Universal Acoustic Range and Processor (UARP) Initial System Trial

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Defence Research and Development Canada

Reference Document
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Abstract

DRDC – Atlantic Research Centre and Array Systems Computing Inc. have been involved in a successful engagement with the Build in Canada Innovation Program (BCIP) to procure a miniaturized towed-array system that is man-portable between vessels and can be installed, set-up, and set to use in a short interval of time.

The miniaturized towed-array system is called UARP (Universal Acoustic Range and Processor) and will sometimes be referred to as the 'Innovation'.

This field trial is being established to examine the capabilities and operational use of the UARP. Once testing is complete and the data analysis has been done, DRDC – Atlantic Research Centre will produce a report outlining the findings on the performance and use of the UARP.

Résumé

Dans le cadre du Programme d'innovation « Construire au Canada » (PICC), le Centre de recherches de l'Atlantique de RDDC et Array Systems Computing Inc. ont participé à une activité couronnée de succès visant à fournir un système miniaturisé à réseau remorqué qu'on peut transporter d'un navire à un autre et qui peut être rapidement installé, monté et ajusté en vue de son utilisation.

Ce système, appelé « processeur et télémètre acoustique universel » (Universal Acoustic Range and Processor – UARP), est parfois désigné par le terme « innovation ».

L'essai en mer vise à en évaluer les capacités et l'utilisation opérationnelle de l'UARP. Après l'essai et l'analyse des données recueillies, le Centre de recherches de l'Atlantique de RDDC produira un rapport dans lequel il résumera les conclusions tirées quant au rendement et à l'utilisation de l'UARP.

Project UWW 01cz

Universal Acoustic Range and Processor (UARP) Initial System Trial

July 2016

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Universal Acoustic Range and Processor (UARP) Initial System Trial

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Overview

DRDC – Atlantic Research Centre and Array Systems Computing Inc. have been involved in a successful engagement with the Build in Canada Innovation Program (BCIP) to procure a miniaturized towed-array system that is man-portable between vessels and can be installed, set-up, and set to use in a short interval of time.

The miniaturized towed-array system is called UARP (Universal Acoustic Range and Processor) and will sometimes be referred to as the 'Innovation'.

This field trial is being established to examine the capabilities and operational use of the UARP. Once testing is complete and the data analysis has been done, DRDC – Atlantic Research Centre will produce a report outlining the findings on the performance and use of the UARP.

Participation

DRDC Atlantic:

Trial Chief Scientist: Dr. Garry J. Heard

PM / CF Support POC: LCdr Mark Titus

Nine DRDC personnel will be needed for the training, testing, and analysis of the data, which will result in the required Test Report.

Leased Vessel:

Testing will be conducted on and around the vicinity of the DRDC Atlantic Calibration Barge. The Connor's Diving boat used for personnel and equipment transportation will be employed as the tow vessel. No additional funding is required for the use of this boat.

Objectives

The objectives with respect to the testing of the Innovation are:

- Examining the Innovation's basic acoustic sensitivity and frequency response;
- Determining the ease of application of the Innovation, particularly with regard to portability and moving the system between boats (installation/removal);
- Determine how easily the system use and operation can be grasped by a new operator, including how an operator responds to a new set of sonar displays;
- Within the opportunities afforded by the testing plan, examine the response of the system to weather and sea state conditions and what impact these conditions might have on the choice of towing vessel;
- Determine the limits of the Innovation with regard to operational speed, rates of turn, depth maintenance, etc.;
- Determine the operational requirements (electrical power, mechanical support, transportation, general conditions, etc.) of the Innovation;
- Examine the Innovation's capabilities for display of sonar data; and
- Determine the Innovation's acoustic signal detection capabilities.

CAF Support

Not applicable; there are no expected costs as the boat is covered by the transportation contract.

Network Accreditation and Certification

Not applicable.

Experiments

The testing will emulate three "at-sea" scenarios which will be covered in five test phases, each of one day duration:

- **Scenario 1**: the array will be held static on a stationary platform, while a reference sound source will approach and circle the platform.
- **Scenario 2:** the array will be run for several hours to collect and process data in a harbour/coastal environment. Scenarios 1 and 2 when taken together will verify overall functionality and specifically the level of gain for different frequencies as well as verifying that the target is visible in the broadband and has the correct spectral components in the narrowband display.
- **Scenario 3:** the array will be towed from a moving platform with a sound source at a distance. Once detected, the boat will maneuver towards the source. This will test self-noise levels, estimate array deformity through maneuvers, verify received strength of target signal upon approach, etc.

