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INTEGRATED COMMUNICATION SPECIFICATION

for the

REDUCED SHIPS-CREW BY VIRTUAL PRESENCE (RSVP) ADVANCED TECHNOLOGY DEMONSTRATION (ATD)

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1 Introduction

This document describes data communication throughout the Reduced Ships-Crew by Virtual Presence (RSVP) system. A system diagram highlighting the communication interfaces is given in Figure 1. There are four classes of communication in the RSVP system.

- Access Point internal
- Remote station internal
- Wired network
- Wireless network

These four topics are discussed in turn in Section 2. Section numbers noted in Figure 1 refer to the figures in this document.

2 RSVP Interfaces

2.1 Access Point Internal

2.1.1 Access Point Control Processor to Access Point Controller Microprocessor Radio

2.1.1.1 APCP to APCM Radio Mechanical Interface

The APCP and APCM Radio are contained in separate housings that are connected by two electrical cables, one carrying signals, and the other supplying power from the APCP to the APCM.

The cable carrying signals connect to a standard DB9 null modem interface, L-COM part number DMA060MF. The cable is a fully populated straight-through cable, L-COM part number CS2N9MF-x. ("x" specifies the length in meters and is TBD.) The female end of the cable is attached at the APCP. The male end is attached at the APCM.

The cable carrying electrical power supplies +5 VDC to the APCM Radio, drawing on the APCP power supply. Cable specifications are TBD.

2.1.1.2 APCP to APCM Radio Electrical Interface

Pin assignments in the cable between APCP and APCM are given in Table 1.

APCP to APCM Radio messages consist of a string of up to 4096 bytes (including those added for "byte stuffing," as described below, each encoded as 11 bits transmitted in the following order:

- Start bit
- 8 data bits, least significant first
- Parity bit

- Stop bit

Table 1. Pin assignments in APCM to APCP cable

Female Connector		Male Connector	
Signal	**Pin**	**Pin**	**Signal**
DCD	1	4	DTR
RD	2	3	TD
TD	3	2	RD
DTR	4	1	DCD
DTR	4	6	DSR
SG	5	5	SG
DSR	6	4	DTR
RTS	7	8	CTS
CTS	8	7	RTS
No connection	9	9	No connection
Ground	Shield	Shield	Ground

All messages begin with two bytes whose content is the hexadecimal value 80FF and end with two bytes whose content is the hexadecimal value 80FE. Messages do not have an intrinsic length. A receiver locates the end of a message by scanning for the message trailer.

"Byte stuffing" is used to prevent a receiver from interpreting data in the message that happens to have the value 80FE as a message trailer. A sender adds a byte containing 80 immediately following every data byte whose value happens to be 80. A receiver removes a byte containing 80 whenever there are two consecutive 80s (N bytes when there are 2N consecutive 80s). If there are an odd number of consecutive 80s, either the last 80 is part of the trailer or an error has occurred. Table 2 gives examples of how a receiver interprets various inputs.

Table 2. Examples of Receiver Interpretation of Byte-Stuffed Inputs

Bytes received	Interpretation by receiver
80 80 80 80 FE	Data: 80 80 FE
80 80 80 80 80 FE	Data: 80 80; Trailer
80 80 80 80 80 XX (other than FE)	Error

2.1.1.3 APCP to APCM Radio Sequencing

APCP to APCM Radio comprises four elements, which are described in turn in the following subsections.

- Autonomy
- Initialization
- Sensor data acquisition
- Network management

2.1.1.3.1 Autonomy

An APCP will operate normally in the event that the APCM Radio is disconnected at either end of the cable, or loses power. An APCM Radio will maintain itself in an inactive state in the event that it is disconnected at either end of the cable.

2.1.1.3.2 Initialization

APCP to APCM Radio sequencing for initialization is illustrated in Figure 2.

The AP and the APCM will be powered up at the same time. The AP will use wall power and will provide power to the APCM.

Both processors begin to boot at power up. The states of the AP and APCM processors are independent and each must be aware of the others' state. One will boot faster than the other will, and operator, software signal, or error may reset the processors.

The following sequences define the various events/actions that take place from power on through cyclic communications.

1. **Establish Communication**

   Since the AP has no knowledge of the APCM's state, it will try to establish communications by issuing a "HELLO" message every TBD seconds. When the APCM detects this message it responds.

   If no response is received within TBD transmittals, the AP will issue an "APCM timeout" alert, indicating that the APCM is not functioning. The APCP remains in this state until a response is received.

   The APCM commands the APCM radio not to transmit or receive while Establish Communication is taking place.

2. **APCM Reset**

   Following the successful establishment of communications, the APCP commands a reset to the APCM. Upon receipt, the APCM executes built-in test (BIT), clears RAM, and reloads all ROM data values. The APCP responds with the BIT results.

   If no response is received within TBD seconds, the APCP issues an APCP Communications Timeout Alert and will attempt to re-establish communications.

If a non-zero status is received, the APCP determines the TBD sequence, based upon the value.

The APCM commands the APCM radio not to transmit or receive while APCM Reset is taking place.

3. **Parameter Download**

   Following a successful APCM reset, the APCP sends the "Initiate Parameter Download" message. Following this command, required as well as optional parameter blocks can be sent. Examples are the Operational Parameters, Valid Sensor IDs, and Data Package Descriptions. The APCM acknowledges each package.

   If no response is received within TBD seconds, the APCP issues an "APCP Communications Timeout" alert and attempts to re-establish communications.

   If a non-zero status is received, the APCP determines the TBD sequence, based upon the value.

   The Parameter Load sequence is terminated by the "End Parameter Load" message. The APCM responds with a zero status to indicate that all the required parameters have been loaded.

   If the response is nonzero, indicating that the APCM has not received all the required parameters, a TBD Alert is posted and no further sequencing occurs.

   The APCM commands the APCM radio not to transmit or receive while Parameter Download is taking place.

4. **Begin Radio XMIT/RCV**

   After Establish Communication, APCM Reset, and Parameter Download have been performed, both processors are ready to communicate with external sensors. The APCP issues the "Begin Radio XMIT/RCV" command to the APCM and the APCM responds with the state of the radio, following a TBD radio startup sequence.

2.1.1.3.3 Sensor Data Acquisition

APCP to APCM Radio sequencing for sensor data acquisition is illustrated in Figure 3.

The logic is TBD.

2.1.1.3.4 Network Management

APCP to APCM Radio sequencing for network management is illustrated in Figure 4.

The logic is TBD.

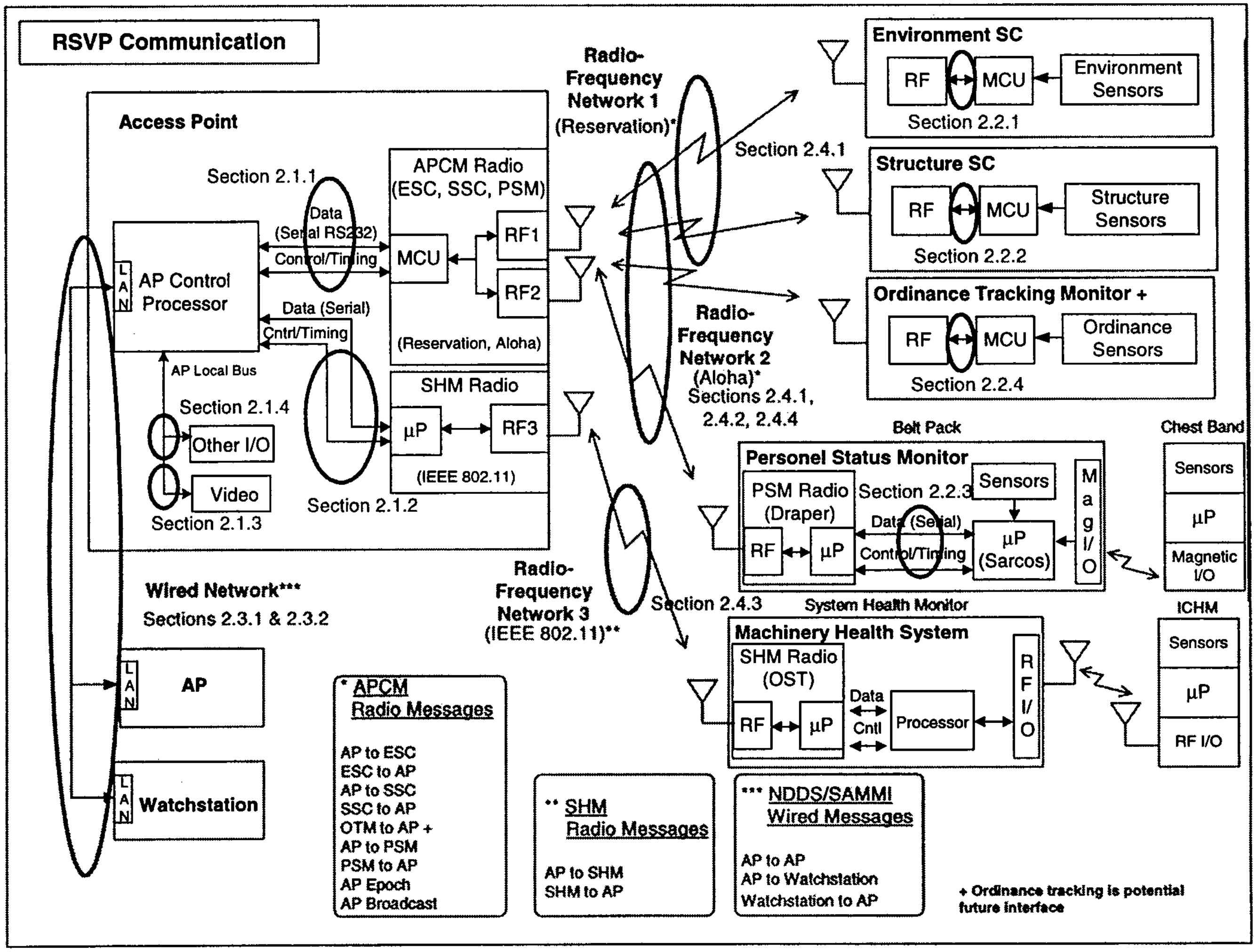

Figure 1. RSVP Communication System Architecture

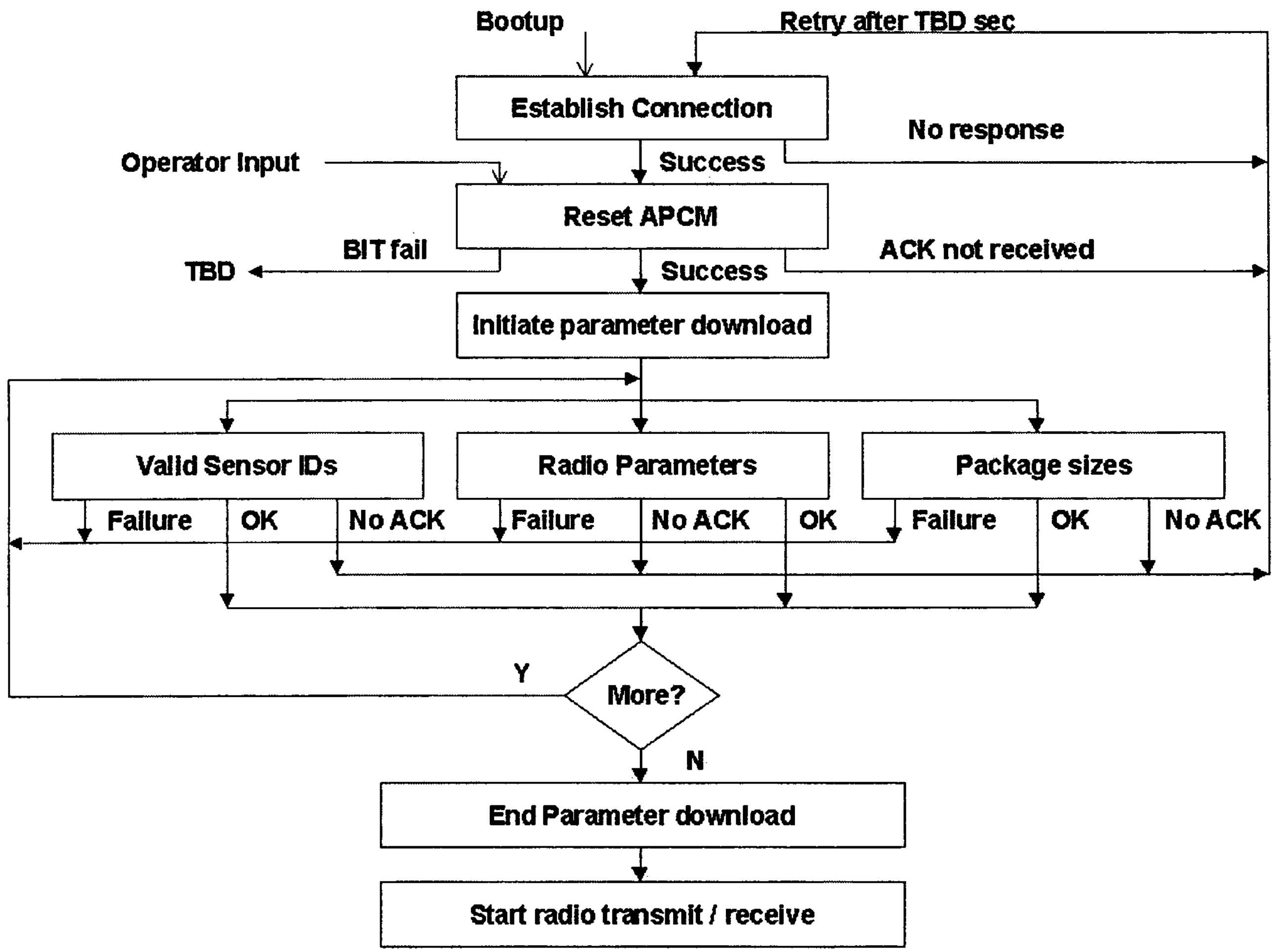

Figure 2. APCP to APCM Radio Initialization Sequencing

Figure is TBD

Figure 3. APCP to APCM Radio Sensor Data Acquisition Sequencing

Figure is TBD

Figure 4. APCP to APCM Radio Network Management Sequencing

2.1.1.4 APCP to APCM Radio Message Description

Table 3 summarizes the messages at the APCP to APCM Radio interface. The content of these messages is defined in individual tables in Appendix A.

