Evolution of Sensor-Based Data Services for Collaborative Research

Enabling Dynamic Assessment of Data through Web Services

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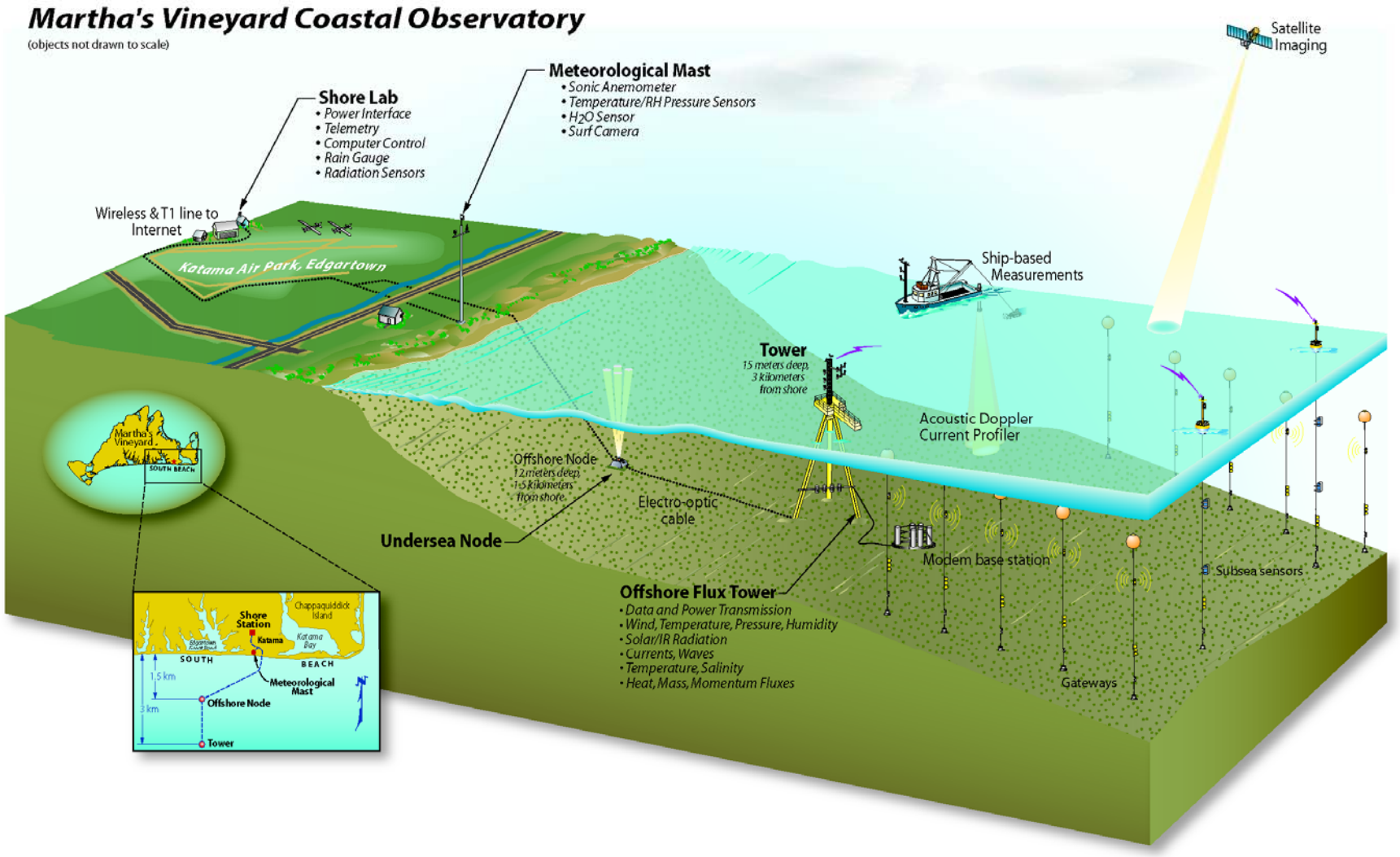


