

Integrated Ocean Observing System (IOOS) Data Integration Framework (DIF) Project

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DIF Sr Systems Architect

Acknowledgements

NOAA Offices:

- NWS/NDBC
- NOS/CO-OPS
- NOS/CSC
- OAR/PMEL
- NESDIS/NGDC
- NMFS/SWFSC
- NESDIS/NCDDC
- NESDIS/NODC
- NOS/CSDL
- OAR/AOML
- NOS/IOOS

External:

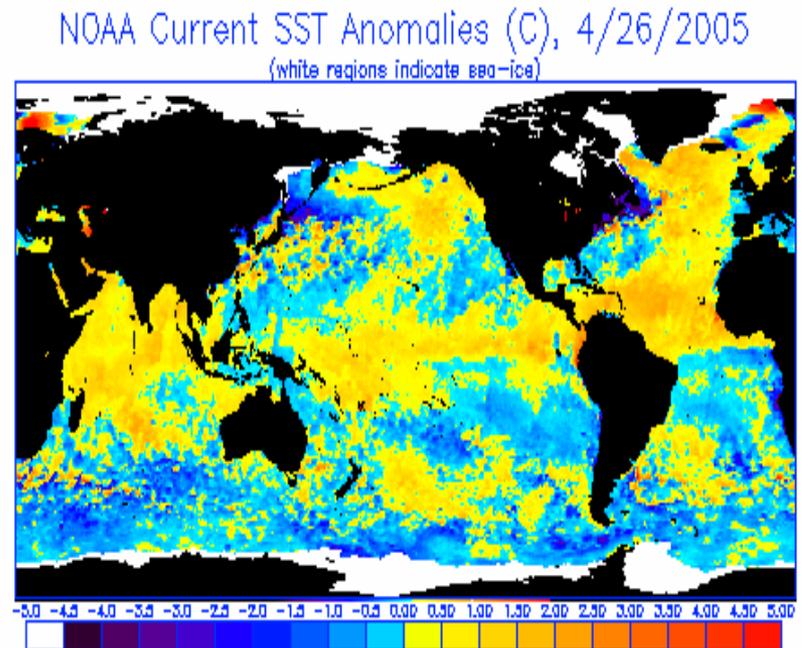
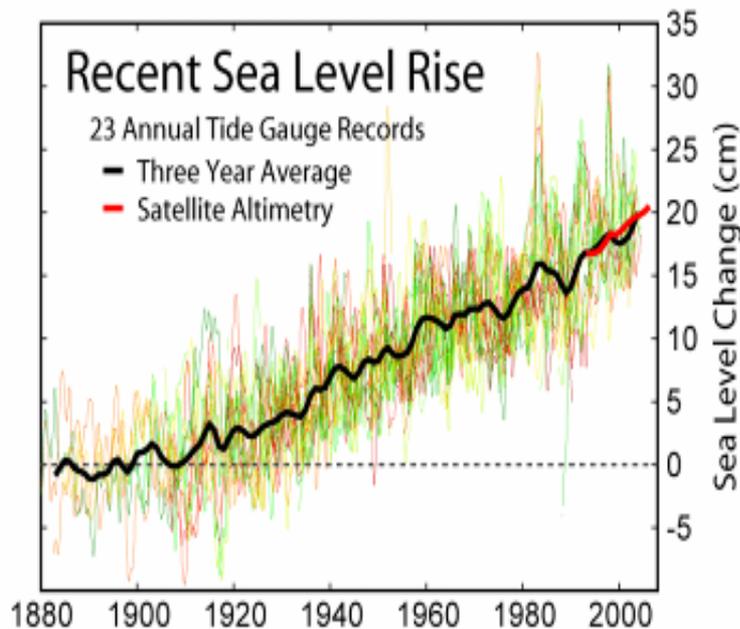
- AOOS
- CenCOOS
- GCOOS
- MACOORA
- NANOOS
- NERACOOS
- PacIOOS
- SECOORA
- SCCOOS
- SURA

Outline

- **IOOS program overview**
- **Data Integration Framework (DIF) pilot**
- **Data Providers and Customers**
- **Recommended Web Services**
- **IOOS Practices**
- **Towards IOOS DMAC**

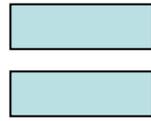
Why Is Ocean Information So Important?

- Oceans are a primary driver of weather and climate
 - Potential to store 1000X more heat and 50X more carbon than the atmosphere (ocean acidification)
 - 85% of the rain and snow that provides water to our citizens come directly from the ocean.

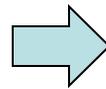
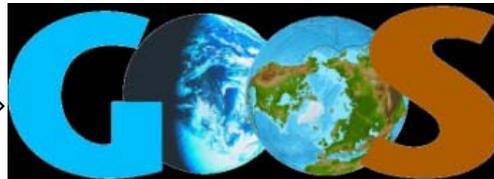
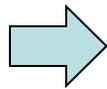


US IOOS[®]

US IOOS: a National Endeavor



But Part of a Global Framework



IOOS

GOOS

GEOSS



IOOS Regional Associations

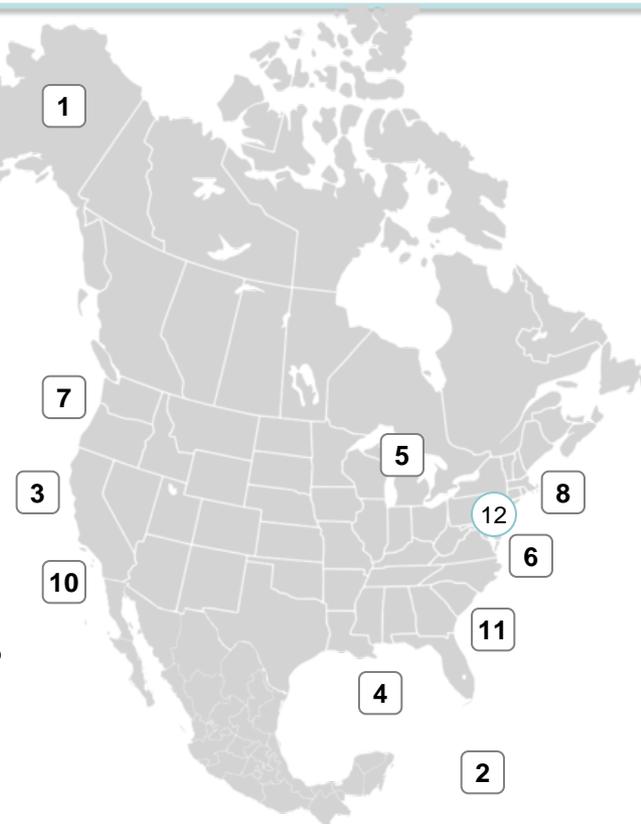
IOOS Regional Component

A network of 11 regional coastal ocean observing systems that meet national and regional needs for local ocean observations, data management, and modeling

1 national partnership providing sensor validation/verification

Meeting National missions through:

- Expanded observations and modeling capacity
- Connections to users and stakeholders
- Implementation of national data standards
- Sensor validation/verification
- Products transitioned to other regions and to National operations



