

# Information Sharing Between Platforms in DRDC's Networked Underwater Warfare Demonstration Trial

[Paper ID 172]  
16<sup>th</sup> ICCRTS  
Quebec City  
21-23 June 2011

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# Motivation:

## Requirement: The Need for Connectivity in Anti-Submarine Warfare (ASW):

- Cluttered, asymmetric, politically sensitive, littoral warfare environments
  - Need for rapid and accurate detection, classification and localization of potential targets
- Involvement of aircraft, ships and submarines of several nations
  - Uniform standards for comms and tactics and understanding
- Multistatic sonar operations
  - May be useless in the absence of real-time coordination



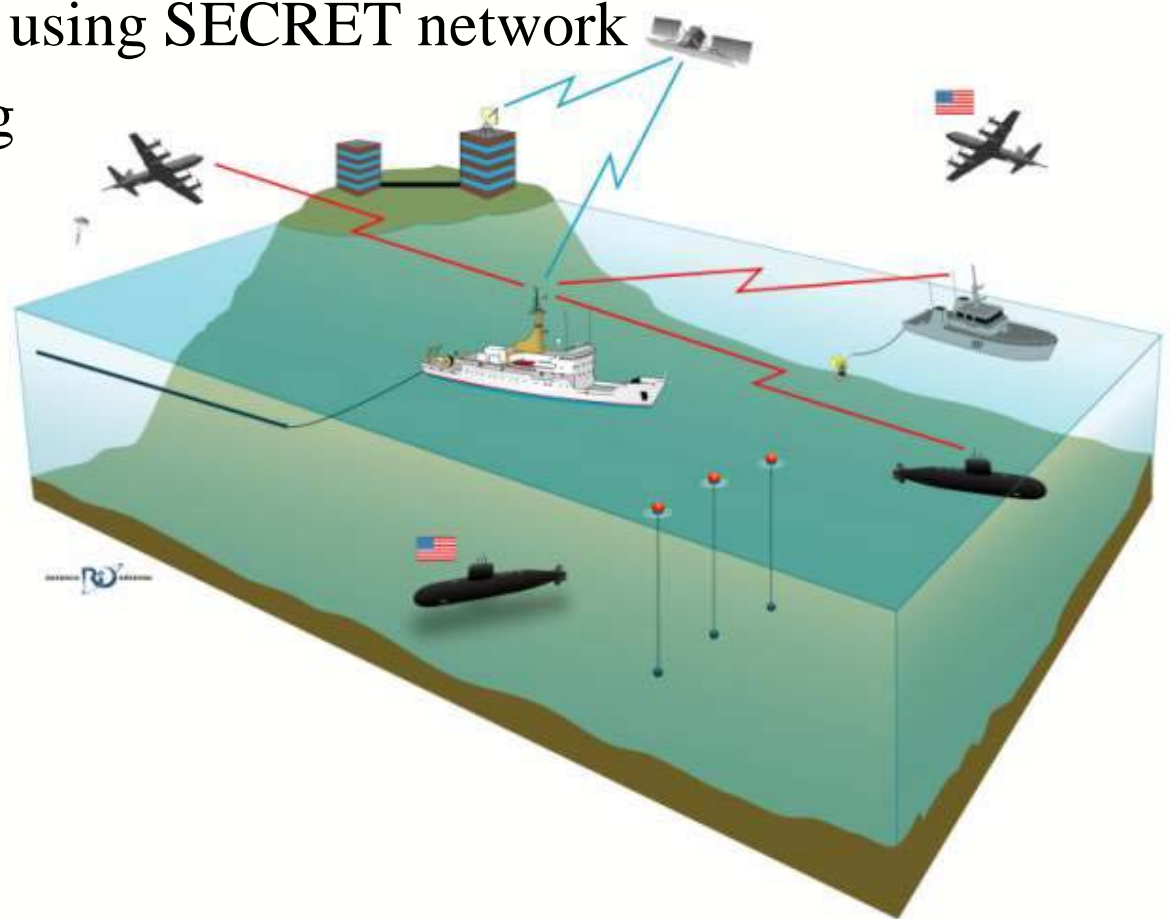
**Networked data exchange for  
information sharing and coordination**

## NUW - Objectives

- Develop and demonstrate technologies to fuse tactical sensor information to form and maintain an improved ASW portion of the Common Tactical Undersea Picture
- Improve the effectiveness of Underwater Warfare by investigating a flexible information/knowledge management architecture that can support several sonar systems and include land/air based sensors
- To demonstrate that the formation of the underwater portion of the COP (Common Operating Picture) can be done faster and more accurately by sharing information

# NUW Demonstration Trial Concept

- Hi-level concept including platforms was formed early (2002-2003)
- allowed early engagement of parties of interest and early planning with N6 for network certification
- ASW operation
- Information exchange using SECRET network
- Initially 4 Nodes using UHF/SNR:
  - CFAV QUEST
  - MPA
  - MCDV
  - SSK
- Later (2005) added Reachback using inmarsat:
  - CFMWC
  - METOC