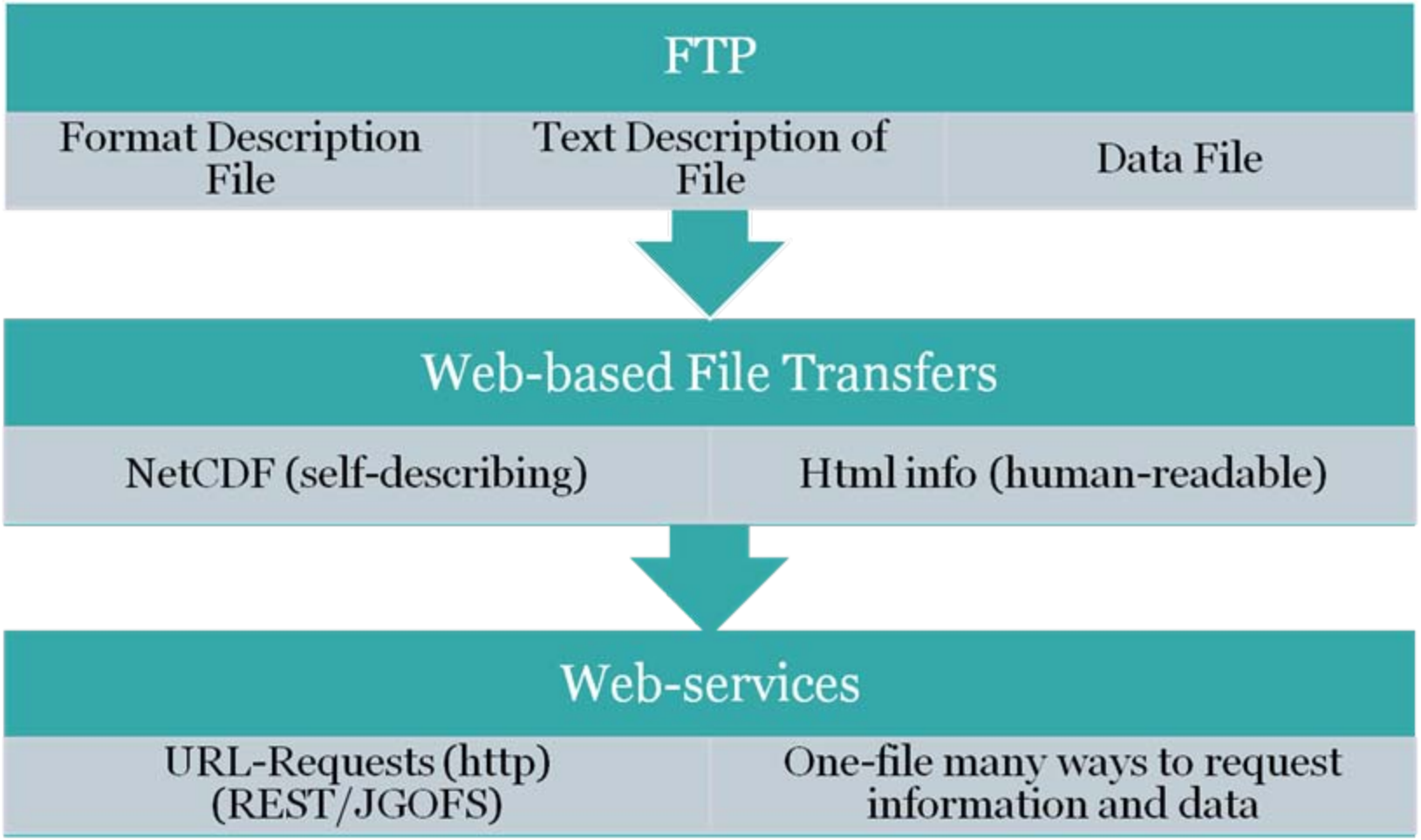
Sensor -> TCP/IP
since 2001

Several Research Projects each year

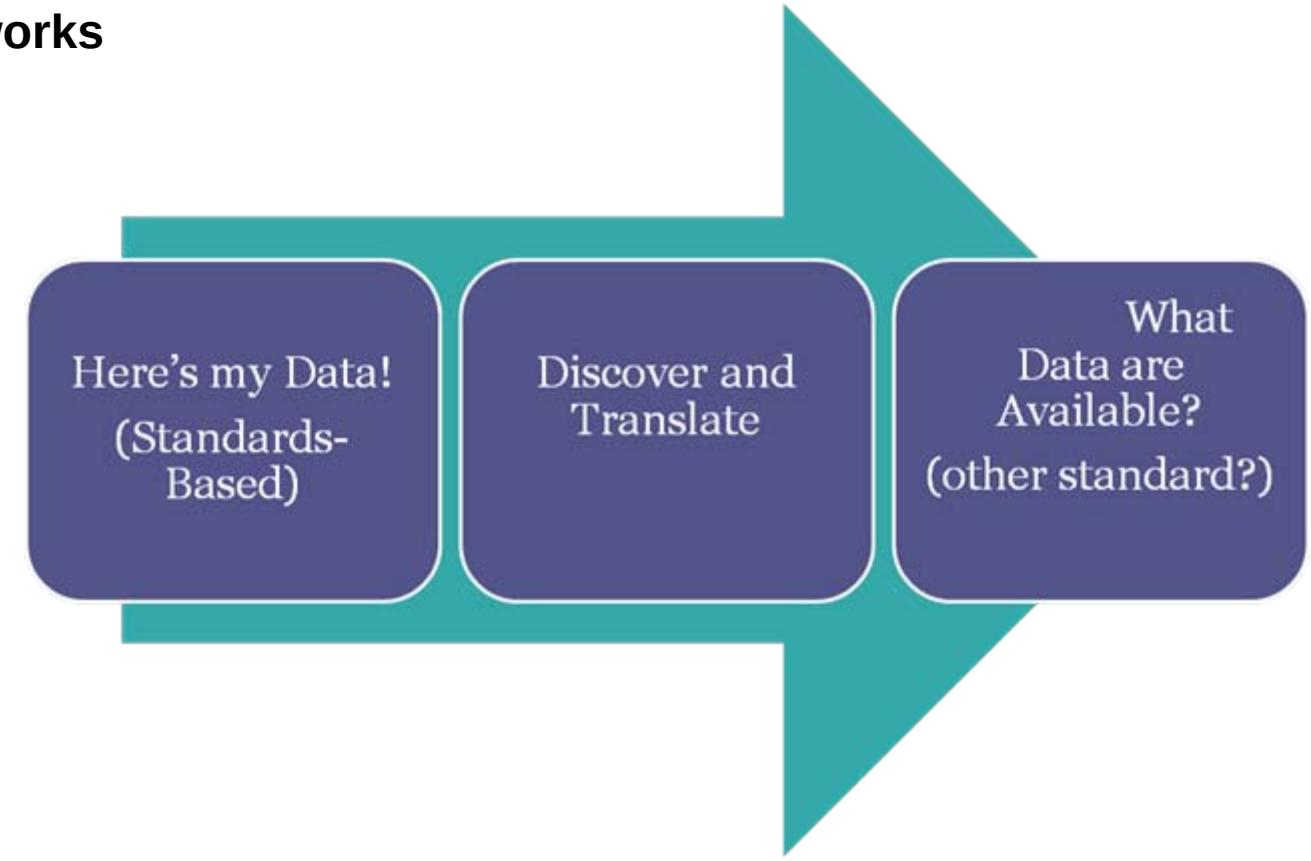
- Tools have helped in communication needed to coordinate interdisciplinary research
  (Google Docs/Google Earth/ Plone/Drupal)

- Share core real-time data
  (with supported research and the world)
  Wind, RH, Air Pressure, Solar/IR Radiation
  Waves, *in situ* Currents, CTD, water depth

Transformation over past 15-20 years: working with colleagues -> working with others in your community -> the world!

