

VISON OF OCEAN & SPACE COLLABORATION

The University of Tokyo 4 October 2016



Real-Time AIS Tracking from Space Expands Opportunities for Global Ocean Observing and Maritime Domain Awareness



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This presentation discusses a future capability currently in development. Any performance data metrics are based on our current analysis and will be validated through testing and on-orbit performance metrics

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Automatic Identification System (AIS)

- AIS (Automatic Identification System) was designed primarily as a collision avoidance system for large class vessels
- Since 2004, the International Maritime Organization (IMO) has required AIS transponders to be aboard all vessels that exceed 300 gross tons
- Over 130,000 ships worldwide have installed these transponders making AIS one of the most successful maritime technology deployments of all time
- AIS technology is increasingly being deployed on
 - Smaller vessels
 - Aids-To-Navigation (AtoN)
 - Search and Rescue (SAR) transponders



Vessel Information (TROPIC BREEZE)

AIS Type: Tanker	
Ship Type: Oil And Chemical Tanker	Flag: Belize
Ship Sub-Type: Oil Products Tanker	Source: S-AIS
Class: A	

IMO: 8906315	MMSI: 312815000
Call Sign: V3RP7	Size: 49.0m x 10.0m
Latest Position at: 2015-10-15 05:49:21	
Latitude: 25.121620	Longitude: -76.955387
Course: 52.0°	Speed: 6.5kn
Heading: 55.0°	Rate of Turn: 0.0° /min

Status: Under Way Using Engine

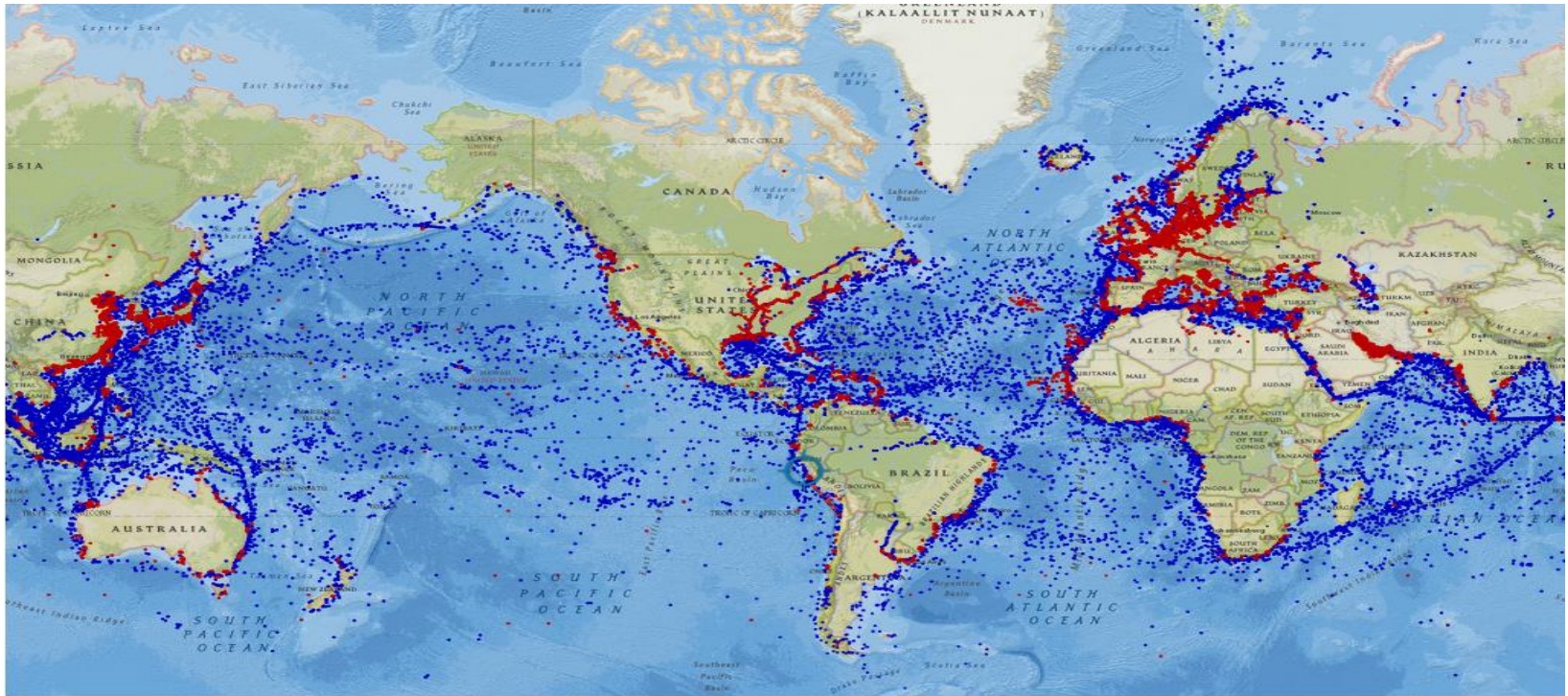
Latest Report at: 2015-10-09 20:47:14	
Destination:	Est. Arrival: Nov-30 00:00
Cargo:	Draught: 0.0m