1. Alaska Ocean Observing Systems (AOOS)
2. Caribbean Regional Association (CaRA)
3. Central and Northern California Coastal Ocean Observing System (CeNCOOS)
4. Gulf Coastal Ocean Observing System (GCOOS)
5. Great Lakes Observing System (GLOS)
6. Mid-Atlantic Coastal Ocean Observing System Regional Association (MACOORA)
7. Northwest Association of Networked Ocean Observing Systems (NANOOS)
8. Northeast Regional Association of Coastal Ocean Observing Systems (NERACOOS)
9. Pacific Islands Ocean Observing System (PacIOOS)
10. Southern California Coastal Ocean Observing System (SCCOOS)
11. Southeast Coastal Ocean Observing System Regional Association (SECOORA)
12. Alliance for Coastal Technologies (ACT) {Sensor V & V}



Integrated Coastal and Ocean Observation System Act

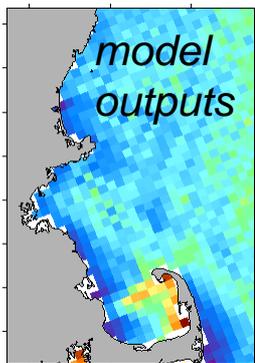
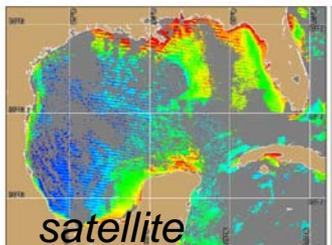
Public Law No. 111-11

- **Directs President to establish a National Integrated Coastal and Ocean Observation System**
 - Establishes Interagency Ocean Observation Committee
- **Interagency Ocean Observation Committee**
 - Establish System protocols and standards for IOOS Data Management
- **Identifies NOAA as Lead Federal Agency**
- **Defines “Regional Information Coordination Entities”**
- **Mandates Report to Congress every 2 years**
- **Establishes Civil Liability for NOAA**
- **Authorizes appropriation of “such sums as are necessary” through 2013**

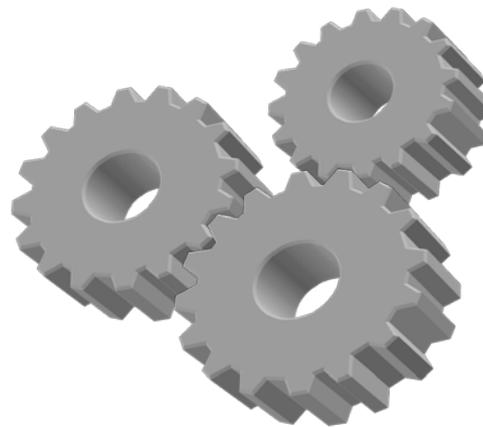
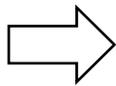


NOAA IOOS Program Components

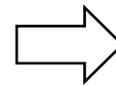
- Support for regional coastal observing systems
- Interagency coordination & standards adoption
- Improving interoperability and data management



