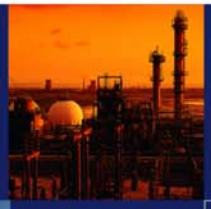
Crossbow

XServe Users Manual

Revision C, December 2006

PN: 7430-0111-01





www.xbow.com

Table of Contents

About This Document

The following annotations have been used to provide additional information.

NOTE

Note provides additional information about the topic.

☑ EXAMPLE

Examples are given throughout the manual to help the reader understand the terminology.

IMPORTANT

This symbol defines items that have significant meaning to the user

⚠ WARNING

The user should pay particular attention to this symbol. It means there is a chance that physical harm could happen to either the person or the equipment.

The following paragraph heading formatting is used in this manual:

1 Heading 1

1.1 Heading 2

1.1.1 Heading 3

This document also uses different body text fonts (listed in Table 0-1) to help you distinguish between names of files, commands to be typed, and output coming from the computer.

Table 0-1. Font types used in this document.

Font Type	Usage
`Courier New Normal`	Sample code and screen output
`Courier New Bold`	Commands to be typed by the user
Times New Roman Italic	TinyOS files names, directory names
Franklin Medium Condensed	Text labels in GUIs

1 Introduction

1.1 Wireless Mesh Networking Overview

Wireless sensor networks have attracted a wide interest from industry due to their diversity of applications. Sensor networks are pervasive by nature; the number of nodes in a network is nearly boundless. Therefore, a key to realizing this potential is multi-hop mesh networking, which enables scalability and reliability.

A mesh network is really a generic name for a class of networked embedded systems that share several characteristics including:

- **Multi-Hop**—the capability of sending messages peer-to-peer to a base station, thereby enabling scalable range extension;
- **Self-Configuring**—capable of network formation without human intervention;
- **Self-Healing**—capable of adding and removing network nodes automatically without having to reset the network; and
- **Dynamic Routing**—capable of adaptively determining the route based on dynamic network conditions (e.g., link quality, hop-count, gradient, or other metric).

When combined with battery power management, these characteristics allow sensor networks to be long-lived, easily deployed, and resilient to the unpredictable wireless channel. With mesh networking, the vision of pervasive and fine-grained sensing becomes reality.

A wireless network deployment is composed of the three distinct software tiers:

- The **Client Tier** provides the user visualization software and graphical interface for managing the network. Crossbow provides free client software called *MoteView* that bundles software from all three tiers to provide an end-to-end solutions.
- The **Server Tier** is an always-on facility that handles translation and buffering of data coming from the wireless network and provides the bridge between the wireless motes and the internet clients. *XServe* and *XOtap* are server tier applications that can run on a PC or Stargate.
- The **Mote Tier**, where *XMesh* resides, is the software the runs on the cloud of sensor nodes forming a mesh network. The *XMesh* software provides the networking algorithms required to form a reliable communication backbone that connects all the nodes within the mesh cloud to the server.

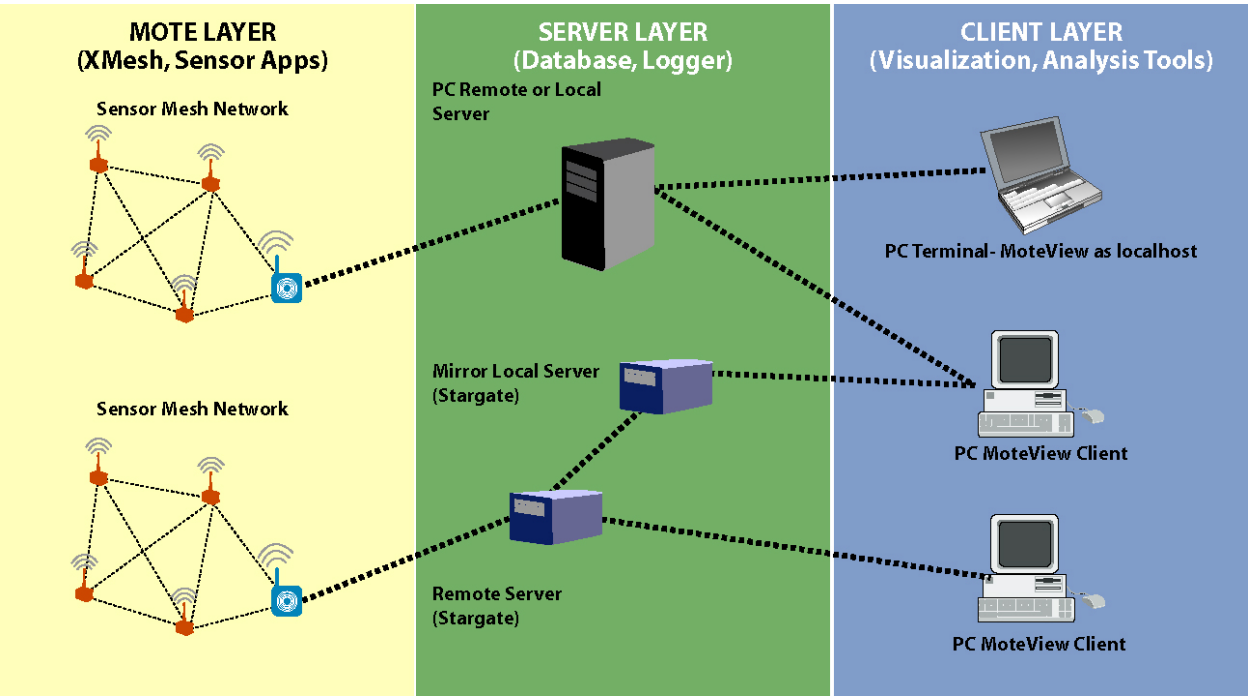


Figure 1-1. Software Framework for a Wireless Sensor Network

1.2 XServe Overview

XServe serves as the primary gateway between wireless mesh networks and enterprise applications interacting with the mesh. At its core, *XServe* provides services to route data to and from the mesh network with higher level services to parse, transform and process data as it flows between the mesh and the outside applications. Higher level services are customizable using XML based configuration files and loadable plugin modules.

XServe offers multiple communication inputs for applications wishing to interact with *XServe* or the mesh network. Users can interact with *XServe* through a terminal interface where as applications can access the network directly or through a powerful XML RPC command interface.

1.3 XServe Services Overview

XServe provides different levels of service depending on how it is configured and installed.

- **Serial Forwarder:** At its core *XServe* provides basic routing services to the Mote network. As a serial forwarder *XServe* allows applications to communicate directly with the application. Applications send and receive raw data directly to the mote network with no high level parsing, converting or processing. In serial forwarding mode, *XServe* applications installed on multiple machines can form a chain of routing modules forwarding data from the Mote tier through an enterprise network.
- **Application Server:** *XServe* can act as an application server providing higher level services such as parsing, transforming and processing data at run time. Users can parse Mote tier data

from the compact raw data format used by motes into a set of named data values. While parsing, data can be converted, merged or separated at bit level granularity based on the semantic meaning of the data. Parsed data can be sent for extra processing by user defined business logic. *XServe* provides pre-configured post processing modules for printing data to the terminal screen, writing data to file, storing data in a database, and publishing data as an XML stream.

2 Installation and Getting Started

2.1 Supported Platforms and Operating Systems

XServe is supported on the following platforms:

Operating System	Platform
Windows/Cygwin	X86
Linux	X86
	ARM

2.2 Mote Tier Requirements

XServe directly connects to a mesh network through a base station mote. Base station motes can be connected to the *XServe* machine using the following hardware:

- **MIB510** serial gateway using an RS-232 serial port or a USB port and a USB-to-serial converter that is compatible with the PC and its operating system.
- **MIB520** serial gateway using a USB port.
- **MIB600** Ethernet gateway using a wired Ethernet or 802.11 wireless card only if the MIB600 is on a LAN with wireless access.
- **Direct Serial Connection** using the 51 pin connector on the Stargate platform.

2.3 PC Installation Steps

1. Shut down all running programs on your computer.
2. Insert the *MoteWorks* CD into the computer's CD-ROM drive.
3. Follow the steps provided in *MoteWorks Getting Started Guide.*

2.4 *MoteWorks* Sensor and Data Acquisition Applications

XServe supports all Crossbow sensor and data acquisition applications. *MoteWorks* provides two variants of each application:

1. ***XMesh*** enabled applications**:** *XMesh* is Crossbow's multihop mesh networking protocol that has various options including low-power listening, time synchronization, sleep modes, any-to-base and base-to-any routing. All of our sensor and data acquisition boards are supported with *XMesh* enabled applications. *XServe* is connected to these applications thorugh a base station running the *XMeshBase* application. The Table 2-1 provides a summary of the *XMesh* applications the corresponding sensor boards.

Table 2-1. Sensor and data acquisition boards and the corresponding *XMesh* application

Sensor and Data Acquisition Boards	Application Name	Location of Driver Folder
MDA100CA	XMDA100	MoteWorks/apps/XMesh/XMDA100
MDA100CB	XMDA100CB	MoteWorks/apps/XMesh/XMDA100CB
MDA300	XMDA300	MoteWorks/apps/XMesh/XMDA300
MDA320	XMDA320	MoteWorks/apps/XMesh/XMDA320
MDA325	XMDA325	MoteWorks/apps/XMesh/XMDA325
MDA500	XMDA500	MoteWorks/apps/XMesh/XMDA500
MEP410	XMEP410	MoteWorks/apps/XMesh/XMEP410
MEP510	XMEP510	MoteWorks/apps/XMesh/XMEP510
MSP410	XMSP410	MoteWorks/apps/XMesh/XMSP410
MTS101	XMTS101	MoteWorks/apps/XMesh/XMTS101
MTS300CA/310CA	XMTS310	MoteWorks/apps/XMesh/XMTS310
MTS300CB/310CB	XMTS310CB	MoteWorks/apps/XMesh/XMTS310CB
MTS410	XMTS410	MoteWorks/apps/XMesh/XMTS410
MTS400/420	XMTS420	MoteWorks/apps/XMesh/XMTS420
MTS450	XMTS450	MoteWorks/apps/XMesh/XMTS450
MTS510	XMTS510	MoteWorks/apps/XMesh/XMTS510

2. ***XSensor*** applications**:** *XSensor* applications are test applications for Crossbow's sensor and data acquisition boards. They allow the user to quickly and easily test sensor and data acquisition boards when attached to Mote. These applications send the output over the Mote's UART thereby allowing the user to test these boards without using an RF link. Testing by RF link can also be done by programming a base station with *TOSBase* and connecting it to *XServe***.** *XSensor* application send data one hop so all test Motes must be within RF range of the base station. The Table 2-2 provides a summary of the *XSensor* applications the corresponding sensor boards.

Table 2-2. Sensor and data acquisition boards and the corresponding *XSensor* application

Sensor and Data Acquisition Boards	Application Name	Location of Driver Folder
MDA100	XSensorMDA100	MoteWorks/apps/XSensor/ XSensorMDA100
MDA300	XSensorMDA300	MoteWorks/apps/XSensor/XSensorMDA300
MDA320	XSensorMDA320	MoteWorks/apps/XSensor/XSensorMDA320
MDA325	XSensorMDA325	MoteWorks/apps/XSensor/XSensorMDA325
MDA500	XSensorMDA500	MoteWorks/apps/XSensor/XSensorMDA500
MEP410	XSensorMEP410	MoteWorks/apps/XSensor/XMEP410
MEP510	XSensorMEP510	MoteWorks/apps/XSensor/XSensorMEP510
MTS101	XSensorMTS101	MoteWorks/apps/XSensor/XSensorMTS101
MTS300/310	XSensorMTS300	MoteWorks/apps/XSensor/XSensorMTS300
MTS400/420	XSensorMTS400	MoteWorks/apps/XSensor/XSensorMTS400
MTS410	XSensorMTS410	MoteWorks/apps/XSensor/XSensorMTS410
MTS450	XSensorMTS450	MoteWorks/apps/XSensor/XSensorMTS450
MTS510	XSensorMTS510	MoteWorks/apps/XSensor/XSensorMTS510

NOTE: Instructions on how to compile and install these applications are in *MoteWorks Getting Started Guide*.

2.5 Starting *XServe* with MoteWorks applications [Quick Start]

XServe is pre-configured to work with all MoteWorks sensor applications. Before starting *XServe*, refer to *MoteWorks Getting Started Guide* to learn how to compile, install, and deploy a *MoteWorks* sensor network. Once a network has been deployed, run *XServe* on the PC connected to the Mote Tier base station.

To quickly begin viewing sensor data connect *XServe* to the COM device connected to your sensor network base station using the following command:

`xserve.exe –device=com<#>`

The **<#>** is to be replaced by the COM port number to which the MIB510 or MIB520 (the higher of the two virtual COM ports assigned by your PC) is attached. Starting *XServe* in this manner automatically displays each sensor network packet directly to the terminal screen in 3 different formats: a) raw, b) parsed, and c) converted.

- **Raw Format**: Raw format displays the data in it pure binary form displaying each byte of the data as a pair of base16 hexidecimal numbers. Raw format is useful for debugging sensor data since data is displayed unaltered, in the same format sent by the motes over the network.
- **Parsed Format**: Parsed format displays the data as a set of name-values pairs. *XServe* parses the raw format and extracts individual fields of data associating them with the field name. Parsed format displays the field name of the data with original base16 hexidecimal number associated with it.
- **Converted Format**: Converted format also displays the data as name-values pairs, but each value has been converted from its raw value into the appropriate unit of measure for the field.

Below is an example out from an *XMTS101* application data packet. The packet is displayed in raw, parsed and converted formats.

```
$ xserve -device=com4
XServe Ver 2: $Id: xserve.c,v 1.24 2005/12/14 10:05:13 pipeng Exp $
Using params: [raw] [parsed] [converted] [server port=9001]
Opening serial device: \\.\COM4 @ 57600
[2005/12/20 14:57:56]  Serial Source Msg: sync
[2005/12/20 14:57:56] 7E 00 00 91 14 82 01 01 00 7E 01 04 01 F1 00 2C 01 F3 00 F
2 00 F5 00 FE 00  [25]
[2005/12/20 14:57:56] MTS101 [sensor data converted to engineering units]:
   health:     node id=0x01  battery:  = 0x17e mv
   tempurature: =0x104 degC  light: = 0xf1 mv
   adc0 = 0x12c mv adc1 = 0xf3 mv adc2 = 0xf2 mv
   adc3 = 0xf5 mv adc4 = 0xfe mv
[2005/12/20 14:57:56] MTS101 [sensor data converted to engineering units]:
```

```
health:     node id=1  battery:  = 3278 mv
tempurature: =3.581866 degC  light: = 772 mv
adc0 = 300 mv adc1 = 243 mv adc2 = 242 mv
adc3 = 245 mv adc4 = 254 mv
```

3 Using XServe

3.1 *XServe* Overview

XServe is a versatile application which can be configured to format and present data in multiple manners. It can connect to the Mote Tier directly or through other forwarding applications including other *XServes*. *XServe* also provides built in monitoring and conversion tools for greater reliability and versatility.

At its core *XServe* provides basic routing services to the Mote network. As a serial forwarder *XServe* allows enterprise applications to communicate directly with the sensor network. Applications send and receive raw data directly to the mote network with no high level parsing, converting or processing. In serial forwarding mode, *XServe* applications installed on multiple machines can form a chain of routing modules forwarding data from the mote tier through an enterprise network. For more information on the Serial Forwarding protocol (See Section 7.1.3).

XServe also provides higher level services for enterprise applications by abstracting the sensor network so enterprise applications can focus on business logic. *XServe* can be configured to parsing sensor packets into a series of name values pairs giving richer meaning to the sensor data. While parsing, *XServe* can transform the data from its raw format to the appropriate unit of measure for the sensor reading. Once parsed, sensor data can be presented in multiple formats based on an individual applications needs.

3.1.1 XServe Data Formats

XServe manages data in three different formats: a) raw, b) parsed, and c) converted.

- **Raw Format**: Raw format displays the data in it pure binary form displaying each byte of the data as a pair of base16 hexidecimal numbers. Raw format is useful for debugging sensor data since data is displayed unaltered, in the same format sent by the motes over the network.
- **Parsed Format**: Parsed format displays the data as a set of name-values pairs. *XServe* parses the raw format and extracts individual fields of data associating them with the field name. Parsed format displays the field name of the data with original base16 hexidecimal number associated with it.
- **Converted Format**: Converted format also displays the data as name-values pairs, but each value has been converted from its raw value into the appropriate unit of measure for the field.

3.1.2 XServe Presentation Formats

XServe is pre-configured to present data in four ways: a) print, b) export file, c) database logging, and d) XML (extenstible markup lanuage) data stream.

- **Print:** Print displays all data directly to the terminal screen. By default xserve displays all data to screen for users to view.
- **Export File:** Export file exports each data packet to its own data specific file. Each packet is entered as a single row in the file and each field is delimited using a user specified delimiter. The filename and delimiter for MoteWorks application are specified in the applications XML Configuration file (See Section 7.2.1). If the no configuration file is

available for the data packet then the data is displayed on to the display terminal in a comma delimited format.

- **Database Logging:** Database logging stores each data packet in its own data specific database table. Each packet represents a single row in the table. The packet can either be inserted as a new row or can be used to update an existing row. The configuration for each *MoteWorks* application data packet is specified in the applications Configuration XML file (See Section 7.2.1).
- **XML Stream:** XML Stream presents each data packet as an XML document. The XML document is published to listening applications thorugh an XML socket connection. If no applications are listening the XML Document is displayed to the terminal screen.

3.2 *XServe* Command Line Parameters

```
Usage: xserve <-?|r|a|p|c|xr|xp|xc|dbxmlr|xmlp|xmlc|v|alert|m>
              <-l=tablename>
              <-dbserver=servername> <-dbport=portnum>
              <-dbname=database name> <-dbuser=username>
              <-dbpasswd=password>
              <-h=path,hostname,portnum,config_file>
              <-m=com,baud,protocol,slaveaddress,defaultregistervaluesas>
              <-xmlfile=filename> <-xmlport=portnum>
              [<-sf=hostname:port> | <-fsf=hostname:port> | <-device=dev>]
              <-port=num> <-baud=num> <-platform=plt>
              <-debug=level>
              <-configfiles=filename:filename:>
              <-loadparsers=filename:filename:...>
              <-loaddatasinks=filename:filename:...>
              <-heartbeat=<num missed>

   -?         = display help [help]
   -r         = raw display of tos packets [raw]
   -a         = ascii display of tos packets [ascii]
   -p         = parsed display of tos packets [parsed]
   -c         = converted display of tos packets [conveted]
   -xr        = raw tos packets xported to file [export raw]
   -xp        = parsed tos packets exported to file [export parsed]
   -xc        = converted tos packets exported to file [export converted]
   -db        = parsed tos packets exported to db [database parsed]
   -dbserver  = database server name (default=localhost)
   -dbport    = database server port number (default=5432)
   -dbname    = database name (default=MoteView db)
```

```
  -dbuser    = database user (default=MoteView user)
  -dbpasswd  = database user password (default=MoteView user password)
  -l         = parsed tos packets exported to db
               (deprecated) [database parsed]
  -xmlr      = raw tos packets exported to xml [xml raw]
  -xmlp      = parsed tos packets exported to xml [xml parsed]
  -xmlc      = converted tos packets exported to xml [xml converted]
  -xmlfile   = file name to store exported xml (default=screen)
  -xmlport   = port number to start the xml server
  -v         = show version of all modules
  -h         = display data through web server
  -m         = export data using modbus
  -port      = set server port <default = 9001>
  -sf        = connect to unframed serial forwarder
  -fsf       = connect to framed serial forwarder
  -device    = connect to serial device <default = /dev/ttyS0>
  -baud      = set serial baud rate <default = 57600>
  -platform  = set platform. <default = mica2>
               values=mica2dot|mica2|mica|telos|micaz
  -debug     = set debug level. <default = DBG_WARNING>
  -alert     = alert when data values are above/below specified ranges
  -daemon    = run in daemon mode
  -nomonitor = run without a system monitor
  -configfiles = load xml configuration files.
  -loadparsers = load only the listed parsers files.
                 (default=all files are loaded)
  -loaddatasinks = load only the listed datasinks files.
                   (default=all files are loaded)
  -heartbeat = turn on the heartbeat monitor and reset after <num missed>
  -convZto2  = convert incoming network packets from micaZ headers to
               mica2 headers and vice versa
  -conv2toZ  = convert incoming network packets from mica2 headers to
               micaZ headers and vice versa
```

3.2.1 System Parameters

`-v`

Displays version numbers for each *XServe* loaded component.

`-daemon`

By default *XServe* starts as a forground process. The –daemon flag starts *XServe* as a background process.

-nomonitor

XServe is run as group of processes all monitored by a parent process. The –nomonitor flags runs *XServe* as a single process.

3.2.2 Serial Forwarding Parameters

-port=<portnum>

Sets the Serial Forwarder server port number for applications wishing to connect to *XServe* through Serial Forwarder. The default is 9001.

3.2.3 Mote Tier Connection Parameters

-sf=<hostname:port>

Connects to Mote Tier through an application running an unframed Serial Forwarding protocol (See Section 7.1.3).

-fsf=<hostname:port>

Connects to the Mote Tier through an application running a framed Serial Forwarding protocol (See Section 7.1.3).

-device=<COM#>

Connects to Mote Tier through a direct COM port. The default connection is to COM1.

-baud=<baudrate>

Sets the baud rate for the COM device. The default value is 56700.

3.2.4 Print Parameters

-r

Displays packets to terminal screen in base16 hexidecimal format

```
$ xserve -r
XServe Ver 2: $Id: xserve.c,v 1.24 2005/12/14 10:05:13 pipeng Exp $
Using params: [raw] [server port=9001]
Opening serial forwarder: localhost : 9001
[2005/12/19 09:29:36] 7E 00 33 7D 1B 00 00 00 00 00 00 00 01 81 7E 00 C0 00 D9 0
1 56 01 DA 00 B2 00 AE 00 BC 00 A4 00  [32]
```

-a

Displays packet to terminal screen in ASCII character format

-p

Displays packet to terminal screen in parsed format.

```
$ xserve -p
XServe Ver 2: $Id: xserve.c,v 1.24 2005/12/14 10:05:13 pipeng Exp $
```

```
Using params: [parsed] [server port=9001]
Opening serial forwarder: localhost : 9001
 [2005/12/19 09:29:36] MDA500 [sensor data converted to engineering units]:
   health:     node id=0x00
   battery:    volts=0xc0 mv
   thermistor: resistance=0x1d9 ohms, tempurature=0x1d9 C
   adc chan 2: voltage=0x156 mv
   adc chan 3: voltage=0xda mv
   adc chan 4: voltage=0xb2 mv
   adc chan 5: voltage=0xae mv
   adc chan 6: voltage=0xbc mv
   adc chan 7: voltage=0xa4 mv
```

-c

Displays packet to terminal screen in converted format.

```
$ xserve -c
XServe Ver 2: $Id: xserve.c,v 1.24 2005/12/14 10:05:13 pipeng Exp $
Using params: [converted] [server port=9001]
Opening serial forwarder: localhost : 9001
 [2005/12/19 09:29:36] MDA500 [sensor data converted to engineering units]:
   health:     node id=0
   battery:    volts=3200 mv
   thermistor: resistance=8600 ohms, tempurature=28.201022 C
   adc chan 2: voltage=1069 mv
   adc chan 3: voltage=681 mv
   adc chan 4: voltage=556 mv
   adc chan 5: voltage=544 mv
```

3.2.5 Export File Parameters

-xr

Exports packet to file in raw format.

```
$ xserve -device=com4 -xr
XServe Ver 2: $Id: xserve.c,v 1.24 2005/12/14 10:05:13 pipeng Exp $
Using params: [export raw] [server port=9001]
Opening serial device: \\.\COM4 @ 57600
0x7E00009114820101007E01FF00EB005701EF00ED00F500FC00
```

-xp

Exports packet to file in parsed format.

```
$ xserve -device=com4 -xp
XServe Ver 2: $Id: xserve.c,v 1.24 2005/12/14 10:05:13 pipeng Exp $
Using params: [export parsed] [server port=9001]
Opening serial device: \\.\COM4 @ 57600
0x0,0x01,0x91,0x82,0x1,0x17e,0xff,0xeb,0x157,0xef,0xed,0xf5,0xfc
```

-xc

Exports packet to file in converted format.

```
$ xserve -device=com4 -xc
XServe Ver 2: $Id: xserve.c,v 1.24 2005/12/14 10:05:13 pipeng Exp $
Using params: [export converted] [server port=9001]
Opening serial device: \\.\COM4 @ 57600
0,1,145,130,1,3278,3.097866,753,343,239,237,245,252
```

3.2.6 Database Logging Parameters

-db

Logs packet to database in parsed format.

```
$ ./xserve -device=com4 -db
XServe Ver 2: $Id: xserve.c,v 1.24 2005/12/14 10:05:13 pipeng Exp $
Using params: [db parsed] [server port=9001]
Opening serial device: \\.\COM4 @ 57600
[2005/12/20 16:18:53]  Serial Source Msg: sync
INSERT into mts101_results (result_time,nodeid,voltage,temp,light,adc0,adc1,adc2
,adc3,adc4) values (now(),1,382,260,240,311,247,240,244,254)
```

-dbserver=<servername>

Sets the PostgreSQL database server name. The default value is "localhost".

-dbport=<portnum>

Sets the PostgreSQL database server port. The default value is 5432.

-dbname=<database name>

Sets the PostgreSQL database name. The default value is the MoteView database.

-dbuser=<username>

Sets the PostgreSQL database user name. The default is the MoteView database user name.

-dbpasswd=<password>

Sets the PostgreSQL database user password. The default is the MoteView database user password.

3.2.7 XML Stream Parameters

-xmlr

Exports the packet to a XML stream in raw format.

```
$ xserve -device=com4 -xmlr
XServe Ver 2: $Id: xserve.c,v 1.24 2005/12/14 10:05:13 pipeng Exp $
Using params: [xml raw] [server port=9001]
Opening serial device: \\.\COM4 @ 57600
<?xml version="1.0" ?>
<MotePacket>
<RawPacket>0x7E00009114820101007E01FF00EA004101EE00EB00F100F700</RawPacket>
</MotePacket>
```

-xmlp

Exports the packet to a XML stream in parsed format.

```
$ xserve -device=com4 -xmlp
XServe Ver 2: $Id: xserve.c,v 1.24 2005/12/14 10:05:13 pipeng Exp $
Using params: [xml parsed] [server port=9001]
Opening serial device: \\.\COM4 @ 57600
<?xml version="1.0" ?>
<MotePacket>
<ParsedDataElement><Name>amtype</Name><RawValue>0x0</RawValue></ParsedDataElement>
<ParsedDataElement><Name>nodeid</Name><RawValue>0x01</RawValue></ParsedDataElement>
<ParsedDataElement><Name>group</Name><RawValue>0x91</RawValue></ParsedDataElement>
<ParsedDataElement><Name>board_id</Name><RawValue>0x82</RawValue></ParsedDataElement>
<ParsedDataElement><Name>packet_id</Name><RawValue>0x1</RawValue></ParsedDataElement>
<ParsedDataElement><Name>voltage</Name><RawValue>0x17e</RawValue></ParsedDataElement>
<ParsedDataElement><Name>temp</Name><RawValue>0xff</RawValue> </ParsedDataElement>
<ParsedDataElement><Name>light</Name><RawValue>0xea</RawValue></ParsedDataElement>
<ParsedDataElement><Name>adc0</Name><RawValue>0x141</RawValue></ParsedDataElement>
<ParsedDataElement><Name>adc1</Name><RawValue>0xee</RawValue></ParsedDataElement>
<ParsedDataElement><Name>adc2</Name><RawValue>0xeb</RawValue></ParsedDataElement>
<ParsedDataElement><Name>adc3</Name><RawValue>0xf1</RawValue></ParsedDataElement>
<ParsedDataElement><Name>adc4</Name><RawValue>0xf7</RawValue></ParsedDataElement>
</MotePacket>
```

-xmlc

Exports the packet to a XML stream in converted format.

```
$ xserve -device=com4 -xmlr -xmlp -xmlc
XServe Ver 2: $Id: xserve.c,v 1.24 2005/12/14 10:05:13 pipeng Exp $
Using params: [xml raw] [xml parsed] [xml converted] [server port=9001]
Opening serial device: \\.\COM4 @ 57600
<?xml version="1.0" ?>
<MotePacket>
<ParsedDataElement><Name>amtype</Name><ConvertedValue>0</ConvertedValue></ParsedDataElement>
<ParsedDataElement><Name>nodeid</Name><ConvertedValue>1</ConvertedValue></ParsedDataElement>
<ParsedDataElement><Name>group</Name><ConvertedValue>145</ConvertedValue></ParsedDataElement>
<ParsedDataElement><Name>board_id</Name><ConvertedValue>130</ConvertedValue></ParsedDataElement>
<ParsedDataElement><Name>packet_id</Name><ConvertedValue>1</ConvertedValue></ParsedDataElement>
<ParsedDataElement><Name>voltage</Name><ConvertedValue>3278</ConvertedValue></ParsedDataElement>
<ParsedDataElement><Name>temp</Name><ConvertedValue>3.097866</ConvertedValue></ParsedDataElement>
<ParsedDataElement><Name>light</Name><ConvertedValue>749</ConvertedValue></ParsedDataElement>
<ParsedDataElement><Name>adc0</Name><ConvertedValue>321</ConvertedValue></ParsedDataElement>
<ParsedDataElement><Name>adc1</Name><ConvertedValue>238</ConvertedValue></ParsedDataElement>
<ParsedDataElement><Name>adc2</Name><ConvertedValue>235</ConvertedValue></ParsedDataElement>
<ParsedDataElement><Name>adc3</Name><ConvertedValue>241</ConvertedValue></ParsedDataElement>
<ParsedDataElement><Name>adc4</Name><ConvertedValue>247</ConvertedValue></ParsedDataElement>
</MotePacket>
```

-xmlfile=<filename>

Specifies location to store XML stream if no subscribers connected to receive the XML document. The default location is to the terminal screen.