The five phases of testing are as follows:

A. Measurement of Basic Array Sensitivity and Frequency Response

Duration: 1 day

Equipment: Standard acoustic calibration facilities (all provided by Barge) and desktop workstation with analysis software.

Tasks:

1. Mount the array to a hydrophone test jig. The array will be arranged in a coil with hydrophones separated from each other.
2. Position calibrated acoustic source approximately five metres from the array. Lower both array and source to 20 metres depth on support arms or to greatest achievable depth not more than 20 metres
3. Conduct hydrophone sensitivity and directivity tests across array bandwidth. Frequency is limited to 150 Hz and above for calibration at the Barge. Calibration will be conducted by recording data files and exporting them for spectral analysis.
4. Analyze recorded data files and determine array hydrophone calibrations.

Additional details:
This measurement effort is the practical fulfilment of some of the goals described for Scenario 1. It is not possible to fully extend the array and support it due to the array's length, which is larger than practical for our calibration facilities.

B. Long-Term Data Recording
Duration: 1 day

Equipment: Standard calibration equipment and desktop workstation with analysis software.

Tasks:

1. Mount the array as described in experiment A.
2. Mount a reference hydrophone beside the array.
3. Lower the array and reference hydrophone to 20 metres depth
4. Record data overnight in an unattended fashion.
5. Inspect array system operation on return to Barge on second day.
6. Analyze the collected data to determine run time and ensure continuous system operation, compare array hydrophone noise levels to reference hydrophone levels.

Additional details:
This measurement effort is the practical fulfilment of some of the goals described for Scenario 2. This experiment will ensure that the system can operate for extended periods of time and will ensure that system noise levels are dominated by and track the ambient noise levels.

C. Array beamforming and system operation test
Duration: 1 day

Equipment: DRDC Acoustic Calibration Barge, acoustic projector system, small boat, GPS, Desktop workstation.

Tasks:

1. Mount the acoustic projector at 10 metres depth in the Barge moon pool.
2. Test projector operation and emit a comb of CW signals at known frequencies with moderate acoustic source level.
3. Set up the Innovation on the small boat.
4. Position the boat with a 200-m offset from the Barge at a distance ~1 km from the Barge. Deploy the array and transit on a fixed course at constant speed past the barge for a distance run of 2 km. Record GPS track information. Take note of any other vessels in the area and determine if observed signals are related to them.
5. Record data with the Innovation.
6. Repeat offset runs several times to cover the entire operating bandwidth of the Innovation
7. Analyze recorded data files and GPS tracks to determine apparent bearing accuracy of the Innovation.

Additional details:
This experiment will fulfil the remaining requirements of Scenarios 1 and 2. Using the known acoustic signals from the fixed source mounted on the Barge, we will be able to determine the Innovation's bearing accuracy (in the test environment). By observing vessels of opportunity we will qualitatively determine the Innovation's performance with multiple acoustic noise sources.

D. Measurement of Array Noise Levels
Duration: 1 day

Equipment: DRDC Acoustic Calibration Barge, acoustic projector system, small boat, GPS, Desktop workstation.

Tasks:

1. Mount the acoustic projector at 10 metres depth in the Barge moon pool.
2. Test projector operation and emit one or more CW signals at known frequencies with moderate acoustic source level.
3. Set up the Innovation on the small boat.
4. Position the boat 0.5 km offset from the Barge and 1 or more kilometres distant.
5. Deploy the array and proceed on a fixed course and speed. Repeat to cover full operational speed range.
6. Analyze recorded data files and determine array flow noise levels by comparison to fixed projector lines of known level.

Additional details:
This measurement effort will determine the array's self-noise levels versus speed due to flow. With this measurement we will have all of the measurements necessary to predict the array's performance.

E. Array Performance During Maneuvers
Duration: 1 day

Equipment: DRDC Acoustic Calibration Barge, acoustic projector system, small boat, GPS, Desktop workstation.

Tasks:

1. Mount the acoustic projector at 10 metres depth in the Barge moon pool.
2. Test projector operation and emit one or more CW signals at known frequencies with moderate acoustic source level.
3. Set up the Innovation on the small boat.
4. Position the boat 0.5 km offset from the Barge and 1 or more kilometres distant.
5. Deploy the array and proceed on a fixed course and at slow speed. Continue until the source appears to be in the broadside beam, then change course to put the source signal in a beam approximately 45-degrees forward. Continue to change course and maintain the signal in the 45-degree beam direction. Record GPS track and acoustic data. Observe the array beam performance with the constantly changing course.
6. Repeat the run, but this time wait until the target signal appears in the 45-degree forward bearing beam, then turn directly toward the source and hold the signal in the end-fire beam. Continue until in close proximity with the Barge.
7. Analyze recorded data files and determine array track.

