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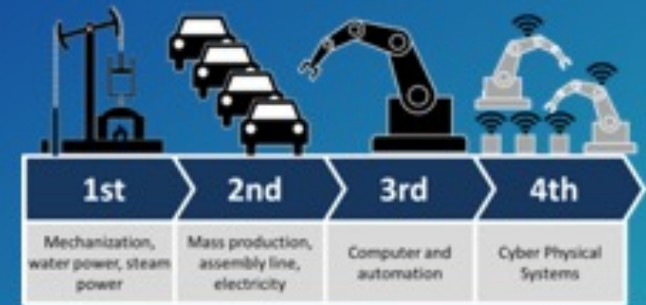
THE  
SCIENCE  
OF  
WHERE™

## *MSDI in the Cyber-Physical Revolution*

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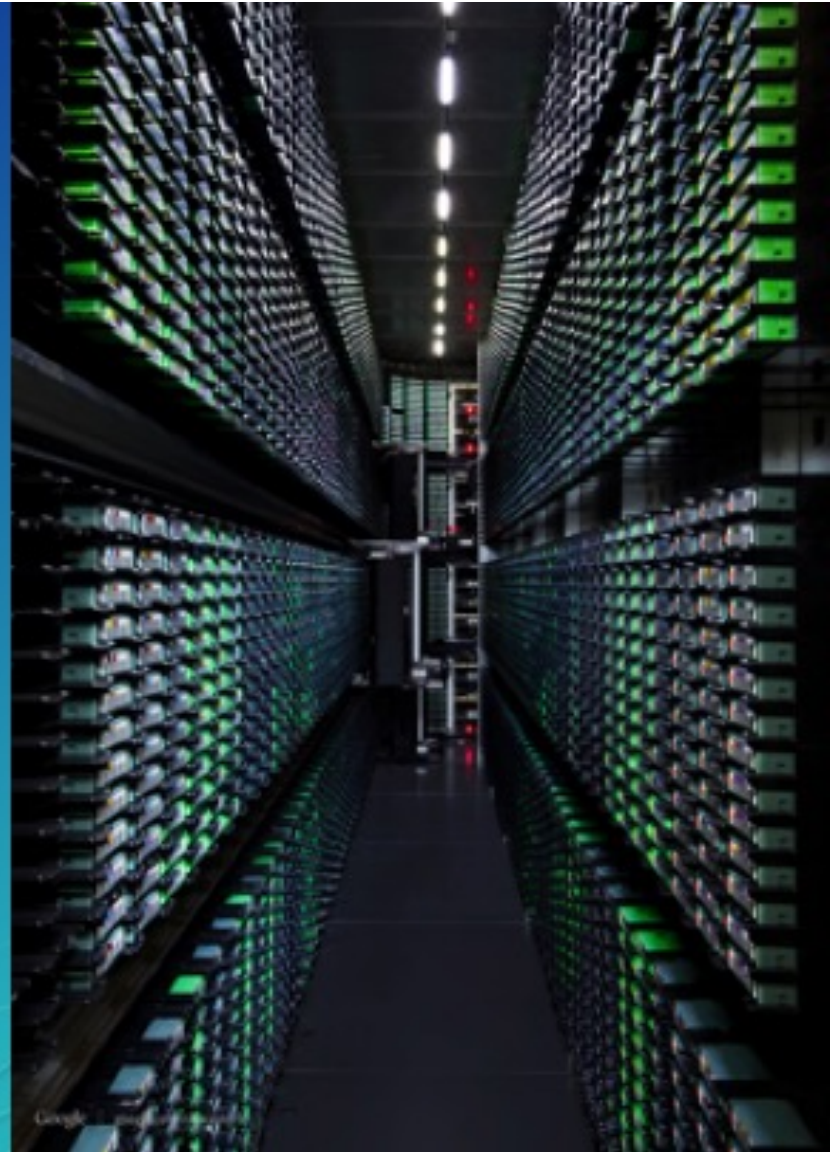
# The Fourth Industrial revolution

- Lineal Growth vs Exponential growth
- We can't use the past to predict the future
- Change is accelerating
  - Faster changes in the next 50 years than in the past few hundred
  - a new "Seaconomics" era
  - GDP and cargo volumes are decoupled
- Change creates new opportunities – new technologies
- A Digital Vision → powered by Data (in time and space)



## Key technological factors

- Big Data
  - Volume, Velocity and Variety
- Internet of Things (IoT)
- Artificial Intelligence (AI)
- Augmented Reality