Ship Image

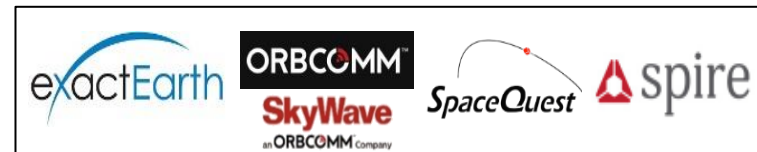
A photograph of the vessel TROPIC BREEZE, a red and white tanker ship, sailing on the water. The ship is viewed from a distance, showing its full length and the surrounding sea and sky.

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Terrestrial and Satellite Coverage



- **Terrestrial**
- **Satellite:**



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What Can We See Today?

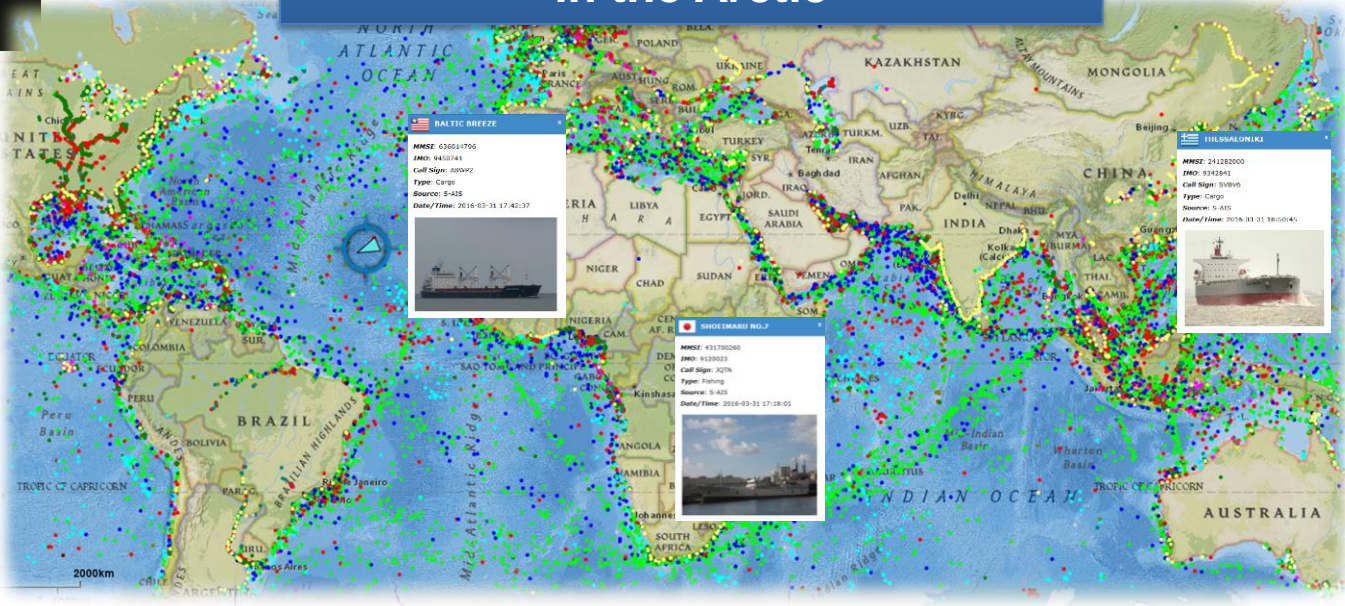


Global Coverage with frequent revisits in the Arctic