Table 3. Messages at the APCP to APCM Radio Interface

Message	Source	Destination	Function	Trigger	Content
Hello	APCP	APCM	Command to transmit status	APCP determination	Table 25
Hello Acknowledge	APCM	APCP	Hello message received; no failure or request for service	Receipt of message	Table 26
Trouble	APCM	APCP	Hello command received; APCM has failed or requests service	Receipt of message	Table 27
Reset	APCP	APCM	Command to clear all data	Startup, reboot, power fail	Table 28
Reset Acknowledge	APCM	APCP	Reset command received	Receipt of message	Table 29
Authorized SCs	APCP	APCM	Specified SC(s) allowed to receive service	New SC(s) installed	Table 30
Authorized SCs Acknowledge	APCM	APCP	SC(s) will be granted access upon request	Receipt of Message	Table 31
Error Full Routing	APCM	APCP	Routing table full, can't add new SC	Receipt of Authorized SC or SCs message	Table 32
Frequency Setting	APCP	APCM	Command to use particular channels for communication (only valid immediately after Reset)	Reset	Table 33
Frequency Setting Acknowledge	APCM	APCP	Frequency Setting message received, will be honored	Receipt of message	Table 34

Message	Source	Destination	Function	Trigger	Content
Error – APCM Not Reset	APCM	APCP	Frequency Setting message received, but will not be honored due to APCM not being reset	Receipt of message	Table 35
Downlink	APCP	APCM	Command to send data to SC or PSM	Operator input at watchstation	Table 36
Downlink Acknowledge	APCM	APCP	Downlink message received, will be honored	Receipt of message	Table 37
Downlink Unknown	APCM	APCP	Downlink message received, but will not be honored because SC or PSM unknown	Receipt of message	Table 38
Downlink Size Error	APCM	APCP	Downlink message received, but will not be honored because message too large to fit in network management header	Receipt of message	Table 39
APCM Assignments	APCP	APCM	Identifies channels used by other APs in compartment	Subsequent to reset	Table 40
APCM Assignments Acknowledge	APCM	APCP	APCM Assignments message received, will be put into effect upon receipt of Frequency Setting message	Receipt of message	Table 41
Get Routing Table	APCP	APCM	Request for APCM routing table	APCP determination	Table 42
Routing Table	APCM	APCP	Data requested by Get Routing Table message	Receipt of message	Table 43

Message	Source	Destination	Function	Trigger	Content
Set Aging Threshold	APCP	APCM	Number of network management messages before a silent SC is considered dead	Following reset	Table 44
Aging Threshold Acknowledge	APCM	APCP	Set Aging Threshold message received, will be honored immediately	Receipt of message	Table 45
Set RSSI Threshold	APCP	APCM	Minimum RSSI that SC not already in network must meet to be admitted to network	Following reset	Table 46
RSI Threshold Acknowledge	APCM	APCP	Set RSSI Threshold message received, will be honored immediately	Receipt of message	Table 47
Routing Addition	APCM	APCP	Specified SC has been admitted to network	Event	Table 48
Routing Deletion	APCM	APCP	Specified SC has been deleted from network	Event	Table 49
Uplink	APCM	APCP	Data received from SC or PSM	Event	Table 50

2.1.2 Access Point Control Processor to System Health Monitor Radio

2.1.2.1 APCP to SHM Radio Mechanical Interface

The SHM Radio will be connected to the APCP via a PCI board. The mechanical interface will conform to the PCI Local Bus Standard[1].

2.1.2.2 APCP to SHM Radio Electrical Interface

The SHM Radio will be connected to the APCP via a PCI board. The electrical interface will conform to the PCI Local Bus Standard[1].

2.1.2.3 APCP to SHM Radio Sequencing

An APCP will operate normally in the absence of an SHM Radio board. An APCM Radio will maintain itself in an inactive state in the absence of an SHM board.

2.1.2.4 APCP to SHM Radio Message Description

Table 4 summarizes the messages at the APCP to SHM Radio interface. The content of these messages is defined in individual tables in Appendix A.

Table 4. Messages at the APCP to SHM Radio Interface

Message	Source	Destination	Function	Trigger	Content
TBD					

2.1.3 Access Point Control Processor to Video

The video unit has two parts – One is the actual video camera and the other is a PC-card video controller. Both units are made by Videum and have been tested in FY99 demonstrations.

2.1.3.1 APCP to Video Mechanical Interface

The Camera unit is 8" x 6" x 6" and has connections for an external power supply, an SVID interface and an RCA plug for a twisted pair interface.

The video controller card is a PCI bus card, which is installed into the AP's backplane. It has external connections for both an RCA connector and an SVID connector.

2.1.3.2 APCP to Video Electrical Interface

The camera requires an external power source giving 13.5 VDC and 1 A. The camera is shipped with the power supply, which requires AC power. The camera has two interfaces to the controller:

- Twisted pair cable having RCA adapters at each end. This cable can be 100 feet long. Video data from the camera to the PC controller card is transferred over this interface, but not pan and tilt commands to the camera.
- SVID interface that provides video as well as commands to the camera.

The video controller interfaces to the processor's PCI bus and conforms to the PCI bus electrical standard.

2.1.3.3 APCP to Video Sequencing

The Camera and the APCP are independent devices. Either may be powered on at any time without the other being powered on. The AP software is able to detect the state of the camera by software resident on the controller card.

2.1.3.4 APCP to Video Message Description

The communications from APCP applications software to the interface controller is through a COTS API, which is made by Videum.

2.1.4 APCP to Other I/O

In a fully implemented system based on RSVP principles, the APCP could have interfaces to devices not included in the demonstrations. These might include

- Sensors wired directly to the AP
- Interface to wired networks, such as automotive or industrial buses

2.2 Remote Station Internal

2.2.1 Environment Sensor Cluster Microcontroller to Environment Sensor Cluster Radio

2.2.1.1 ESC MCU to ESC Radio Mechanical Interface

TBD

2.2.1.2 ESC MCU to ESC Radio Electrical Interface

The Environment Sensor Cluster MCU and Environment Sensor Cluster Radio both operate at 3.3V nominal, +/-10%. Radio power is controlled by the MCU. For digital signals, logic 0 is 0 V, and logic 1 is 3.3 V. Signals in the Sensor Cluster MCU/Radio interface are described in Table 5.

Table 5. Signals in Sensor Cluster MCU to Sensor Cluster Radio Interface

Signal Name	Description	Source	Destination
RFDATAOUT	serial data	Radio	MCU
RSSI	Analog RF level	Radio	MCU
RFDATAIN	serial data	MCU	Radio
RF_SYN_CLK	clock to strobe input to radio synthesizer	MCU	Radio
RF_SYN_DATA	serial data input to radio synthesizer	MCU	Radio
RF_SYN_STB	counter load strobe to radio synthesizer	MCU	Radio
RF_RCV_ON	Receiver enable (logic 1 enables)	MCU	Radio
RF_XMIT_ON	Transmitter enable (logic 1 enables)	MCU	Radio
RF_ON	Radio enable (logic 1 enables)	MCU	Radio

2.2.1.3 ESC MCU to ESC Radio Sequencing

2.2.1.3.1 Initialization

The following is the sequence of events for RF transmission.

- Assert RF_RCV_ON and RF_ON
- Transfer 22 bits to synthesizer in radio to program it to operate at desired frequency
  - Shift out 11 bits on RF_SYN_DATA with RF_SYN_CLK
  - Assert RF_SYN_STB
  - Shift out 11 bits on RF_SYN_DATA with RF_SYN_CLK
  - Assert RF_SYN_STB
- Wait for oscillator to stabilize and lock to loop (5 ms maximum)
- De-assert RF_RCV_ON and assert RF_XMIT_ON
- Wait for transient to die out (100 μs maximum)
- Transfer serial data via RFDATAIN
- De-assert RF_ON and RF_XMIT_ON

The following is the sequence of events for RF reception.

- Assert RF_RCV_ON and RF_ON
- Wait for 100 μs
- Transfer 22 bits to synthesizer in radio to program it to operate at desired frequency
  - Shift out 11 bits on RF_SYN_DATA with RF_SYN_CLK
  - Assert RF_SYN_STB
  - Shift out 11 bits on RF_SYN_DATA with RF_SYN_CLK
  - Assert RF_SYN_STB
- Wait for oscillator to stabilize and lock to loop (5 ms maximum)
- Clear UART buffer of erroneous characters, if any (performed automatically by radio)
- Wait for transient to die out (100 μs maximum)
- Transfer serial data via RFDATAOUT
- De-assert RF_ON and RF_RCV_ON

2.2.1.3.2 Data Timing

Following initialization, the data transfer rate is 57,600 baud. Total message time must fit within 8 ms.

2.2.1.3.3 State Diagrams

Figure 5 through Figure 9 present state diagrams that define Sensor Cluster operation.

