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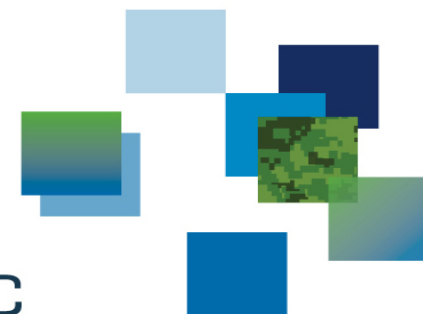
SigMa Lab – Concept and Development

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2018 NATO MODELLING & SIMULATION GROUP (NMSG) SYMPOSIUM

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NOTICE (U)

(U) This document has been reviewed and DOES NOT CONTAIN controlled goods.

Outline

- Background
- SigMa Lab concept
- Pieces of SigMa Lab
 - SCOR Sim
 - APRON
 - SASS
 - SEMS/SENS
- Conclusion, way ahead

Background – Why Signature Management?

- Both above water and underwater ship signatures are crucial information for own-ship operational decision making.
- All navies make considerable effort to regularly measure signatures but, for a variety of reasons, these measurements (rangings) are often not performed.
- Also, between rangings, signatures can change and ships may either not be aware of these changes or may not be able to revisit the range.
- In partnership with the Centre for Ship Signature Management and, in particular, Norway, Germany and the Netherlands, DRDC developed a prototype signature management system (SMS) for real-time monitoring and management of ship signatures under the COSIMAR (Continuous Operational Signature Monitoring, Awareness and Recommendation) project.

Background – The SigMa Lab

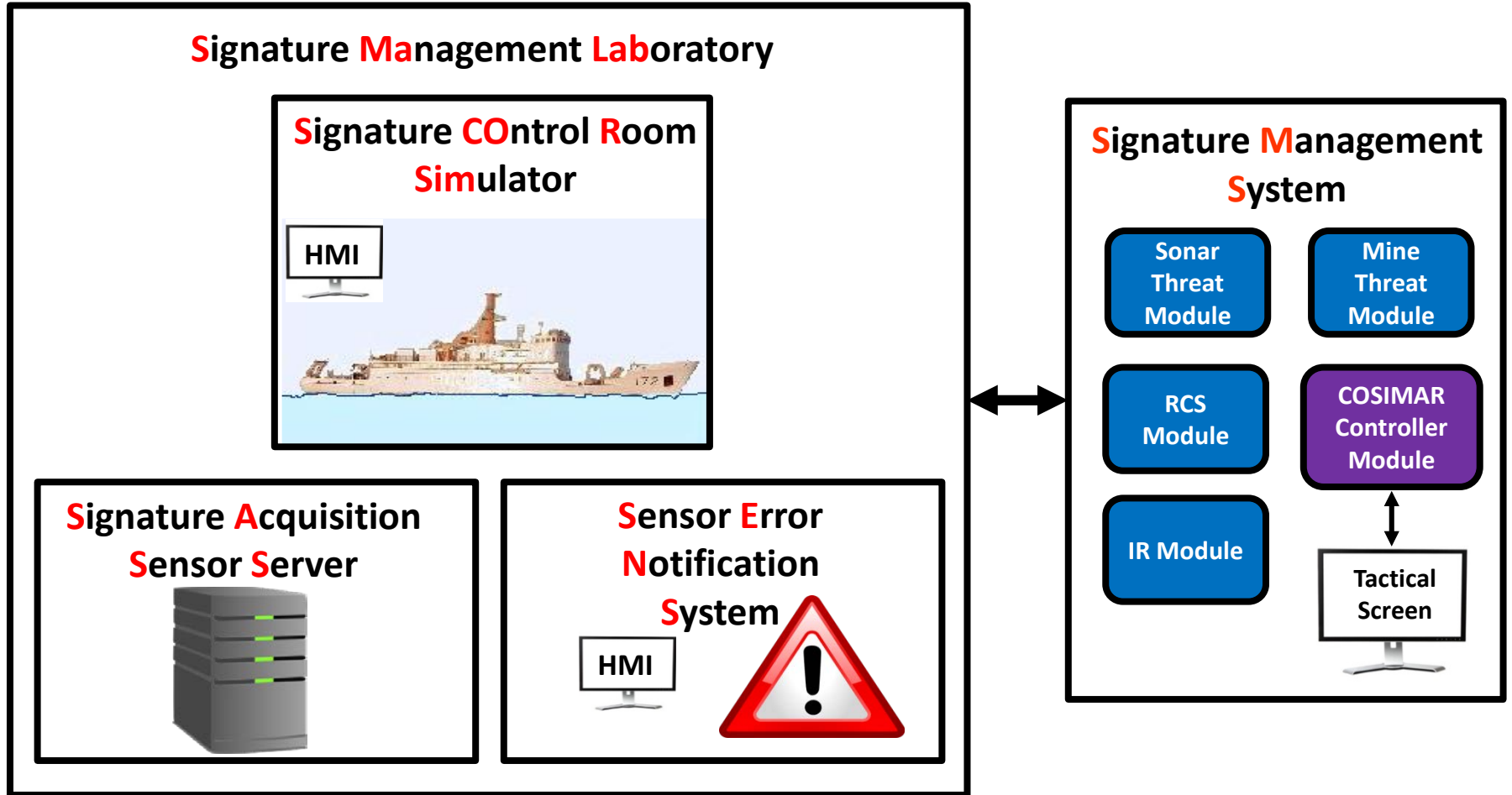
- As part of the COSIMAR signature management project, DRDC was to provide *CFAV Quest* for the final prototype testing.
- The original plan involved installing both the Signature Management System (SMS) and the Sensor Error Notification System (SENS) on *Quest* tied into a data acquisition system and the onboard network.
- In early 2015, the RCN decided to tie up *Quest* and it has now been scrapped.
- In response, DRDC proposed delivering a simulated environment in which to test the COSIMAR SMS and SENS.
- This capability is called the SigMa (Signature Management) Lab.
- DRDC also developed a free-play simulation of *Quest* (SCORSim) to assist with demonstrating the SMS and SENS.



