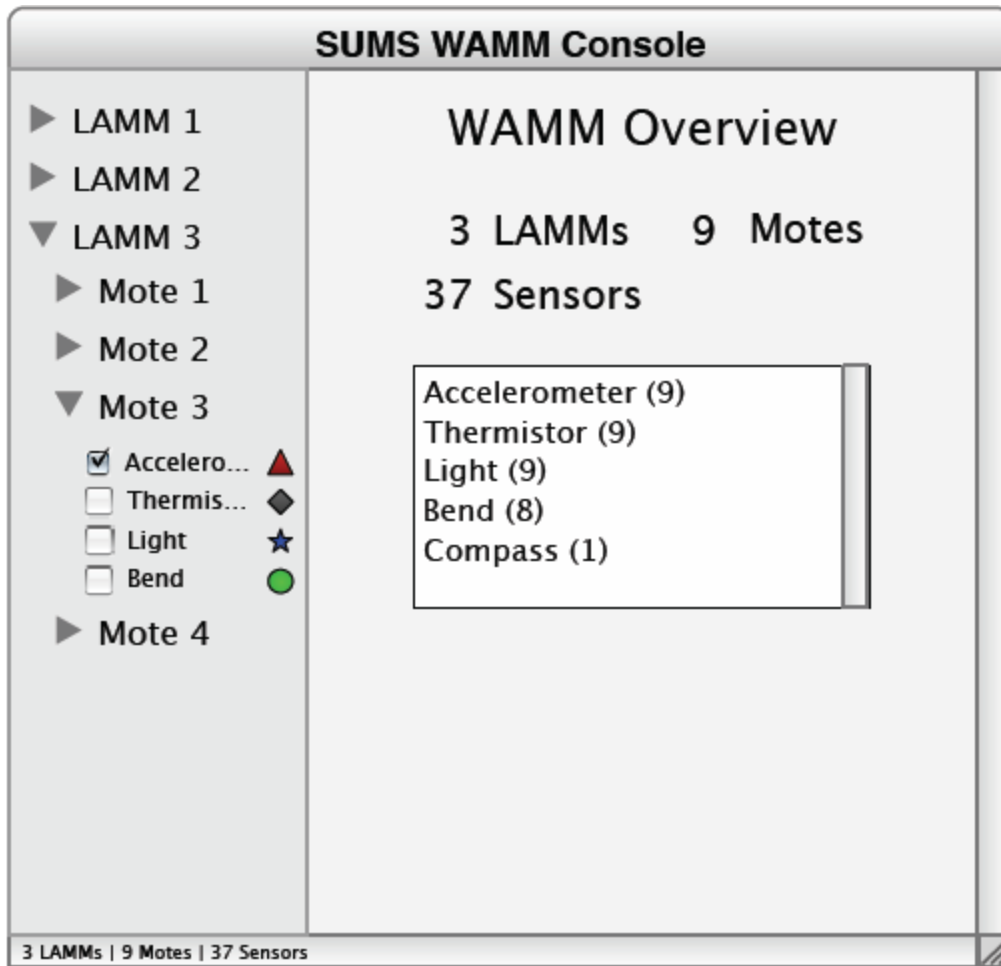
2.1.12 Once LAMMs connect, a hierarchical view of the LAMMs, their motes, and their sensors appears in the sidebar. The main content area of the window displays summary information similar to 2.1.6 for the LAMM console.
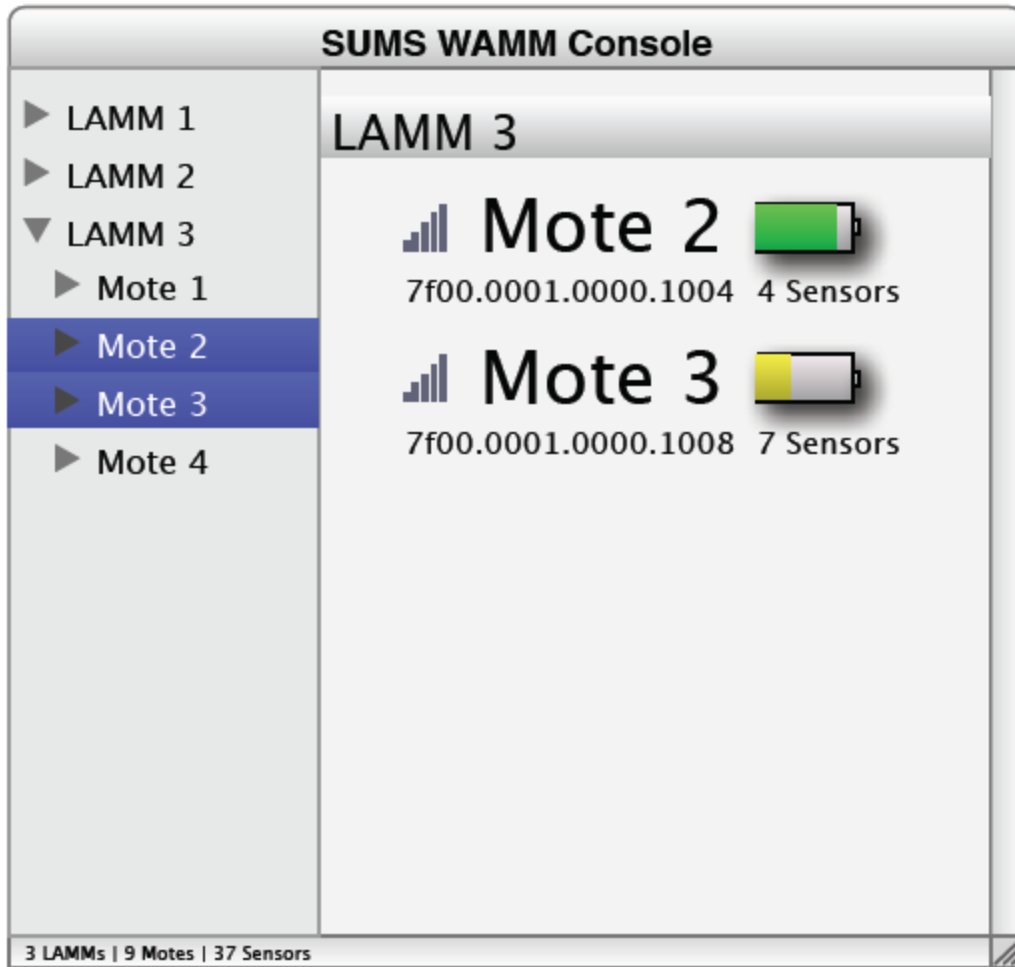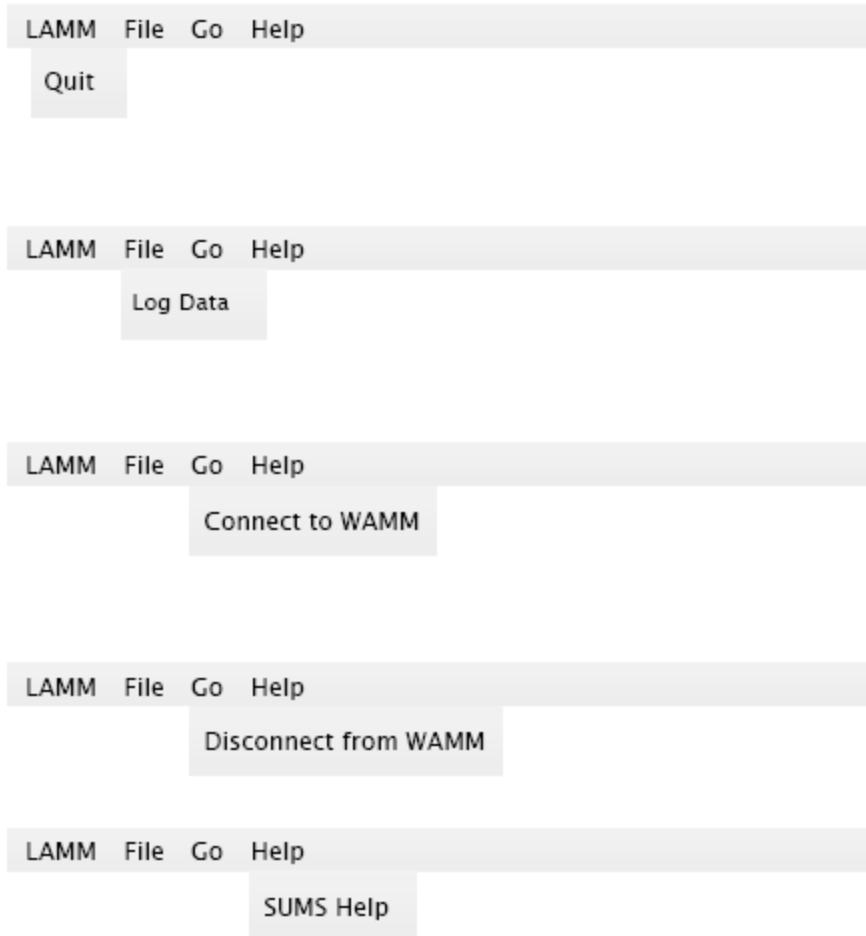
2.1.13   This screen shows that the user has selected two motes in the same LAMM. They are grouped under the LAMM 3 heading. As with 2.1.8 and the LAMM console, summary information about the mote is displayed if the mote is collapsed in the sidebar.