-xmlport=<portnum>

The port number XML stream subscribers must connect to to receive XML docments. The default is 9002.

3.2.8 Web Access Parameters

-h=<path,hostname,portnum,configfile>

XServe provides a built in Web Server to access *XServe*'s web interface. The –h flag starts the web server. The path is the location of the web directory, the hostname is name of the web server machine, the portnum is the port to access the web server and the config file is the path to a configuration file to configure the web server. By default the values are <../web, localhost, 8080, NULL>. See Section 5.

3.2.9 Modbus Parameters

`-m=<COM#,baudrate,protocol,` slave address `, default reg values>`

Exports data via Modbus interface. The default value on windows platform is "*/dev/ttyS2,9600,RTU,32,0*".

3.2.10 Configuration Parameters

`-configfiles=<filename1:filename2:…>`

Loads only the specified XML configuration files. The default value is to load all XML configuration files.

`-loadparsers=<filename1:filename2:…>`

Loads only the specified parser libraries. The default value is to load all available parser libraries.

`-loaddatasinks=<filename1:filename2:…>`

Loads only the specified datasink libraries. The default value is to load all available datasink libraries.

3.2.11 System Monitoring Parameters

`-alert`

XServe can monitor individual fields in packets to alert users if the value has over/under specified values. The –alert flags turns on this monitoring feature (See Section 7.3.1.4).

`-heartbeat=<num missed>`

XServe can monitor the link to the base station to verify that it is running. In the case of the MIB5*x*0 series of Sensor Programming Boards, the heartbeat monitor can also restart the base station if a failure has been detected (See Section 7.3.1.6).

3.2.12 System Tools Parameters

`-convZto2`

XServe provides system tools to convert MICAz platform TinyOS packets to MICA2 TinyOS packets. When the **`-convZto2`** flags is provided all packets from the Mote Tier will be converted from MICAz to MICA2 packets, and all packets to the Mote Tier will be converted from MICA2 packets to MICAz packets.

`-conv2toZ`

XServe provides system tools to convert MICA2 platform TOS packets to MICAz TOS packets. When the –conv2toZ flag is provided all packets from the Mote Tier will be

converted from MICA2 to MICAz packets, and all packets to the Mote Tier will be converted from MICAz packets to MICA2 packets.

3.2.13 Debug Parameters

`-debug=<debuglevel>`

XServe provides various levels of debugging output. The available debug levels are:

`XDBG_1` (most detail)

`XDBG_2`

`XDBG_3`

`XDBG_4`

`XDBG_5` (least detail)

`XDBG_INFO`

`XDBG_WARNING` (default value)

`XDBG_ERROR`

4 Using XCommand

4.1 *XCommand* Overview

MoteWorks sensor applications allow users to query state variables and actuate devices on the Mote such as LEDS, sounder, or relays. This feature is called *XCommand*. *XServe* provides two interfaces for enterprise applications to send commands to the MoteTier using *XCommand*. Users can send and receive *XCommands* using *XServeTerm*, a terminal command application. Applications can send and receive *XCommands* using an *XML RPC* interface.

The *XCommand* allow you to *get*, *set*, or *reset* parameters for the sensor boards. The Table 4-1 shows the command categories and commands.

Table 4-1 *XCommand* Categories and Description

Command Category	Command	Arguments	Description
Power Management	RESET SLEEP WAKEUP		To reset the sleep and wakeup time.
Basic Update Rate	SET_RATE		To get or set the update rate. The set_rate command changes the data acquisition duty cycle of the mote. The first argument is the new timer interval in milliseconds.
Mote Configuration Parameter Settings	• GET_CONFIG • SET_NODEID • SET_GROUP • SET_RF_POWER • SET_RF_CHANNEL		This set of commands allows you to get and set radio frequency and power, including channel.
Actuation	ACTUATE • SET_LED • SET_SOUND • SET_RELAY	0=OFF, 1=ON, 2=TOGGLE 0=OFF, 1=ON 0=OFF, 1=ON	This set of commands actuates each individual LED with the option to operate on all three LEDs. This command turns the sounder off or on. This command turns the relays on or off.

Each command responds back with an acknowledgement to confirm that it has received the command. The only exceptions are actuation commands. They do not send an acknowledgement response.

4.2 Using XServeTerm

The *XServeTerm* application provides a terminal interface to *XCommand*. To start *XServeTerm* use the following command:

xserveterm –server=<*host:port*>

Starting *XServeTerm* in this manner will connect the application to the *XServe* running at host and listening on port.

4.2.1 XServeTerm Parameters

XServeTerm has many modes of operation. The list of these command line options is provided below.

```
Usage: xcommand <-?> <-server=host:port> <-network=xmesh|xsensor>
   -?           = display help [help]
   -server      = xserve command port [host:port]
   -network     = network type (default = xmesh) [xmesh|xsensor]
   -seq         = starting sequence number (default=100)
   -group       = network group id (default=145)
```

-server

XServeTerm uses *XServe* to communicate with the Mote Tier. The `-server` flag gives the host and port number of the *XServe* application connected to the sensor network. By default the host is localhost and the port is 9003.

-network=<xmesh|xsensor>

MoteWorks provides two types of sensor applications: *XSensor* applications and *XMesh* applications. The –network flag indicates which type of sensor application *XServeTerm* is sending commands to. The default value is *XMesh*.

-seq=<number>

When communicating with *XSensor* applications *XCommand* requires a unique sequence number for each command. The –seq flag sets the starting sequence number *XServeTerm* will use when communicating with the network. The sequence number is incremented internally after each executed command. The default value is 100.

-group=<groupid>

The `-group` flag sets the network group id for the network you are connecting too. The default value is 145.

4.2.2 XCommand Parameters

Once you have started *XServeTerm*, the user will be given a command prompt from which to issue commands. To obtain a list of commands type the following:

XCmdTerm> help

The help command will list all available commands and arguments. The list of these command line options is provided below.

```
Available Commands:
   set_timeout <timeout ms>
   set_starting_sequence <sequence number>
   set_default_group <group id>
```

```
   get_config  <destination address>
   set_rate <destination address> <new rate>
   set_nodeid <destination address> <new node id>
   set_groupid <destination address>  <new group id>
   set_rfchannel <destination address>  <new rf channel>
   set_rfpower <destination address>  <new rfpower>
   sleep <destination address>
   wake <destination address>
   reset <destination address>
   xserve.shutdown
   actuate <destination address> <device> <state>
               device ids              states
               ----------              ------
               green led       0       off     0
               yellow led      1       on      1
               red led         2       toggle  2
               all leds        3
               sounder         4
               relay1          5
               relay2          6
               relay3          7
```

`set_timeout <timeout ms>`

Each command (except Actuation commands) returns a response. The `set_timeout` flag tells *XServeTerm* the amount of time the application should wait for a response. The default value is 5000 ms.

`set_starting_sequence <sequence number>`

The sequence number is used by *XSensor* applications as a unique identifies for each command. The starting value can be set at startup as an *XServeTerm* aruguement or at run time using the `set_starting_sequence` command.

`set_default_group <group id>`

This sets the default group id for each command. It can be set at startup as an *XServeTerm* argument or at run time using the `set_default_group` command.

`get_config <destination address>`

The `get_config` command requests configuration information from `<destination address>`.

```
XCmdTerm:> get_config 5
SUCCESS: Command executed successfully. (SUCCESS:Success)
NODE ID: 5
UID: 01301FED0A00007D
```

```
GROUP ID: 125
RADIO CHANNEL: 24
RADIO POWER: 15
```

set_rate <destination address> <new rate>

The set_rate command sets the sampling rate of the application at <destination address> to new sample rate <new rate>.

```
XCmdTerm:> set_rate 5 100
SUCCESS: Command executed successfully. (SUCCESS:Success)
NODE ID: 5
SAMPLE RATE: 100
```

set_nodeid <destination address> <new node id>

The set_nodeid command sets the node id of the mote at <destination address> to node id <new node id>.

```
XCmdTerm:> set_nodeid 5 10
SUCCESS: Command executed successfully. (SUCCESS:Success)
NODE ID: 10
```

set_groupid <destination address> <new group id>

The set_groupid command sets the group id of the mote at <destination address> to group id <new group id>

```
XCmdTerm:> set_groupid 10 145
SUCCESS: Command executed successfully. (SUCCESS:Success)
NODE ID: 10
GROUP ID: 145
```

set_rfchannel <destination address> <new rf channel>

The set_rfchannel command sets the radio channel of the mote at <destination address> to channel <new rf channel>

```
XCmdTerm:> set_rfchannel 10 23
SUCCESS: Command executed successfully. (SUCCESS:Success)
NODE ID: 10
RADIO CHANNEL: 23
```

set_rfpower <destination address> <new rfpower>

The set_rfpower command sets the radio power of the mote at <destination address> to setting <new rf power>

```
XCmdTerm:> set_rfpower 10 15
SUCCESS: Command executed successfully. (SUCCESS:Success)
NODE ID: 10
RADIO POWER: 15
```

sleep <destination address>

The `sleep` command directs the application to stop sampling data. This does not sleep the radio, only the applications sampling.

```
XCmdTerm:> sleep 10
SUCCESS: Command executed successfully. (SUCCESS:Success)
NODE ID: 10
```

wake <destination address>

The `wake` command directs the application to resume sampling data.

```
XCmdTerm:> wake 10
SUCCESS: Command executed successfully. (SUCCESS:Success)
NODE ID: 10
```

reset <destination address>

The `reset` command directs the mote to do a hardware reset.

```
XCmdTerm:> reset 10
SUCCESS: Command executed successfully. (SUCCESS:Success)
NODE ID: 10
```

xserve.shutdown

The `xserve.shutdown` command shutsdown the xserve application it is connected to, disconnecting all external connections and cleaning up all processes. The `xserve.shutdown` command does not have a response.

actuate <destination address> <device> <state>

The `actuate` command allows users to actuate various devices on each of the Motes by setting the state of the device. Table 4-2 provides a list of devices and their corresponding states.

Table 4-2 Available Device State Options for Actuate Command

Device	Device ID	Device States
GREEN LED	0	OFF=0, ON=1, TOGGLE=2
YELLOW LED	1	OFF=0, ON=1, TOGGLE=2
RED LED	2	OFF=0, ON=1, TOGGLE=2
ALL LED	3	OFF=0, ON=1, TOGGLE=2
SOUNDER	4	OFF=0, ON=1, TOGGLE=2
RELAY 1	5	OFF=0, ON=1, TOGGLE=2
RELAY 2	6	OFF=0, ON=1, TOGGLE=2
RELAY 3	7	OFF=0, ON=1, TOGGLE=2

```
XCmdTerm:> actuate 10 2 0
SUCCESS: Command executed successfully. (SUCCESS:Success)
NODE ID: 10
```

4.3 Using XML RPC

The *XCommand* API in *XServe* is presented as a set of *XML RPC* (remote procedure calls) functions. *XML RPC* is simple framework that allows computers to execute remote procedures using XML. In a typical exchange a computer sends an XML document to a specifed *XServe* command port (9003) and *XServe* executes the command. After execution the result is wrapped in an XML document and sent over the connection back to the requesting computer.

XServe implements a simple communication protocol over TCP/IP to send XML documents back and forth. The first 4 bytes over the socket indicate the length of the payload. The bytes are in network byte order. *XServe* expects all applications to send and to receive requests using this protocol. Below is an example *XCommand* XML RPC document:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xsensor.sleep</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>seqNumber</name>
     <value>
      <int>108</int>
     </value>
    </member>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

4.4 XML RPC Document Structure

4.4.1 MethodCall Tag

The root document of an XML RPC method call is the <methodCall> tag. Each XML RPC call must contain one and only one <methodCall> tag.

```
<methodCall>
…
</methodCall>
```

4.4.2 MethodName Tag

The actual name of the remote procedure to be executed is wrapped in the <methodName> tag. There is only one instance of <methodName> inside the <methodCall> tag.

```
<methodName>
METHODNAME
</methodName>
```

4.4.3 Parameters Tag

Method arguments are passed as a set of parameters. *XCommand* methods accept a single parameter. The argument is an array of of name-value pairs. Each name-value pair represents one of the arguments for the method. The ordering of the name-value pairs in the array does not matter.

```
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>PARAMETER NAME</name>
     <value>
      <int>PARAMETER VALUE</int>
     </value>
    </member>
       …
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

The value parameter is wrapped in a type which indicates the type of value being sent. Available values are <int>, <boolean>, <string>, <double>, <dateTime.iso8601>, and <base64>. Examples of each type are provided in Table 4-3 below.

Table 4-3 Example Parameter Tags

Type	Definition	Example Value
<int>	4 byte signed integer	-12
<Boolean>	Binary true or false values	0 (false) or 1 (true)
<string>	String value	Hello world
<double>	Double precision floating point number	12.215
<dateTime.iso8601>	Date/Time	11980717T14:08:55
<base64>	Base64 encoded binary	W91IGNhbid0IHJlYWQgdGhpcyE=

The complete XML RPC specifications can be found at http://www.xmlrpc.com.

4.5 XCommand XML RPC Document Structure

4.5.1 XMesh XML RPC Commands

MethodName:

`xmesh.get_config`: Requests configuration information from a Mote.

Arguments:

Name	Description	Value Type
destAddress	The node id from which configuration information is requested.	<int>
groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the responding Mote.	<int>
groupId	The group id of the responding Mote.	<int>
rfPower	The radio power of the responding Mote.	<int>
rfChannel	The radio channel of the responding Mote.	<int>
uidString	The 64 bit unique identifies for the mote as a hexadecimal string	<string>

MethodName:

`xmesh.set_rate`: Sets the sampling rate of destination address' application.

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>

groupId	The group id of the XMesh network	<int>
newRate	The new sampling rate for the node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the responding Mote.	<int>
rate	The sampling rate the node is set after the command	<int>

MethodName:

`xmesh.set_nodeid`: Sets the node id of the destination address.

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newNodeId	The new node id for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the Mote after execution of the command	<int>

MethodName:

`xmesh.set_groupid`: Sets the group id of destination address.

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newGroupId	The new group id for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

nodeId	The node id of the responding Mote.	<int>
groupId	The group id of the Mote after executing the command	<int>

MethodName:

`xmesh.set_rfchannel`: Sets the radio channel of destination address.

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newRfChannel	The new radio channel for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the responding Mote.	<int>
rfChannel	The radio channel after executing the command	<int>

MethodName:

xmesh.set_rfpower: Sets the radio power of destination address.

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newRfPower	The new radio power for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the responding Mote.	<int>
rfPower	The radio power after executing the command	<int>

MethodName:

`xmesh.reset`: Resets the destination address.

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

MethodName:

`xmesh.wake`: Directs the application to resume sampling data

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

MethodName:

`xmesh.sleep`: Directs the application to stop sampling data

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

MethodName:

`xmesh.actuate`: Actuates a device on the Mote

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
actDevice	The id of the device to actuate	<int>
actState	The state to set the specified device	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

4.5.2 XSensor XML RPC Commands

MethodName:

`xsensor.get_config`: Requests configuration information from a Mote.

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the responding Mote.	<int>
groupId	The group id of the XMesh network	<int>
rfPower	The radio power of the responding Mote.	<int>
rfChannel	The radio channel of the responding Mote.	<int>
uidString	The 64 bit unique identifier for the Mote	<int>

MethodName:

`xsensor.set_rate`: Sets the sampling rate of destination address' application.

Arguments:

Name	Description	Value Type

seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newRate	The new sampling rate for the node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the responding Mote.	<int>
rate	The sampling rate the node is set after the command	<int>

MethodName:

`xsensor.set_nodeid`: Sets the node id of the destination address.

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newNodeId	The new node id for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the Mote after execution of the command	<int>

MethodName:

`xsensor.set_groupid`: Sets the group id of destination address.

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>

newGroupId	The new group id for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the Mote after execution of the command	<int>
groupId	The group id of the Mote after executing the command	<int>

MethodName:

`xsensor.set_rfchannel:` Sets the radio channel of destination address.

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newRfChannel	The new radio channel for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the Mote after execution of the command	<int>
rfChannel	The radio channel after executing the command	<int>

MethodName:

`xsensor.set_rfpower:` Sets the radio power of destination address.

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newRfPower	The new radio power for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the Mote after execution of the command	<int>
rfPower	The radio power after executing the command	<int>

MethodName:

`xsensor.reset:` Resets the destination address.

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

MethodName:

`xsensor.wake:` Directs the application to resume sampling data

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

MethodName:

`xsensor.sleep`: Directs the application to stop sampling data.

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codename	The name of the response	<string>
codeDescription	A text description of the response code	<string>

MethodName:

`xsensor.actuate`: Actuates a device on the mote

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
actDevice	The id of the device to actuate	<int>
actState	The state to set the specified device	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

4.5.3 XServe XML RPC Commands

MethodName:

`xserve.shutdown`: Shuts down the *XServe* server it is connected to.

Arguments:

No arguements

Response:

No response

5 Using *XServe* Web Interface

User can access *XServe* and perform most of the functions via web interface. It is convenient for user who is far away from the server. There are four main functions in web interface that are listed below:

- Health report
- Real time data parsing
- Command
- XOTAP.

To run web interface in *XServe*, use

```
-h
```

or –h with options (items contained within the less than/greater than brackets <>)

```
-h=<MainPage,HostName,Port,ConfigFile>
```

The `-h` will use default setting for the web interface, which is "*../web,localhost,8080*".

NOTE: Run XServe from **/opt/MoteWorks/tools/xserve/bin/bin** in order for the web interface to work.

After *XServe* starts with the `-h` option, the user can access *XServe* via web interface. Open a web browser, and go to http://localhost:8080 or http://hostname:8080 . The web page shown in Figure 5-1 will appear.

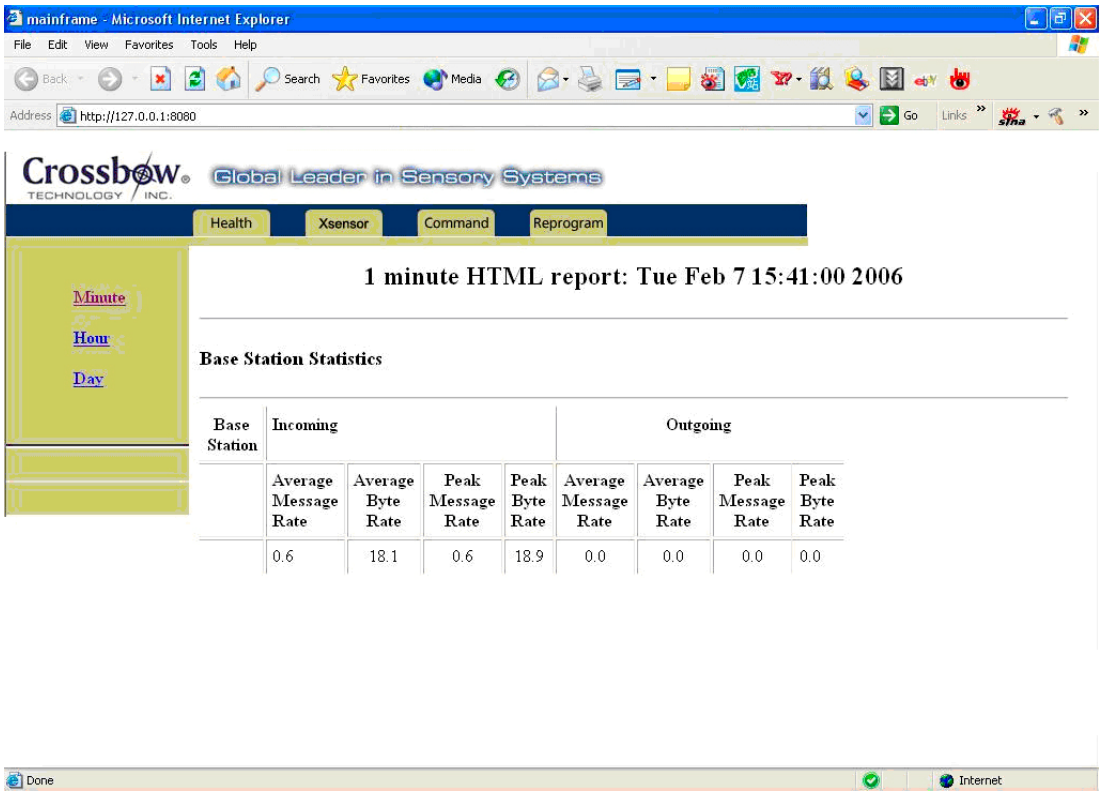


Figure 5-1. Screenshot of *XServe* Web Interface

On the main page you will see four tabs that represent the following four functions:

1. **Health**: provides health statistic report. The web page is created by *XServe* every minute. User can browse three types of report: last minute report, last hour report and yesterday report.
2. **XSensor**: User can use this function to view the real-time data. Before using this function, make sure xserve has started xml server already. That is '-xmlport=9002' and one of '-xmlr', '-xmlp','-xmlc' must be turned on.

   An example web page is shown in Figure 5-2.

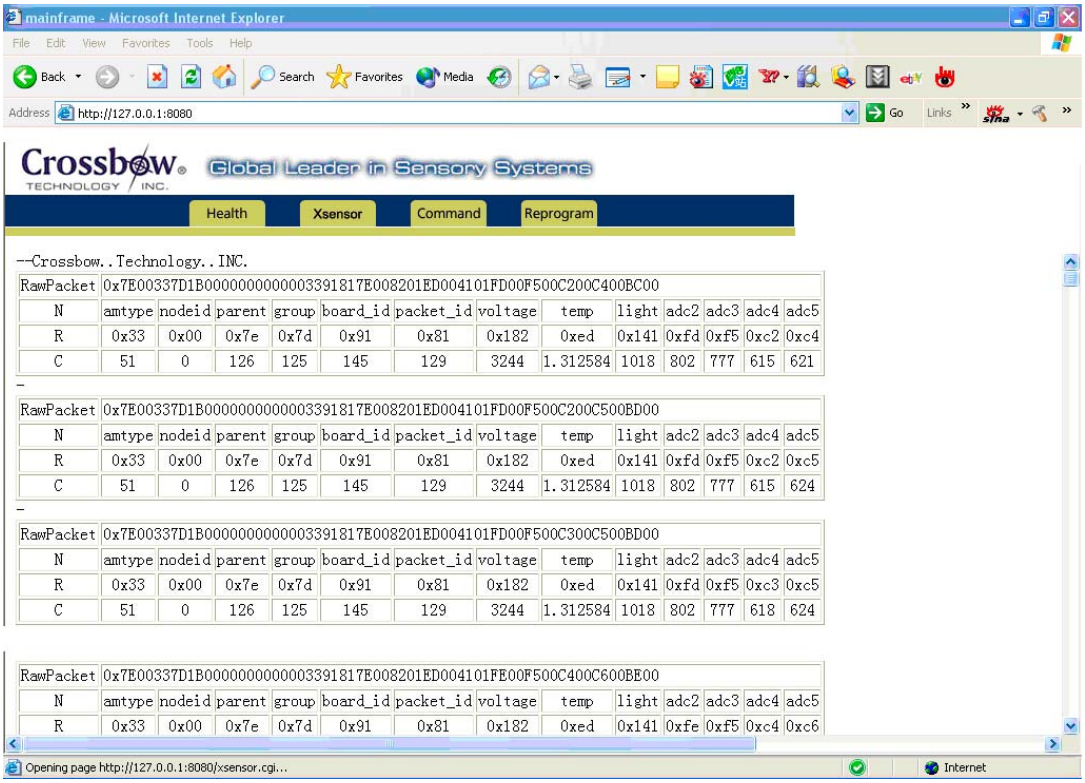


Figure 5-2. Screenshot of *XSensor* Web Interface

3. **Command**: The web interface provides the function to send commands to *XServe*. There are three types of commands that are available: Power Management, Mote Configuration and Actuation. An example web page is shown in Figure 5-3.

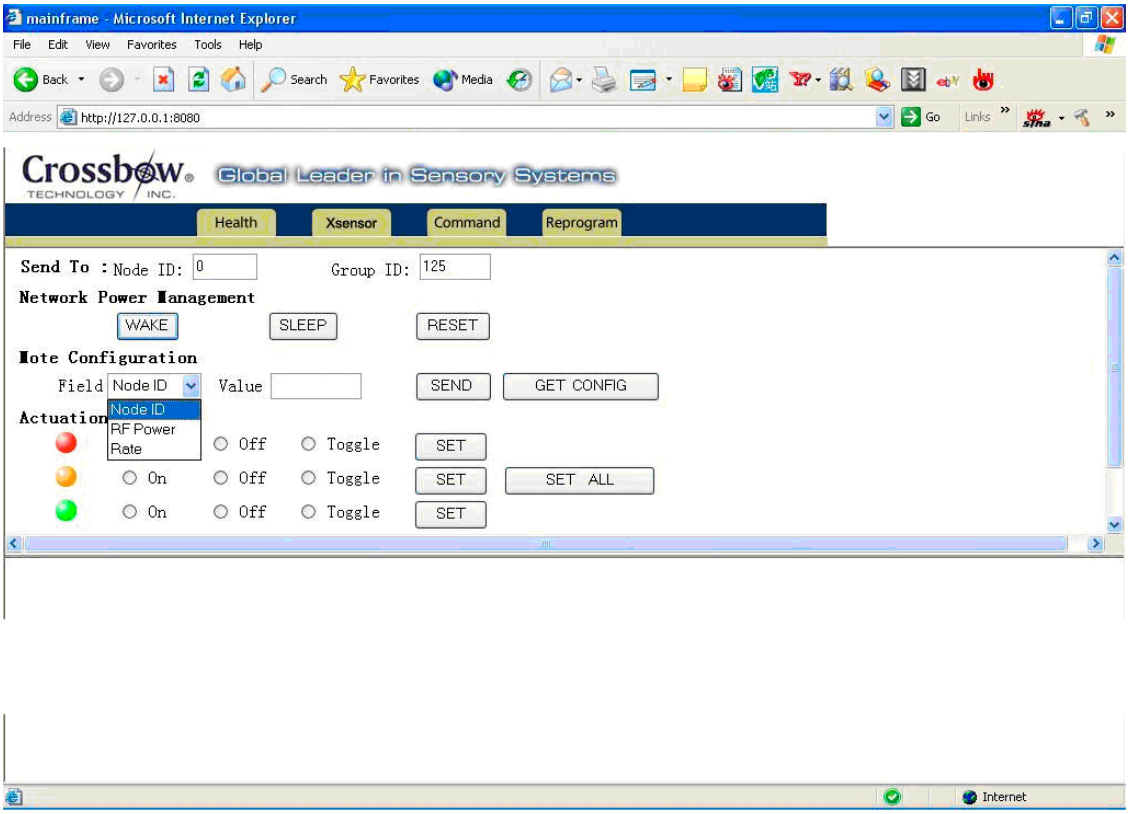


Figure 5-3. Screenshot of Command Web Interface

In the web interface, all commands are end-to-end and hence Node ID and Group ID must be specified.

4. **Reprogram**: provides *XOtap* interface. It supports Query, Boot and Download. An example web page is shown in Figure 5-4.

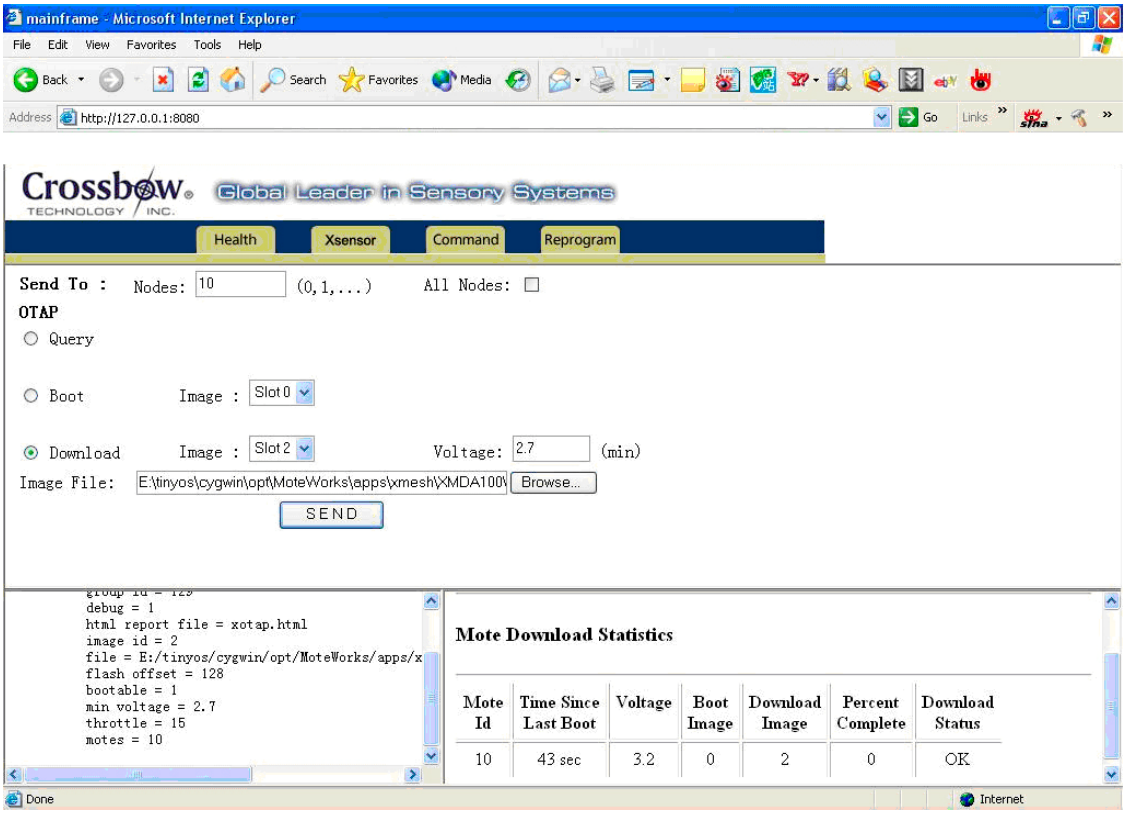


Figure 5-4. Screenshot of Command Web Interface

6 Using *Xserve* Modbus Interface

6.1 Modbus Overview

The Modbus protocol was originally developed in 1978 to exchange information between devices on a factory floor. Modbus has since become a fairly ubiquitous communication mechanism in industrial environments, and is now the defacto standard for PLC systems. Modbus devices communicate over a serial network in a master/slave (request/response) relationship using one of two transmission modes: ASCII (American Standard Code for Information Interchange) mode or RTU (Remote Terminal Unit) mode.

6.2 Modbus Message Structure

Modbus defines a standardized message structure that is independent of the type of physical interface used. The same messages are used for example by Modbus over RS232 as on *Modbus/TCP* over ethernet. This common interface definition allows Modbus messages from legacy devices to be sent over an upgraded industrial network infrastructure, without the need for large changes in the software. A device can also communicate with several Modbus nodes at once, even if they are connected with different interface types, without the need to use a different protocol for every connection.

On simple interfaces like RS485 or RS232, the Modbus messages are sent in plain form over the network. In this case the network is dedicated to Modbus. When using more versatile network systems like TCP/IP over ethernet, the Modbus messages are embedded in packets with the format necessary for the physical interface. In that case Modbus and other types of connections can co-exist at the same physical interface at the same time. Although the main Modbus message structure is *peer-to-peer*, Modbus is able to function on both *point-to-point* and *multihop* networks.

Each Modbus message has the same structure. Four basic elements are present in each message. The sequence of these elements is the same for all messages, to make it easy to parse the content of the Modbus message. A conversation is always started by a master in the Modbus network. A Modbus master sends a message and—depending of the contents of the message—a slave takes action and responds to it. There can be more masters in a Modbus network. Addressing in the message header is used to define which device should respond to a message. All other nodes on the Modbus network ignore the message if the address field doesn't match their own address.

Table 6-1. Modbus Message Structure

Field	Description
Device address	Address of the receiver
Function code	Code defining message type
Data	Data block with additional information
Error check	Numeric check value to test for communication errors

More details on Modbus interface is available at

http://www.modbus.org/

http://modbus.control.com/

6.3 Using *XServe* Modbus Interface

XServe can store wireless sensor network data and make it available via a modbus interface. When *XServe* runs with modbus mode enabled, *XServe* acts as a modbus slave. Thus sensor data from the network can be queried from *XServe* directly by a modbus master via Modbus serial protocol. Both RTU and ASCII serial protocols are supported.

XServe will provide a single, flat address register map of sensor values that can be queried over the ModBus interface. The mapping of nodeid, sensor to offset is provided by the user in XML. The format of this XML is described below.

To run Modbus in *XServe*, use

`-m`

or `-m` with options (items contained within the less than/greater than brackets <>)

`-m=<COM port, baudrate, protocol type<RTU/ASCII>, slave address, default register value>`

When no extended options are passed with the `-m` flag, the following default settings will be used: '*/dev/ttyS2,9600,RTU,32,0*'. If you run using arguments **`xserve -r -m`** or **`xserve -xmlr -m`**, the parsed values will be stored into the modbus registers database; if run using arguments **`xserve -c -m`** or **`xserve -xmlc -m`** the converted values will be stored into modbus registers database.

To query the data in the mesh, the map from (nodeid, sensor) to modbus register should be defined in a related xml config file. For example, to use modbus interface in an MTS310 *XMesh* network, mapping from sensors to modbus registers should be defined in the '*mts310_mesh_config.xml*' file as shown below. The value format of mapping is `<modbus register address, sensor type, nodeid>`. The example below only supports 2 nodes; node 0 and node 1, users can add more maps for other nodes as needed.