SigMa Lab Concept

- Basic concept was to create a virtual *Quest* operating in a virtual environment.
- This virtual *Quest* would provide all necessary data (ship and sensor data) to the network for distribution to the SMS and SENS.
- The SigMa Lab must also provide the infrastructure in which the SMS will operate (not expected to reside on only one computer).
- The SMS will predict the signature and recommend changes to the ship configuration, state, or operation.
- The simulated ship should be able to respond to these changes and update all sensor data.
- Note that the system does not have to be *Quest*.

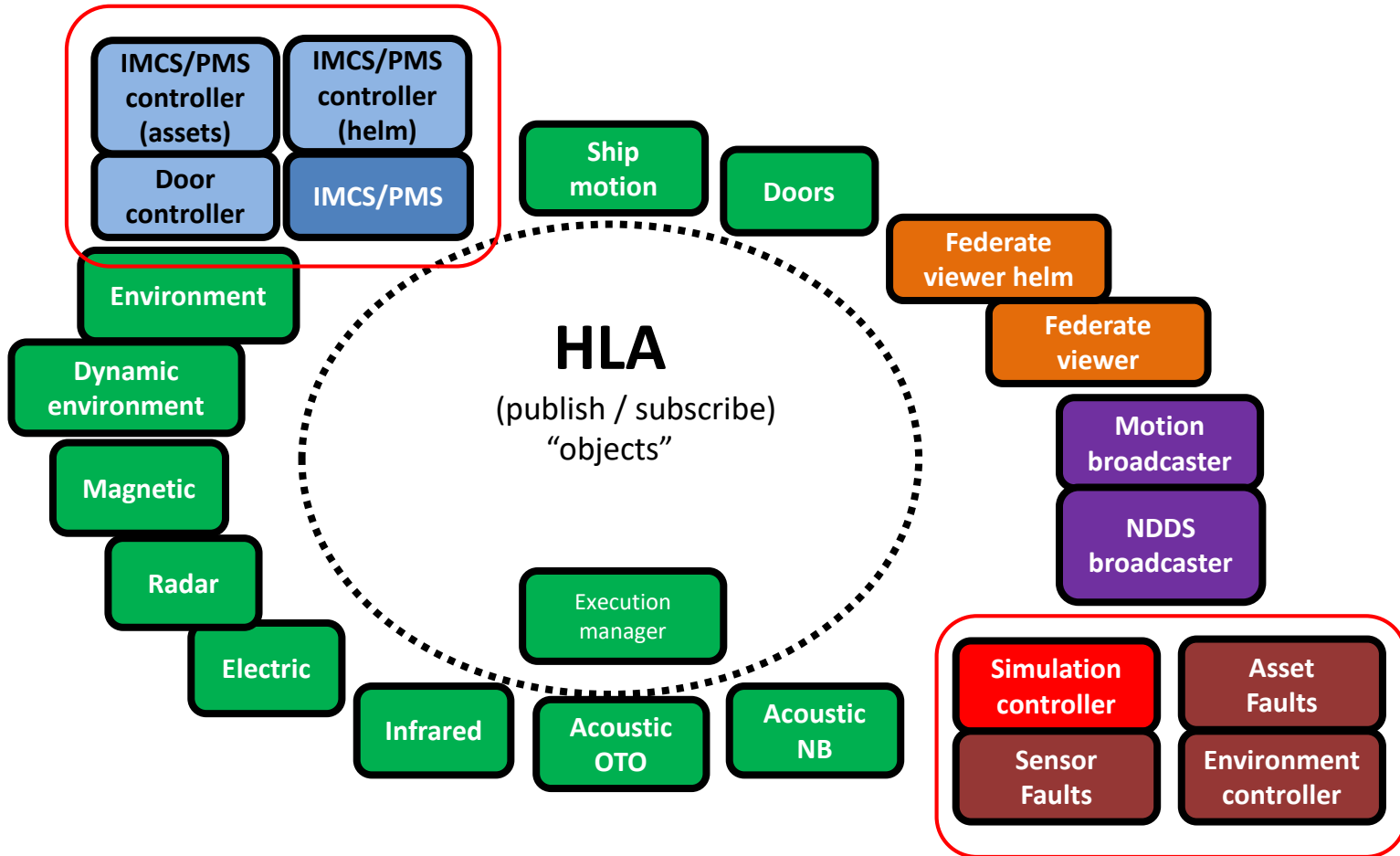
Overview



SCORSim (Signature COntrol Room Simulator)

- The SMS requires sensor information for the system to function.
- The simulator must be able to estimate the **sensor information**, **ship state**, and the **environment** and be able to follow a variety of realistic scenarios.
- Sensor data include ship data (course, speed, etc.), hull vibrations, IMCS info, shaft currents, hull potential, magnetic info, door sensors, hull temperatures, and stack temperatures.
- Environmental data include atmospheric and ocean environmental data, and ocean bathymetry.
- Simulator controls includes helm, machinery states, signature errors, environmental controls, locations, etc.