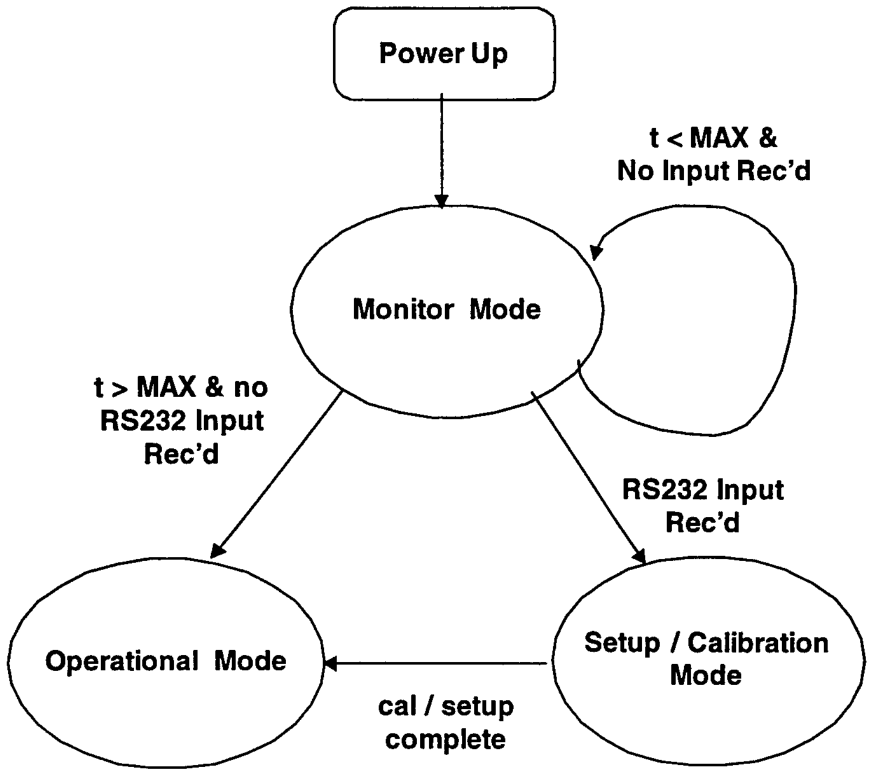

Figure 5. Sensor Cluster State Diagram, 1 of 5

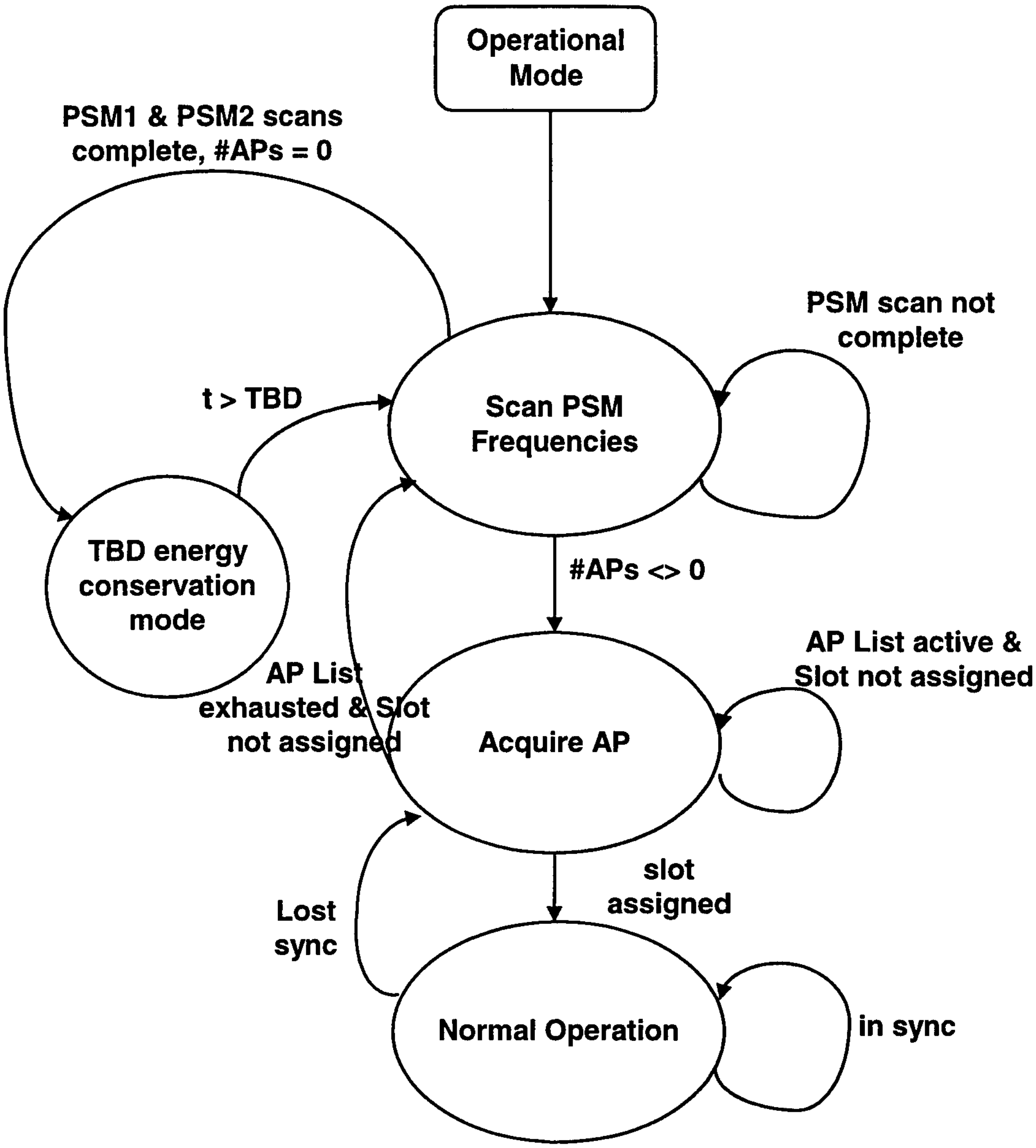

Figure 6. Sensor Cluster State Diagram, 2 of 5

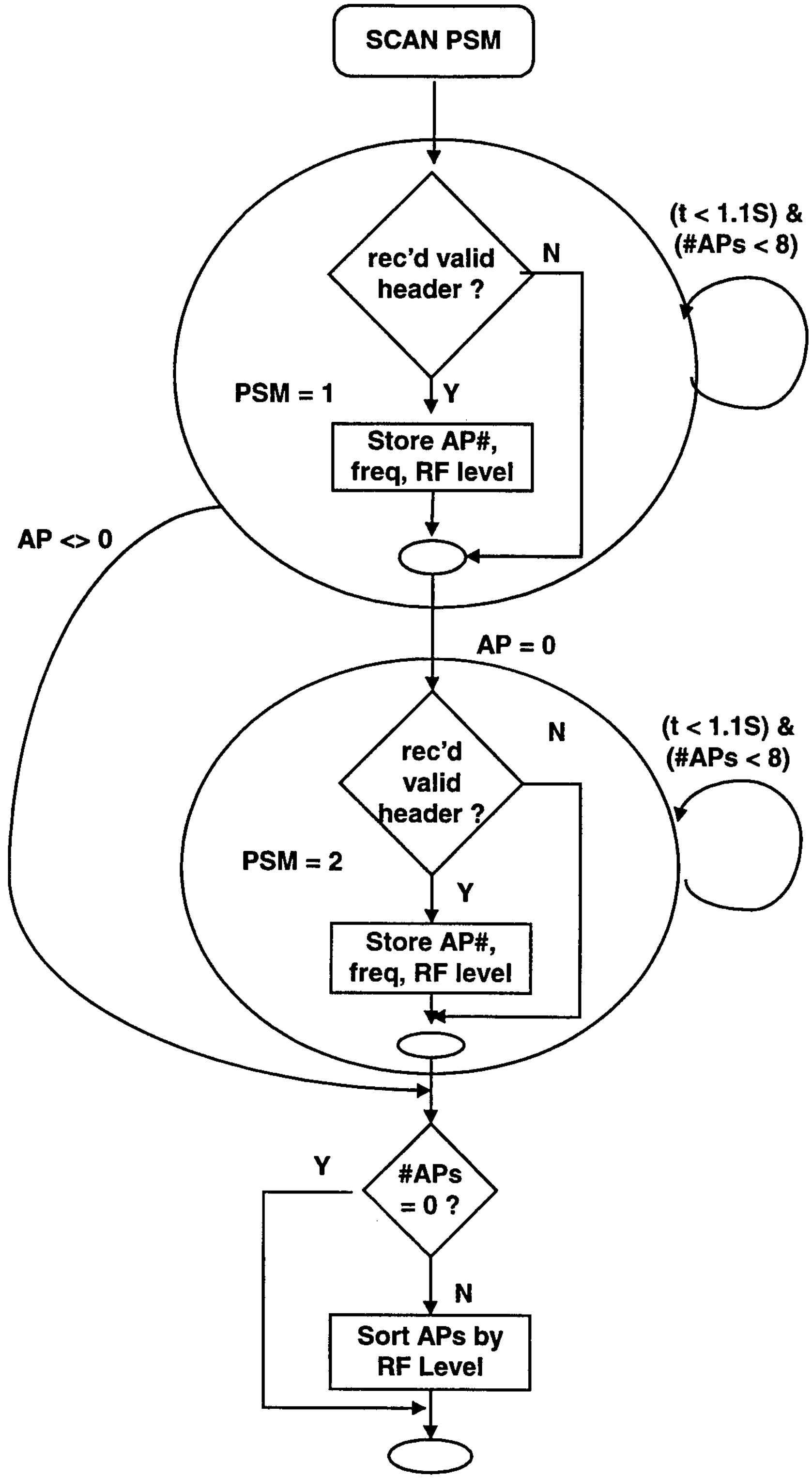

Figure 7. Sensor Cluster State Diagram, 3 of 5

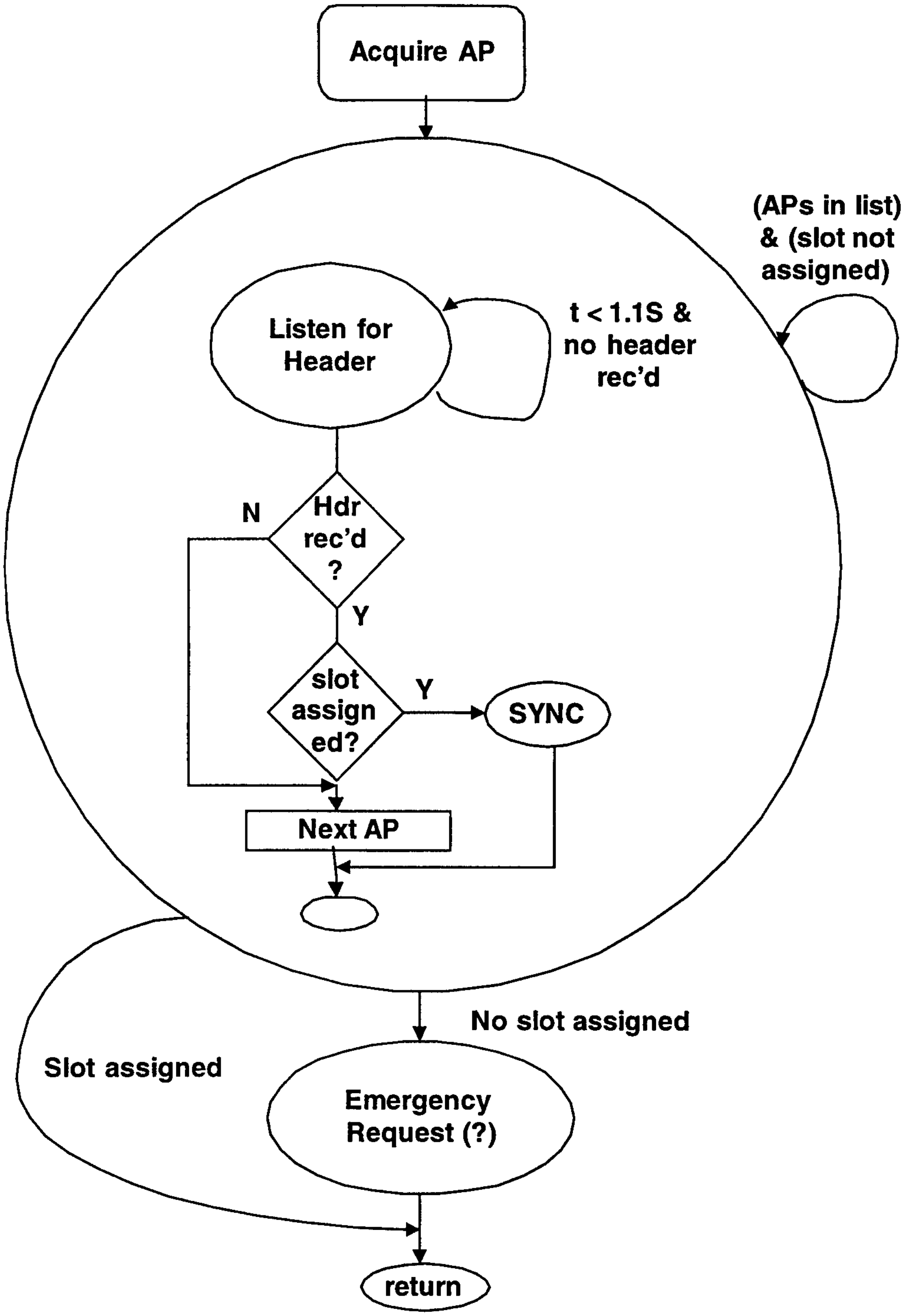

Figure 8. Sensor Cluster State Diagram, 4 of 5

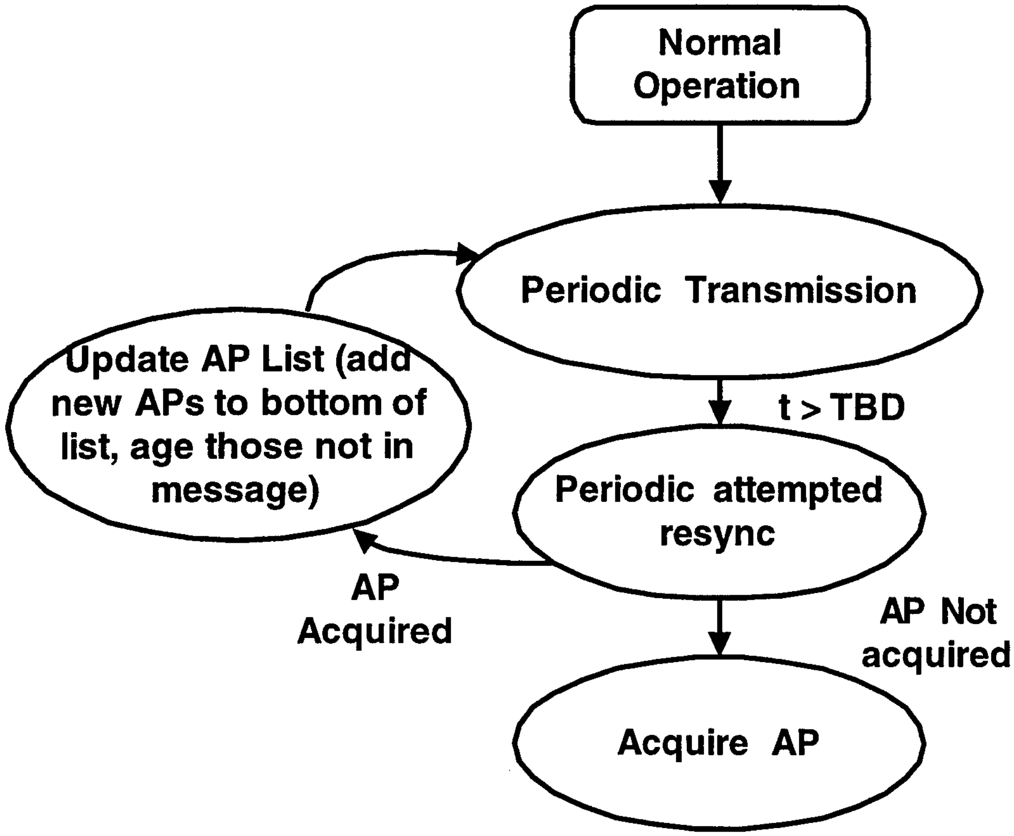

Figure 9. Sensor Cluster State Diagram, 5 of 5

2.2.1.4 ESC MCU to ESC Radio Message Description

ESC MCU to ESC Radio messages consist of a string of up to TBD bytes, each encoded as 11 bits transmitted in the following order:

- Start bit
- 8 data bits, least significant first
- Parity bit
- Stop bit

The interpretation of individual bytes is the same as for Access Point to Sensor Cluster communication, as described in section 2.4.1.4. The ESC Radio serves as a conduit between AP and ESC MCU.

