‘Make in India’ Paradigm: Roadmap for a Future Ready Naval Force

Session 9: Coastal Surveillance, Response Systems and Platforms

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Aligned with Customer Priorities

**COMMAND, CONTROL & INTELLIGENCE**
Raytheon integrates proven radars, sensors, navigation systems, and cyber technology to enable customers to collect, analyze and distribute information in real-time, giving them new ways to perceive and manage data.

**ELECTRONIC WARFARE**
Raytheon's advanced electronic warfare systems and capabilities give our warfighters the continued strategic advantage to effectively and safely execute their missions in the modern threat environment.

**MISSILE DEFENSE**
Raytheon's proven missile defense systems deliver protection against a broad range of current and emerging threats—ensuring peace of mind for the U.S. and its allies and making Raytheon the world’s most trusted partner in missile defense.

**PRECISION WEAPONS**
Raytheon's reliable and cost-effective precision weapons hit the target, and only the target, while protecting warfighters, and helping to manage the cost of battle over the long term.

**TRAINING & SERVICES**
Raytheon's innovative approaches and proven tools help customers successfully train staff, sustain skills and maintain operations for a wide variety of high-consequence missions worldwide.

**CYBER**
With decades of cyber and intelligence expertise, Raytheon offers unmatched end-to-end capabilities that help customers secure their space and confidently navigate the cyberspace.

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BROAD AND DEEP PORTFOLIO OF ADVANCED SOLUTIONS

Raytheon has more than 15,000 contracts
The Pavit, a 77 meter, 1000-ton vessel:

- Abandoned near Oman with machinery problems
- Drifted across the Arabian Sea and entered India's EEZ
- Remained undetected through tiers of security
- Eventually grounded at Juhu Beach

Requirement for Persistent Maritime Domain Awareness

To protect maritime sovereignty and economic resources, enforcement agencies require persistent real-time information concerning the location, identification and activity of ships operating within their 200 nautical mile Exclusive Economic Zone (EEZ).

Areas of Concern:
– National/Border Security
– Resource Protection (fisheries, oil and gas etc.)
– Piracy
– Illegal Immigration
– Narcotic Trafficking
– Environmental Monitoring and Protection
– Search and Rescue
– Safe Navigation
INTEGRATED MARITIME DOMAIN AWARENESS FOR BORDER SECURITY

- Persistent Wide Area Surveillance
- Classify, Identify, Sort, Prioritize
- Generate COP
- Identify Anomalous Behaviors
- Actions

Airborne Solutions
Surface Solutions
Subsurface Solutions
Intel Data Base Solutions
Coastal & Over-the-Horizon Surveillance

Raytheon Canada has developed two key sensors to provide persistent surveillance of both cooperative and non-cooperative vessels

- High Frequency Surface Wave Radar – HFSWR
- Marine Small Target Tracker - MSTT

- HFSWR monitors vessel traffic throughout the 200 nm Exclusive Economic Zone

- MSTT provides small vessel detection in territorial waters

- Together, HFSWR & MSTT in conjunction with microwave radar provide a complete maritime picture

- MSTT and HFSWR provide high confidence tracks in standard message formats and integrate easily with all Command & Control and Decision Support Systems.
Objective is to identify vessels of interest at a range where appropriate action can be taken
Radars for Maritime Domain Awareness

### Surveillance

**Land-based VTS radars**
- 20m vessel 60 km
- Persistent Tracking

**Land-based HFSWR**
- 20m vessel, 280 km
- Persistent Tracking
- Day/night dependency

**Land-based OTH radars (HF)**
- 20m vessel, 3000 km
- Persistent Tracking

### Reconnaissance

**Space-based C-Band radars**
- Minimum detectable vessel 25m
- Approx. 500km swath
- Vessel Position Update ~ every 2-days

**Airborne radars**
- 20m vessel to ~ 100km

**Ship-based Navigation radars**
- 20 m vessel to ~40 km in calm conditions

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**Fixed Radars Required for Persistent Surveillance**

Platform Mounted Radars for Reconnaissance.
Land based Radar for Persistency

Coastal Microwave Radar
Only operates in a Line-of-Sight mode
Generally limited to first 20 or 30 nautical miles (nm).

HF Surface Wave Radar
Lower the frequency the greater the range. Typical minimum range 20 nm

Microwave Radar

High-Frequency Over-the-Horizon Skywave Radar
Radar beam refracts off of an ionospheric layer
HFSWR: the Foundation of a Maritime Domain Awareness System

provides continuous, persistent surveillance of surface vessels throughout a nation’s 200 nautical mile Exclusive Economic Zone (EEZ)

100%Canadian

HFSWR Program Timelines

1988-2002: Canadian R&D

2003-2007: SWR503 System Operational with Canadian Navy


2008: First international sale to Asian Navy.

2011-15: Raytheon Canada receives PASE TDP contract to develop 3rd Generation HFSWR system for Canadian Government.
Halifax HFSWR Site

Transmit Antenna #1

Receive Array

Equipment Shelter
3rd Generation HFSWR Design Highlights

- Direct Conversion Receiver-Exciter technology
  - A software based radar approach
- Extensive use of COTS products
- Computer Operating System
  - All S/W functions hosted on a common processing system with industry standard Linux OS.
- Custom Transmitter
  - Excellent gain and phase linearity
  - Resulting in low and constrained side-lobes
- Intelligent Spectrum Monitoring
  - Automated Pro-active Option Available
  - Cognitive Operation Enabled: Sense and Adapt
  - Enables operation in the congested HF spectrum without causing interference to other users
### 3rd Gen HFSWR Performance Specifications

<table>
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<tr>
<th>VESSEL TYPE</th>
<th>MAXIMUM DETECTION RANGE (km)</th>
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<tr>
<td></td>
<td>Sea States 0-4*</td>
<td>Sea States 5-6</td>
<td>Sea State 7</td>
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<tr>
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<td>Large Vessel</td>
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<td>&gt;3000 ton</td>
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<td>displacement</td>
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**DAY/NIGHT TRACK RANGES FOR MEDIUM VESSEL IN SS5 ARE APPROX DOUBLE THOSE ACHIEVED WITH FIRST/SECOND GENERATION TECHNOLOGY**
Summary: Over-the-Horizon Surveillance

- HFSWR was designed to be an affordable system to provide surveillance 200+ nautical miles EEZ
  - Allows naval assets to be deployed very efficiently and effectively to interdict real problems
  - Very low maintenance and completely unmanned operation from remote locations
  - Easily integrated with other systems (AIS, cameras, etc)

A Proven Naval force multiplier

HFSWR – Seeing Beyond