# INFORMATION EXCHANGE REQUIREMENTS....

# Information Exchange Requirements (TM2004-168)

- Used a bottom up approach
- Asked a team of underwater warfare scientists and sonar operators what type of information would be useful to have in an ASW operation
- Compared list with other standards (LINK) and JC3IEDM (emerging at time as LC2IEDM)
- Found no standard could cover requirement in detail and imposed bandwidth constraints

- 12 Data types required for ASW:
  - Environmental Data
  - Receiver Information
  - Source Information
  - Echo Repeater Information
  - Ping Information
  - Main Blast Data
  - Feature Data
  - Contact Data
  - Track Data
  - Sonograms
  - Email/Chat Messages
  - Tactical Information
- Added:
  - Web-pages (html)
  - Data files (doc, pdf, jpeg etc)

# Detailed Information Example

## Ping Information

- **3 sub-types:**

### Ping Status:

- Source ID
- Event Number
- Success or Failure Flag
- Source Level Measured (peak)

### Next Ping information:

- Event number (each ping has a unique number for identification)
- Ping Source ID
- Next Wavetrain (either a Waveform/Wavetrain information structure or a reference Wavetrain ID)
- Start Time for Wavetrain
- Wavetrain Rate (period between wavetrains if applicable)
- Last ping in sequence notification as a notification to end processing or not to expect further pings.

### Waveform/Wavetrain data:

- Wavetrain ID
- Wavetrain Name
- Wavetrain Source ID
- Wavetrain Start Time
- Number of Waveforms Forming the Wavetrain
- For each Waveform
  - Waveform ID
  - Waveform type (e.g. CW, FM)
  - Envelope type (e.g. Hamming)
  - Duration of waveform
  - Offset Time from start of wavetrain
  - Amplitude or source level
  - Source level reference (absolute/relative)
  - Characteristic Frequency 1 (e.g. Centre Frequency)
  - Characteristic Frequency 2 (e.g. Modulation Frequency)
  - Characteristic Frequency 3 (e.g. Bandwidth)
  - Sampled Waveform (To handle other waveforms)



# Information Exchange for the User:

The system must provide:

- Only the information the operator needs when it is needed
- Tools to facilitate the formation of a Team distributed across all platforms and nodes
- Bandwidth Management
  - Setting information priorities
  - Information Push/Pull capability
  - Data subscriptions and notifications
- Consistent COP between platforms

**IMPORTANT DESIGN CRITERION:**

**The COP need not be identical but it must be consistent!**

# Information Priority

## Data Value with ASW Operation Phase

Decreasing Priority →

	Must Have	Good to Have	Nice To Have
Increasing Urgency ↓	<b>Search and Detection (I)</b> Environmental Data Receiver Information Source Information Ping Information Contact Data Tactical Information	Other Tracks Email/Chat Main Blast Data Feature Data Sonograms	Track Data
	<b>Localization and Classification (II)</b> Environmental Data Receiver Information Source Information Ping Information Contact Data Track Data Tactical Information	Other Tracks Email/Chat Main Blast Data Feature Data Sonograms	
	<b>Prosecution (III)</b> Receiver Information Source Information Ping Information Track Data Tactical Information	Other Tracks Contact Data	Email/Chat Main Blast Data Feature Data Environmental Data Sonograms
	<b>Post Prosecution</b>	This has elements of both Search and Detection and Localization and Classification	

NOTE: Only altered data is transmitted.

# **NUW MARCH 2007 SEA TRIAL....**

# Key Personnel and Organizations

- Project Manager: LCdr Lex Stuart DRDC
  - Trial Chief Scientist: Byron Topp DRDC
  - Scientific Authority: Marcel Lefrançois DRDC
  - Sub Liaison Officer: Lt(N) Stephane Ouellet N32
- 
- DRDC (NUW Technology Demonstration Project)
  - ONR (Bilateral agreement to examine tracking technology)
  - NAVAIR (BTEC (Battlespace Tactical Environmental Characterization))
  - NRC (National Research Council (Canada) Convair 580 aircraft)
  - CFMWC (Reachback cell hosting and added expertise)
  - METOC (Environmental Predictions)
  - N32 (MARLANT Sub Ops)
  - MOG5 (Maritime Operations Group)
  - MP&EU (Air Operators)
  - ADAC (Sonar Operators)
  - N6 (network accreditation and assistance)
  - CFEC (CFXNet Satellite connection between CFAV QUEST and CFMWC)
  - General Dynamics Canada (NECS/NUW system contractor)