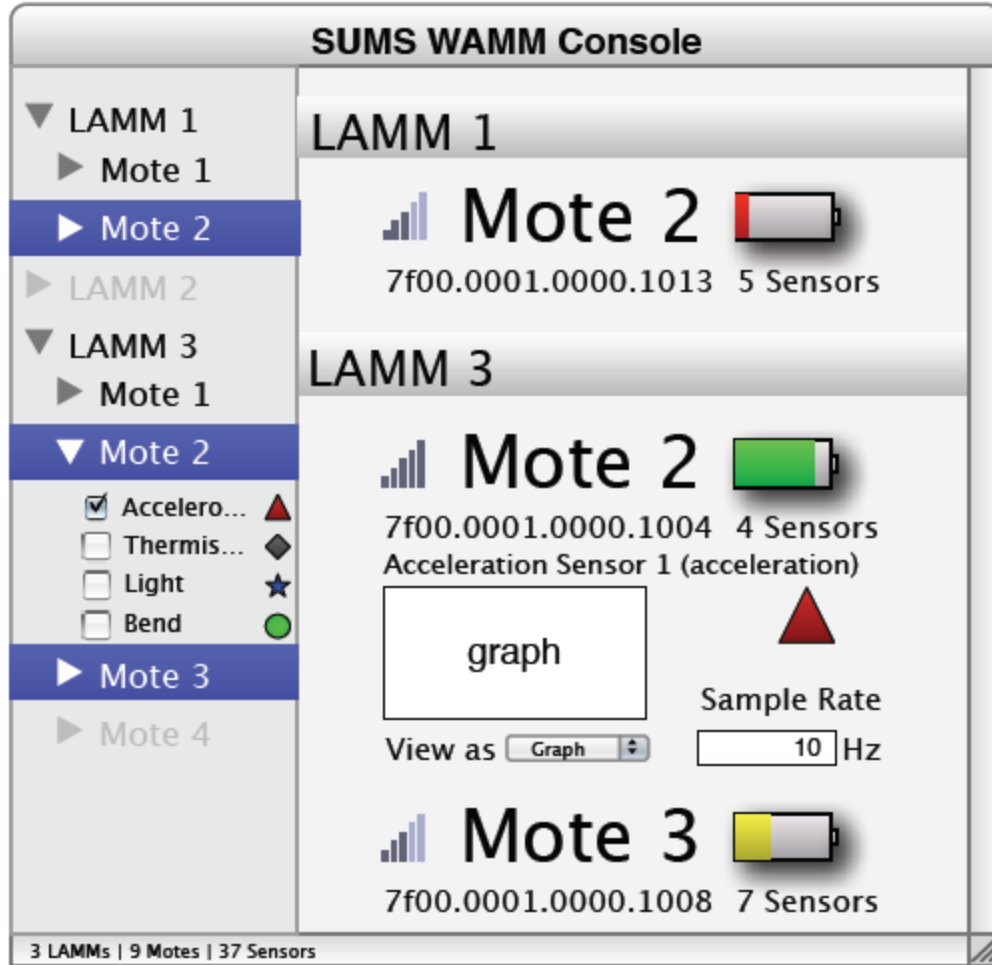
2.1.14 This screen is similar to 2.1.13, but it shows that the user has selected three motes across two LAMMs. Also, LAMM 3-Mote 2 has been expanded and is displaying information about the accelerometer.
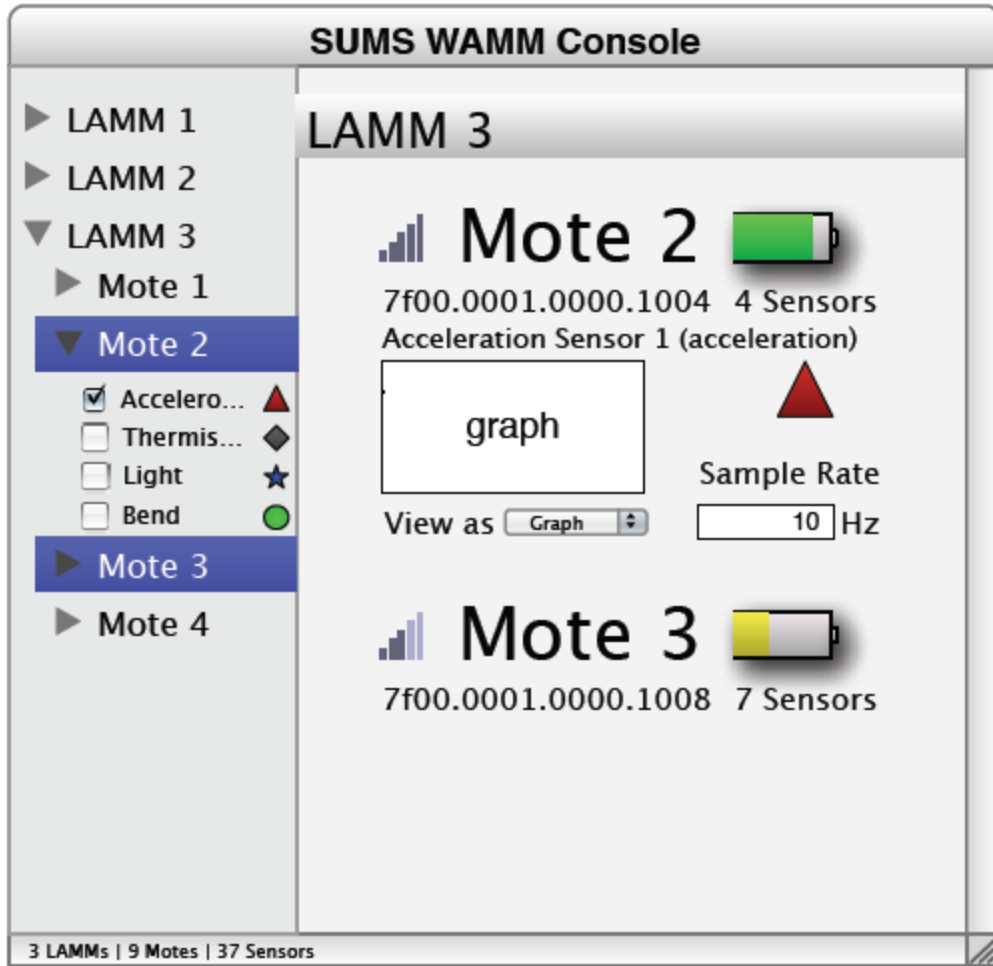
2.1.15   This is the same as 2.1.14, but shows that the users have selected only two motes from LAMM 3. The motes are still grouped under the LAMM 3 heading and the expanded mote is still displaying the accelerometer sensor data.

