

**It is an Interconnected World  
Except in the Maritime Domain**

**In 2008**

**Satellite AIS (S-AIS) Changed All that!**



# Background

- As the US Science & Technology Advisor for MDA for 10+ years, 2001-2012, we looked at every Platform, from satellites to undersea vehicles, and every Sensor, Processing, Fusion, Analysis, Display/Decision Aid and Dissemination system, we could find.
- By mid-2005 it was obvious commercial Space is THE crucial /core component to Global Maritime Awareness.
- This brief is the result of that Research, which continues to this day.

# Satellite AIS

## The Game Changer

Most Significant Change to Maritime  
Operations since the Screw propeller

(Yes, More Significant than GPS!)

Guy Thomas  
geo.guy.thomas@C-SIGMA.space  
410-971-6999

**BLUF:**

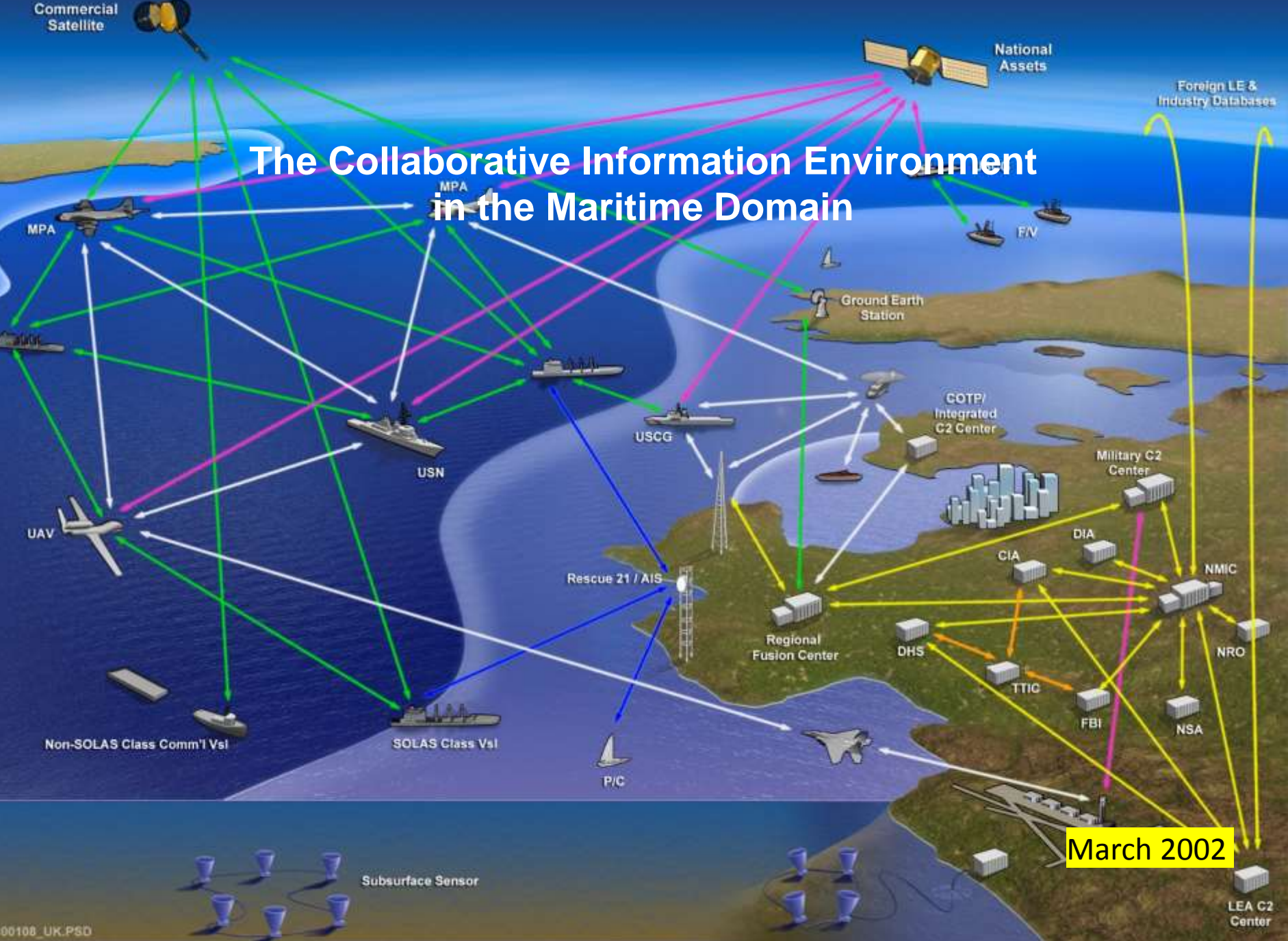
**Unclassified Space**

**is NOT MSA!**

**(But there can be no**

**Real MSA without it!)**

# The Collaborative Information Environment in the Maritime Domain



March 2002



## **MARITIME SITUATIONAL AWARENESS \***

**Needed for:**

➤ **Security**

- **Counter Smuggling**
  - **Drugs**
  - **People**
  - **Arms**
  - **Goods/Counterban**
- **Counter Piracy**

➤ **Safety**

➤ **Environmental Protection**

➤ **Resource Conservation**

➤ **Disaster Mitigation**

➤ **Disaster Recovery**

**\* It is Feasible to Use One Center For  
Global Coordination & Collaboration of  
all Space Assets!**

# **4 GLOBAL COMMONS**

**1) Maritime**

**2) Air**

**3) Space**

**4) Cyber**

**Major Recent Advancements in Last 2,  
Space & Cyber,  
Potentially HUGE Effects on Maritime  
Especially MSA**

**SPACE-BASED  
MARITIME SITUATIONAL AWARENESS  
WHERE 3 GLOBAL COMMONS  
CONVERGE**

**You Cannot Surge Trust!  
It needs to be earned.**

**ADM Mike Mullen**



# Quotes from NATO MSA Meeting April 2016

1. Establish a Global MDA
  - A. Coordinate & Synchronize
  - B. Command, Procedures, & Coordinate
  - C. Develop Linkage between MDA Organizations
  