# We can see their effects: Autonomous Ships

Fast developments around the world



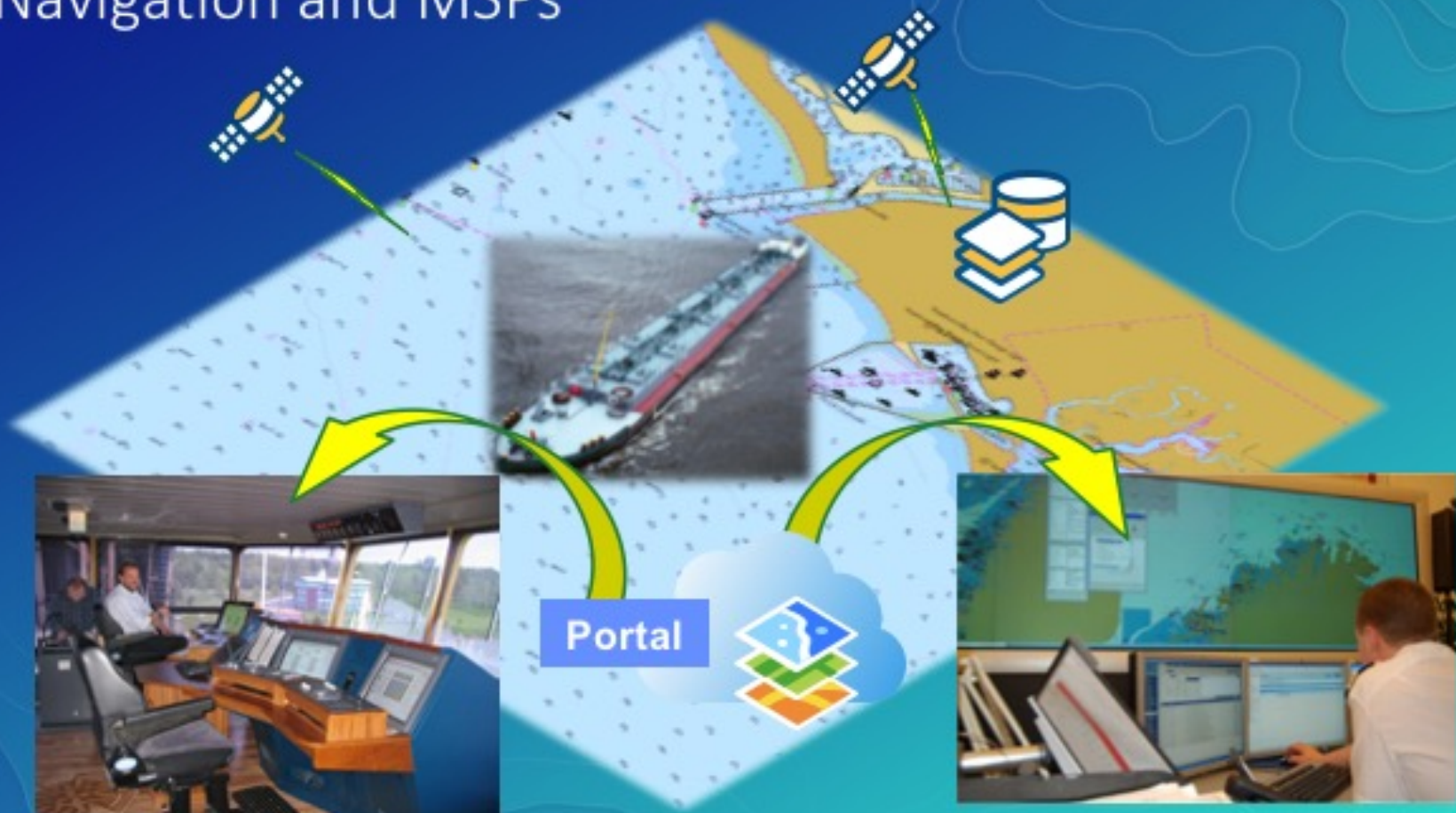
Bigger, more efficient, more complex: **new machine readable products**

## Smart Ports

- Maasvlakte2 terminal in the Port of Rotterdam
- Unmanned electric AGVs
- Remote operated unmanned cranes



# E-Navigation and MSPs



## The e-Navigation Strategy Implementation Plan\* (SIP)

- Improved, harmonized and user-friendly bridge design;
- Means for standardize and automated reporting;
- Improved reliability, resilience and integrity of bridge equipment and **navigation information**;
- Integration and presentation of available **information in graphical displays** received via communication equipment; and
- Improved Communication of **VTS Service Portfolio** (not limited to VTS stations).