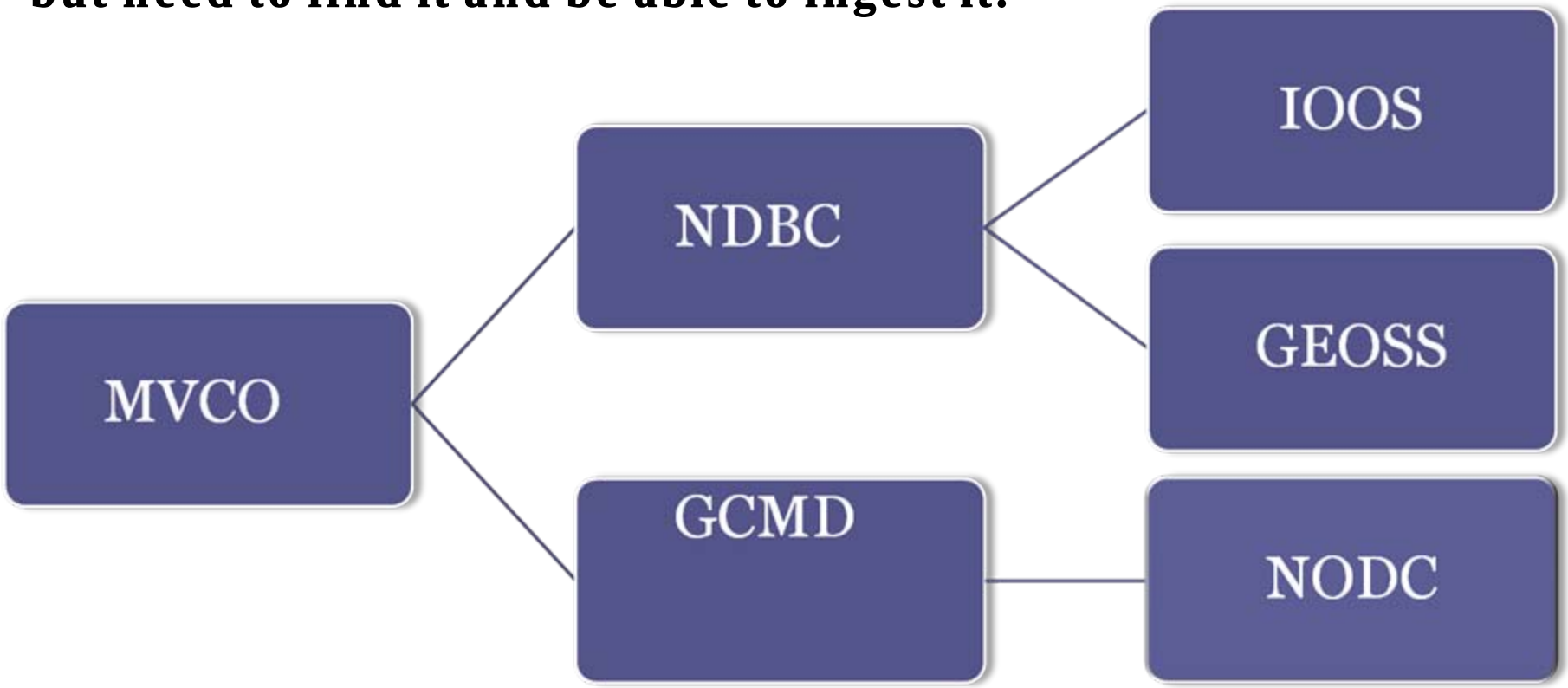


Adhere to Standards-based Frameworks



DATA PROVIDER makes data available in internationally adopted standards-based framework …

DATA COLLECTORS know what data they want …
but need to find it and be able to ingest it!



CHOICES! OOSTethys (made it easy to get started 2006 … provide guides and templates with SOS)

- Open Geospatial Consortium (OGC)
  – standards-based, geo-enable the web

(strict rules -> easy translations between frameworks)

- Sensor Web Enablement (SWE) – most earth observations are based on sensor-derived properties with processing history

(non-domain specific framework …
enables interdisciplinary research)

Sensor Web Enablement provides

..... Sensor and Process Lineage

Sensor Observation Service (SOS) delivers services via constructed URL requests

(defines service and parameters)

providing subscription service and enabling interoperability through web services which are OS agnostic!


S.org - Real-Time D...
OPENIOOS.ORG
AN INTEGRATED OCEAN OBSERVING SYSTEM TESTBED
WHERE STANDARDS ENABLE INNOVATION
HOME | ABOUT OPENIOOS | CONTACT US
POWERED BY SURA SCOOP IN SUPPORT OF IOOS
REAL-TIME DATA
24/7 PREDICTIONS
RETROSPECTIVES
MODELING TEST BED
GUIDES & RESOURCES
Real-Time Data
Sea Surface Temperature
OGC Sensor Web
Conceptual Design
System Architecture
DATA PROVIDERS
AOOS
COMPS/USF
COMPUSULT
CeNCOOS
CenGOOS - GCOOS
DISL - GCOOS
GoMOOS
MBARI
MVCO
NANOOS
NASA
NOAA / NDBC
NOAA / NOS
TABS TAMU
COOA UNH
OceanWatch
SARTI UPC
SmartBay
OOSTETHYS DEVELOPERS
GoMOOS
MMI
MBARI
Real-Time Data from an OGC Sensor Web
This interoperability demonstration represents an effort to develop a Web Services Architecture for Ocean Observing that is enabling observing systems to move closer to the vision of 'network as platform'. We are seeking participants who would like to serve their in-situ observation data via SOS based Web Services. To learn more, visit the OOSTethys.org website.
2061 Platforms reporting
Click the station icons on the map for the latest observations.
Map
Satellite
Hybrid
1000 mi
1000 km
Zoom To:
- select -
Organizations:
- All -
OOSTethys.org
How it works
How to participate
Serve your data
SOS Registry
Google Earth KML
Requires GoogleEarth™
OpenIOOS.org -...

Three required SWE Sensor Observation Services

- **GetCapabilities delivers:**

  WHAT SYSTEM DESCRIPTIONS ARE AVAILABLE?
  WHAT SYSTEM OBSERVATIONS ARE AVAILABLE?

- **DescribeSensor provides descriptions of the system (observable properties to observed properties) and each component of a data system. (describe the sensor, describe the setup, describe the processing, etc.)**

- **GetObservation – Different offerings from the same data file, fully-described including the units, data-format etc.**

QARTOD to OGC (q2o.whoi.edu)

Funded by US NOAA Integrated Ocean Observing System (2008-2010) to demonstrate and model the integration of data quality assessment capabilities in OGC Sensor Web Enablement frameworks.

