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Lifecycle of IMS hydroacoustic hydrophone stations, and technical approach to their sustainment

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Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO)

CTBTO PREPARATORY COMMISSION

INTRODUCTION AND MAIN RESULTS

The lifecycles of the three subsystems of an IMS hydroacoustic hydrophone station span one order of magnitude. On the other hand, external events such as undersea landslides, fishing, anchoring or energetic surf zones near-shore pose the highest risks of sudden outage of the underwater system. This poster shows how a differentiated approach that takes into account the lifecycle and characteristics of each of the three subsystems (and avoids replacing an entire underwater system when one component is failed) leads to an efficient sustainment strategy for these complex and costly IMS stations. The potential use of new technologies which are becoming available for improving the lifecycle management is also addressed, such as distributed acoustic sensing (DAS) and modularity with underwater wet-mate cable connectors for targeted repairs, as well as the rationale for end-to-end response checks of the system in-situ to enhance the systems' state-of-health assessment.

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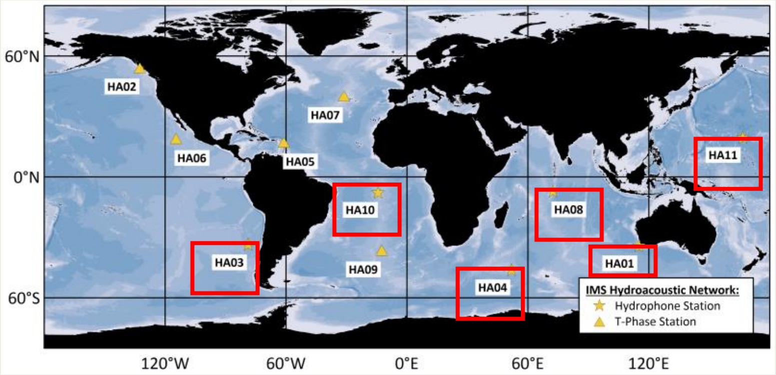
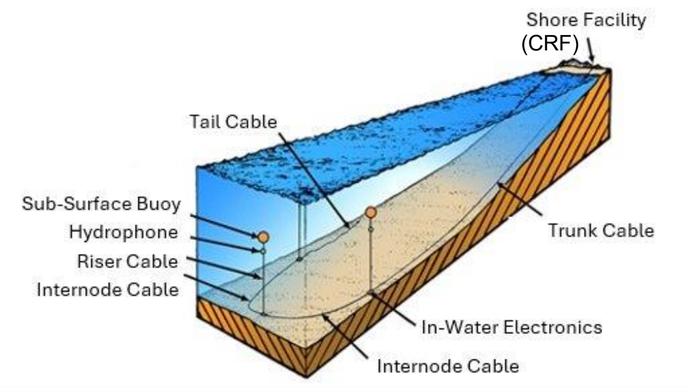
Introduction

The six IMS hydroacoustic (HA) **hydrophone stations** have two triplets of hydrophones each, one North and one South of the islands where the cable is landed, except for HA01 Australia which has one single triplet to the West. The HA hydrophone stations are the most costly IMS stations and the most complex ones to sustain.



Map showing the location of IMS HA stations, hydrophone stations (red boxes) and T-stations. The entire HA network is certified as of 2017.



Schematic of an IMS HA hydrophone station. From left to right: hydrophone triplet, trunk cable and on-shore equipment.

HA hydrophone station subsystems, their lifecycles and sustainment approaches

Subsystem Description and Cost ($, $$, $$$)	Operational Life Expected	Main Risks	Sustainment Approaches, their Cost ($, $$, $$$) and Risk Mitigation
On-shore: Central Recording Facility (CRF), on-land computer systems, power supplies and satellite communication. Infrastructure. **($)**	About 5 years for electronics. Infrastructure 20 years.	Electronics systems aging. Power surges. CRF integrity.	**Proactive sustainment.** Spares rotation every 2 years, equipment replenishment and periodic engineering improvements for electronics. (**$**) Infrastructure maintenance. Lightning protection.
Undersea trunk cable near-shore to diver depth: Telecommunications electrical and fibre-optic cable with added protection by cast-iron split-pipe or horizontal directional drilled conduit to diver depth. **($$)**	>> 40 years (Low-power use, no repeaters, extensive history of use in undersea telecoms)	Sudden risks: anchoring, fishing, energetic surf-zone, cable exposure by moving sediments, corrosion of aging cast-iron split-pipe. Aging risk very low.	**Run-to-failure**. Cable repair or new shore landing when failed (**$$**) . Community cable awareness. Cable Armoring & route planning. Regular inspection by divers 1-5 years interval, stabilization and protection as needed (**$**). Monitor cable health with optical & electrical Time-Domain Reflectometry (TDR) - present. *DAS/interferometry - future*.
Undersea trunk cable off-shore in deep water: Telecommunications electrical and fibre-optic cable. **($$$)**		Sudden risks: fishing (incl. fish-aggregating devices), landslides, deep-sea turbidity currents, rock movements. Aging risk very low.	**Run-to-failure**. Cable repair when failed (**$$-$$$**). Community cable awareness. Cable Armoring & route planning. Spot check cable health with TDR – present, and *DAS/interferometry – future*. *Modularity with wet-mate connectors to separate cable from triplet life-cycle management – future*.
Hydrophone triplet **($$$)**	> 25-30 years from manufacturer analysis (H08S is 25 years old, H01W is 24 years old)	Sudden risks: similar to deep-sea trunk cable. Long-term stress from currents on risers. Aging risk higher than deep-sea trunk cable.	**Run-to-failure**. Replace only the triplet upon failure (**$$-$$$**). Community awareness. Check triplet health through data quality, triplet state-of-health telemetry, in-situ electronics response spot checks-present. *Enhanced health telemetry, end-to-end response checks in-situ (**see O4.4-273**), modularity – future*.