The power of data brokers and requirements for data openness for machine to machine communication

The Example of Using Earth Science Data to Enhance Global Maritime Situational Awareness in the Blue Hub.

Conor Delaney,
Maritime Affairs Unit

21 October 2015

European Commission

Joint Research Centre

Maritime Domain Awareness

Illegal immigration

Maritime Security

Maritime Traffic

Piracy

Fisheries and Aquaculture

Maritime Safety and Security

Transport Safety and Security

Maritime Safety

Illegal fishing

Oil pollution

The Blue Hub

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The Blue Hub

- WebGIS – Open Layers (http://openlayers.org/)

- Map Server - Geo Server (http://geoserver.org/)

- Post GIS - Geo Database extender http://postgis.net/

- PostgreSQL - Data Base Server (http://www.postgresql.org/)

- Natural Earth – Public Domain Map Dataset (http:// http://www.naturalearthdata.com/)

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Region-wide MSA Maritime Situational Awareness

- Real-time ship positions

- Combining Satellite AIS, Terrestrial AIS, LRIT

- Up to 17 AIS satellites from Norway, LuxSpace, Orbcomm, exactEarth, SpaceQuest

17 million position messages in one month for this area alone

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Environment Versus Piracy

J. Hansen, "*Information Domination: Dynamically Coupling METOC and INTEL for Improved Guidance for Piracy Interdiction*". 2011 U.S.A. Naval Research Laboratory Review.

D. Cook and S. Garrett, *"Somali Piracy and the Monsoon"*. Weather, Climate and Society., 5, 309–316. Oct. 2013. American Meteorological Society

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Meteorology & Oceanography Data is already part of numerous research and commercial offerings

Commercial Online GIS: This allows data discovery and analysis in a sophisticated WEBGIS. Data is downloaded to Cloud Storage

Integrated Ocean Observing System: Data display in a Web GIS to display data from a number of sources which may be downloaded

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Technology Convergence - Synergies

- **Cloud Computing**
  - Storage and Processing in the Cloud, scalable on demand
  - Computing everywhere: Web Browser is the OS
  - Personal computing devices increasing (Phones and Tablets)
  - OpenSource = Community Source Development

- **Multiple Data Sources at Many Different Scales (Maritime Version)**
  - Velocity: Event Processing, Data Feeds from Sensors
  - Volume: Satellite Observations, Sea State Forecasts, AIS data
  - Variety: Many Different Observation Platforms

- **Future Internet – Already Here**
  - Network Technologies: Mobile Broadband getting cheaper and available
  - The Internet of Things: Sensors + Web Server + IPv6

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Free Remote Sensing Data + Free Big Data Processing Tools

Sentinel-1 Image (ESA) + Google Earth Engine

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Distributed Data Networks – USA Strategy

National Oceanographic Data Center has implemented interoperable data technologies to enhance the use of oceanographic data in the NODC archives **e.g.**

OPeNDAP Hyrax Server
http://data.nodc.noaa.gov/opendap/
 Users of the DAP standard can subset datasets, transform data into ASCII, and access the metadata embedded in a file in several ways.

THREDDS Data Server (TDS)
http://data.nodc.noaa.gov/thredds/
 Thematic Realtime Environmental Distributed Data Services (THREDDS) Data Server (TDS) is a web server that provides metadata and data access for scientific datasets, using OPeNDAP, OGC WMS and WCS, HTTP

However these technologies are still in the realm of the Earth Science, requiring:
- Domain knowledge for the data
- Domain knowledge for the data standards are protocols

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Unified Access Framework from NOAA

Projects: (too many to name)

Data formats: netCDF | GRIB | HDF | ...

Service stack: netCDF-CF-DAP-THREDDS-WMS

Applications: Matlab | ArcGIS | Ferret | GrADS | Google Earth | IDV | LAS | ERDDAP | ...

Users: (too many to name)

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ERDDAP solves those problems
by acting as a middleman.

No changes needed. Internet Data Server Types

DiGIR/OBIS | SOS | WMS | Files | Database +DAP | Grids +DAP | Web Pages | ...

ERDDAP acts as a middleman. ERDDAP Internet

DiGIR/OBIS | SOS | WMS | Program (Java?) | DAP | NetCDF .nc | Web Browser | ...

Internet Data Client Types

You can use your favorite client to get data from many sources.

ArcGIS | Google Earth | Matlab | R | .json | ODV | .png Image

You can get data into many common programs and file types.

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ENVIROFI PROJECT

Data delivered as web services and composed within the web paged.