SCORSim HLA



SCORSim – Controller/Viewer

IMCS

- Helm control
- Sets asset states

Doors

- Opens/closes doors
- Adds/removes RAM covers on cranes

Environment

- Controls environment and ship-state

Faults

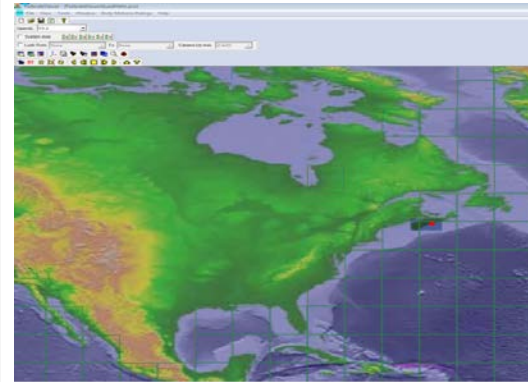
- Adjusts assets and sensors
- Introduces errors

Federate viewer



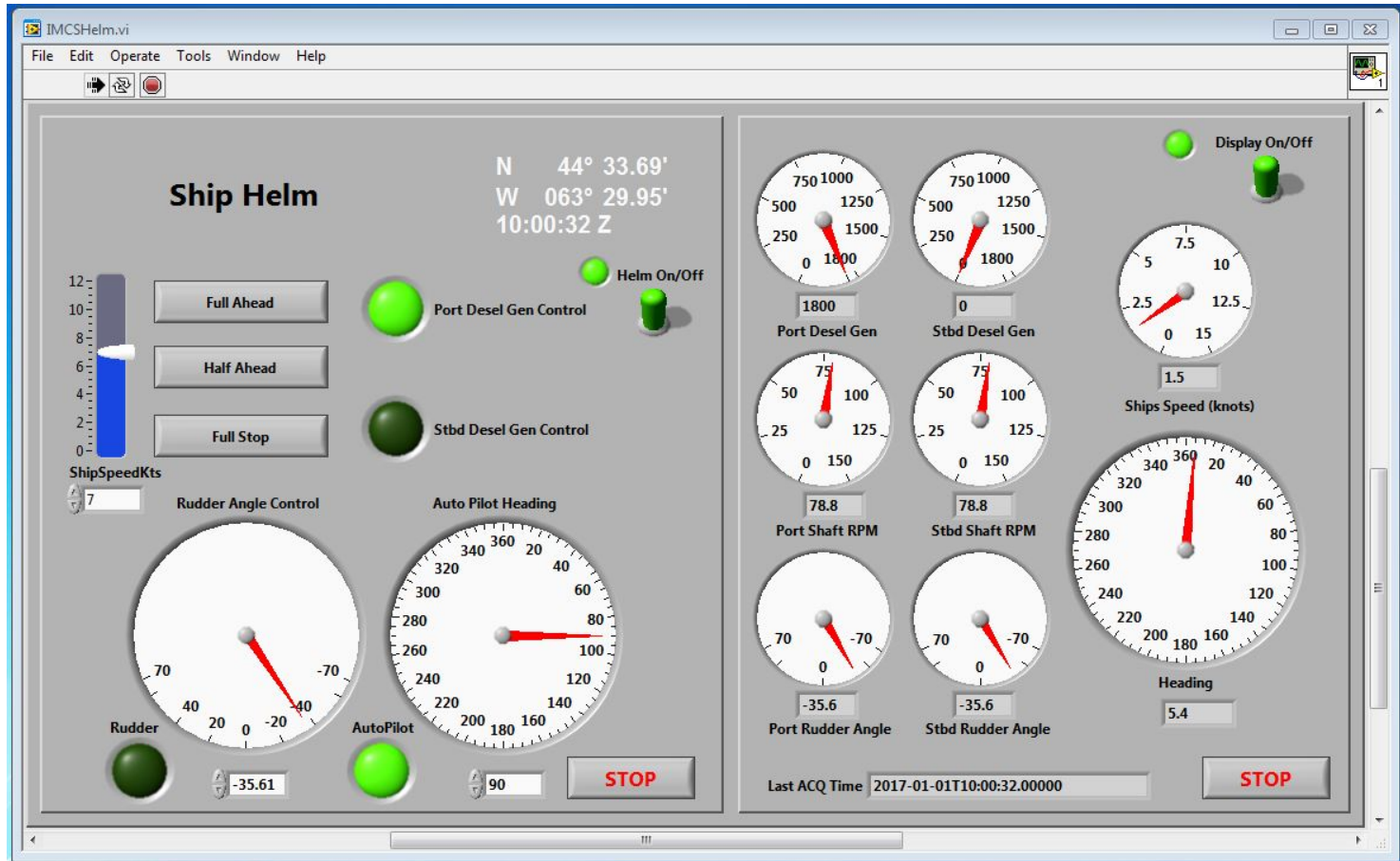
- Visualizes ship motion
- Different camera settings available

Helm viewer



- Shows ship location, heading and course
- Database boundaries of salinity and temperature

IMCS Controller (Helm)



IMCS Controller (Assets)

AssetsController.vi

File Edit Operate Tools Window Help

Publish On/Off

Subscribe On/Off

Assets Controller

TopicS: assets PortS: 50000

TopicP: IMCS PortP: 50000

Scenario FileName: C:\ScorSimControllers\Config\AssetsController\DefaultAssetsController.xml

loadFile saveFile browseFile

AntennaDish Amplifier Compressor Cooling CraneHood Doors Fans HullICCP Generators Propulsion Pumps Shaker

identifier	description	status
GEN1	DC-Generator-SB	▶
GEN2	DC-Generator-PS	▶
GEN3	Gasturbine	▶
GEN4	AC-Generator-AFT	▶
GEN5	AC-Generator-FWD	▶

identifier	timeStamp	mode	revolutions	load	temperature	deviating	error
GEN1	2017-01-01T10:02:19.999Z	off	0	0	0	▶	null
GEN2	2017-01-01T10:02:19.999Z	on	1800	0	0	▶	null
GEN3	2017-01-01T10:02:19.999Z	off	0	0	0	▶	null
GEN4	2017-01-01T10:02:19.999Z	off	0	0	0	▶	null
GEN5	2017-01-01T10:02:19.999Z	off	0	0	0	▶	null

Assets Auto Update Send Command syncController

STOP Last ACQ Time: 2017-09-20T12:36:35.77908 STOP

IMCS Controller (Environment)