```
<XDataSink name="Generic Modbus Datasink">
      <XDSParam name="Mapping1" value="1,voltage,0"/>
      <XDSParam name="Mapping2" value="2,temp,0"/>
      <XDSParam name="Mapping3" value="3,light,0"/>
      <XDSParam name="Mapping4" value="4,accel_x,0"/>
       <XDSParam name="Mapping5" value="5,accel_y,0"/>
      <XDSParam name="Mapping6" value="6,mag_x,0"/>
      <XDSParam name="Mapping7" value="7,mag_y,0"/>
      <XDSParam name="Mapping8" value="8,mic,0"/>
      <XDSParam name="Mapping9" value="9,voltage,1"/>
      <XDSParam name="Mapping10" value="10,temp,1"/>
      <XDSParam name="Mapping11" value="11,light,1"/>
      <XDSParam name="Mapping12" value="12,accel_x,1"/>
```

```
      <XDSParam name="Mapping13" value="13,accel_y,1"/>
      <XDSParam name="Mapping14" value="14,mag_x,1"/>
      <XDSParam name="Mapping15" value="15,mag_y,1"/>
      <XDSParam name="Mapping16" value="16,mic,1"/>
</XDataSink>
```

7 Advanced *Xserve* Functionality

7.1 XServe Architecture

This section covers *XServe* architecture and defines the interfaces to extend *XServe* for application specific requirements. *XServe*'s architecture consists of a core set of services, a cross-platform portability layer, and a set of plug-in modules. The user can extend *XServe* by developing an extension module in C as dynamically loaded library, or by supplying XML Configuration files to define data parsers and configure a generic set of datasinks.

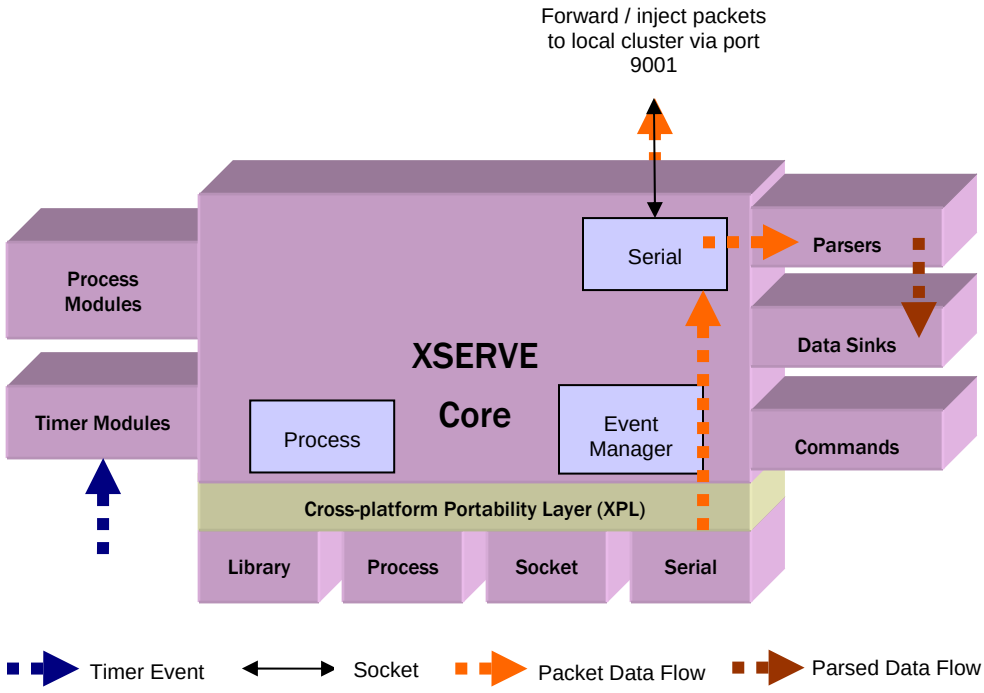


Figure 7-1. *XServe* Block Diagram

The *XServe* core services provide the following functionality:

- Event Management—handles concurrent I/O. Processes serial and socket byte streams.
- Process Monitor—starts all the process modules, monitors them, and restarts them if they die.
- Serial Forwarder—virtualizes the mesh connections and supplies raw packets access to clients.

The *XServe* higher level services fall into the following categories:

- Parsers—extracts logical fields from a data packet and builds name / value pairs
- Data Sinks—detects relevant name / value data rows and performs special handling
- Command Modules—takes user command requests and injects correct packet into mesh
- Task Modules—handles recurring events or timeouts
- Process Modules—Provides services run, as external processes, and monitored by *XServe*.

7.1.1 Event Management

XServe is an event based sytem. Service and modules register event handlers with the Event Manager to be notified when certain events occur in the system. The Event Management service is a core feature of *XServe* and is used by all incoming communication from the Mote Tier or from enterprise applications.

7.1.2 Process Management

XServe relies on external processes to manage Web Services and Modbus communication. These processes are started and monitored by the Process Management system. The *XServe* processes itself is started as an external process and is monitored by the Process Management system. If any of the processes under the Process Management system dies due to a system error, an effort is made by the Process Management system to restart the process.

7.1.3 Serial Forwarder

At its core *XServe* provides basic routing services to the Mote network. As a serial forwarder *XServe* allows enterprise applications to communicate directly with the Mote Tier. Applications send and receive raw data directly to the mote network with no high level parsing, converting or processing. *XServe* provides an unframed Serial Forwarder for enterprise applications to connect to and can connect to either a framed or unframed Serial Forwarder to communicate with the Mote Tier. For more information on Serial Forwarder protocol and the framed and unframed link connection (see Section 13.2).

On the Mote Tier side, *XServe* can connect directly via a serial port, or it can connect indirectly through another Serial Forwarder application. This functionality allows multiple *XServe* instances to connect as a chain, for example, *XServe* acting as a Serial Forwarder can run directly on a stargate while an instance of *XServe* running higher level services can run on a PC handling data input from the *XServe* on the stargate.

On the enterprise application side, *XServe* provides an unframed Serial Forwarder server port. Multiple enterprise applications can connect to *XServe* simultaneously and each will receive raw data from the Mote Tier and will have the ability to send their own raw packet data through *XServe* to the Mote Tier. When communicating with the Serial Forwarder, users should remember that *XServe* sends and receive raw packet, with no extra processing done on the packet. Packets sent to *XServe* toward the Mote Tier will be sent as is to the network.

7.1.4 Parsers

Parsers are the initial modules which handle data as it arrives from the Mote Tier. Parsers are responsible for extracting data from the packet and constructing a set of name-value pairs for entries in the packet. Only one Parser is responsible for parsing a given data packet. Each parser contains a filter to determine whether it is responsible for parsing the given packet. An example of typical filter could be:

```
if (AM_TYPE = 50) and (BOARD_ID = 89)
```

The first parser to match is then responsible for the packet. The parser splits the packet into fields and groups these into a DataRow object which is then passed to other *DataSink* modules

internally. When the parser builds a *DataRow*, it optionally sends the fields through unit conversion depending on the command line arguments given by the user.

7.1.5 Datasinks

Datasinks are processing modules which take a Parsed *DataRow* and perform specialized handling. The Datasink is free to do anything with the *DataRow* including modify it. Unlink Parsers, where only one Parser is responsible for a packet, all Datasinks loaded into the system have access to *DataRow*. Each Datasink contains a filter which determines at runtime whether it will process a particular DataRow or not. *XServe* provides an initial set of Datasinks for implementing printing data to the terminal screen, exporting packets to a file, logging data into a database, and export data to an XML Stream.

7.1.6 Command Modules

XServe provides an XML RPC interface to allow enterprise applications to issue commands to either the network or to *XServe* itself. Command modules are responsible for handling these XML RPC events. Currently *XCommand* methods are implemented in *XServe* through the Command Module interface.

7.1.7 Task Modules

Tasks represent modules which are scheduled to occur in periodic fashion. These can include monitor services, accumulating statistics, or updating values. These tasks run independent of packet arrival events. Currently the Report Server which displays HTML pages and statistics runs as a Task Module.

7.1.8 Process Modules

Process modules are external process run by *XServe* to provide service. These processes are managed by the Process Management system. Currently the HTTP Web Server and the Modbus Communication process are both run as Process Modules.

7.2 Parsers

Parsers are implemented as dynamically loadable libraries which are loaded by *XServe* on start up. *XServe*'s default action is to load all parsers from the Parser Library Directory. A subset of parsers can be loaded using the –loadparsers startup flag (See Section 3.2.10). The Parser library directory is set by default to "***../lib/parsers***" and assumes *XServe* is started from the directory in which it is installed. The Parser Library Directory can be changed by setting the *ParserLibDir* field in the Parameters File (See Section 7.4).

Users can extend XServe to parse their own packets in two ways

- Creating a XML Configuration file
- Building a C module using the Parser Dynamic Loadable Library Interface

7.2.1 XML Configuration Parser

XML Configuration files define parsing rules for *XServe*'s Generic XML Configuration Parser. The XML Configuration Parser internally constructs parsers from XML Configuration documents allowing users to easily extend *XServe* to parse user specific packets.

XML Configuration files consist of 3 sections:

- **Field Definitions:** Field Definitions map field names to portions of the data packet. They also include conversion rules for fields that require conversion.
- **Filter Definitions:** Filter Defintions construct logical statements which determine whether a packet is to be parsed by this particular parsing configuration.
- **DataSink Parameters:** Datasink Parameters define parser specific parameters for each Datasink.

Below is a portion XML Configuration for a MTS300 data packet:

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE XServeConfig SYSTEM "./xserve_config.dtd">
<XServeConfig>
  <XFieldExtractor name="XMTS300 Multihop Config XML" order="3">
    <XFields>
      <XField name="amtype" byteoffset="2" length="1" type="uint8"/>
      <XField name="nodeid" byteoffset="7" length="2" type="uint16" specialtype="nodeid"/>
      <XField name="parent" byteoffset="14" length="2" type="uint16" specialtype="parentid"/>
      <XField name="group" byteoffset="3" length="1" type="uint8"/>
      <XField name="board_id" byteoffset="12" length="1" type="uint8" specialtype="boardid"/>
      <XField name="packet_id" byteoffset="13" length="1" type="uint8"/>
      <XField name="voltage" byteoffset="16" length="2" type="uint16">
        <XConversion function="(1252352/x)" returntype="uint16">
          <XConvParam variablename="x" fieldname="voltage" type="float"/>
        </XConversion>
      </XField>
      <XField name="temp" byteoffset="18" length="2" type="uint16"/>
      <XField name="light" byteoffset="20" length="2" type="uint16">
        <XConversion function="(y * (1252352/x) / 1023)" returntype="uint16">
          <XConvParam variablename="x" fieldname="voltage" type="float"/>
          <XConvParam variablename="y" fieldname="light" type="uint16"/>
        </XConversion>
      </XField>
      <XField name="mic" byteoffset="22" length="2" type="uint16"/>
    </XFields>
    …
  </XFieldExtractor>
</XServeConfig>
```

<XFieldExtractor>

The root document of any XML Configuration file is <XFieldExtractor>. Field Extractor defines a single parser containing a set of fields, a filter, and any data sink parameters.

```
<XFieldExtractor name=NAME order=ORDER>
…….
</XFieldExtractor>
```

Table 7-1. XFieldExtractor Attributes

Attribute	Description	Required
name	The name of the XML Parser. XML Parser names should be unique.	YES
order	DataRows are passed to Datasinks in a specified order. The order is determined by the the order attribute. Orders are sorted with lowest number being first and highest number being last	YES

<XFields>

The root of the Field Definition section is the <XFields> tag. There is only <XFields> tag in a Field Extractor and it contains all Field mapping definitions.

```
<XFields>
…….
</XFields>
```

<XField>

The <XField> tag defines a single name value pair mapping. The name value pairing is done by assigning a portion of the bytes in the data packet to a name.

```
<XField name="light" byteoffset="20" length="2" type="uint16">
…
</XField>
```

Table 7-2. XField Attributes

Attribute	Description	Required
name	The name of the field. The name should be unique within the Field Extractor.	YES
byteoffset	The position of the value of this field in the packet relative to the beginning of the packet.	YES
length	The size of the value in bytes.	YES
type	The type of the field value. Possible values are: • byte • char • short • int • long • uint8 • uint16 • uint32	YES

Attribute	Description	Required
	• uint64 • raw • string • float • double	

<XBitField>

The <XBitField> tag is a specialized version of the <XField> tag, allowing the user to extract fields at the bit level granularity. This is useful for extracting information from a bit map or extracting data from data which has been byte compressed.

For example, the Surge Application sends the voltage reference in the top 9 bits of a uint32 field in the data packet. To extract the voltage reference from the 32 bit number we need to mask out the top 9 bits and then shift the value over 23 bits. The <XBitField> allows users to define this type of operational logic.

```
<XBitField name="vref" byteoffset="17" length="4" type="uint32" mask="0xFF800000" shift="23">
…
</XBitField>
```

Table 7-3. XBitField Attributes

Attribute	Description	Required
Name	The name of the field. The name should be unique within the Field Extractor.	YES
Byteoffset	The position of the starting byte in which the value of the field is contained in the packet relative to the beginning of the packet.	YES
Length	The size of the bytes containing the value of the field.	YES
Type	The type of the field value. Possible values are: • byte • char • short • int • long • uint8 • uint16 • uint32 • uint64 • raw • string • float • double	YES
mask	The hexadecimal mask over the bytes which will extract the necessary bytes with a logical AND.	YES
shift	The number of bits to shift the resulting masked value to position the value correctly	YES

<XConversion>

Each Field Definition maps the raw values from the packet to a named field. In most cases the value in the packet is a hardware specific value and is not in a format which is understandable by users or external applications. To handle this, each field definition tag can optionally contain a <XConversion> tag which describes a mathematical equation to convert the raw values into a user desired unit of measure. The equation can contain values from other fields in the packet allowing complex equations. The values used for each field input into the equation are the raw value pulled from the data packet.

For example a light reading from a sensor packet requires convertion from its raw resistance value to a unit of conversion appropriate for light (mV). Below is the necessary equation:

Light(mV) = (((light_value) * (1252352/(voltage_value)) / 1023)* 4)

The equation takes both the light reading in the packet and the voltage value in the packet to convert it to the correct unit of measure.

```
<XField name="light" byteoffset="21" length="1" type="uint8">
    <XConversion function="((y * (1252352/x) / 1023)* 4)" returntype="uint16">
              <XConvParam variablename="x" fieldname="vref" type="float"/>
              <XConvParam variablename="y" fieldname="light" type="uint8"/>
     </XConversion>
</XField>
```

Table 7-4. XConversion Attributes

Attribute	Description	Required
function	The mathematical equation required to convert the value to its appropriate unit of measure	YES
returntype	The type of the field value after conversion. Possible values are: • byte • char • short • int • long • uint8 • uint16 • uint32 • uint64 • raw • string • float • double	YES

<XConversionParam>

The <XConversionParam> tag maps the variable in the function to a field name in the actual parser. This allows users to build generic equations to use over and over and then map the actual variables differently in each conversion function.

Table 7-5. XConversionParam Attributes

Attribute	Description	Required
variablename	The variable name in the equation which needs to be mapped to a field	YES
Fieldname	The field name which is mapped to the variable in the equation	YES
type	The type the field's raw value needs to be cast to when in the equation. Possible values are: • byte • char • short • int • long • uint8 • uint16 • uint32 • uint64 • raw • string • float • double	YES

<XFilter>

Each Field Definition defines a parser for a particular type of packet. The <XFilter> tag defines a filter which is used by *XServe* to determine whether a particular packet should be parsed by this Field Definition. The XFilter is a set of logical operations on a set of conditions. The available logical operations are AND, OR, and NOT. The logical operations can be nested if required.

The MTS310 sensor board parser should only be used to parse a data packet based on the following logic:

(AMTYPE == 0x31 OR AMTYPE==0x33) AND BOARDID==0x83

```
<XFilter>
	<XCondAnd>
		<XCondOr>
			<XCond name="IsEqual">
				<XFilterParam name="fieldname" value="amtype"/>
				<XFilterParam name="fieldvalue" value="0x31"/>
			</XCond>
			<XCond name="IsEqual">
				<XFilterParam name="fieldname" value="amtype"/>
				<XFilterParam name="fieldvalue" value="0x33"/>
			</XCond>
		</XCondOr>
		<XCond name="IsEqual">
```

```
                    <XFilterParam name="fieldname" value="board_id"/>
                    <XFilterParam name="fieldvalue" value="0x83"/>
                </XCond>
        </XCondAnd>
</XFilter>
```

<XCondAnd>

<XCondOr>

<XCondNot>

<XCond>

The <XCond> tag defines the name of the condition you wish to test. Currently the only condition available is the IsEqual condition for a fieldname and a value. The IsEqual condition takes the fieldname and the fieldvalue as its parameters.

Table 7-6. XCond Attributes

Attribute	Description	Required
name	The name of the condition. Available conditions are: • IsEqual	YES

<XFilterParam>

The <XFilterParam> defines the parameters to each condition.

Table 7-7. XFilerParam Attributes

Attribute	Description	Required
name	The name of the parameter to pass into the filter	YES
value	The value of the named parameter to pass into the filter.	YES

<XDataSinks>

Each parser can pass its own parameters into a DataSink to configure the data sink specifically for that packet type. More information on the DataSink parameter configuration is available in Section 7.3.

```
<XDataSinks>
    <XDataSink name="Generic Print Datasink">
        <XDSParam name="printstring"  \
                  value="SURGE [sensor data converted to engineering units]:\n
                        health:  node id=%s  parent=%s  seq_no=%s\n   battery     = %s mv\n
                        temperature = %s degC\n   light:      = %s ADC mv\n   AccelX:     = %s g,
                        AccelY: = %s g\n   MagX:       = %s mgauss, MagY:   = %s mgauss "/>
        <XDSParam name="printfields" \
                  value="nodeid,parent,epoch,vref,thermistor,light,accelX,accelY,magX,magY"/>
</XDataSink>
```

Table 7-8. XDataSinks Attributes

Attribute	Description	Required
name	The name of the data sink to be configured.	YES

<XDSParams>

The <XDSParam> defines the parameters to each datasink.

Table 7-9. XDSParams Attributes

Attribute	Description	Required
Name	The name of the parameter to pass into the datasink	YES
value	The value of the named parameter to pass into the datasink	YES

7.2.2 Parser Dynamic Loadable Library Interface

The Parser Dynamic Loadable Library (PDLL) Interface is useful for application with complex parsing needs which cannot be met by an XML Configuration file. The PDLL Interface allows users to build their own C-based parsers and compile them to Dynamically Loaded Libraries (DLL). Once built, the parser can be placed in the Parser Library Directory to be loaded by *XServe* for usage.

The PDLL Interface comprises of 3 components:

1. An initialization function
2. A pair of filter and parse callback functions
3. A callback registration structure

7.2.2.1 Initialization Function

The initialization function is called after the parser has been loaded into *XServe*. Any initialization procedures and checks should be done in this function. At a minimum the initialization function should register the parser callbacks through the callback registration structure. The method signature of the initialization function is below:

```
void initialize_parser()
```

7.2.2.2 Callback Functions

The parser callback interface contains two functions. The filter function takes the raw packet from the Mote Tier and determines if the given parser is responsible for parsing the packet. The parse function is responsible for converting the raw packet into a DataRow. The DataRow is *XServe* data structure which contains the named value pairs of the parsed data and any converted values. Both the filter and parse method can have any unique name. They are called via a function pointer passed in with callback registration structure so the exact method names are unimportant.

The signature for the filter function is provided below:

```
int filter(unsigned char* buffer, int length,XServeParams* xparams)
```

Arguement	Description
buffer	The raw data packet as a character byte array.
length	The length the character byte array passed into the function
xparams	The XServeParams structure contains the initial command line arguments passed in. It allows the library to parse the command line arguments looking for library specific values.
Return Value	The filter returns 1 if is responsible for parsing the packet and returns 0 if it not responsible for parsing the packet.

The signature for the parse function is provided below:

```
XDataRow* parser(unsigned char* buffer, int length,XServeParams* xparams)
```

Arguement	Description
buffer	The raw data packet as a character byte array.
length	The length the character byte array passed into the function
xparams	The XServeParams structure contains the initial command line arguments passed in. It allows the library to parse the command line arguments looking for library specific values.
Return Value	The parser returns a pointer to XDataRow structure.

7.2.2.3 Callback Registration Structure

The callback registration structure registers the parser and its callback functions with *XServe*. Unless the parser is registered *XServe* will not use it. The callback registration structure looks as follows:

```
typedef struct XParseHandler {
  char*   name;
  char*   version;
  int rank;
  PacketParseFilter filter;
  PacketParser parser;
} XParseHandler;
```

Field	Description
Name	The display name of the parser
Version	The version information of the parser
Rank	The ordered rank of the parser. Parsers are called in relative order to determine if they are responsible for parsing a packet.
filter	The function pointer to the parsers filter function
Parser	The function pointer to the parsers parse function

To register all callback registration structure the parser should call the following function:

```
void xparse_register_handler(XParseHandler *handler)
```

7.3 Data Sinks

Like Parsers, Data Sinks are implemented as dynamically loadable libraries which are loaded by *XServe* on start up. *XServe*'s default action is to load all parsers from the DataSink Library Directory. A subset of data sinks can be loaded using the –loaddatasinks startup flag (See Section 3.2.10). The DataSink Library Directory is set by default to "*../lib/datasinks*" and assumes *XServe* is started from the directory in which it is installed. The DataSink Library Directory can be changed by setting the DataSinkLibDir field in the Parameters File (See Section 7.4).

Users can extend *XServe* to add their own datasink processing by building a C module using the Datasink Dynamic Loadable Library Interface or users can configure provided datasinks using XML Configuration files.

7.3.1 XML Configuration Generic Datasinks

XServe provides a set of Generic Datasinks which can be configured by an XML Configuration file. The list of provided Datasinks is follows:

- Generic Print Datasink
- Generic File Datasink
- Generic Simple XML Datasink
- Generic Alert Datasink
- Open Log Datasink
- Heartbeat Datasink

7.3.1.1 Generic Print Datasink

The Generic Print DataSink displays data on the terminal screen. The layout and the fields displayed on the screen for each packet are configurable using a XML Configuration file.

```
<XDataSink name="Generic Print Datasink">
        <XDSParam name="printstring"  \
                  value="SURGE [sensor data converted to engineering units]:\n
                        health:  node id=%s  parent=%s  seq_no=%s\n   battery     = %s mv\n
                        temperature = %s degC\n   light:      = %s ADC mv\n   AccelX:     = %s g,
                        AccelY: = %s g\n   MagX:       = %s mgauss, MagY:   = %s mgauss "/>
        <XDSParam name="printfields" \
                  value="nodeid,parent,epoch,vref,thermistor,light,accelX,accelY,magX,magY"/>
</XDataSink>
```

The Generic Print Datasink takes the following parameters.

Table 7-10. Generic Print DataSink Parameters

Parameter	Description	Required
printstring	This is a template string which will format the display out to screen. Each % value will be filled in with the corresponding field value	YES

printfields	The print fields are the name of the fields whose value will replace each % in the printstring template. Each % is replaced with a field in order.	YES

7.3.1.2 Generic File Datasink

The Generic File Datasink outputs data to a specified file. The field delimator, the header, and the file name are all configurable by a XML Configuration file.

```
<XDataSink name="Generic File Datasink">
   <XDSParam name="rawfilename" value="/opt/tinyos-1.x/raw_surge_data.txt"/>
   <XDSParam name="parsedfilename" value="/opt/tinyos-1.x/parsed_surge_data.txt"/>
   <XDSParam name="convertedfilename" value="/opt/tinyos-1.x/converted_surge_data.txt"/>
   <XDSParam name="delim" value=","/>
   <XDSParam name="header" value="yes"/>
</XDataSink>
```

The Generic File DataSink takes the following paramteres.

Table 7-11. Generic File DataSink Parameters

Parameter	Description	Required
rawfilename	The filename where raw data output is written	NO (If the parameter is not given then no raw data will be written to file)
parsedfilename	The filename where parsed data output is written.	NO (If the parameter is not given then no parsed data will be written to file)
convertedfilename	The filename where converted data output is written.	NO (If the parameter is not given then no converted data will be written to file)
Delim	The delimator to be used to separate field names	NO (The default value is ',')
Header	A Boolean indicating whether the file should have a header	NO (The default value is 'yes')

7.3.1.3 Generic Simple XML Datasink

The Generic Simple XML Datasink is responsible for printing an XML stream for each data packet. The Generic Simple XML Datasink is not configurable by XML but can be configured by two command line inputs `–xmlfile` and `–xmlport` (See Section 3.2.7)

```
<?xml version="1.0" ?>
<MotePacket>
<RawPacket>0x7E00117D160000000000000000000007E00060000BEC07A60798E74</RawPacket>
<ParsedDataElement>
```

```
        <Name>amtype</Name>
<RawValue>0x11</RawValue><ConvertedValue>17</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>nodeid</Name>
<RawValue>0x00</RawValue><ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>parent</Name>
<RawValue>0x7e</RawValue><ConvertedValue>126</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>vref</Name>
<RawValue>0x017c</RawValue><ConvertedValue>3295</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>epoch</Name>
<RawValue>0x0006</RawValue><ConvertedValue>6</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>light</Name>
<RawValue>0xc0</RawValue><ConvertedValue>2474</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>thermistor</Name>
<RawValue>0x7a</RawValue><ConvertedValue>23.045807</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>magX</Name>
<RawValue>0x60</RawValue><ConvertedValue>51.857669</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>magY</Name>
<RawValue>0x79</RawValue><ConvertedValue>65.362270</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>accelX</Name>
<RawValue>0x8e</RawValue><ConvertedValue>2360.000000</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>accelY</Name>
<RawValue>0x74</RawValue><ConvertedValue>280.000000</ConvertedValue>
```

```
</ParsedDataElement>
</MotePacket>
```

The XML stream output by this datasink can provide the raw packet, the parsed values, and the converted values.

<MotePacket>

This tag denotes a logical block that contains data from a single packet from a single mote.