2. Need Leadership and Vision
  - A. Provide Focus on MSA

**Proposed Way Ahead:  
Use Development and Deployment  
of Space-Based MSA as Focus for  
World-Wide MSA**

# **MDA Manifesto (2002)**

(according to Guy Thomas)

**From Each According to their Ability  
To Each According to their Needs**

**No where more true than in  
SPACE-Based MSA**

**Makes for a better, safer, more secure WORLD!**



# C-SIGMA

Collaboration in Space for

\*For International Stewardship of the Maritime Environment and its Resources

\*For Maritime Safety

\*For Security

Global Maritime Awareness

Photo  
Courtesy of



Guy Thomas

[g.guy.thomas@c-sigma.org](mailto:g.guy.thomas@c-sigma.org)



# Four Types of Satellites

- Satellite AIS
- Synthetic Aperture Radar
- Optical Imager
- Communications (M2M/SMS/LRIT)

- Each makes a Unique Contribution
- See **C-SIGMA** Core Brief for more Details

# Space Systems are Very Cost Effective

- Space Systems makes terrestrial systems (Ships & planes) many times more effective
- Space Systems, tell decision makers where to pinpoint their search.
- HUGE Saving of Fuel, Time and Wear
- Dramatically increases effectiveness of Terrestrial Systems

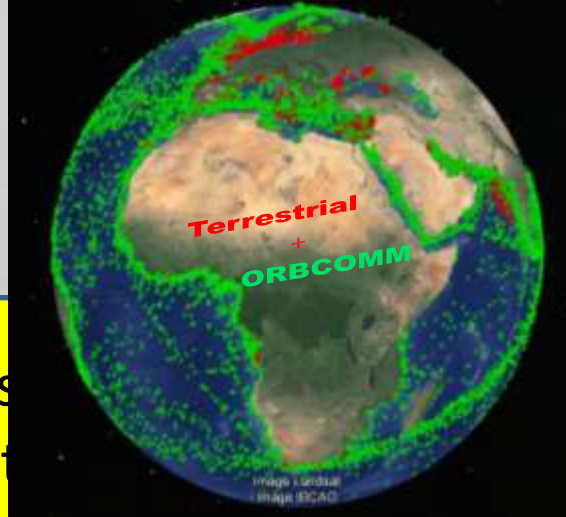
# S-AIS

Created to provide Maritime Security to USA, its use has expanded far beyond.

- Environmental Protection
  - Maritime Resource Protection
  - Safety
    - Commodities Trading
    - Route Planning
      - Ship Maintenance
      - + + +



# WHAT IS AIS?



ance system that broadcasts  
her data via VHF (line of sight)

- Mandated by the International Maritime Organization (IMO) to be installed on hundreds of thousands of larger vessels
- ORBCOMM Worked on S-AIS concept from October 2001 with Johns Hopkins' Applied Physics Laboratory (JHU/APL)
- ORBCOMM Pioneered the collection of AIS data from space in 2004 with the US Coast Guard
- ORBCOMM Launched first 6 Sat Constellation in 2008.

**ORBCOMM provides the industry's most comprehensive AIS service**

- **ORBCOMM launched 11 next generation  
December 2015 **19 now on orbit****

- **Reporting to 16+ Ground stations**

**Time late down to just a few minutes, Globally**

- **exactEarth plans to launch 30 + in the next 4 years (?), with cross-link reporting, taking time late to very near real time.**

- **Spire Global is in the process of launching 40+ which will also have reporting periods in the few minutes.**

# Sufficiency Latency is here now

Latency = Time from

Collection Opportunity-to-Collection-to-Report

With completion of ORBCOMM constellation

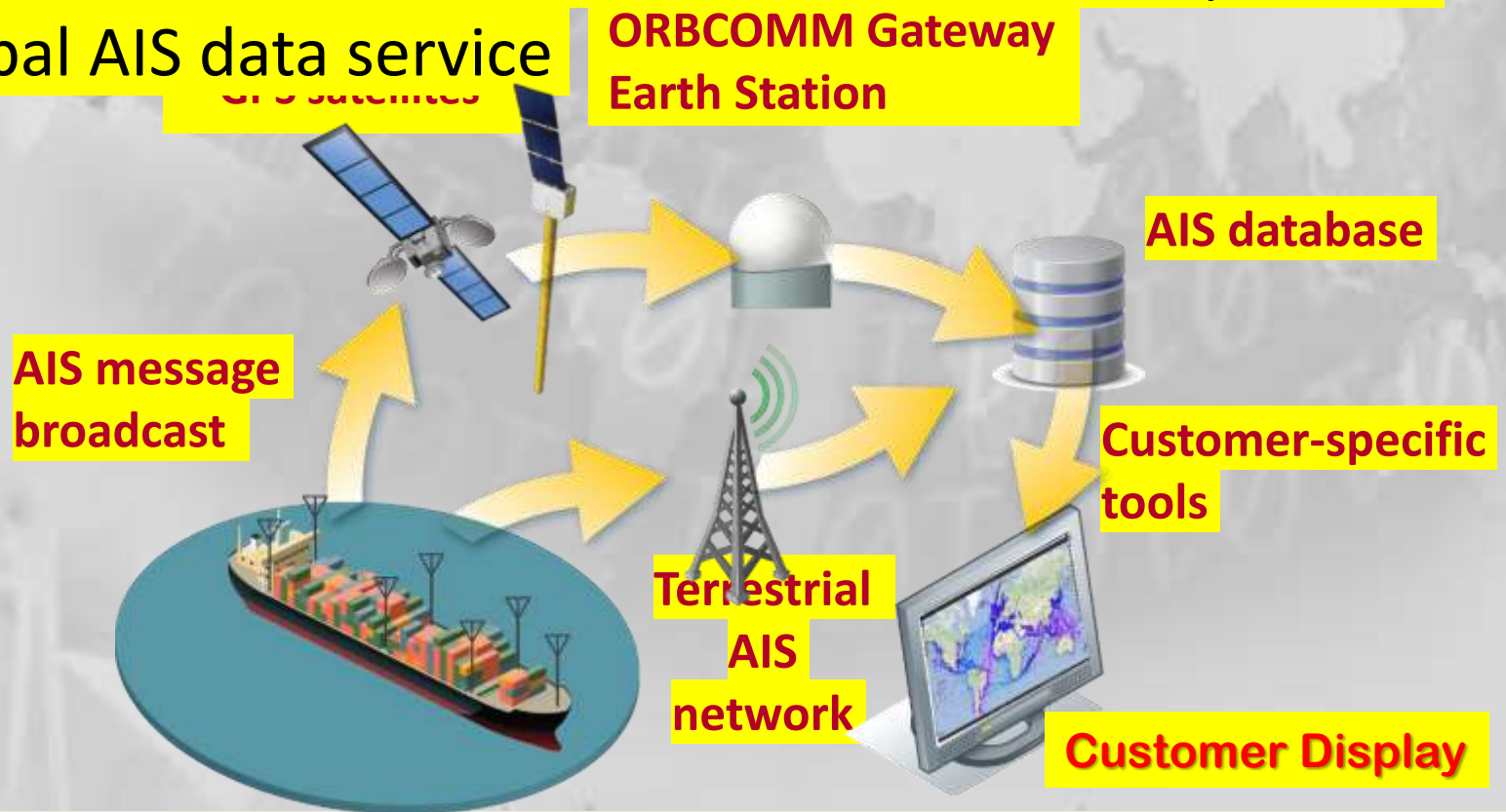
Latency < 10 minutes in the most populated areas of the world.

