Multi-base TDMA with Global Data Visibility

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Overview

This Tech Brief describes the configuration and issues related to creating a TDMA system with the following features:

- Multiple base stations

- Unlimited data sinks (nodes interested in receiving the data)

- Finite data sources (nodes receiving data)

- Global data visibility (all nodes within the system receive all messages)

The Tech Brief describes the configuration and technical issues related to the GPS tracking radios supplied to SAIC for the SOCOM demo in June 2011.

The radios Raveon delivered for the SOCOM demo are:

1. One VHF green GPS transponder,3 Khaki colored transponders

2. One Base Station comprised of
   a. An RV-M7-VB-M7-GX radio
   b. A Sena LS110 Ethernet terminal server

c. A metal enclosure for the above to be mounted on a tower.

System Demo Requirements

Based upon emails and discussions, here are the demo requirements as we understand them:

1. The primary requirements are in the "Demonstration Plan" document from PEO STRI of May 2011.

2. One of the demo requirements is to modify the reporting rate of a unit(s) in real time via the control center.
    JS Comments: *This is not supported with the current Raveon system, because we program the units ahead of time with their reporting slots/rates. But the units can automatically switch reporting rate if they get triggered by either a Man Down event or a trigger bit (911 switch).*

3. The spec calls for a "threshold" reporting rate of every 90 seconds and an "objective" rate of 30 seconds, for a max of 400 players. I think we will propose all players report at the 30 second rate, so the maximum number of slots/sec needed is 14 (leaves 30% reserve), which leaves room for increasing the reporting rate for a selected number of units. I do not think there will ever be a single exercise with over 200 players! So for the demo let's see if we can come up with a way to change the rate of 1 or 2 players in real time, maybe by a command from the Riptide EXCON.
    JS Comment: *Raveon is working on this, and we expect to have firmware to do this. See the section in this document describing how to change report rate over-the-air.*

4. The SOCOM SMS SOW requires minimum updates (Threshold) of 90 seconds and Objective of every 30 seconds. I would recommend a 30 second epoch to show that could be the standard for handling 400 players with a 30% reserve for quicker updates as needed. But if what you are saying is that that a player cannot update faster than one epoch period (i.e. 30 seconds), then maybe for the system we should go with a 5 second epoch, and update the players every 30 seconds (and show them on a chart that we can handle 400 players easily), and then let them change in real-time to have them update at the 5 second rate. This will show

our capability to go to 5 second updates, which I believe is their desire. I do not think they are ever thinking of one second updates.

JG Comment: *Also, no problem with me on the 5 second update rate, with a 1 second epoch to show how we can increase the update rate in real time.*

Configuration Notes

General System Configuration

TDMA Epoch (TDMATIME) is set to 1 second.

TDMA SlotTime (SLOTTIME) is set to 100mS

Encryption is enabled (KEYPHRASE RAVEON)

Idle TX rate (IDLERATE) is 5 seconds.

Transmit rate (TXRATE) when active is 1 second.

Radio frequency is set to 148.100MHz.

IF bandwidth is wide-band.

Over-the-air data rate is 9600bps.

GPS Transponders

Man down feature is enabled. Down-time to trigger is 15 seconds. (MANDOWN 15)

The DTR digital input is Bit 0. It is enabled as a "Trigger Bit" to cause the unit to automatically switch to fast reporting.

> TRIGBITS 1 enables this bit as a trigger bit.

> TRIGPOL 0   sets trigger polarity to default (Active high)

Transponders are in GPS mode 4 (GPS 4). They will TX and RX data as well as report their position.

Serial port baud rate is 4800.

Message output format is $GPWPL

Base Station Radio

It is set to GPS mode 2 (GPS 2)

Serial port baud rate is 38400.

Message output format is $PRAVE.