Information

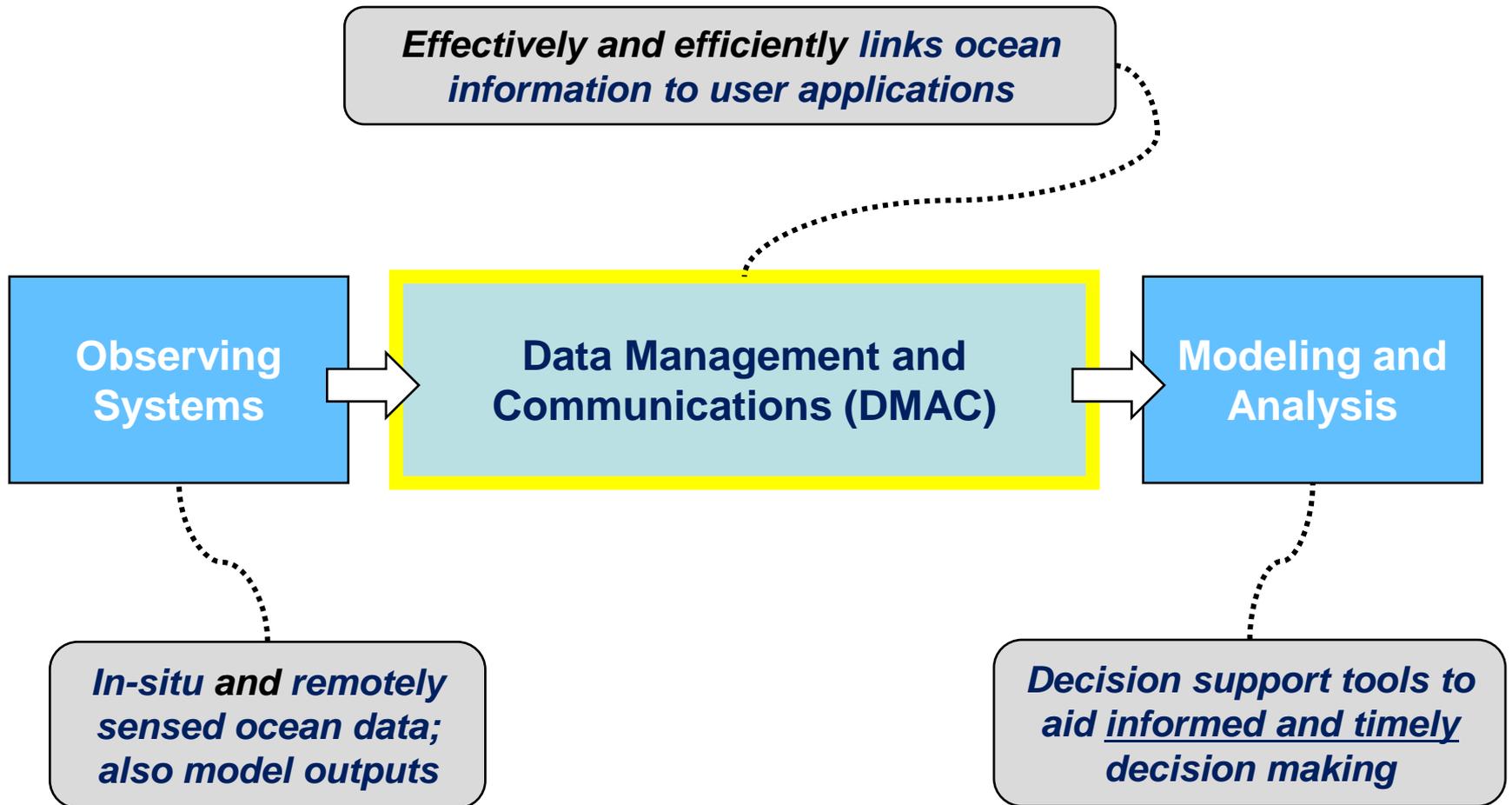


Data Management
and Standards



Societal Benefit

IOOS Functional Areas



Core Principles

- **Adopt open standards & practices**



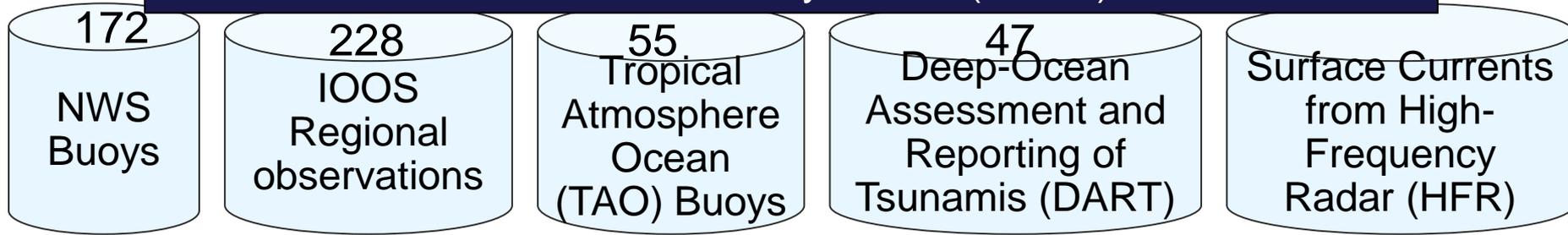
- **Federated, service-oriented architecture**
 - Data made accessible via OGC or DAP services
 - Not SOAP/WSDL services
 - Data stays with data providers
 - Service adapters for existing systems

Primary DIF Partners

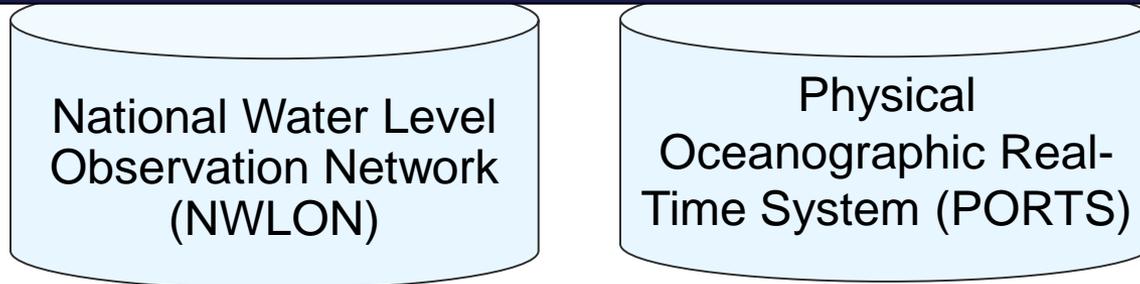
- **NOAA Data Providers**
 - NWS NDBC (National Data Buoy Center)
 - NOS CO-OPS (Ctr for Operational Oceanographic Prod & Svcs)
 - NESDIS CoastWatch
- **Customer Focus Areas**
 - HAB (Harmful Algal Bloom Forecast System)
 - IEA (Integrated Ecosystem Assessments)
 - CI (Coastal Inundation)
 - HI (Hurricane Intensification)
- **Regional associations**
 - As represented in web services working group

IOOS DIF Project Data Providers

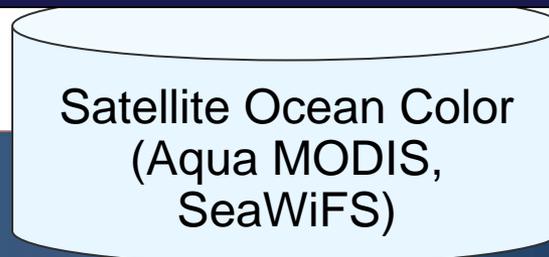
National Weather Service (NWS)
National Data Buoy Center (NDBC)



National Ocean Service (NOS)
Center for Operational Oceanographic Products and Services (CO-OPS)

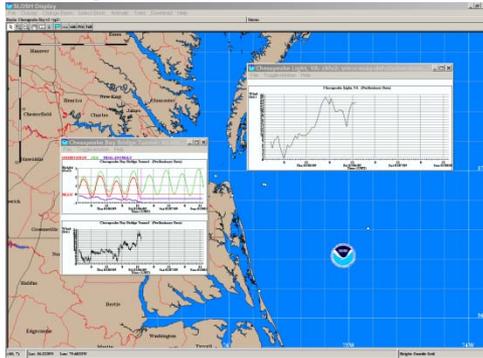


National Environmental Satellite, Data, and Information Service (NESDIS)
CoastWatch

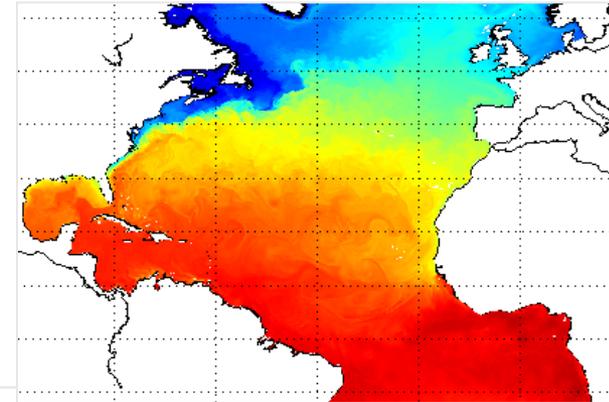


IOOS DIF Customer Projects

Coastal Inundation: Sea, Lake and Overland Surge from Hurricanes (SLOSH) model

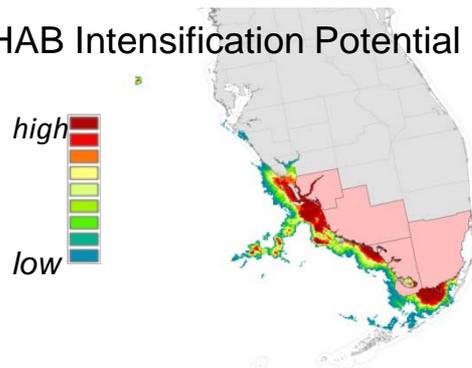


Hurricane Intensity: Real-Time Ocean Forecast System (RTOFS-Atlantic)



Harmful Algal Blooms: HAB Forecast System (HAB-FS)

HAB Intensification Potential



Integrated Ecosystem Assessments: Environmental Research Division Data Access Protocol (ERDDAP) application