<RawPacket>

This tag carries the entire packet as a raw hex encoded in ASCII starting with 0x.

<ParsedDataElement>

This tag denotes a logical block that contains information about one parsed field of data. Including RawValue or ConvertedValue.

<ConvertedDataElement>

This tag denotes a logical block that contains information about one converted field of data.

<Name>

This tag carries the name of a field.

<RawValue>

This tag carries the raw value for a field.

<ConvertedValue>

This tag carries the converted value for a field.

7.3.1.4 Generic Alert Datasink

The Generic Alert DataSink defines a set of bounds on a particular value. The datasink can alert users on the terminal screen and in the log file a particular packes values have deviated from an acceptable range. The bound for each data value can set in an XML Configuration file.

```
<XDataSinks>
	<XDataSink name="Generic Alert Datasink">
		<XDSParam name="voltage" value="[2500,3500]"/>
		<XDSParam name="humid" value="[0,100]"/>
		<XDSParam name="humtemp" value="[-5,45]"/>
		<XDSParam name="prtemp" value="[-5,45]"/>
		<XDSParam name="press" value="[900,1100]"/>
		<XDSParam name="accel_x" value="[-2000,2000]"/>
		<XDSParam name="accel_y" value="[-2000,2000]"/>
		<XDSParam name="taoch0" value="[0,500]"/>
	</XDataSink>
</XDataSinks>
```

Table 7-12. Generic Alert DataSink Parameters

Parameter	Description	Required
Name	This is the name of the field to be bound	YES
values	This is the data bound on the converted value in the fomat: [lower,upper]	YES

7.3.1.5 Open Log DataSink

The Open Log Datasink is responsible for logging data packets to a database. Currently the only database supported by *XServe* is the PostgreSQL database. To configure the connection parameters of the PostgreSQL database, use the `–dbserver`, `-dbport`, `-dbname`, `-dbuser`, `-dbpassword` command line parameters.

The Open Log Datasink allows users to create tables, define rules on table, define insert statements and define update statements.

```
<XDataSink name="Open Log Datasink">
       <XDSParam name="tablename_1" value="mts300_results"/>
       <XDSParam name="createsql_1"
                 value="CREATE TABLE mts300_results ( result_time timestamp without time
                        zone,epoch integer, nodeid integer, parent integer,voltage
                        integer, temp integer, light integer)"/>
       <XDSParam name="tablename_2" value="mts300_results_l"/>
       <XDSParam name="createsql_2"
                 value="CREATE TABLE mts300_results_l ( result_time timestamp without
                       time zone,epoch integer, nodeid integer, parent integer,voltage
                       integer, temp integer, light integer)"/>
       <XDSParam name="rulesql_2"
                 value="CREATE RULE cache_mts300_results AS ON INSERT TO mts300_results
                        DO ( DELETE FROM mts300_results_l WHERE nodeid = NEW.nodeid;
                        INSERT INTO mts300_results_l VALUES (NEW.*); )"/>

       <XDSParam name="insertsql_2"
                 value="INSERT into mts300_results (result_time, nodeid,parent, voltage,
                        temp, light) values (now(),%i,%i,%i,%i,%i)"/>
       <XDSParam name="insertfields_2" value="nodeid,parent,voltage,temp,light"/>
</XDataSink>
```

Table 7-13. Generic Log DataSink Parameters

Parameter	Description	Required
tablename	This is the name of the database table packet data will be sent to. The datasink uses the table name to check the existence of the table.	YES
createsql	This is the sql string which will be executed if no table with the given tablename is found in the database	NO (If the parameter is not given then the datasink will not create a table if the table name does not exist

		and will not attempt to insert/update the given row)
rulesql	This is sql which will used with the create sql to define any rules on the table	NO
insertsql	This is the insert sql statement which will be executed to insert the row into the database table	NO (If the parameter is not given then no inserts will be performed)
insertfields	Thevalues of the field names listed in insertfields will replace the % in the insertsql in the order they are listed.	YES if an insertsql statement is given. NO otherwise.
updatesql	The update sql statement which will be executed to update the database table	NO (If the parameter is not given then no updates will be perfomed)
updatefields	Thevalues of the field names listed in updatefields will replace the % in the updatesql in the order they are listed.	YES if an updatesql statement is given. NO otherwise.

When logging a data packet into a database it may be necessary to execute multiple insert and update statements over multiple tables. The Open Log Datasink manages this by grouping statements together using the "_#" format in the parameter names. All '_#' names are grouped together and groups are executed in the order of their #.

7.3.1.6 Heartbeat Datasink

The base station is the most critical component in a sensor network since it is the entry point of all data. To guarantee the base station is working correctly *XServe* provides a monitoring tool to monitor whether the base station is functioning properly. It does this by monitoring heartbeat packets from the base station.

The heartbeat data sink insures proper operation of the base station by setting a timeout for a heartbeat packet. If a configured number of heartbeats are not sent by the base station, the heartbeat module resets the base station (MIB510) and/or alerts the user that the base station is not responding. Users can set these parameters using the –hearbeat command line parameter.

NOTE: Instructions for setting the base station to emit hearbeat packets are available in the *XMesh User's Manual*.

7.3.2 Datasink Dynamic Loadable Library Interface

The Datasink Dynamic Loadable Library (DDLL) Interface is useful for user defined post processing not provided by an existing Datasink. The DDLL Interface allows users to build their own C-based datasinks and compile them to Dynamically Loaded Libraries (DLL). Once built, the datasink can be placed in the Datasink Library Directory to be loaded by *XServe* for usage.

The DDLL Interface comprises of 3 components:

- An initialization function
- A pair of filter and process callback functions
- A callback registration structure

7.3.2.1 Initialization Function

The initialization function is called after the datasink has been loaded into *XServe*. Any initialization procedures and checks should be done in this function. At a minimum, the initialization function should register the datasink callbacks through the callback registration structure. The method signature of the initialization function is below:

```
void initialize_datasink()
```

7.3.2.2 Callback Functions

The datasink callback interface contains two functions. The filter function takes the *XDataRow* from the parser and determines if the given datasink is responsible for processing the packet. The process function is responsible for doing any user defined processing with the DataRow. The DataRow is *XServe* data structure which contains the named value pairs of the parsed data and any converted values. Both the filter and process method can have any unique name. They are called via a function pointer passed in with callback registration structure so the exact method names unimportant.

The signature for the filter function is below:

```
int filter(XDataRow* row, XServeParams* xparams){
```

Arguement	Description
Row	The Data Row created from the parser
xparams	The XServeParams structure contains the initial command line arguments passed in. It allows the library to parse the command line arguments looking for library specific values.
Return Value	The filter returns 1 if is responsible for processing the packet and returns 0 if it not responsible for processing the packet.

The signature for the process function is below:

```
void process(XDataRow* row, XServeParams* xparams){
```

Arguement	Description
Row	The Data Row created from the parser
xparams	The XServeParams structure contains the initial command line arguments passed in. It allows the library to parse the command line arguments looking for library specific values.

7.3.2.3 Callback Registration Structure

The callback registration structure registers the datasink and its callback functions with *XServe*. Unless the datasink is registered *XServe* will not use it. The callback registration structure looks as follows:

```
typedef struct _XStoreHandler {
  char*   name;
  char*   version;
  int rank;
  PacketStoreFilter filter;
  PacketStore process;
```

```
} XStoreHandler;
```

Table 7-14. Callback Registration Fields

Field	Description
Name	The display name of the parser
Version	The version information of the parser
Rank	The ordered rank of the parser. Parsers are called in relative order to determine if they are responsible for parsing a packet.
filter	The function pointer to the datasinks filter function
process	The function pointer to the datasink parse function

To register all callback registration structure the parser should call the following function:

```
void xstore_register_handler(XStoreHandler* handle)
```

7.4 Properties Files

XServe requires various external files to operate correctly. By default *XServe* assumes that it has been started from the installation directory and that all pertinent files are located as installed. In some cases users may like to move *XServe* to run from any directory. In these cases *XServe* will require a pointer to the location of the necessary external files.

The pointer to these necessary files resides in properties files. *XServe* looks for the location of this properties file by checking the environment variable `XSERVER_PARAMETER_FILE`. If the environment variable is not found then *XServe* will assume it is running from the installation directory and will look for files relative to that location. For example:

```
XSERVE_PARAMETER_FILE=/opt/MoteWorks/tools/xserve/bin/xparams.properties
```

The properties file must contain the following parameters.

Table 7-15. Properties Files Parameters

Property	Description
ConfigXMLDir	The directory where the XML Configuration files are located
ParserLibDir	The directory where the parsers are located
DataSinkLibDir	The directory where the datasinks are located
CommandLibDir	The directory where the command modules are located
XServeWebDir	The location where XServe web files are located
XServeLodDir	The location log files should be written

8 Appendix A: Mote Packet Reference

This section details the packet formats for *MoteWorks* sensor applications.

8.1 TinyOS Header

All TinyOS packets share the following Active Message header.

Bytes: 2	**1**	**1**	**1**	**Variable**
Destination Address	AM Type	AM Group	Length	Data Payload
TinyOS Header				

8.1.1 Data Fields

The TinyOS header has the following fields:

Table 8-1 Header contents of a TinyOS message

Type	Field Name	Description
uint16_t	**addr**	Single hop destination address
uint8_t	**type**	Active message type
uint8_t	**group**	Active message group ID
uint8_t	**length**	Length of entire message

8.2 XMesh Header

Any packet delivered over *XMesh* contains the following multi-hop header.

Bytes: 5	**2**	**2**	**2**	**1**	**Variable**
TinyOS Header	Source Address	Origin Address	Sequence Number	Application ID	Data Payload
	XMesh Header				

8.2.1 Data Fields

The XMesh multihop header has the following fields:

Table 8-2 Header contents of an XMesh message

Type	Field Name	Description
uint16_t	**sourceaddr**	Single hop sender address
uint16_t	**originaddr**	Node ID of originator of message
int16_t	**seqno**	Sequence number for link estimation
uint8_t	**socket**	Application ID

8.3 XSensor Header

All XSensor applications have the *XSensor* header.

Bytes: 5	0/7	1	1	2	Variable
TinyOS Header	XMesh Header	Sensor Board ID	Sensor Packet ID	Parent	Data Payload
		XSensor Header			

8.3.1 Sensor Board ID

This field identifies uniquely which sensor board sent the packet and how the sensor readings are organized in the subsequent payload.

Table 8-1 *XSensor* sensor board id for all data acquisition boards and sensor boards

Sensor Board Model Number	Board ID (Hex)	Board ID (Decimal)	Description
MTS101	0x82	130	External analog sensor inputs (6 to 10 bit ADCs), photoresistor, and thermistor.
MTS300	0x83	131	Buzzer, photoresistor, acoustic microphone, and thermistor
MTS310	0x84	132	Accelerometer (2-axis), buzzer, photoresistor, acoustic microphone, magnetometer (2-axis), and thermistor.
MTS400	0x85	133	Accelerometer (2-axis), barometer (built-in ADC), pPhoto-sensitive light, relative humidity and temperature (built-in 12 bit ADC).
MTS420	0x86	134	Accelerometer (2-axis), barometer (built-in ADC), GPS module, photosynthetic light, relative humidity and temperature (built-in 12 bit ADC).
MDA300	0x81	129	External analog sensor Inputs (10 to 12 bit ADCs), relative humidity and temperature (built-in 12 bit ADC), and relays (normally open and normall closed).
MTS510	0x02	2	Accelerometer (2-axis), photo sensor, microphone.
MDA500	0x01	1	External analog and digital inputs
MEP510	0x04	4	Mote Environmental Package – temperature, relative humidity, MICA2DOT
MEP410	0x8A	138	Mote Environmental Package – temperature, relative humidity, pressure, photosynetic light (two), broadband light (two), MICA2
MDA320	0x90	139	External analog sensors(10 to 12 bit ADCs), built-in 16-bit ADC, digital inputs, and relays (normally open and normall closed)/
MDA100	0x91	140	External analog sensor inputs (6 to 10 bit ADCs), photoresistor, and thermistor.
MSP410	0xA0	160	Sense and respond reference board – MTS400 sensor set plus PIR, microphone, beeper, two relays, two analog inputs, 2 general purpose digital input/output

8.4 CRC

The packet ends with a CRC that is calculated on the entire packet excluding the packet header and the CRC field itself. A CRC is calculated by XORing the current byte with a shifted CRC accumulator. The CRC is always 2 bytes. The code to calculate a CRC follows:

```
uint16_t xcrc_byte(uint16_t crc, uint8_t b)
   {
   uint8_t i;

   crc = crc ^ b << 8;
   i = 8;
   do
   if (crc & 0x8000)
   crc = crc << 1 ^ 0x1021;
   else
   crc = crc << 1;
   while (--i);

   return crc;
   }

   int xcrc_calc(char *packet, int index, int count) {
   int crc = 0;

   while (count > 0) {
   crc = xcrc_byte(crc, packet[index++]);
   count--;
   }
   return crc;
   }
```

9 Appendix B: Sensor Packet Reference

The Table 9-1 shows a list of sensor and data acquisition boards (MTS and MDA Series) that are supported by *XServe*.

Table 9-1 Sensor and Data Acquisition Boards supported by *XServe*

Sensor board model number	Description
MTS101	External analog sensor inputs (6 to 10 bit ADCs), photoresistor, and thermistor.
MTS300	Buzzer, photoresistor, acoustic microphone, and thermistor
MTS310	Accelerometer (2-axis), buzzer, photoresistor, acoustic microphone, magnetometer (2-axis), and thermistor.
MTS400	Accelerometer (2-axis), barometer (built-in ADC), pPhoto-sensitive light, relative humidity and temperature (built-in 12 bit ADC).
MTS420	Accelerometer (2-axis), barometer (built-in ADC), GPS module, photosynthetic light, relative humidity and temperature (built-in 12 bit ADC).
MDA300	External analog sensor Inputs (10 to 12 bit ADCs), relative humidity and temperature (built-in 12 bit ADC), and relays (normally open and normall closed).
MTS510	Accelerometer (2-axis), photo sensor, microphone.
MDA500	External analog and digital inputs
MEP510	Mote Environmental Package – temperature, relative humidity, MICA2DOT
MEP410	Mote Environmental Package – temperature, relative humidity, pressure, photosynetic light (two), broadband light (two), MICA2
MDA320	External analog sensors(10 to 12 bit ADCs), built-in 16-bit ADC, digital inputs, and relays (normally open and normall closed)/
MDA100	External analog sensor Inputs (6 to 10 bit ADCs), photoresistor, and thermistor.
MSP410	Sense and respond reference board – MTS400 sensor set plus PIR, microphone, beeper, two relays, two analog inputs, 2 general purpose digital input/output

9.1 MTS101

The MTS101 sensor board has a precision thermistor, light sensor/photocell, and general prototyping area. It is used with the MICAz and MICA2 Motes.

9.1.1 Packet Structure

<table>
<tr><td>Bytes: 5</td><td>0/7</td><td>4</td><td>2</td><td>2</td><td>2</td><td>10</td><td>2</td></tr>
<tr><td rowspan="2">TinyOS Header</td><td rowspan="2">XMesh Header</td><td rowspan="2">XSensor Header</td><td>Voltage</td><td>Thermistor</td><td>Light</td><td>…</td><td rowspan="2">CRC</td></tr>
<tr><td colspan="4">MTS101 Payload</td></tr>
</table>

9.1.2 Data Fields

The MTS101 packet has the following fields:

Table 9-2 Data Payload contents of MTS101 Packet

Type	Field Name	Description
uint16_t	**voltage**	Battery reading (also known as vref or voltage)
uint16_t	**thermistor**	Thermistor sensor reading
uint16_t	**Light**	Light sensor reading.
uint16_t	**Adc0**	Analog to Digital Converter reading
uint16_t	**Adc1**	Analog to Digital Converter reading
uint16_t	**Adc2**	Analog to Digital Converter reading
uint16_t	**Adc3**	Analog to Digital Converter reading
uint16_t	**Adc4**	Analog to Digital Converter reading

9.1.3 XML Packet Description

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE XServeConfig SYSTEM "./xserve_config.dtd">
<XServeConfig>
        <XFieldExtractor name="XMTS101 Multihop Config XML" order="3">
                <XFields>
                        <XField name="amtype" byteoffset="2" length="1" type="uint8"/>
                        <XField name="nodeid" byteoffset="7" length="2" type="uint16"
specialtype="nodeid"/>
                        <XField name="parent" byteoffset="14" length="2" type="uint16"
specialtype="parentid"/>
                        <XField name="group" byteoffset="3" length="1" type="uint8"/>
                        <XField name="board_id" byteoffset="12" length="1" type="uint8"
specialtype="boardid"/>
                        <XField name="packet_id" byteoffset="13" length="1" type="uint8"/>
                        <XField name="voltage" byteoffset="16" length="2" type="uint16"/>
                        <XField name="temp" byteoffset="18" length="2" type="uint16"/>
                        <XField name="light" byteoffset="20" length="2" type="uint16"/>
                        <XField name="adc0" byteoffset="22" length="2" type="uint16"/>
                        <XField name="adc1" byteoffset="24" length="2" type="uint16"/>
                        <XField name="adc2" byteoffset="26" length="2" type="uint16"/>
                        <XField name="adc3" byteoffset="28" length="2" type="uint16"/>
                        <XField name="adc4" byteoffset="30" length="2" type="uint16"/>
                </XFields>
                </XFilter>
                </XDataSinks>
        </XFieldExtractor>
</XServeConfig>
```

NOTE: For details on the field convertion for a given sensor, see Appendix C.

9.1.4 XML Data Output

```
<?xml version="1.0" ?>
<MotePacket>
	<RawPacket>0x7E00337D1B000000000000000082817E007D011D02E2015D01FF00E400F0000D01</RawPacket>
	<ParsedDataElement>
		<Name>amtype</Name>
		<RawValue>0x33</RawValue>
		<ConvertedValue>51</ConvertedValue>
	</ParsedDataElement>
	<ParsedDataElement>
		<Name>nodeid</Name>
		<RawValue>0x00</RawValue>
		<ConvertedValue>0</ConvertedValue>
	</ParsedDataElement>
	<ParsedDataElement>
		<Name>parent</Name>
		<RawValue>0x7e</RawValue>
		<ConvertedValue>126</ConvertedValue>
	</ParsedDataElement>
	<ParsedDataElement>
		<Name>group</Name>
		<RawValue>0x7d</RawValue>
		<ConvertedValue>125</ConvertedValue>
	</ParsedDataElement>
	<ParsedDataElement>
		<Name>board_id</Name>
		<RawValue>0x82</RawValue>
		<ConvertedValue>130</ConvertedValue>
	</ParsedDataElement>
	<ParsedDataElement>
		<Name>packet_id</Name>
		<RawValue>0x81</RawValue>
		<ConvertedValue>129</ConvertedValue>
	</ParsedDataElement>
	<ParsedDataElement>
		<Name>voltage</Name>
		<RawValue>0x17d</RawValue>
		<ConvertedValue>3287</ConvertedValue>
	</ParsedDataElement>
	<ParsedDataElement>
```

```
                <Name>temp</Name>
                <RawValue>0x21d</RawValue>
                <ConvertedValue>27.440985</ConvertedValue>
        </ParsedDataElement>
        <ParsedDataElement>
                <Name>light</Name>
                <RawValue>0x1e2</RawValue>
                <ConvertedValue>1548</ConvertedValue>
        </ParsedDataElement>
        <ParsedDataElement>
                <Name>adc0</Name>
                <RawValue>0x15d</RawValue>
                <ConvertedValue>349</ConvertedValue>
        </ParsedDataElement>
        <ParsedDataElement>
                <Name>adc1</Name>
                <RawValue>0xff</RawValue>
                <ConvertedValue>255</ConvertedValue>
        </ParsedDataElement>
        <ParsedDataElement>
                <Name>adc2</Name>
                <RawValue>0xe4</RawValue>
                <ConvertedValue>228</ConvertedValue>
        </ParsedDataElement>
        <ParsedDataElement>
                <Name>adc3</Name>
                <RawValue>0xf0</RawValue>
                <ConvertedValue>240</ConvertedValue>
        </ParsedDataElement>
        <ParsedDataElement>
                <Name>adc4</Name>
                <RawValue>0x10d</RawValue>
                <ConvertedValue>269</ConvertedValue>
        </ParsedDataElement>
```

9.1.5 Print Raw

```
[2005/12/19 12:29:04] 7E 00 33 7D 1B 00 00 00 00 00 00 00 82 81 7E 00 7D 01 1D 02 E2 01 5D 01 FF
00 E4 00 F0 00 0D 01  [32]
```

9.1.6 Print Parsed

```
[2005/12/19 12:32:41] MTS101 [sensor data converted to engineering units]:
   health:     node id=0x00  battery:  = 0x17d
   tempurature: =0x21d  light: = 0x1e2
   adc0 = 0x15d mv adc1 = 0xff adc2 = 0xe4
   adc3 = 0xf0 mv adc4 = 0x10d
```

9.1.7 Print Converted

```
[2005/12/19 13:33:50] MTS101 [sensor data converted to engineering units]:
   health:     node id=0  battery:  = 3287 mv
   tempurature: =27.440985 degC  light: = 1548 mv
   adc0 = 349 mv adc1 = 255 mv adc2 = 228 mv
   adc3 = 240 mv adc4 = 269 mv
```

9.1.8 XMTS101 Logging Output

```
INSERT into mts101_results (result_time,nodeid,parent,voltage,temp,light,adc0,adc1,
adc2,adc3,adc4) values (now(),1,0,380,535,514,412,261,226,237,254)
```

9.2 MTS300

The MTS300CA is a flexible sensor board with a variety of sensing modalities. These modalities include Light, Temperature, Acoustic Range and Recorder (microphone), and Sounder (buzzer). The MTS300CA is for use with both MICAz and MICA2 Motes.

9.2.1 Packet Structure

<table>
<tr><td>Bytes: 5</td><td>0/7</td><td>4</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td rowspan="2">TinyOS Header</td><td rowspan="2">XMesh Header</td><td rowspan="2">XSensor Header</td><td>Voltage</td><td>Thermistor</td><td>Light</td><td>Microphone</td><td rowspan="2">CRC</td></tr>
<tr><td colspan="4">MTS300 Payload</td></tr>
</table>

9.2.2 Data Fields

The MTS300 packet has the following fields:

Table 9-3 Data Payload contents of MTS300 Packet

Type	Field Name	Description
uint16_t	**voltage**	Battery reading (also known as vref or voltage)
uint16_t	**thermistor**	Thermistor sensor reading
uint16_t	**Light**	Light sensor reading.
uint16_t	**microphone**	Measurement of acoustic range and recording.

9.3 MTS310

The MTS310CA is a flexible sensor board with a variety of sensing modalities. These modalities include Light, Temperature, Microphone, Sounder (buzzer), Accelerometer (2-Axis), and Magnetometer (2-Axis). The MTS310CA is compatible with both MICAz and MICA2 Motes.

9.3.1 Packet Structure

<table>
<tr><td>Bytes: 5</td><td>0/7</td><td>4</td><td>2</td><td>2</td><td>2</td><td>10</td><td>2</td></tr>
<tr><td rowspan="2">TinyOS Header</td><td rowspan="2">XMesh Header</td><td rowspan="2">XSensor Header</td><td>Voltage</td><td>Thermistor</td><td>Light</td><td>…</td><td rowspan="2">CRC</td></tr>
<tr><td colspan="4">MTS310 Payload</td></tr>
</table>

9.3.2 Data Fields

The MTS310 packet has the following fields:

Table 9-4 Data Payload contents of MTS310 Packet

Type	Field Name	Description
uint16_t	**voltage**	Battery reading (also known as vref or voltage)
uint16_t	**thermistor**	Thermistor sensor reading
uint16_t	**Light**	Light sensor reading.
uint16_t	**microphone**	Measurement of acoustic range and recording.
uint16_t	**Accel_x**	Acceleration reading on the x –axis.
uint16_t	**Accel_y**	Acceleration reading on the y –axis.
uint16_t	**mag_x**	Magnetic reading on the x-axis.
uint16_t	**mag_y**	Magnetic reading on the y-axis.

9.3.3 XMTS300 XML Packet Description

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE XServeConfig SYSTEM "./xserve_config.dtd">
<XServeConfig>
<XFieldExtractor name="XMTS300 Multihop Config XML" order="3">
       <XFields>
              <XField name="amtype" byteoffset="2" length="1" type="uint8"/>
              <XField name="nodeid" byteoffset="7" length="2" type="uint16"
specialtype="nodeid"/>
              <XField name="parent" byteoffset="14" length="2" type="uint16"
specialtype="parentid"/>
              <XField name="group" byteoffset="3" length="1" type="uint8"/>
              <XField name="board_id" byteoffset="12" length="1" type="uint8"
specialtype="boardid"/>
              <XField name="packet_id" byteoffset="13" length="1" type="uint8"/>
              <XField name="voltage" byteoffset="16" length="2" type="uint16"/>
              <XField name="temp" byteoffset="18" length="2" type="uint16"/>
```

```
            <XField name="light" byteoffset="20" length="2" type="uint16"/>
            <XField name="mic" byteoffset="22" length="2" type="uint16"/>
      </XFields>
      </XFilter>
     </XDataSinks>
</XFieldExtractor>
</XServeConfig>
```

9.3.4 XML Data Output

```
<?xml version="1.0" ?>
<MotePacket>
<RawPacket>0x7E00117D160000000000000000000007E00060000BEC07A60798E74</RawPacket>
<ParsedDataElement>
       <Name>amtype</Name>
       <RawValue>0x11</RawValue>
       <ConvertedValue>17</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
       <Name>nodeid</Name>
       <RawValue>0x00</RawValue>
       <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
       <Name>parent</Name>
       <RawValue>0x7e</RawValue>
       <ConvertedValue>126</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
       <Name>vref</Name>
       <RawValue>0x017c</RawValue>
       <ConvertedValue>3295</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
       <Name>epoch</Name>
       <RawValue>0x0006</RawValue>
       <ConvertedValue>6</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
       <Name>light</Name>
       <RawValue>0xc0</RawValue>
       <ConvertedValue>2474</ConvertedValue>
</ParsedDataElement>
```

```
<ParsedDataElement>
        <Name>thermistor</Name>
<RawValue>0x7a</RawValue><ConvertedValue>23.045807</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>magX</Name>
        <RawValue>0x60</RawValue>
        <ConvertedValue>51.857669</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>magY</Name>
        <RawValue>0x79</RawValue>
        <ConvertedValue>65.362270</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>accelX</Name>
        <RawValue>0x8e</RawValue>
        <ConvertedValue>2360.000000</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>accelY</Name>
        <RawValue>0x74</RawValue>
        <ConvertedValue>280.000000</ConvertedValue>
</ParsedDataElement>
</MotePacket>
```

9.3.5 Print Raw

```
[2005/12/19 14:15:24] 7E 00 33 7D 1B 00 00 00 00 00 00 00 83 81 7E 00 7D 01 20 02 AD 02 CA 00 00
00 00 00 00 00 00 00  [32]
```

9.3.6 Print Parsed

```
[2005/12/19 14:15:53] MTS300 [sensor data converted to engineering units]:
   health:     node id=0x00 parent=0x7e
   battery:  = 0x17d
   temperature=0x220
   light: = 0x2b6
   mic: = 0xc8
```

9.3.7 Print Converted

```
[2005/12/19 14:16:50] MTS300 [sensor data converted to engineering units]:
   health:     node id=0 parent=126
   battery:  = 3287 mv
   temperature=27.693773 degC
   light: = 2268 ADC mv
   mic: = 202 ADC counts
```

9.3.8 XMTS300 Logging Output

```
INSERT into mts300_results (result_time,nodeid,parent,voltage, temp,light) values
(now(),0,126,381,543,698)
```

9.4 MTS400

The MTS400 sensor board has a variety of weather sensing modalities. These modalities include Temperature, Humidity, Barometric Pressure, Light, and Accelerometer (2-Axis). The MTS400 is compatible with both MICA2 and MICAz Motes.

9.4.1 Packet Structure

Bytes: 5	**0/7**	**4**	**2**	**2**	**2**	**20**	**2**
TinyOS Header	XMesh Header	XSensor Header	Voltage	Humidity	Temperature	…	CRC
			MTS400 Payload				

9.4.2 Data Fields

The MTS400 packet has the following fields:

Table 9-5 Data Payload contents of MTS400 Packet

Type	Field Name	Description
uint16_t	**voltage**	Battery reading (also known as vref or voltage)
uint16_t	**humidity**	Humidity reading.
uint16_t	**temp**	Temperature reading.
uint16_t	**cal_word1**	Pressure calibration word 1 (intersema pressure sensor)
uint16_t	**cal_word2**	Pressure calibration word 2 (intersema pressure sensor)
uint16_t	**cal_word3**	Pressure calibration word 3 (intersema pressure sensor)
uint16_t	**cal_word4**	Pressure calibration word 4 (intersema pressure sensor)
uint16_t	**intersematemp**	This is the humidity and pressure sensor reading.
uint16_t	**intersemapressure**	This is the barometric pressure and temperature sensor reading.
uint16_t	**taosch0**	**<Need info>**
uint16_t	**taosch1**	**<Need info>**
uint16_t	**accel_x**	Acceleration reading on the x –axis.

uint16_t	**accel_y**	Acceleration reading on the y –axis.

9.5 MTS420

The MTS420 sensor board has a variety of weather sensing modalities plus Global Positioning System (GPS) readings. These modalities include Temperature, Humidity, Barometric Pressure, Light, and Accelerometer (2-Axis). The MTS420 is compatible with both MICA2 and MICAz Motes.