6.5 million AIS position reports daily

<30 Minute Avg. global latency

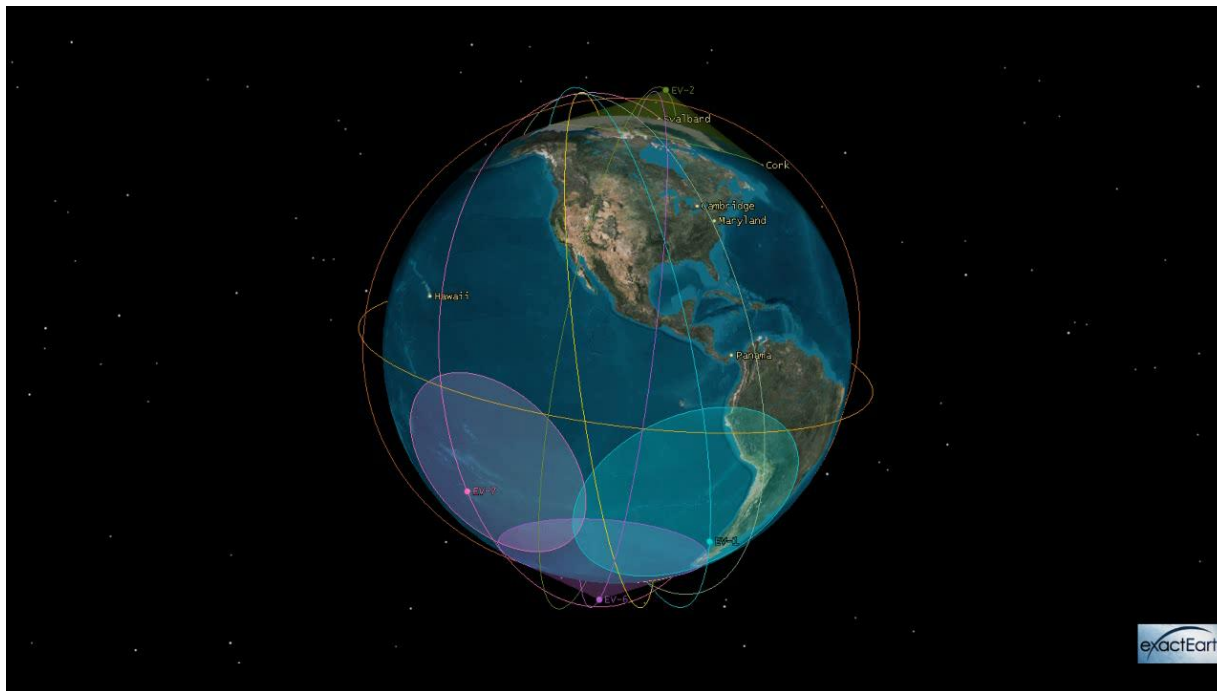
53,000+ Unique vessels detected in space daily



Base map visualization by esri

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exactView™ Constellation – 1st Generation



- In June 2016, M3MSat launched with dawn-to-dusk orbit optimal for correlation/fusion with SAR satellites

- 9 satellites on orbit today
- 26 ground stations online now, 3 more in progress

What are we doing Enhance Situational Awareness?