## Trial Location

- Emerald Basin
- Approx 60NM from Halifax

# Blue Force



**HMCS  
SUMMERSIDE**

- Acoustic Source



**NRC Convair 580**

- Sonobuoys
- TACNAV
- Sonar Operators



**CFAV QUEST**

- Towed Array
- Radar
- AIS
- XBT
- Sonobuoys
- TF Command



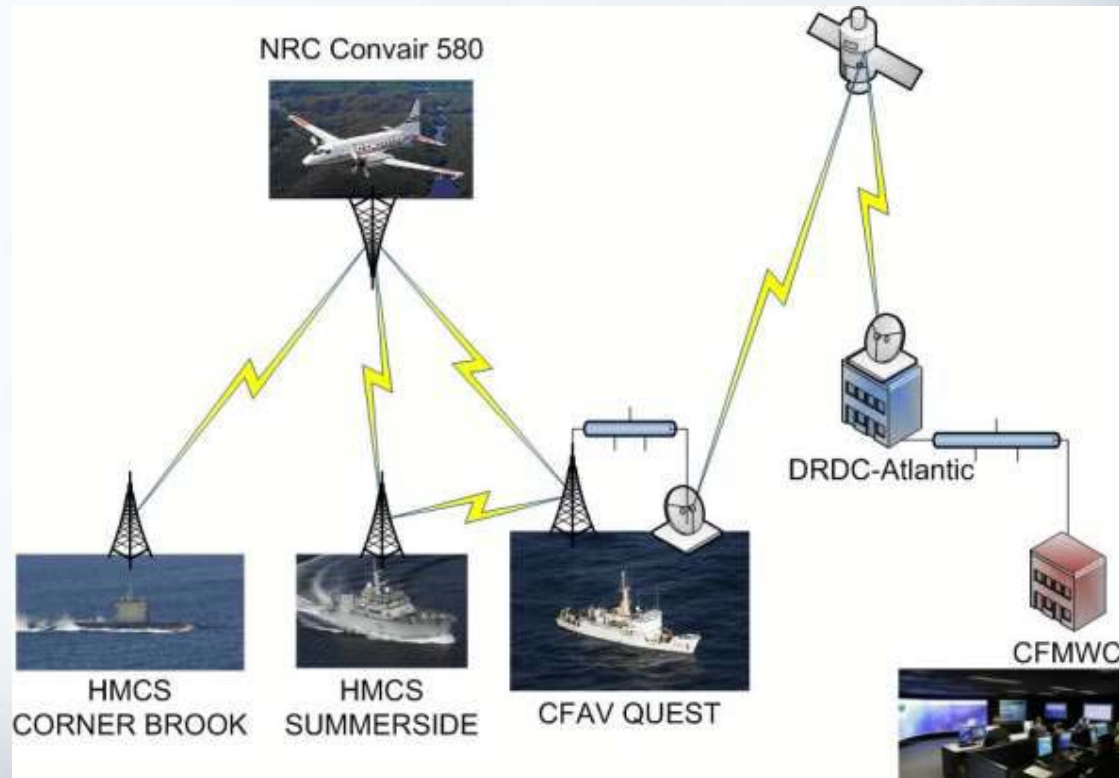
**HMCS  
CORNER BROOK**



**Reach-Back  
(CFMWC)**

# NUW at-sea Network

- Uses Sub-Net Relay (SNR) from ipunwired (now Rockwell Collins)
- Over UHF radio (LOS) (ARC-210 on aircraft / WSC-3 on ships and SSK)
- 64 kilo-bit per second bandwidth (SNR and Satellite)
- SNR uses a slotted time management system to send data – slots are dynamically allocated depending on load
- GPS used to synchronize slot timing (accurate time base placed on SSK)
- Automatic connect after disconnect handled in SNR
- Will automatically form a data relay to other nodes (surface ships relay aircraft to SSK)
- Secret level – encrypted using KG84
- Seamless connection to Reach Back via QUEST using CFXnet (direct connection to at sea network)



# Target (SSN) (USS NORFOLK)

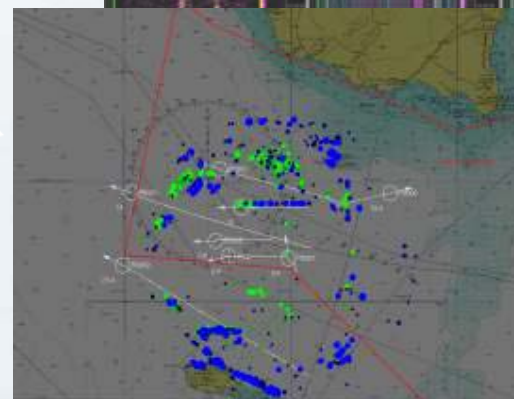
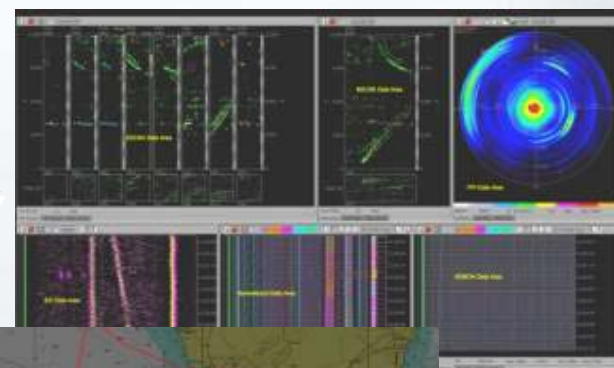
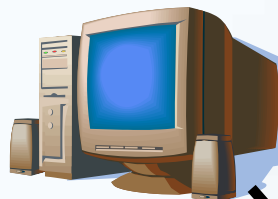