QARTOD – NOAA funded community development of best practices in QA/QC for waves, in situ currents, CTD/DO

What QC tests were done? What was the result?

To promote common understanding and trust in the evolving ocean observing systems of systems

Q2O Methodology

- Meet with domain experts – what information is needed and how should they be communicated?

- Define and encode QC tests and parameters
- Define and encode processing blocks

- Link QC flags to tests (that are defined, registered and encoded)
- Link through SWE input, output and parameters for all processes

TIME SERIES (Raw Calibrated Data)				
Category	**Criteria**	**Order**	**Flag**	**Action**
Acceleration test	**User defined (a>M*g)**	**3**	**Soft**	**Recommended M<=1/2. Interpolate/extrapolate up to N contiguous points. N is user defined. Include in % count.**
Mean test, variance test	**User defined, location dependent**	**4**	**1. Soft** **2. Hard**	**1. Flag unexpected values.** **2. Reject unreasonable values.**

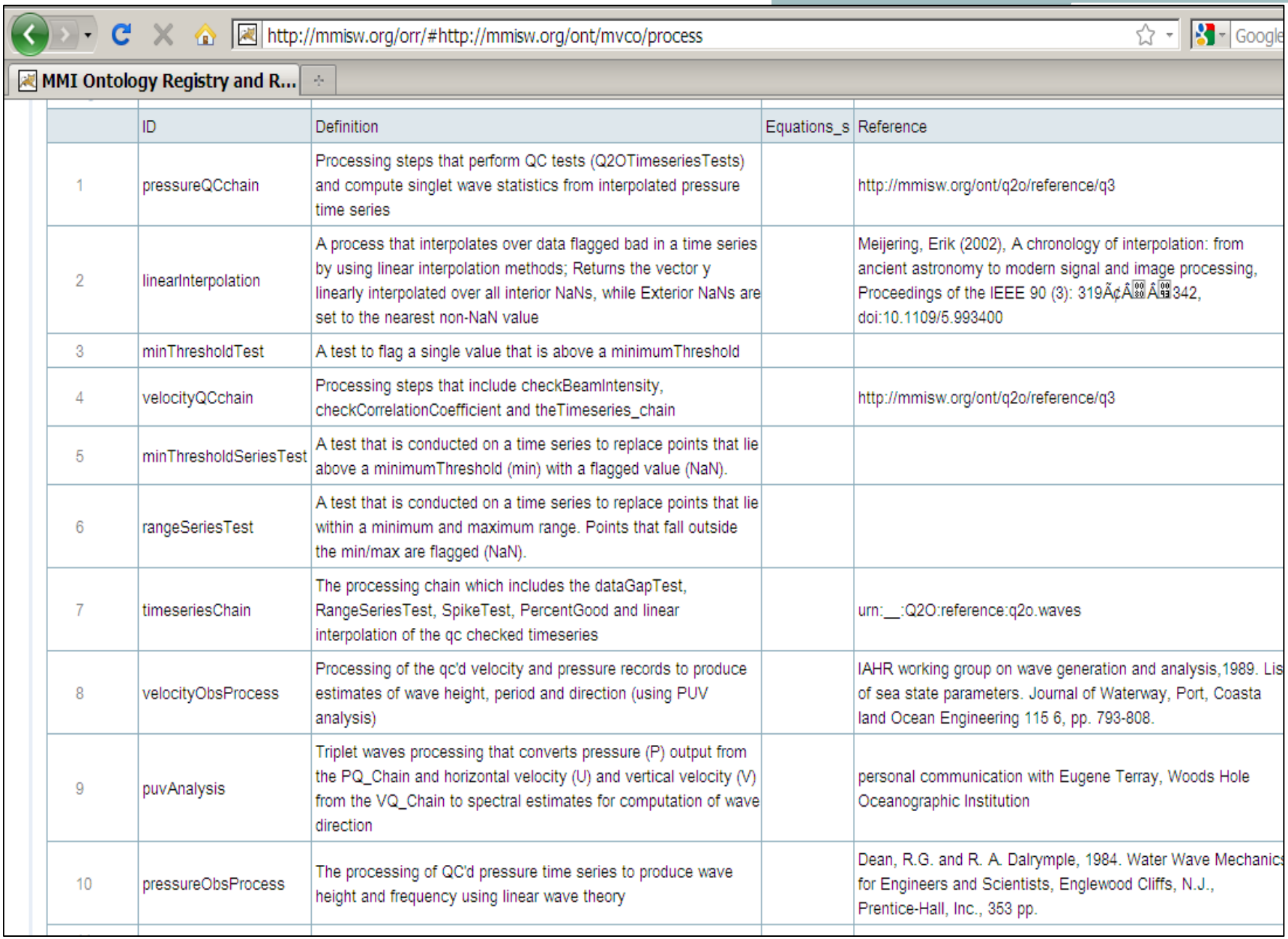
=== Tests and Criteria ==========
"ID", "Long Name", "Short Name", "Definition", "Symbol", "Reference", "Figure", "Approval", "Relationship", "Equation", "[Notes]"
==========
"urn:__:Q2O:test:accelerationTest", "Acceleration Test", "", "The second derivative for each point of the time series of vertical surface displacement is a computed or direct measure of acceleration. The acceleration measurement is tested it against natural limits, approximated as M*g.", "", "urn:__:Q2O:ref:qartod_waves_2007", "", "", "urn:__:Q2O:criteria:maximumAccelerationFactor", "", "[Reworded from reference to make it more general for other applications besides waves.]"