*To be completed in 2015-2019 to provide industry with harmonized information to design products and services for e-Navigation solutions*

*\*No provisions for Autonomous ships*

# Maritime Services Portfolios

- As part of the improved provision of services to vessels through e-navigation;
- The means of providing electronic information in a harmonized way

No.	Identified Service	Identified Responsible Service Provider
MSP1	VTS Information Service (IS)	VTS Authority
MSP2	Navigational Assistance Service	National competent VTS Authority/Coastal/Port Authority
MSP3	Traffic Organization Service (TOS)	National competent VTS Authority/Coastal/Port Authority
MSP4	Local Port Service (LPS)	Local Port/Harbor Operator
MSP5	Maritime Safety Information Service (MSI)	National competent authority
MSP6	Pilotage Service	Pilot Authority/Pilot Organization
MSP7	Tugs Service	Tug Authority
MSP8	Vessel Shore Reporting	National competent authority, Ship owner/Operator/Master

No.	Identified Service	Identified Responsible Service Provider
MSP9	Tele-medical Assistance Service (TMAS)	National Health Organization/dedicated Health Org.
MSP10	Maritime Assistance Service (MAS)	Coastal/Port Authority/Organization
MSP11	Nautical Chart Service	National Hydrographic Authority
MSP12	Nautical Publications Service	National Hydrographic Authority
MSP13	Ice Navigation Service	National competent authority
MSP14	Meteorological Information Service	National Meteorological Authority/WMO/Public Institutions
MSP15	Real-time Hydrographic and Environmental Service	National Hydrographic and Meteorological Authorities
MSP16	Search and Rescue	SAR Authorities



## Common Maritime Data Structures (CMDS)

- Desired infrastructure supporting e-Navigation
  - Include parameters for priority, source, and ownership of information
- Building on the IHO S-100 GI Registry
  - Shore-based data models
  - Shipboard data models
- Harmonization of models through the IMO-IHO Harmonization Group
- IALA Universal Maritime Data Model (UMDM)
- IALA Domain S-201 to S-299
  - S-201 Aid to Navigation Information
  - S-20x Inter-VTS Exchange Format
  - S-20x Application Specific Messages
  - S-20x (Maritime Safety Information developed from IHO Domain S-124)
- CMDS are the glue between and within MSPs

# Foundation: Marine Spatial Data Infrastructures (MSDIs)

- SDI is “the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data.”
- Processes that integrate technologies, policies, standards, organizations and people;
- Structure of working practices and relationships across data producers and users for **access, sharing and analyzing** geospatial information across government and commerce;
- **Hardware, software and system** components necessary to support the processes



# Geospatial technology at the foundation of MSDI

UN ENC Offshore Boundaries  
Coastal Research Hydrography  
MSDI Oceanography Surveys Soundings  
Records Charts Litoral Insights Bathymetry  
Analysis Ocean MSP Resources  
IMO e-Navigation Science  
ALA  
EMU



*At all levels of the organization*

## Some MSDI practical examples



# NOAA PORTS: Physical Oceanographic Real-Time System

NOAA/CO-OPS/PORTS

## Physical Oceanographic Real-Time System®

Have you ever wondered how that new pair of tennis shoes arrived at your door? Or how those bananas got to your grocery store? Maybe you just bought a brand new car. How did it get here?

The U.S. marine transportation system consists of more than 21,000 miles of navigable waters and is the backbone for the movement of goods, services, and people throughout the nation and abroad. Huge cargo ships transport goods through different ports across the country, but how do ship operators know if they can fit under bridges or through narrow channels safely? These ships use real-time information provided by NOAA's Physical Oceanographic Real-Time System® (PORTS®) to make it happen! Find out more about how water level and other oceanographic data are critical for maritime commerce, economic efficiency, and coastal resource protection below.

### PORTS® is an Information System

To meet members' NOAA Center for Operational Oceanographic Products and Services (CO-OPS) part of the National Ocean Service, developed the Physical Oceanographic Real-Time System (PORTS), a fully integrated real-time information system that provides them with comprehensive, operational awareness of the operating environment, enabling the safe, timely, and operational decisions. Through a partnership with CO-OPS and its users, PORTS® delivers accurate and reliable environmental observations to assist in over 20 of the nation's major ports and is a critical decision support tool for maritime commerce and coastal resource management.