Additional IOOS DIF Data Providers *(in progress)*

NOAA /OAR/AOML

Atlantic Oceanographic and Meteorological Lab

Synthetic
Temperature &
Salinity Profiles

NOAA/NOS/CSDL

Coast Survey Development Lab

Model Forecast
Currents

AOOS
Alaska

NANOOS
Northwest

CeNCOOS
Cen & Nor CA

NERACOOS
Northeast

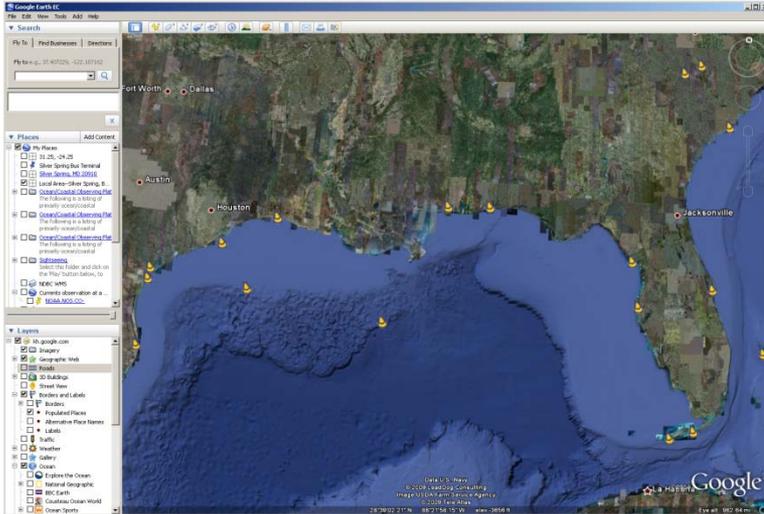
PacIOOS
Hawaii

SCCOOS
So Calif

GCOOS
GoMex

SECOORA
Southeast

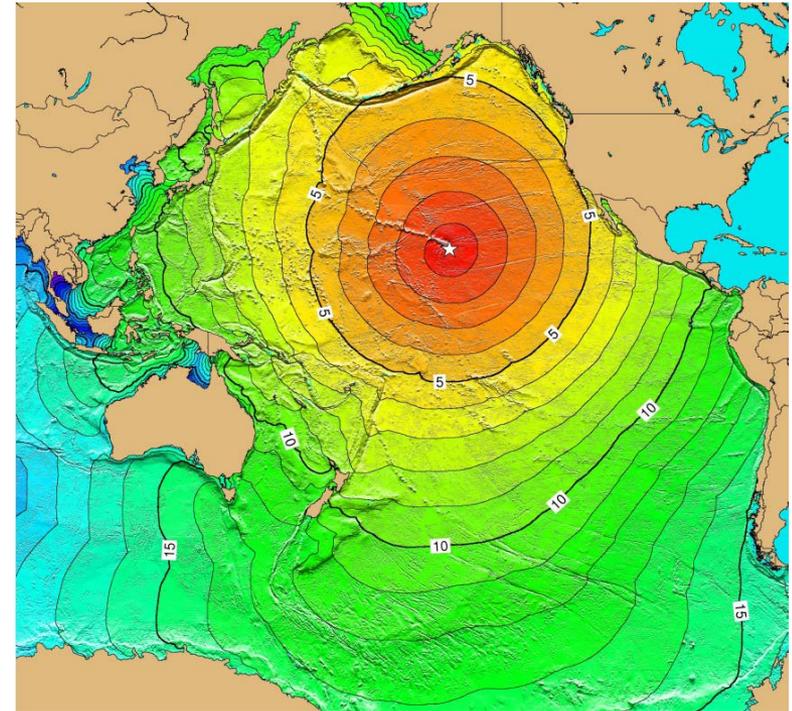
Additional IOOS DIF Customers *(in progress)*



Screenshot of Google Earth

Google: Standardized access to observations for Google Oceans

➤ Exploring KML+JSON



Travel time map for November 29, 1975 tsunami in Hawaii (NOAA NGDC).

Tsunami scientists: Prepackaged collections of event-specific observations from DART buoys

Recommended Web Services and Data Encodings

Data Type

Web Service

Encoding

In-situ data (buoys,
piers, towed sensors)

OGC Sensor
Observation Service
(SOS)

XML based on OGC
Observations and
Measurements (O&M)

Gridded data (model
outputs, satellite)

OpenDAP and/or
OGC Web Coverage
Service (WCS)

NetCDF using Climate
and Forecast (CF)
conventions

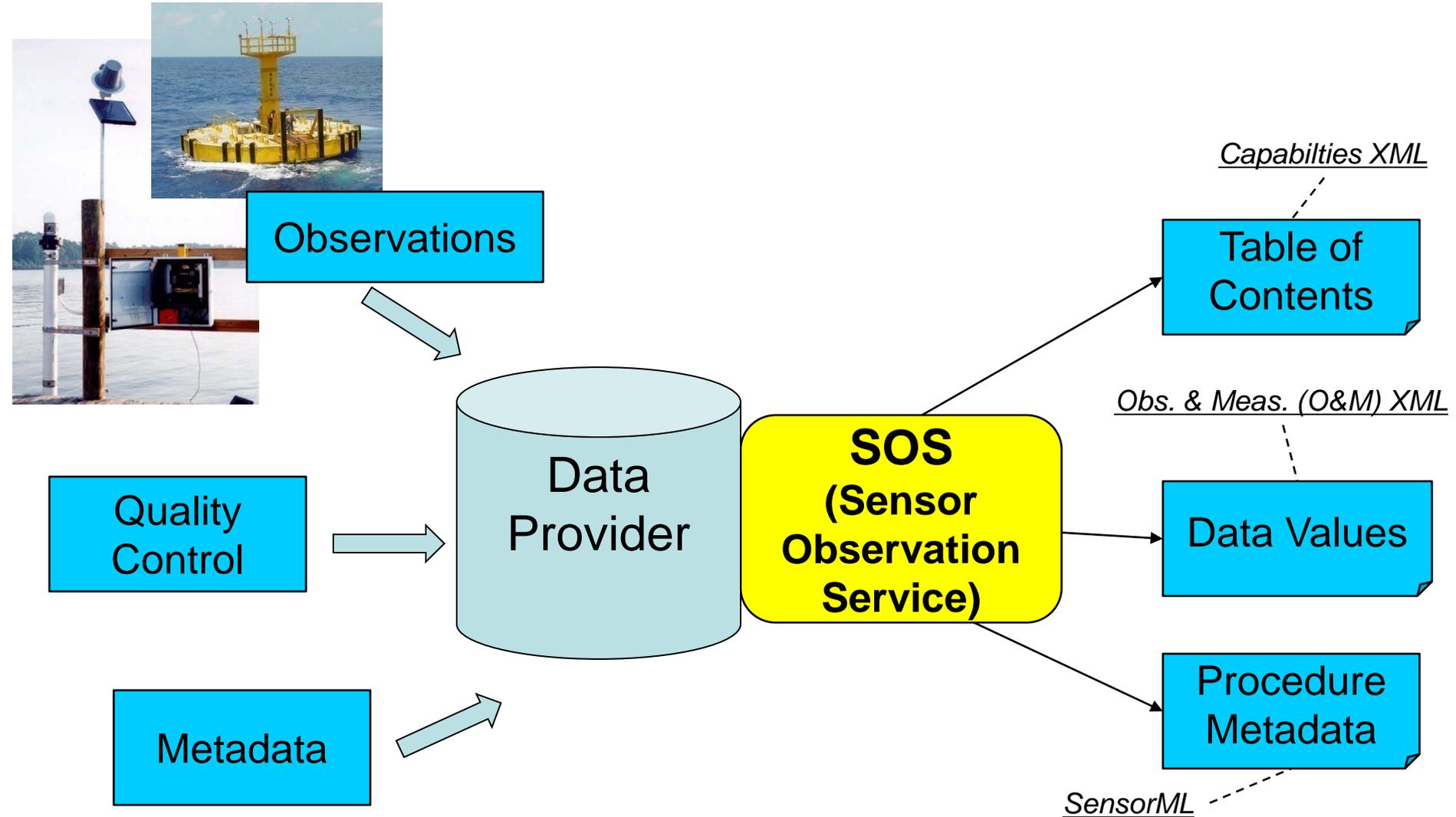
Images of data

OGC Web Map Service
(WMS)