http://mmisw.org/ont/q2o/20081118T031715/qcCategory/accelerationTest

http://marinemetadata.org (</MMI>)
and the MMI ontology repository and register:
http://mmisw.org

Terms for all input, output, parameters, tests and processes should be well described and registered, enabling ontologies (relationships) to be developed to map across political, institutional and domain specific content:
(VOCABULARY MAPPING)
seaWaterTemperature <->oceanTemperature

spikeTest <-> outlierTest



	ID	Definition	Equations_s	Reference
1	pressureQCchain	Processing steps that perform QC tests (Q2OTimeseriesTests) and compute singlet wave statistics from interpolated pressure time series		http://mmisw.org/ont/q2o/reference/q3
2	linearInterpolation	A process that interpolates over data flagged bad in a time series by using linear interpolation methods; Returns the vector y linearly interpolated over all interior NaNs, while Exterior NaNs are set to the nearest non-NaN value		Meijering, Erik (2002), A chronology of interpolation: from ancient astronomy to modern signal and image processing, Proceedings of the IEEE 90 (3): 319Ã¢Â Â 342, doi:10.1109/5.993400
3	minThresholdTest	A test to flag a single value that is above a minimumThreshold		
4	velocityQCchain	Processing steps that include checkBeamIntensity, checkCorrelationCoefficient and theTimeseries_chain		http://mmisw.org/ont/q2o/reference/q3
5	minThresholdSeriesTest	A test that is conducted on a time series to replace points that lie above a minimumThreshold (min) with a flagged value (NaN).		
6	rangeSeriesTest	A test that is conducted on a time series to replace points that lie within a minimum and maximum range. Points that fall outside the min/max are flagged (NaN).		
7	timeseriesChain	The processing chain which includes the dataGapTest, RangeSeriesTest, SpikeTest, PercentGood and linear interpolation of the qc checked timeseries		urn:__:Q2O:reference:q2o.waves
8	velocityObsProcess	Processing of the qc'd velocity and pressure records to produce estimates of wave height, period and direction (using PUV analysis)		IAHR working group on wave generation and analysis,1989. Lis of sea state parameters. Journal of Waterway, Port, Coasta land Ocean Engineering 115 6, pp. 793-808.
9	puvAnalysis	Triplet waves processing that converts pressure (P) output from the PQ_Chain and horizontal velocity (U) and vertical velocity (V) from the VQ_Chain to spectral estimates for computation of wave direction		personal communication with Eugene Terray, Woods Hole Oceanographic Institution
10	pressureObsProcess	The processing of QC'd pressure time series to produce wave height and frequency using linear wave theory		Dean, R.G. and R. A. Dalrymple, 1984. Water Wave Mechanics for Engineers and Scientists, Englewood Cliffs, N.J., Prentice-Hall, Inc., 353 pp.