### About PORTS®

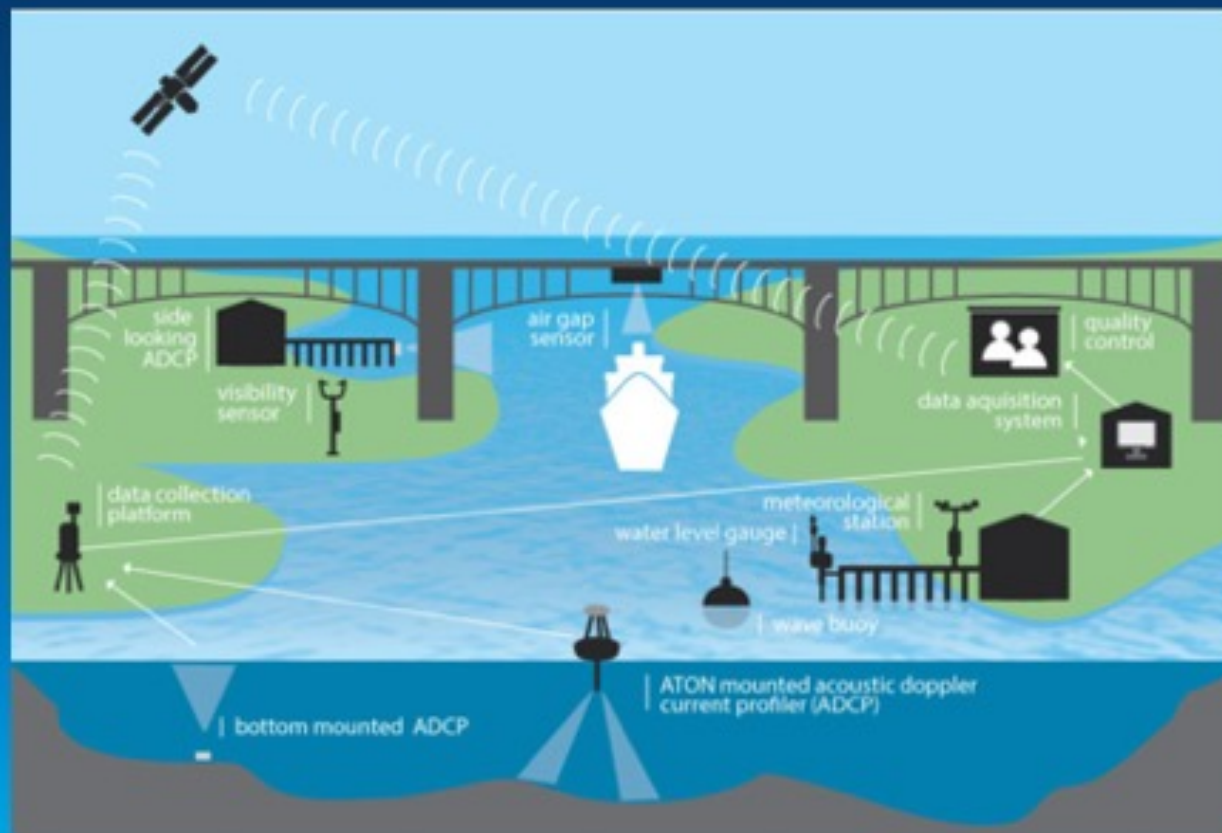
PORTS® sensors measure oceanographic and meteorological conditions, such as water levels, currents, salinity, wind, and bridge clearance. Each integrated system of sensors, conceptualized to support a national need, is tailored to the specific needs of the local community. PORTS® systems come in a variety of sizes and configurations, each specifically designed to meet local user requirements. The largest of the existing PORTS® installations is comprised of over 70 separate sensors, the smallest consists of a single water level gauge and meteorological instruments to measure winds, air temperature, barometric pressure, etc.

### Navigation

PORTS® offers local communities and ports multiple ways to see real-time gauge ships, but a portion of the nation's ports is unable to see real-time PORTS® data from their