LAMM   File   Go   Help
 Quit

LAMM   File   Go   Help
      Log Data

LAMM   File   Go   Help
            Connect to WAMM

LAMM   File   Go   Help
            Disconnect from WAMM

LAMM   File   Go   Help
               SUMS Help

2.1.16 This shows the various menu options that will be available in the LAMM console. The "Log Data" menu item will allow the user to log data to a SQLite 3 database. This will log all data for whatever sensors are being displayed (see 2.1.9) at the time the menu item is invoked. The "Go" menu's item will change from "Connect" to WAMM to "Disconnect" from WAMM depending on its connection state.

WAMM   File   Help

   Quit

WAMM   File   Help

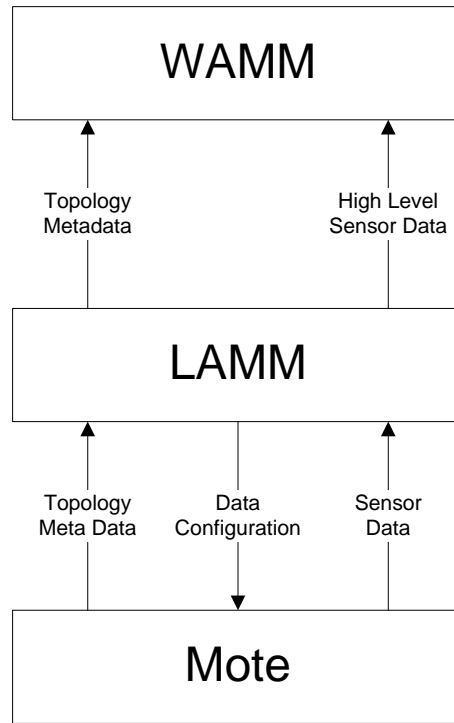   Log Data

WAMM   File   Help

       SUMS Help

2.1.17 This contains the menu items for the WAMM console. These are similar to the LAMM console menu items shown in 2.1.16 with the notable absence of the "Go" menu. Since the WAMM receives connections passively, this menu item is not present on the WAMM console