GeoTIFF, PNG etc.
-possibly with
standardized styles

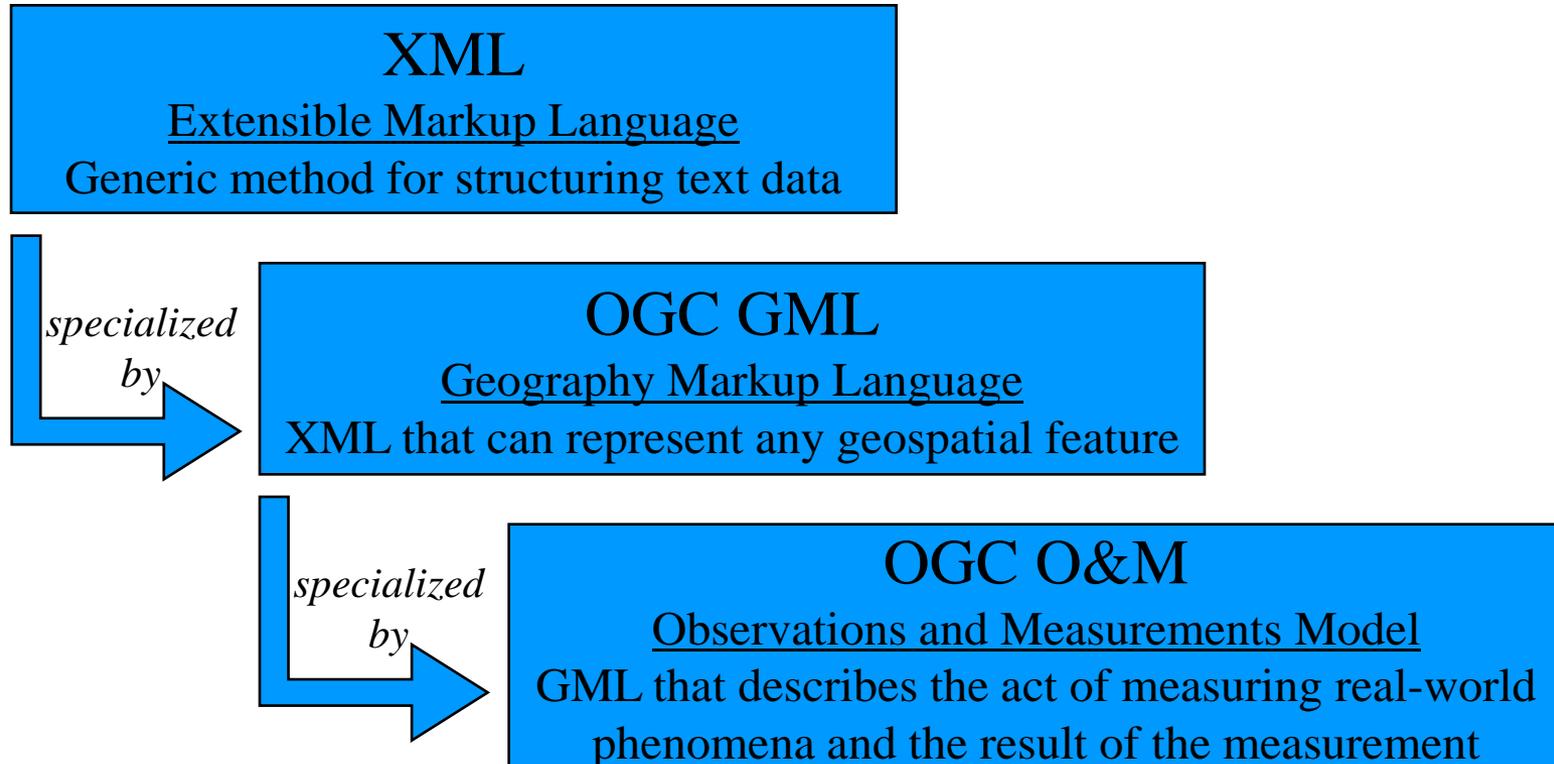
SOS for *in situ* Observations

Sensor Systems



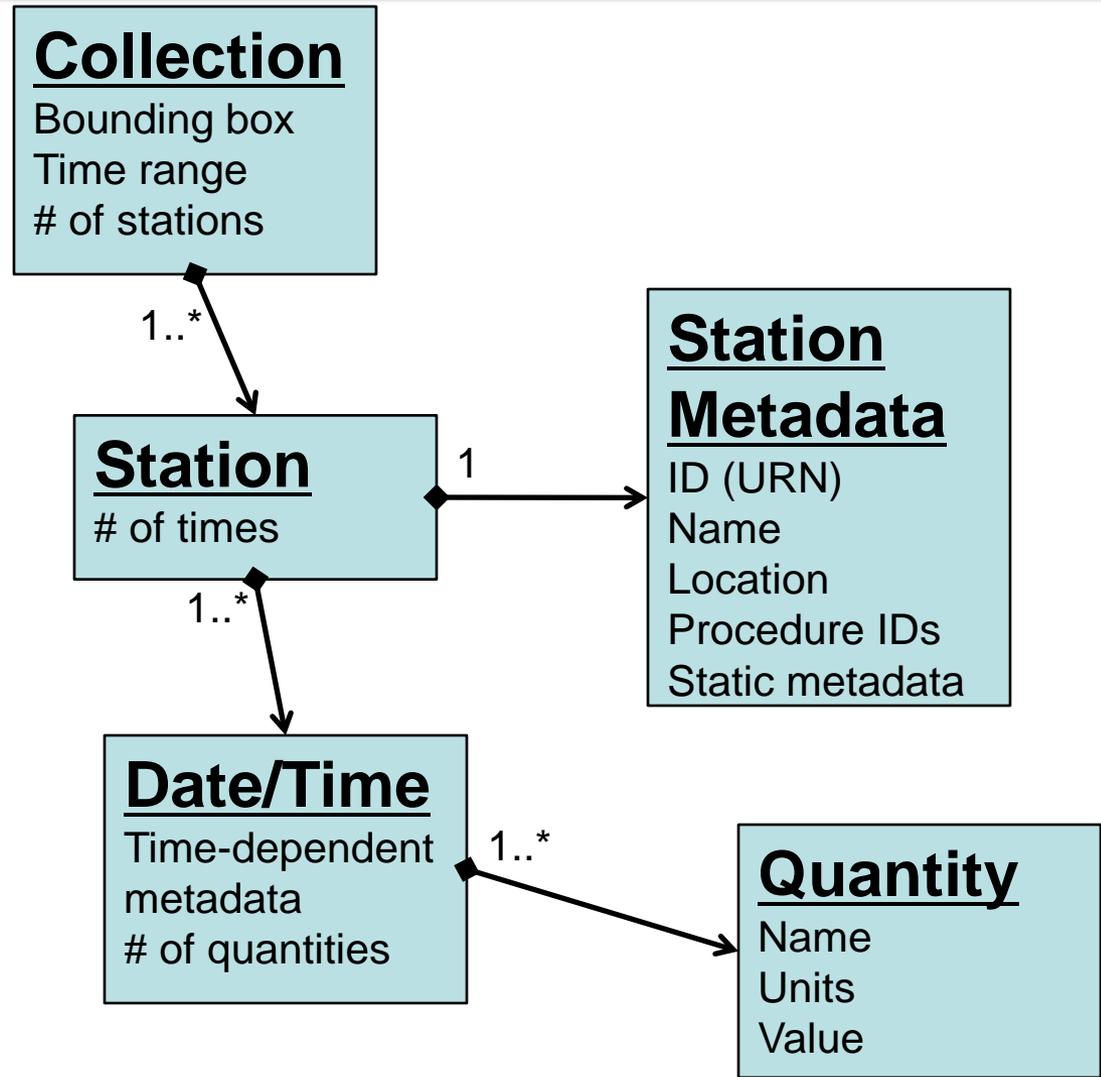
SOS GetObservation Response

XML Encoding of In-Situ Data



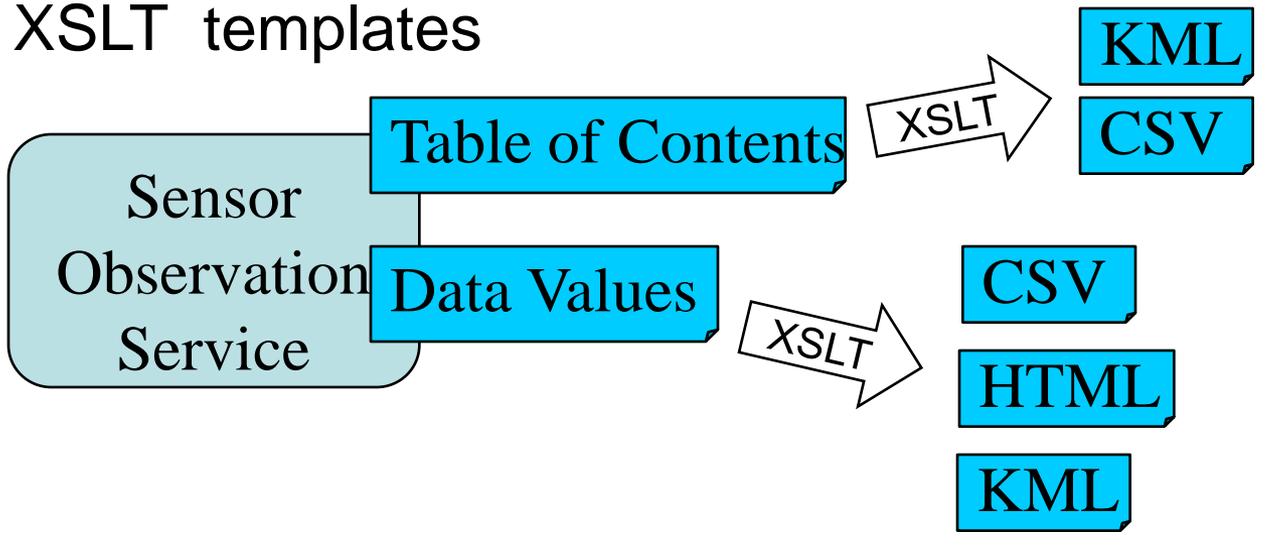