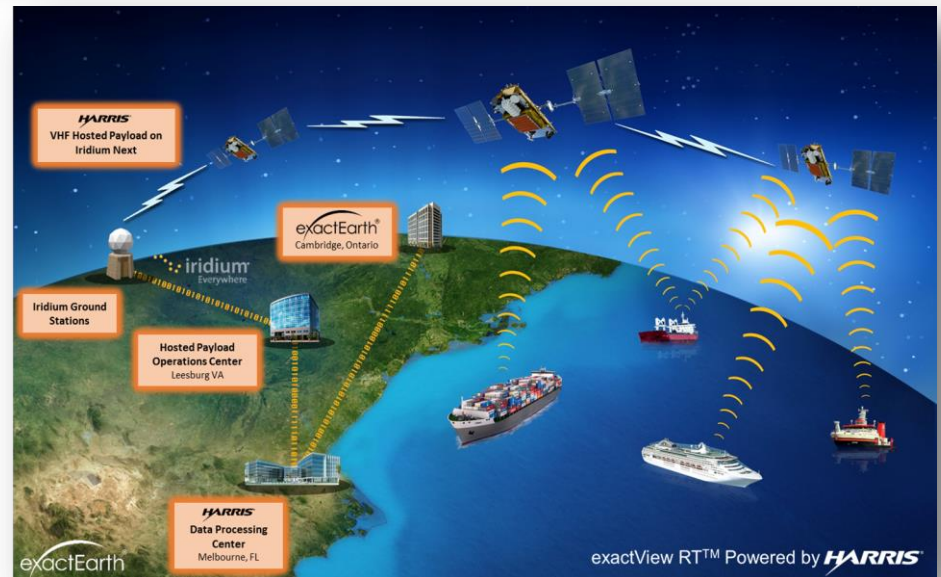
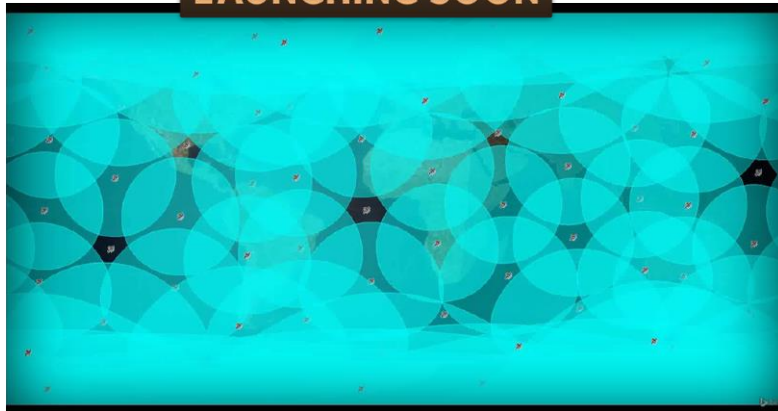
95%+
of The Globe
Under
Persistent
Coverage

3X-4X
Unique
vessels
detected every
day

< 1
Minute Avg.
global revisit



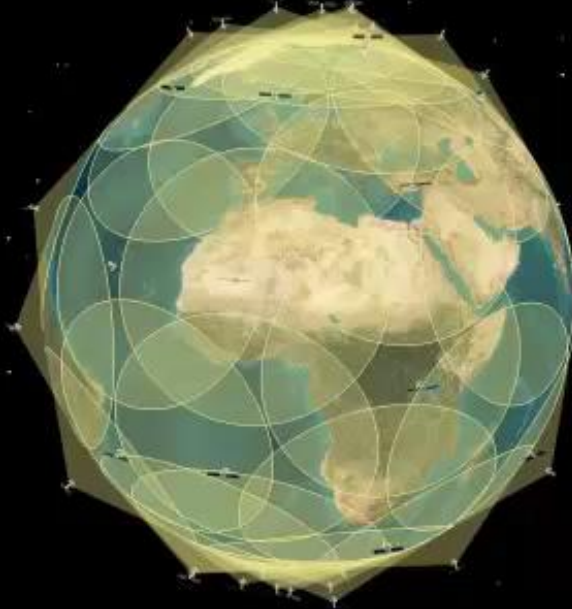
LAUNCHING SOON



Hosted Payloads on Iridium NEXT – Reprogrammable VHF Constellation

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Next Generation Real-Time Satellite AIS



The "RT" Solution

Real-time AIS tracks, high-density historical data, sea-state and weather fusion to enable more accurate predictions

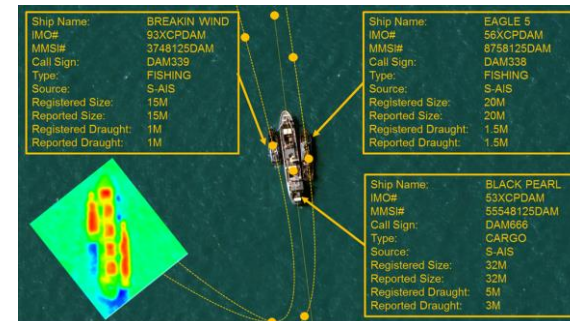
Real-time change detection of any change in status including the moment it is turned on/off

"Voyage of Life"™ is the cataloging of ships metadata and changes throughout the of life of a vessel. (Position, IMO#, Owner, Flag, MMSI, ...) Data is validated and tracked against 6 years of historical AIS data and other sources

Position Verification via 58+ LEO payloads allows accurate geo-location beyond the self-reported position

