



# NAVAL RESEARCH LABORATORY

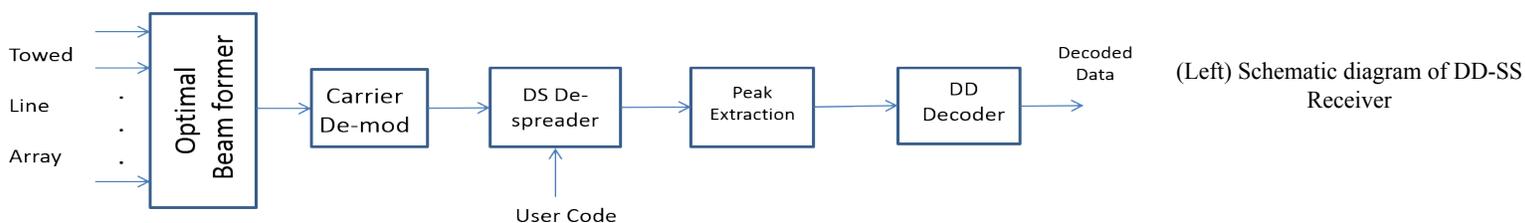
The Corporate Laboratory for the Navy and Marine Corps

## Mobile Underwater Acoustic Communications

NRL researchers have developed a method for mobile underwater acoustic communications that encodes a communication signal for transmitting a doubly differential (DD) spread spectrum (SS) communication output signal. The doubly differential spread spectrum (DD-SS) method results in a highly reliable and efficient system for long range acoustic communications (LRAC).

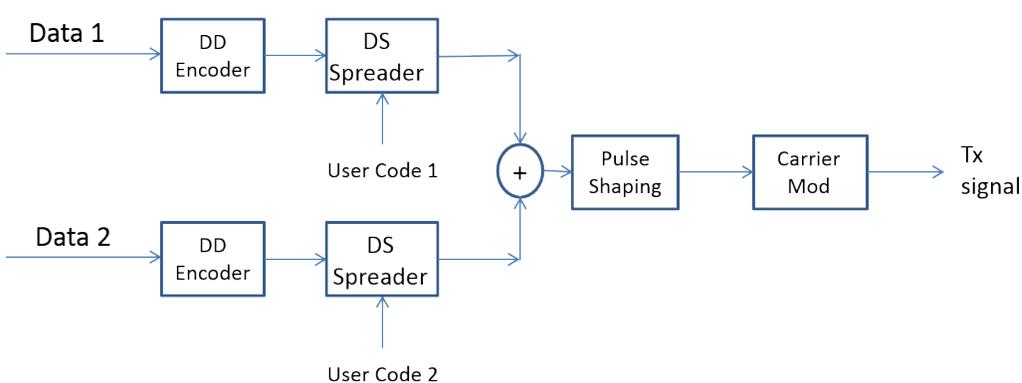
Existing systems attempt to communicate at long ranges of hundreds, even thousands of kilometers. However, most research and experiments have centered on fixed LRAC whereby both the source and receiver are moored. For mobile LRAC applications, the source and/or receiver move at a substantial speed. As a result, a number of difficulties arise which are much more problematic in mobile LRAC. Some examples of system deficiencies are low signal-to-noise ratios (SNRs), sizable Doppler shifts, and severe inter-symbol interference (ISI).

The innovative NRL DD-SS encoding methodology increases the SNR through a processing gain, eliminates ISI via multipath suppression, and enables bandwidth efficiency improvement with data multiplexing. Additionally, the use of DD coding/decoding obviates the need for explicit phase/Doppler tracking and correction. Thus, a system incorporating a doubly differential spread spectrum technique performs robustly against unpredictable fluctuations in underwater communication environments, making it particularly suitable for mobile LRAC.



(Left) Schematic diagram of DD-SS Receiver

(Below) Schematic diagram of DD-SS Transmitter



### Advantages

- Reliable signal reception at extremely low signal-to-noise ratios
- Very robust against unpredictable fluctuations in underwater communication environments
- Lower system cost requiring less receiver components than existing system

### Opportunities

- Mobile long range acoustic communications achieved for remote unmanned underwater vehicles

### Licensing and Collaboration Opportunities

US Patent No. 9,030,918 is available for License to companies with commercial interest. Collaborative research and development is available under a Cooperative Research and Development Agreement (CRADA).