SnT 2021

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PREPARATORY COMMISSION

Safeguarding data availability at IMS Hydroacoustic hydrophone stations by improving on-shore digital data handling equipment

Mario Zampolli[(1)], Jerry P. Stanley[(1)], Georgios Haralabus[(1)], Moctar Moumouni Kountche[(1)], Manuel Hojesky[(2)], Jeff Jenneve[(3)], Peter Jorgensen[(3)], Doug Bowlus[(3)], Guy Cekada[(3)]

E-mail: mario.zampolli@ctbto.org

[(1)] CTBTO/IMS/ED, [(2)] Zühlke Engineering (Austria), [(3)] L3Harris MariPro (USA)

POSTER

P4.3-267

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ABSTRACT

The IMS hydroacoustic (HA) network monitors continuously the world's oceans with only six hydrophone stations (11 triplets). The acoustic signals acquired by the hydrophones are digitized underwater and transmitted via fibre-optic cable to an on-shore Digital Data Formatting Interface (DDFI). The DDFI builds data packets and sends these to the Commission's Standard Station Interface (SSI), where CD1.1 data frames are formed and forwarded to Vienna via satellite. Loss of data from even a single triplet has a high impact on the network's overall coverage and is often associated with the following root causes: SSI malfunction, local DDFI-SSI network or satellite transmission issues. An engineering effort was undertaken to mitigate the impact of such data-loss scenarios by adding to the DDFI a local disk buffer storing hydrophone and diagnostic data. This buffer is accessible through newly developed SSI functionalities, which allow backfilling of user-specified data segments and retrieval of diagnostic data logs by remote user request. The enhanced backfilling makes it possible to recover from the above described data-loss situations, whereas remote retrieval of DDFI diagnostic data leads to more efficient station troubleshooting. Rollout of these new capabilities to HA01, HA03 and HA04 is being planned for the period 2021-2022.

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INTRODUCTION

- In IMS Hydroacoustic (HA) Hydrophone stations, digitized data is sent from the underwater triplet to the Central Recording Facility (CRF).
- The shore data handling equipment in the CRF provides data formatting, time-stamping using GPS pulse-per-second (PPS), merging with diagnostic data and transmission via the satellite communications infrastructure.
- The equipment presently installed in the IMS HA stations' CRF's is resilient against disconnections that affect the satellite transmission equipment in the CRF, but other potential failure modes remain.
- In 2020, upgrades to the shore processing equipment which enhance the resilience to the remaining failure modes identified and improve remote diagnostics of the CRF data handling equipment were developed and extensively tested in the laboratory.
- Roll-out of the upgrades to the shore processing equipment at HA01 Cape Leeuwin (Australia), is planned for June 2021, with HA03 (Juan Fernandez Islands, Chile) and HA04 (Crozet Islands, France) upgrades to follow in the coming years.