Slot quantity of 2, which will give it a bit more air-time allocation to send over-the-air commands if necessary. (SLOTQTY 2)
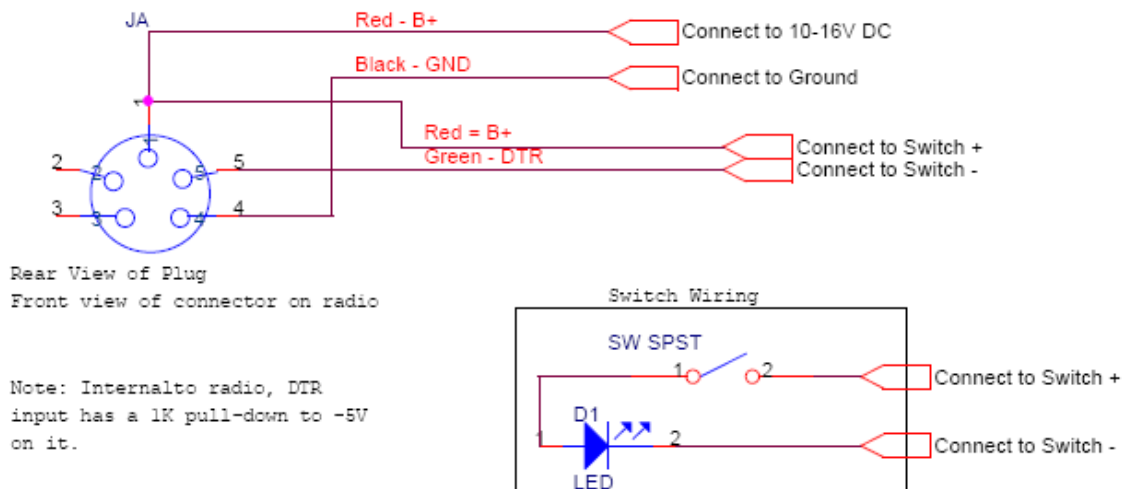
GPS position report rate of 60 seconds (TXRATE 60)   This allows us to monitor the health of the base from a remote location.

Radio Configuration

S/N	MYID	SLOTNUM	SLOTQTY	TOID	ID Mask	Comments
1799853	1	1	2	1	F000	This unit is inside the metal base station box.
1811955	4	4	1	1	F000	Cabled. It is Khaki colored
	5	5	1	1	FFFF	
1796225	6	6	1	1	F000	Khaki colored.
	7	7	1	1	FFFF	

911 Cable Wiring

Supplied to SAIC is a cable with the Lemo connector on the end of it to be used to power the radio and connect a 911 switch. The wiring diagram is below.

JA

Red - B+ — Connect to 10-16V DC

Black - GND — Connect to Ground

Red = B+ — Connect to Switch +
Green - DTR — Connect to Switch -

2   5
3   4

Rear View of Plug
Front view of connector on radio

Note: Internalto radio, DTR
input has a 1K pull-down to -5V
on it.

Switch Wiring

SW SPST
1   2 — Connect to Switch +

D1
1   2 — Connect to Switch -
LED

Raveon also supplied one programming cable to power the radio and allow an RS232 serial connection to the radio.

For reference, Pin 2 is RS232 RX data and pin 3 is RS232 TX data. One the 911 cable, these pins are not wired.

Over-The-Air changing of the TX Rate

Currently, Raveon does not support this, but we are looking into getting this working very soon. We have two mechanisms of programming over the air, but the TXRATE parameter was not enabled for these functions. We will release a version of firmware (C24) that will allows the TXRATE parameter to be adjusted over the air.   There are two methods built into Raveon radios that allow over-the-air reprogramming. One is executing Remote Procedure Requests (RPRs) and the other uses the "WMX" packet protocol interface.

Method 1: RPR

Modems with firmware C3 and above have over-the-air diagnostics capability. When the modem is in the COMMAND mode, some commands may be issued that are intended for use on other modems in the system. The modem connected to the command user's device will send the command to the intended remote M7 Series over-the-air on the currently selected channel.

The remote modem will process the requested command (whether or not it is in its COMMAND mode) and then transmit its response back to the requesting modem. Depending upon baud-rate, the command, and the system configuration, the response

may take some time to execute. The requesting M7 Series modem will time-out after 5 seconds if a response does not come back.

RPR commands are generally used to interrogate remote modems, and find out their internal statistics, operation parameters, and how they were configured.