# NOAA CO-OPS PORTS



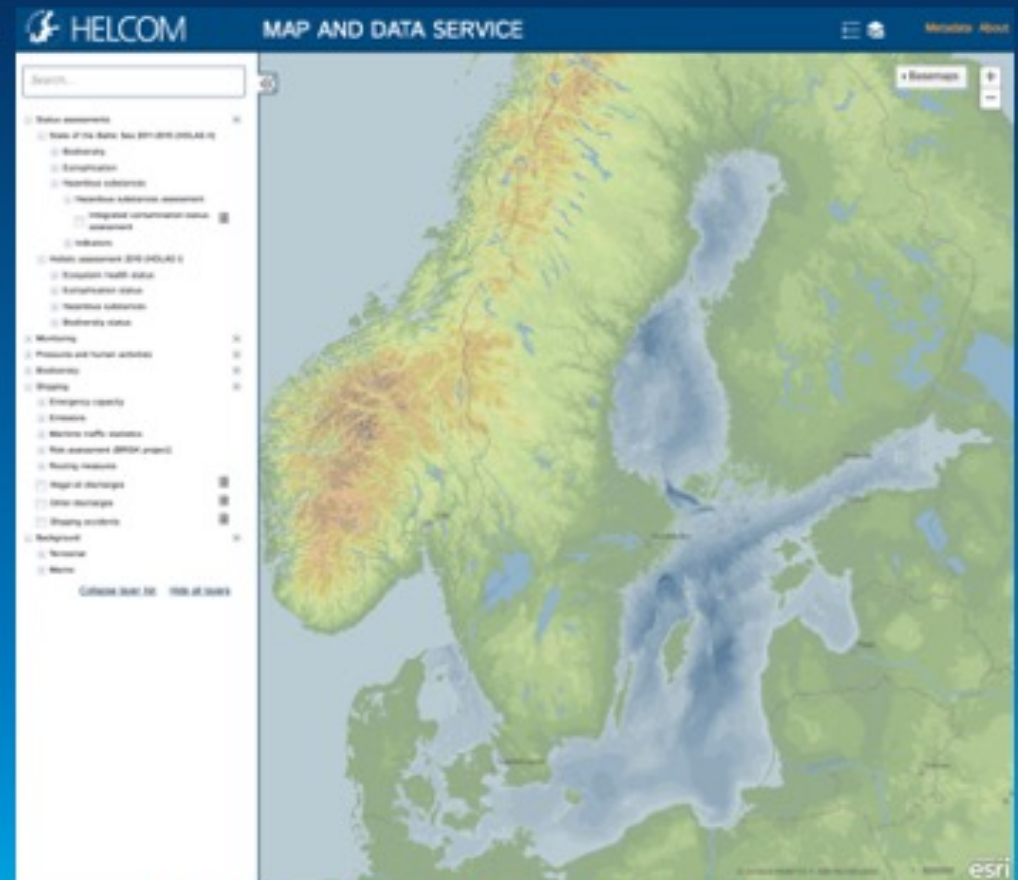
## Air Gap technology



# HELCOM Map and Data Services

Baltic Marine Environment Protection Commission – Helsinki Commission

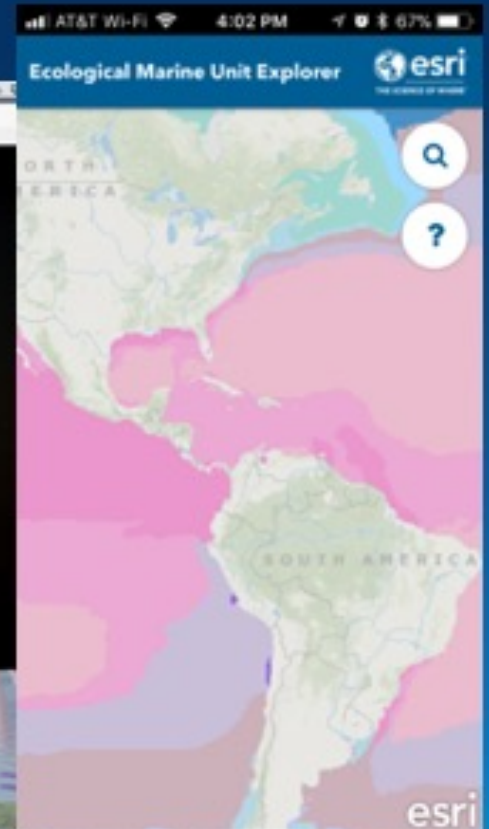
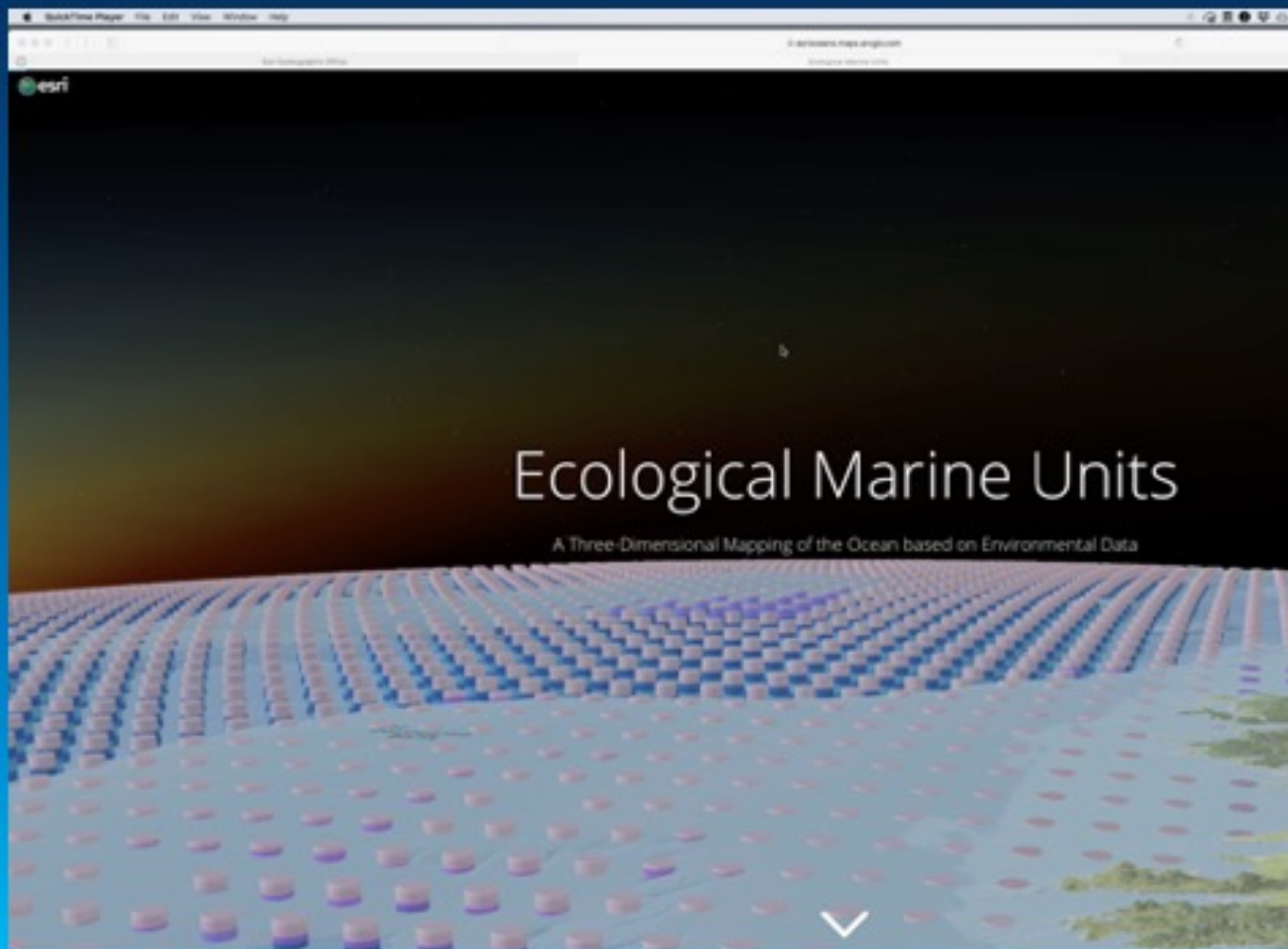
- Governing body of the Helsinki Convention
- Denmark, Estonia, The EU, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden;
- Established four decades ago;
- The 1992 Helsinki Convention entered into force on January 17, 2000;
- Eight main groups: Gear, Maritime, Pressure, Response, State & Conservation, Fish, Agri, Maritime Spatial Planning;
- Its vision for the future is a **healthy Baltic Sea environment** with diverse biological components functioning in balance, resulting in a good ecological status and supporting a wide range of **sustainable economic and social activities**.