EnvironmentController.vi

File Edit Operate Tools Window Help

Environment Controller

TopicS: environment PortS: 50000

TopicP: controller:Environment PortP: 50000

Scenario FileName: C:\ScorSimControllers\Config\EnvironmentController\DefaultEnvironmentController.xml

forceUpdate

loadFile saveFile browseFile

GeoLocation Ocean Weather Atmosphere

EnvironmentOceanCtrl

waterDepth: 18 waterConductivity: 3.03 seaTemperature: 4.93

bottomConductivity: 0.3 optimisationDepth: 0 surfaceTemperature: 5.0

referencePosition: latitude: 44.56 longitude: -63.49

referenceTimeStamp Ctrl: 10:00:00.200 AM 01/01/2017

depth(m)	sound(m/s)
0	1488.49
10	1488.64
20	1488.78
30	1488.86
50	1489.06
75	1489.24
100	1485.88

Sound Speed

EnvironmentOcean

surfaceTemperature: 4.97 seaTemperature: 4.93 waterDepth: 18 waterConductivity: 3.03 bottomConductivity: 0.3 optimisationDepth: 0 soundSpeed: referenceTimeStamp: 2017-01-01T10:00:00.200000Z referencePosition: latitude: 44.56 longitude: -63.49 depth: 0 soundSpeed: 1488.49 1488.64

Environment FileName: C:\ScorSimControllers\Config\EnvironmentController\DefaultEnvironmentController.xml

loadFile saveFile browseFile

Auto Update Send Command syncController STOP

Last ACQ Time: 2017-01-01T10:01:28.99899 STOP

IMCS Controller (Asset Faults)

AssetsFaultController.vi

File Edit Operate Tools Window Help

Assets FAULT Controller

Publish On/Off Subscribe On/Off

TopicS: PortS:
 TopicP: PortP:

Reset Asset Error loadFile saveFile browseFile

Scenario FileName:

AntennaDish Amplifier Compressor Cooling CraneHood Doors Fans HullICCP Generators Propulsion Pumps Shaker

pumpAssetsCtrl

identifier	description	fault	acousticResponse
PU1	Black-Water-Pump-FWD-1	AssetMalfunction	HighNoise
PU2	Black-Water-Pump-FWD-2	AssetMalfunction	LowNoise
PU3	Black-Water-Pump-AFT-1	null	
PU5	Sanitary-SW-Supply-Pump	null	
PU6	FW-Pump-1	null	
PU7	FW-Pump-2	null	

pumpAssets

identifier	timeStamp	mode	revolutions	load	deviating	error
PU1	2017-01-01T10:03:44.999Z	off	0	0	<input checked="" type="checkbox"/>	null
PU2	2017-01-01T10:03:44.999Z	off	0	0	<input checked="" type="checkbox"/>	null
PU3	2017-01-01T10:03:44.999Z	off	0	0	<input checked="" type="checkbox"/>	null
PU5	2017-01-01T10:03:44.999Z	off	0	0	<input checked="" type="checkbox"/>	null
PU6	2017-01-01T10:03:44.999Z	off	0	0	<input checked="" type="checkbox"/>	null
PU7	2017-01-01T10:03:44.999Z	off	0	0	<input checked="" type="checkbox"/>	null

Assets Auto Update: syncController: STOP

Last ACQ Time: STOP

IMCS Controller (Sensor Faults)

Sensors FAULT Controller

acousticDataOTO PortS Publish On/Off Subscribe On/Off

TopicContactS 50000

contactSensor

TopicP PortP Scenario FileName

controller:SensorsFaults 50000 C:\ScorSimControllers\Config\SensorsFaultController\DefaultSensorsFaultController.xml

loadFile saveFile browseFile

AcousticSensors ContactSensors

acousticSensorsCtrl

identifier	location	fault	DbAdj	PeakFreqAdj
A1	LD-Forepeak	errorDB	0	0
A2	LD-Forepeak	NoSignal	0	0
A3	LD-Bow-Thruster-	errorPeakFrequency	0	0
A4	LD-Bow-Thruster-		0	0
A5	TT-Refrigeration-		0	0
A6	TT-Refrigeration-		0	0

Reset Acoustic Sensor Error

acousticSensors

identifier	timeStamp	status deviating	error
A1	2017-01-01T10:06:30.000Z	off	null
A2	2017-01-01T10:06:30.000Z	off	null
A3	2017-01-01T10:06:30.000Z	off	null
A4	2017-01-01T10:06:30.000Z	off	null
A5	2017-01-01T10:06:30.000Z	off	null
A6	2017-01-01T10:06:30.000Z	off	null