If a <CR> is entered into the requesting M7 Series while it is waiting for a remote response, it will then abort the request and not send the time-out message if the remote request does not come back. Even when a <CR> is entered, if the response is received from a remote modem, the M7 Series that initiated the RPR will output the response.

RPR Protocol

All M7 Series modems with Firmware version D2 and above have the ability to send a Remote Procedure Request to other M7 Series modems. The requesting M7 Series must be in the COMMAND mode. A M7 Series modem is put into the command mode using the **+++** sequence per the *M7 Series Data Radio MODEM Technical Manual*. Section 5.3 describes the various RPR commands that are available.

When a M7 Series modem receives an RPR response message back from the remote modem that executed the RPR, it will output the message in the following general format:

<REPLY>	The Phrase "<REPLY>" in ASCII characters, followed by a and ASCII <CR> and <LF>.
FROM=1234	The Phrase "FROM=" followed by the 4-digit ID of the modem that sent the RPR response, and then a <CR> <LF> sequence.
RSSI=-76	The RPR response text. This may be one parameter, a list of parameters, or other information. It is dependent upon the RPR command. See section 5.3 for a description of the RPR responses.
</REPLY>	The Phrase "</REPLY>" in ASCII characters, followed by a and ASCII <CR> and <LF>. This phrase may be used to determine the end of the RPR message.

All RPR responses end with a <CR><LF> sequence. So for example, the line <REPLY> is actually sent as: *< R E P L Y >* <CR> <LF>

Remote Procedure Request Commands

The following RPR commands are supported. All RPR commands, except the PING command must be preceded with the text **RPR.**

PING

PING xxxx	Send a "PING" to modem xxxx where xxxx is 0000 thru FFFE. A PING is a short request transmitted over the air to another modem that tells the remote modem to answer back with a short status packet.

Example: PINGs remote modem 1234.

PING 1234	*User enters request to PING station 1234*
<REPLY> FROM=1234 RSSI=-76 </REPLY>	*Response back from remote modem 1234 indicates that the RSSI of this modem, as received by modem 1234 was –76dBm.*

A modem will respond to a PING request if its ID exactly matches the ID specified in the ping. The Address Mask in the modem ping pinged is not used to determine if it should respond to a PING. As long as all modems in a system each have a unique ID, then any individual modem may be PINGed.

RPR ATVR

RPR xxxx ATVR   Request the software version of remote modem xxxx where xxxx is 0000 thru FFFE.

Example: Request the software version from modem 1234.

RPR 1234 ATVR	*User enters request to station 1234*

`<RPR>`
`FROM=1234`
`ATVR=D2`
`</RPR>`
	Response back from remote modem 1234 indicates that the modem's firmware is verion "D2".

RPR ATVB

RPR xxxx ATVB   Request the DC input voltage of remote modem xxxx where xxxx is 0000 thru FFFE.

Example: Request the software version from modem 1234.

RPR 1234 ATVB	*User enters request to station 1234*

`<RPR>`
`FROM=1234`
`ATVB=12520`
`</RPR>`
	Response back from remote modem 1234 indicates that the modem's dc input voltage is 12525mV (12.520 volts)

WMX Protocol

What is WMX?

WMX is a serial communication protocol, used in Raveon's wireless modems, to allow a user to have full control over these sending and receiving of data. It allows the user of a Raveon modem to specify the destination ID when sending data. It also allows the user to identify the source of data when data is received.

Without the WMX protocol, a Raveon wireless modem transparently send and receives data to and from other Raveon modems, and the ID of the modems in the network are all pre-configured at time of installation.

With WMX, the user my specify "on-the-fly" the destination ID of data that is to be transmitted. All received data is passed to the user in a pre-defined format, so the source of the data may be determined.

Also, the WMX protocol allows for sending "Commands" to other radio modems. This allows the user to execute certain functions or control certain features of another remote modem – using the WMX Command protocol.

To enable the WMX protocol on the M7 series of radios, issue the **WMX 1** command. **WMX 0** disables it.

WMX Frame Format Overview

Contact Raveon for a document describing the WMX protocol. Here is an overview.

WMX Frames are used to pass data into and out of a radio modem. The bytes in the data field of the frame, field 6, contains the data that is transferred. The same frame format is used to send or receive data.