9.5.1 Packet Structure

Bytes: 5	**0/7**	**4**	**2**	**2**	**2**	**28**	**2**
TinyOS Header	XMesh Header	XSensor Header	Voltage	Thermistor	Light	…	CRC
			MTS420 Payload				

9.5.2 Data Fields

The MTS420 packet has the following fields:

Table 9-6 Data Payload contents of MTS420 Packet

Type	Field Name	Description
uint8_t	**Hours**	GPS time: hour
uint8_t	**minutes**	GPS time: minute
uint8_t	**Lat_deg**	GPS Latitude: degree
uint8_t	**Long_deg**	GPS Longitude: degree
uint32_t	**dec_sec**	GPS time: second
uint32_t	**Lat_dec_min**	GPS Latitude: minute
uint32_t	**Long_dec_min**	GPS Longitude: minute
uint8_t	**NSEWind**	GPS Velocity
uint8_t	**Fixed**	GPS Fix status

9.5.3 XML Packet Description

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE XServeConfig SYSTEM "./xserve_config.dtd">
<XServeConfig>
        <XFieldExtractor name="XMTS400 Multihop Config XML" order="3">
                <XFields>
                        <XField name="amtype" byteoffset="2" length="1" type="uint8"/>
                        <XField name="nodeid" byteoffset="7" length="2" type="uint16"
specialtype="nodeid"/>
                        <XField name="parent" byteoffset="14" length="2" type="uint16"
specialtype="parentid"/>
                        <XField name="group" byteoffset="3" length="1" type="uint8"/>
                        <XField name="board_id" byteoffset="12" length="1" type="uint8"
```

```
specialtype="boardid"/>
                        <XField name="packet_id" byteoffset="13" length="1" type="uint8"/>
                        <XField name="voltage" byteoffset="16" length="2" type="uint16"/>
                        <XField name="humid" byteoffset="18" length="2" type="uint16"/>
                        <XField name="humtemp" byteoffset="20" length="2" type="uint16"/>
                        <XField name="calibW0" byteoffset="22" length="2" type="uint16"/>
                        <XField name="calibW1" byteoffset="24" length="2" type="uint16"/>
                        <XField name="calibW2" byteoffset="26" length="2" type="uint16"/>
                        <XField name="calibW3" byteoffset="28" length="2" type="uint16"/>
                        <XField name="prtemp" byteoffset="30" length="2" type="uint16"/>
                        <XField name="press" byteoffset="32" length="2" type="uint16"/>
                        <XField name="taosch0" byteoffset="34" length="2" type="uint16"/>
                        <XField name="taosch1" byteoffset="36" length="2" type="uint16"/>
                        <XField name="accel_x" byteoffset="38" length="2" type="uint16"/>
                        <XField name="accel_y" byteoffset="40" length="2" type="uint16"/>
                        <XField name="taoch0" byteoffset="34" length="2" type="uint16"/>
                        <XField name="calibB0" byteoffset="22" length="1" type="uint8"/>
                        <XField name="calibB1" byteoffset="23" length="1" type="uint8"/>
                        <XField name="calibB2" byteoffset="24" length="1" type="uint8"/>
                        <XField name="calibB3" byteoffset="25" length="1" type="uint8"/>
                        <XField name="calibB4" byteoffset="26" length="1" type="uint8"/>
                        <XField name="calibB5" byteoffset="27" length="1" type="uint8"/>
                        <XField name="calibB6" byteoffset="28" length="1" type="uint8"/>
                        <XField name="calibB7" byteoffset="29" length="1" type="uint8"/>
                </XFields>
            </XFilter>
            </XDataSinks>
       </XFieldExtractor>
</XServeConfig>
```

9.5.4 XML Output

```
<?xml version="1.0" ?>
<MotePacket>
<RawPacket>0x7E00337D370000000000000086877E007F012A02A81ACAB459
AE2A9FD2B1D869C04AE4FFB3FFE101AC0108390000E4DF000000000000000000000000</RawPacket>
<ParsedDataElement>
        <Name>amtype</Name>
        <RawValue>0x33</RawValue>
        <ConvertedValue>51</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>nodeid</Name>
```

```
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>parent</Name>
        <RawValue>0x7e</RawValue>
        <ConvertedValue>126</ConvertedValue>
        </ParsedDataElement>
<ParsedDataElement>
        <Name>group</Name>
        <RawValue>0x7d</RawValue>
        <ConvertedValue>125</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>board_id</Name>
        <RawValue>0x86</RawValue>
        <ConvertedValue>134</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>packet_id</Name>
        <RawValue>0x87</RawValue>
        <ConvertedValue>135</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>voltage</Name>
        <RawValue>0x17f</RawValue>
        <ConvertedValue>3269</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>humid</Name>
        <RawValue>0x22a</RawValue>
        <ConvertedValue>17</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>humtemp</Name>
        <RawValue>0x1aa8</RawValue>
        <ConvertedValue>28</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibW0</Name>
        <RawValue>0xb4ca</RawValue>
        <ConvertedValue>46282</ConvertedValue>
```

```
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibW1</Name>
        <RawValue>0xae59</RawValue>
        <ConvertedValue>44633</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibW2</Name>
        <RawValue>0x9f2a</RawValue>
        <ConvertedValue>40746</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibW3</Name>
        <RawValue>0xb1d2</RawValue>
        <ConvertedValue>45522</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>prtemp</Name>
        <RawValue>0x69d8</RawValue>
        <ConvertedValue>29.492188</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>press</Name>
        <RawValue>0x4ac0</RawValue>
        <ConvertedValue>1016.629969</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>taosch0</Name>
        <RawValue>0xffe4</RawValue>
        <ConvertedValue>65508</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>taosch1</Name>
        <RawValue>0xffb3</RawValue>
        <ConvertedValue>65459</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>accel_x</Name>
        <RawValue>0x1e1</RawValue>
        <ConvertedValue>620.000000</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>accel_y</Name>
```

```
        <RawValue>0x1ac</RawValue>
        <ConvertedValue>-440.000000</ConvertedValue>
</ParsedDataElement>
<ParsedData Element>
        <Name>hours</Name>
        <RawValue>0x8</RawValue>
        <ConvertedValue>8</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>minutes</Name>
        <RawValue>0x39</RawValue>
        <ConvertedValue>57</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>latitudedegree</Name>
        <RawValue>0x0</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>longitudedegree</Name>
        <RawValue>0x0</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>seconds</Name>
        <RawValue>0xdfe4</RawValue>
        <ConvertedValue>57.316000</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>latitudeminutes</Name>
        <RawValue>0x0000</RawValue>
        <ConvertedValue>0.000000</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>longitudeminute</Name>
        <RawValue>0x0000</RawValue>
        <ConvertedValue>0.000000</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>nsewind</Name>
        <RawValue>0x0</RawValue>
        <ConvertedValue>0</ConvertedValue>
```

```
</ParsedDataElement>
<ParsedDataElement>
        <Name>fixed</Name>
        <RawValue>0x0</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>lightval</Name>
        <RawValue>0xffe4</RawValue>
        <ConvertedValue>26.801702</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB0</Name>
        <RawValue>0xca</RawValue>
        <ConvertedValue>202</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB1</Name>
        <RawValue>0xb4</RawValue>
        <ConvertedValue>180</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB2</Name>
        <RawValue>0x59</RawValue>
        <ConvertedValue>89</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB3</Name>
        <RawValue>0xae</RawValue>
        <ConvertedValue>174</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB4</Name>
        <RawValue>0x2a</RawValue>
        <ConvertedValue>42</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB5</Name>
        <RawValue>0x9f</RawValue>
        <ConvertedValue>159</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB6</Name>
```

```
        <RawValue>0xd2</RawValue>
        <ConvertedValue>210</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB7</Name>
        <RawValue>0xb1</RawValue>
        <ConvertedValue>177</ConvertedValue>
</ParsedDataElement>
</MotePacket>
```

9.5.5 Print Raw

```
[2005/12/19 14:44:50] 7E 00 33 7D 37 00 00 00 00 00 00 00 86 87 7E 00 7E 01 EB 01 28 1C CA B4 59
AE 2A 9F D2 B1 52 6C 5E 4A E4 FF B2 FF E2 01 AB 01 09 00 00 00 ED 0C 00 00 00 00 00 00 00 00 00
00 00 00  [60]
```

9.5.6 Print Parsed

```
[2005/12/19 14:46:18] MTS420 [sensor data converted to engineering units]:
   health:       node id = 0x00
   battery:              = 0x17f mv
   humidity:             = 0x22a%
   Temperature:          = 0x1aa8 degC
   IntersemaTemperature: = 0x69d8 degC
   IntersemaPressure:    = 0x4ac0 mbar
   Light :               = 0xffe4 lux
   X-axis Accel:         = 0x1e1 mg
   Y-axis Accel:         = 0x1ac mg
   Fix taken at 0x8:0x39:0xdfe4 UTC
   Latitude 0x0 deg 0x0000
   Longitude 0x0 deg 0x0000
   Fix Quality: 0x0
```

9.5.7 Print Converted

```
[2005/12/19 14:47:18] MTS420 [sensor data converted to engineering units]:
   health:       node id = 0
   battery:              = 3287 mv
   humidity:             = 15%
   Temperature:          = 31 degC
   IntersemaTemperature: = 33.242188 degC
   IntersemaPressure:    = 1016.175597 mbar
   Light :               = 25.585199 lux
```

```
   X-axis Accel:         = 600.000000 mg
   Y-axis Accel:         = -420.000000 mg
   Fix taken at 8:59:27.312000 UTC
   Latitude 0 deg 0.000000
   Longitude 0 deg 0.000000
   Fix Quality: 0
```

9.5.8 XMTS420 Logging Output

```
INSERT into mts420_results
(result_time,nodeid,parent,voltage,humid,humtemp,prtemp,press,taosch0,taosch1,accel_x,accel_y,Hou
rs,Minutes,seconds,Latitudedegree,Latitudeminutes,Longitudedegree,Longitudeminute,nsewind,Fixed)
values (now(),0,126,383,554,6824,27096,19136,65508,65459,481,428,8,57,57316,0,0,0,0,0,0)
```

9.6 MDA300

The MDA300 is an environmental monitoring board. It has a variety of sensing modalities, which include eight, 12-bit analog inputs, eight digital input/output, two relay channels, a selectable sensor excitation of 2.5V, 3V, and 5V. It can support numerous onboard environmental sensors including humidity, soil moisture, PAR light, and wind speed. The MDA300 is compatible with both MICA2 and MICAz Motes.

9.6.1 Packet Structure

<table>
<tr><td>Bytes: 5</td><td>0/7</td><td>4</td><td>2</td><td>2</td><td>2</td><td>12</td><td>2</td></tr>
<tr><td rowspan="2">TinyOS Header</td><td rowspan="2">XMesh Header</td><td rowspan="2">XSensor Header</td><td>Voltage</td><td>Humidity</td><td>Temp</td><td>…</td><td rowspan="2">CRC</td></tr>
<tr><td colspan="4">MDA300 Payload</td></tr>
</table>

9.6.2 Data Packet Structs

The MDA300 packet has the following fields:

Table 9-7 Data Payload contents of MDA300 Packet

Type	Field Name	Description
uint16_t	**vref**	Battery reading (also known as vref or voltage)
uint16_t	**humid**	Humidity sensor reading.
uint16_t	**humtemp**	Humidity and temperature sensor reading.
uint16_t	**adc0**	Analog to Digital Converter reading
uint16_t	**adc1**	Analog to Digital Converter reading.
uint16_t	**adc2**	Analog to Digital Converter reading.
uint16_t	**dig0**	Digital I/O reading.
uint16_t	**dig1**	Digital I/O reading.
uint16_t	**dig2**	Digital I/O reading.

9.6.3 XML Packet Description

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE XServeConfig SYSTEM "./xserve_config.dtd">
<XServeConfig>
	<XFieldExtractor name="XMDA300 Multihop PK6 Config XML" order="3">
		<XFields>
			<XField name="amtype" byteoffset="2" length="1" type="uint8"/>
			<XField name="nodeid" byteoffset="7" length="2" type="uint16"
specialtype="nodeid"/>
			<XField name="parent" byteoffset="14" length="2" type="uint16"
specialtype="parentid"/>
			<XField name="group" byteoffset="3" length="1" type="uint8"/>
			<XField name="board_id" byteoffset="12" length="1" type="uint8"
specialtype="boardid"/>
			<XField name="packet_id" byteoffset="13" length="1" type="uint8"/>
			<XField name="voltage" byteoffset="16" length="2" type="uint16"/>
			<XField name="humid" byteoffset="18" length="2" type="uint16"/>
			<XField name="humtemp" byteoffset="20" length="2" type="uint16"/>
			<XField name="adc0" byteoffset="22" length="2" type="uint16"/>
			<XField name="adc1" byteoffset="24" length="2" type="uint16"/>
			<XField name="adc2" byteoffset="26" length="2" type="uint16"/>
			<XField name="digi0" byteoffset="28" length="2" type="uint16"/>
			<XField name="digi1" byteoffset="30" length="2" type="uint16"/>
			<XField name="digi2" byteoffset="32" length="2" type="uint16"/>
		</XFields>
		</XFilter>
		</XDataSinks>
	</XFieldExtractor>
</XServeConfig>
```

9.6.4 XML Output

```
<?xml version="1.0" ?>
<MotePacket>
<RawPacket>0x7E00337D1D000000000000000081867E007D01DA02501AB80B0B0C420B000000000000</RawPacket>
<ParsedDataElement>
	<Name>amtype</Name><
	RawValue>0x33</RawValue>
	<ConvertedValue>51</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
	<Name>nodeid</Name>
	<RawValue>0x00</RawValue>
```

```
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>parent</Name>
        <RawValue>0x7e</RawValue>
        <ConvertedValue>126</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>group</Name>
        <RawValue>0x7d</RawValue>
        <ConvertedValue>125</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>board_id</Name>
        <RawValue>0x81</RawValue>
        <ConvertedValue>129</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>packet_id</Name>
        <RawValue>0x86</RawValue>
        <ConvertedValue>134</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>voltage</Name>
        <RawValue>0x17d</RawValue>
        <ConvertedValue>3287</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>humid</Name>
        <RawValue>0x2da</RawValue>
        <ConvertedValue>24.251596</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>humtemp</Name>
        <RawValue>0x1a50</RawValue>
        <ConvertedValue>27.612799</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc0</Name>
        <RawValue>0xbb8</RawValue>
        <ConvertedValue>226.869565</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
```

```
        <Name>adc1</Name>
        <RawValue>0xc0b</RawValue>
        <ConvertedValue>192.214286</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc2</Name>
        <RawValue>0xb42</RawValue>
        <ConvertedValue>2882</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>digi0</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>digi1</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>digi2</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
</MotePacket>
```

9.6.5 Print Raw

```
[2005/12/19 15:54:28] 7E 00 33 7D 1D 00 00 00 00 00 00 00 81 86 7E 00 7D 01 C6 02 79 1A 36 0B 42
0B 54 0B 00 00 00 00 00 00  [34]
```

9.6.6 Print Parsed

```
[2005/12/19 15:55:17] MDA300 [sensor data converted to engineering units]:
   health:     node id=0x00 parent=0x7e battery=0x17d mV
   echo10: Soil Moisture=0xb83%
   echo20: Soil Moisture=0xbc2%
   soil temperature   =0xc3a F
   temperature:       =0x1a88 C
   humidity:          =0x2c4 %
```

9.6.7 Print Converted

```
[2005/12/19 15:57:19] MDA300 [sensor data converted to engineering units]:
   health:     node id=1 parent=0 battery=3304 mV
   echo10: Soil Moisture=39.217391%
   echo20: Soil Moisture=40.285714%
   soil temperature   =113.8 F
   temperature:       =27.847999 C
   humidity:          =18.333629 %
```

9.6.8 XMDA300 Logging Output

```
INSERT into mda300_results
(result_time,nodeid,parent,voltage,humid,humtemp,adc0,adc1,adc2,digi0,digi1,digi2) values
(now(),0,126,381,732,6805,3077,2875,2880,0,0,0)
```

9.7 MTS510

The MTS510 series sensor is a flexible sensor board for MICA2DOT with a variety of sensing modalities. These modalities can be exploited in developing sensor networks for a variety of applications including personnel detection, low-frequency seismic sensing, movement, robotics, and other applications.

9.7.1 Packet Structure

<table>
<tr><td>Bytes: 5</td><td>0/7</td><td>4</td><td>1</td><td>2</td><td>2</td><td>6</td><td>2</td></tr>
<tr><td rowspan="2">TinyOS Header</td><td rowspan="2">XMesh Header</td><td rowspan="2">XSensor Header</td><td>Voltage</td><td>Thermistor</td><td>Light</td><td>…</td><td rowspan="2">CRC</td></tr>
<tr><td colspan="4">MTS510 Payload</td></tr>
</table>

9.7.2 Data Fields

The MTS510 packet has the following fields:

Table 9-8 Data Payload contents of MTS510 Packet

Type	Field Name	Description
uint8_t	**vref**	Voltage reading.
uint16_t	**thermistor**	Thermistor reading.
uint16_t	**light**	Light sensor reading.
uint16_t	**accel_x**	Acceleration reading on the x-axis.
uint16_t	**accel_y**	Acceleration reading on the y-axis.
uint16_t	**sound[5]**	Sound sample reading.

9.7.3 XML Packet Description

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE XServeConfig SYSTEM "./xserve_config.dtd">
<XServeConfig>
        <XFieldExtractor name="XMDA500 Multihop P1 Config XML" order="3">
                <XFields>
                        <XField name="amtype" byteoffset="2" length="1" type="uint8"/>
                        <XField name="nodeid" byteoffset="7" length="2" type="uint16"
specialtype="nodeid"/>
                        <XField name="parent" byteoffset="14" length="2" type="uint16"
specialtype="parentid"/>
                        <XField name="group" byteoffset="3" length="1" type="uint8"/>
                        <XField name="board_id" byteoffset="12" length="1" type="uint8"
specialtype="boardid"/>
                        <XField name="packet_id" byteoffset="13" length="1" type="uint8"/>
                        <XField name="light" byteoffset="16" length="2" type="uint16"/>
                        <XField name="accel_x" byteoffset="18" length="2" type="uint16"/>
                        <XField name="accel_y" byteoffset="20" length="2" type="uint16"/>
                        <XField name="mic0" byteoffset="22" length="2" type="uint16"/>
                        <XField name="mic1" byteoffset="24" length="2" type="uint16"/>
                        <XField name="mic2" byteoffset="26" length="2" type="uint16"/>
                        <XField name="mic3" byteoffset="28" length="2" type="uint16"/>
                        <XField name="mic4" byteoffset="30" length="2" type="uint16"/>
                        <XField name="mic"  byteoffset="22" length="2" type="uint16"/>
                </XFields>
                </XFilter>
                </XDataSinks>
        </XFieldExtractor>
</XServeConfig>
```

9.7.4 XML Output

```
<?xml version="1.0" ?>
<MotePacket>
<RawPacket>0x7E00337D1E000000000000000002837E00C3E5019903D201F60190028F0290028D029102</RawPacket>
<ParsedDataElement>
        <Name>amtype</Name>
        <RawValue>0x33</RawValue>
        <ConvertedValue>51</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>nodeid</Name>
        <RawValue>0x00</RawValue>
```

```
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>parent</Name>
        <RawValue>0x7e</RawValue>
        <ConvertedValue>126</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>group</Name>
        <RawValue>0x7d</RawValue>
        <ConvertedValue>125</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>board_id</Name>
        <RawValue>0x2</RawValue>
        <ConvertedValue>2</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>packet_id</Name>
        <RawValue>0x83</RawValue>
        <ConvertedValue>131</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>voltage</Name>
        <RawValue>0xc3</RawValue>
        <ConvertedValue>3150</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>tempR</Name>
        <RawValue>0x1e5</RawValue>
        <ConvertedValue>9014</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>temp</Name>
        <RawValue>0x1e5</RawValue>
        <ConvertedValue>27.188729</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>light</Name>
        <RawValue>0x399</RawValue>
        <ConvertedValue>921</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
```

```
        <Name>accel_x</Name>
        <RawValue>0x1d2</RawValue>
        <ConvertedValue>320.000000</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>accel_y</Name>
        <RawValue>0x1f6</RawValue>
        <ConvertedValue>1040.000000</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>mic0</Name>
        <RawValue>0x290</RawValue>
        <ConvertedValue>656</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>mic1</Name>
        <RawValue>0x28f</RawValue>
        <ConvertedValue>655</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>mic2</Name>
        <RawValue>0x290</RawValue>
        <ConvertedValue>656</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>mic3</Name>
        <RawValue>0x28d</RawValue>
        <ConvertedValue>653</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>mic4</Name>
        <RawValue>0x291</RawValue>
        <ConvertedValue>657</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>mic</Name>
        <RawValue>0x290</RawValue>
        <ConvertedValue>655</ConvertedValue>
</ParsedDataElement>
</MotePacket>
```

9.7.5 Print Raw

```
[2005/12/19 16:18:29] 7E 00 33 7D 1E 00 00 00 00 00 00 00 02 83 7E 00 C5 E1 01 9B 03 D2 01 F5 01
86 02 80 02 82 02 86 02 86 02  [35]
```

9.7.6 Print Parsed

```
[2005/12/19 16:18:56] MTS510 [sensor data converted to engineering units]:
   health:     node id=0x01
   battery:    volts=0xc4 mv
   thermistor: resistance=0x1e0 ohms, tempurature=0x1e0 C
   light:        =0x27b ADC counts
   X-axis Accel: =0x1d6 g
   Y-axis Accel: =0x1d2 g
   mic = 0x236 ADC counts
```

9.7.7 Print Converted

```
[2005/12/19 16:19:32] MTS510 [sensor data converted to engineering units]:
   health:     node id=1
   battery:    volts=3150 mv
   thermistor: resistance=8874 ohms, tempurature=27.525187 C
   light:        =997 ADC counts
   X-axis Accel: =360.000000 g
   Y-axis Accel: =280.000000 g
   mic = 568 ADC counts
```

9.7.8 XMTS510 Logging Output

```
INSERT into mts510_results (result_time,nodeid,parent,voltage,temp,light,accel_x,accel_y,mic)
values (now(),1,0,196,481,972,469,463,557)
```

9.8 MDA500

The MDA500 series data acquisition board provides a flexible user-interface for connecting external signals to the MICA2DOT Mote. This sensor board can connect to all of the major I/O signals of the MICA2DOT Mote.

9.8.1 Packet Structure

Bytes: 5	**0/7**	**4**	**2**	**2**	**2**	**10**	**2**
TinyOS	XMesh	XSensor	Voltage	Thermistor	ADC2	…	CRC

Header	Header	Header	**MDA500 Payload**	

9.8.2 Data Fields

The MDA500 packet has the following fields:

Table 9-9 Data Payload contents of MDA500 Packet

Type	Field Name	Description
uint16_t	**battery**	Battery reading (also known as Vref or voltage)
uint16_t	**thermistor**	Temperature reading.
uint16_t	**adc2**	Analog to Digital Converter reading
uint16_t	**adc3**	Analog to Digital Converter reading
uint16_t	**adc4**	Analog to Digital Converter reading
uint16_t	**adc5**	Analog to Digital Converter reading
uint16_t	**adc6**	Analog to Digital Converter reading
uint16_t	**adc7**	Analog to Digital Converter reading

9.8.3 XML Packet Description

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE XServeConfig SYSTEM "./xserve_config.dtd">
<XServeConfig>
        <XFieldExtractor name="XMDA500 Multihop Config XML" order="3">
                <XFields>
                        <XField name="amtype" byteoffset="2" length="1" type="uint8"/>
                        <XField name="nodeid" byteoffset="7" length="2" type="uint16"
specialtype="nodeid"/>
                        <XField name="parent" byteoffset="14" length="2" type="uint16"
specialtype="parentid"/>
                        <XField name="group" byteoffset="3" length="1" type="uint8"/>
                        <XField name="board_id" byteoffset="12" length="1" type="uint8"
specialtype="boardid"/>
                        <XField name="packet_id" byteoffset="13" length="1" type="uint8"/>
                        <XField name="voltage" byteoffset="16" length="2" type="uint16"/>
                        <XField name="tempR" byteoffset="18" length="2" type="uint16"/>
                        <XField name="temp" byteoffset="18" length="2" type="uint16"/>
                        <XField name="adc2" byteoffset="20" length="2" type="uint16"/>
                        <XField name="adc3" byteoffset="22" length="2" type="uint16"/>
                        <XField name="adc4" byteoffset="24" length="2" type="uint16"/>
                        <XField name="adc5" byteoffset="26" length="2" type="uint16"/>
                        <XField name="adc6" byteoffset="28" length="2" type="uint16"/>
                        <XField name="adc7" byteoffset="30" length="2" type="uint16"/>
                </XFields>
                </XFilter>
                </XDataSinks>
```

```
        </XFieldExtractor>
</XServeConfig>
```

9.8.4 XML Output

```
<?xml version="1.0" ?>
<MotePacket>
<RawPacket>0x7E00337D1B00000000000000001817E00C000D9015601DA00B200AE00BC00A400</RawPacket>
<ParsedDataElement>
        <Name>amtype</Name>
        <RawValue>0x33</RawValue>
        <ConvertedValue>51</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>nodeid</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>parent</Name>
        <RawValue>0x7e</RawValue>
        <ConvertedValue>126</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>group</Name>
        <RawValue>0x7d</RawValue>
        <ConvertedValue>125</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>board_id</Name>
        <RawValue>0x1</RawValue>
        <ConvertedValue>1</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>packet_id</Name>
        <RawValue>0x81</RawValue>
        <ConvertedValue>129</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>voltage</Name>
        <RawValue>0xc0</RawValue>
        <ConvertedValue>3200</ConvertedValue>
</ParsedDataElement>
```

```
<ParsedDataElement>
        <Name>tempR</Name>
        <RawValue>0x1d9</RawValue>
        <ConvertedValue>8600</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>temp</Name>
        <RawValue>0x1d9</RawValue>
        <ConvertedValue>28.201022</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc2</Name>
        <RawValue>0x156</RawValue>
        <ConvertedValue>1069</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc3</Name>
        <RawValue>0xda</RawValue>
        <ConvertedValue>681</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc4</Name>
        <RawValue>0xb2</RawValue>
        <ConvertedValue>556</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc5</Name>
        <RawValue>0xae</RawValue>
        <ConvertedValue>544</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc6</Name>
        <RawValue>0xbc</RawValue>
        <ConvertedValue>588</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc7</Name>
        <RawValue>0xa4</RawValue>
        <ConvertedValue>513</ConvertedValue>
</ParsedDataElement>
</MotePacket>
```

9.8.5 Print Raw

```
[2005/12/19 17:05:46] 7E 00 33 7D 1B 00 00 01 00 00 00 00 01 81 00 00 BF 00 D3 01 A0 01 16 01 F9
00 C6 00 DA 00 C1 00  [32]
```

9.8.6 Print Parsed

```
[2005/12/19 17:06:15] MDA500 [sensor data converted to engineering units]:
   health:     node id=0x00
   battery:    volts=0xc0 mv
   thermistor: resistance=0x1d7 ohms, tempurature=0x1d7 C
   adc chan 2: voltage=0x159 mv
   adc chan 3: voltage=0xdf mv
   adc chan 4: voltage=0xba mv
   adc chan 5: voltage=0xb6 mv
   adc chan 6: voltage=0xbb mv
   adc chan 7: voltage=0xad mv
```

9.8.7 Print Converted

```
[2005/12/19 17:06:41] MDA500 [sensor data converted to engineering units]:
   health:     node id=0
   battery:    volts=3200 mv
   thermistor: resistance=8600 ohms, tempurature=28.201022 C
   adc chan 2: voltage=1082 mv
   adc chan 3: voltage=697 mv
   adc chan 4: voltage=563 mv
   adc chan 5: voltage=569 mv
   adc chan 6: voltage=572 mv
   adc chan 7: voltage=553 mv
```

9.8.8 XMDA500 Logging Output

```
INSERT into mda500_results
(result_time,nodeid,parent,voltage,temp,adc2,adc3,adc4,adc5,adc6,adc7)values
(now(),0,126,191,472,341,217,175,182,176,166)
```

9.9 MEP510

The MEP510 microclimate sensor node offers proven wireless technology and an integrated digital temperature/relative humidity sensor in a versatile outdoor package. This sensor board can connect to the major I/O signals of the MICA2DOT Mote with 433MHz frequence.