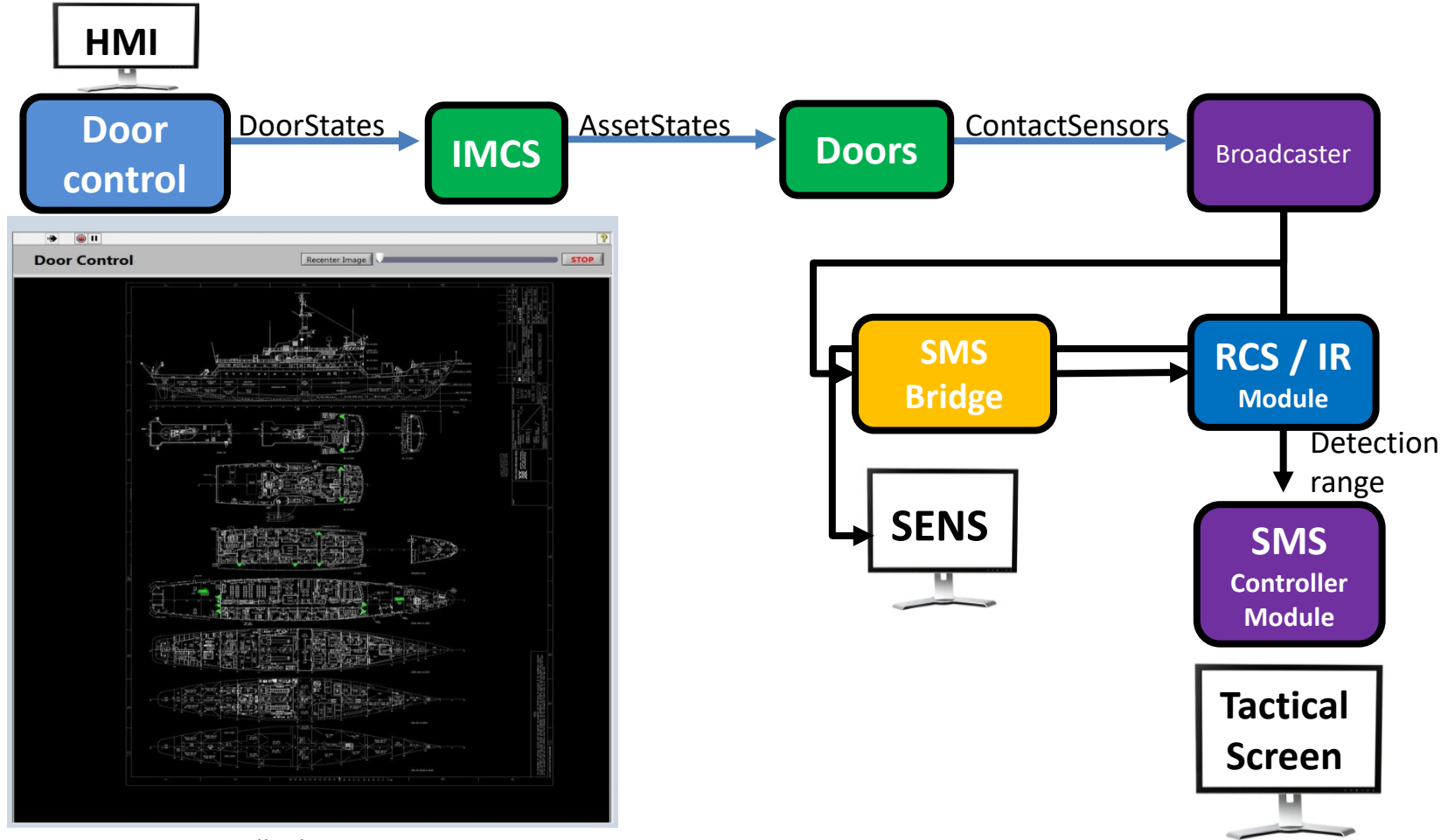
Sensor Auto Update Send Command syncController STOP

Last ACQ Time 2017-09-20T12:40:59.76648 STOP

Sensor Data

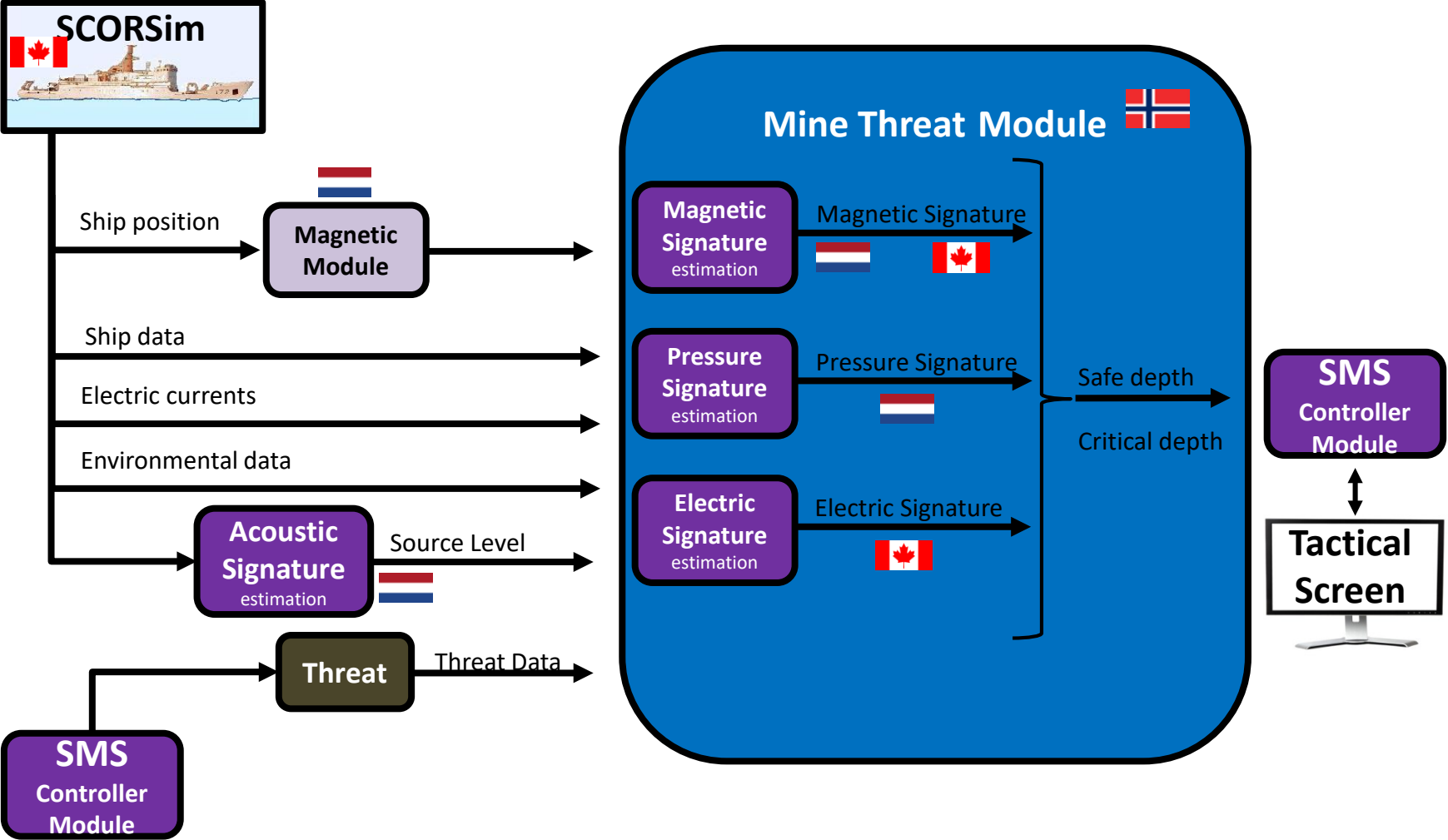
- SCORSim is also required to produce all sensor data. Modules were needed for:
 - Accelerometers – acoustic federates (1/3-octave and narrow band).
 - Magnetometers – simulation completed but not activated.
 - Temperature sensors – limited simulation developed but not activated.
 - ICCP and ASG currents – simulation developed.
 - Doors and RAM
- Magnetic and IR signature modules cannot currently utilize real-time sensor data.