2.2.1.4.1 Conversion of transmitted data to engineering units

Equation 1 is used to convert the transmitted value of RSSI to engineering units.

Equation 1

RSSI (dB) = (Transmitted value * (3.3 V / 256) –0.3 V) * (1 dB / 0.01625 V)

Equation 2 is used to convert the transmitted value from a linear temperature sensor to degrees Celsius.

Equation 2

$$T(°C) = 28\ mV * 25\ °C / ((\text{Transmitted value} * 3.3\ V / 256) - 0.25V)$$

Equation 3 is used to convert the transmitted value from a thermistor to degrees Kelvin.

Equation 3

$$T(°K) = 1 / ((1/T_0) - (\ln(R_0/(3.3\ V * R/ \text{Transmitted value}) - R) /\beta))$$

where

T_0 (temperature at which R_0 is measured) = 298° K

R_0 (nominal resistance) = 100,000 Ω

β(Beta) = 3750

R (for habitation-range thermistors) = 49,900 Ω

R (for wide-range thermistor) = 10,000 Ω

Equation 4 is used to convert the transmitted value for a threshold set point to degrees Kelvin.

Equation 4

$$T(°K) = 3.3\ V * R / (R_0/((\ 10^{(\beta*((1/T_0) - 1/\text{Transmitted value})))} + R)$$

where

T_0 (temperature at which R_0 is measured) = 298° K

R_0 (nominal resistance) = 100,000 Ω

β(Beta) = 3750

R (for habitation-range thermistors) = 49,900 Ω

R (for wide-range thermistor) = 10,000 Ω

Equation 5 is used to convert the transmitted value from a pressure sensor to pounds per square inch atmospheric (PSIA).

Equation 5

P(PSIA) = Transmitted value * (3.3 V / 256) * (1 PSIA / 0.06V)

Sound is measured with respect to ambient noise. Adjustable gain allows interrupt level to change dynamically with environment. Equation 6 is used to convert the transmitted value for microphone gain to actual gain. (A small gain represents a large volume over ambient, and vice versa.) Equation 7 is used to convert gain to dB.

Equation 6

$\text{Gain} = 0.1 * 2^{\text{Transmitted value}}$

Equation 7

TBD

Equation 8 is used to convert the transmitted value from an oxygen sensor to O_2 concentration in percent.

Equation 8

O_2(%) = Transmitted value * 20.9% / Calibration Value at 20.9%

Equation 9 is used to convert the transmitted value from a carbon monoxide sensor to CO concentration in parts per million.

Equation 9

CO(PPM) = Transmitted Value / (2.16 mV / PPM)

Equation 10 is used to convert the transmitted value from an ionization smoke detector to TBD (engineering units).

Equation 10

TBD

Equation 11 is used to convert the transmitted data from a photoelectric smoke detector to TBD (engineering units).

Equation 11

TBD

Equation 12 is used to convert the transmitted value from a voltage sensor to Volts. It is used for battery and reference voltages.

Equation 12

V = Transmitted value * 3.3 V / 256

Equation 13 is used to convert the transmitted value from a humidity sensor to percent relative humidity.

Equation 13

TBD

2.2.2 Structure Sensor Cluster Microcontroller to Structure Sensor Cluster Radio

2.2.2.1 SSC MCU to SSC Radio Mechanical Interface

TBD

2.2.2.2 SSC MCU to SSC Radio Electrical Interface

The Structure Sensor Cluster MCU and Structure Sensor Cluster Radio both operate at 3.3V nominal, +/-10%. Radio power is controlled by the MCU. For digital signals, logic 0 is 0 V, and logic 1 is 3.3 V. Signals in the Sensor Cluster MCU/Radio interface are described in Table 5.

2.2.2.3 SSC MCU to SSC Radio Sequencing

SSC MCU to SSC Radio sequencing is the same as ESC MCU to ESC Radio sequencing, as described in section 2.2.1.3.

2.2.2.4 SSC MCU to SSC Radio Message Description

SSC MCU to SSC Radio messages consist of a string of up to TBD bytes, each encoded as 11 bits transmitted in the following order:

- Start bit
- 8 data bits, least significant first
- Parity bit
- Stop bit

The interpretation of individual bytes is the same as for Access Point to Sensor Cluster communication, as described in section 2.4.1.4. The SSC Radio serves as a conduit between AP and SSC MCU.

2.2.2.4.1 Conversion of transmitted data to engineering units

Equation 1 (section 2.2.1.4.1) is used to convert the transmitted value of RSSI to engineering units.

Equation 14 is used to convert the transmitted value from a strain sensor to TBD (engineering units).

Equation 14

TBD

Equation 15 is used to convert the transmitted data from a high-g accelerometer to TBD (engineering units).

Equation 15

TBD

Equation 16 is used to convert the transmitted value a low-g accelerometer to TBD (engineering units).

Equation 16

TBD

2.2.3 Personnel Status Monitor Microcontroller to Personnel Status Monitor Radio

The Personnel Status Monitor comprises an Integrated Sensor Unit (ISU) worn on the torso and a Communication Interface Unit worn on the belt. Communication between these units is inherent to the Sarcos-supplied devices, and is outside the scope of RSVP.

Figure 10 depicts the PSM CIU (or "beltpack"), which comprises the PSM microcontroller and the PSM Radio.

2.2.3.1 PSM MCU to PSM Radio Mechanical Interface

TBD

2.2.3.2 PSM MCU to PSM Radio Electrical Interface

The PSM MCU and PSM Radio both operate at 3.3V nominal, +/-10%. Radio power is controlled by the MCU. All signals are digital. Logic 0 is 0 V, logic 1 is 3.3 V. Signals in the PSM MCU/PSM Radio interface are described in Table 6.

Table 6. Signals in PSM MCU to PSM Radio Interface

Signal Name	Description	Source	Destination
PREQ	0 to 1: interrupt MCU to waken if in Sleep mode 1: transfer bytes to MCU over RDO, under control of PGNT 1 to 0: transfer complete	Radio	MCU
PGNT	1: allow bytes to be transferred over RDO 0: suspend transfer (used to accomplish flow control)	MCU	Radio
RDO	serial data	Radio	MCU
RREQ	0 to 1: interrupt Radio to waken if in Sleep mode 1: transfer bytes to Radio over PDO, under control of RGNT 1 to 0: transfer complete	MCU	Radio
RGNT	1: allow bytes to be transferred over PDO 0: suspend transfer (used to accomplish flow control)	Radio	MCU
PDO	serial data	MCU	Radio
MCLK	28.8 kHz master clock	Radio	PSM

2.2.3.3 PSM MCU to PSM Radio Sequencing

Figure 11 illustrates the PSM Radio to PSM MCU and PSM MCU to PSM Radio communications sequences.

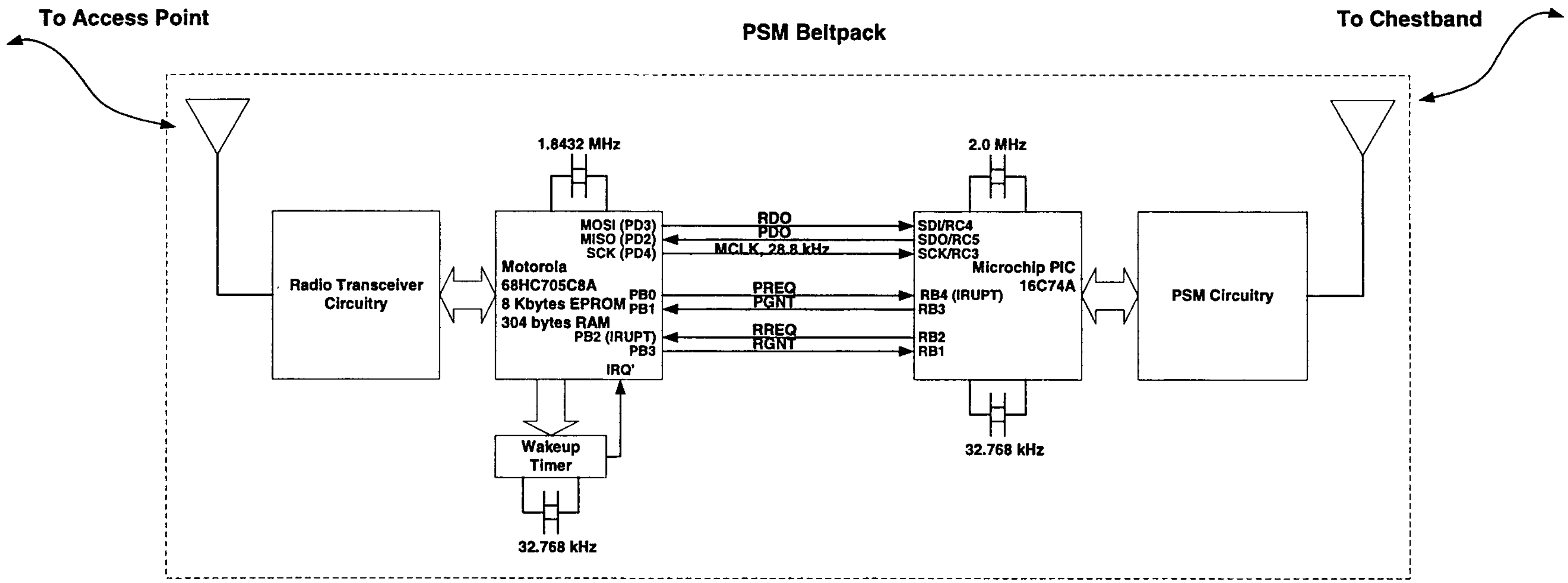

Figure 10. Personal Status Monitor Communication Interface Unit

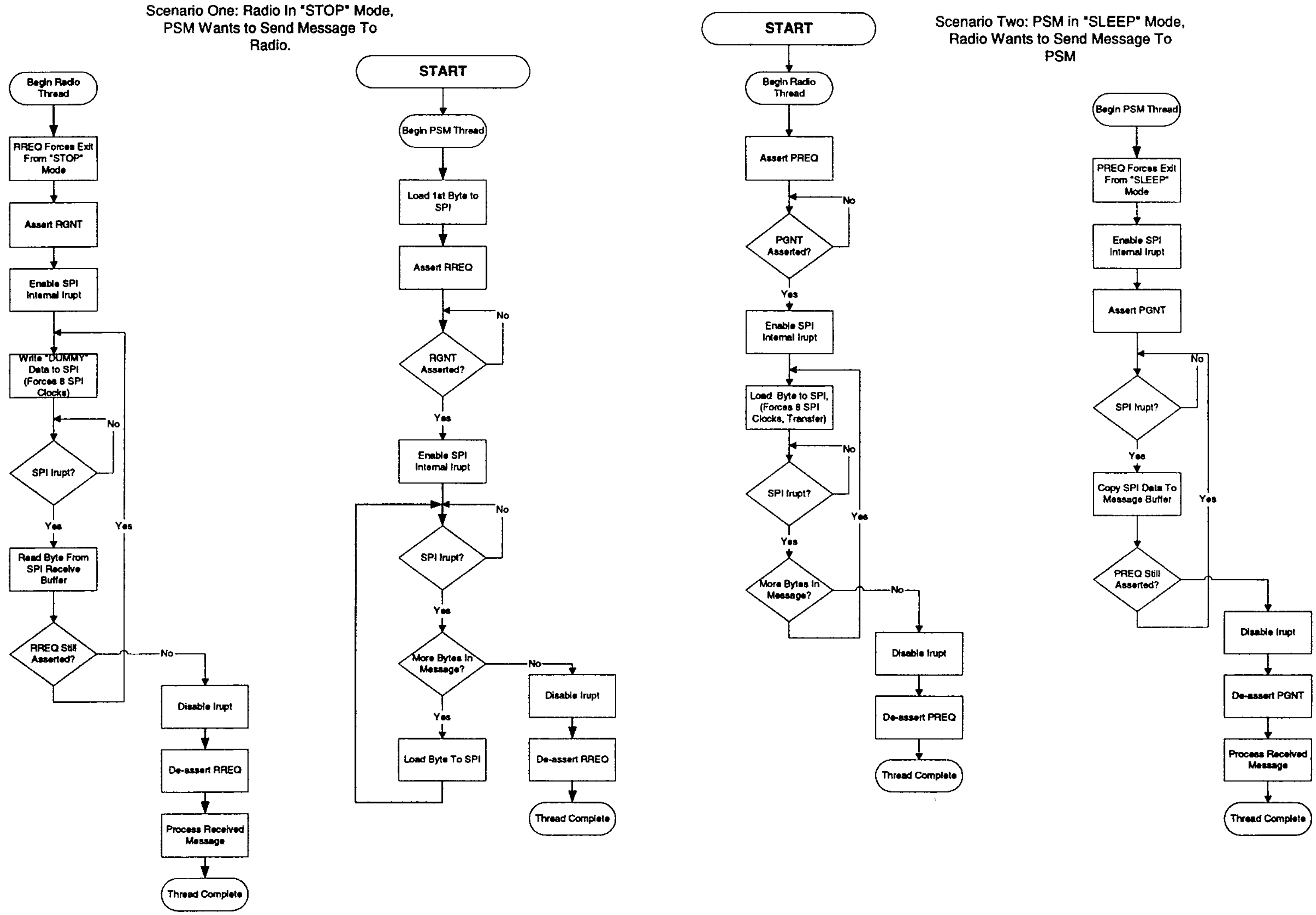

Figure 11. Personal Status Monitor to PSM Radio Communications Sequencing

2.2.3.4 PSM MCU to PSM Radio Message Description

PSM MCU to PSM Radio Messages consist of a string of up to TBD bytes, each encoded as 8 data bits (no start, stop, or parity bits) transmitted MSB first.