2.2 Subsystem Connections
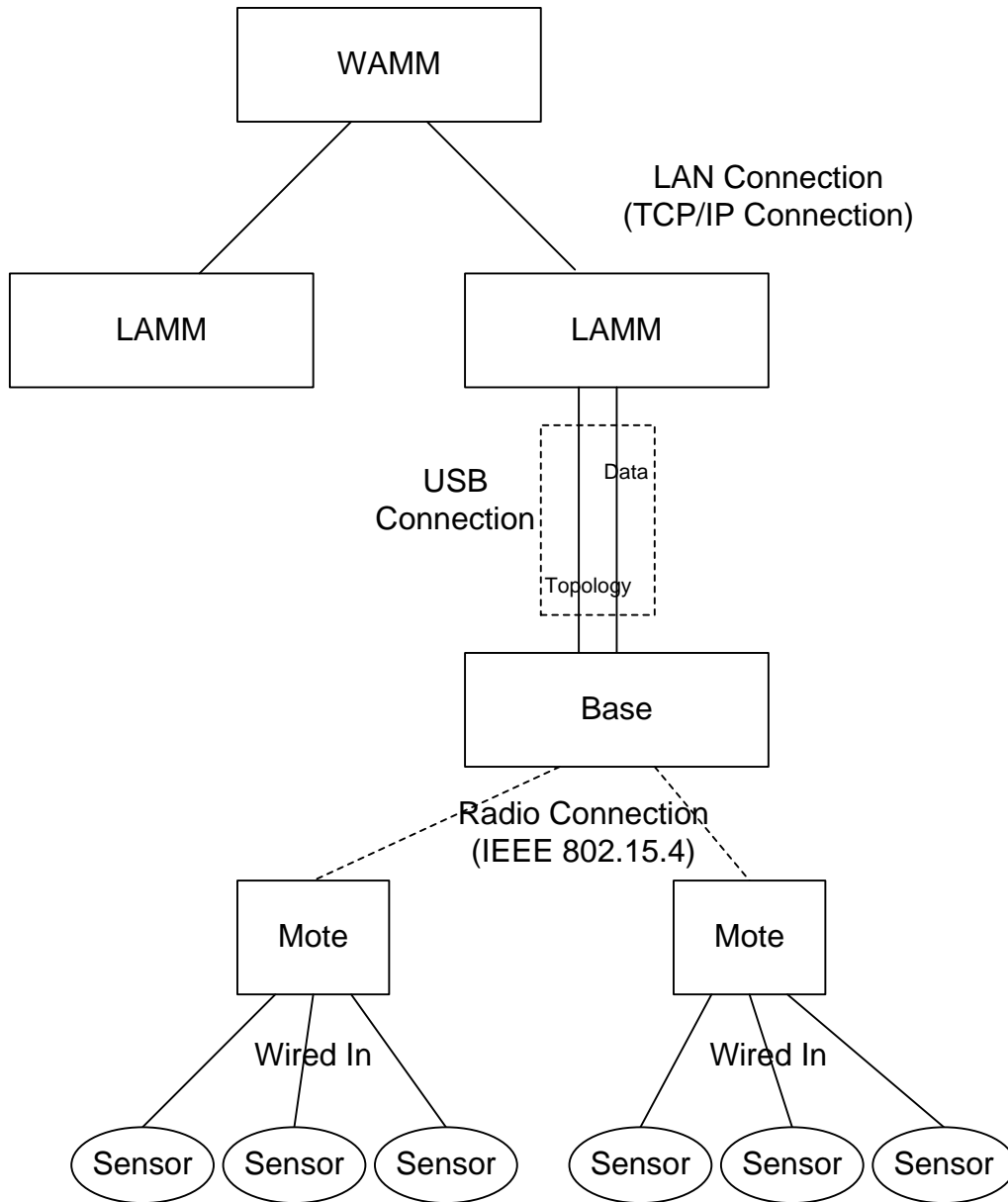
This diagram shows the hardware and software connections between subsystems. The software connections are in parenthesis. The WAMM and LAMM are connected together in a Local Area Network and use a TCP/IP connection to communicate. The LAMM and base station are physically connected by a USB connection. In software, they will have two internal streams for communication: a basic data stream and a higher priority topology stream. The base station connects with the motes through a radio connection compliant with the IEEE 802.15.4 standard. Sensors are physically wired to their respective mote's sensor board.

2.3 Data Flow Diagram

```
                    ┌─────────────────────────┐
                    │          WAMM           │
                    └─────────────────────────┘
                         ↑              ↑
                    Topology        High Level
                    Metadata        Sensor Data

                    ┌─────────────────────────┐
                    │          LAMM           │
                    └─────────────────────────┘
                      ↑          ↕         ↑
                 Topology      Data      Sensor
                 Meta Data  Configuration  Data

                    ┌─────────────────────────┐
                    │          Mote           │
                    └─────────────────────────┘
```

This diagram demonstrates the flow of data from the mote level up to the WAMM level. Topology and mote metadata will be accessible throughout the system. The LAMM level will be able to send configuration data such as sampling rate and sensor filtering to the mote. Sensor data will be marked as high level or low level data, decided by the programmer that implements SUMS on the SPOTs. High level data will flow completely from the mote to the WAMM, but low level data will stop at the LAMM.