Data flow within SCORSim (door example)



Door controller home screen

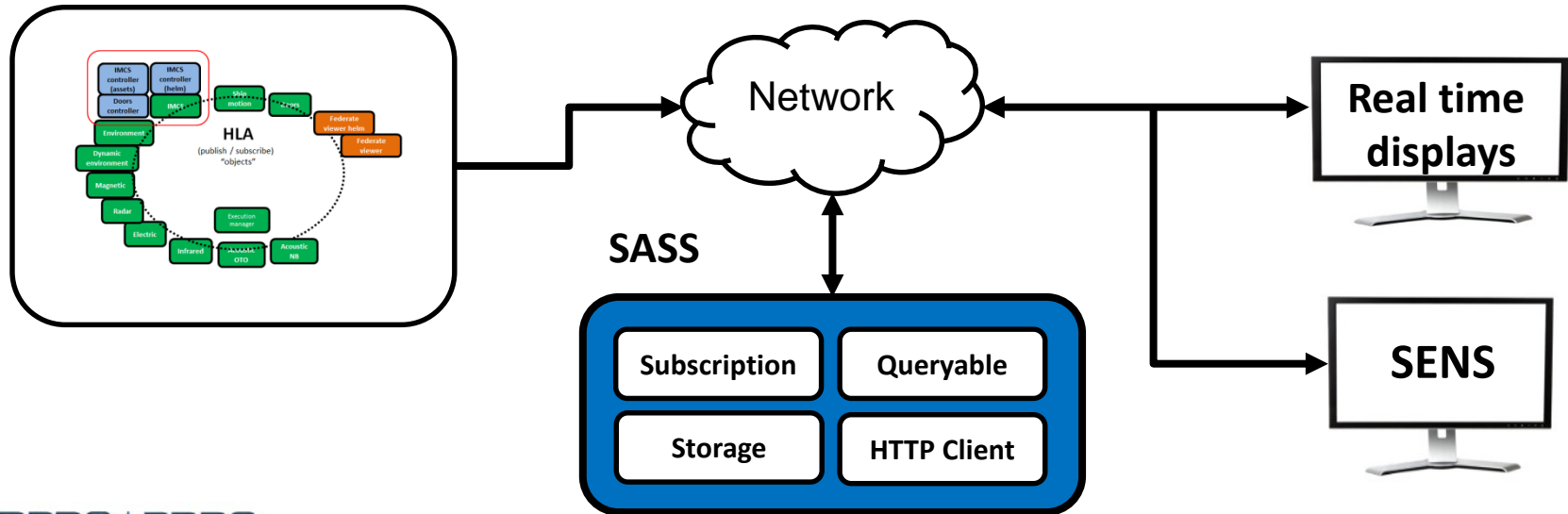
Mine Threat – Estimation



SigMa Acquisition Sensor Server (SASS)

- Stores topics for later HTTP querying and retrieval.
- Predetermined time resolution of storage and queries, typically a minute.
- Future capability for preloading static information, e.g. bathymetry.