Messages are not acknowledged.

Table 7 summarizes the messages at the PSM MCU to PSM Radio interface. The content of these messages is defined in individual tables in Appendix A.

Table 7. PSM MCU to PSM Radio Messages

Message	Source	Destination	Function	Trigger	Content
Enter Normal Operation	PSM Radio	PSM MCU	Command to leave Sleep mode	Receipt of Exit Standby message from APCM	Table 51
Enter Standby	PSM Radio	PSM MCU	Command to enter Sleep mode	Receipt of Enter Standby message from APCM	Table 52
Downlink Data	PSM Radio	PSM MCU	Packet of downlink data	Event	Table 53
Physiological Data	PSM MCU	PSM Radio	Packet of physiological data	Time or PSM decision based on data fusion	Table 54
Low Voltage Shutdown	PSM MCU	PSM Radio	Battery needs to be recharged or replaced	Low voltage detected	Table 57

2.3 Wired Network

2.3.1 Access Point to Access Point

2.3.1.1 AP to AP Mechanical Interface

Access Points are connected to the wired network by means of RJ45 connectors and Category 5 Cable.

2.3.1.2 AP to AP Electrical Interface

The electrical interface to the wired network consists of a COTS 10/100Base-T network interface card.

2.3.1.3 AP to AP Sequencing

There is no restriction on the order in which APs come on line and go off line.

The minimum number of APs per compartment required for the AP(s) in the compartment to function properly is one. The maximum number of AP per compartment is TBD (for large spaces such as Main Engine Rooms, approximately 10; for other ship spaces, approximately 4). The minimum number of compartments for which APs must be active is zero (that is, any AP can be the first to come on line; the system supports APs coming online again after all APs have gone off line).

2.3.1.4 AP to AP Message Description

Table 8 summarizes the messages at the AP to AP interface. The content of these messages is defined in subsequent tables.

Table 8. AP to AP Messages

Message Name	Trigger	Publisher	Subscriber	Server	Client	Message Description	Content
Sensor Data	data	AP	AP			Shared intracompartment data	Table 9
Data Fusion Package	time	AP	AP			Aggregated data set used for fusion	Table 10

Table 9. Content of Sensor Data Message

Name	Type	Values	Interpretation
Data	<specialized by sensor>		

Table 10. Content of Data Fusion Package Message

Name	Type	Values	Interpretation
Data	Vector<vector<specialized by sensor>>		Most recent readings from all sensors

2.3.2 Access Point to Watchstation

2.3.2.1 AP to Watchstation Mechanical Interface

Access Points and watchstations are connected to the wired network by means of RJ45 connectors and Category 5 Cable.

2.3.2.2 AP to Watchstation Electrical Interface

The electrical interface to the wired network consists of a COTS 10/100Base-T network interface card.

2.3.2.3 AP to Watchstation Sequencing

There is no restriction on the order in which APs and watchstations come on line and go off line. Watchstations can come on line and go off line at any time without causing APs to operate incorrectly. APs can come on line and go off line at any time without causing watchstations to operate incorrectly.

The minimum number of watchstations required for APs to function properly is zero.

The minimum number of APs required for watchstations to function properly is zero. The maximum number of watchstations RSVP can support is TBD (for the demonstrations, approximately 3; for a full implementation on a destroyer, approximately 20; for a full implementation on a carrier approximately 100).

The maximum number of AP per compartment that RSVP watchstations can support is TBD (for large spaces such as Main Engine Rooms, approximately 10; for other ship spaces, approximately 4).

Video transmission from an AP to a watchstation is initiated by command from the watchstation, and is terminated by a command from the watchstation or the observation by the AP that the watchstation is no longer connected.

Transmission of recorded video from an AP to a watchstation is performed upon command from the watchstation.

2.3.2.4 AP to Watchstation Message Description

Table 11 summarizes the messages at the AP to Watchstation interface. The content of these messages is defined in subsequent tables.

Table 11. AP to Watchstation Messages

Message Name	Trigger	Publisher	Subscriber	Source	Target	Message Description	Content
Alarm	Data fusion	AP	WS			Data fusion detected alarm condition	Table 12
Video	GUI	AP	WS			Video frames	Table 13
Sensor Data	New data	AP	WS			Continuous data update	Table 14
Time Synchronization	Time	AP	AP,WS			Eliminate old data problems	Table 15
Request Compartment Occupancy	GUI			WS	AP	Number and status of sailors	Table 16
Compartment Occupancy	Request	AP	WS			Quantity and Ids and status	Table 17
Request Sensor Data	GUI			WS	AP	Request one set of data or continuous update	Table 18
Sensor Data Reply	Request	AP	WS				Table 19
Request Sensor ID	GUI			WS	AP	Or could be in data base at WS	TBD
Sensor ID	Request			AP	WS		TBD
Diagnostics	GUI	AP	WS	AP	WS	What wrong with RSVP	TBD
Data Fusion Script	GUI			WS	AP		TBD
Request Recorded Video	GUI			WS	AP		TBD
Recorded Video	Request	AP	WS				TBD
Downlink	TBD			AP	WS		

Table 12. Content of Alarm Message

Name	Type	Values	Interpretation
Text	char[128]		AP generated message about the alarm
PubAP	int		ID of AP publishing alarm
Severity	enumSeverity	ALERT	
		ALARM	
		FIRE_OUT	
Sensor Cluster's Sensor ID	vector<int>		Ids of sensors associated with alarm

Table 13. Content of Video Message

Name	Type	Values	2.3.2.4.1.1 Interpretation
Lenth	int		Length of data stream
Data	UCHAR		Video data byte stream

Table 14. Content of Sensor Data Message

Name	Type	Values	Interpretation
SensorData	<specialized by sensor>		Sensor data subscription

Table 15. Content of Time Synchronization Message

Name	Type	Values	Interpretation
Time	Time		time

Table 16. Content of Request Compartment Occupancy Message

Name	Type	Values	Interpretation
TBD	TBD		TBD
TBD	TBD		TBD

Table 17. Content of Compartment Occupancy Reply Message

Name	Type	Values	Interpretation
Quantity	int	0:N	Number of individuals in compartments
SailorIDs	vector<int>		Ids of sailors in compartment
Sailor status	TBD	11 = R(ed) 10 = Y(ellow) 01 = U(nknown) 00 = G(reen)	Status of individual sailor in compartment

Table 18. Content of Request Sensor Data Message

Name	Type	Values	Interpretation
ReplyOrSub	enumReplyOrSub	REPLY	Respond with data in reply message
		PUBLICATION	Create publication for continuous update
StartTime	time	DEFAULT time	1 hour ago
EndTime	time	DEFAULT time	Now
Interval	time	DEFAULT time	5 minutes

Table 19. Content of Request Sensor Reply Message

Name	Type	Values	Interpretation
Quantity	enumRequestStatus	PUBLICATION_CREATED	Number of individuals in compartments
		PUBLICATION_FAILURE	
		REPLY_ENCLOSED	
		REPLY_FAILURE	
vSensorData	vector<specialized by sensor>		Sensor data reply

2.4 Wireless Network

The RSVP concept comprises three wireless network concepts.

1. Aloha. This network is employed for communication where low data rates are acceptable and the availability of electric power is limited. It is employed where the remote station is mobile. Care must be taken to keep the loading on this network as low as possible, because message reliability decreases sharply as loading increases. The Aloha network will be available in all ship spaces participating in an RSVP demonstration, and in a fully implemented system, it would be available in all ship spaces. The Aloha network is used for all AP-to-PSM communication. It is used by APs to transmit the Ids of the channels to which they are tuned. In the event that RSVP is modified to support ordinance monitoring, ordinance-to-AP messages would be carried over the Aloha network. Owing to the unavailability of a commercial radio with suitable low-power characteristics, the radios for this network are being designed and fabricated by the Draper Laboratory.
2. Reservation. This network is used for communication where low data rates are acceptable, the availability of electric power is limited, and message traffic is predictable. The reservation network will be available in all ship spaces participating in an RSVP demonstration, and in a fully implemented system, it would be available in all ship spaces. The reservation network is used for all AP-to-SC communication except the transmission of AP channel ID. Owing to the unavailability of a commercial radio with suitable low-power characteristics, the radios for this network are being designed and fabricated by the Draper Laboratory.
3. Commercial standard. This network is used for communication where high data rates are required and where the electric power draw is not an issue. The only identified user of this network is AP to SHM communication; consequently, only compartments that contain machinery need a commercial standard network. IEEE 802.11 is the selected technology.

Messages transmitted over the air interface employ 16-bit Cyclic Redundancy Check (CRC) for error detection. The generator polynomial is $X^{16} + X^{15} + X^2 + 1$.

Certain messages transmitted over the air interface include a byte containing Relative Signal Strength Indicator (RSSI). The units of RSSI are Volts per dBm, where dBm means power referenced to a 1-mW reference.

2.4.1 Access Point to Sensor Cluster

2.4.1.1 APCM to SC Radio Mechanical Interface

Access Points are not mechanically connected to Sensor Clusters.

In principle, to operate in the 2.4 GHz band, an SC needs a line-of-sight relationship between its antenna and the antenna of the AP with which it communicates. However, the multi-path environment found in a ship's compartment has the effect of creating a usable link between any two points in all but the most extreme circumstances.

2.4.1.2 APCM to SC Radio Electrical Interface

The APCM and SC transfer messages across the air interface. Messages consist of a string of bytes in standard asynchronous serial format, using one start bit, one stop bit, and a trailing parity bit. The sense of the parity bit is odd during a message preamble, and even otherwise. The basic data rate is 57.6 kbps, which is compatible with other elements of the RSVP system. Radiated RF power is under 1 mw. Frequency-shift-keyed FM is employed.

2.4.1.3 APCM to SC Radio Sequencing

2.4.1.3.1 Aloha channel

A single channel is used throughout the ship as the Aloha channel. The ID of the Aloha channel is provided to the Access Point as part of the initialization procedure. The choice of channel is programmable, in case unforeseen circumstances cause the channel to become unusable. Remote stations that use the Aloha channel are preprogrammed with the Ids of two possible channels, a primary and an alternate.

Each Access Point transmits a message containing the ID of the channel it employs on the reservation network. There is no acknowledgement or retransmission of a failed message. This message is transmitted at a nominal rate of 1Hz. The exact transmission frequency is randomized to reduce the probability of collisions recurring. Access Points receive on the Aloha channel from time to time for the purpose of judging the health of the channel.

Sensor Clusters do not transmit on the Aloha channel. The Sensor Cluster channel acquisition procedure includes the Sensor Cluster receiving on the Aloha channel to obtain AP messages that identify which channels are assigned to which APs.

2.4.1.3.2 Reservation Channel

Each Access Point is assigned a particular reservation channel on which it transmits and receives. The channel assignment is programmable, in case difficulty communicating on a particular channel is encountered. A Sensor Cluster becomes "connected" to an AP via an exchange of messages called the acquisition process. The acquisition process includes the AP giving the SC a "slot" ID that defines the interval that is reserved (hence the term "reservation channel") for SC transmission. The acquisition process is initiated by the Sensor Cluster that wants to be acquired. An Access Point may decline to accept a Sensor Cluster that wishes to be acquired, but a Sensor Cluster that has been denied may reapply with an "urgent" priority, which the Access Point will honor. Grounds for an AP declining to accept an SC include

- The SC is not in the same compartment as the AP
- The SC would put the number of SCs "connected" to the AP over a threshold, TBD (approximately 50)
- The RSSI as detected by the AP is much less than that detected by the SC

An Access Point determines that a Sensor Cluster has failed by observing the absence of messages in the SC's reserved slot. The AP responds to the failure by recording it for purposes of assessing the health of the RSVP system, and by making the failed SC's reserved slot available for assignment to another SC. No other action is necessary.

A Sensor Cluster determines that an Access Point has failed by observing the absence of messages at the time the AP is expected to transmit. The Sensor Cluster responds to the failure by performing the acquisition process to "connect" with another AP. No other action is necessary.

