DSP Comm: AquaComm Modem

27 September 2013
High Reliability of Communications

- Designed for highly reliable underwater communications
  - Works in virtually any real world sea state where others have failed
  - Dramatically reduces operational risks and maintenance costs

- Major organizations have tested and proven the reliability of this modem through commercial use
  - Brings certainty and confidence that your application will work
Low Power Consumption

• This modem uses 10 – 20 times less power than competing modems
  • Lower maintenance requirements and total cost of ownership
  • Broadens the applications the modem can be used for
Ease of Integration

• Small form factor, lightweight
  • Quick and low-cost integration

• Transparent command modes
  • Lower total cost of ownership

• Command structure that is easy to understand

• Can quickly and successfully integrate with numerous products
Small Form and Lightweight

• Less than half the size of competing modems
  • Broadens the types of applications the modem can be used for
## Specs

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
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<tbody>
<tr>
<td><strong>Data rates</strong></td>
<td>100 or 480 bits per second depending on model</td>
</tr>
<tr>
<td><strong>Bit Error Rate</strong></td>
<td>$10^{-6}$ bit error rate or better</td>
</tr>
<tr>
<td><strong>Acoustic Doppler Tolerance</strong></td>
<td>High immunity to noise and to multi-path and Doppler fading.</td>
</tr>
<tr>
<td><strong>Bandwidth</strong></td>
<td>Broadband operation 16KHz to 30KHz</td>
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<tr>
<td><strong>Range</strong></td>
<td>Tested to 3km range. Longer ranges possible</td>
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<tr>
<td><strong>Modulation</strong></td>
<td>Direct sequence spread spectrum / OFDM</td>
</tr>
<tr>
<td><strong>Error detection</strong></td>
<td>CRC16 error detection</td>
</tr>
<tr>
<td><strong>Through water communications protocol</strong></td>
<td>Confirmed packet delivery with error detection. If the transmitting end does not receive an acknowledgement, it will resend the data two more times. Number of retries is configurable.</td>
</tr>
<tr>
<td><strong>Addressing</strong></td>
<td>Uniquely addressable. Six digit numeric address set through host command.</td>
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<tr>
<td><strong>Receive sensitivity</strong></td>
<td>Ability to set the receive sensitivity</td>
</tr>
<tr>
<td><strong>Transmit power</strong></td>
<td>Ability to set the transmit power level</td>
</tr>
<tr>
<td><strong>Physical size</strong></td>
<td>8cm x 7cm x 1.5cm (excluding transformer)</td>
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</table>

| **Electronics**               | Digital signal processor based                                         |
| **Power supply input voltage**| DC 5V to 9V                                                            |
| **Current consumption @ 6V DC**| 42mA (nominal) in normal wake operation                                |
|                               | 4.2mA in power save receive                                            |
|                               | Less than 150uA in sleep mode                                          |
| **External connections**      | 10 pin KK header to connect power, host communications, reset line and wake up line |
|                               | 2 pin terminal to connect hydrophone transducer                        |
| **Host communications**       | RS232 serial communications.                                           |
|                               | 9600 baud (default), 1 start bit, 1 stop bit, no parity               |
|                               | 4800, 2400 or 1200 baud programmable                                  |
|                               | Either TTL voltage levels (3.3V) or RS232 voltage levels selectable   |
| **Host command**              | Simple ASCII command set to configure and command the modem           |
| **Temperature range**         | -5 degC to +50 degC                                                    |
References

http://www.dspcomm.com/products_aquacomm.html

• DSPComm website
Challenges to UAN Security

• Long Propagation Delays
• Narrow Bandwidth
• Multipath Effects
• Cannot directly apply existing terrestrial security schemes to UAN’s (Underwater Acoustic Networks)
• Difficult to model an aqueous environment accurately

### UAN Threats, attacks, and defenses

<table>
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<tr>
<th>Protocol Stack</th>
<th>Security Issues</th>
<th>Attacks</th>
<th>Defenses</th>
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<td>Physical Layer</td>
<td>Intrusion Detection</td>
<td>Jamming</td>
<td>CDMA Scheme Low duty cycle Tamper-proofing Hiding nodes</td>
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</table>

Types of Attack

- Denial of Service (DoS) Attack
- Wormhole Attack
- Dummy (signal) Jammer
- Smart (Deceptive) Attack

Wormhole Attack

A wormhole attack is a denial of service attack in which an adversary records a packet at one location in the network, tunnels the packet to another location and replays the recorded packet.

Dummy (Signal) Attack

- Knows nothing about the protocols of the network
- Generates noise to corrupt packets
- UAN’s exist in an open environment and are particularly vulnerable.

Smart (Deceptive) Attack

• Knows some information about the network protocols
• Generally does not follow the MAC (medium access control protocol)
• Uses legitimate control or data packets to corrupt the channel
• This type of jammer will pretend to be a legitimate node.

Modes of Attack

• Constant Attack – Continually injects signals (noise or regular packets) into the communications channel.

• Random Attack – Will alternate between attacking and sleeping in a pseudo-random fashion.

• Reactive Attack – When network activity is sensed the jammer will start attempting to jam the network. This is considered to be more advanced.

Jammer

• The same as was used by Zuba?

Effective Jamming

- Preamble is the most effective attacking point
- Effective scheme requires three phases:
  - Detection of transmission (1)
  - Starting jamming transmission (2)
  - Period of jamming transmission (3)
  - Signal Propagation Time (4)

Physical Layer Potential Solutions (OFDM)

- Chaotic Modulation instead of QAM or BPSK
  - Trade performance for security
  - Tested in terrestrial networks, nothing found on UAN’s
Project Specifications

• Team 185 Project Specification on Google Docs