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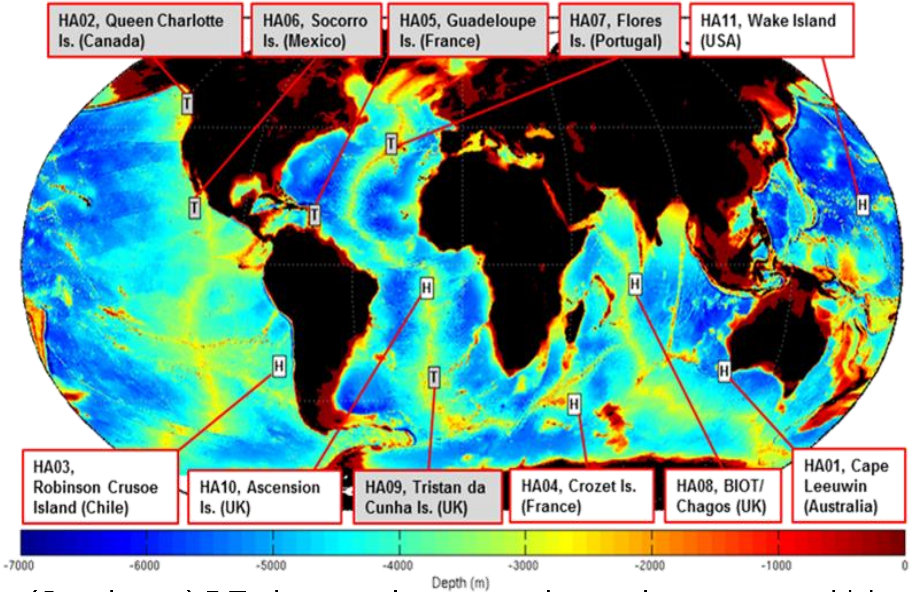
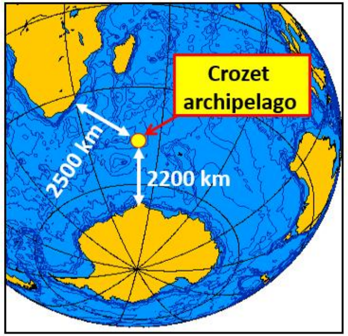
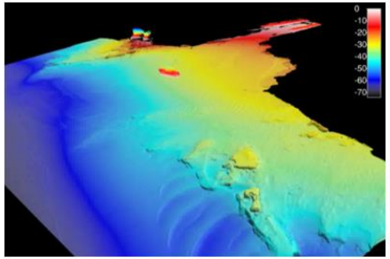
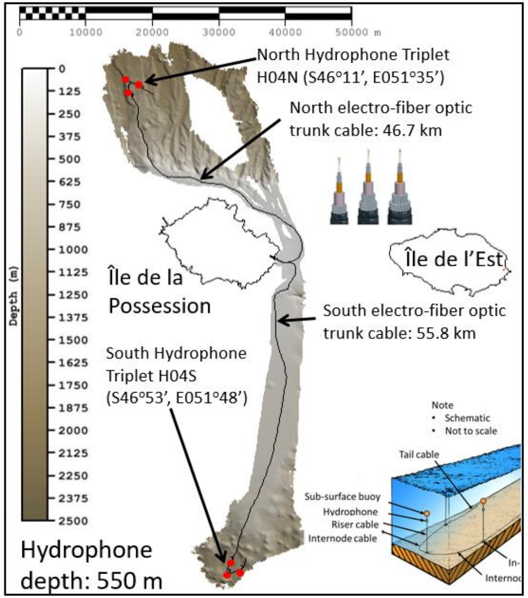
The IMS HA Network









- (Grey boxes) 5 T-phase stations: near-shore seismometers, which record waterborne hydroacoustic waves coupled upslope into the earth's crust.
- (White boxes) 6 Hydrophone stations: moored hydrophones pick up hydroacoustic waves in the water column.

- Focus of this e-Poster is on the HA Hydrophone stations.

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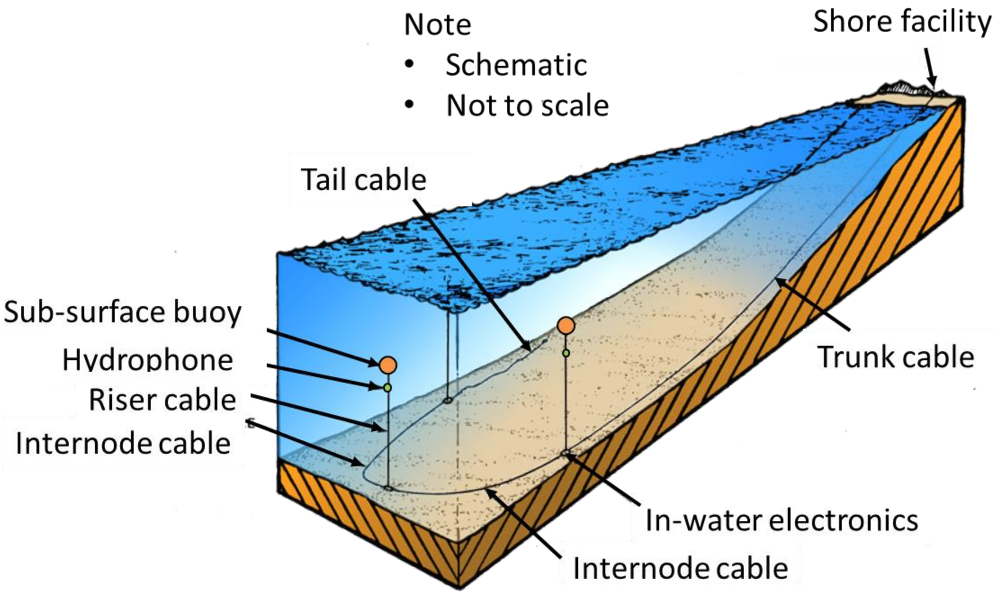
Schematic of an IMS HA Underwater System (UWS)