An Access Point transmits a message for Sensor Clusters once per second ±100 μs, regardless of whether it actually has information to convey, and regardless of whether any Sensor Clusters are connected to the Access Point. Each Access Point listens for messages from Sensor Clusters on the AP's channel.

Each Sensor Cluster connected to the AP has been assigned a fixed time at which the SC is allowed to transmit a message. The AP receiver is enabled at this time, but the SC may or may not transmit.. Whether the SC transmits or not is determined by the SC based on the time that has elapsed since its last transmission and the SC's assessment of whether the sensor data is "interesting." When the sensor data is "uninteresting" the SC transmits a message (in its reserved slot) periodically (approximately every 10th second). When the sensor data is "interesting" the SC transmits messages more often (but always in its reserved slot).

2.4.1.4 APCM to SC Radio Message Description

APCM to SC Radio Messages consist of a string of up to TBD bytes, each encoded as 11 bits transmitted in the following order:

- Start bit
- 8 data bits, least significant first
- Parity
- Stop bit

Bytes in uplink messages (SC Radio to APCM) have odd parity. Bytes in downlink messages (APCM to SC Radio) have even parity.

The first three bytes of every message constitute a header. The hexadecimal value of these bytes is FF00FF. Care is taken in the layout of subsequent bytes of the message to ensure that the sequence FF00FF cannot occur elsewhere in the message. If necessary, the range of an analog value is restricted to 1-254 instead of the usual 0-255.

Table 20 summarizes the messages at the AP to SC Radio interface. The content of these messages is defined in individual tables in Appendix A.

Table 20. APCM to SC Radio Messages

Message	Source	Destination	Function	Trigger	Content
Network Management Data Frame	APCM	SC	Synchronization; identify start of frame	Time (periodic @ 1 Hz)	Table 58
AP Slot Assignment	APCM	SC	Identifies slot reserved for SC	Sensor Cluster Request message	Table 59
Downlink Data	APCM	SC	Data packet	Event	Table 60
Sensor Cluster Request	SC	APCM	Request "connection" to AP	SC decision (occurs rarely)	Table 61
Sensor Cluster Emergency Request	SC	APCM	Request "connection" to AP after being unsuccessful	SC decision (occurs rarely)	Table 62
Environment Sensor Cluster Analog Uplink	SC	APCM	Data packet	SC decision based on time & interest criteria (period is 1-10 s)	Table 63
Environment Sensor Cluster Sound Uplink	SC	APCM	Data packet	SC decision based on time & interest criteria (period is 1-10 s)	Table 64
Structure Sensor Cluster Uplink	SC	APCM	Data packet	SC decision based on time & interest criteria (period is 1-10 s)	Table 65

2.4.2 Access Point Communication Module to Personnel Status Monitor

2.4.2.1 APCM to PSM Radio Mechanical Interface

Access Points are not mechanically connected to Personnel Status Monitors.

In principle, to operate in the 2.4 GHz band, a PSM needs a line-of-sight relationship between its antenna and the antenna of the AP with which it communicates. However, the multi-path environment found in a ship's compartment has the effect of creating a usable link between any two points in all but the most extreme circumstances.

2.4.2.2 APCM to PSM Radio Electrical Interface

The APCM and PSM Radio transfer messages across the air interface. Messages consist of a string of bytes in standard asynchronous serial format, using one start bit, one stop bit, and a trailing parity bit. The sense of the parity bit is odd during a message preamble, and even otherwise. The basic data rate is 57.6 kbps, which is compatible with other elements of the RSVP system. Radiated RF power is under 1 mw. Frequency-shift-keyed FM is employed.

2.4.2.3 APCM to PSM Radio Sequencing

APCM to PSM Radio communication is carried out over the Aloha channel. A PSM may transmit a message at any time, which will in general be received by multiple APs, possibly located in multiple compartments. A PSM is expected to transmit messages containing vital signs at a rate of once every 60 seconds in routine situations, and at a rate of once every 15 seconds when the wearer is under severe physiological distress (as determined by the PSM). In the event that the PSM determines that it is undergoing rapid motion, it will transmit a message at 1 Hz to aid the location algorithm. The division of responsibilities between PSM MCU and PSM Radio to accomplish this is given in Table 21. The PSM adds a random component to transmission periods to reduce the probability of recurring collisions.

Access Points determine that a PSM has failed by observing that messages are not being received. Such determination must be coordinated with other APs, since the absence of message can be caused by the PSM's wearer being in a location where it cannot be heard by particular APs, or by the wearer moving to a different compartment.

2.4.2.4 APCM to PSM Radio Message Description

AP to PSM Radio Messages consist of a string of up to TBD bytes, each transmitted as 11 bits in the following order:

- Start bit
- 8 data bits, least significant first
- Parity
- Stop bit

Bytes in uplink messages (PSM Radio to APCM) have odd parity. Bytes in downlink messages (APCM to PSM Radio) have even parity.

The first three bytes of every message constitute a header. The hexadecimal value of these bytes is FFOOFF. Care is taken in the layout of subsequent bytes of the message to ensure that the sequence FFOOFF cannot occur elsewhere in the message. If necessary, the range of an analog value is restricted to 1-254 instead of the usual 0-255.

Table 22 summarizes the messages at the AP to PSM Radio interface. The content of these messages is defined in individual tables in Appendix A.

Table 21. PSM Radio and PSM MCU Responsibilities for Physiological Data and Positioning Messages

Condition		Response	
Rapid Motion	**Physiological Distress**	**PSM MCU**	**PSM Radio**
Yes	Yes	Transmit Physiological Data message to PSM radio every 15 s. Set "Rapid Motion" flag in message.	Transmit Physiological Data message to APCM radio as received. Transmit Positioning message to APCM radio every 1 s except when Physiological Data message is transmitted.
Yes	No	Transmit Physiological Data message to PSM radio every 60 s. Set "Rapid Motion" flag in message.	Transmit Physiological Data message to APCM radio as received. Transmit Positioning message to APCM radio every 1 s except when Physiological Data message is transmitted.
No	Yes	Transmit Physiological Data message to PSM radio every 15 s. Reset "Rapid Motion" flag in message.	Transmit Physiological Data message to APCM radio as received. Do not transmit positioning messages
No	No	Transmit Physiological Data message to PSM radio every 60 s. Reset "Rapid Motion" flag in message.	Transmit Physiological Data message to APCM radio as received. Do not transmit positioning messages

Table 22. APCM to PSM Radio Messages

Message	Source	Destination	Function	Trigger	Content
Network Manage-ment Data Frame	APCM	PSM Radio	Synchronization	Time (@ 1 Hz in the absence of a message directed to a specific PSM)	Table 66
Enter Standby	APCM	PSM Radio	Command all PSMs or specific PSM to enter Standby mode; transmitted @ 1 Hz for 60 s	Event	Table 67
Exit Standby	APCM	PSM Radio	Command all PSMs or specific PSM to exit Standby mode; transmitted @ 1 Hz for 60 s. This message is used to activate all PSMs when ship goes to General Quarters	Event	Table 68
Downlink Data	APCM	PSM Radio	Data packet	Event	Table 69
Physiologi-cal Data	PSM Radio	APCM	Corresponds to PSM MCU to PSM Radio physiological data packets	Event – message received from PSM MCU	Table 70
Positioning	PSM Radio	APCM	Short message used by tracking algorithm	Transmitted @ 1 Hz when wearer moving rapidly	Table 71
Low Power Shutdown	PSM Radio	APCM	PSM is about to shut down; battery needs to be replaced or recharged	Event – message received from PSM MCU	Table 72

2.4.3 Access Point Communication Module to System Health Monitor

2.4.3.1 APCM to SHM Mechanical Interface

Access Points are not mechanically connected to System Health Monitors.

In principle, to operate in the 2.4 GHz band, an SHM needs a line-of-sight relationship between its antenna and the antenna of the AP with which it communicates. However, the multi-path environment found in a ship's compartment has the effect of creating a usable link between any two points in all but the most extreme circumstances.

2.4.3.2 APCM to SHM Radio Electrical Interface

The APCM and SHM Radio transfer messages across the air interface. Messages consist of a string of serial bytes in conformance with IEEE standard 802.11.

2.4.3.3 APCM to SHM Radio Sequencing

TBD

2.4.3.4 APCM to SHM Radio Message Description

Table 23 summarizes the messages at the APCM to SHM Radio interface. The content of these messages is defined in individual tables in Appendix A.

Table 23. APCM to SHM Radio Message Summary

Message	Source	Destination	Function	Trigger	Content
ICHM Calibration	APCM	SHM	TBD	TBD	Table 73
ICHM Data	SHM	APCM	TBD	TBD	Table 74
ICHM Alert	SHM	APCM	TBD	TBD	Table 75
SHM System Status	SHM	APCM	TBD	TBD	Table 76
Configuration Data	SHM	APCM	TBD	TBD	Table 77

2.4.4 Access Point Communications Module to Ordinance Tracking Monitor

This section describes how an Ordinance Tracking Monitor (OTM) system might be integrated with RSVP. It is included for planning purposes only.

Communication between the OTM and RSVP relies upon residual capacity in the Aloha physical layer, which was designed to support an advanced Personnel Status Monitor (PSM). The OTM is envisioned as a transmit-only device, thereby allowing it to exploit the ultra low-power transmitter architecture used elsewhere in the RSVP system. Each OTM sends messages to the RSVP system approximately every 30 minutes. Upon reception, this data is logged to a system database from which it may be queried via the watchstation.

Each OTM is controlled by a low-power microprocessor such as the Microchip PIC16 or Motorola HC05. Every TBD minutes (approximately 30) the microprocessor wakes and samples the ambient temperature using an integral temperature sensor. Multiple sensors may be employed as required to ensure a given level of reliability. Other phenomena may be sensed. The sensed data measurements are relayed to the RSVP system, using the co-located 2.4 GHz radio transmitter. The measurements are also stored to local nonvolatile memory, in which is kept the entire profile acquired over the life of the tag. The microprocessor also provides an external serial interface. Using this interface, an external device may retrieve the measurement profile and ordnance serial number, as well as perform diagnostics on the tag operation.

2.4.4.1 Access Point Communication Module to Ordinance Tracking Monitor Mechanical Interface

Access Points are not mechanically connected to Ordinance Tracking Monitors.

In principle, to operate in the 2.4 GHz band, an OTM needs a line-of-sight relationship between its antenna and the antenna of the AP with which it communicates. However, the multi-path environment found in a ship's compartment has the effect of creating a usable link between any two points in all but the most extreme circumstances.

2.4.4.2 Access Point Communication Module to Ordinance Tracking Monitor Electrical Interface

The OTM and APCM transfer messages across the air interface. Messages consist of a string of bytes in standard asynchronous serial format, using one start bit, one stop bit, and a trailing parity bit. The sense of the parity bit is odd during a message preamble, and even otherwise. The basic data rate is 57.6 kbps, which is compatible with other elements of the RSVP system. Radiated RF power is under 1 mw. Frequency-shift-keyed FM is employed.

2.4.4.3 Access Point Communication Module to Ordinance Tracking Monitor Sequencing

There are no restrictions on Ordinance Tracking Monitors coming on line, going off line, or moving in or out of range of any APCM. The minimum number of APs required for OTMs to perform correctly is zero. The minimum number of OTMs required for APs to perform correctly is zero. The maximum number of OTMs is TBD.

2.4.4.4 Access Point Communication Module to Ordinance Tracking Monitor Message Description

APCM to OTM Radio Messages consist of a string of up to TBD bytes, each encoded as 11 bits transmitted in the following order:

- Start bit
- 8 data bits, least significant first
- Parity
- Stop bit

Bytes in uplink messages (OTM to APCM) have odd parity. Bytes in downlink messages (APCM to OTM) have even parity.

The first three bytes of every message constitute a header. The hexadecimal value of these bytes is FF00FF. Care is taken in the layout of subsequent bytes of the message to ensure that the sequence FF00FF cannot occur elsewhere in the message. If necessary, the range of an analog value is restricted to 1-254 instead of the usual 0-255.

Table 24 summarizes the messages at the APCM to SHM Radio interface. The content of these messages is defined in a table in Appendix A.

Table 24. APCM to SHM Radio Message Summary

Message	Source	Destination	Function	Trigger	Content
OTM Uplink	OTM	APCM	Periodic data transfer	Time	Table 78

3 References and Bibliography

3.1 References

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3.2 Bibliography

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3. Schwartz, G., *Systems Engineering Study for the Reduced Ships-Crew by Virtual Presence (RSVP) Advanced Technology Demonstration (ATD)*, Draper Laboratory Document 389826, Rev -, April 1999.