# **THE NETWORK ENABLED COMBAT SYSTEM (NECS)....**

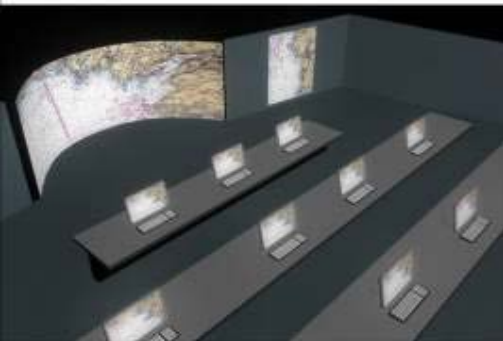
# DRDC's System Test Bed (STB)

- A software toolbox providing data management, data processing, data interfaces and visualization functionality using open source tools.
- Derived from TIAPS TDP
- Encourages use of COTS equipment and high degree of code-reuse
- Built on an open architecture
- Current (2010) License distribution is STB V1.0



# The Network Enabled Combat System (NECS)

- Built through extending TIAPS version of STB
- Extensions added for collaborative information environment for COP compilation
- Features:
  - GCCS-M Chart Display
  - Display and/or process organic and other platform sensor data
  - Active and passive sonar
  - AIS
  - Radar
  - Blue Force Tracking
  - Chat over low bandwidth networks
  - Automatic web-page publishing from combat system for enhanced situational awareness and historical information – both within platform and off-platform pages can be accessed



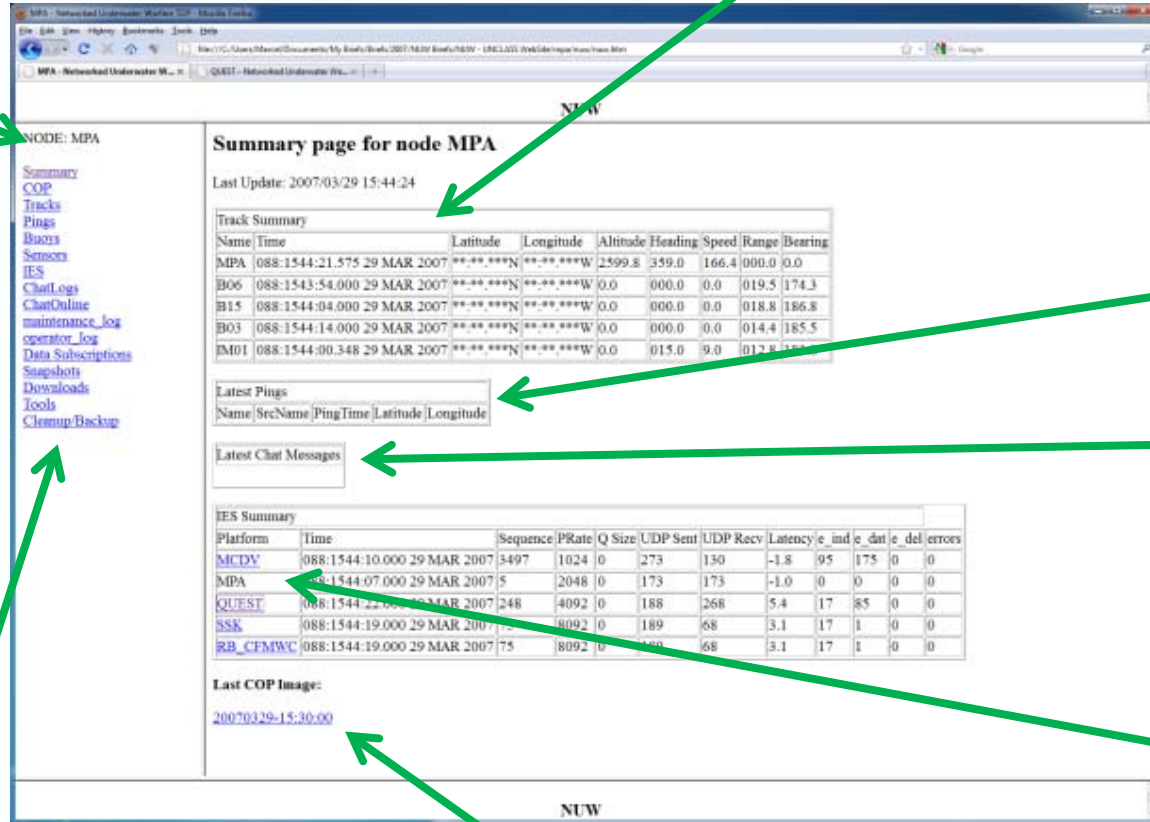
## NUW Web-site(s)

- These are created direct from Combat System (NECS) – there is one on each platform/node
- Web-pages service means disadvantaged units/stations can participate as long as they can attach a web-browser to the network
- No need for operator interaction to create complex web-page
- Intent is to pass data (give awareness)
- Allows for non-standard file publishing (the unexpected)
- Specific design for low-bandwidth (pages are not pretty – they are simple to reduce number of bytes)
- ASW portion of trial (about 4 days (8 hours each)) fits onto 1 CD (421MB)