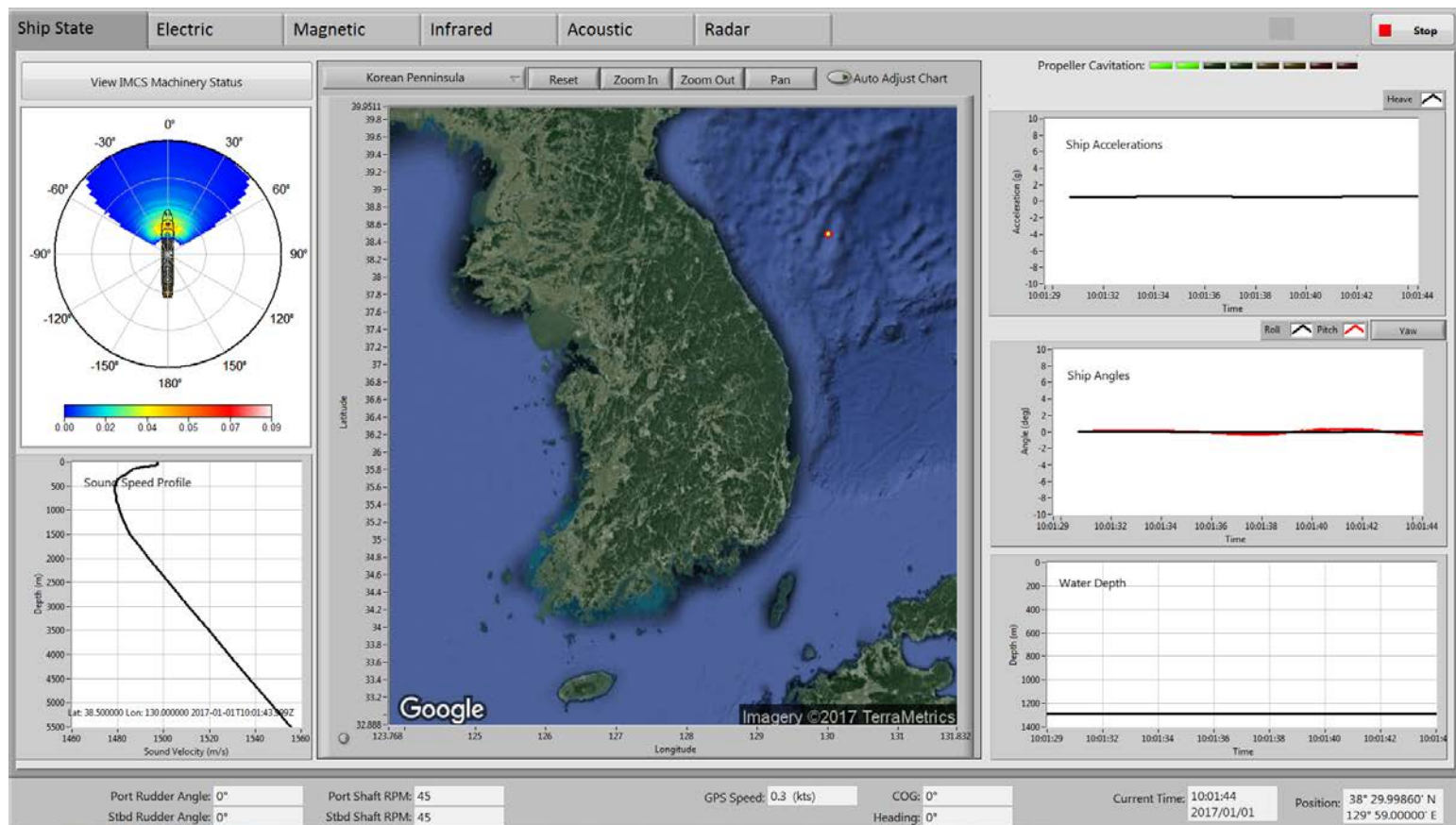
COSIMAR Framework



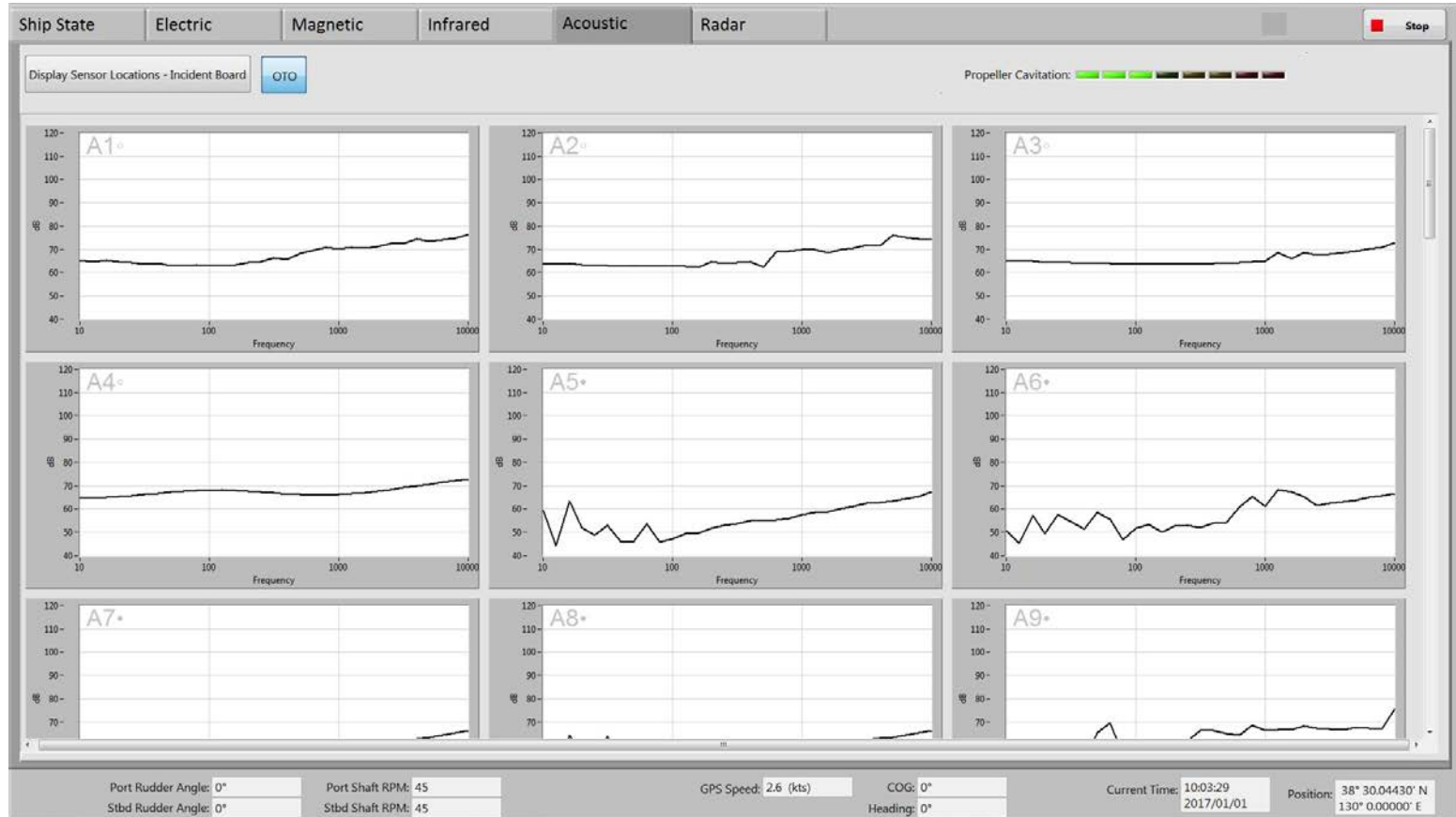
SEMS/SENS

- Original SENS was intended as trials tool which would be re-imagined for naval implementation.
- We have since migrated SENS to SEMS (SEnsor Monitoring System) for trials work.
- Created new SENS more in line with operational purposes.
- SEMS monitors ship state and provides continuous display of sensors. Useful for monitoring sensors during trials and troubleshooting sensor fit.
- SENS provides capabilities for detecting errors in sensors and assets and investigating signature issues.