Registered vocabulary URL in SWE encodings

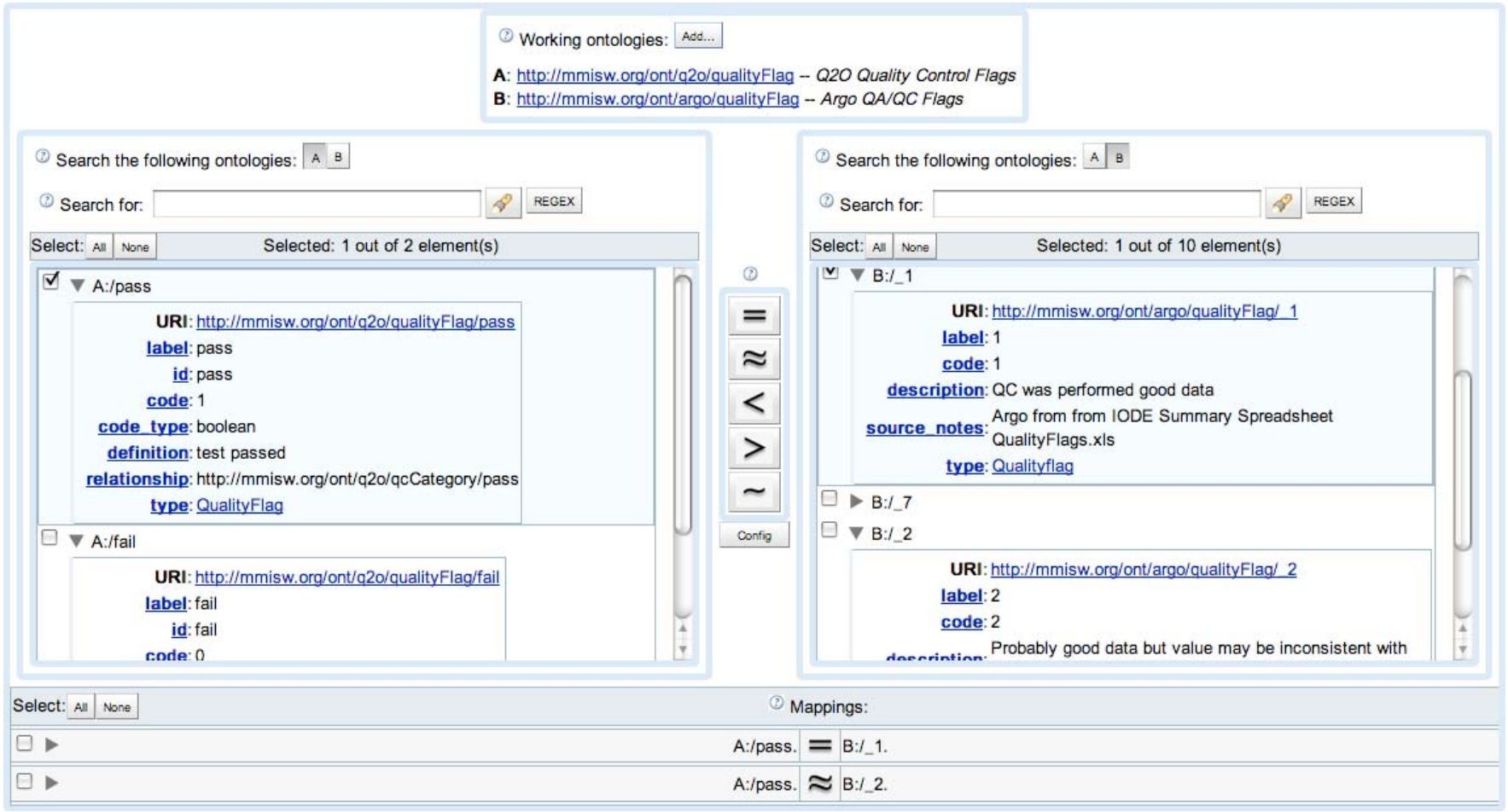
```
<swe:field name="waveHeightAll">
<swe:Quantity
definition="http://mmisw.org/ont/mvco/properties/waveHeightAll">
<swe:uom code="cm"/>
</swe:Quantity>
</swe:field>
```

By constructing confined values to specific terms … these terms can be mapped allowing differing values to have the same meaning …

```
<swe:field name="cMFlag">
<swe:Category definition="http://mmisw.org/ont/mvco/qcflag/cMFlag">
<swe:codeSpace xlink:href="http://mmisw.org/ont/mvco/flag"/>
</swe:Category>
```

	id	definition	code_type	relationship	code
1	pass	The ability to successfully satisfy a test or meet a requirement.	boolean	http://mmisw.org/ont/mvco/parameter/flag	0
2	fail	The inability to successfully satisfy a test or meet a requirement.	boolean	http://mmisw.org/ont/mvco/parameter/flag	1

By registering and creating ontology – QC flags can be resolved!