# NECS Entry/Summary page

Publishing Node or Site

Track Summary



Summary page for node MPA

Last Update: 2007/03/29 15:44:24

Track Summary

Name	Time	Latitude	Longitude	Altitude	Heading	Speed	Range	Bearing
MPA	088:1544:21.575 29 MAR 2007	***.***N	***.***W	2599.8	359.0	166.4	000.0	0.0
B06	088:1543:54.000 29 MAR 2007	***.***N	***.***W	0.0	000.0	0.0	019.5	174.3
B15	088:1544:04.000 29 MAR 2007	***.***N	***.***W	0.0	000.0	0.0	018.8	186.8
B03	088:1544:14.000 29 MAR 2007	***.***N	***.***W	0.0	000.0	0.0	014.4	185.5
IM01	088:1544:00.348 29 MAR 2007	***.***N	***.***W	0.0	015.0	9.0	013.8	185.5

Latest Pings

Name	SecName	PingTime	Latitude	Longitude

Latest Chat Messages

IES Summary

Platform	Time	Sequence	PRate	Q Size	UDP Sent	UDP Recv	Latency	e	ind	e	dat	e	del	errors
MCIDV	088:1544:10.000 29 MAR 2007	3497	1024	0	273	130	-1.8	95	175	0	0	0	0	0
MPA	088:1544:07.000 29 MAR 2007	5	2048	0	173	173	-1.0	0	0	0	0	0	0	0
QUEST	088:1544:22.000 29 MAR 2007	248	4092	0	188	268	5.4	17	85	0	0	0	0	0
SSK	088:1544:19.000 29 MAR 2007	75	8092	0	189	68	3.1	17	1	0	0	0	0	0
RB_CFMWC	088:1544:19.000 29 MAR 2007	75	8092	0	189	68	3.1	17	1	0	0	0	0	0

Last COP Image:  
[20070329-15:30:00](#)

Latest Pings

Latest Chat Messages

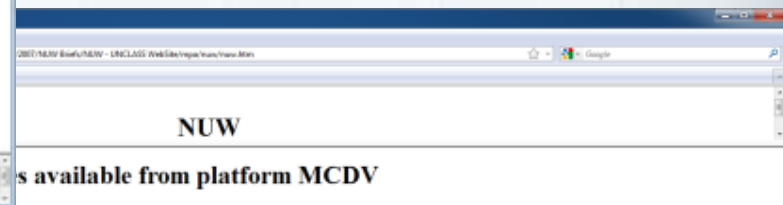
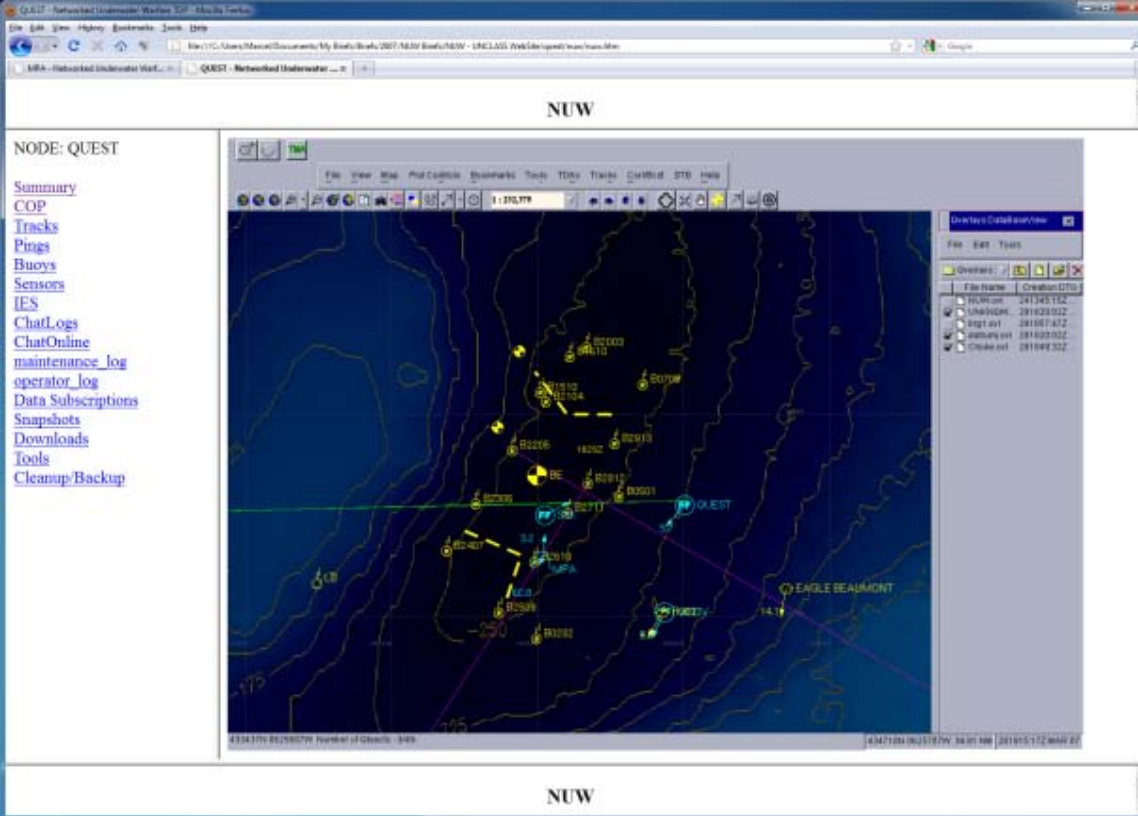
Links to Connected Nodes