IOOS Data Model for Time Series at a Collection of Points

- **Collection**
 - Station 1
 - Time 1
 - quantity 1
 - quantity 2
 - Time 2
 - quantity 1
 - quantity 2
 - Station 2
 - Time 1
 - quantity 1
 - quantity 2
 - Time 2
 - quantity 1
 - quantity 2

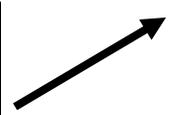
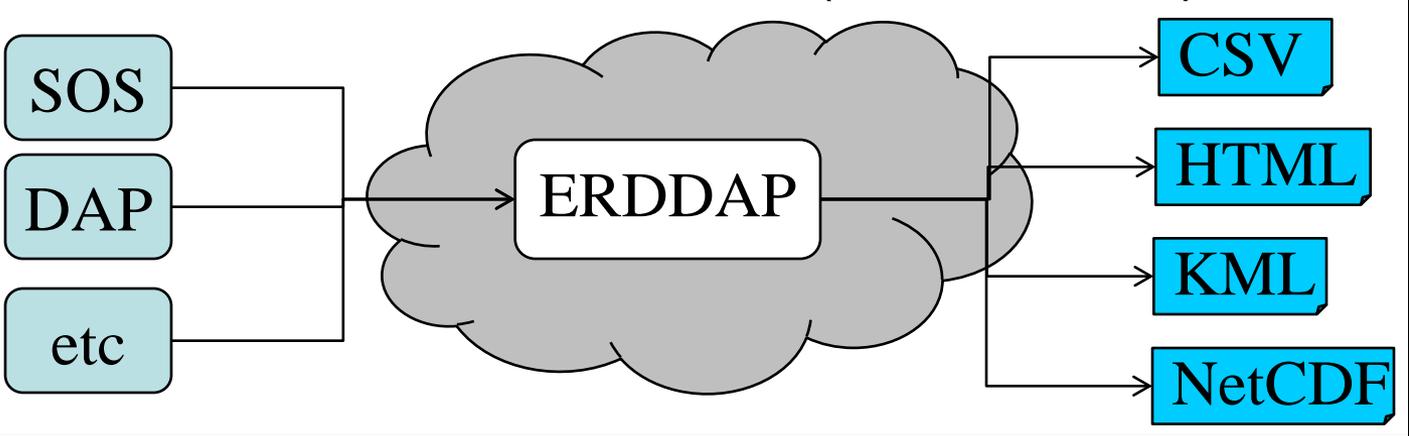