3. Use Cases
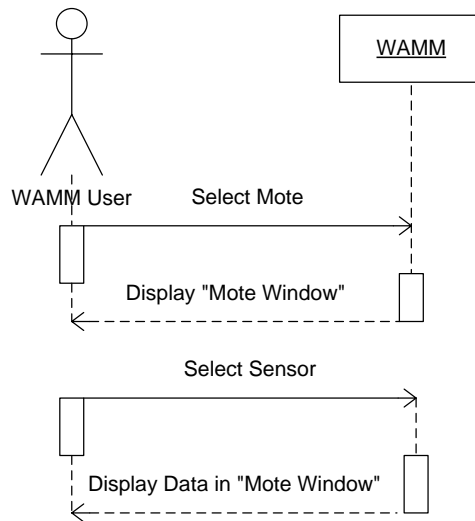
3.1 WAMM
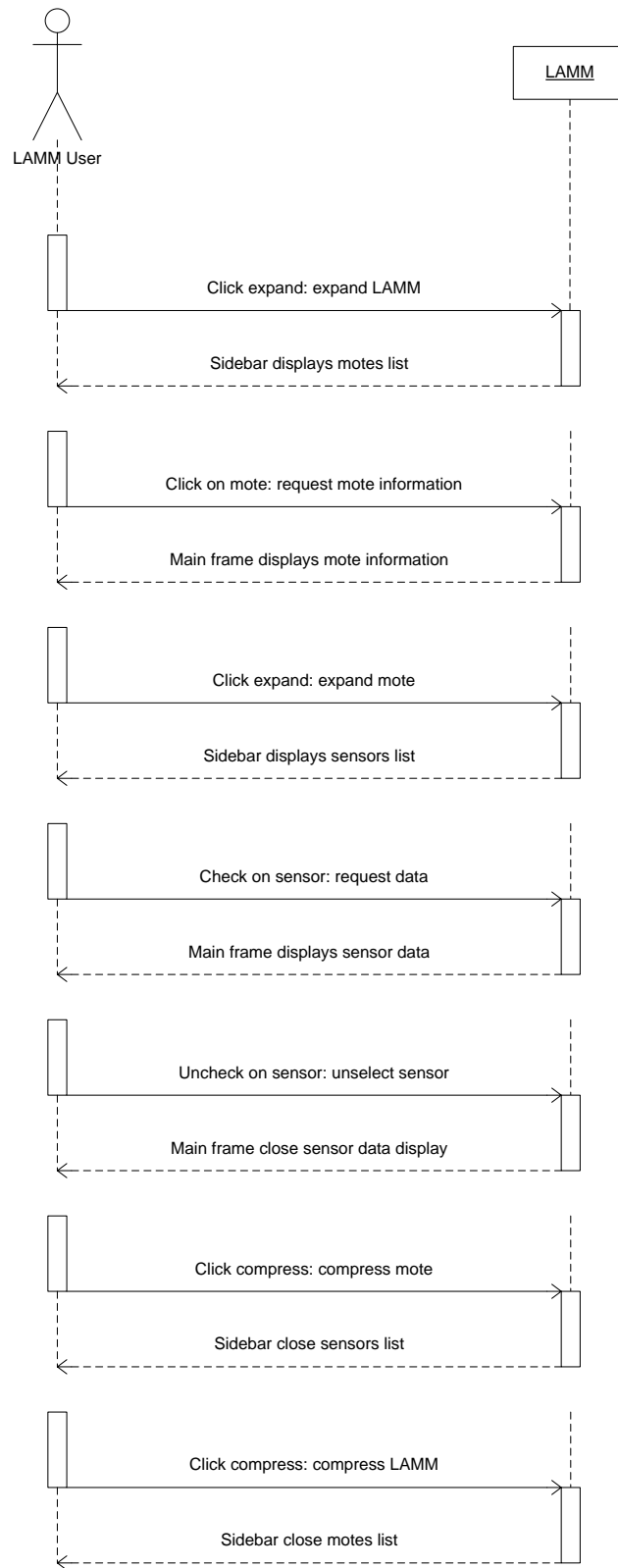
Name: View Topology

Actor: WAMM User

Description: Viewing the topology of LAMMs within the WAMM system

Precondition: At least one LAMM is connected to the WAMM

Primary Scenario (Flow):

1. Wait for LAMMs to send topology.
2. Display LAMM in side bar.
3. Expand LAMM to view available motes.
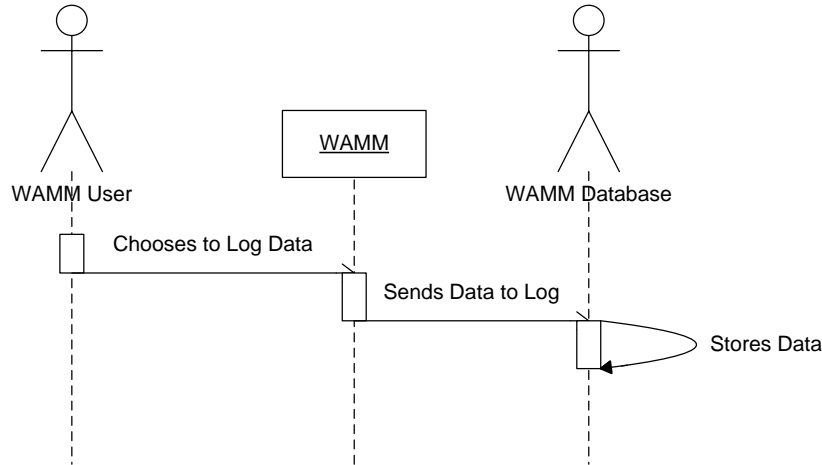4. Expand mote to view available sensors.

Name: View High Level Data

Actor: WAMM User

Description: Viewing the high level (interpreted) data on the WAMM

Precondition: At least one LAMM is connected to the WAMM. At least one mote is connected to LAMM

Primary Scenario (Flow):

1. Expand LAMM to view available motes.
2. Expand mote to view available sensors.
3. Click on a sensor to show the sensor data in the view window.

Name: Log Data
Actors: WAMM User, WAMM Database
Description: Logging the data into a database
Precondition: At least one LAMM is connected to the WAMM. At least one mote is connected to LAMM
Primary Scenario (Flow):

1. Expand LAMM to view available motes.
2. Expand mote to view available sensors.
3. Click on a sensor to show the sensor data in the view window.
4. Click log data in the menu bar to begin logging the data
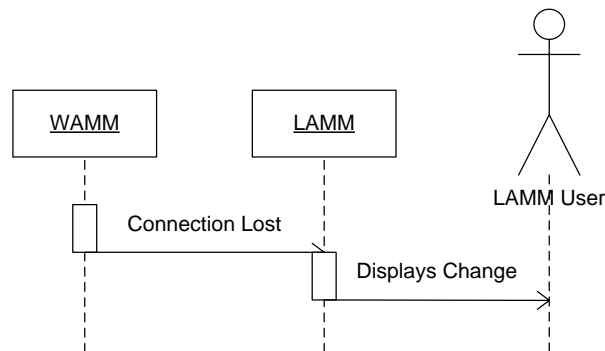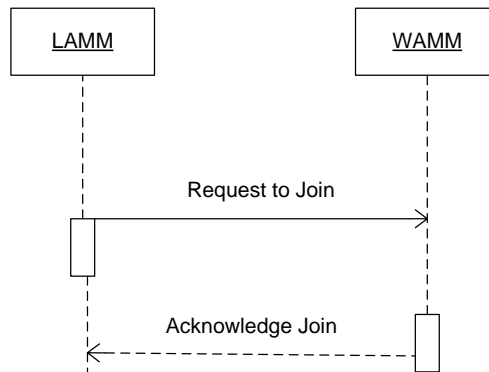