Data handling equipment in the CRF (shore facility)

Digital Data Formatting Interface (DDFI) (x2):

- Receives digital hydrophone & state-of-health (SOH) data from the UWS triplets via the fibre-optic trunk cables.
- Creates data packets with GPS PPS time-stamp.
- Building & SOH alarms.
- UWS control.

Standard Station Interface (SSI) (x2):

- Creates CD1.1 continuous data frames.
- Provides Authentication Signature.
- Passes CD1.1 frames to satellite communications infrastructure.
- UWS control through DDFI.

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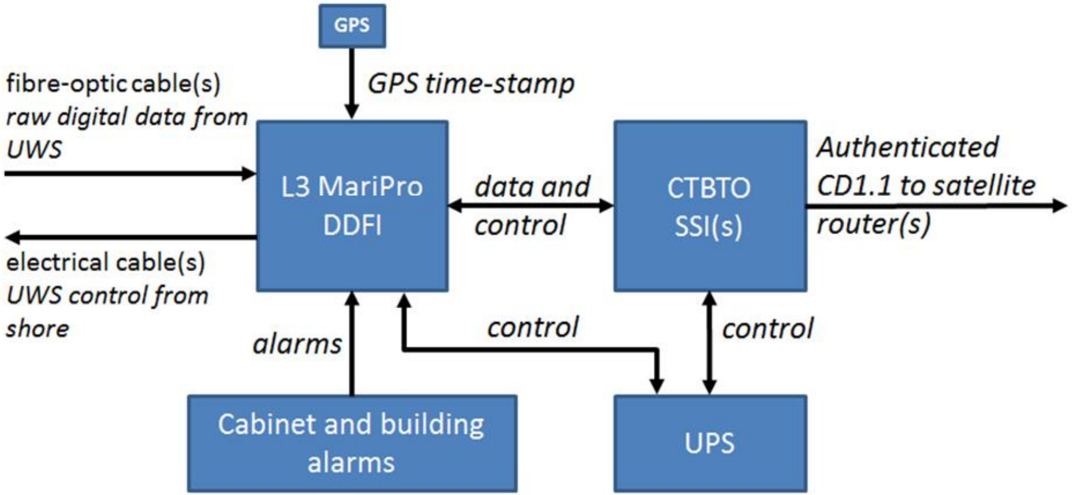
High-level schematic of data-flow and controls in the CRF



- DDFI (Digital Data Formatting Interface), see previous slide.
- SSI (Standard Station Interface), see previous slide. SSI is accessible remotely via the satellite link.
- UPS (Uninterruptible Power Supply), with Ethernet link for secure shutdown of DDFI(s) and SSI(s).

<u>Resilience presently built into the system:</u>

- If connection between SSI and satellite router is interrupted, SSI stores DDFI data in a buffer from which it can be backfilled.
- Once satellite connection is re-established, SSI *automatically* backfills data from its internal buffer.

<u>Remaining failure modes identified, which potentially can lead to data loss with the present systems in the field:</u>

- SSI malfunction/downtime/database issues, no data stored on SSI buffer.
- Loss of data beyond the satellite router.
- In these cases, however, DDFI may continue to work properly, generating time-stamped data packets which are lost.