Link to latest COP

Site (Node) Navigation Area

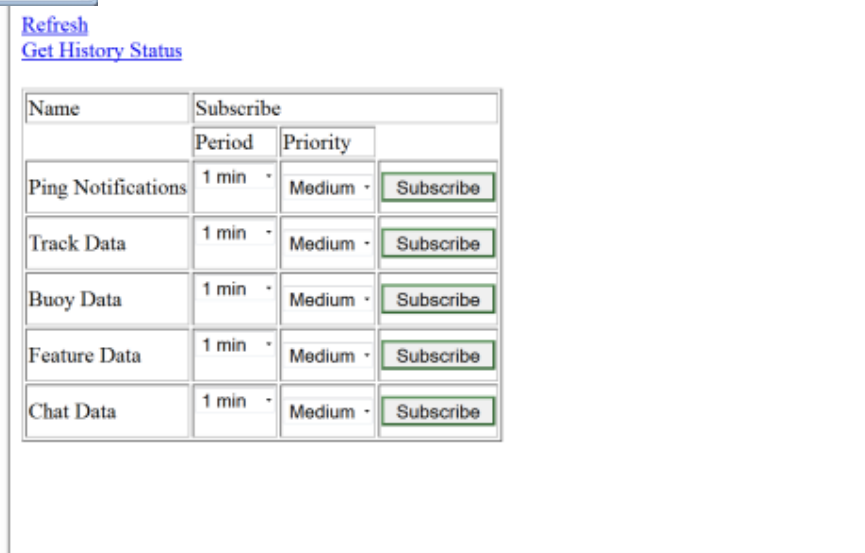
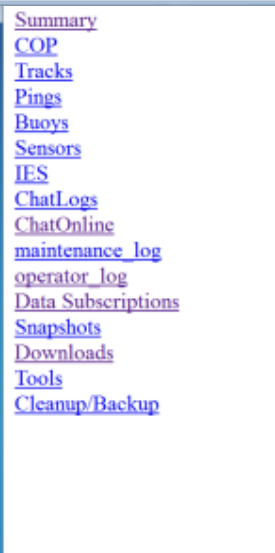
## COP Web Page

Current COP is added to site automatically at set intervals (operator may review history)



## Data Subscription Page

Shows data available from each site/node. User may set up a subscription with an update interval and priority (low/medium/ high)



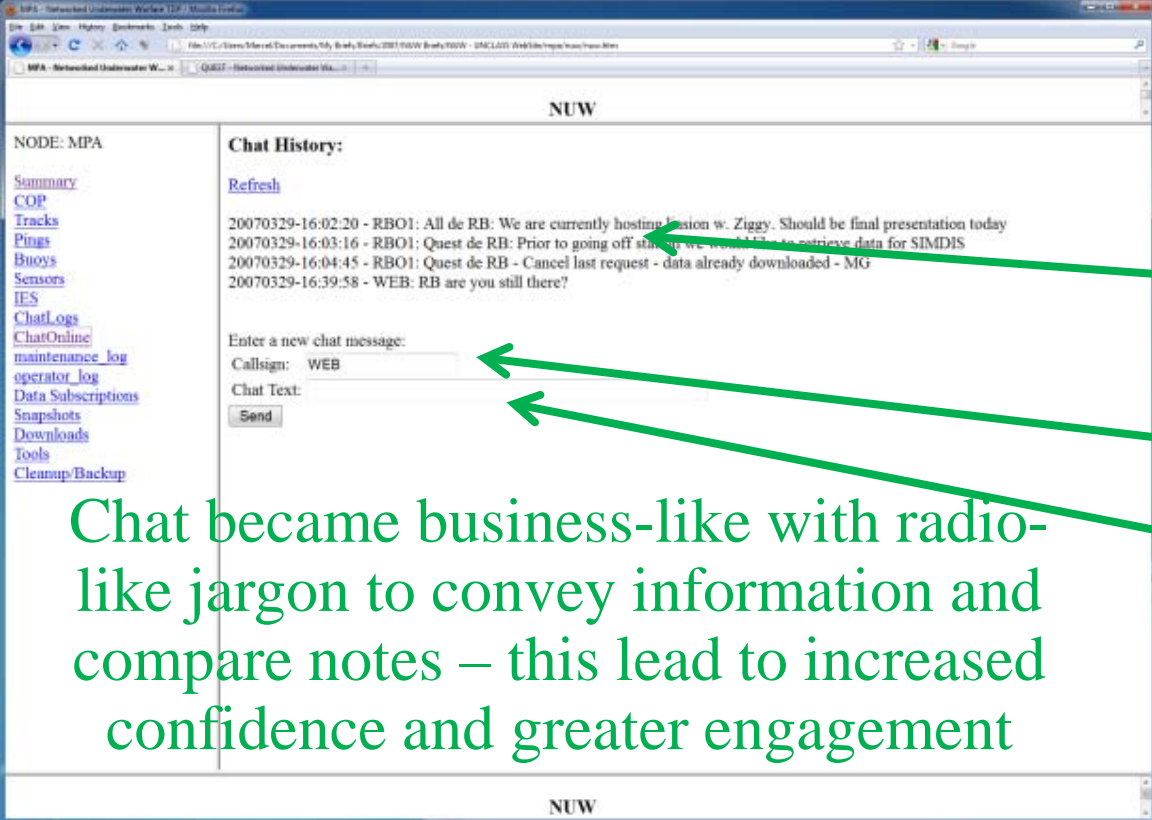
## Chat Web Page

Shows latest chat and allows one to send a one-line chat message

Callsign Entry

Chat Line

Chat became business-like with radio-like jargon to convey information and compare notes – this lead to increased confidence and greater engagement