Name: Disconnect
Actor: WAMM User
Description: Disconnect LAMM from WAMM
Precondition: none
Primary Scenario (Flow):

1. LAMM sends disconnect information to WAMM
2. WAMM displays disconnect notification to user
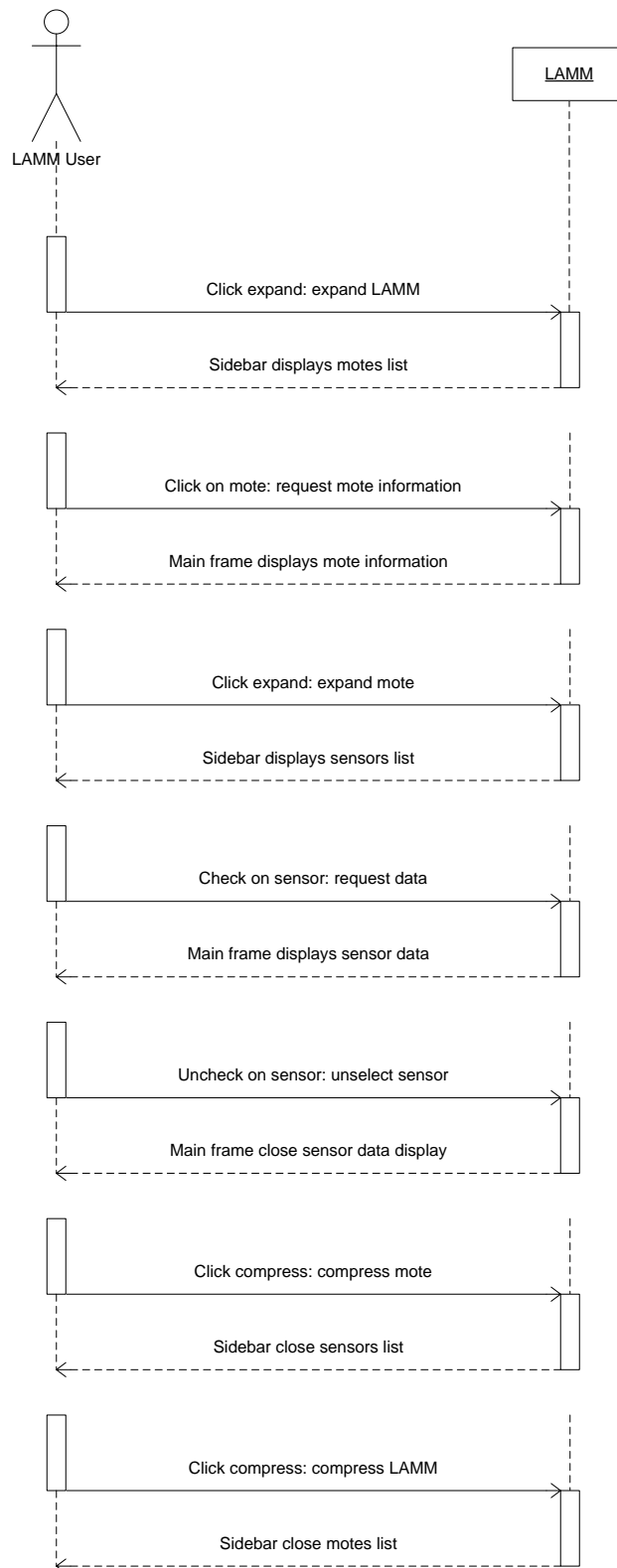
3.2 LAMM

Name: Connect to WAMM
Actor: LAMM User
Description: Connect to WAMM at given IP
Precondition: WAMM is available for connection
Primary Scenario (Flow):
1. User selects connect to WAMM.
2. Prompt user for WAMM IP.
3. Send "request to join".
4. Receive "acknowledge join".

LAMM

LAMM User

Click expand: expand LAMM

Sidebar displays motes list

Click on mote: request mote information

Main frame displays mote information

Click expand: expand mote

Sidebar displays sensors list

Check on sensor: request data

Main frame displays sensor data

Uncheck on sensor: unselect sensor

Main frame close sensor data display

Click compress: compress mote

Sidebar close sensors list

Click compress: compress LAMM

Sidebar close motes list

Name: View Topology
Actor: LAMM User
Description: View the topology of motes on a LAMM
Precondition: At least one mote is connected to LAMM
Primary Scenario (Flow):

1. After mote join, wait for topology
2. Display motes in side bar.
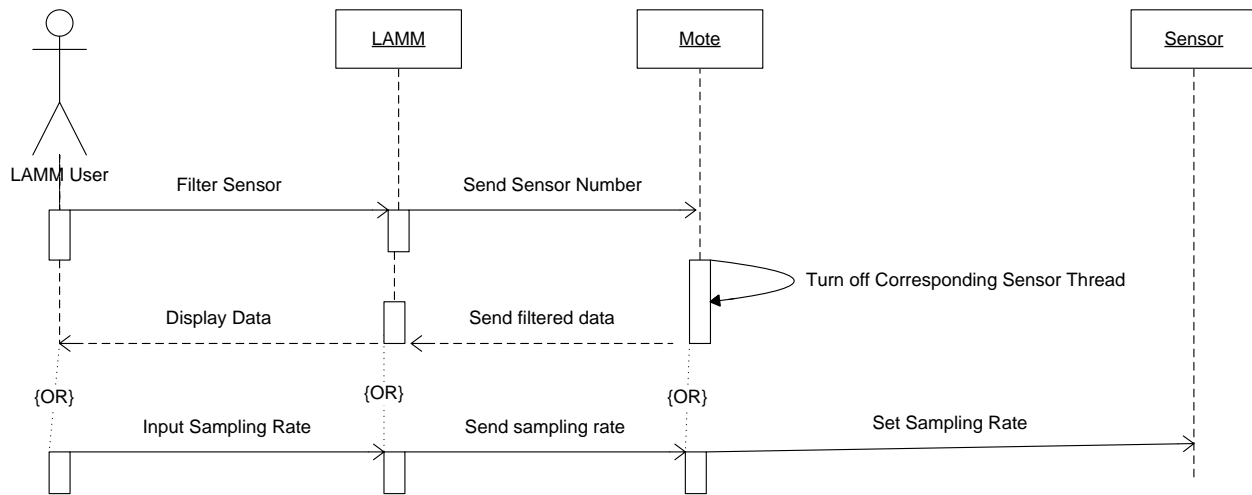3. Expand motes to see available sensors.
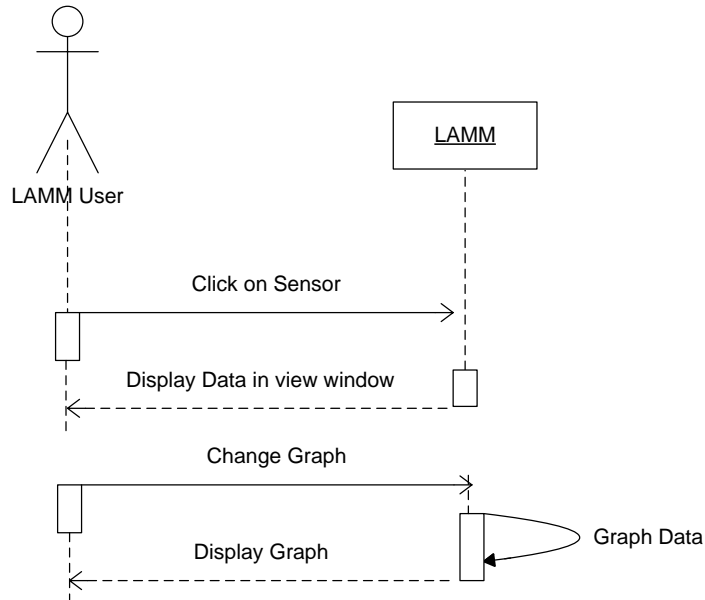
Name: View Data
Actor: LAMM User
Description: Viewing the sensor data on the WAMM
Precondition: At least one mote is connected to LAMM
Primary Scenario (Flow):