4 Abbreviations and Acronyms

A	Ampere
AC	Alternating Current
ACK	Acknowledgement
A/D	Analog/Digital
ADC	Analog- to- Digital Converter
AP	Access Point
APCP	Access Point Control Processor
APCM	Access Point Communication Module
ARL	Advanced Research Laboratory
BIT	Built-In Test
BPM	Beats per Minute
C	Centigrade
CIC	Combat Information Center
CO	Carbon Monoxide
COTS	Commercial-off-the-Shelf
CRC	Cyclic Redundancy Check
CIU	Communication Interface Unit (component of PSM)
CW	Continuous Wave
dB	Decibel
DSSS	Direct Sequence Spread Spectrum
ESC	Environment Sensor Cluster
FFT	Fast Fourier Transform
FM	Frequency Modulation
FSK	Frequency-Shift-Keyed
GHz	Gigahertz
GMT	Greenwich Mean Time
GTE	General Telephone and Electronics
GUI	Graphical User Interface
Hz	Hertz
I/O	Input/Output
ICHM	Intelligent Component Health Monitor

ID	Identifier (or Identification)
ISM	Industrial, Scientific, and Medical
ISU	Integrated Sensor Unit (component of PSM)
K	Kelvin
LAN	Local Area Network
LSB	Least Significant Bit
m	Meter
MCU	Microcontroller Unit
ms	Millisecond
MSB	Most Significant Bit
mw	Milliwatt
NIC	Network Interface Card
O_2	Oxygen
PCI	Peripheral Component Interface
PPM	Parts per Million
PSIA	Pounds per Square Inch Atmospheric
PSM	Personnel Status Monitor
PSU	Pennsylvania State University
PUB	Publish(er)
RAM	Random-Access Memory
RCA	Radio Corporation of America
RF	Radio Frequency
ROM	Read-Only Memory
RSSI	Relative Signal Strength Indicator
RSVP	Reduced Ship-Crew by Virtual Presence
s	Second
SC	Sensor Cluster
SHM	System Health Monitor
SSC	Structure Sensor Cluster
SUB	Subscribe(er)
SVID	System V Interface Definition
TBD	To be determined

TCP/IP	Transmission Control Protocol/Internet Protocol
TDMA	Time-Division Multiple Access
UART	Universal Asynchronous Receiver Transmitter
V	Volt
VDC	Volts Direct Current
WLAN	Wireless Local Area Network
WS	Watchstation

5 Appendix A: Message Content

5.1 APCP to APCM Radio Message Content

Table 25 through Table 50 define the content of the messages at the APCP to APCM Radio interface.

Table 25. Content of Hello Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	01	Message type
4	80	First byte of trailer
5	FE	Second byte of trailer

Table 26. Content of Hello Acknowledge Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	81	Message type
4	80	First byte of trailer
5	FE	Second byte of trailer

Table 27. Content of Trouble Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	FF	Message type
4	80	First byte of trailer
5	FE	Second byte of trailer

Table 28. Content of Reset Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	02	Message type
4	80	First byte of trailer
5	FE	Second byte of trailer

Table 29. Content of Reset Acknowledge Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	82	Message type
4	80	First byte of trailer
5	FE	Second byte of trailer

Table 30. Content of Authorized SCs Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	82	Message type
4	XX	First byte of serial number of first SC being enabled
5	XX	Second byte of serial number of first SC being enabled
6	XX	Third byte of serial number of first SC being enabled
7	XX	Fourth (last) byte of serial number of first SC being enabled
. . .		
4N + 4	XX	First byte of serial number of last (Nth) SC being enabled
4N + 5	XX	Second byte of serial number of last (Nth) SC being enabled
4N + 6	XX	Third byte of serial number of last (Nth) SC being enabled
4N + 7	XX	Fourth (last) byte of serial number of last (Nth) SC being enabled
4N + 8	80	First byte of trailer
4N + 9	FE	Second byte of trailer

Table 31. Content of Authorized SCs Acknowledge Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	85	Message type
4	80	First byte of trailer
5	FE	Second byte of trailer

Table 32. Content of Error Full Routing Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	TBD	Message type
4	80	First byte of trailer
5	FE	Second byte of trailer

Table 33. Content of Frequency Setting Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	06	Message type
4	XX	Reservation channel ID
5	XX	Aloha channel ID
6	80	First byte of trailer
7	FE	Second byte of trailer

Table 34. Content of Frequency Setting Acknowledge Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	86	Message type
4	80	First byte of trailer
5	FE	Second byte of trailer

Table 35. Content of Error – APCM Not Reset Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	TBD	Message type
4	80	First byte of trailer
5	FE	Second byte of trailer

Table 36. Content of Downlink Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	07	Message type
4	XX	First byte of serial number of SC or PSM to receive data
5	XX	Second byte of serial number of SC or PSM to receive data
6	XX	Third byte of serial number of SC or PSM to receive data
7	XX	Fourth (last) byte of serial number of SC or PSM to receive data
8	XX	Number (N) of data bytes
9	XX	First data byte
...		
N + 8	XX	Last (Nth) data byte
N + 9	80	First byte of trailer
N + 10	FE	Second byte of trailer

Table 37. Content of Downlink Acknowledge Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	82	Message type
4	XX	First byte of serial number of SC or PSM to receive data
5	XX	Second byte of serial number of SC or PSM to receive data
6	XX	Third byte of serial number of SC or PSM to receive data
7	XX	Fourth (last) byte of serial number of SC or PSM to receive data
8	80	First byte of trailer
9	FE	Second byte of trailer

Table 38. Content of Downlink Unknown Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	TBD	Message type
4	XX	First byte of serial number of SC or PSM to receive data
5	XX	Second byte of serial number of SC or PSM to receive data
6	XX	Third byte of serial number of SC or PSM to receive data
7	XX	Fourth (last) byte of serial number of SC or PSM to receive data
8	XX	Number (N) of data bytes
9	XX	First data byte
...		
N + 8	XX	Last (Nth) data byte
N + 9	80	First byte of trailer
N + 10	FE	Second byte of trailer

Table 39. Content of Downlink Size Error Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	TBD	Message type
4	XX	First byte of serial number of SC or PSM to receive data
5	XX	Second byte of serial number of SC or PSM to receive data
6	XX	Third byte of serial number of SC or PSM to receive data
7	XX	Fourth (last) byte of serial number of SC or PSM to receive data
8	XX	Number (N) of data bytes
9	XX	First data byte
...		
N + 8	XX	Last (Nth) data byte
N + 9	80	First byte of trailer
N + 10	FE	Second byte of trailer

Table 40. Content of APCM Assignments Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	08	Message type
4	XX	Number (N) of APs in compartment except this one
5	XX	Channel ID of first AP in compartment
...		
N + 5	XX	Channel ID of last (Nth) AP in compartment
N + 6	80	First byte of trailer
N + 7	FE	Second byte of trailer

Table 41. Content of APCM Assignments Acknowledge Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	88	Message type
4	80	First byte of trailer
5	FE	Second byte of trailer

Table 42. Content of Get Routing Table Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	09	Message type
4	80	First byte of trailer
5	FE	Second byte of trailer

Table 43. Content of Routing Table Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	89	Message type
4	XX	Number (N) of bytes in routing table
5	XX	First byte of routing table
...		
N + 4	XX	Last (Nth) byte of routing table
N + 5	80	First byte of trailer
N + 6	FE	Second byte of trailer

Table 44. Content of Set Aging Threshold Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	0A	Message type
4	XX	First byte of aging threshold
5	XX	Second byte of aging threshold
6	80	First byte of trailer
7	FE	Second byte of trailer

Table 45. Content of Aging Threshold Acknowledge Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	8A	Message type
4	80	First byte of trailer
5	FE	Second byte of trailer

Table 46. Content of Set RSSI Threshold Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	0B	Message type
4	XX	First byte of RSSI threshold
5	XX	Second byte of RSSI threshold
6	80	First byte of trailer
7	FE	Second byte of trailer

Table 47. Content of RSSI Threshold Acknowledge Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	8B	Message type
4	80	First byte of trailer
5	FE	Second byte of trailer

Table 48. Content of Routing Addition Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	41	Message type
4	XX	First byte of serial number of SC being added to routing table
5	XX	Second byte of serial number of SC being added to routing table
6	XX	Third byte of serial number of SC being added to routing table
7	XX	Fourth (last) byte of serial number of SC being added to routing table
8	80	First byte of trailer
9	FE	Second byte of trailer

Table 49. Content of Routing Deletion Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	42	Message type
4	XX	First byte of serial number of SC being deleted from routing table
5	XX	Second byte of serial number of SC deleted from routing table
6	XX	Third byte of serial number of SC deleted from routing table
7	XX	Fourth (last) byte of serial number of SC deleted from routing table
8	80	First byte of trailer
9	FE	Second byte of trailer

Table 50. Content of Uplink Message

Byte Number	Value (Hex)	Interpretation
1	80	First byte of header
2	FF	Second byte of header
3	44	Message type
4	XX	First byte of serial number of SC or PSM sending data
5	XX	Second byte of serial number of SC or PSM sending data
6	XX	Third byte of serial number of SC or PSM sending data
7	XX	Fourth (last) byte of serial number of SC or PSM sending data
8	XX	Number (N) of data bytes
9	XX	First data byte
...		
N + 8	XX	Last (Nth) data byte
N + 9	80	First byte of trailer
N + 10	FE	Second byte of trailer

5.2 PSM MCU to PSM Radio Message Content

Table 51 through Table 57 define the content of the messages at the Personnel Status Monitor MCU to Personnel Status Monitor Radio interface.

Table 51. Content of Enter Normal Operation Message

Byte Number	Value (Hex)	Interpretation
1	02	Number of bytes in this message
2	81	Message type

Table 52. Content of Enter Standby Message

Byte Number	Value (Hex)	Interpretation
1	02	Number of bytes in this message
2	82	Message type

Table 53. Content of PSM Downlink Data Message

Byte Number	Value (Hex)	Interpretation
1	N	Number of bytes in this message
2	83	Message type
3,4	XXXX	Compartment ID (12 bits), AP ID (4 bits)
5,6	XXXX	Ship ID
N - 6	XX	First (of N - 6) data byte
...		
N	XX	Last (of N - 6) data byte

Table 54. Content of Physiological Data Message

Byte Number	Value (Hex)	Interpretation
1	09	Number of bytes in this message
2	01	Message type
3	see Table 55	Status byte 1
4	XX	Heart rate, BPM
5	XX	Axillary temperature, °C
6	XX	Environmental temperature, °C
7	see Table 56	Status byte 2
8	XX	CIU battery voltage, Volts
9	FF	Reserved

Table 55. Content of PSM Physiological Data Message Status Byte 1

Bit Number	Function	Interpretation
7 (MSB)	Rapid Motion Flag	1 = rapid motion 0 = no rapid motion
6,5,4	Orientation	Tbd
3,2	Sailor Status	11 = R(ed) 10 = Y(ellow) 01 = U(nknown) 00 = G(reen)
1	ISU Battery Status	1 = battery low; 0 = battery ok
0 (LSB)	CIU Battery Status	1 = battery low; 0 = battery ok

Table 56. Content of PSM Physiological Data Message Status Byte 2

Bit Number	Function	Interpretation
7 (MSB)	Shivering Flag	1 = shivering detected 0 = no shivering
6	Electrode Contact Quality	1 = electrode contact fail 0 = electrode contact ok
5	Panic Button Flag	1 = panic button depressed 0 = no panic button
4	Memory Full	1 = memory full 0 = memory ok
3,2	Motion Status	11 = tbd 10 = tbd 01 = tbd 00 = tbd
1,0	Unused	N/A

Table 57. Content of Low Voltage Shutdown Message

Byte Number	Value (Hex)	Interpretation
1	02	Number of bytes in this message
2	62	Message type

5.3 APCM to SC Radio Message Content

Table 58 through Table 65 define the content of the messages at the APCM to Sensor Cluster Radio interface.

Table 58. Content of SC Network Management Data Frame Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of APCM header
2	00	Second byte of APCM header
3	FF	Third byte of APCM header
4	40	Message type
5	XX	First byte of this AP's reservation channel frequency
6	XX	Frame time
7	XX	Flags
8	XX	Second byte of this AP's reservation channel frequency
9	XX	Third byte of this AP's reservation channel frequency
10	XX	Fourth byte of this AP's reservation channel frequency
11	XX	Fifth byte of this AP's reservation channel frequency
12	XX	Sixth byte of this AP's reservation channel frequency
13	XX	Seventh byte of this AP's reservation channel frequency
14	XX	Eighth (last) byte of this AP's reservation channel frequency

Table 59. Content of AP Slot Assignment Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of APCM header
2	00	Second byte of APCM header
3	FF	Third byte of APCM header
4	41	Message type
5	XX	First byte of this AP's reservation channel frequency
6	XX	Second byte of this AP's reservation channel frequency
7	XX	Frame time
8	XX	Flags
9	XX	Third byte of this AP's reservation channel frequency
10	XX	Fourth byte of this AP's reservation channel frequency
11	XX	Fifth byte of this AP's reservation channel frequency
12	XX	Sixth byte of this AP's reservation channel frequency
13	XX	Seventh byte of this AP's reservation channel frequency
14	XX	Eighth (last) byte of this AP's reservation channel frequency
15	XX	First byte of SC's ID
16	XX	Second byte of SC's ID
17	XX	Third byte of SC's ID
18	XX	Fourth (last) byte of SC's ID
19	XX	Slot number

Table 60. Content of SC Downlink Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of APCM header
2	00	Second byte of APCM header
3	FF	Third byte of APCM header
4	50	Message type
5	XX	First byte of SC's ID (if bytes 5-8 are all zero, message applies to all SCs)
6	XX	Second byte of SC's ID
7	XX	Third byte of SC's ID
8	XX	Fourth (last) byte of SC's ID
9	XX	Bytes (N) remaining in this message
10	XX	First data byte
...		
N + 9	XX	Last (Nth) data byte