<http://maps.helcom.fi/website/mapservice/index.html>

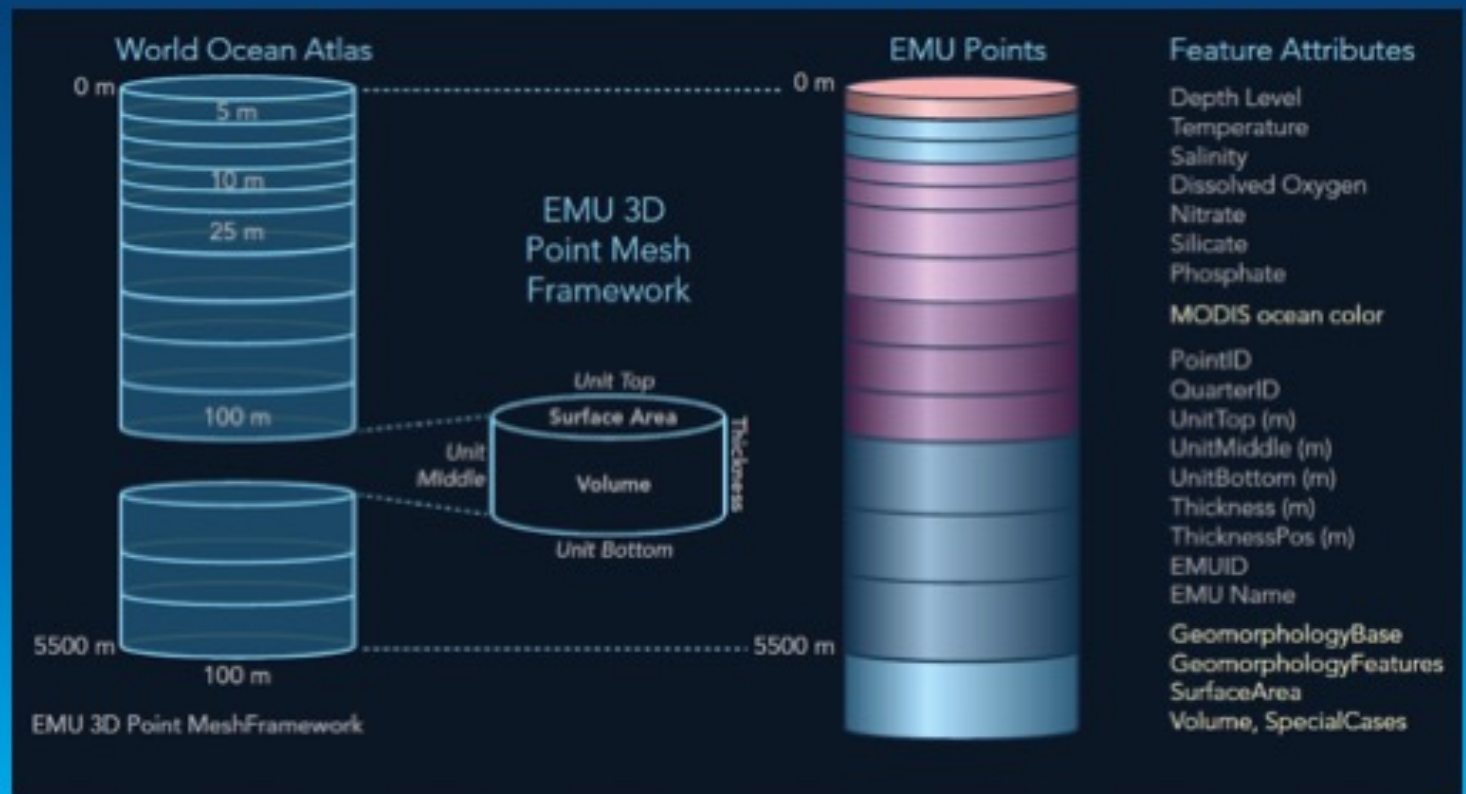


# Ecological Marine Units (EMUs)



# EMU 3D Point Mesh Framework

- 52,000,000 points
- ¼ degree by ¼ degree in the horizontal
- Variable z depth (z thickness ranges from 5 m to 5,500 m)
- Data values represent the average of five “prominent decadal means”
- No temporal component related to seasonality
- The point mesh lives in ArcGIS Pro



## Some more MSDI examples, take a look!

- NOAA PORTS Storymap <https://arcg.is/1v14Dn>
- Ecological Marine Units Project <https://arcg.is/00WTXn>
- Living Atlas of the World [www.esri.com/livingatlas](http://www.esri.com/livingatlas)
- Atlas of Ocean Wealth OECS <http://maps.oceanwealth.org>



## IHO S-100 Universal Hydrographic Data model

- Framework to develop hydrographic standards based on ISO TC211/ISO1900 Series
- **True GIS availability**
- A new IHO GI Registry (S-99)
- Several domains
  - Hydrographic Domain → S-101 to S-199
  - IALA Domain → S-201 to S-299
  - IOC Domain → S-301 to S-399
  - Various (IEHG, JCOMM, IEC) → S-401 to ...

They all come together for the future of Maritime...