1. Expand motes to see available sensors.
2. Click sensor to view sensor data in view window.
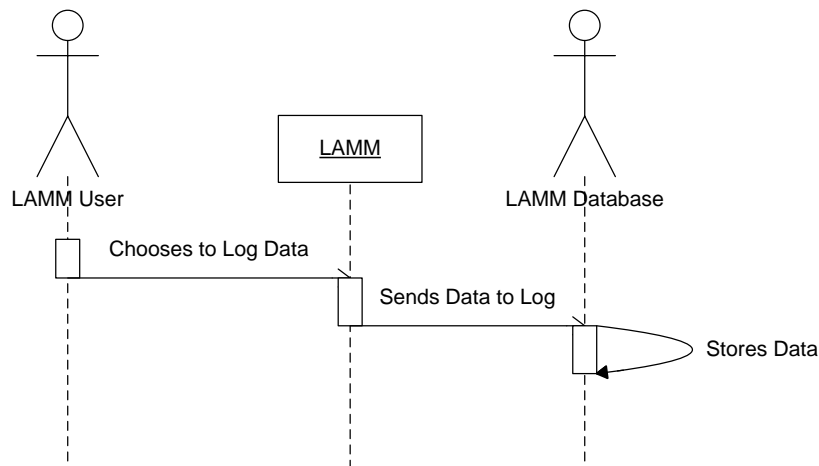
Name: Configure Data

Actor: LAMM User

Description: Filter sensors or input sampling rate

Precondition: At least one mote is connected to LAMM

Primary Scenario (Flow):

1. User selects a sensor and clicks to filter out.
2. LAMM sends message to mote to turn off sensor
3. Mote turns off thread of sensor.
4. Mote continues to send data without filtered sensor

(OR)

1. Once a sensor is displayed, click the text box for sampling rate and input the desired sampling rate.
2. LAMM sends sampling rate to Mote.
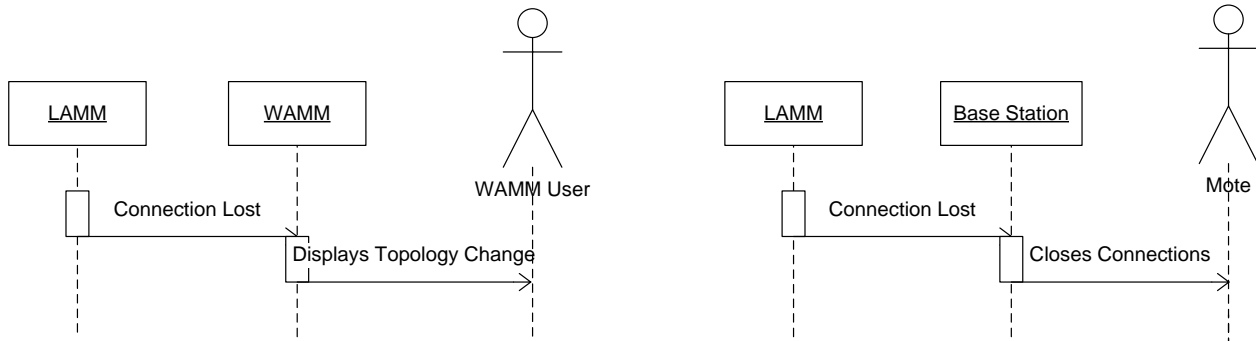3. Mote begins to take samples at specified rate.

Name: Log Data

Actors: LAMM User, LAMM Database

Description: Log data into a database

Precondition: At least one mote is connected to LAMM

Primary Scenario (Flow):

1. Expand mote to view available sensors.
2. Click on a sensor to show the sensor data in the view window.
3. Click log data to begin logging data.
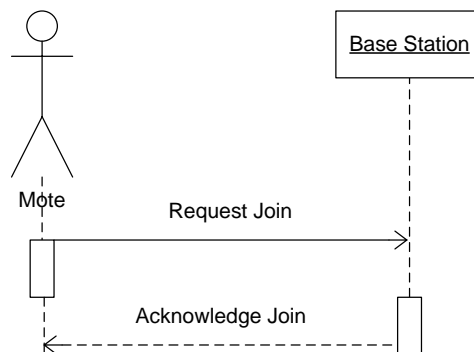

Name: Disconnect

Actor: LAMM User

Description: Disconnect LAMM from WAMM or Base Station

Precondition: LAMM must be connected to WAMM

Primary Scenario (Flow):