< than a minute in many areas & instances due to global distribution of ORBCOMM Ground Station allow direct reporting from ship-to- satellite-to-ground station-to-user.



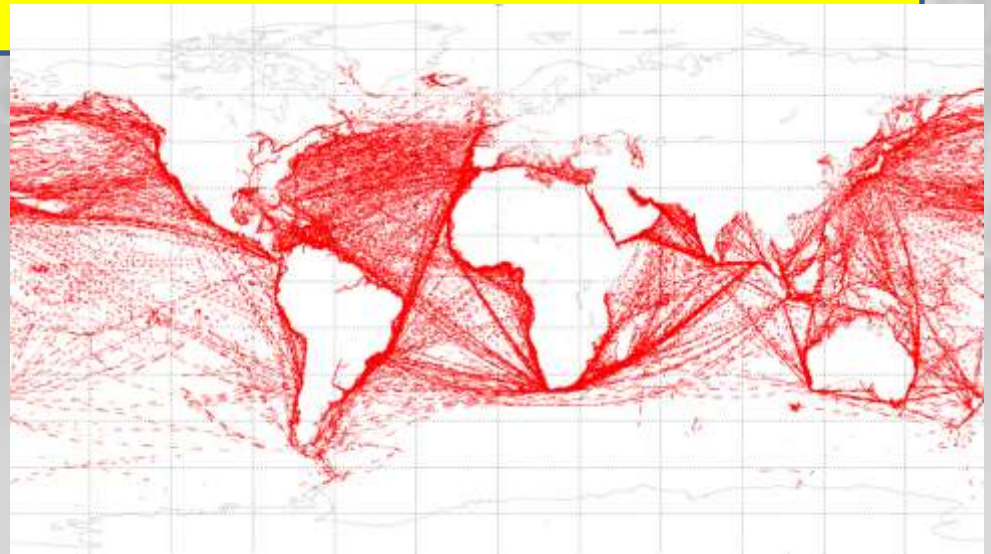
# ORBCOMM's Satellite AIS System

- ORBCOMM leverages its established commercial M2M satellite business, recent satellite deployments and established infrastructure worldwide to provide global AIS data service