9.9.1 Packet Structure

Bytes: 5	0/7	4	1	2	2	4	2
TinyOS Header	XMesh Header	XSensor Header	Voltage	Thermistor	Humidity	…	CRC
			MEP510 Payload				

9.9.2 Data Fields

The MEP510 packet has the following fields:

Table 9-10 Data Payload contents of MEP510 Packet

Type	Data Fields	Description
uint8_t	**voltage**	Battery reading (also known as vref or voltage)
uint16_t	**thermistor**	Temperature reading.
uint16_t	**humidity**	Humidity reading
uint16_t	**temp_hum**	Temperature reading.
uint16_t	**board_id**	Sensorboard id: 0x04

9.9.3 XML Packet Description

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE XServeConfig SYSTEM "./xserve_config.dtd">
<XServeConfig>
        <XFieldExtractor name="XMEP510 Multihop Config XML" order="3">
                <XFields>
                        <XField name="amtype" byteoffset="2" length="1" type="uint8"/>
                        <XField name="nodeid" byteoffset="7" length="2" type="uint16"
specialtype="nodeid"/>
                        <XField name="parent" byteoffset="14" length="2" type="uint16"
specialtype="parentid"/>
                        <XField name="group" byteoffset="3" length="1" type="uint8"/>
                        <XField name="board_id" byteoffset="12" length="1" type="uint8"
specialtype="boardid"/>
                        <XField name="packet_id" byteoffset="13" length="1" type="uint8"/>
                        <XField name="seqno" byteoffset="16" length="2" type="uint16"/>
                        <XField name="voltval" byteoffset="18" length="1" type="uint8"/>
                        <XUnionField name="voltage" type="uint16" optor="lshift"
leftname="voltval" rightname="2"/>
                        <XField name="tempR" byteoffset="19" length="2" type="uint16"/>
                        <XField name="thermister" byteoffset="19" length="2" type="uint16"/>
                        <XField name="humidity" byteoffset="21" length="2" type="uint16"/>
                        <XField name="temp_hum" byteoffset="23" length="2" type="uint16"/>
                </XFields>
                </XFilter>
                </XDataSinks>
```

```
        </XFieldExtractor>
</XServeConfig>
```

9.9.4 XML Output

```
<?xml version="1.0" ?><MotePacket>
<RawPacket>0x7E00337D14000000000000000004827E00070061D00146023F1B</RawPacket>
<ParsedDataElement>
        <Name>amtype</Name>
        <RawValue>0x33</RawValue>
        <ConvertedValue>51</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>nodeid</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>parent</Name>
        <RawValue>0x7e</RawValue>
        <ConvertedValue>126</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>group</Name>
        <RawValue>0x7d</RawValue>
        <ConvertedValue>125</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>board_id</Name>
        <RawValue>0x4</RawValue>
        <ConvertedValue>4</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>packet_id</Name>
        <RawValue>0x82</RawValue>
        <ConvertedValue>130</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>seqno</Name>
        <RawValue>0x07</RawValue>
        <ConvertedValue>7</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
```

```
        <Name>voltval</Name>
        <RawValue>0x61</RawValue>
        <ConvertedValue>3167</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>tempR</Name>
        <RawValue>0x1d0</RawValue>
        <ConvertedValue>8300</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>thermister</Name>
        <RawValue>0x1d0</RawValue>
        <ConvertedValue>28.966376</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>humidity</Name>
        <RawValue>0x246</RawValue>
        <ConvertedValue>18</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>temp_hum</Name>
        <RawValue>0x1b3f</RawValue>
        <ConvertedValue>29</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>voltage</Name>
        <RawValue>0x0184</RawValue>
        <ConvertedValue>388</ConvertedValue>
</ParsedDataElement>
</MotePacket>
```

9.9.5 Print Raw

```
[2005/12/20 11:32:14] 7E 00 33 7D 14 00 00 00 00 00 00 00 04 82 7E 00 1A 00 60 D0 01 00 02 27 1B
[25]
```

9.9.6 Print Parsed

```
[2005/12/20 11:32:42] mep510 [sensor data converted to engineering units]:
   health:     node id=0x00 parent=0x7e seq=0x28
   battery: =0x60
   thermistor: resistance=0x1d1, tempurature=0x1d1
```

```
   temperature: =0x1b15
   humidity: =0x214
```

9.9.7 Print Converted

```
[2005/12/20 11:33:32] mep510 [sensor data converted to engineering units]:
   health:     node id=0 parent=126 seq=13
   battery: =3200 mv
   thermistor: resistance=8300 ohms, tempurature=28.966376 C
   temperature: =29 degC
   humidity: =18%
```

9.9.8 XMEP510 Logging Output

```
INSERT into mep_results
(result_time,nodeid,parent,epoch,voltage,thermister,humidity,temp_hum,board_id) values
(now(),0,126,39,384,465,544,6936,4)
```

9.10 MEP410

The MEP410 is a turnkey environmental monitoring system designed for online measurement of important environmental parameters including temperature, humidity, photosynthetic solar radiation, and barometric pressure. In addition to nursuries and vineyards, the MEP system has also been deployed in a variety of remote or sensitive environmental habitats.

9.10.1 Packet Structure

Bytes: 5	**0/7**	**4**	**1**	**2**	**2**	**4**	**2**
TinyOS Header	XMesh Header	XSensor Header	seq_no	vref	humid	…	CRC
			MEP410 Payload				

9.10.2 Data Fields

The MEP410 packet has the following fields:

Table 9-11 Data Payload contents of MEP410 Packet

Type	Data Fields	Description
uint16_t	**seq_no**	Sequence number
uint16_t	**vref**	Battery reading (also known as vref or voltage)
uint16_t	**humid**	Humidity reading (External)
uint16_t	**humtemp**	Temperature reading. (External)
uint16_t	**inthum**	Humidity reading.(Internal)
uint16_t	**inttemp**	Temperature reading. (Internal)
uint16_t	**photo [4]**	Light sensor readings.

uint16_t	**accel_x**	Acceleration reading on the x –axis.
uint16_t	**accel_y**	Acceleration reading on the y –axis.
uint16_t	**prtemp**	Temperature reading.
uint16_t	**press**	Atmospheric pressure reading.
uint16_t	**presscalib[4]**	Calibration data.

9.10.3 XML Packet Description

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE XServeConfig SYSTEM "./xserve_config.dtd">
<XServeConfig>
        <XFieldExtractor name="XMEP410 Multihop Config XML" order="3">
                <XFields>
                        <XField name="amtype" byteoffset="2" length="1" type="uint8"/>
                        <XField name="nodeid" byteoffset="7" length="2" type="uint16"
specialtype="nodeid"/>
                        <XField name="parent" byteoffset="14" length="2" type="uint16"
specialtype="parentid"/>
                        <XField name="group" byteoffset="3" length="1" type="uint8"/>
                        <XField name="board_id" byteoffset="12" length="1" type="uint8"
specialtype="boardid"/>
                        <XField name="packet_id" byteoffset="13" length="1" type="uint8"/>
                        <XField name="seqno" byteoffset="16" length="2" type="uint16"/>
                        <XField name="voltage" byteoffset="18" length="2" type="uint16"/>
                        <XField name="humidity" byteoffset="20" length="2" type="uint16"/>
                        <XField name="temp_hum" byteoffset="22" length="2" type="uint16"/>
                        <XField name="inthum" byteoffset="24" length="2" type="uint16"/>
                        <XField name="inttemp" byteoffset="26" length="2" type="uint16"/>
                        <XField name="par_top" byteoffset="28" length="2" type="uint16"/>
                        <XField name="tsr_top" byteoffset="30" length="2" type="uint16"/>
                        <XField name="par_bottom" byteoffset="32" length="2" type="uint16"/>
                        <XField name="tsr_bottom" byteoffset="34" length="2" type="uint16"/>
                        </XField>
                </XFields>
                </XFilter>
                </XDataSinks>
        </XFieldExtractor>
</XServeConfig>
```

9.10.4 XML Output

```
<?xml version="1.0" ?><MotePacket>
<RawPacket>0x7E00337D2F000000000000008A817E0000007C018C02641A9E026E1A0000000000000000C00100025667
4A4634C259A1E0AA39C4</RawPacket>
<ParsedDataElement>
        <Name>amtype</Name>
```

```
        <RawValue>0x33</RawValue>
        <ConvertedValue>51</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>nodeid</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>parent</Name>
        <RawValue>0x7e</RawValue>
        <ConvertedValue>126</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>group</Name>
        <RawValue>0x7d</RawValue>
        <ConvertedValue>125</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>board_id</Name>
        <RawValue>0x8a</RawValue>
        <ConvertedValue>138</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>packet_id</Name>
        <RawValue>0x81</RawValue>
        <ConvertedValue>129</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>seqno</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>voltage</Name>
        <RawValue>0x17c</RawValue>
        <ConvertedValue>3295</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>humidity</Name>
        <RawValue>0x28c</RawValue>
        <ConvertedValue>21</ConvertedValue>
</ParsedDataElement>
```

```
<ParsedDataElement>
        <Name>temp_hum</Name>
        <RawValue>0x1a64</RawValue>
        <ConvertedValue>27</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>inthum</Name>
        <RawValue>0x29e</RawValue>
        <ConvertedValue>22</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>inttemp</Name>
        <RawValue>0x1a6e</RawValue>
        <ConvertedValue>27</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>par_top</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>tsr_top</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>par_bottom</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>tsr_bottom</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>temp_pr</Name>
        <RawValue>0x6756</RawValue>
        <ConvertedValue>27.836914</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>pressure</Name>
        <RawValue>0x464a</RawValue>
```

```
        <ConvertedValue>1018.967717</ConvertedValue>
</ParsedDataElement>
</MotePacket>
```

9.10.5 Print Raw

```
[2005/12/20 11:51:33] 7E 00 33 7D 2F 00 00 00 00 00 00 00 8A 81 7E 00 00 00 77 01 86 02 62 1A 95
02 74 1A 00 00 00 00 00 00 00 00 C0 01 FF 01 58 67 49 46 34 C2 59 A1 E0 AA 39 C4  [52]
```

9.10.6 Print Parsed

```
[2005/12/20 11:57:20] MEP410 [sensor data converted to engineering units]:
   health:    id         = 0x00
   battery:              = 0x17d
   humidity [external]   = 0x298, Temp [external]   = 0x1a8e
   humidity [internal]   = 0x298, Temp [internal]   = 0x1a67
   IntersemaTemperature: = 0x6757
   IntersemaPressure:    = 0x4649
   Photo[1..4]:          = 0x00, 0x01, 0x00, 0x00
```

9.10.7 Print Converted

```
[2005/12/20 11:58:20] MEP410 [sensor data converted to engineering units]:
   health:    id         = 0
   battery:              = 3295 mv
   humidity [external]   = 22%, Temp [external]   = 28 degC
   humidity [internal]   = 22%, Temp [internal]   = 28 degC
   IntersemaTemperature: = 27.983398 degC
   IntersemaPressure:    = 1018.891895 mbar
   Photo[1..4]:          = 0mv, 0mv, 0mv, 0mv
```

9.10.8 XMEP410 Logging Output

```
INSERT into mep_results
(result_time,nodeid,parent,epoch,voltage,humidity,temp_hum,inthum,inttemp,par_top,tsr_top,par_bot
tom,tsr_bottom,temp_pr,pressure,board_id) values
(now(),0,126,0,380,682,6778,686,6819,0,0,0,0,26474,17991,138)
```

9.11 MDA320

The MDA320 is an environmental monitoring board. It has a variety of sensing modalities, which include eight, 16-bit analog inputs, eight digital input/output, a selectable sensor excitation of 2.5V, 3V, and 5V. It can support numerous onboard environmental sensors including

humidity, soil moisture, PAR light, and wind speed. The MDA320 is compatible with both MICA2 and MICAz Motes.

9.11.1 Packet Structure

Bytes: 5	**0/7**	**4**	**2**	**2**	**2**	**12**	**2**
TinyOS Header	XMesh Header	XSensor Header	Voltage	Adc0	Adc1	…	CRC
			MDA300 Payload				

9.11.2 Data Packet Structs

The MDA320 packet has the following fields:

Table 9-12 Data Payload contents of MDA320 Packet

Type	Data Fields	Description
uint16_t	**voltage**	Battery reading (also known as vref or voltage)
uint16_t	**adc0**	Analog to Digital Converter reading
uint16_t	**adc1**	Analog to Digital Converter reading.
uint16_t	**adc2**	Analog to Digital Converter reading.
uint16_t	**adc3**	Analog to Digital Converter reading.
uint16_t	**dig0**	Digital I/O reading.
uint16_t	**dig1**	Digital I/O reading.
uint16_t	**dig2**	Digital I/O reading.
uint16_t	**dig3**	Digital I/O reading.

9.11.3 XML Packet Description

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE XServeConfig SYSTEM "./xserve_config.dtd">
<XServeConfig>
        <XFieldExtractor name="XMDA320 Multihop PK6 Config XML" order="3">
                <XFields>
                        <XField name="amtype" byteoffset="2" length="1" type="uint8"/>
                        <XField name="nodeid" byteoffset="7" length="2" type="uint16"
specialtype="nodeid"/>
                        <XField name="parent" byteoffset="14" length="2" type="uint16"
specialtype="parentid"/>
                        <XField name="group" byteoffset="3" length="1" type="uint8"/>
                        <XField name="board_id" byteoffset="12" length="1" type="uint8"
specialtype="boardid"/>
                        <XField name="packet_id" byteoffset="13" length="1" type="uint8"/>
                        <XField name="voltage" byteoffset="16" length="2" type="uint16"/>
                        <XField name="adc0" byteoffset="18" length="2" type="uint16"/>
                        <XField name="adc1" byteoffset="20" length="2" type="uint16"/>
                        <XField name="adc2" byteoffset="22" length="2" type="uint16"/>
```

```
                        <XField name="adc3" byteoffset="24" length="2" type="uint16"/>
                        <XField name="digi0" byteoffset="26" length="2" type="uint16"/>
                        <XField name="digi1" byteoffset="28" length="2" type="uint16"/>
                        <XField name="digi2" byteoffset="30" length="2" type="uint16"/>
                        <XField name="digi3" byteoffset="32" length="2" type="uint16"/>
                </XFields>
                </XFilter>
                </XDataSinks>
        </XFieldExtractor>
</XServeConfig>
```

9.11.4 XML Output

```
<?xml version="1.0" ?><MotePacket>
<RawPacket>0x7E0033911D000000000000090867E008101EF24B924BD24BF24000000000000000</RawPacket>
<ParsedDataElement>
        <Name>amtype</Name>
        <RawValue>0x33</RawValue>
        <ConvertedValue>51</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>nodeid</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>parent</Name>
        <RawValue>0x7e</RawValue>
        <ConvertedValue>126</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>group</Name>
        <RawValue>0x91</RawValue>
        <ConvertedValue>145</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>board_id</Name>
        <RawValue>0x90</RawValue>
        <ConvertedValue>144</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>packet_id</Name>
        <RawValue>0x86</RawValue>
```

```
        <ConvertedValue>134</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>voltage</Name>
        <RawValue>0x181</RawValue>
        <ConvertedValue>3252</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc0</Name>
        <RawValue>0x24ef</RawValue>
        <ConvertedValue>360</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc1</Name>
        <RawValue>0x24b9</RawValue>
        <ConvertedValue>358</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc2</Name>
        <RawValue>0x24bd</RawValue>
        <ConvertedValue>358</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc3</Name>
        <RawValue>0x24bf</RawValue>
        <ConvertedValue>358</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>digi0</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>digi1</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>digi2</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
```

```
<ParsedDataElement>
        <Name>digi3</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
</MotePacket>
```

9.11.5 Print Raw

```
[2005/12/20 12:24:08] 7E 00 33 91 1D 00 00 00 00 00 00 00 90 86 7E 00 81 01 F7 24 A9 24 A9 24 A6
24 00 00 00 00 00 00 00 00  [34]
```

9.11.6 Print Parsed

```
[2005/12/20 12:24:41] MDA320 [sensor data converted to engineering units]:
   health:     node id=0x00 parent=0x7e battery=0x181
   adc chan 0: voltage=0x24f1
   adc chan 1: voltage=0x24b5
   adc chan 2: voltage=0x24b9
   adc chan 3: voltage=0x24b7
   dig chan 0: =0x00
   dig chan 1: =0x00
   dig chan 2: =0x00
   dig chan 3: =0x00
```

9.11.7 Print Converted

```
[2005/12/20 12:25:16] MDA320 [sensor data converted to engineering units]:
   health:     node id=0 parent=126 battery=3252 mV
   adc chan 0: voltage=360 mV
   adc chan 1: voltage=358 mV
   adc chan 2: voltage=358 mV
   adc chan 3: voltage=357 mV
   dig chan 0: =0
   dig chan 1: =0
   dig chan 2: =0
   dig chan 3: =0
```

9.11.8 XMDA300 Logging Output

```
INSERT into mda320_results (result_time,nodeid,parent,voltage,adc0,adc1,adc2,adc3,digi0, digi1,
digi2, digi3) values (now(),0,126,385,9456,9400,9405,9406,0,0,0,0)
```

9.12 MSP410

The MSP410CA Mote Security Package is a PCB integrated wireless (433 MHz transceiver), high performance sensor for experimental physical security/intrusion detection systems. The MSP410CA internal sensor suite includes both magnetic and pyroelectric/passive infrared sensors (PIR) as well as a dormant (not software activated) microphone. The two-axis magnetic field sensor detects perturbations in the local magnetic field. Its state-of-the-art noise filtering algorithms minimize false-detects while still maintaining maximum detection ranges up to 60 feet, depending on object size and ferrous content. It is intended for deployment as part of a robust mesh network of intrusion detection sensors.

9.12.1 Packet Structure

<table>
<tr><td>Bytes: 5</td><td>0/7</td><td>4</td><td>2</td><td>1</td><td>1</td><td>10</td><td>2</td></tr>
<tr><td rowspan="2">TinyOS Header</td><td rowspan="2">XMesh Header</td><td rowspan="2">XSensor Header</td><td>Sequence Number</td><td>Voltage</td><td>Quad</td><td>…</td><td rowspan="2">CRC</td></tr>
<tr><td colspan="4">MSP410 Payload</td></tr>
</table>

9.12.2 Data Fields

The MSP410 packet has the following fields:

Table 9-13 Data Payload contents of MSP410 Packet

Type	Field Name	Description
uint16_t	**seq_no**	
uint8_t	**voltage**	Battery reading (also known as vref or voltage)
uint8_t	**quad**	Bit field of which quadrants fired
uint16_t	**Pir**	Passive infrared magnitude over threshold pir(10-bit adc) - pir(10-bit detect_threshold) Note: 0 = no pir detect
uint16_t	**mag**	Magnetometer magnitude over threshold mag(adc) - mag(detect_threshold) Note: 0 = no magnetometer detect
uint16_t	**audio**	Microphone magnitude over threshold mic(adc) - mic(detect_threshold) Note: 0 = no microphone detect
uint16_t	**Pir_threshold**	Base line window detect value for passive infrared motion sensor
uint16_t	**mag_threshold**	Base line window detect value for magnetometer
uint16_t	**audio_threshold**	Base line window detect value for microphone

9.12.3 Quadrant

```
// xxx1 => quadrant 1 has fired
// xx1x => quadrant 2 has fired
// x1xx => quadrant 3 has fired
// 1xxx => quadrant 4 has fired
// note- multiple quadrants can fire simultenously
```

// note- quadrant orienation relative to
// note - physical XSM unit not defined yet
// note - 0000 => no pir detect

9.12.4 XML Packet Description

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE XServeConfig SYSTEM "./xserve_config.dtd">
<XServeConfig>
       <XFieldExtractor name="XMSP410 Multihop PK1 Config XML" order="3">
              <XFields>
                     <XField name="amtype" byteoffset="2" length="1" type="uint8"/>
                     <XField name="nodeid" byteoffset="7" length="2" type="uint16"
specialtype="nodeid"/>
                     <XField name="parent" byteoffset="14" length="2" type="uint16"
specialtype="parentid"/>
                     <XField name="group" byteoffset="3" length="1" type="uint8"/>
                     <XField name="board_id" byteoffset="12" length="1" type="uint8"
specialtype="boardid"/>
                     <XField name="packet_id" byteoffset="13" length="1" type="uint8"/>
                     <XField name="seqno" byteoffset="16" length="2" type="uint16"/>
                     <XField name="voltage" byteoffset="18" length="1" type="uint8"/>
                     <XField name="quad" byteoffset="19" length="1" type="uint8"/>
                     <XField name="pir" byteoffset="20" length="2" type="uint16"/>
                     <XField name="mag" byteoffset="22" length="2" type="uint16"/>
                     <XField name="audio" byteoffset="24" length="2" type="uint16"/>
              </XFields>
              </XFilter>
              </XDataSinks>
       </XFieldExtractor>
</XServeConfig>
```

9.12.5 XML Output

```
<?xml version="1.0" ?><MotePacket>
<RawPacket>0x7E00337D1C00000000000033A0017E00B500D200130313020000E0026400FF0300</RawPacket>
<ParsedDataElement>
      <Name>amtype</Name>
      <RawValue>0x33</RawValue>
      <ConvertedValue>51</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
     <Name>nodeid</Name>
```

```
      <RawValue>0x00</RawValue>
      <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
      <Name>parent</Name>
      <RawValue>0x7e</RawValue>
      <ConvertedValue>126</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
      <Name>group</Name>
      <RawValue>0x7d</RawValue>
      <ConvertedValue>125</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
      <Name>board_id</Name>
      <RawValue>0xa0</RawValue>
      <ConvertedValue>160</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
      <Name>packet_id</Name>
      <RawValue>0x1</RawValue>
      <ConvertedValue>1</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
      <Name>seqno</Name>
      <RawValue>0xb5</RawValue>
      <ConvertedValue>181</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
      <Name>voltage</Name>
      <RawValue>0xd2</RawValue>
      <ConvertedValue>2981</ConvertedValue>
</ParsedDataElement>
```

```
<ParsedDataElement>
     <Name>quad</Name>
     <RawValue>0x0</RawValue>
     <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
     <Name>pir</Name>
     <RawValue>0x313</RawValue>
     <ConvertedValue>787</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
     <Name>mag</Name>
     <RawValue>0x213</RawValue>
     <ConvertedValue>531</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
     <Name>audio</Name>
     <RawValue>0x00</RawValue>
     <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
</MotePacket>
```

9.12.6 Print Raw

```
[2006/03/02 11:47:41] 7E 00 33 7D 1C 00 00 00 00 00 00 33 A0 01 7E 00 BC 01 D2 00 16 03 FC 01 00
00 E0 02 64 00 FF 03 00  [33]
```

9.12.7 Print Parsed

```
[2006/03/02 11:47:41] 7E 00 33 7D 1C 00 00 00 00 00 00 33 A0 01 7E 00 BC 01 D2 00 16 03 FC 01 00
00 E0 02 64 00 FF 03 00  [33]
[2006/03/02 11:47:41] MSP410 [sensor data converted to engineering units]:
   health:     node id=0x00 parent=0x7e seq=0x1bc
   battery:  = 0xd2
   quad:     = 0x0
   pir:      = 0x316
   mic:      = 0x00
   Mag:      = 0x1fc
```

9.12.8 Print Converted

```
[2006/03/02 11:47:41] MSP410 [sensor data converted to engineering units]:
   health:     node id=0 parent=126 seq=444
   battery:  = 2981 mv
   quad:     = 0 ADC
   pir:      = 790 ADC
   mic:      = 0 ADC
   Mag:      = 508 ADC
```

9.12.9 XMSP410 Logging Output

```
INSERT into msp410_results (result_time,epoch,nodeid,parent,voltage,quad,pir,audio,mag) values
(now(),469,0,126,210,31,1023,0,514)
```

9.13 MDA100

The MDA100CA sensor and data acquisition board has a precision thermistor, a light sensor/photocell and general prototyping area. Designed for use with MICA2 and MICAz Motes, the prototyping area supports connection to all 51 pins on the expansion connector, and provides an additional 42 unconnected solder points for breadboarding.

9.13.1 Packet Structure

<table>
<tr><td>Bytes: 5</td><td>0/7</td><td>4</td><td>1</td><td>2</td><td>2</td><td>4</td><td>2</td></tr>
<tr><td rowspan="2">TinyOS Header</td><td rowspan="2">XMesh Header</td><td rowspan="2">XSensor Header</td><td>vref</td><td>Thermistor</td><td>photo</td><td>…</td><td rowspan="2">CRC</td></tr>
<tr><td colspan="4">MDA100 Payload</td></tr>
</table>

9.13.2 Data Fields

The MDA100 packet has the following fields:

Table 9-14 Data Payload contents of MDA100 Packet

Type	Data Fields	Description
Uint16_t	**vref**	Battery reading (also known as vref or voltage)
uint16_t	**thermistor**	Temperature reading.
uint16_t	**photo**	Light sensor reading.
uint16_t	**adc2**	Analog to Digital Converter reading
uint16_t	**adc3**	Analog to Digital Converter reading
uint16_t	**adc4**	Analog to Digital Converter reading
uint16_t	**adc5**	Analog to Digital Converter reading
uint16_t	**adc6**	Analog to Digital Converter reading

9.13.3 XML Packet Description

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE XServeConfig SYSTEM "./xserve_config.dtd">
<XServeConfig>
	<XFieldExtractor name="XMDA100 Multihop Config XML" order="3">
		<XFields>
			<XField name="amtype" byteoffset="2" length="1" type="uint8"/>
			<XField name="nodeid" byteoffset="7" length="2" type="uint16"
specialtype="nodeid"/>
			<XField name="parent" byteoffset="14" length="2" type="uint16"
specialtype="parentid"/>
			<XField name="group" byteoffset="3" length="1" type="uint8"/>
			<XField name="board_id" byteoffset="12" length="1" type="uint8"
specialtype="boardid"/>
			<XField name="packet_id" byteoffset="13" length="1" type="uint8"/>
			<XField name="voltage" byteoffset="16" length="2" type="uint16"/>
			<XField name="temp" byteoffset="18" length="2" type="uint16"/>
			<XField name="light" byteoffset="20" length="2" type="uint16"/>
			<XField name="adc2" byteoffset="22" length="2" type="uint16"/>
			<XField name="adc3" byteoffset="24" length="2" type="uint16"/>
			<XField name="adc4" byteoffset="26" length="2" type="uint16"/>
			<XField name="adc5" byteoffset="28" length="2" type="uint16"/>
			<XField name="adc6" byteoffset="30" length="2" type="uint16"/>
		</XFilter>
		</XDataSinks>
	</XFieldExtractor>
</XServeConfig>
```

9.13.4 XML Output

```
<?xml version="1.0" ?><MotePacket>
<RawPacket>0x7E00337D1B000000000000003391817E008101AB02BB038302AE01E300D500C600</RawPacket>
<ParsedDataElement>
	<Name>amtype</Name>
	<RawValue>0x33</RawValue>
	<ConvertedValue>51</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
	<Name>nodeid</Name>
	<RawValue>0x00</RawValue>
	<ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
```

```
        <Name>parent</Name>
        <RawValue>0x7e</RawValue>
        <ConvertedValue>126</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>group</Name>
        <RawValue>0x7d</RawValue>
        <ConvertedValue>125</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>board_id</Name>
        <RawValue>0x91</RawValue>
        <ConvertedValue>145</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>packet_id</Name>
        <RawValue>0x81</RawValue>
        <ConvertedValue>129</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>voltage</Name>
        <RawValue>0x181</RawValue>
        <ConvertedValue>3252</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>temp</Name>
        <RawValue>0x2ab</RawValue>
        <ConvertedValue>40.388356</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>light</Name>
        <RawValue>0x3bb</RawValue>
        <ConvertedValue>3036</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc2</Name>
        <RawValue>0x283</RawValue>
        <ConvertedValue>2044</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc3</Name>
        <RawValue>0x1ae</RawValue>
```

```
        <ConvertedValue>1367</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc4</Name>
        <RawValue>0xe3</RawValue>
        <ConvertedValue>721</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc5</Name>
        <RawValue>0xd5</RawValue>
        <ConvertedValue>677</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc6</Name>
        <RawValue>0xc6</RawValue>
        <ConvertedValue>629</ConvertedValue>
</ParsedDataElement>
</MotePacket>
```

9.13.5 Print Raw

```
[2006/03/02 12:48:48] 7E 00 33 7D 1B 00 00 00 00 00 00 33 91 81 7E 00 81 01 AA 02 BE 03 86 02 AF
01 E3 00 D3 00 C4 00  [32]
```

9.13.6 Print Parsed

```
[2006/03/02 12:48:48] MDA100 [sensor data converted to engineering units]:
 health: node id = 0x00 battery:  = 0x181
 temperature: = 0x2aa
 light:  = 0x3be
 adc chan 2: = 0x286
 adc chan 3: = 0x1af
 adc chan 4: = 0xe3
 adc chan 5: = 0xd3
 adc chan 6: = 0xc4
```

9.13.7 Print Converted

```
[2006/03/02 12:48:48] MDA100 [sensor data converted to engineering units]:
 health: node id = 0 battery:  = 3252 mv
 temperature: = 20.286861 degC
 light:  = 3046 mv
 adc chan 2: = 2054 mv
```

```
 adc chan 3: = 1370 mv
 adc chan 4: = 721 mv
 adc chan 5: = 670 mv
 adc chan 6: = 623 mv
```

9.13.8 XMDA100 Logging Output