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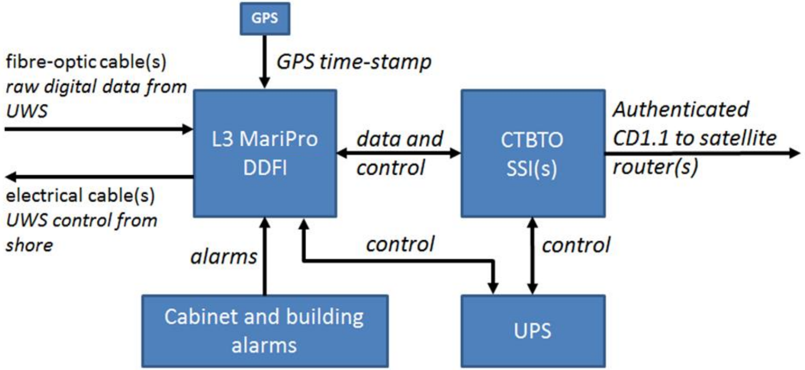
Enhancements to address remaining CRF data-handling equipment failure modes identified



- DDFI (Digital Data Formatting Interface).
- SSI (Standard Station Interface). SSI is accessible remotely via the satellite link.
- UPS (Uninterruptible Power Supply), with Ethernet link for secure shutdown of DDFI(s) and SSI(s).

DDFI enhancements:

A DDFI internal disk-buffer was developed which holds:

- ✓ UWS hydrophone data.
- ✓ UWS diagnostic data log (UWS voltages, current, status and alarms).
- ✓ DDFI internal diagnostics log, with DDFI diagnostic messages and alarms (cabinet & building alarms, and UWS parameters out-of-bounds alarms).
- ✓ SAMBA shared drive to enable access to all DDFI internal disk buffer contents.

SSI enhancements:

- ✓ Backfill *on-demand* from the DDFI internal disk buffer, to recover data in those cases when the SSI was unable to store or transmit it.
- ✓ Extraction on-demand of selected portions of the DDFI/UWS internal logs for analysis through the SSI remote login and/or for download via satellite link.

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Overview of DDFI/SSI enhancements developed and their benefit

Enhancement	Benefit	Comment/Status
SSI backfill on-demand from DDFI's internal data buffer.	Resilience to data-loss from remaining SSI/Satellite equipment failure modes.	Lab-tested extensively with equipment in the USA and remote connection to test-receiver in Vienna (Q3 2020).
Extraction on-demand/access to selected portions of the DDFI/UWS internal logs & alarms logs for analysis through the SSI remote login and/or for download via satellite link.	Enhanced remote trouble-shooting of the DDFI and UWS, with same level of DDFI diagnostic information that is available to a local operator.	Lab-tested extensively with equipment in the USA and remote connection to test-receiver in Vienna (Q3 2020).
Simple SSI command-line instruction to trigger UWS calibration sequence.	Remote triggering of UWS calibration without need for Graphical User Interface interaction.	Additional feature. Lab-tested with equipment in the USA and remote connection to test-receiver in Vienna (Q3 2020).