Data Frame Format

Field Number	Number of bytes	Field Name	ASCII Code	Function
	1	Start of Header (SOH)	1 (0x01)	Indicates beginning of a frame
1	1	Control Field[*1]	Variable 0x40 – 0xFF	This byte contains frame control information specific to the type of frame.
2	0-4	Destination Address	ID in ASCII hex, 0000-FFFF	0-4 ASCII HEX representation of the destination address. For transmitting, may be left NULL (no characters). If NULL the destination address will then be set by the ATDT address programmed into the sending modem.
	1	Separator 1 (!)	33 (0x21)	Field separator character.
3	0-4	Source Address (Optional when transmitting)	ID in ASCII hex, 0000-FFFF	0-4 ASCII HEX representation of the source address. For transmitting, usually left NULL (no characters) as the source address will then be set by the MYID address programmed into the sending modem.
	1	Separator 2 (")	34 (0x22)	Field separator character.
4	0-4	Group Number (Optional when transmitting)	Group number in ASCII 0-255	0-3 ASCII decimal digits representing the group this Frame belongs to. Group 0=255 is the wildcard.
	1	Separator 3 (#)	35 (0x23)	Field separator character (when transmitting, may be left out if sequence field is not used)
5	0-4	Sequence (Optional when transmitting)	ASCII number 0-255	A sequence number for this transmission to uniquely identify it. Set to 0 or NULL to let the modem automatically assign the sequence.
	1	Separator 4 ($)	36 (0x24)	Field separator character (may be left out if info field is not used)
6	0-16	RSSI Field (Optional	ASCII digits	RSSI Information about this packet.
	1	Start of Text (SOT)	2 (0x02)	Indicates beginning of data
7	1-500	Data Field		The data bytes sent/received by the user. May be any binary data bytes except the DLE ETX sequence. *See Binary Encoding* section on how to send 8-bit binary data.
	2	End of Text (DLE ETX)	16 (0x10) 3 (0x03)	ETX end of the data frame
8	0 - 4	ASCII hex Checksum (Optional)	Variable 0-FFFF	The 16-bit checksum of all the previous bytes, starting with the SOH through the end of the data bytes, not including DLE/ETX. Most significant digit first.
	1	End of Transmission	4 (0x04)	Indicates end of the frame

		(EOT)		

Note that the Data Field should not contain the DLE ETX sequence, as this is used to identify the end of the data. If the user's application may have this sequence in its data, Raveon recommends that a character stuffing/replacing system be implemented to replace this sequence with another sequence.

Control Field

The Control Field is used to identify the type of frame, and manage certain options.

Bit Num	7	6	5	4	3	2	1	0
Usage	Reserved	Always1	Reserved	ACK Requested	Frame Type			
Value (Set to 0 if reserved)	0	1	0	0 = no 1 = yes	0 = Transmit Data 1 = Reserved for OEM use 2 = Received Data 3 = ACK received 4 = Command Request 5 = Command Response			

The lower 4 bits of the Control Filed identify the type of WMX frame being passed.

Bit 4 is used to specify if the user wishes the receiving modem to send an acknowledgement that the message was received. If bit 4 is 0, not AKC is requested. If it is 1, the receiving modem will automatically send a special ACK message back over-the-air to let the sending station know it received the message.

Currently, products supporting the WMX protocol have frame buffers capable of handling WMX frames with up to 256 bytes of data.

WMX Control Byte List

0x40   Send Data, no ACK required

0x50   Send Data, ACK (Future Version)

0x42   Receive Data

0x44   Send a command, no ACK required

0x45   Received a response to a command

0x54   Send a command, ACK requested

Command Request Field Format

When exchanging commands or the results of commands, the bytes in the Data Field of the frame, field 7, contains information specific to requested type of command or the response returned.