Operational Ocean Model – Data Feed

Near Real Time Ocean Weather Buoy Feed (M6 – Buoy)

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WEB Architecture – New Paradigm

- **New developement paradigm aimed at constrained devices:**
  - Tablets and mobile phones:
    - Lower processing power and limited on device storage
    - Mobile Internet...user is paying for the data download

  - The WEB Browser is the OS!
    - WEBGL enables GPU accelerated usage of physics and image processing in browser
    - Data delivery to the browser via technologies like JSON
    - New development frameworks such as JQuery, JavaScript and AJAX for browser based applications
    - OGC is enabling geospatial interoperability
    - Web Services = data + analysis = information.

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ERDDAP Catalogue

- **We are using NOAA technology called ERDDAP that:**
  - Allows us a to treat the NOAA published distributed data archive as single contiguous resource
  - Allows us to construct a catalog of the data we are interested in and publish that catalog as a data resource
  - Provides a Web API that allows to work directly in the CLOUD

Workflow - Overview

bluehub.jrc.ec.europa.eu/erddap/griddap/**noaa_pfeg_6418_1448_e8d1.csv**?ssh[($DATE_NOW)][(1.0)][($S_BOUND):($N_BOUND)][($W_BOUND):($E_BOUND)],ice_coverage[($DATE_NOW)][(1.0)][($S_BOUND):($N_BOUND)][($W_BOUND):($E_BOUND)],ice_thickness[($DATE_NOW)][(1.0)][($S_BOUND):($N_BOUND)][($W_BOUND):($E_BOUND)

- Batch Script
  - Download data
  - Process Data
  - Add data to PostGis

- Geo Server
  - Publishes Data from PostGIS
  - Layers is displayed via Openlayers

Data Sources - Forecasts

Global Wind Conditions
2015-09-01 06:00
- Light Air > 0.3 m/s
- Light Breeze > 1.6 m/s
- Gentle Breeze > 3.4 m/s
- Moderate Breeze > 5.5 m/s
- Fresh Breeze > 8.0 m/s
- Strong Breeze > 10.8 m/s
- Near Gale > 13.9 m/s
- Gale > 17.2 m/s
- Strong Gale > 20.8 m/s
- Storm > 24.5 m/s
- Violent Storm > 28.5 m/s
- Hurricane > 32.7 m/s

NOAA/NCEP
- Global Forecast System (GFS) numerical weather prediction model
  - Wind Fields (we display as Beaufort scale)

- Wave Watch III (WW3) numerical wave model
  - Wave Forecast (we display as WMO Sea State)

- Real-Time Ocean Forecast System (Global RTOFS) at the NOAA National Centers for Environmental Prediction
  - Daily Sea Ice Extent Forecast for Arctic

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Piracy, Maritime Awareness and Risks (PMAR)

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Arctic

- Multisensor Analyzed Sea Ice Extent (NSIDC)

- Realtime Ocean Forecast System (RTOFS - NOAA)

NOAA Data Access Procedural Directive

"The purpose of this Directive is to declare that all NOAA environmental data (with limited exceptions, upon approval of a waiver) shall be made discoverable and accessible via the Internet in a timely fashion."

NOAA is a scientific agency within the focused on the conditions of the oceans and the atmosphere.

Machine Readable

- Web sites, web pages, or portals requiring human intervention to operate shall not qualify as meeting the machine-readable access requirement 2.3 above, but may be provided as a supplement to machine-readable methods.

- Data shall be publicly available over the Internet without requiring a password, registration, or conditions on use…

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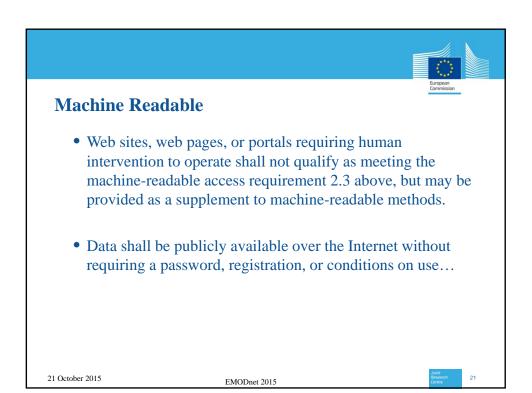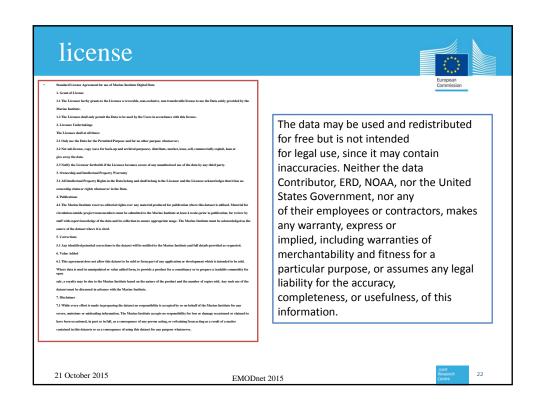
Maritime Domain Awareness ERDDAP