```
INSERT into xbw_da100_results
(result_time,nodeid,parent,voltage,temp,light,adc2,adc3,adc4,adc5,adc6) values
(now(),0,126,385,680,960,653,433,227,212,196)
```

9.14 MTS410

The MTS410CA is a general purpose sensor board. It offers the same set of sensors as found on the MTS400. In addition it has a pyroelectric/passive infrared sensor for motion detection, a microphone for acoustic monitoring. There is a screw terminal block for interfacing to external devices. The terminal block as two analog inputs (10 bit ADC), two GPIO, and two relays (one normally open, the other normally closed). The features offered on the board allows for a wide variety of applications ranging from a simple wireless weather station to building automation device.

9.14.1 Packet Structure

<table>
<tr><td>Bytes: 5</td><td>0/7</td><td>4</td><td>1</td><td>2</td><td>2</td><td>4</td><td>2</td></tr>
<tr><td rowspan="2">TinyOS Header</td><td rowspan="2">XMesh Header</td><td rowspan="2">XSensor Header</td><td>seq_no</td><td>vref</td><td>pir</td><td>…</td><td rowspan="2">CRC</td></tr>
<tr><td colspan="4">MTS410 Payload</td></tr>
</table>

9.14.2 Data Fields

The MTS410 packet has the following fields:

Table 9-15 Data Payload contents of MDA100 Packet

Type	Data Fields	Description
uint16_t	**seq_no**	Sequence number
uint16_t	**vref**	Battery reading (also known as vref or voltage)
uint16_t	**pir**	Passive infrared magnitude over threshold
uint16_t	**humidity**	Humidity reading.
uint16_t	**cal_wrod[4]**	Pressure calibration words
uint16_t	**intersematemp**	This is the humidity and pressure sensor reading
uint16_t	**pressure**	This is the barometric pressure and temperature sensor reading.
uint16_t	**accelx**	Acceleration reading on the x –axis.
uint16_t	**accely**	Acceleration reading on the y –axis.
uint16_t	**taoch0**	Light sensor reading.

uint16_t	**taoch1**	Light sensor reading.
uint16_t	**audio**	Microphone reading
uint16_t	**adc5**	Analog to Digital Converter reading
uint16_t	**adc6**	Analog to Digital Converter reading

9.14.3 XML Packet Description

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE XServeConfig SYSTEM "./xserve_config.dtd">
<XServeConfig>
        <XFieldExtractor name="XMTS410 Multihop PK1 Config XML" order="3">
                <XFields>
                        <XField name="amtype" byteoffset="2" length="1" type="uint8"/>
                        <XField name="nodeid" byteoffset="7" length="2" type="uint16"
specialtype="nodeid"/>
                        <XField name="parent" byteoffset="14" length="2" type="uint16"
specialtype="parentid"/>
                        <XField name="group" byteoffset="3" length="1" type="uint8"/>
                        <XField name="board_id" byteoffset="12" length="1" type="uint8"
specialtype="boardid"/>
                        <XField name="packet_id" byteoffset="13" length="1" type="uint8"/>
                        <XField name="seqno" byteoffset="16" length="2" type="uint16"/>
                        <XField name="voltage" byteoffset="18" length="2" type="uint16">
                        <XField name="pir" byteoffset="20" length="2" type="uint16"/>
                        <XField name="humid" byteoffset="22" length="2" type="uint16"/>
                        <XField name="humtemp" byteoffset="24" length="2" type="uint16"/>
                        <XField name="calibW0" byteoffset="26" length="2" type="uint16"/>
                        <XField name="calibW1" byteoffset="28" length="2" type="uint16"/>
                        <XField name="calibW2" byteoffset="30" length="2" type="uint16"/>
                        <XField name="calibW3" byteoffset="32" length="2" type="uint16"/>
                        <XField name="prtemp" byteoffset="34" length="2" type="uint16"/>
                        <XField name="press" byteoffset="36" length="2" type="uint16"/>
                        <XField name="accel_x" byteoffset="38" length="2" type="uint16"/>
                        <XField name="accel_y" byteoffset="40" length="2" type="uint16"/>
                        <XField name="taosch0" byteoffset="42" length="2" type="uint16"/>
                        <XField name="taosch1" byteoffset="44" length="2" type="uint16"/>
                        <XField name="mic" byteoffset="46" length="2" type="uint16"/>
                        <XField name="adc5" byteoffset="48" length="2" type="uint16"/>
                        <XField name="adc6" byteoffset="50" length="2" type="uint16"/>
                        <XField name="light" byteoffset="42" length="2" type="uint16"/>
                </XFields>
                </XFilter>
                </XDataSinks>
        </XFieldExtractor>
```

```
</XServeConfig>
```

9.14.4 XML Output

```
<?xml version="1.0" ?><MotePacket>
<RawPacket>0x7E00337D2F00000000000033A2827E00000081016C00E0017F1AC8B258E1E89BAFB2596FCA49E101120289008C000000BC00A900</RawPacket>
<ParsedDataElement>
        <Name>amtype</Name>
        <RawValue>0x33</RawValue>
        <ConvertedValue>51</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>nodeid</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>parent</Name>
        <RawValue>0x7e</RawValue>
        <ConvertedValue>126</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>group</Name>
        <RawValue>0x7d</RawValue>
        <ConvertedValue>125</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>board_id</Name>
        <RawValue>0xa2</RawValue>
        <ConvertedValue>162</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>packet_id</Name>
        <RawValue>0x82</RawValue>
        <ConvertedValue>130</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>seqno</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
```

```
        <Name>voltage</Name>
        <RawValue>0x181</RawValue>
        <ConvertedValue>3252</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>pir</Name>
        <RawValue>0x6c</RawValue>
        <ConvertedValue>108</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>humid</Name>
        <RawValue>0x1e0</RawValue>
        <ConvertedValue>14</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>humtemp</Name>
        <RawValue>0x1a7f</RawValue>
        <ConvertedValue>28</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibW0</Name>
        <RawValue>0xb2c8</RawValue>
        <ConvertedValue>45768</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibW1</Name>
        <RawValue>0xe158</RawValue>
        <ConvertedValue>57688</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibW2</Name>
        <RawValue>0x9be8</RawValue>
        <ConvertedValue>39912</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibW3</Name>
        <RawValue>0xb2af</RawValue>
        <ConvertedValue>45743</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>prtemp</Name>
        <RawValue>0x6f59</RawValue>
        <ConvertedValue>27.754102</ConvertedValue>
```

```
</ParsedDataElement>
<ParsedDataElement>
        <Name>press</Name>
        <RawValue>0x49ca</RawValue>
        <ConvertedValue>998.325581</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>accel_x</Name>
        <RawValue>0x1e1</RawValue>
        <ConvertedValue>620.000000</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>accel_y</Name>
        <RawValue>0x212</RawValue>
        <ConvertedValue>1600.000000</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>taosch0</Name>
        <RawValue>0x89</RawValue>
        <ConvertedValue>137</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>taosch1</Name>
        <RawValue>0x8c</RawValue>
        <ConvertedValue>140</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>mic</Name>
        <RawValue>0x00</RawValue>
        <ConvertedValue>0</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc5</Name>
        <RawValue>0xbc</RawValue>
        <ConvertedValue>597.788973</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>adc6</Name>
        <RawValue>0xa9</RawValue>
        <ConvertedValue>537.374130</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
```

```
        <Name>light</Name>
        <RawValue>0x89</RawValue>
        <ConvertedValue>-0.354841</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB0</Name>
        <RawValue>0xc8</RawValue>
        <ConvertedValue>200</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB1</Name>
        <RawValue>0xb2</RawValue>
        <ConvertedValue>178</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB2</Name>
        <RawValue>0x58</RawValue>
        <ConvertedValue>88</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB3</Name>
        <RawValue>0xe1</RawValue>
        <ConvertedValue>225</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB4</Name>
        <RawValue>0xe8</RawValue>
        <ConvertedValue>232</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB5</Name>
        <RawValue>0x9b</RawValue>
        <ConvertedValue>155</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB6</Name>
        <RawValue>0xaf</RawValue>
        <ConvertedValue>175</ConvertedValue>
</ParsedDataElement>
<ParsedDataElement>
        <Name>calibB7</Name>
        <RawValue>0xb2</RawValue>
        <ConvertedValue>178</ConvertedValue>
```

```
</ParsedDataElement>
</MotePacket>
```

9.14.5 Print Raw

```
[2006/03/02 14:07:26] 7E 00 33 7D 2F 00 00 00 00 00 00 33 A2 82 7E 00 00 00 82 01 EE 01 AB 01 02
1A C8 B2 58 E1 E8 9B AF B2 3E 6E F1 49 CF 01 0C 02 CE 00 B7 0000 00 B0 00 9F 00  [52]
```

9.14.6 Print Parsed

```
[2006/03/02 14:07:26] MTS410 [sensor data converted to engineering units]:
   health:       node id = 0x00
   battery:              = 0x182
   humidity:             = 0x1ab%
   Temperature:          = 0x1a02
   IntersemaTemperature: = 0x6e3e
   IntersemaPressure:    = 0x49f1
   AccelX:               = 0x1cf
   AccelY:               = 0x20c
   mic: = 0x00
   pir: = 0x1ee
   adc chan5: = 0xb0
   adc chan6: = 0x9f
   light: = 0xce
```

9.14.7 Print Converted

```
[2006/03/02 14:07:26] MTS410 [sensor data converted to engineering units]:
   health:       node id = 0
   battery:              = 3244 mv
   humidity:             = 12%
   Temperature:          = 26 degC
   IntersemaTemperature: = 25.708984 degC
   IntersemaPressure:    = 998.443785 mbar
   AccelX:               = 260.000000 mg
   AccelY:               = 1480.000000 mg
   mic: = 0 ADC
   pir: = 494 ADC
   adc chan5: = 558.182406 mv
   adc chan6: = 504.267060 mv
   light: = 17.540429 lux
```

9.14.8 XMTS410 Logging Output

```
INSERT into mts410_results (result_time,nodeid,parent,voltage,pir,humid,humtemp,accel_x,
accel_y,prtemp,press,taosch0,taosch1,mic,adc5,adc6) values
(now(),0,126,386,516,426,6656,463,524,28223,18927,206,182,0,173,157)
```

10 Appendix C: Sensor Data Conversions

XServe can convert raw data into the System International (SI) units of measurements as well as other easy-to-read engineering units.

10.1 Converting Battery Reading for MICA2

The function, **`uint16_t xconvert_battery_mica2 (uint16_t vref)`** uses following calculation to convert MICA2 battery reading from raw vref ADC data to Engineering Units:

BV = RV × ADC_FS/data

where:

BV = Battery Voltage

ADC_FS = 1023

RV = Voltage Reference for mica2 (1.223 volts)

data = data from the adc measurement of channel 1

BV (volts) = 1252.352/data BV (mv) = 1252352/data

NOTE: The thermistor resistance to temperature conversion is highly non-linear.

10.1.1 Reference Implementation

```
{
  float      x   = (float)vref;
  uint16_t vdata =  (uint16_t) (125235 / x);
  return vdata;
}
```

10.1.2 XML Implementation

```
<XField name="voltage" byteoffset="16" length="2" type="uint16">
      <XConversion function="(1252352/x)" returntype="uint16">
            <XConvParam variablename="x" fieldname="voltage" type="float"/>
      </XConversion>
</XField>
```

10.2 Converting Battery Reading for MICA2DOT

The function, **`uint16_t xconvert_battery_dot (uint16_t vref)`** uses following calculation to convert MICA2DOT battery reading from raw ADC data to Engineering Units:

BV = RV × ADC_FS/data

where:

BV = Battery Voltage

ADC_FS = 1023

RV = Voltage Reference (0.6 volts)

data = data from the adc measurement of channel 1

BV (volts) = 614.4/data BV (mv) = 614400/data

NOTE: The battery voltage is returned as uint16 in millivolts (mV).

10.2.1 Reference Implementation

```
{
  float      x   = (float)vref;
  uint16_t vdata =  (uint16_t) (614400 / x); /*613800*/
  return vdata;
}
```

10.2.2 XML Implementation

```
<XField name="voltage" byteoffset="16" length="1" type="uint8">
      <XConversion function="(614400/x)" returntype="uint16">
            <XConvParam variablename="x" fieldname="voltage" type="float"/>
      </XConversion>
</XField>
```

10.3 Converting Thermistor Reading

The function, **`uint16_t xconvert_thermistor_resistance(uint16_t thermistor)`** uses following calculation to convert thermistor reading from raw ADC data to Engineering Units.

ADC = 1023 × Rthr/(R1+Rthr)

where:

R1 = 10K

Rthr = unknown thermistor resistance

Rthr = R1 × (ADC_FS-ADC/ADC)
and ADC_FS = 1023

The following properties exist:

- Thermistor is a temperature variable resistor.
- There is a 10k resistor in series with the thermistor resistor.
- The thermistor resistance to temperature conversion is highly non-linear.
- Returns the thermistor resistance as uint16 in unit (Ohms)

10.3.1 Reference Implementation

```
{
  float    adc   = (float)thermistor;
  uint16_t Rthr  = 10000 * (1023-adc) / adc;
  return Rthr;
}
```

10.3.2 XML Implementation

```
<XField name="tempR" byteoffset="17" length="2" type="uint16">
      <XConversion function="(10000*x / (1023-x))" returntype="uint16">
            <XConvParam variablename="x" fieldname="tempR" type="uint16"/>

      </XConversion>
</XField>
```

10.4 Converting Thermistor Reading in Celsius

The function, **`float xconvert_thermistor_temperature (uint16_t thermistor)`** converts the temperature reading from thermistor as floating in degrees Celsius.

10.4.1 Reference Implementation

```
{
  float temperature a, b, c, Rthr;
   a  = 0.001307050;
   b  = 0.000214381;
   c  = 0.000000093;
   Rthr = xconvert_thermistor_resistance (thermistor);

   temperature  = 1/(a+b*log(Rthr)+c*pow(log(Rthr),3));

   temperature -= 273.15; //Convert from Kelvin to Celcius

   //printf ("debug: a=%f b=%f Rt=%f temp=%f\n", a, b, c,
   Rt, temperature);


  return temperature;
}
```

10.4.2 XML Implementation

```
<XField name="temp" byteoffset="18" length="2" type="uint16">
      <XConversion function="((1/(.001307050 + 0.000214381 * log( (10000 *
(1023-x))/x   ) + 0.000000093 * (log( (10000 * (1023-x))/x )^3))) - 273.15)"
returntype="float">
            <XConvParam variablename="x" fieldname="temp" type="uint16"/>

      </XConversion>
</XField>
```

10.5 Converting Voltage of an ADC Channel

The function**, `uint32_t xconvert_adc_single (uint16_t adc_sing)`** uses following formula to compute the voltage of an ADC Channel using the reference voltage:

Convert 12 bit data to mV: Dynamic range is 0 to 2.5

voltage = (adc_data × 2500mV) / 4096

= (adc_data × 625mV) / 1024

NOTE: The final formula will minimize the fixed point bit shifting round off errors.

10.5.1 Reference Implementation

```
{
  uint32_t analog_mV = (625*(uint32_t)adc_sing)/1024;
  return analog_mV;
}
```

10.5.2 XML Implementation

```
<XField name="adc0" byteoffset="9" length="2" type="uint16">
      <XConversion function="x*625/1024" returntype="uint16">
            <XConvParam variablename="x" fieldname="adc0" type="float"/>

      </XConversion>
</XField>
```

10.6 Converting Voltage of an ADC Channel using Reference

The function**, `int32_t xconvert_adc_precision (uint16_t adc_prec)`** uses following formula to compute the voltage of an ADC Channel using the reference voltage:

Convert 12-bit data to uV: Dynamic range is ±12.5mV

voltage = 12500 × (adc_data/2048 -1)

= (5 × 625 × data/512) - 12500

= 5 × ((625 × data/512) - 2500)

NOTE: The final formula will minimize the fixed point bit shifting round off errors.

10.6.1 Reference Implementation

```
{
  int32_t analog_uV=5*(((625*(uint32_t)adc_prec)/512-2500);
  return analog_uV;
}
```

10.6.2 XML Implementation

```
<XField name="adc7" byteoffset="9" length="2" type="uint16">
      <XConversion function="5*((625*x/512)-2500)" returntype="uint16">
            <XConvParam variablename="x" fieldname="adc7" type="uint16"/>
      </XConversion>
</XField>
```

10.7 Converting Moisture Reading

The function, **`float xconvert_echo10 (uint16_t data)`** computes moisture reading to engineering units.

10.7.1 Reference Implementation

```
{
  float moisture = data*(1/11.5)-34;
  //float conv   = ((float) data)*2.5/4096;
  //float moisture = (100*(0.000936*(conv*1000)-0.376)+0.5);
  return moisture;
}
```

10.7.2 XML Implementation

```
<XField name="adc0" byteoffset="22" length="2" type="uint16">
      <XConversion function="x*(1/11.5) - 34" returntype="float">
            <XConvParam variablename="x" fieldname="adc0" type="float"/>
      </XConversion>
</XField>
```

10.8 Converting ADC Count of Accelerometer

The function, **`float xconvert_accel (uint16_t accel_raw)`** computes ADC count of accelerometer for the X-axis reading to engineering units.

10.8.1 Reference Implementation

```
    {
  uint16_t AccelData;

  uint16_t calib_neg_1g = 400;
  unit16_t calib_pos_1g = 500;

  float scale_factor;
  float reading;

  AccelData = accel_raw;

  scale_factor = (calib_pos1g –calib_neg1g)/2;
  reading = 1.0-(calib_pos_1g-AccelData)/scale_factor;
  reading = reading * 1000.0;
  return reading;
}
```

10.8.2 XML Implementation

```
<XField name="accel_x" byteoffset="24" length="2" type="uint16">
      <XConversion function="1000.0 * (1.0 - (500 - x)/((500 - 400)/2))"
returntype="float">
            <XConvParam variablename="x" fieldname="accel_x" type="uint16"/>
      </XConversion>
</XField>
```

10.9 Converting ADC Count of Thermistor

The function, **`float xconvert_sensirion_temp (XSensorSensirion * data)`** computes ADC count of thermistor reading to engineering units.

10.9.1 Reference Implementation

```
{
  float TempData, fTemp;

  TempData = (float)data->thermistor;
  fTemp = -38.4 + 0.0098 * TempData;


  return fTemp;
}
```

10.9.2 XML Implementation

```
<XField name="humtemp" byteoffset="13" length="2" type="uint16">
      <XConversion function="(-38.4 + 0.0098*x)" returntype="float">
            <XConvParam variablename="x" fieldname="humtemp" type="float"/>

      </XConversion>
</XField>
```

10.10 Converting ADC Count of Humidity

The function, **`float xconvert_sensirion_humidity (XSensorSensirion * data)`** computes ADC count of humidity senor reading to Engineering Units.

10.10.1 Reference Implementation

```
{
  float HumData = (float) data ->humidity;
  float fTemp   = xconvert_sensirion_temp (data);

  float fHumidity = -4.0+0.0405*HumData-0.00000028*HumData*HumData;
  fHumdity = (fTemp-25.0)*(0.01+0.000008*HumData)+fHumidity;

  return fHumidity;
}
```

10.10.2 XML Implementation

```
<XField name="humid" byteoffset="11" length="2" type="uint16">
      <XConversion function="(-38.4 + 0.0098*y - 25.0)*(0.01 + 0.00008 * x) -
4.0 + 0.0405 * x - 0.0000028 * x * x" returntype="float">
            <XConvParam variablename="x" fieldname="humid" type="float"/>
            <XConvParam variablename="y" fieldname="humtemp" type="float"/>

      </XConversion>
</XField>
```

10.11 Converting ADC Count of Barometric Pressure/Temperature

The function, **`float xconvert_intersema_pressure (XSensorIntersema * data, uint16_t * calibration)`** computes ADC count of Intersema MS5534A barometric pressure/temperature sensor reading to Engineering Units (mbar).

The Intersema MS5534A barometric pressure/temperature sensor includes the following properties:

- Six Calibration Coefficients (C1…C6) are extracted from four, 16 bits, word(s) from sensor.
- Temperature measurement: UT1=8*C5+20224 dT=data-UT1 Temp=(degC x10)=200+dT(C6+50)/1024
- Pressure measurement: OFF=C2*4 + ((C4-512)*dT)/1024 SENS=C1+(C3*dT)/1024 + 24576 X=(SENS*(PressureData-7168))/16384 - OFF Press(mbar)= X/32+250.

10.11.1 Reference Implementation

```
{
  float UT1, dT;
  float OFF, SNES,X,Press;
  uint16_t C1, C2, C3, C4, C5; //, C6; //intersema calibration coefficents

  uint16_t PressureData = data->pressure;
  uint16_t TempData = data->temp;

  C1 = calibration [0] >>1;
  C2 = ((calibration[2] & 0x3f) <<6) | (calibration & 0x3f);
  C3 = calibration[3] >>6;
  C4 = calibration[2] >>6;
  C5 = ((calibration[0]&1) <<10) | (calibration[1] >>6);
  //C6 = calibration[1] & 0x3f;

  UT1=8* (float) C5+20224;
  dT = (float)TempData-UT1;
  OFF = (float)C2*4+((float)C3*dT)/1024 + 24576;
  SENS = (SENS*((float)PressureData-7168.0))/16384 –OFF;
  Press = X/32.0 + 250.0;

  return Press;
}
```

10.11.2 XML Implementation

```
<XField name="press" byteoffset="32" length="2" type="uint16">
      <XConversion function="((((a &gt;&gt; 1)+(d &gt;&gt; 6)*(y-(8*(((a
&amp; 1) &lt;&lt; 10) | (b &gt;&gt; 6))+20224))/1024.0+24576)*(x-
7168.0))/16384 - ((((c &amp; 63) &lt;&lt; 6) | (d &amp; 63))*4 + ((c
&gt;&gt; 6)-512.0)*(y-(8*(((a &amp; 1) &lt;&lt; 10) | (b &gt;&gt;
6))+20224))/1024))/32.0 +250.0" returntype="float">
            <XConvParam variablename="x" fieldname="press" type="float"/>
            <XConvParam variablename="y" fieldname="prtemp" type="float"/>
            <XConvParam variablename="a" fieldname="calibW0" type="uint16"/>
            <XConvParam variablename="b" fieldname="calibW1" type="uint16"/>
            <XConvParam variablename="c" fieldname="calibW2" type="uint16"/>
            <XConvParam variablename="d" fieldname="calibW3" type="uint16"/>
      </XConversion>
</XField>
```

10.12 Intersema Temperature Conversion

This function computes ADC count of Intersema barometric pressure/temperature sensor reading to engineering units (deg C).

10.12.1 Reference Implementation

```
float
xconvert_intersema_temp (XSensorIntersema * data, uint16_t * calibration)
{
  float UT1, dT, Temp;
  uint16_t C5, C6; //intersema calibration coefficients

  uint16_t TempData = data->temp;

  C5 = ((calibration[0]&1) <<10) | (calibration[1] >>6);
  C6 = calibration[1] & 0x3f;

  UT1=8* (float) C5+20224;
  dT = (float)TempData-UT1;
  //temperature (degCx10)
  Temp – 200.0 + dT* ((float) C6+50.0)/1024.0;
  Temp /=10.0;

  return Temp;
}
```

10.12.2 XML Implementation

```
<XField name="prtemp" byteoffset="30" length="2" type="uint16">
      <XConversion function="(200.0+(x-(8*(((a &amp; 1) &lt;&lt; 10) | (b
&gt;&gt; 6))+20224))*((b &amp; 63)+50.0)/1024.0)/10.0" returntype="float">
            <XConvParam variablename="x" fieldname="prtemp" type="float"/>
            <XConvParam variablename="a" fieldname="calibW0" type="uint16"/>
            <XConvParam variablename="b" fieldname="calibW1" type="uint16"/>
      </XConversion>
</XField>
```

10.13 Davis Soil Temperature Conversion

This function returns soil temperature in engineering units (Celcius) from a raw ADC reading from a Davis probe.

10.13.1 Reference Implementation

```
float
xconvert_spectrum_soiltemp (uint16_t * data)
```

```
{
  uint8_t index = (uint8_t) data;
  float fTemp = SpectrumLookUpTable[index];

  return fTemp;
}
```

11 Appendix D: Health Packet Reference

11.1 Health Messages

Health packets are automatically transmitted from each Mote to the base station. These packets contain information about how well the Mote is performing in the mesh regarding radio traffic. Information such as battery voltage and parent's RSSI is also included. The packets are transmitted at a rate dependant on the **`ROUTE_UPDATE_INTERVAL`** parameter.

The base station will forward these packets along with other data packets to *XServe*.

11.1.1 *Packet Structure*

<table>
<tr><th>Bytes: 5</th><th>0/7</th><th>4</th><th>1</th><th>1</th><th>2</th><th>10</th><th>2</th></tr>
<tr><td rowspan="2">TinyOS Header</td><td rowspan="2">XMesh Header</td><td rowspan="2">XSensor Header</td><td>type_node</td><td>version</td><td>type</td><td>…</td><td rowspan="2">CRC</td></tr>
<tr><td colspan="5">Health Payload</td></tr>
</table>

11.1.2 *Header Packet*

There are two types of health packets in *XMesh*:

1. Statistics Health Packets
2. Neighbor Health Packets

The two health packets are transmitted sequentially (in an alternative fashion, one every health update interval) and use the same packet format. All Health packets have a similar header component which describes the information contained within the health packet:

Table 11-1 Data Fields in the Health Packet

Data Fields	Data Fields	Description
uint8_t	**type_node**	This is for backward compatibility. The value of the first 4 bits for XMesh2 will always be 0xF. Any other value means this is an XMesh1 health packet.
uint8_t	**version**	This is the health packet version number. In XMesh2 the version number is 0x20
uint16_t	**type**	The value of this field indicates if the packet is a statistics packet or a neighbor packet. Statistic packets have a type of 0x01 and neighbor packets have a type of 0x02

11.1.3 Data Packet – Statistics Health Packet

Statistical health packets contain statistical information about the packets being sent through the particular node. The following types of data are sent in this type of packet:

- Accumulating packet counter (`num_node_packets`, `num_fwd_pkts`, `num_drop_pkts`, `num_rexmits`) represent statistical information on packet transmissions from the node gathered since boot time.
- Instantaneous power information such current voltage readings and accumulated power usage in low power.
- Current parent id and information such as link quality and rssi value.

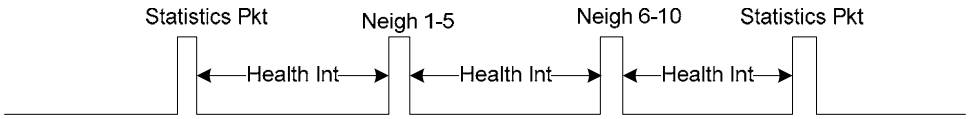
The statistics health packet fields are provided in Table 11-2.

Table 11-2 Data Fields in the Statistics Health Packet

Type	Data Fields	Description	
uint16_t	**seq_num**	This is the sequence number of the health packet.	
uint16_t	**num_node_pkts**	Number of application packets that have been generated locally.	
uint16_t	**num_fwd_pkts**	Number of radio packets that the mote has forwarded in the mesh.	
uint16_t	**num_drop_pkts**	Number of radio packets that the mote has dropped due to failed link level retransmissions.	
uint16_t	**num_rexmits**	This is the number of times that the message was re-transmitted.	
uint8_t	**battery_voltage**	Battery reading.	
uint16_t	**power_sum**	Power statistics for the low power radio stack (not used)	
uint8_t	**rsvd_app_type**	Reserved Crossbow field for identifying sending application.	
hn_quality	**nodeinfo**	A record containing information about the link to the present parent	
		uint16_t **node_id**	Parent's ID
		uint8_t **link_quality**	Link quality to parent (high 4 bits send quality and low 4 bits receive quality).
		uint8_t **hop_count**	The number of hops the parent is from the base station
		uint8_t **radio_link_indicator**	The rssi or lqi value of the parent

11.1.4 Data Packet – Neighbor Health Packet

The Neighbor health contains information about the Mote's neighborhood and radio link quality to these motes. Motes track up to sixteen neighbors. Health packets can only send back information on five neighbors at any one time. If the table contains more than five neighbors the information is contained in sequential neighbor packets. These are still alternated with the statistics packets. The diagram below shows the sequence of health packets for a mesh with 10 neighbors in the neighborhood list.



The format for the neighborhood health packets is provided in Table 11-3.

Table 11-3 Data Fields in the Neighborhood Health Packet

Type	Data Fields	Description
uint8_t	**type_node**	This field is in the Health header. The bottom 4 bits will contain the number of

Type	Data Fields	Description	
		neighbors sent in the packet.	
hn_quality	**nodeinfo**	Records containing information about the link quality of the neighbor. Each record consist of the following elements:	
		uint16_t **node_id**	Parent's ID
		uint8_t **link_quality**	Link quality normalized to 255 (100%). 100% indicates that both the parent and child hear 100% of each other's messages.
		uint8_t **hop_count**	Hop count
		uint8_t **radio_link_indicator**	The rssi or lqi value of the parent

Appendix D: Heartbeat Packet Reference

11.2 Heartbeat Messages

Heartbeat packets, when enable, are periodically transmitted by the base station to signal that it is still alive. For more details on the heartbeat packet, see the XMesh manual.

11.2.1 *Packet Structure*

Bytes: 5	**2**	**2**
TinyOS Header	Sequence number	CRC
	Heartbeat Payload	

11.2.2 Data Fields

The payload of the heartbeat packet is very simple; it only contains a sequence number.

Data Fields	Description
uint16_t **seq_no**	The new rate for the application

12 Appendix E: XCommand Packet Reference

12.1 *XCommand* Messages

MoteWorks sensor applications allow users to query state variables and actuate devices on the Mote such as LEDS, sounder, or relays. This feature is called *XCommand*. *XServe* provides two interfaces for enterprise applications to send commands to the Mote tier using *XCommand*. Users can send and receive *XCommand*s using *XServeTerm*, a terminal command application. Applications can send and receive *XCommand*s using an XML-RPC interface.

The *XCommand* allow you to *get*, *set*, or *reset* parameters for the sensor boards. The Table 12-1 shows the command categories and arguments:

Table 12-1. XCommand Categories and Descriptions

Command Category	Command	Arguments	Description
Power Management	RESET = 0x10 SLEEP = 0x11 WAKEUP = 0x12	N/A	To reset the sleep and wakeup time.
Basic Update Rate	SET_RATE = 0x20	**newrate**	To get or set the update rate. The set_rate command changes the data acquisition duty cycle of the mote. The first argument is the new timer interval in milliseconds.
Mote Configuration Parameter Settings	GET_CONFIG = 0x30 SET_NODEID = 0x31 SET_GROUP = 0x32 SET_RF_POWER = 0x33 SET_RF_CHANNEL = 0x34	N/A **nodeid** **group** **rf_power** **rf_channel**	This set of commands allows you to get and set radio frequency and power, including channel.
Actuation	ACTUATE = 0x40	**device** 0=LED_GREEN, 1=LED_YELLOW, 2=LED_RED, 3=LEDS_ALL, 4=SOUNDER, 5=RELAY1, 6=RELAY2, 7=RELAY3 **state** 0=OFF, 1=ON, 2=TOGGLE X=VALUE	The actuate command can control a given device to go into a particular state. This command can be used to actuate each individual LED with the option to operate on all three LEDs. This command can also be used to turn the sounder or a relay on or off.

Each command responds back with an acknowledgement to confirm that it has received the command. The only exceptions are actuation commands. They do not send an acknowledgement response.

12.2 *XCommand* Query

The following the *XCommand* query packet structure.

12.2.1 *Packet Structure*

Bytes: 5	**0/7**	**4**	**1**	**1**	**2**	**10**	**2**
TinyOS Header	XMesh Header	XSensor Header	type_node	version	type	…	CRC
			XCmd Query Payload				

12.2.2 Query Header

Data Fields	Description
uint16_t **cmdcode**	The operation code for the command
uint8_t **cmdKey**	The command key for mapping requests to responses

12.2.3 Data Fields

Depending on the command operation code one of the given fields will be in the data header.