Additional details:
This measurement effort follows the ideas of Scenario 3 and will determine the array's performance during maneuvers and the ability to close on an acoustic source.

Schedule

The schedule for the array field tests is uncertain at present due to delays in the manufacturing of the system. A relative schedule is presented below.

Week prior COMEX	UARP array has arrived at DRDC and waiting arrival of Array Systems Inc. personnel.
Saturday/Sunday	Lab closed.
COMEX	Array Systems Personnel (ASP) arrive at DRDC and check-in.
COMEX + 1	ASP arrive at DRDC and unpack the UARP.
COMEX + 2	ASP personnel test the UARP.
COMEX + 3	ASP conduct in-house training on UARP for DRDC personnel.
COMEX + 4	Training complete and UARP readied for transport to Barge.
Weekend	Lab closed.
COMEX + 7	Barge testing begins.

COMEX + 11	Barge testing ends.
Weekend	Lab closed.
COMEX + 14–16	Optional Barge test time in case of need.

Equipment

Barge	Boat	Miscellaneous
- UARP Array - Acoustic projectors calibrated, 200–5000 Hz. - Reference hydrophone - Calibration system - Net mount for UARP - 20-m supports	- Recording GPS - Mount site for UARP - UARP display set up area - Walkie-talkie	- Tools - Super-88 Vinyl Tape - Tie Wraps assorted - Marine Band Walkie-Talkies - Scope - DMM

Records

A trial log book will be maintained in electronic form.

Overtime

Working day lengths are limited by the transportation vessel contract. Extensive over-time is not anticipated to be required; however, transportation of gear to and from the dock may extend the normal working day. Additional effort may also be required from time-to-time in order to ensure a successful trial outcome in a timely fashion. Personnel will be paid for hours worked and a log of over-time will be kept by the Chief Scientist.

No work on weekends is currently anticipated.

A blanket over-time request will be created and forwarded to H/US for advance approval in case extra working time is needed. The OT, if any, will be minimal and is to be covered by the centre.

Security

Operations will be conducted in an unclassified manner. System operation will be shut-down as necessary to ensure that classified data is not collected

Physical security for the equipment is limited. There is no overnight commissionaire on the barge. The barge is alarmed.

Safety

In general, safety will be the responsibility of the masters of the individual vessels and the Chief Scientist and his delegated Safety Officer. All procedures mandated are to be followed. All participants will be responsible to remain vigilant to safety concerns in the trial conduct.

Each individual will be accompanied by appropriate sea-going personal protection gear. Steel toed boots, hard hat, floater jacket, rain gear, and gloves are required as a minimum.

Environmental

All work will be conducted in the Bedford Basin with the Acoustic Calibration Barge as the focus of the activities. This work is covered under the new Stantec Report, "Updated Environmental Baseline Study of the DRDC Acoustic Calibration Barge."

Communications

Hand portable radios will be used between the vessel, barge, and shore.

Personnel

This field activity will involve a total of eleven personnel, three of which are from Array Systems Inc. The participants are listed below.

Since this trial is being held within two hours of medical treatment, in accordance with DRDC SOP, medicals are NOT required for the personnel.

Field Team

1.	Garry J. Heard	Chief Scientist
2.	Derek Clark	Computer Specialist
3.	Stephane Blouin	Defence Scientist
4.	Sean Pecknold	Defence Scientist
5.	Val Shepeta	Electronics Technologist
6.	Tim Murphy	Electronics Technologist
7.	Dan Graham	Electronics Technologist
8.	Ricky Vienneau	Mechanical Technologist
9.	Tracey Robertson	Photographer
10.	Kristopher Huber	Array Systems Inc.
11.	Rajesh Jha	Array Systems Inc.
12.	Timothy Moorhouse	Array Systems Inc.

Signatures

Project Manager: LCdr TITUS

Name LCdr Mark Titus Signature

Section Head: G. Heard

Name Dan Hutt Signature

Centre Director:

Name Calvin Hyatt Signature

Distribution

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- CR
- Garry Heard
- Derek Clark
- Val Shepeta
- Dan Graham
- Tim Murphy
- Ricky Vienneau
- Tracey Robertson
- Kris Huber
- Timothy Moorhouse
- Rajesh Jha