Format Conversion Tools

XSLT templates

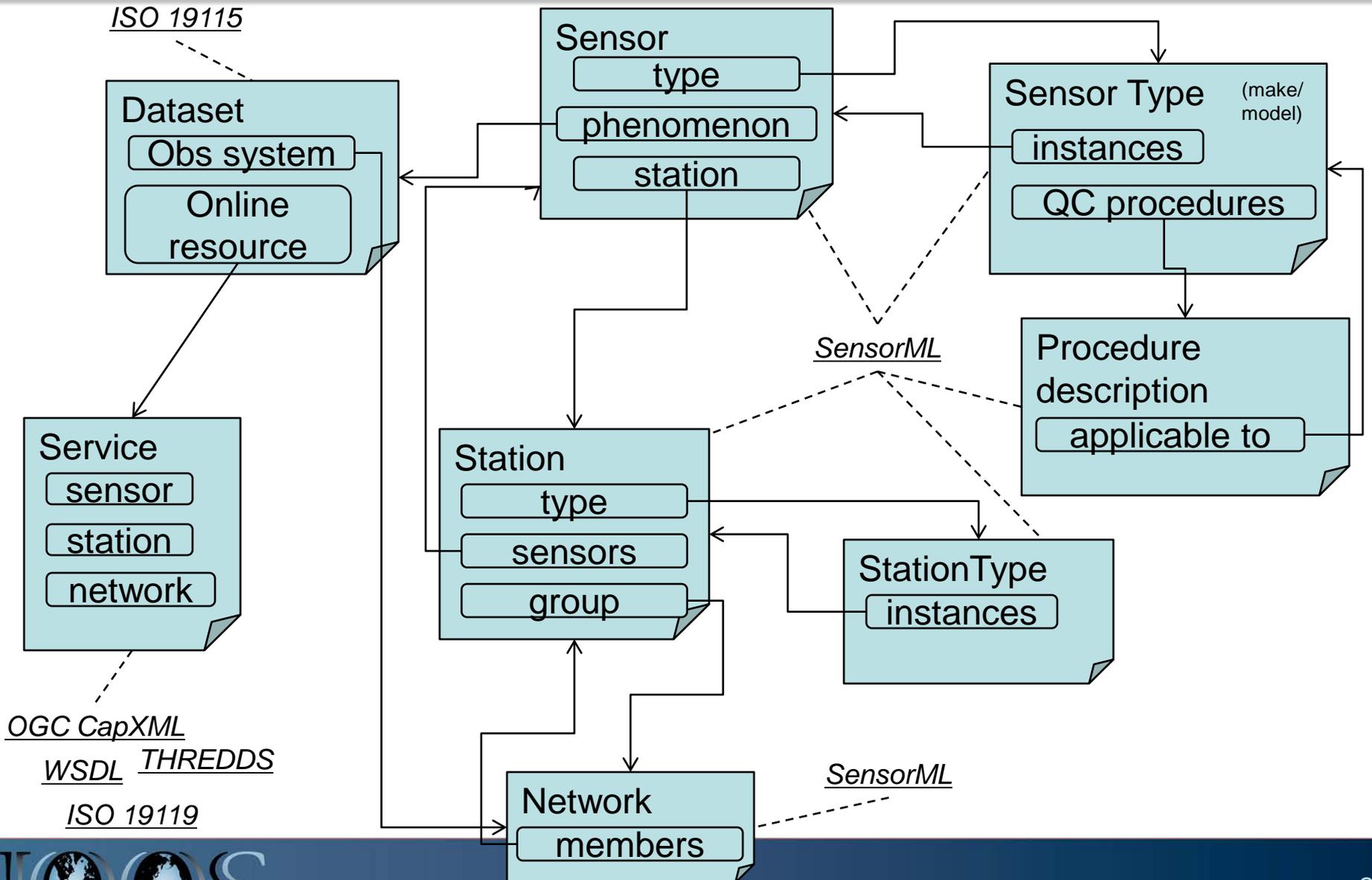


Scalable translation service (NSF OOI/CI)



IOOS Metadata Linkage Model

(Sensors, Stations, Networks, Datasets and Services)



SOS Profile/Best Practices

- **SOS and O&M specs are fairly general**
 - Need community specialization/restriction
- **IOOS adopting, defining or researching practices:**
 - O&M schema
 - KML+JSON (Javascript Object Notation)
 - URIs for sensors, stations, networks, CRS, phenomenon names
 - HTTP GET request encoding
 - SensorML metadata
 - Observation Offerings

IOOS Practice: Observation Offerings

- **Each station (buoy, fixed sensor package) is a separate Offering from the SOS**
 - Allows requests for data from 1 station at a time
- **Multi-station Offerings:**
 - “All stations” Offering
 - User specifies bounding box instead of station ID
 - Soon: program-specific or **event-specific Offerings**
 - E.g., “all Hurricane Katrina data”
 - Maybe: phenomenon-specific Offerings
 - E.g., “all temperature data”
- **Offering includes ID and English name**
 - gml:name = ID
 - gml:description = name
- **May replace multiple sensor IDs per offering with single station ID**