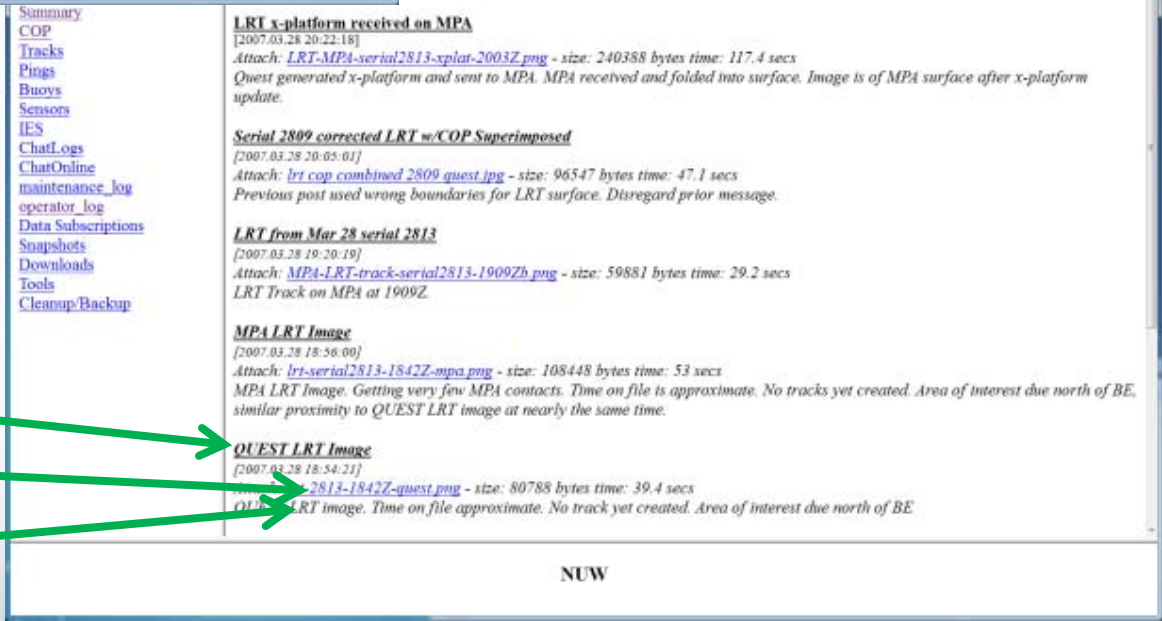
## Operator Log Page

files/documents/pictures could be published and retrieved on web site

Entry

Link to File

Description



# NECS Locations: 14 systems + 9 PC's

- Varying functionality depending on platform capability.
- 9 Additional Web-browser PC's were connected:  
 (3) on QUEST, (2) MPA, (1) MCDV, (3) CFMWC.

Location	Number	Description	Notes
CFAV QUEST	1	Stand-alone	Using only data organic to QUEST
	1		
	1	Networked	Sharing information and collaborating with other platforms/nodes
	1		
CORNERBROOK	1	Headless	Chart generated internally (no display)
	1	Laptop	In Ops room providing interface and display
SUMMERSIDE	2	Solaris	In VP2 container plus terminal in Ops room (at Captain's Request)
NRC Convair	1	IMPACT	STB mated with IMPACT for sonobuoy processing
	1	Laptop	Terminal for TACNAV
CFMWC	2	Solaris	
	2	PC	Limited Chart capability



# ACHIEVING A COMMON AWARENESS...

# Common COP

- All connected platforms/operators worked simultaneously on the same COP thus insuring a common view
- Underlying data was shared – view (layers) individually selected