Data Fields	Description
uint32_t **newrate**	The new rate for the application
uint16_t **nodeid**	The new node id
uint8_t **group**	The new group id
uint8_t **rf_power**	Radio Frequency Power reading.
uint8_t **rf_channel**	Radio Frequency channel reading.

actuate {
uint16_t **device**
uint16_t **state**
}
	The device to actuate and the state to set it to.

12.3 *XCommand* Response

The following packets are sent by the mote in response to an *XCommand*. These are data packet formats that are tied to the same command and are handled by the *XCommand* component for MICA2, MICAz, and MICA2DOT platforms.

The *XCommand* packet has the following standard response.

12.3.1 Response Header

The *XCommand* response packet has the following fields.

Type	Data Fields	Description
uint8_t	**responseCode**	The success or failure response
uint8_t	**commandKey**	The command key for mapping requests to responses

12.3.2 Data Fields

The *XCommand* response packet contains exactly one of the following payloads depending on the response code in the response header.

Type	Data Fields	Description
uint8_t	**uid[8]**	64-bit unique identifier for node
uint8_t	**nodeid**	Motes Node Id
uint8_t	**group**	Motes Group Id
uint8_t	**rf_power**	Radio Frequency Power reading.
uint8_t	**rf_channel**	Radio Frequency channel reading.

12.4 *XCommand* XML RPC Reference

Commands are issued to the motes using *XServe*'s XML RPC interface. The following is a complete listing of all *XCommand* methods and their corrisponding XML RPC.

12.4.1 XMesh XML RPC Commands

MethodName:

`xmesh.get_config`

Requests configuration information from a Mote.

Arguments:

Name	Description	Value Type
destAddress	The node id from which configuration information is requested.	<int>
groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the responding Mote.	<int>
groupId	The group id of the responding Mote.	<int>
rfPower	The radio power of the responding Mote.	<int>
rfChannel	The radio channel of the responding Mote.	<int>
uidString	The 64 bit unique identifies for the mote as a hexadecimal string	<string>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
```

```
<methodCall>
<methodName>xmesh.get_config</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>destAddress</name><value><int>0</int></value>
    </member>
    <member>
     <name>groupId</name><value><int>145</int></value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
```

```
     </value>
    </member>
    <member>
     <name>nodeId</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>125</int>
     </value>
    </member>
    <member>
     <name>rfPower</name>
     <value>
      <int>15</int>
     </value>
    </member>
    <member>
     <name>rfChannel</name>
     <value>
      <int>24</int>
     </value>
    </member>
    <member>
     <name>uidString</name>
     <value>
      <string>01301FED0A00007D</string>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

xmesh.set_rate

Sets the sampling rate of destination address' application.

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newRate	The new sampling rate for the node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the responding Mote.	<int>
rate	The sampling rate the node is set after the command	<int>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xmesh.set_rate</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
    <member>
     <name>newRate</name>
     <value>
      <int>100</int>
```

```
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
     </value>
    </member>
    <member>
     <name>nodeId</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
```

```
     <name>rate</name>
     <value>
      <int>100</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xmesh.set_nodeid`

Sets the node id of the destination address.

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newNodeId	The new node id for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the Mote after execution of the command	<int>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xmesh.set_nodeid</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
```

```
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
    <member>
     <name>newNodeId</name>
     <value>
      <int>0</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
```

```
      <string>Success</string>
     </value>
    </member>
    <member>
     <name>nodeId</name>
     <value>
      <int>0</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xmesh.set_groupid`

Sets the group id of the destination address.

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newGroupId	The new group id for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the responding Mote.	<int>
groupId	The group id of the Mote after executing the command	<int>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xmesh.set_groupid</methodName>
<params>
 <param>
  <value>
   <struct>
```

```
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
    <member>
     <name>newGroupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
```

```
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
     </value>
    </member>
    <member>
     <name>nodeId</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xmesh.set_rfchannel`

Sets the radio channel of destination address.

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newRfChannel	The new radio channel for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>

codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the responding Mote.	<int>
rfChannel	The radio channel after executing the command	<int>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xmesh.set_rfchannel</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
    <member>
     <name>newRfChannel</name>
     <value>
      <int>24</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
```

```
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
     </value>
    </member>
    <member>
     <name>nodeId</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>rfChannel</name>
     <value>
      <int>24</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xmesh.set_rfpower`

Sets the radio power of destination address.

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newRfPower	The new radio power for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the responding Mote.	<int>
rfPower	The radio power after executing the command	<int>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xmesh.set_rfpower</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
    <member>
     <name>newRfPower</name>
     <value>
```

```
      <int>15</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
     </value>
    </member>
    <member>
     <name>nodeId</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
```

```
     <name>rfPower</name>
     <value>
      <int>15</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xmesh.reset`

Resets the destination address.

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xmesh.reset</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
```

```
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xmesh.wake`

Directs the application to resume sampling data

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xmesh.wake</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
```

```
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xmesh.sleep`

Directs the application to stop sampling data

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>

groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xmesh.sleep</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
```

```
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xsensor.actuate`

Actuates a device on the Mote

Arguments:

Name	Description	Value Type
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
actDevice	The id of the device to actuate	<int>
actState	The state to set the specified device	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
```

```
<methodName>xmesh.actuate</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>destAddress</name>
     <value>
      <int>10</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
    <member>
     <name>actDevice</name>
     <value>
      <int>2</int>
     </value>
    </member>
    <member>
     <name>actState</name>
     <value>
      <int>0</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
```

```
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

12.4.2 XSensor XML RPC Commands

MethodName:

`xsensor.get_config`

Requests configuration information from a Mote.

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>

codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the responding Mote.	<int>
groupId	The group id of the XMesh network	<int>
rfPower	The radio power of the responding Mote.	<int>
rfChannel	The radio channel of the responding Mote.	<int>
uidString	The 64 bit unique identifier for the Mote	<int>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xsensor.get_config</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>destAddress</name><value><int>0</int></value>
    </member>
    <member>
     <name>groupId</name><value><int>145</int></value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
```

```
<member>
 <name>codeName</name>
 <value>
  <string>SUCCESS</string>
 </value>
</member>
<member>
 <name>codeDescription</name>
 <value>
  <string>Success</string>
 </value>
</member>
<member>
 <name>nodeId</name>
 <value>
  <int>0</int>
 </value>
</member>
<member>
 <name>groupId</name>
 <value>
  <int>125</int>
 </value>
</member>
<member>
 <name>rfPower</name>
 <value>
  <int>15</int>
 </value>
</member>
<member>
 <name>rfChannel</name>
 <value>
  <int>24</int>
 </value>
</member>
<member>
 <name>uidString</name>
 <value>
  <string>01301FED0A00007D</string>
```

```
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xsensor.set_rate`

Sets the sampling rate of destination address' application.

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newRate	The new sampling rate for the node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the responding Mote.	<int>
rate	The sampling rate the node is set after the command	<int>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xsensor.set_rate</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>seqNumber</name>
     <value>
      <int>102</int>
     </value>
```

```
    </member>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
    <member>
     <name>newRate</name>
     <value>
      <int>100</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
```

```
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
     </value>
    </member>
    <member>
     <name>nodeId</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>rate</name>
     <value>
      <int>100</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xsensor.set_nodeid`

Sets the node id of the destination address.

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newNodeId	The new node id for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the Mote after execution of the command	<int>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xsensor.set_nodeid</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>seqNumber</name>
     <value>
      <int>103</int>
     </value>
    </member>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
    <member>
     <name>newNodeId</name>
     <value>
      <int>0</int>
     </value>
    </member>
   </struct>
  </value>
```

```
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
     </value>
    </member>
    <member>
     <name>nodeId</name>
     <value>
      <int>0</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xsensor.set_groupid`

Sets the group id of destination address.

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newGroupId	The new group id for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the Mote after execution of the command	<int>
groupId	The group id of the Mote after executing the command	<int>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xsensor.set_groupid</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>seqNumber</name>
     <value>
      <int>104</int>
     </value>
    </member>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
```

```
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
    <member>
     <name>newGroupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
```

```
      <string>Success</string>
     </value>
    </member>
    <member>
     <name>nodeId</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xsensor.set_rfchannel`

Sets the radio channel of destination address.

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newRfChannel	The new radio channel for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the Mote after execution of the command	<int>
rfChannel	The radio channel after executing the command	<int>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xsensor.set_rfchannel</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>seqNumber</name>
     <value>
      <int>105</int>
     </value>
    </member>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
    <member>
     <name>newRfChannel</name>
     <value>
      <int>24</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
```

```
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
     </value>
    </member>
    <member>
     <name>nodeId</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>rfChannel</name>
     <value>
      <int>24</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xsensor.set_rfpower`

Sets the radio power of destination address.

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
newRfPower	The new radio power for this node	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>
nodeId	The node id of the Mote after execution of the command	<int>
rfPower	The radio power after executing the command	<int>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xsensor.set_rfpower</methodName>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>seqNumber</name>
     <value>
      <int>106</int>
     </value>
    </member>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
```

```
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
    <member>
     <name>newRfPower</name>
     <value>
      <int>15</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
```

```
     </value>
    </member>
    <member>
     <name>nodeId</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>rfPower</name>
     <value>
      <int>15</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xsensor.reset`

Resets the destination address.

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xsensor.reset</methodName>
```

```
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>seqNumber</name>
     <value>
      <int>108</int>
     </value>
    </member>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
</methodCall>
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
```

```
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xsensor.wake`

Directs the application to resume sampling data

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xsensor.wake</methodName>
<params>
```

```
 <param>
  <value>
   <struct>
    <member>
     <name>seqNumber</name>
     <value>
      <int>108</int>
     </value>
    </member>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
```

```
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xsensor.sleep`

Directs the application to stop sampling data.

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xsensor.sleep</methodName>
<params>
 <param>
  <value>
   <struct>
```

```
    <member>
     <name>seqNumber</name>
     <value>
      <int>108</int>
     </value>
    </member>
    <member>
     <name>destAddress</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
```

```
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

MethodName:

`xsensor.actuate`

Actuates a device on the Mote

Arguments:

Name	Description	Value Type
seqNumber	The unique sequence number for the command	<int>
destAddress	The node id to which the command is sent	<int>
groupId	The group id of the XMesh network	<int>
actDevice	The id of the device to actuate	<int>
actState	The state to set the specified device	<int>

Response:

Name	Description	Value Type
codeNumber	The response code	<int>
codeName	The name of the response	<string>
codeDescription	A text description of the response code	<string>

Request XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodCall>
<methodName>xsensor.actuate</methodName>
<params>
 <param>
  <value>
   <struct>
```

```
    <member>
     <name>seqNumber</name>
     <value>
      <int>100</int>
     </value>
    </member>
    <member>
     <name>destAddress</name>
     <value>
      <int>10</int>
     </value>
    </member>
    <member>
     <name>groupId</name>
     <value>
      <int>145</int>
     </value>
    </member>
    <member>
     <name>actDevice</name>
     <value>
      <int>2</int>
     </value>
    </member>
    <member>
     <name>actState</name>
     <value>
      <int>0</int>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodCall>
```

Response XML:

```
<?xml version="1.0" encoding="UTF-8"?>
<methodResponse>
<params>
 <param>
```

```
  <value>
   <struct>
    <member>
     <name>codeNumber</name>
     <value>
      <int>0</int>
     </value>
    </member>
    <member>
     <name>codeName</name>
     <value>
      <string>SUCCESS</string>
     </value>
    </member>
    <member>
     <name>codeDescription</name>
     <value>
      <string>Success</string>
     </value>
    </member>
   </struct>
  </value>
 </param>
</params>
</methodResponse>
```

12.4.3 XServe XML RPC Commands

MethodName:

`xserve.shutdown`

Shuts down the *XServe* server it is connected to.

Arguments:

No Arguements

Response:

No Response

Request XML:

```
 <?xml version="1.0" encoding="UTF-8"?>
<methodCall>
```

```
<methodName>xserve.shutdown</methodName>
<params/>
</methodCall>
```

13 Appendix F: Connection Protocols

XServe is capable of connecting to the Mote Tier through a variety of mechanisms. *XServe* also provides a set of protocols for applications wishing to communicate with *XServe* directly or communicate with the Mote Tier through *XServe*.

The base station Mote communicates using a Serial Framer Protocol. The Serial Framer protocol is a framing protocol designed to allow the base station to communicate reliably over the UART. Any application communicating directly with the base station mote must use the Serial Framer protocol.

Since UART communication is allows only a single application to communicate with the base station, applications connected to the UART can provide a Serial Forwarder protocol which allows multiple applications to connect to the base station through socket connections to the Serial Forwarder application. When connecting to a Serial Forwarder, serial forwarding applications can unframe packets from the mote, or can keep them framed before forwarding them on (such as with the MIB600). *XServe* can connect to both framed Serial Forwarding applications and unframed serial forwarding applications.

XServe provides an unframed serial forwarding protocol for applications wishing to use *XServe* as a Serial Forwarder.

13.1 Serial Framer Protocol

To ensure that the byte stream over the UART is reliable, the Mote utilizes the Serial Framer protocol. The protocol is a framer protocol adding a special byte to the beginning and end of each packet to indicate the beginning and end of the packet. This special byte is called the SYNC_BYTE. To guarantee that the SYNC_BYTES are unique, if the applications data contains this special framing byte it is modified slightly in a process called "*byte stuffing*". Byte stuffing tags the byte as modified and then modifies the framing byte in the data by changing it in a reversible manner. The receiving application can then recognize the modified bytes in the data and revert them back to their correct value. In addition to framing the packet the Serial Framer protocol provides the following services:

- **Integrity check via CRC:** The Serial Framer protocol provides a 2 byte CRC check at the end of each message packet. This allows receiving applications to verify if the packet was corrupted during transmission over the UART line.
- **Optional packet Acknowledgement (ACK) parameters:** Applications can optionally request reliability services on a packet by packet basis. Each packet contains a type which indicates whether the sending application requires an explicit acknowledgment packet sent by the receiving application. Of course the cost of the extra ACK packet is reduced throughput over the UART.

13.1.1 Packet Format

The data packets are framed (at the start and end) by 0x7e (SYNC_BYTE) bytes. Each packet has the form: `<packet type><data bytes 1…n><16-bit CRC>`

Sync	Type	Data	Data	CRC	Sync
0x7E	0x42	TOS_Msg_Header	Payload	0xAFE2	0x7E

- **Sync:** Each packet is framed on either end by a SYNC_BYTE. The value of the SYNC_BYTE is 0x7E.
- **Type:** The type field indicates the type of packet sent. There are five packet frame types:
  - `P_PACKET_NO_ACK = 0x42`: A user-packet with no acknowledgement required.
  - `P_PACKET_ACK = 0x41`: A user-packet that requires acknowledgement.
  - `P_ACK = 0x40`: Required response for `P_PACKET_ACK` packet.
  - `P_UNKNOWN`: Unknown packet type received. Requires response of type `P_UNKNOWN`.
- **Data:** This is the packet payload. If the packet payload contains the special SYNC_BYTE, it is escaped out. The escaping algorithm is described below.
- **CRC:** The 2-byte CRC is a redundancy check on the packet type and the data bytes. It is used by the receiving application to verify the packet is not been corrupted during transport. The CRC calculation includes the type byte through the end of the data payload.

If the SYNC_BYTE is sent in data portion of the application it would confuse the receiving application by making prematurely end the packet. To avoid this, if a SYNC_BYTE is in the data portion of the packet, the byte is escaped out. Escape bytes are:

- Proceeded with 0x7d (ESC_BYTE), then the byte value X0R (exclusive or) with 0x20. For example, 0x7e is converted to 0x7d5e.
- 0x7d and 0x7e bytes must be escaped.
- 0x00 to 0x1f and 0x80 to 0x9f can be optionally escaped.

13.2 Serial Forwarder Protocol

XServe can both connect to a Serial Forwarding application and provides a Serial Forwarding interface for applications wishing to connect to the Mote Tier through a Serial Forwarder. *XServe* is cabable of connecting to a Serial Forwarder sending unframed packets or framed packets. Framed packets contain data which is still in the Serial Framer format and requires *XServe* to unframe it.

For applications connecting to XServe through the Serial Forwarder interface, the protocol contains two parts:

- **Connection Protocol**: The connection protocol defines how an application can connect to the Serial Forwarder port.
- **Packet Protocol:** The packet protocol defines the packet format.

13.2.1 Connection Protocol

When connecting to a Serial Forwarder, the initial connection phase requires a simple protocol version check. Both applictions send their version information, and then choose the minimum version between the version received and the version they sent. XServe runs version two of the protocol and is backward compatible with version one.

Protocol is as follows:

1. On connection open send 2 bytes: 'T' and '`<version>`'. The two available versions are 0x20 (character value: ' ') and 0x21 (character value: '`!`').
2. If the received version is 0x20 then the protocol is version one and the initiation ends.
3. Otherwise if the version is 0x21, then send 4 bytes representing the platform of the connected mote.

13.2.2 Packet Format

The Serial Forwarder protocol is simpler than the Serial Framer because TCP/IP provides a reliable link layer. Each packet has the form: <length><data payload><16-bit CRC>

Length	**Data**	**Data**	**CRC**
0x2D	TOS_Msg_Header	Payload	0x23D4

The first byte is the length of the remaining data payload. The Data portion contains the packet data.

14 Appendix G: Database Administration

14.1 PostgreSQL

> **NOTE:** To use the command line interface for *PostgreSQL* you **must** have the *Cygwin* shell installed on your PC. Instructions for installing *Cygwin* from TinyOS InstallShield Wizard are detailed in the *MoteWorks Getting Started Guide*.

PostgreSQL is an advanced relational database system that is provided with the *Cygwin* on the PC and is available on the Stargate. The database tables that *MoteView* accesses can be manipulated directly by advanced users. To access the *PostgreSQL* database, from a *Cygwin* shell type

`psql –h localhost –U tele task`

Below is an example of what you should get as a response to that command:

```
$ psql -h localhost -U tele task
Welcome to psql 7.4.5, the PostgreSQL interactive terminal.


Type:  \copyright for distribution terms
       \h for help with SQL commands
       \? for help on internal slash commands
       \g or terminate with semicolon to execute query
       \q to quit


task=#
```

14.2 SQL

SQL is the generic command language used to manipulate databases such as *PostgreSQL*. SQL commands can be typed in directly from the *PostgreSQL* command shell. A list of common and useful commands follows:

14.2.1 Display all readings

Type

`select * from <tablename>;`

The `select` statement will display results out `from` the given `<tablename>`. The `*` character is a wildcard meaning that all columns should be displayed.

```
task=# select * from surge_results;
        result_time         | epoch | nodeid | parent | light | temp | voltage | mag_x
| mag_y | accel_x | accel_y
----------------------------+-------+--------+--------+-------+------+---------+------
-+-------+---------+---------
 2004-07-12 12:47:54.29425  |   757 |      4 |      0 |   182 |  135 |     229 |   255
|   255 |     200 |     200
 2004-07-12 12:48:02.26325  |   758 |      4 |      0 |   181 |  135 |     229 |   252
|   252 |     200 |     200
```

14.2.2 Display subset of readings

```
task=# select result_time,temp,light from surge_results where nodeid=1;
        result_time         | temp | light
----------------------------+------+-------
 2004-07-12 12:48:07.31025  |  136 |   234
 2004-07-12 12:48:15.29325  |  136 |   232
```

14.2.3 Rename a table

Type **ALTER TABLE <*tablename*> RENAME TO <*newname*>;**

14.2.4 Delete all readings from table

Type **DELETE FROM <*tablename*>;**

14.2.5 Deleting specific readings from table

- To delete all results before the specified date, type

DELETE FROM <tablename> WHERE result_time < '2004-11-20';

- To delete all results with ADC voltage reading greater than 400.

DELETE FROM <tablename> WHERE voltage > 400;

- To delete all results from node number 3.

DELETE FROM <tablename> WHERE nodeid = 3;

14.2.6 Delete table entirely

Type **DROP TABLE <tablename>;**

14.3 Database Tools

PostgreSQL comes with other tools for offline manipulation of data besides the psql shell. The more useful of these are described here. These windows command prompt version of these tools are installed to ***C:\Program Files\PostgreSQL\8.0.0-rc1\bin*** by default. The *psql* tool is available from the *Cygwin* command prompt as well.

14.3.1 PostgreSQL Export

To output entire task database to a file, e.g., **my_database.out**.

```
pg_dump –h localhost –U tele –f my_database.out task
```

To save contents of `surge_results` table to a file of SQL commands named `surge.out`:

```
pg_dump –h localhost –U tele –t surge_results –f surge.out task
```

14.3.2 PostgreSQL Inport

To load files from a PostgreSQL exported table, use the following command:

```
psql task < surge.out
```

15 Appendix H: XServe Simulator

15.1 Data Simulation

XServe provides a tool to simulate both upstream data from the Mote Tier and downstream data from an application. The simulation tool is useful for testing new parsers and datasinks in the system. It can also be useful for off-line replay of collected data. The simulation data can be loaded from a file or from a database table.

Below is a list of the available commands:

```
Usage: xsim <-?> -file=filename <-rate=packrate> <-cycle> [-
upstream=port|downstream=host:port] <-debug=dgblevel>
   -?         = display help [help]
   -file      = sim file to load
   -dbsim     = sim database config file to load
   -begin     = sim database time(begin=2005-10-01) only for database
   -rate      = packet delivery rate (default=2000ms)[ms]
   -cycle     = cycle to top when eof reached (default=off)
   -upstream  = upstream simulation. define connection port for xserve
                (default=9001)
   -downstream = downstream simulation. define connection host and port into xserve
                 (default=localhost:9001)
   -debug     = debug level (default=XDBG_WARNING)
   -dbserver  = database server name (default=localhost)
   -dbport    = database server port number (default=5432)
   -dbname    = database name (default=MoteView db)
   -dbuser    = database user (default=MoteView user)
   -dbpasswd  = database user password (default=MoteView user password)
```

15.1.1 Command Line Parameters

`-rate`

This is the rate at which the data will be generated for simulation.

`-cycle`

This indicates whether the simulator should automatically restart to the beginning of the simulation after it is finished. The default value is to stop after the current simulation run has completed.

`-upstream=<portnum>`

This indicates the simulator should simulate an upstream connection from the Mote Tier. *XServe* connects to the simulator as if though connecting to a Serial Forwarder. The

<portnum> is the port on which the simulator should run. The default port is 9001. If neither upstream nor downstream is indicated the default behaviour is to run as if an upstream simulator.

-downstream=<hostname:portnum>

This indicates simulator should simulate a downstream connection from an enterprise application. The application connects to *XServe* as though the Serial Forwarder interface. The <hostname:portnum> are the host and port of the *XServe* applications serial forwarding port.

15.1.2 File Simulation Parameters

-file=<filename>

This indicates that the simulation information will come from a file. The file is composed of data packets in written in hexadecimal format. Each packet is on its own line. Simulation packets for existing MoteWorks applications are in the "*sim/simfile*" directory on the *XServe* install.

Below is an example file for the *XMesh* MEP 510 application:

```
7E00337D14000000000000004827E00070061D00146023F1B
7E00337D14000000000000004827E00080061D00148023D1B
7E00337D14000000000000004827E00090060CF0146023B1B
7E00337D14000000000000004827E000A0060CF0142023B1B
7E00337D14000000000000004827E000B0061D0013C023A1B
7E00337D14000000000000004827E000C0060CF013602381B
```

15.1.3 Database Simulation Parameters

-dbsim=<filename>

This indicates that the simulation information will come from a database. The packet is constructed using a simulation file. The simulation file uses a date bounded select statement to overwrite a data template with data from each column selected from the data base table.

Below is an example:

```
<SELECT_SQL>: [select * from mda100_results where( result_time > '%s')
limit 1]
<TIME_FIELD>: [result_time]
<DATA_TEMPLATE>:[7E0033911B0000000000000091817E007D01A102C803BE011301E0
00E200DC00]
<FIELD_DATA>:[name=nodeid,pos=7,type=uint16]
<FIELD_DATA>:[name=parent,pos=14,type=uint16]
<FIELD_DATA>:[name=voltage,pos=16,type=uint16]
<FIELD_DATA>:[name=temp,pos=18,type=uint16]
<FIELD_DATA>:[name=light,pos=20,type=uint16]
```

```
<FIELD_DATA>:[name=adc2,pos=22,type=uint16,default=0]
<FIELD_DATA>:[name=adc3,pos=24,type=uint16,default=1]
<FIELD_DATA>:[name=adc4,pos=26,type=uint16,default=2]
<FIELD_DATA>:[name=adc5,pos=28,type=uint16,default=3]
<FIELD_DATA>:[name=adc6,pos=30,type=uint16,default=4]
```

The select sql field indicates the select which needs to run to retrieve the data. In this case the bounded by a result_time. The data template is the packet template which gets filled by the field data columns. Each field data maps a column name to a position in the template and a type. The positions in the template are replaced by the value in the column.

-begin

When selecting data from a database table using the dbsim file, it is useful to limit the range of the rows used. This is done using the result time filter using the –begin flag. The begin flag only selects rows from before a given time.

-dbserver=<servername>

Set the PostgreSQL database server name. The default value is "`localhost`".

-dbport=<portnum>

Set the PostgreSQL database server port. The default value is 5432.

-dbname=<database name>

Set the PostgreSQL database name. The default value is the *MoteView* database.

-dbuser=<username>

Set the PostgreSQL database user name. The default is the *MoteView* database user name.

-dbpasswd=<password>

Set the PostgreSQL database user password. The default is the *MoteView* database user password.

16 Appendix I: Upgrading *XServe* Handlers to *XServe* Datasinks

16.1 Differences between previous versions of XServe and current XServe

In previous versions of *XServe* applications could extend *XServe*'s packet parsing and processing using *XServe* Handlers. Handlers are C based code modules which register callback functions for a particular AM Type. *XServe* would route the data to a particular handler based on the AM Type of the incoming packet. The handler would then be responsible for implementing any parsing and processing on the packet.

In the current release of *XServe* the parsing and processing have been separated to allow processing modules to be shared across multiple AM and packet types. This provides greater extensibility and reliability since components are only responsible for a particular function.

16.2 Upgrading *XServe* Handlers to *XServe* Datasinks

Crossbow recommends using the new Parser and Datasink architecture for *XServe*, but for users with existing Handlers we have provided a tutorial to upgrade a Handler into a Datasink. Under the current *XServe* architecture, data will be parsed by a Generic Legacy Parser which will create a DataRow with only one field in it. The field name will be "data" and it will be of special type LEGACY. The "data" field will contain the entire packet binary which is the same format the previous Handlers received data from *XServe*. With small modifications explained below it is possible to convert a Handler easily into an *XServe* Datasink.

16.2.1 Initialization

Preivously, handlers were initialized by inserting an initialize method in the `xpacket_initialize()` function. The initialization function was responsible for registering the Handler and executing any Handler specific initialization.

In the current XServe it is not longer necessary to add your function into the `xpacket_initialize()` fuction. Now all Datasink modules implement an `initialize_datasink()` method. This method can now contain your previous initialize function.

Previous Initialization:

```
void xpacket_initialize(){
    your_initialize();
}
XPacketHandler your_packet_handler ={
    AMTYPE_YOURS,
    "$Id: your_file.c,v 1.1 2006/01/03 07:43:44 mturon Exp $",
    your_print_parsed,
    your_print_cooked,
    your_export_parsed,
```

```
    your_export_cooked,
    your_log
};

void your_initialize() {
    xpacket_add_amtype(&your_packet_handler);
}
```

New Initialization:

```
void initialize_datasink(){
    your_initialize();
}

XStoreHandler your_store_handler = {
  "Your Datasink Legacy",
  "$Id: your_file.c,v 1.1 2006/01/06 20:35:42 rkapur Exp $",
  XDEFAULT_RANK,
  your_filter,
  your_datasink
};

void your_initialize (){
  xstore_register_handler(&your_store_handler);
}
```

16.2.2 Parsing and Processing

Under the new *XServe* users register an *XStoreHandler* instead of a *XPacketHandler*. The new *XStoreHandler* has a filtering and processing callback function. To upgrade the from a Handler to a Datasink, users need to convert the parsed DataRow resulting from the previously described Generic Legacy Parser into the raw binary data necessary for the previous Handler callbacks.

The filter function should, on the new Datasink, should check whether the DataRow has a "data" field of special type LEGACY. This indicates that the data was created from the Generic Legacy Parsers.

Below is an example of a new filter:

```
int your_filter(XDataRow* row, XServeParams* xparams){
  char* buffer;
  XDataElem* data = xdatarow_find_by_field(row,"data");
  if(!data) return 0;
  if(data->special_type != XDATAROW_LEGACY) return 0;
  buffer = (char*) data->parsed_value;
  if(buffer[XPACKET_TYPE] == AMTYPE_YOURS){
```

```
      return 1;
  }
return 0;
}
```

This code unpacks the "data" field, verifies it's of type LEGACY and then retrieves the raw packet data from the parsed_value field. It can then do a check on the data as was done in the previous Handler version.

The processing portion of the new Datasink should also unpack the data, and then based on the command line inputs call the previous Handler callback functions.

```
void your_datasink(XDataRow* row, XServeParams* xparams){
  char* buffer;
  XDataElem* data = xdatarow_find_by_field(row,"data");
  if(!data) return;
  buffer = (char*) data->parsed_value;
  if (xparams->flags.bits.display_parsed){
    your_print_parsed(buffer);
  }
  if(xparams->flags.bits.display_cooked){
    health_print_cooked(buffer);
  }
  if (xparams->flags.bits.export_parsed){
    your_export_parsed(buffer);
  }
  if(xparams->flags.bits.export_cooked){
    your_export_cooked(buffer);
  }
  if(xparams->flags.bits.log_cooked || xparams->flags.bits.log_parsed){
        your_log();
  }
}
```

Crossbow Technology, Inc.
4145 N. First Street
San Jose, CA 95134
Phone: 408.965.3300
Fax: 408.324.4840
Email: info@xbow.com