**E-Navigation**

**CNDS**

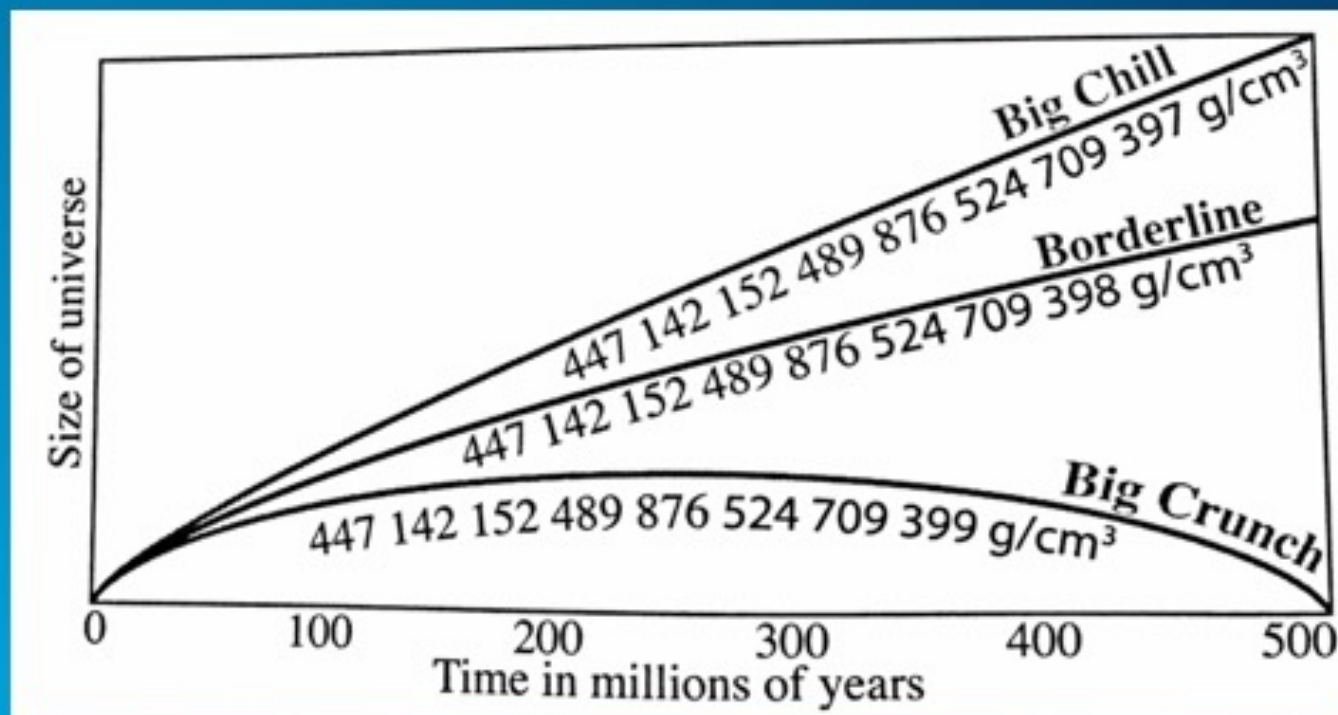
**MSDI**

**Maritime Services  
Portfolios**

**IHO S-100**

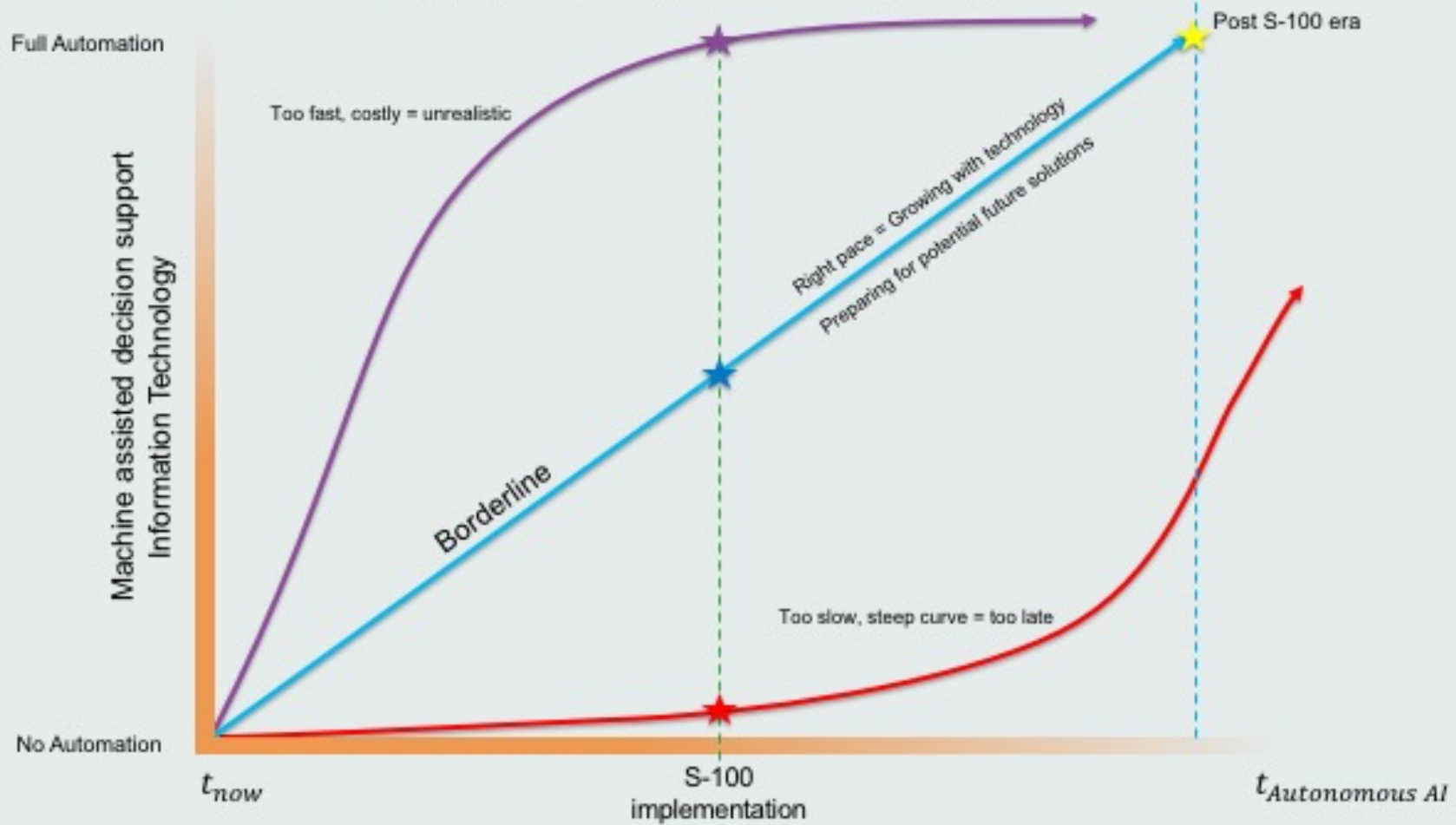
*...and the future is here*

## So what should we do?



Density of our Universe when it was a billionth of a second old  
Highly unstable Borderline  
Balance between Gravity and Pulling forces

# Evolve with Technology ( The Hydrographic Universe expansion)



Graph not at scale, conceptual only



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THE  
SCIENCE  
OF  
WHERE

Thank you!