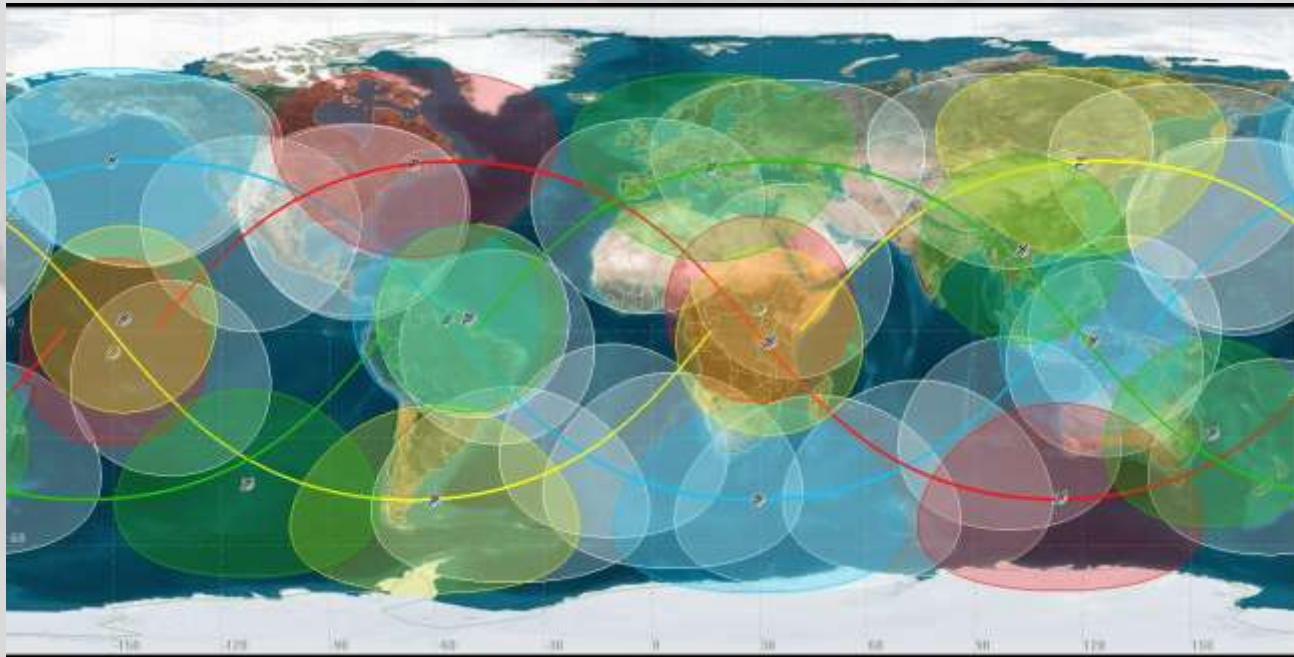


# AIS TODAY

- 19 Satellites + 16 Global Ground Stations
- Multiple Best-in-Class Terrestrial AIS Data Partners
- **23+ Million Messages Daily and > 180,000 Vessels Daily**
- OG2 provides near continuous coverage with average revisit rates of 8-15 minutes and less than 10-minute latency worldwide.



# ORBCOMM CONSTELLATION – SATELLITE FOOTPRINTS



A snapshot in time:  
Orbiting satellites provide near  
continuous coverage

# ORBCOMM GATEWAY EARTH STATIONS



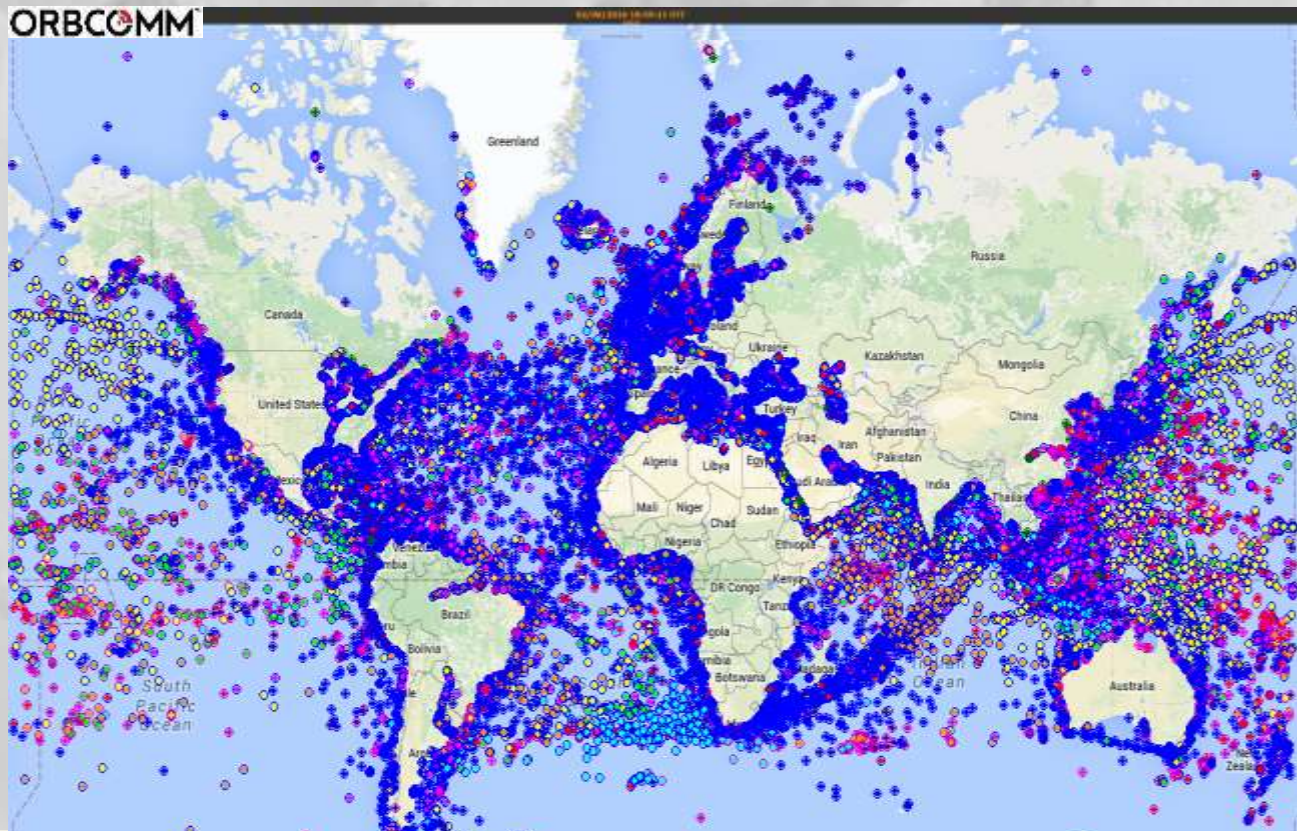


# GLOBAL AIS DATA










- Terrestrial AIS provides real-time coverage in

ORBCOMM

Satellite AIS data provides near-real-time complete global coverage



# AIS APPLICATIONS BEYOND COLLISION AVOIDANCE

Government	 <p>Surveillance and security</p>	 <p>Search and rescue</p>	 <p>See everything – including vessels that don't want to be seen</p> <p>Data fusion with sensors</p>
	 <p>Counter piracy</p>	 <p>Environmental monitoring</p>	 <p>Incident investigation</p>
	 <p>Logistical tracking</p>	 <p>Energy/commodity tracking</p>	 <p>Fishing regulation compliance</p>



# AIS IN USE: FISHERY COMPLIANCE

- Worldwide average fish consumption is 160 million tons per year, China consumes one-third. Regulations are required to prevent overfishing and allow replenishment of supply..



# S-AIS Competition Heats Up

Both Spire and exactEarth/Harris are planning S-AIS constellations with time latencies of < 1 minute.