Table 61. Content of Sensor Cluster Request Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of APCM header
2	00	Second byte of APCM header
3	FF	Third byte of APCM header
4	30	Message type
5	XX	First byte of SC's ID
6	XX	Second byte of SC's ID
7	XX	Third byte of SC's ID
8	XX	Fourth (last) byte of SC's ID
9	XX	RSSI as measured by SC

Table 62. Content of Sensor Cluster Emergency Request Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of APCM header
2	00	Second byte of APCM header
3	FF	Third byte of APCM header
4	31	Message type
5	XX	First byte of SC's ID
6	XX	Second byte of SC's ID
7	XX	Third byte of SC's ID
8	XX	Fourth (last) byte of SC's ID

Table 63. Content of Environment Sensor Cluster Analog Uplink Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of APCM header
2	00	Second byte of APCM header
3	FF	Third byte of APCM header
4	3X	Message type (X = 2 – F)
5	XX	Least significant byte of SC's ID
6	XX	Time until sync
7	XX	First byte of status
8	XX	Second (last) byte of status
9	XX	Humidity
10	XX	Narrow-range temperature
11	XX	Ionization smoke detector reading
12	XX	Photo-electric smoke detector reading
13	XX	Carbon monoxide reading
14	XX	Wide-range temperature
15	XX	3.3-V power level
16	XX	9-V power level
17	XX	Oxygen reading
18	XX	RSSI
19	XX	Differential pressure
20	XX	Absolute pressure
21	XX	Hatch closure switches (1 = hatch closed; 0 = not closed)
22	XX	First byte of CRC
23	XX	Second (last) byte of CRC

Table 64. Content of Environment Sensor Cluster Sound Uplink Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of APCM header
2	00	Second byte of APCM header
3	FF	Third byte of APCM header
4	3X	Message type (X = 2 – F)
5	XX	Least significant byte of SC's ID
6	XX	Time until sync
7	XX	First byte of status
8	XX	Second (last) byte of status
9	XX	Sound voltage, peak-to-peak
10	XX	Sound voltage, average
11	XX	FFT bin # containing highest amplitude
12	XX	Amplitude of FFT bin containing highest amplitude
13	XX	FFT bin # containing 2nd highest amplitude
14	XX	Amplitude of FFT bin containing 2nd highest amplitude
15	XX	Gain
16	XX	First byte of CRC
17	XX	Second (last) byte of CRC

Table 65. Content of Structure Sensor Cluster Uplink Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of APCM header
2	00	Second byte of APCM header
3	FF	Third byte of APCM header
4	3X	Message type (X = 2 – F)
5	XX	Least significant byte of SC's ID
6	XX	Time until sync
7	XX	First byte of status
8	XX	Second (last) byte of status
9	XX	Stress
10	XX	Acceleration measured by low-g accelerometer
11	XX	Acceleration measured by high-g accelerometer
12	XX	First byte of CRC
13	XX	Second (last) byte of CRC

5.4 APCM to PSM Radio Message Content

Table 66 through Table 72 define the content of the messages at the APCM to Personnel Status Monitor Radio interface.

Table 66. Content of PSM Network Management Data Frame Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of APCM header
2	00	Second byte of APCM header
3	FF	Third byte of APCM header
4	50	Message type
5	XX	ID of AP's reservation channel
6	00	Bytes remaining in this message
7	XX	First byte of CRC
8	XX	Second (last) byte of CRC

Table 67. Content of Enter Standby Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of APCM header
2	00	Second byte of APCM header
3	FF	Third byte of APCM header
4	50	Message type
5	XX	ID of AP's reservation channel
6	05	Bytes remaining in this message
7	01	Identifies Standby message
8	XX	First byte of PSM serial number (if bytes 8-11 are all zero, message applies to all PSMs)
9	XX	Second byte of PSM serial number
10	XX	Third byte of PSM serial number
11	XX	Fourth (last) byte of PSM serial number
12	XX	First byte of CRC
13	XX	Second (last) byte of CRC

Table 68. Content of Exit Standby Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of APCM header
2	00	Second byte of APCM header
3	FF	Third byte of APCM header
4	50	Message type
5	XX	ID of AP's reservation channel
6	05	Bytes remaining in this message
7	02	Identifies Exit Standby message
8	XX	First byte of PSM serial number (if bytes 8-11 are all zero, message applies to all PSMs)
9	XX	Second byte of PSM serial number
10	XX	Third byte of PSM serial number
11	XX	Fourth (last) byte of PSM serial number
12	XX	First byte of CRC
13	XX	Second (last) byte of CRC

Table 69. Content of PSM Downlink Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of APCM header
2	00	Second byte of APCM header
3	FF	Third byte of APCM header
4	50	Message type
5	XX	ID of AP's reservation channel
6	XX	Bytes (N) remaining in this message
7	03	Identifies Downlink message
8	XX	First byte of PSM serial number (if bytes 8-11 are all zero, message applies to all PSMs)
9	XX	Second byte of PSM serial number
10	XX	Third byte of PSM serial number
11	XX	Fourth (last) byte of PSM serial number
12,13	XXXX	Compartment ID (12 bits), AP ID (4 bits)
14,15	XXXX	Ship ID
16	XX	First (of N – 11) data byte (if there are no data bytes: N = 11, byte 16 is the first byte of CRC, and byte 17 is the last byte of CRC)
...		
N + 4	XX	Last (of N – 11) data byte
N + 5	XX	First byte of CRC
N + 6	XX	Second (last) byte of CRC

Table 70. Content of Physiological Data Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of PSM header
2	00	Second byte of PSM header
3	FF	Third byte of PSM header
4	60	Message type
5	XX	First byte of PSM serial number
6	XX	Second byte of PSM serial number
7	XX	Third byte of PSM serial number
8	XX	Fourth (last) byte of PSM serial number
9	see Table 55	Status byte 1
10	XX	Heart rate, BPM
11	XX	Axillary temperature, °C
12	XX	Environmental temperature, °C
13	see Table 56	Status byte 2
14	XX	CIU battery voltage, Volts
15	FF	Reserved
16	XX	First byte of CRC
17	XX	Second (last) byte of CRC

Table 71. Content of Positioning Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of PSM header
2	00	Second byte of PSM header
3	FF	Third byte of PSM Header
4	61	Message type
5	XX	First byte of PSM serial number
6	XX	Second byte of PSM serial number
7	XX	Third byte of PSM serial number
8	XX	Fourth byte of PSM serial number
9	see Table 55	Status byte 1
10	XX	First byte of CRC
11	XX	Second (last) byte of CRC

Table 72. Content of Low Power Shutdown Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of PSM header
2	00	Second byte of PSM header
3	FF	Third byte of PSM header
4	62	Message type
5	XX	First byte of PSM serial number
6	XX	Second byte of PSM serial number
7	XX	Third byte of PSM serial number
8	XX	Fourth (last) byte of PSM serial number
9	XX	First byte of CRC
10	XX	Second (last) byte of CRC

5.5 APCM to SHM Message Content

Table 73 through Table 77 define the content of messages at the APCM to System Health Monitor interface.

Table 73. Content of ICHM Calibration Message

Offset	Type	Name	Interpretation
0	Ulong	GMT_Time	time in GMT for ICHM sensor calibration
4	Ulong	GMT_Date	Date in GMT for ICHM calibration
10	Short	ID	ID number for this cal structure
12	Short	Num_Chan	number of channels (sensors) in cal structure
14	Short	Cal_Type[Num_Chan]	1 - m/s^2, 2 - pressure, 3 - volts, 4 - magnetic, 5 - m/s, 6 - m/s, etc.
	Short	Status[Num_Chan]	0 - factory cal, 1 - ICHM validated, 2 - self check ok, 3 - out of spec, 4 - inoper
	Float	Time_Cal	cal constant for time domain integer data (multiply ADC int value by)
	Float	TC_Freq	frequency where time cal was actually measured
	Short	Num_Freq	number of frequencies in the cal structure - 1 for single constant
	Float	f[1]	frequency data in Hz for 1st point, channel 1
	Float	mag[1][1]	magnitude data (multiply int by to calibrate) for 1st point, channel 1
	Float	phz[1][1]	phase data (multiply int by to calibrate into radians) for 1st point, channel 1
	Float	mag[2][1]	magnitude data (multiply int by to calibrate) for 1st point, channel 2
	Float	phz[2][1]	phase data (multiply int by to calibrate into radians) for 1st point, channel 2
	Float	f[n]	frequency data in Hz for nth point, channel 1
	Float	mag[1][n]	magnitude data (multiply int by to calibrate) for nth point, channel 1
	Float	phz[1][n]	phase data (multiply int by to calibrate into radians) for nth point, channel 1

Table 74. Content of ICHM Data Message

Offset	Type	Name	Interpretation
0	256 Char	Comment String	String that describes the run/sensors
256	Ulong	GMT_time	Time in GMT for beginning of record (seconds since 00:00:00 GMT)
260	Ulong	Prec_nsec	decimal part of the precise time in nanoseconds
264	Ulong	GMT_date	GMT date (days since 1 Jan. 1970)
268	Ulong	Record Length	# samples in this record
272	Short	Data Type	1-time, 2-spatial(image), 3-frequency(magnitude), 4-req(magnitude/phase), 5-frequency(real/imaginary)
274	Short	Sample Size	Number of bytes/sample: 1:char, 2:short, 4:int, -4:float
276	Short	Num_Chan	Number of sensor channels
278	Short	Resolution	# A/D bits
280	Short	Calibration	0 = none
280+chan#*2	Float	Reserved	Reserved for future use
282+chan#*2	Float	Sampling Rate	(Fs, Pixels/Line, frequency step)
286+chan#*2	float	Chan1[1] Chan2[1] : ChanN[1] Chan1[2] Chan2[2] : ChanN[2] :	Channel 1 sample 1 Channel 2 sample 1 : Channel N sample 1 Channel 1 sample 2 Channel 2 sample 2 : Channel N sample 2 :

Table 75. Content of ICHM Alert Message

Offset	Type	Name	Interpretation
0	unsigned long	GMT_Time	Time in GMT for last alert calculation update
4	unsigned long	GMT_Date	Date in GMT for last alert calculation update
8	int	Alert_Type	ID number for alert or feature algorithm on ICHM
10	int	Alert_ON	1 - alert exceedence condition is met, 0 - else
12	float	Prob_Thresh	Probability threshold (0.00 - 1.00) for alert condition
16	float	Time_Thresh	Time threshold in hours to failure for alert condition
20	int	Thresh_Update	Set to 1 by SHM for new thresholds, set to 0 by ICHM
22	int	Num_Prob	Number of probability samples in Prob vs time curve
24	float	Time_Step[1]	Time in hours for 1st probability calculation
28	float	Prob_Fail[1]	Estimated probability of failure at Time_Step[1]
32	float	Time_Step[2]	Time in hours for 2nd probability calculation
36	float	Prob_Fail[2]	Estimated probability of failure at Time_Step[2], etc.

Table 76. Content of SHM System Status Message

Offset	Type	Name	Interpretation
0	ulong	GMT_Time	Time in GMT for last status update
4	ulong	GMT_Date	Date in GMT for last status update
8	short	SHM_ID	SHM ID number
10	short	SHM_Status	Overall SHM Status: 0 - offline, 1 - nominal, 2 - failure alert, 3 - servicing alert
12	char[12]	SC_File	Overall SHM configuration filename
24	char[12]	SP_File	Overall SHM prognostic filename
36	short	SHM_Subs	Number of Health Subsystems
38	char[12]	Sub_File[1]	Subsys[1] configuration filename (combos of ICHM's)
50	char[12]	Sub_Prog[1]	Subsys[1] prognostic filename
?	short	Num_ICHM	Number of ICHMs
?	char[12]	IC_File[1]	ICHM[1] configuration filename (combos of sensors)
?	char[12]	IC_Prog[1]	ICHM[1] prognostic filename

Table 77. Content of Configuration Data Message

Offset	Type	Name	Interpretation
0	unsigned long	GMT_Date	Date in GMT for configuration
4	short	Type	Configuration type: 0 - component, 1 - sensor, 2 - ICHM, 3 - SHM
6	short	Num_Elem	Number of elements (1 if Type = 0 or 1)
8	char[12]	Pict_El[1]	Picture filename (JPEG format) element[1]
20	char[12]	Doc_El[1]	Documentation filename element[1] (specs, location, cat #, etc. in HTML)
32	char[12]	Config_El[1]	Further configuration filename (NULL if Type = 0, 1)

5.6 APCM to OTM Message Content

Table 78 defines the content of the message at the AP to Ordinance Tracking Monitor interface.

Table 78. Content of OTM Uplink Message

Byte Number	Value (Hex)	Interpretation
1	FF	First byte of OTM header
2	00	Second byte of OTM header
3	FF	Third byte of OTM header
4	60	Message type
5	XX	First byte of OTM serial number
6	XX	Second byte of OTM serial number
7	XX	Third byte of OTM serial number
8	XX	Fourth (last) byte of OTM serial number
9	XX	Current temperature, °C
10	XX	First byte of number of stored temperature values
11	XX	Second byte of number of stored temperature values
12	XX	Battery level, volts
13	XX	First byte of CRC
14	XX	Second (last) byte of CRC