Design and Development of Data Interface Unit for Torpedo Data Acquisition System

Client Background

The Naval Armament Depot (NAD) at Karanja, Uran in Navi Mumbai is a key facility under the Western Naval Command of the Indian Navy. It handles the safe storage, inspection, maintenance, and handling of naval weapons, ammunition, and explosives. Working in coordination with units like the Weapon Equipment Depot and INS Tunir (Missile Depot), NAD serves as a critical support hub for fleet operations.

The A244S lightweight torpedo, a vital anti-submarine warfare asset, undergoes routine maintenance at NAD, including inspection, pressure testing, guidance system calibration, battery replacement, and propulsion refurbishment. Equipped with specialized handling systems, diagnostic tools, and skilled personnel, NAD ensures each torpedo meets strict safety and performance standards before re-induction into service.

Challenge

Naval Armament Depot (NAD) performs deep water and shallow water testing of the A244S torpedo. These tests use an Italian-origin Data Interface Unit (DIU) connected to the torpedo data acquisition system. The DIU transmits collected data to a PC running Test and Evaluation Software (TES) for analysis.

Proprietary Protocols & Signal Formats
Reverse-engineering the DIU requires understanding proprietary Italian communication protocols and signal standards used with torpedo systems.

High-Speed Data Acquisition & Synchronization
Replication must ensure real-time, lossless data capture and precise timing alignment, especially in underwater environments

Challenge

Hardware Compatibility & Environmental Robustness
The DIU must match ruggedized marine standards — waterproof, pressure-tolerant, and EMI-resistant — to function reliably during torpedo trials.

TES Interface Integration
The replicated unit must seamlessly communicate with the existing Test and Evaluation Software, which may expect specific data structures or handshake protocols.

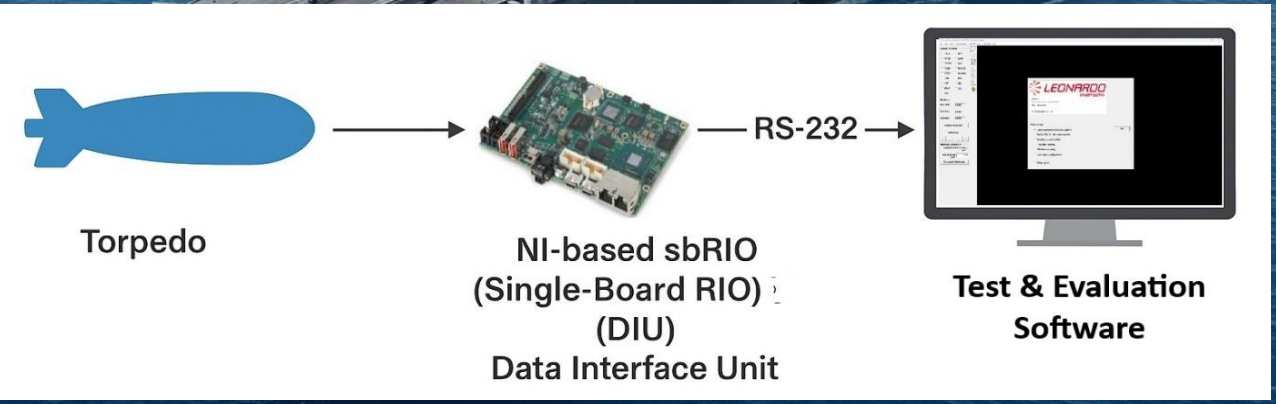
Safety & Compliance Standards
Military-grade devices like DIUs must comply with naval defense safety norms, including data security, system reliability, and operational integrity

Solution

To overcome the challenges in replicating the Italian Data Interface Unit (DIU), we adopted **National Instruments' sbRIO-9638** hardware platform with real-time and FPGA integration. This solution provided the deterministic performance and flexibility required for torpedo test data acquisition and transmission.

The real time data Key Advantages & Implementation Highlights:

- Real-Time Processing with NI Linux RT – stable, time-bound execution for reliable communication.
- Custom FPGA Logic – handled proprietary protocols, signal decoding, and high-speed data capture.
- Rugged & Compact – suitable for harsh torpedo test environments.
- Seamless PC Communication – integrates with existing Test & Evaluation Software (TES).
- Modular & Reprogrammable – supports both deep and shallow water test modes. hardware is system's access



Benefits

1. **Real-Time Operating System (RTOS):** Provides deterministic, time-critical processing essential for torpedo telemetry and control systems.
2. **Integrated FPGA:** Allows implementation of custom signal processing, protocol decoding, and hardware-level data manipulation—ideal for replicating the behavior of proprietary DIU hardware..
3. **Rugged & Deployable Hardware:** Designed for industrial and field conditions, with compact form factor and tolerance to marine testing environments (vibration, temperature, humidity).
4. **High-Speed Data Acquisition:** Supports synchronized, lossless data capture at high speeds, which is critical for torpedo trials.
5. **Flexible Communication Options:** Built-in support for Ethernet, serial, CAN, and other industrial protocols enables smooth interfacing with legacy and modern systems.

Benefits against alternatives

Criteria	NI sbRIO-9638	Typical Alternatives (e.g., Microcontrollers, Custom Boards)
Real-Time Performance	Built-in Real-Time OS with deterministic behavior	Limited or requires complex RTOS integration
FPGA Capability	Onboard FPGA enables custom protocol decoding and fast I/O	External FPGAs add complexity and increase development effort
Development Speed	Rapid prototyping via LabVIEW RT + FPGA	Requires low-level coding (C, VHDL), longer development cycle
Hardware Reliability	Industrial-grade, rugged hardware tested for harsh environments	Often consumer-grade or requires extra ruggedization
System Integration	Seamless with TES via standard interfaces (Ethernet, Serial)	May require middleware or protocol converters
Maintainability & Scaling	Easy to replicate and update via NI tools	Higher cost and time for scaling or design updates
Support & Documentation	Extensive NI support and global user community	Fragmented or vendor-specific documentation

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Thank You !

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