Developments in Timing and Satellite Telemetry with the Micromodem-2

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Extended Abstract for ACM WUWNet 2012:

The Acoustic Communications Group at the Woods Hole Oceanographic institution has developed new systems that tightly integrate satellite communications and precision timing with the Micromodem-2 underwater acoustic modem [1]. These developments support innovation in operating acoustic telemetry systems, acoustic navigation, and TDMA acoustic networks.

The Micromodem-2 has been enhanced to support a variety of complex timing and scheduling techniques. All acoustic transmissions and receptions are now timestamped using a 1MHz clock that is disciplined by a 2ppm internal clock or more accurate external time sources, when available. Telemetry packets and navigation signals can be sent at precise intervals based on an external trigger signal, at a particular second (based on the PPS signal), or at an arbitrary 50 millisecond interval.

By leveraging the field-programmable gate array (FPGA) on the Micromodem-2, we are able to synchronize multiple clock sources, such as the pulse-per-second (PPS) signal from a GPS receiver, and the modem's internal real-time clock. If the external PPS source is lost, the Micromodem-2 maintains a synchronized clock derived from a 2ppm-accurate internal clock, and the modem seamlessly transitions to operation with the best available clock. This synchronization is sufficient to enable TDMA operation for short missions.

To support longer missions or stringent timing requirements such as those required for acoustic navigation, we are developing a module that incorporates a Symmetricom Chip-Scale Atomic Clock (CSAC) and a GPS receiver. This system provides better than 1ppb accuracy for up to a year without external synchrnonization, and can synchronize with a PPS signal from the GPS system when it is available.

Additionally, we have developed and deployed systems that act as acoustic/satellite gateways based upon custom hardware that incorporates an Iridium 9523 satellite modem module. These systems enable remote operation of multi-node or point-to-point acoustic networks, and have been incorporated into the standard WHOI very-shallow-water gateway buoy.

References

[1] E. Gallimore, J. Partan, I. Vaughn, S. Singh, J. Shusta and L. Freitag, "The WHOI Micromodem-2: A scalable system for acoustic communications and networking," in *OCEANS 2010*, Seattle, 2010.