Sea bottom contours

Sonobouys

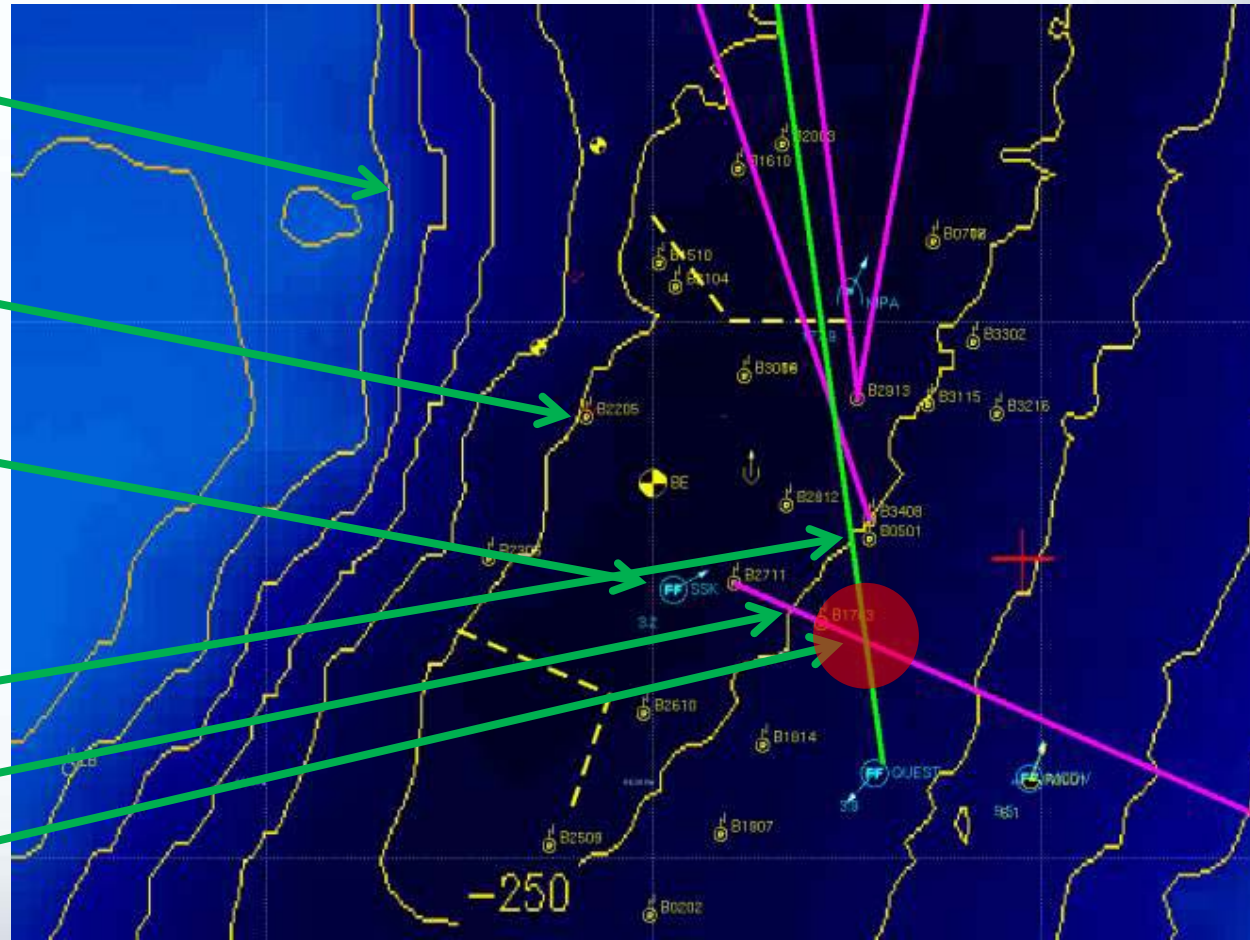
Blue Force tracking

Sonar contacts:

Towed array (green)

Sonobouy (magenta)

Possible Cross-Fix!!



# Web Page Statistics for Demonstration Trial

All web pages served (organic and inorganic to node)							
Total Trial							
	Sites	KBytes	Visits	Pages	Files	Hits	
QUEST	14	271695	77	5664	16292	20048	
MPA	16	9580	184	1329	1760	2608	
MCDV	19	24614	140	804	998	1195	
SSK	17	9726	110	751	1082	1599	
RB	10	24443	250	2430	2989	4371	
Web pages served over SNR and satellite (to other nodes)							
	Sites	KBytes	Visits	Pages	Files	Hits	
QUEST	7	17351	40	559	924	1149	
MPA	12	4933	95	632	814	1029	
MCDV	15	16684	70	280	449	485	
SSK	15	5426	90	612	858	1300	
RB	4	1000	18	109	196	404	

A total of 44.4MB over SNR in 4 days using a 64kb/sec connection filled with other traffic!  
(maintenance/ASW binary data/chat)

# CONCLUSIONS...

# Conclusions

- Demonstrated tactical level information exchange in an at sea ASW operation.
- Demonstrated that a common COP/SA can be formed through:
  - Sharing information at all levels (tactical commanders, reachback and sensor operators)
  - Exchanging tactical data generated from sensor processing in the combat systems (NECS using a priorities exchange)
  - The use of chat to increase collaboration, confidence and operator engagement
  - The use of combat system published and hosted web pages
- Demonstrated that information exchange in an ASW operation can be accomplished using a peer-to-peer network over a low-bandwidth.

# What Next?

- Software is being maintained in DRDC's System TestBed (STB)
- Web-page improvements for future deployments/projects/investigation
  - Better interfaces
  - Improving web-page refresh rates
  - Use as an information portal in operations
  - Use as a data log for future sea trials
- ASW systems and information exchange for AMASE TDP (Advancing Multistatic Active Sonar Employment)
- Input/Advice on next generation combat system specifications??





**DEFENCE**



**DÉFENSE**