MEMORANDUM

2016.05.05

To: Dave Brennan

Fm: Garry Heard

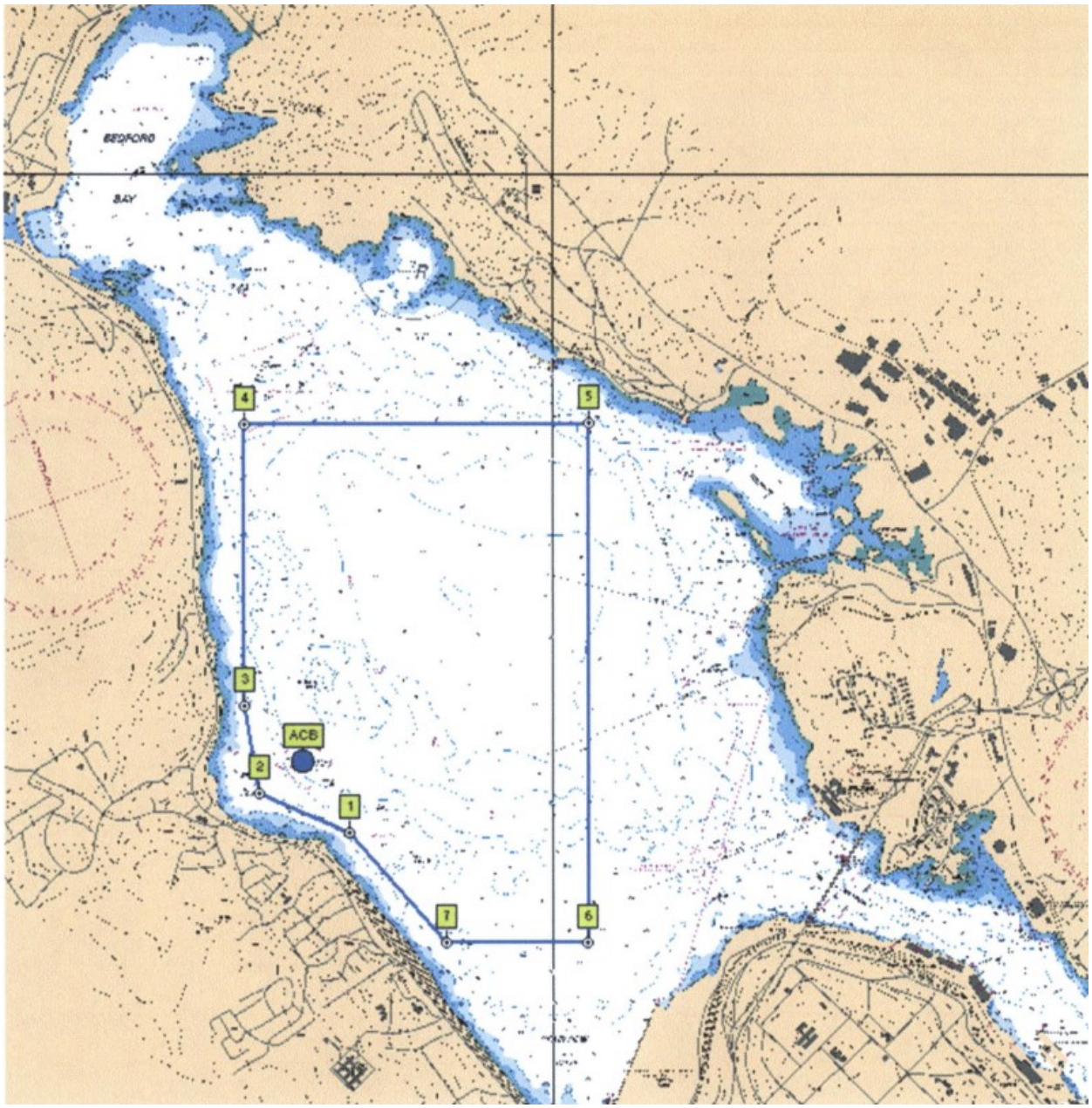
<u>Op Area request and other information related to the UARP node testing at the ACB</u>

1. The op area requested is outlined below.

WP	Lat (N deg)	Lon (E deg)
1	44.680	63.649
2	44.683	63.656
3	44.688	63.657
4	44.702	63.657
5	44.703	63.631
6	44.675	63.631
7	44.675	63.6411
ACB	44.684	63.6521

The attached figure illustrates the region in Bedford Basin that is requested.

2. As of today, the delivery date of the UARP array is 20 June, 2016. Unfortunately, they think that there will be further delays. Therefore testing will likely slide into late July/early August. Partly because I will not be here for the first two weeks of July.
3. Mark Titus is the PM for this effort.


BEDFORD
BAY
4
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ACB
2
1
7
6

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Heard, G.

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acoustics; underwater; towed array