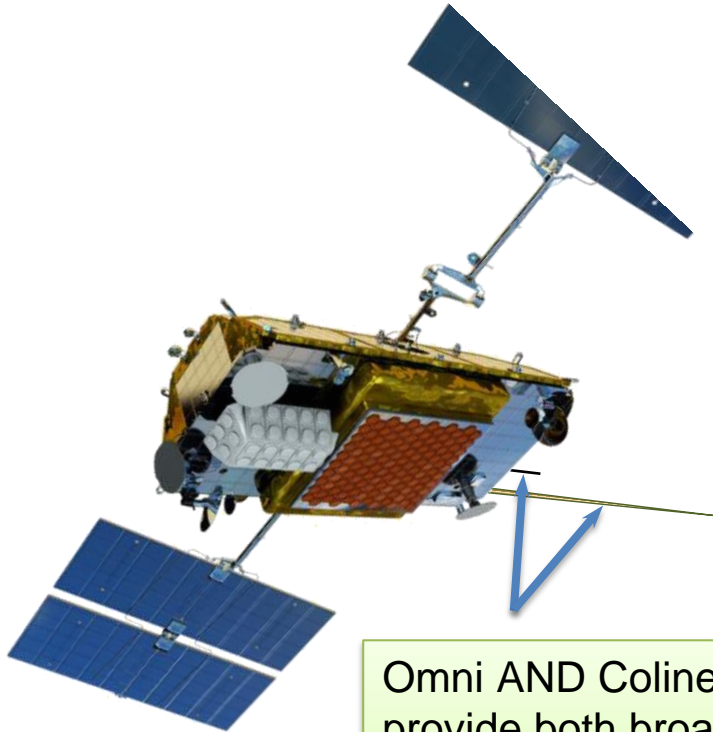
Coincident/Correlated collect with other geospatial and real-time assets

RT System Performance Metrics



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Enhanced Performance in Dense AIS Environments



Omni AND Colinear antennas provide both broad area coverage and dramatically improved detection in congested areas

Deploys with both Omni and Directive Antennas

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Launch and On Orbit Schedule (Notional)

LAUNCHING SOON

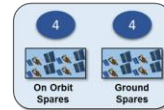
exactView® Real-Time Powered by **HARRIS**



Launch Plan subject to change. Rev June 2016

On Orbit and Operational (Plan)

exactView® Real-Time Powered by **HARRIS**



On Orbit and Operational Plan subject to change. Rev June 2016

Sample Use Cases (many more not listed)

USE CASE	FEATURE	SECURITY	SAFETY	ECONOMIC	ENVIRONMENT
Federal ECA Monitoring	NEW			<i>x</i>	<i>x</i>
Search and Rescue	ENHANCED		<i>x</i>	<i>x</i>	
Vessel Rendezvous	ENHANCED	<i>x</i>			
Arctic Monitoring	ENHANCED	<i>x</i>	<i>x</i>	<i>x</i>	<i>x</i>
Counter Piracy	ENHANCED	<i>x</i>	<i>x</i>	<i>x</i>	
Vessel Traffic Monitoring	ENHANCED	<i>x</i>	<i>x</i>	<i>x</i>	<i>x</i>
Positional Anomalies	ENHANCED	<i>x</i>	<i>x</i>	<i>x</i>	<i>x</i>
ETA & Destination Changes	ENHANCED	<i>x</i>	<i>x</i>	<i>x</i>	<i>x</i>
Anti-Proliferation	ENHANCED	<i>x</i>			
Counter Narcotics	ENHANCED	<i>x</i>			
Coordinated Collection	ENHANCED	<i>x</i>	<i>x</i>		<i>x</i>
Fisheries Protection	ENHANCED			<i>x</i>	<i>x</i>

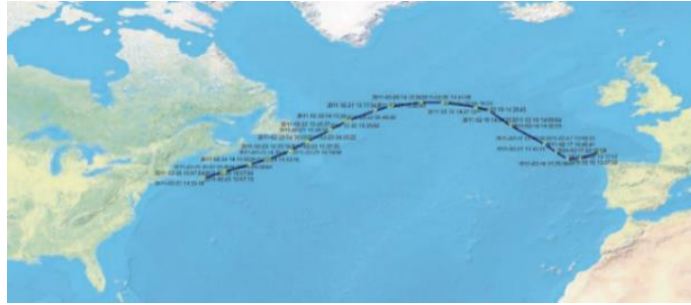
Arctic Monitoring

- Increased Arctic activity
- Many hazards for ships
- Remote, little infrastructure
- RT S-AIS key benefits:
 - Multiple satellites overlap
 - Real-time reporting allows critical tracking of passenger ships
 - Allows monitoring of nearby vessels in case rescue operations are needed
 - Integrates with weather and ice prognosis data
 - Enables Vessel Traffic Monitoring and Information Services to navigate safely even in heavy fog