1. Click disconnect.
2. LAMM sends notification to WAMM.
3. LAMM disconnects from WAMM.

OR

1. LAMM disconnects from base station
2. Base station closes connections with connected motes

3.3 Mote

Name: Join
Actor: Mote
Description: Mote joining LAMM sequence.
Precondition: A base station must be connected to the LAMM. Mote must be in range of base station.
Base station has fewer than 4 motes connected to it.
Primary Scenario (Flow):
1. Request to join base station.
2. Base station creates socket with LAMM.
3. Base station sends "acknowledge join" to mote.
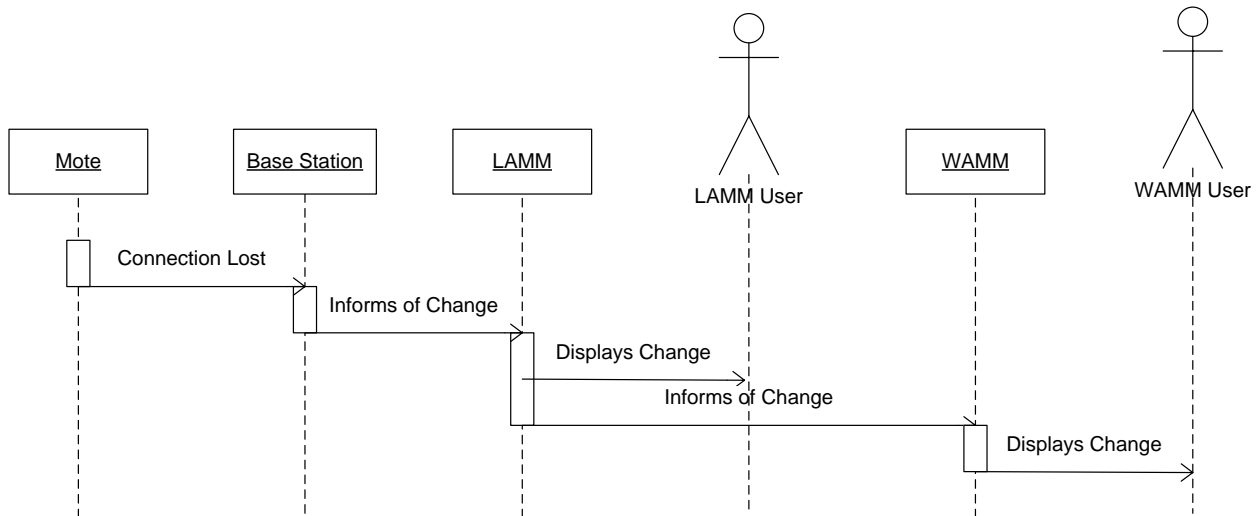
Name: Send Data
Actor: Mote
Description: Mote sends high level, low level, and topology data to LAMM
Precondition: Mote is connected through base station to LAMM.
Primary Scenario (Flow):
1. Get data from sensors.
2. Send data to base station.
3. Base station forwards data to LAMM.

Name: Leave
Actor: Mote
Description: Mote leaves range of base station.
Precondition: Mote was connected to LAMM through base station. LAMM is connected to WAMM.
Primary Scenario (Flow):
1. Base station stops receiving data from mote.
2. Base station informs LAMM of lost mote.
3. LAMM displays mote in gray and removes mote.
4. LAMM informs WAMM of change through topology information.
5. WAMM displays change in topology.
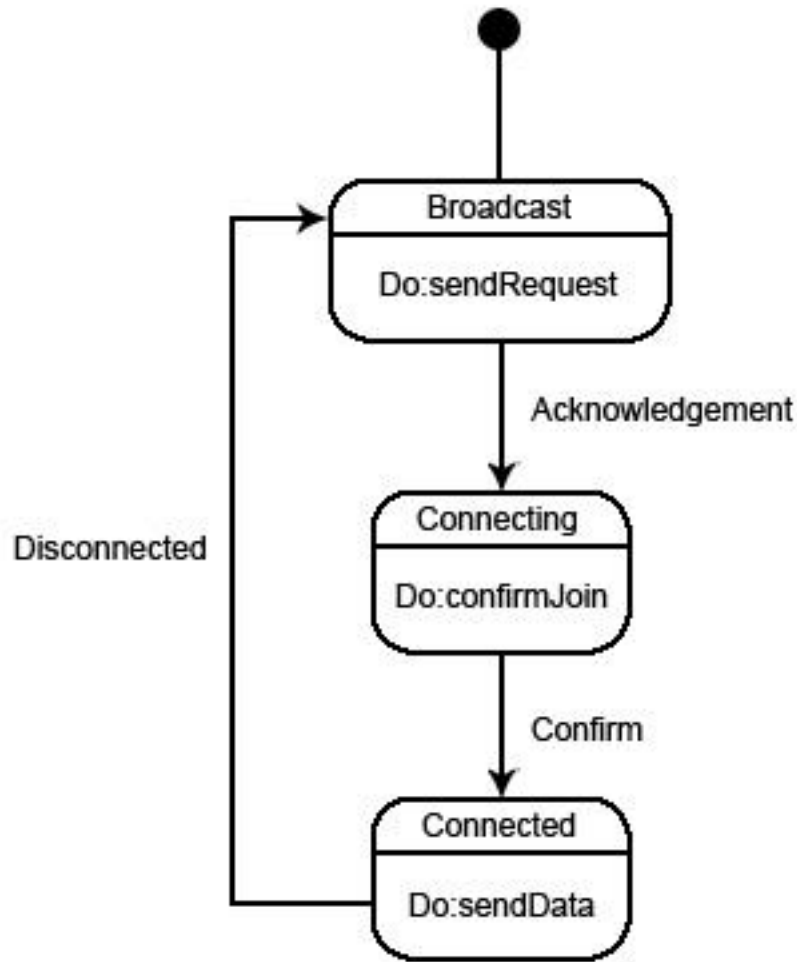
This diagram displays the states of a mote. If the mote is not connected to SUMS, it will broadcast a request to join until a base station sends an acknowledgement to the mote. Once an acknowledgement is received, the mote will send a confirmation to the base station. This confirmation is to prevent problems when multiple base stations acknowledge the mote at the same time. Once the mote is connected to a SUMS base station, it will send data as requested by its LAMM. If somehow the mote becomes disconnected from SUMS, it will begin broadcasting a request to join.