SEMS – Home Screen

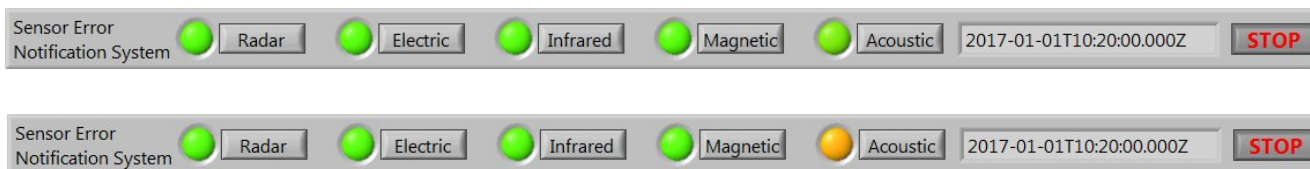


SEMS – Sample Sensor Monitoring

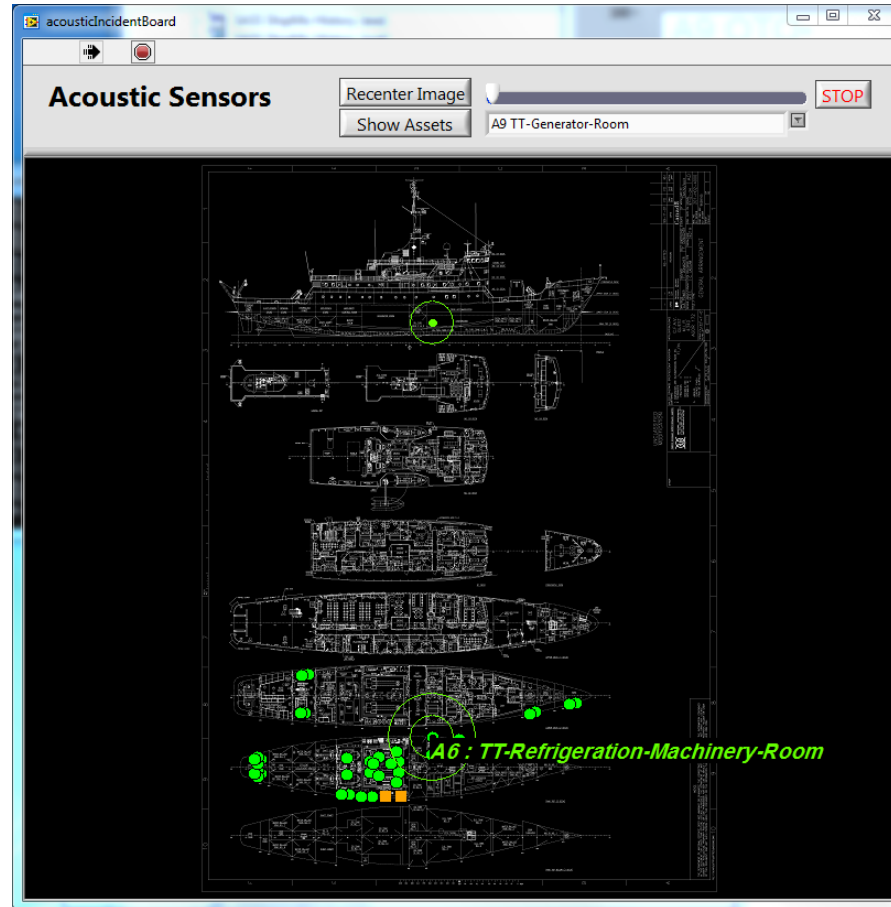


SENS – Basic Interface

- The interface is designed to be simple and occupy minimal screen space, enabling the user to determine sensor status at a glance. Each sensor suite has a light associated with it; green indicates that the suite of sensors is error free.
- SENS notifies the user when a sensor error has been detected (e.g., a limit has been exceeded) by changing the appropriate suite's colour to amber.
- Clicking on the appropriate signature's button brings up an incident board for the ship.



SENS – Error Investigation



SENS – Error Investigation

The screenshot displays the 'Acoustic Sensors' software interface. At the top, there is a 'Recenter Image' button, a progress bar, and a 'STOP' button. Below this, a dropdown menu shows 'A9 TT-Generator-Room'. The main area is a detailed deck plan of a ship, divided into 'LOWER DECK (2 DECK)' and 'TANK TOP (3 DECK)'. The plan includes various rooms and equipment, such as 'MACHINERY COMP', 'EXPLOSIVES STORE', 'TANK', 'CREW' quarters, 'WATER BALLAST TANK', 'DO TANK', 'SERV TANK', and 'PIPE TUNNEL'. A specific sensor location is highlighted with a yellow circle and labeled 'A9 : TT-Generator-Room'. A 'Sensor Error Management' window is open in the center, displaying the following text:

2017/09/20 14:20:57 A9 : TT-Generator-Room
ERRORS:
Encountered: ERROR - Db Adjustment

<right-click for dynamic error management menus>

The window has an 'OK' button at the bottom. The Windows taskbar at the bottom shows the time as 2:21 PM on 20/09/2017.

Conclusion

- The SigMa Lab environment provides a unique capability for examining the performance of signature management systems without taking them to sea.
- It also provides a capability for simulating a variety of vessels and environments which may be useful in evaluating either existing or planned platforms.
- While *Quest* was modelled here, future work could including modelling of the current RCN frigate or the future naval combatant.
- The system may also be useful for other simulation work requiring more complete platform information than exists in current platform simulations.



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