❖ What are these new, faster systems worth?

❖ “Better is the mortal enemy of good enough.”

Winston Churchill

during the Battle of Britain

➤ ORBCOMM has added low cost 2 ways comms



**hali**

# Ground-Breaking Combination

## AIS Class B – M2M Small Vessel Tracking Device

Combination of AIS Class B with  
ORBCOMM 2-way satellite network

Comprehensive and economic  
solution for vessel tracking

Introduced in 2017



# HALI combines the best of both

Since 2008, ORBCOMM has had two complementary systems ,

- ❖ M2M two way comms (used primarily for status reports)
- ❖ AIS

## HALI

- Self contained
- Optional battery or connection to shipboard power.
- HALI broadcasts its position on both M2M and AIS frequencies at the same time,
- Doubles chance of reception on 40+ ORBCOMM satellites
- Send preprogrammed safety and status messages containing name, position and status of sender.

# How Hali works

## Local



Class-B AIS is broadcast to nearby vessels and terrestrial AIS stations

## Global



Class-B AIS is broadcast to both satellite AIS & M2M receivers

## Reliable



ORBCOMM's entire 2-way proprietary global satellite network

## 1. Attach



Powerful and tamper-proof hardware for vessels of all sizes

## 2. Collect



Acknowledged AIS & M2M satellite data, anywhere in the world

## 3. Deliver



Web-based platform with 24/7 support in multiple languages



# S-AIS

Now paired with  
space-based Imaging

- **Radar**

- Day/Night,
- Good/Bad Weather

- **Optical**

- High Definition

COLLABORATIVE COLLECTION

# S-AIS & SARSAATS

A TRUE SYNERGISM



Earth Inertial Axes

24 Oct 2008 19:20:46.000 Time Step: 0:50 sec

# Dynamic Data Analysis

■ **Goal:** Detect suspicious ship **behavior** from position tracking data

■ **Approach:** Define a set of **discrete zones** and predict the ship movements in the grid

■ **Challenges:**

- prediction **precision**
- lack of **positive examples**
- ship traffic **variability**
- **privacy** vs. **security** tradeoff

■ **Scenarios:**

- **vendor** data distribution
- **regional** data distribution





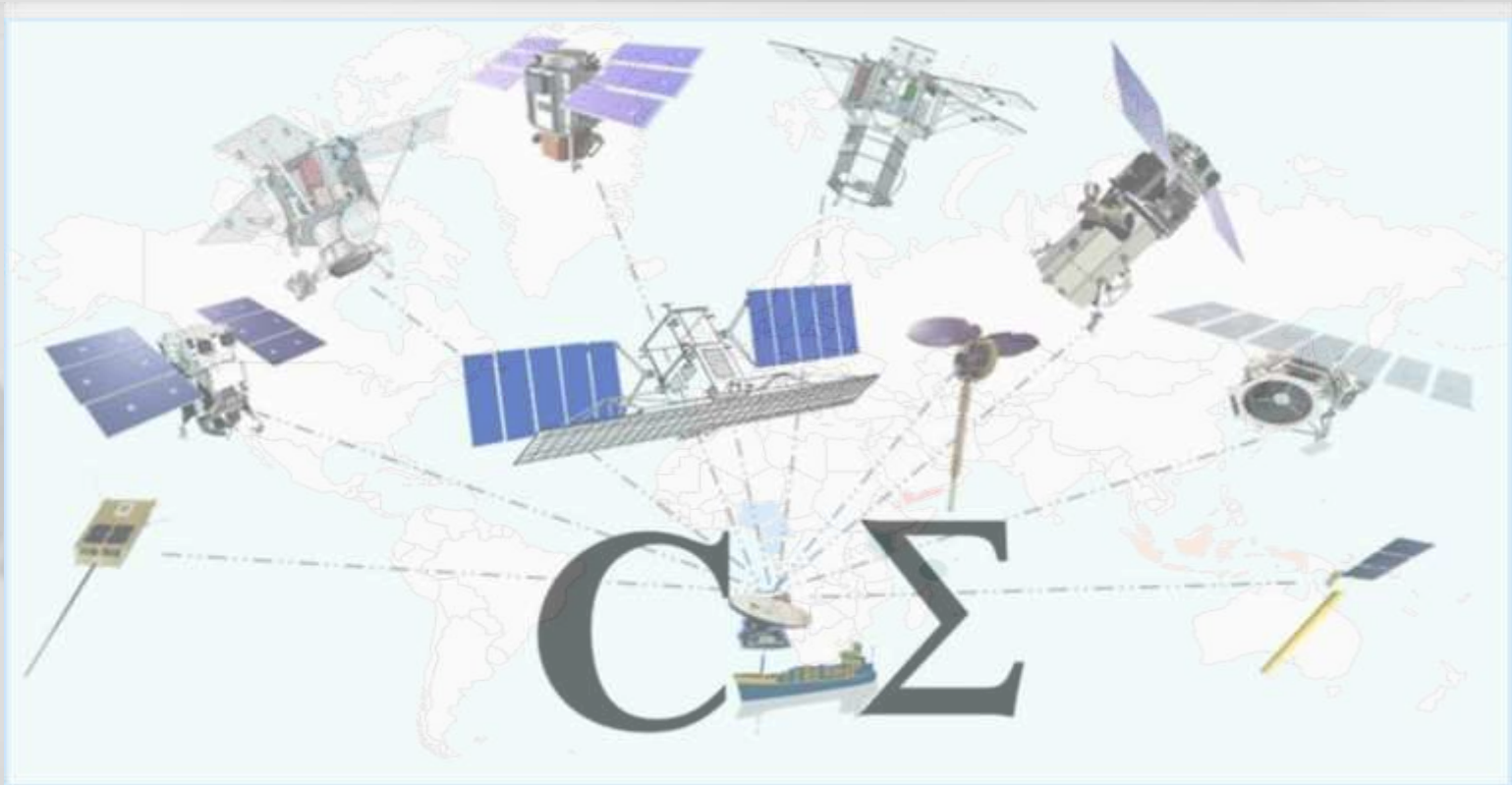
# Dynamic Data Analysis (DDA)