Future Work

- Common met/ocean manufacturers SensorML - fully describe sensor capabilities, characteristics, contact info, etc with defined and registers terms
- Develop a SensorML registry for discovery and sharing of commonly used profiles
- Exercise the ability to utilize these content rich demonstrations
- Build better tools (forms/editors)

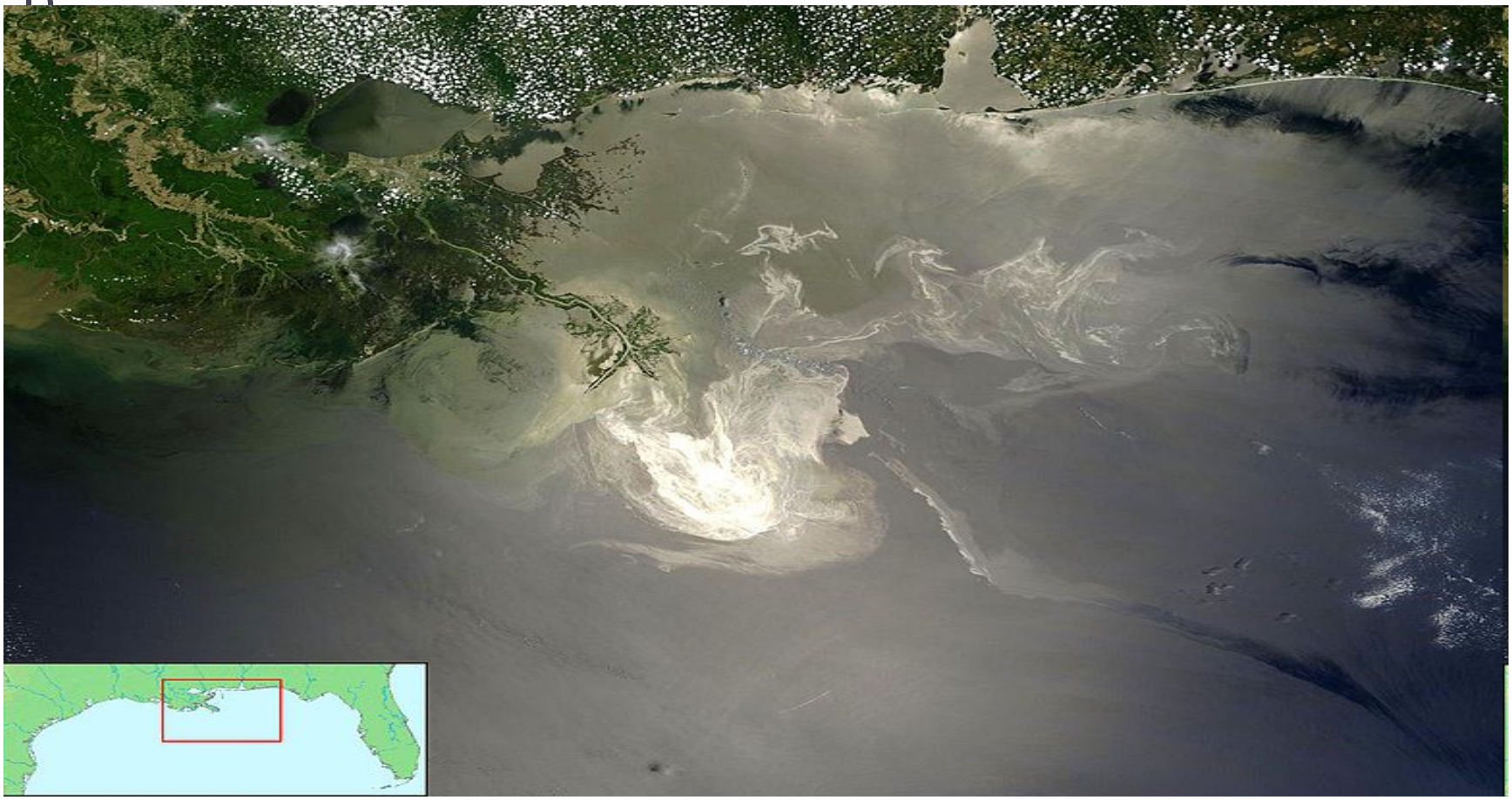
Conclusion: START CLOSE TO SOURCE (Deep Horizon!)

1) *capture and deliver metadata and process lineage* with observations at source
2) *describe/register/encode all terms* (semantics)
3) *adhere* to *standards-based* framework (syntactic interoperability)

Then aggregators can build meaningful (domain specific) ontologies (relationships) with the imparted knowledge of the sensed properties

EXTENDING UTILITY and VALUE of OBSERVATIONS!

Deep Horizon (The oil slick as seen from space by NASA's Terra satellite on May 24, 2010 from http://en.wikipedia.org/wiki/Deepwater_Horizon_oil_spill)



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Enabling Dynamic QA/QC through OGC Sensor Web Enablement

Poster Thursday in XL222
(in attendance 5:30 – 7 pm