Search and Rescue

- Vessels often don't declare trouble ahead of time, resulting in distress signals being sent out at very last moment or in some situations not being sent at all
- An accurate position is not always provided
- RT S-AIS key benefits:
 - Real-time provides up-to-the minute position and status
 - Data can be used to select and immediately notify appropriate nearby ship for rescue ops
 - Data can be used to assess probable risk to ships in advance of situations
 - Ability to coordinate aircraft data with Aerion Iridium NEXT payload



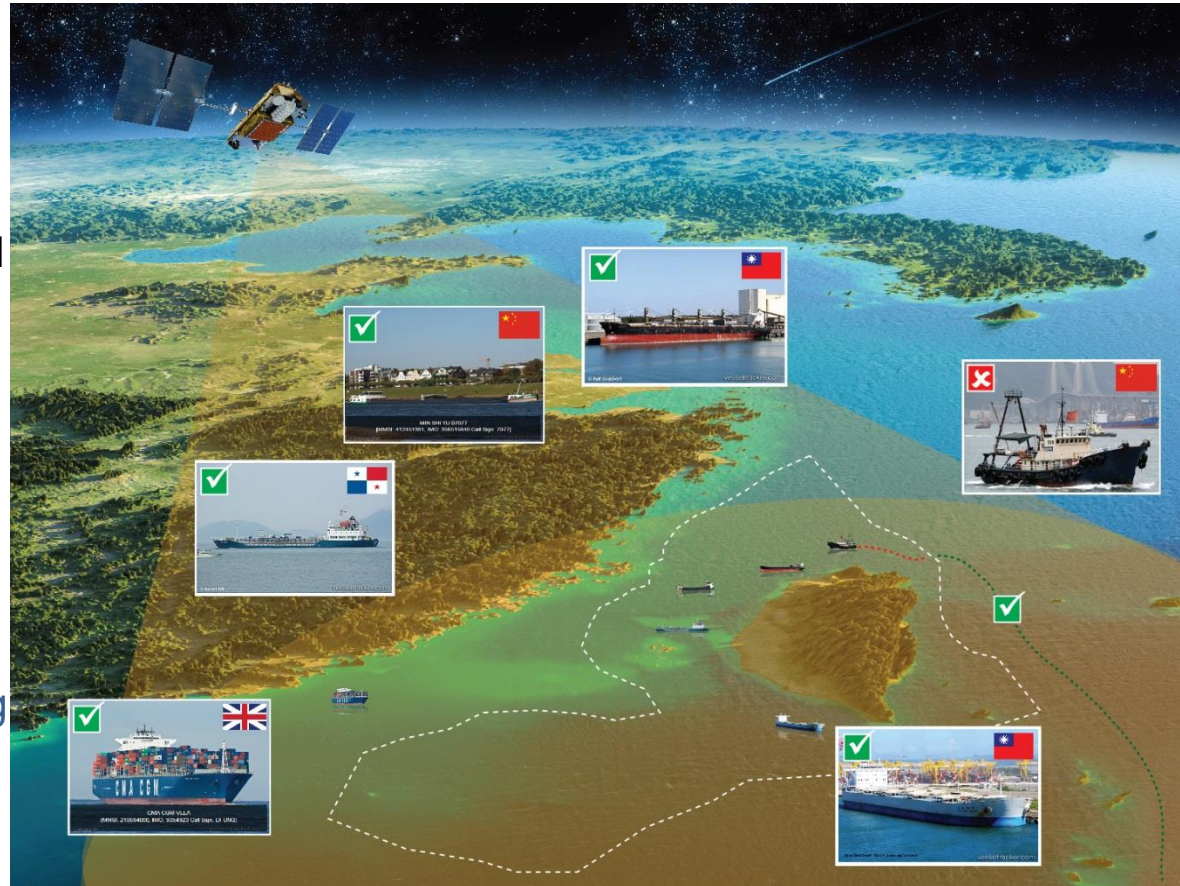
Track of Tug
McAllister that
assisted in the
rescue and towed the
Dintelborg to safety