Generates Knowledge  
& Understanding  
from Diverse Data

- Over 12 organizations
- Very sophisticated DDA systems
- High Tech Race for Supremacy

& The Winner is ***EVERYONE***





**Global Focus  
Regional Execution ?**

**[www.C-SIGMA.space](http://www.C-SIGMA.space)**

# **Maritime Domain Awareness (MDA)**

**Is not Rocket Science!**

**MDA is a lot harder!  
(many more variables)**

German Aerospace Engineer

# QUESTIONS ?



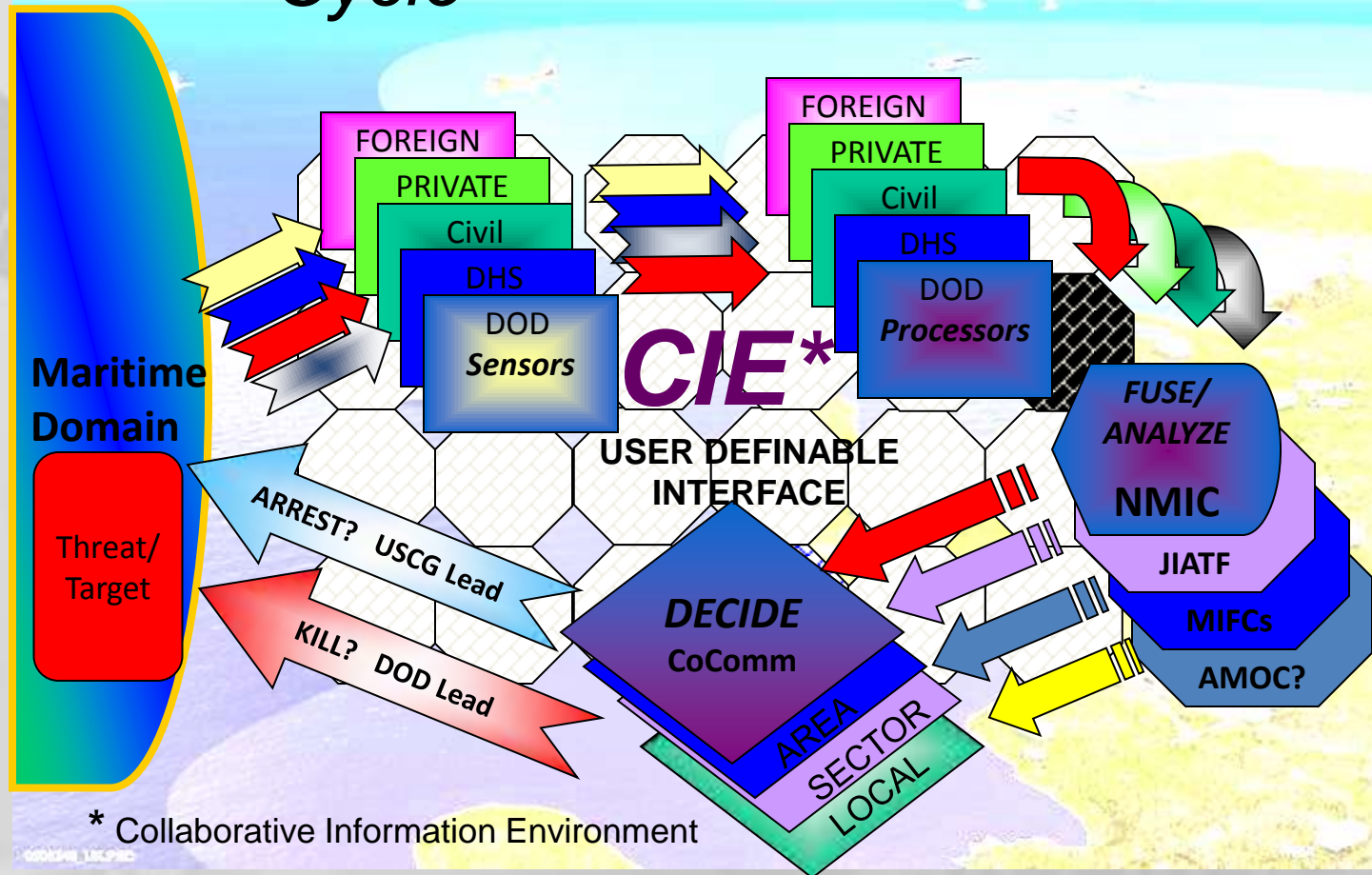
# Fire Away!



# Backups



# Sense - Decide - Act Cycle



# US National Space Policy

Presidential Policy Directive #4 (PPD-4)

28 June 2010

## Implementation Task #1

- Tasks Committee to “Build C-SIGMA”
  - IGNORED
  - “No Money”
- Very Shortsighted
- Frustrating!
- Bureaucracy is the BANE of us all.....