Data Frame Format

Field Number	Number of bytes	Field Name	ASCII Code	Function
	1	(SOT)	1 (0x02)	Indicates beginning of a data
7	1-500	Control Field	Variable 0x40 – 0xFF	These bytes contain the command to be executed, in ASCII string format. A <CR>

				at the end of the string is not necessary.
	2	(DLE ETX)	20 (0x10) 3 (0x03)	ETX end of the data frame

Checksum

The 16-bit checksum is calculated by adding the unsigned binary value of all of the characters starting with the SOH through the ETX bytes. If the result exceeds 16 bits, the reported result should be truncated to 16 bits.

If the user does not wish to implement a checksum, do not put any characters in this field.

RSSI Field

An optional field, the **RSSI Field** may contain additional information about the frame. If present, the first digits following the Separator 4 character indicate the RSSI of the frame. The numbers are assumed to be negative numbers. (i.e. -73dBm will have a value of 73).

The RSSI Field is not required. The presence of the separator 4 character (0x24) indicates that it is present. Only products that support version C of the WMX protocol or higher will output the RSSI value when receiving data.

$PRAVE message format.

The $PRAVE message is sent out the *RV-M7 GX* when it is configured for **GPS 2** mode of operation. This mode is typically used with the RavTrack PC program, or other computer programs that can process position and status information. GPS mode 2 instructs that the output be sent at 38.4K bytes/second out the serial port.

Along with ID and position information, the $PRAVE contains a host of other status information. The length of this message may exceed he standard NMEA limit of 79 characters. Any product or software that uses this message must take this into account.

Following is a list of the fields sent in this message

Field	Usage	Comments
1	$PRAVE	Raveon Proprietary Header
2	From ID	The ID of the transponder that transmitted its position over the air. It is a decimal number, 0 – 9999.
3	To ID	The ID that this position report was sent to. It is a decimal number, 0 – 9999.
4	Latitude	dddmm.mmmm format. It is signed. + is north, – is south. No sign means north. Note: typically there are 4 decimal places, but as few as 0 decimal places are possible. Null field if no GPS lock.
5	Longitude	dddmm.mmmm format. It is signed. + is east, – is west. No sign means east. Note: typically there are 4 decimal places, but as few as 0 decimal places are possible. Null field if no GPS lock.
6	UTC time	The UTC time at the time the transmission was made. Hhmmss format. Null field if no GPS lock.
7	GPS Status	0=not valid position. > 0 is valid GPS. 1=GPS locked and valid position, 2=GPS locked with WAAS corrections applied
8	Num Satellites	The number of satellites in view
9	Altitude	The altitude in meters. Null field if no GPS lock.
10	Temperature	The internal temperature of the RV-M7 in degrees C. Typically this is 5-20 degrees above ambient.
11	Voltage	Input voltage to the device that sent this position.
12	IO status	A decimal number representing the binary input bit status. **Bit 0 is the DTR input (911 button for SOCOM demo).**
13	RSSI	The signal-strength of this message as measured by the receiver, in dBm. Note, if the message went through a repeater, it is the signal lever of the repeated message.
14	Speed	The speed of the device in km/hour, 0-255
15	Heading	The heading of the device 0-360 degrees.

16	Alerts	Alert codes for alerts currently indicated in the device. NULL means no alerts. "P" means a proximity alert. "A"means alert. "C" means critical alert, **"M" means man-down**.
17	Spare	A spare field. May be used for UTC date in the future. Typically NULL.
18	*	The "*" NMEA end-of-message identifier.
19	Checksum	The NMEA 0183 checksum.

Example Sentence:

$PRAVE,0001,0001,3308.9051,-11713.1164,195348,1,10,168,31,13.3,3,-83,0,0,,*66

This example shows a unit at 33° 8.9051 north latitude and 117° 13.1164 east longitude. It is not moving (0 speed). Its signal strength was -83dBm. Its altitude is 168 meters.

For your curiosity or testing purposes, below is a capture of vehicle 0003 driving around the Raveon office in Vista, California.

$PRAVE,0003,0001,3308.9077,-11713.1259,154656,1,8,200,24,11.6,0,-69,0,0,,*76
$PRAVE,0003,0001,3308.9082,-11713.1262,154716,2,8,199,24,11.6,0,-64,0,0,,*7C

Open Issues

1. Does Raveon need to prepare any presentation materials for the demo?

2. Is 148.100MHz and OK frequency to use for the demo?

3.

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