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Fisheries Protection

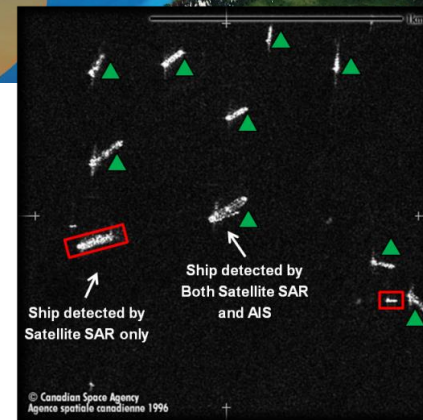
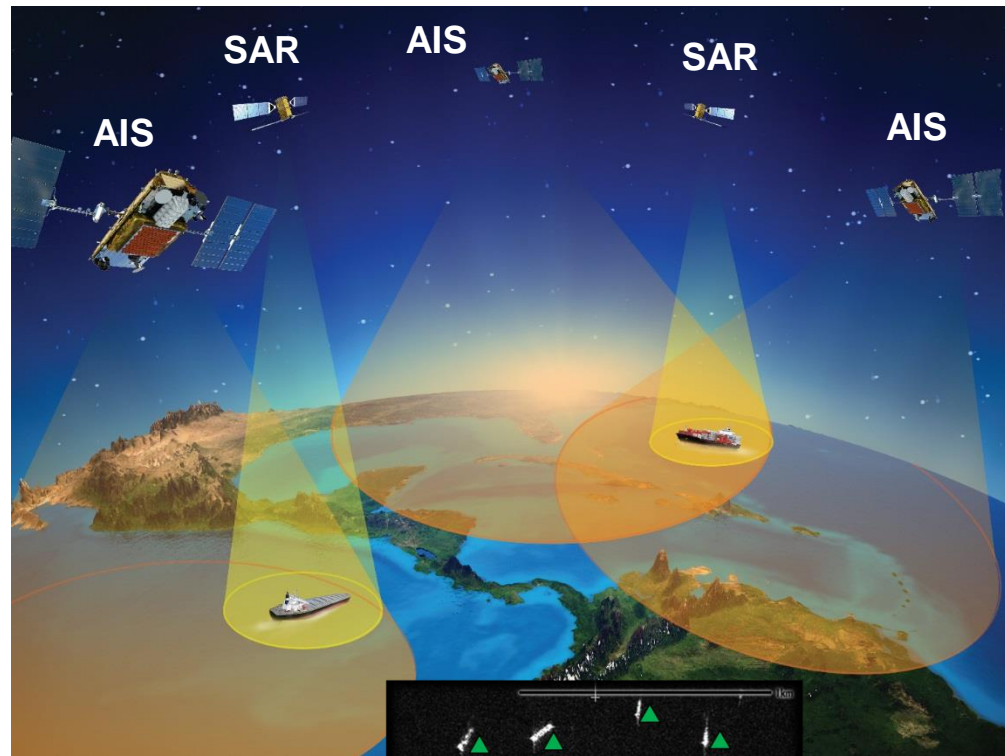
- 53% of the world's marine fishery resources are fully fished or fished to maximum sustainable level (UN FAO, 2010)
- Illegal, unreported and unregulated (IUU) fishing is a major threat
- Marine Protected Area violations frequently go unreported
- RT S-AIS key benefits:
 - Detect change in AIS state immediately
 - Validate vessel positions from VMS to eliminate false reporting
 - Determine proximity of non-cooperative vessels in area
 - Real-time allows prosecution of violators by patrol assets
 - Detect spoofed positions
 - Correlate AIS database with registration to Fishery Management Agencies to identify unregistered vessels in fishing waters



AIS is turned off on the fishing vessel as it enters the MPA

Correlated/Coordinated Collection

- AIS can be easily turned off whether this is accidental or on purpose
- Vessels can broadcast inaccurate position information whether accidental or on purpose (spoofing)
- Both may denote suspicious behavior
- RT S-AIS key benefits:
 - Enhanced Maritime Domain Awareness
 - Detect dark targets coincident with radar collection
 - Detect when AIS is turned OFF immediately
 - Estimate position of vessels broadcasting spoofed positions by using AIS signal characteristics and satellite positions (geo-location)



Defeating AIS Manipulation Practices

Top Five AIS Manipulation Practices

New research by Windward identifies the top AIS manipulation tactics:

- Identity Fraud
- Obscuring Destinations
- 'Going Dark'
- GPS Manipulation
- AIS Spoofing

Source: October 2013 – 2014 "AIS Data on the High Seas: An Analysis of the Magnitude and Implications of Growing Data Manipulation at Sea".