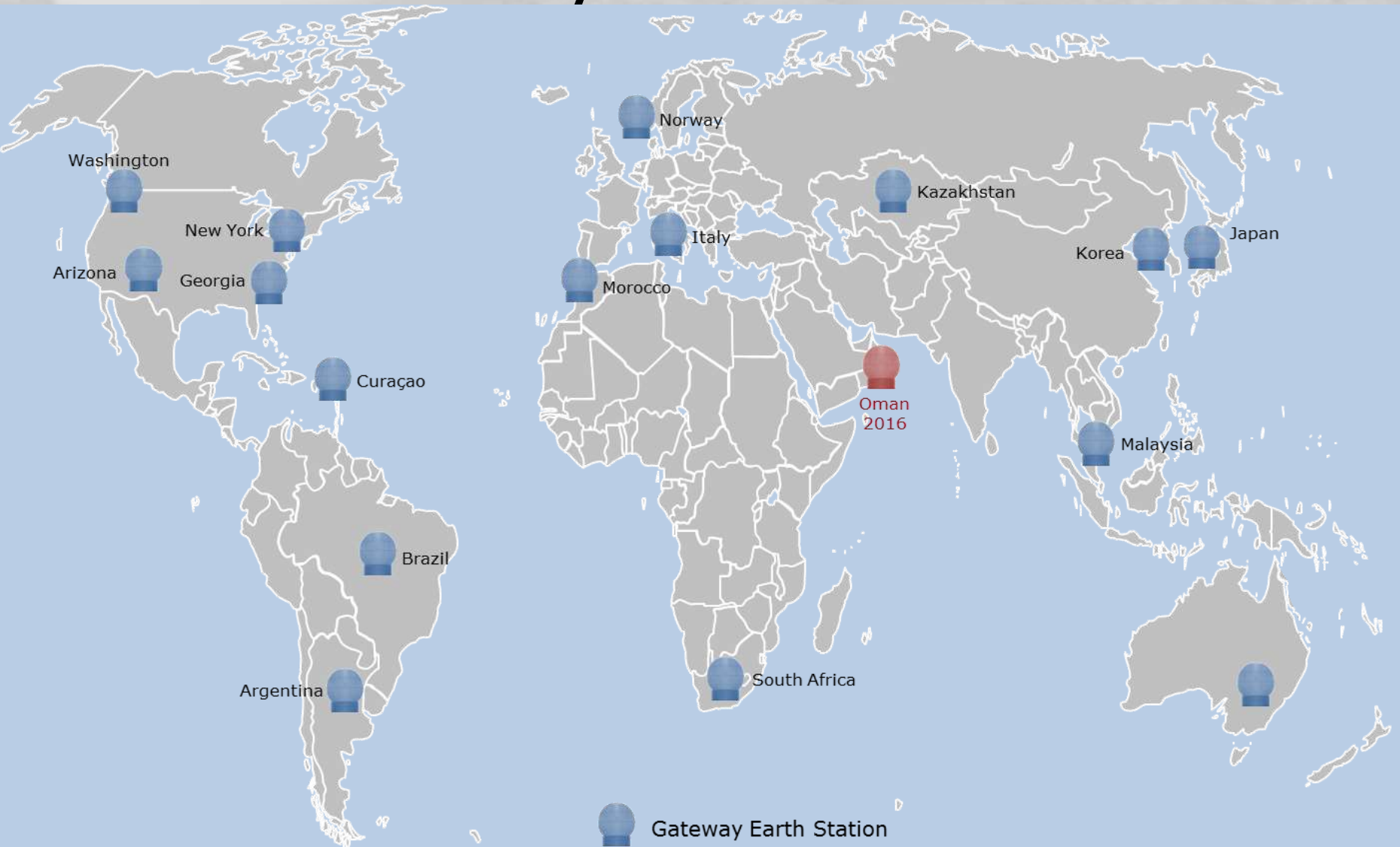
# National Space Policy (PPD-4)

## Implementation Task #1

“(U) Working through the National Maritime Domain Awareness Coordination structure, the Secretaries of Defense, Homeland Security, Transportation, State and Commerce, will develop an unclassified, international available program to foster international collaboration using civil and commercial space systems to enhance global maritime domain awareness to provide: enhanced safety of life at sea; increased mutual security of all users of the maritime domain; improved protection of the maritime environment and the resources of the sea; improved flow of commerce; and better monitoring of the condition and performance of the Marine Transportation System.”