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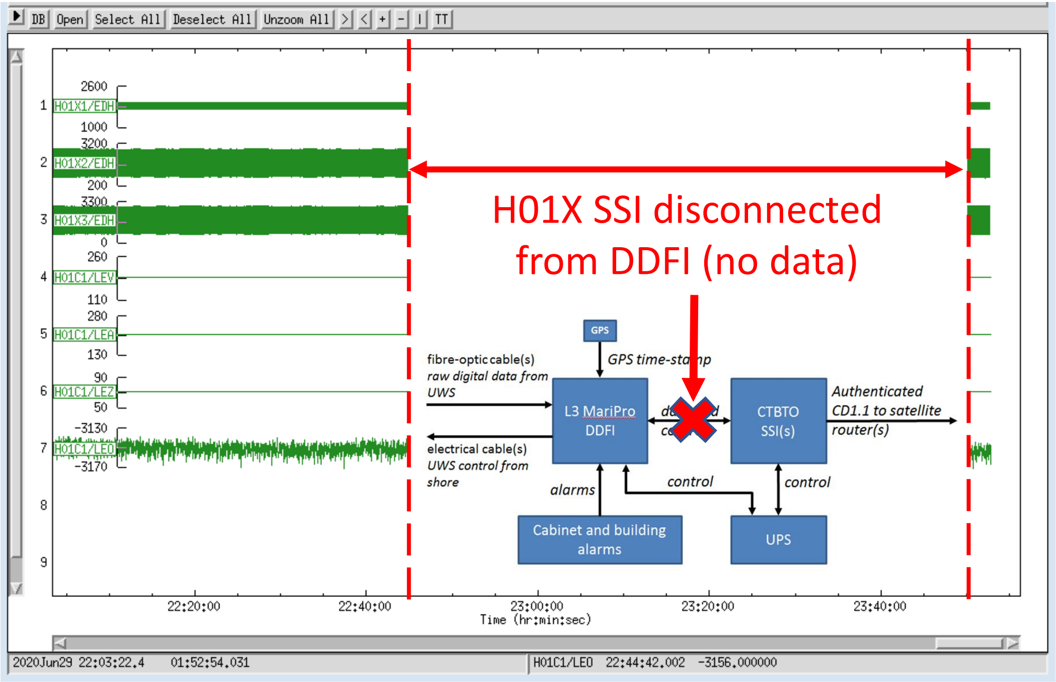
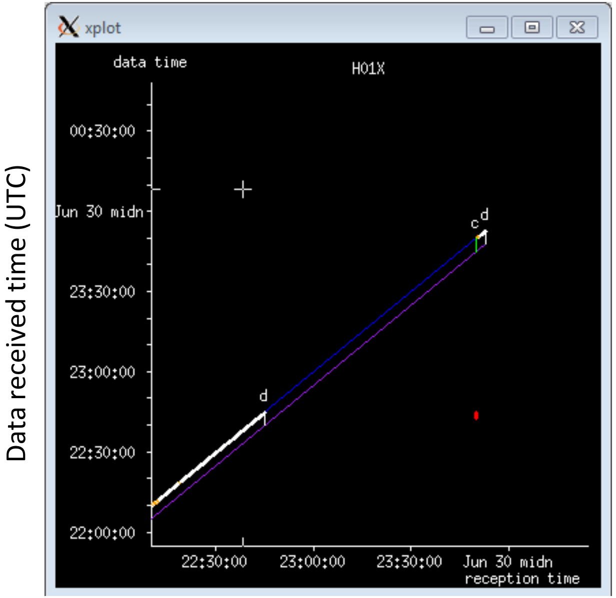
Example of disconnection between SSI and DDFI

Gap in data received in Vienna from test-station H01X (lab in the USA):



Disconnection of the SSI visible in the H01X SSI's sender data file:



Data transmission time (UTC)

Disclaimer: The views expressed on this poster are those of the author and do not necessarily reflect the view of the CTBTO