Manipulation Practice

1. 1% of all ships use **fake identification** information over the past year, resulting in several hundred vessels "in disguise" at any given time
2. **Obfuscation**, with on average, vessels report their next port of call only 41% of the time
3. **Over ¼ of the vessels worldwide turn off** their AIS at least 10% of the time
4. From mid-2013 to mid-2014 there has been a **59% increase in the use of GPS manipulation**
5. AIS can be "**spoofed**" and inserted into the data stream allowing people to create "ghost ships" where none exist



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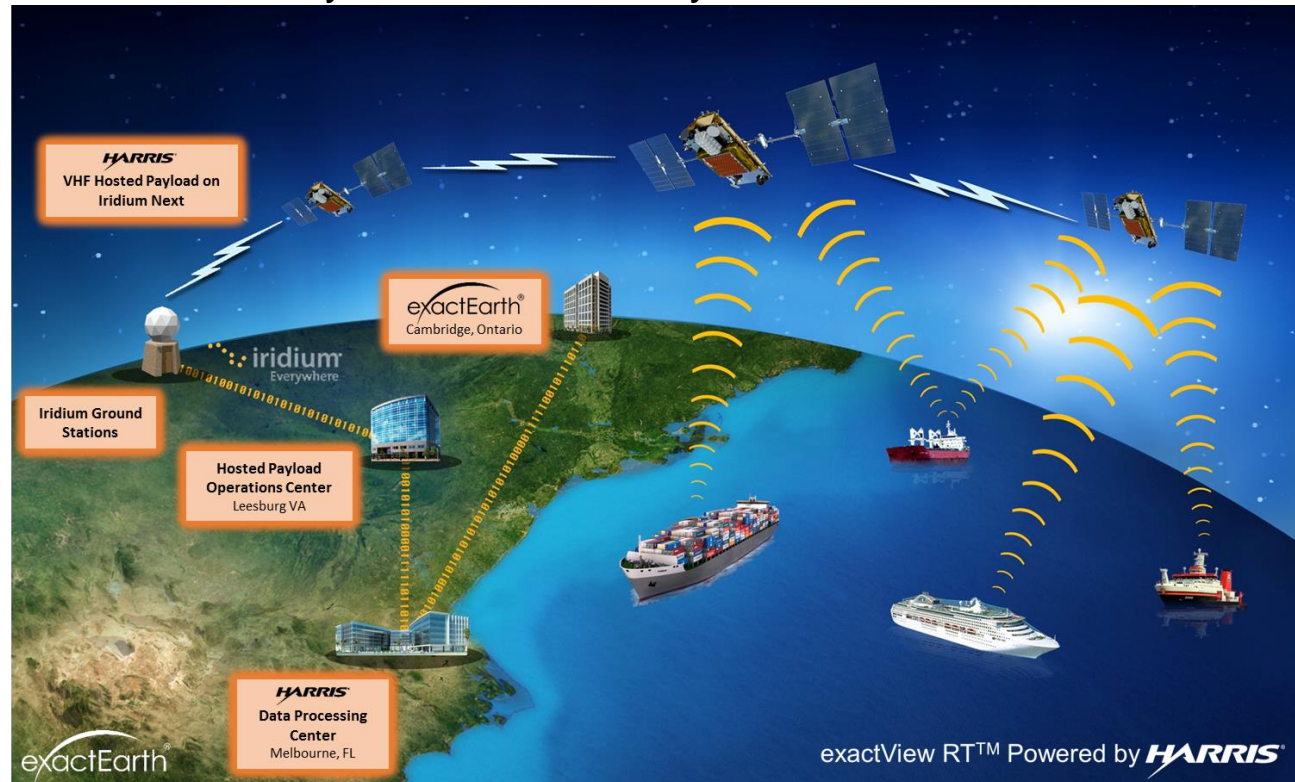
Real-time change detection of any change in status including the moment it is turned on/off

Position Validation via 58+ LEO payloads allows accurate geo-location beyond the self reported position

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Summary

- Current satellite AIS systems have not yet achieved simultaneous global coverage, nor do they provide global, instantaneous delivery/downlinking of collected data; this requires:
 - Large constellation of LEO satellites
 - Superior detection algorithms
 - Architecture that provides real-time delivery without the latency
- Satellite VHF system must also accommodate future maritime changes
- This Next-Gen System will dramatically improve MDA and ocean observing capabilities through persistent monitoring – *everywhere simultaneously over the entire globe*



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Thank You Very Much!

どうもありがとうございます