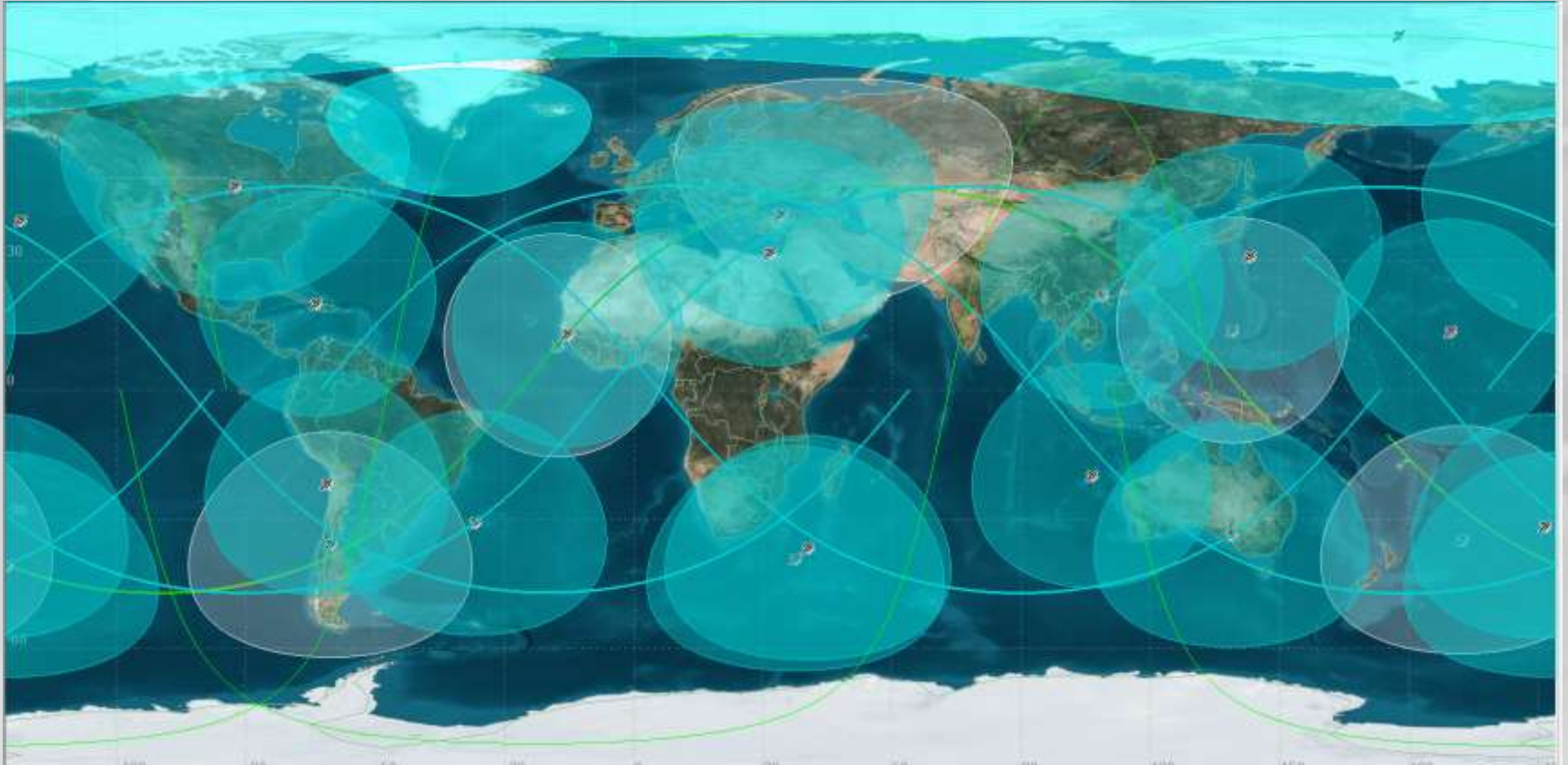
# ORBCOMM

## Gateway Earth Stations





# ORBCOMM Constellation (snapshot)







# MARSEC COE

Uniquely Placed  
Unique Opportunity

\*\*\*\*\*

Lead the Global Deployment  
of  
Space-Based  
Maritime Awareness





**C-SIGMA VII**  
**19-20 April 2017**



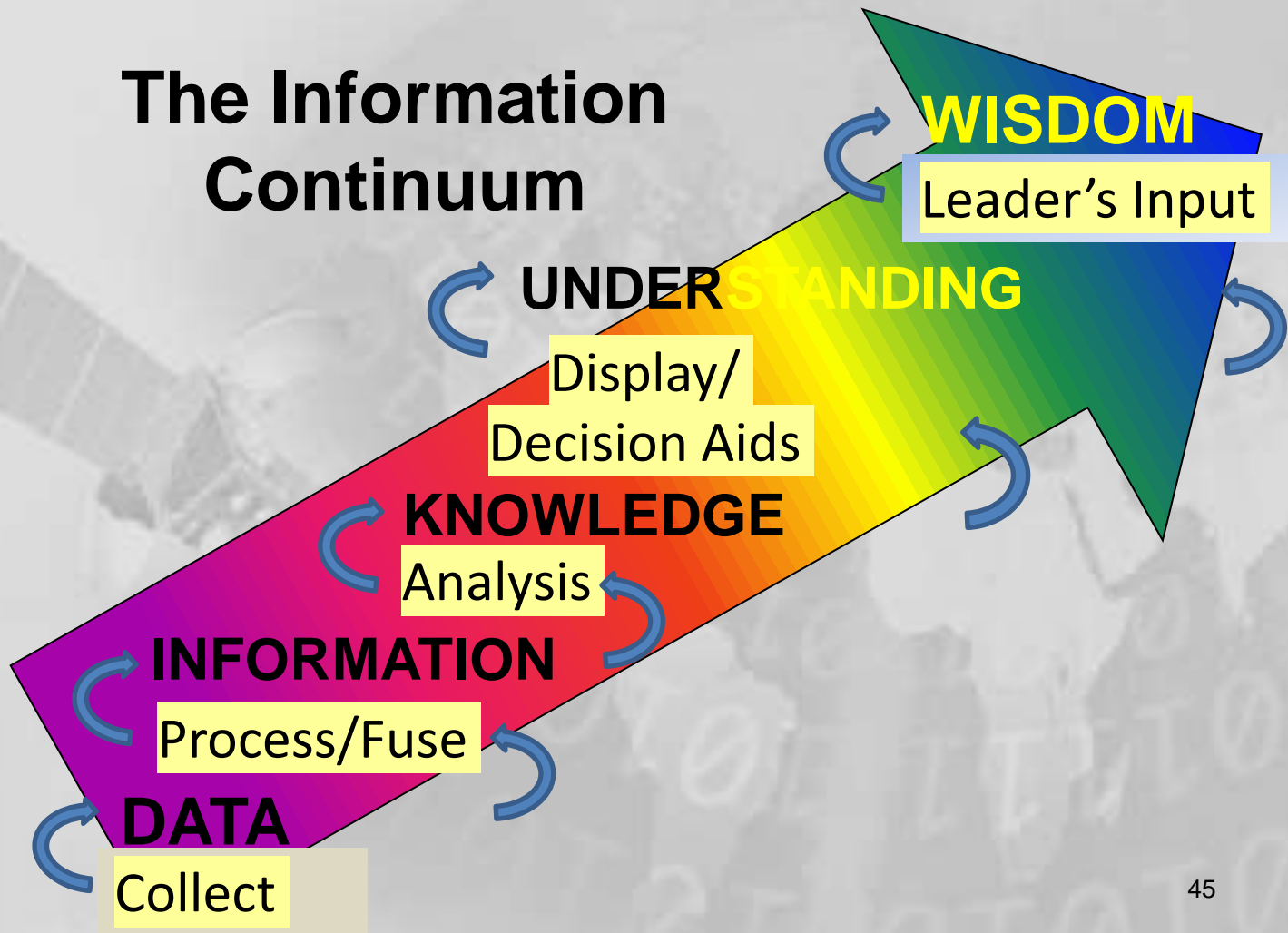
**EMSA, Lisbon, Portugal**



**Collaboration in Space for  
International Global Maritime Awareness**

**www.C-SIGMA.org** **C-SIGMA**

# The Information Continuum





# Horizontal Fusion/Integration

## The Way Ahead