- Embracing and using OpenData from the marine science community

- Using ERDDAP has a key resource for finding and using data

- Exploring the concepts of light weight Apps to deliver targeted marine domain awareness

- Actively developing thematically based ERDDAP servers

1) NOAA/NCEP Global Forecast System (GFS) Atmospheric Model (wind speed and direction)
2) NOAA WaveWatch III (NWW3) Global Wave Model (Global Wave forecast)
3) Near Real Time Geostrophic Currents (Global)

https://bluehub.jrc.ec.europa.eu/erddap/index.html 115 Data Sets
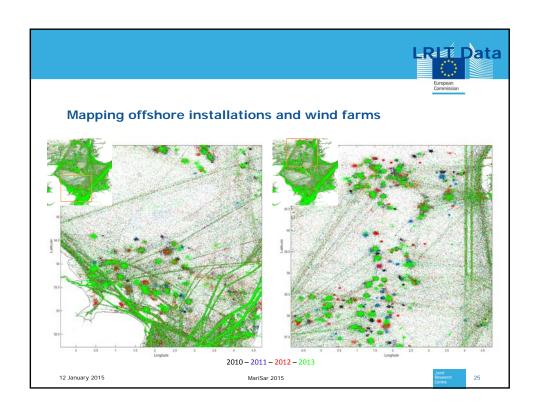
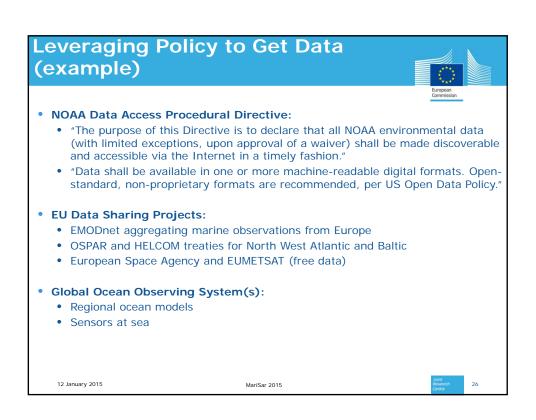**http://coastwatch.pfeg.noaa.gov/erddap/index.html** 884 Data Sets

http://upwell.pfeg.noaa.gov/erddap/index.html 5,766 Data Sets

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Mapping offshore installations and wind farms

2010 – 2011 – 2012 – 2013

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Leveraging Policy to Get Data (example)

- **NOAA Data Access Procedural Directive:**
  - "The purpose of this Directive is to declare that all NOAA environmental data (with limited exceptions, upon approval of a waiver) shall be made discoverable and accessible via the Internet in a timely fashion."
  - "Data shall be available in one or more machine-readable digital formats. Open-standard, non-proprietary formats are recommended, per US Open Data Policy."

- **EU Data Sharing Projects:**
  - EMODnet aggregating marine observations from Europe
  - OSPAR and HELCOM treaties for North West Atlantic and Baltic
  - European Space Agency and EUMETSAT (free data)

- **Global Ocean Observing System(s):**
  - Regional ocean models
  - Sensors at sea

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ERDDAP- WEB API to NOAA Data

ERDDAP (the Environmental Research Division's Data Access Program) is a WEB API to the existing distributed data network

- **message broker**: it receives data request (via html) and converts them into formats used by other data servers
- **queries** data at source archives and returns the result of the query
- **data mediator:** it converts sophisticated marine science data formats and converts them formats more familiar to web/software developers
- **leverages** (among other things): the existing distributed data network
- Creates a **catalogue** of data being published at remote data centers

From EU to worldwide tracking and traffic routes

https://bluehub.jrc.ec.europa.eu/mspArctic/

Open Data: Making Public Data Discoverable

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The Arctic

Arctic maritime challenges emerging
- Claims on territories and resources
  - Fish, oil/gas, minerals
- Safety of maritime operations
  - Ice, weather, bathymetry, traffic, dumping grounds
- New critical maritime routes
- Pressures on natural environment
  - Oil pollution, alien species, air pollution, …

Accurate information is needed for policy planning and operational response
- Including monitoring of shipping activities

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JavaScript+WebGL+NetCDF+CloudStorage

Developer: http://earth.nullschool.net/   Data From: NOAA

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Analysed Sea Surface Temperature (degree_C)
Multi-scale Ultra-high Resolution (MUR) SST analysis, Global, 0.011 Degree, Daily
(2015-03-23T09:00:00Z)
Data courtesy of NASA JPL

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Examples

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Supporting info layers

Predicted Wind Wave fields from NOAA using ERDDAP

Ship density map (monthly)

Age of position:
- < 2 hrs
- 2 - 6 hrs
- 6 - 9 hrs
- > 9 hrs

Age of last incoming data

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