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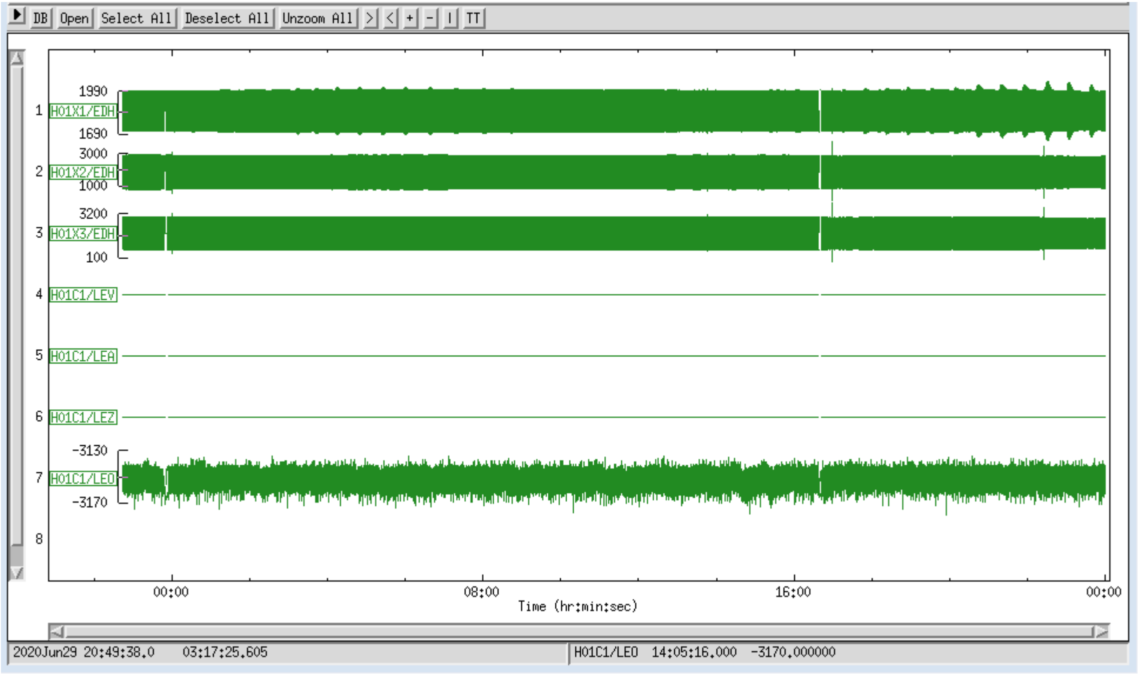
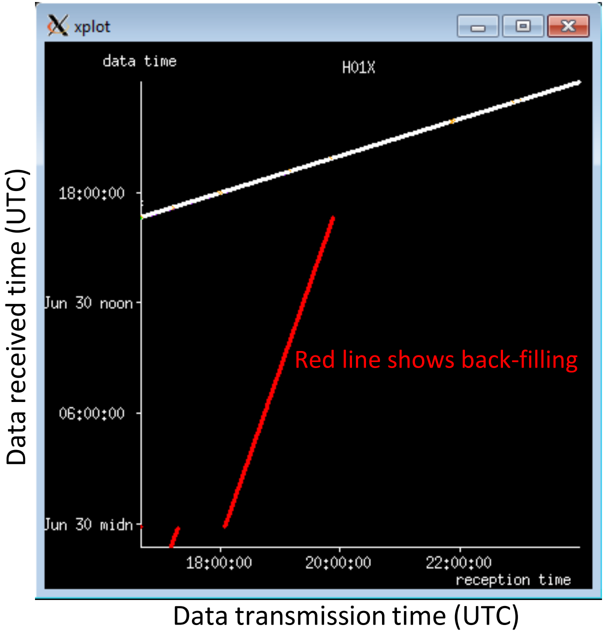
Example of back-filling on-demand from DDFI disk buffer

H01X data back-filled from the DDFI, as received in Vienna



Backfilling visible in the remote receiver file (in Vienna):



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CONCLUSIONS

Status and Plans

- **DDFI and SSI:** Enhancements to improve resilience against data-loss and to improve remote diagnostics of the DDFI and UWS through SSI connection developed, integrated and extensively laboratory tested during Q1 – Q3 2020.
- **SSI:** New version of SSI (Release 2019.04.05, March 2021) incorporating all enhancements described in this ePoster deployed to HA01 Cape Leeuwin (Australia) in Q1 2021 (remotely installed via satellite communications network).
- **DDFI:** Roll-out of upgrade and field testing with SSI R 2019.04.05 at HA01 Cape Leeuwin (Australia) scheduled Q2 2021 during Station Operator site visit with remote support from CTBTO as required.
- **DDFI:** Develop approach and perform necessary developments for compatibility with HA03 (Juan Fernandez Islands, Chile) and HA04 (Crozet Islands, France) planned for 2021 – 2022.
- **DDFI:** Roll-out to HA03 and HA04 planned to start in 2022.