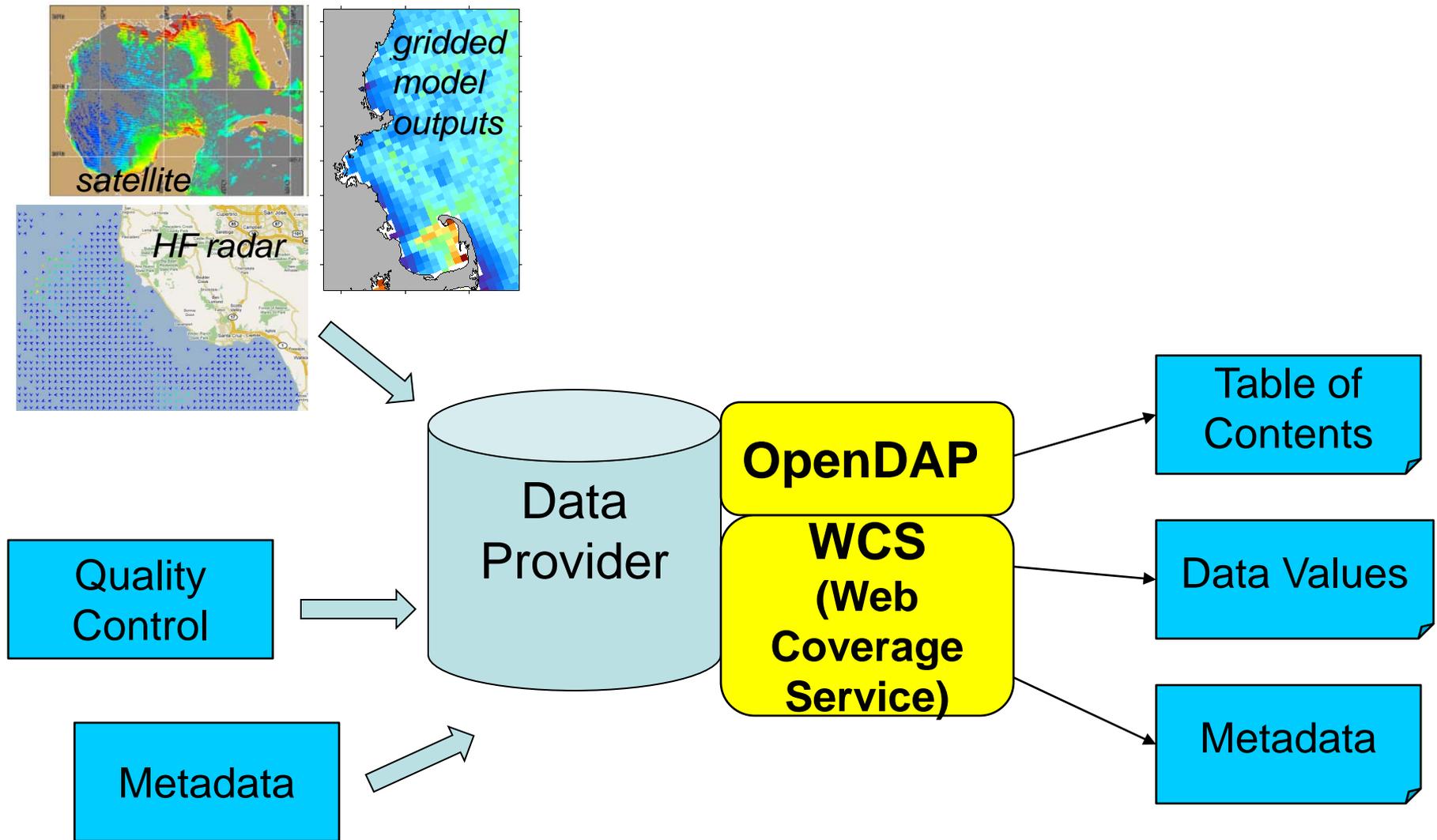
IOOS Practice: Identifiers

- **Using URNs for IDs of sensors, stations, networks (*URN = Uniform Resource Name*)**
- **Following “OGC Definition URN” practice**
- **Examples:**
 - urn:x-noaa:def:network:noaa.nws.ndbc::all
 - urn:x-noaa:def:station:noaa.nws.ndbc::21418
 - urn:x-noaa:def:sensor:noaa.nws.ndbc::21418:tsunameter0
- **Also using URNs for EPGS CRS identifiers**
- **Using URLs for phenomenon names**
 - Adopting MMI/CF URLs:
http://mmisw.org/ont/cf/parameter/sea_water_temperature
 - Allow trailing component as abbreviation
(sea_water_temperature)

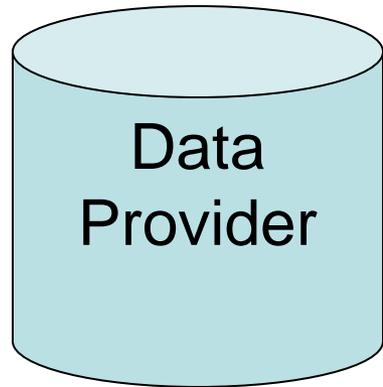
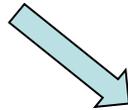
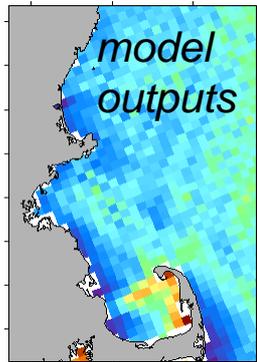
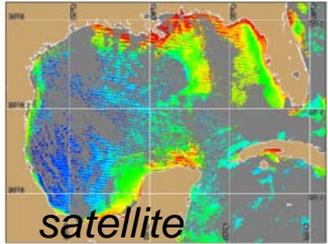
IOOS Practice: GetObservation Request

- **Supporting both HTTP POST requests and HTTP GET**
 - HTTP POST defined in spec, GET left out
 - Mostly following Oceans IE Best Practice for GET
 - For Bounding Box, using FOI that could be a BBOX or (in future) a named FOI:
featureofinterest=BBOX:minlon,minlat,maxlon,maxlat

WCS and/or OpenDAP for Gridded Data and Model Outputs



WMS for Maps of Data



Capabilities XML

PNG, GIF, TIFF, JPEG

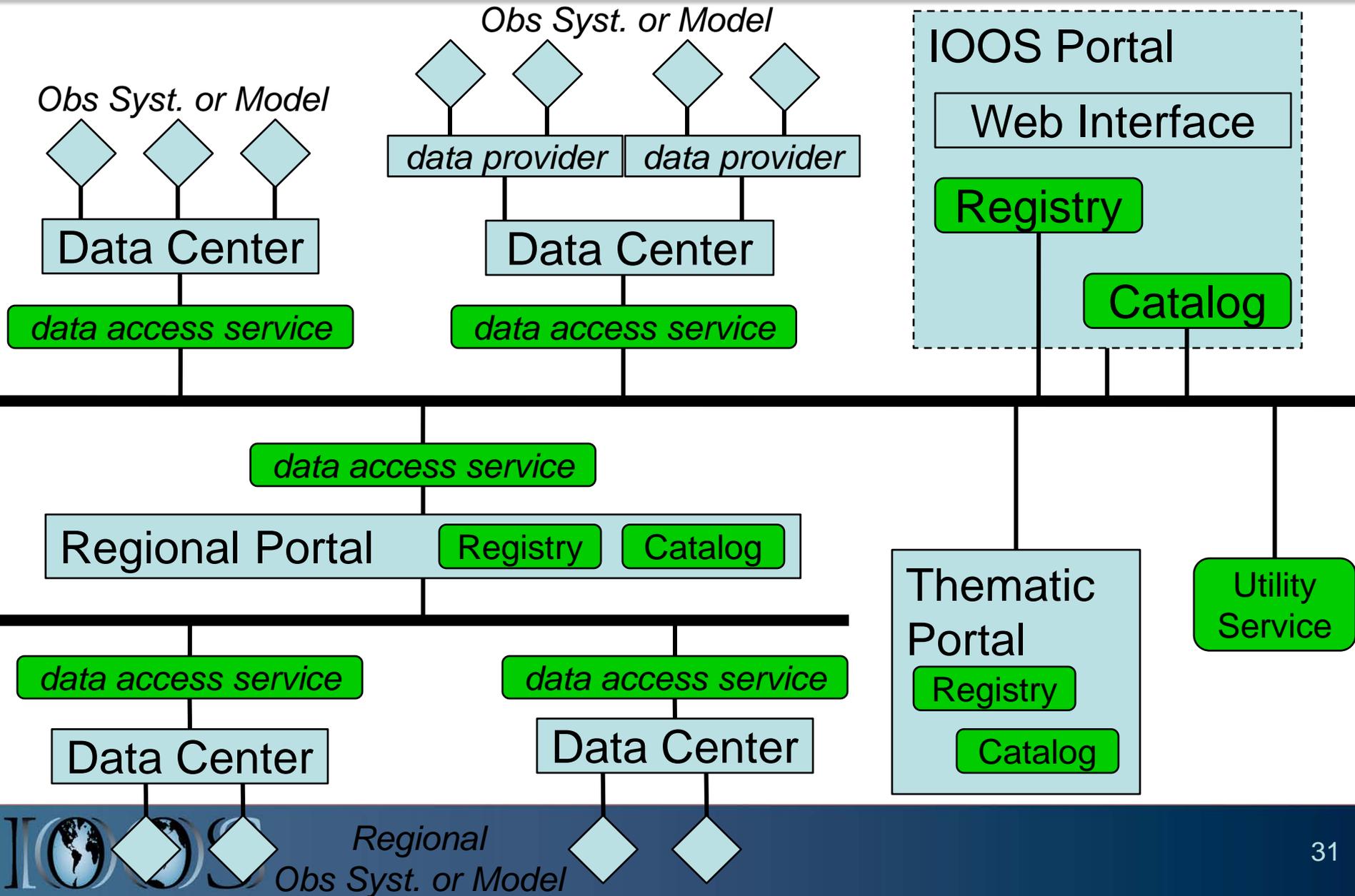
Summary

- **Standardized data access services implemented at operational data providers**
 - SOS: Point, Profile, Time Series, Collections
 - OpenDAP/WCS: Regular Grids
- **Implementing detailed metadata for sensors, platforms, systems**
- **SOS, WMS, WCS submitted as IOOS standards**
 - Need to document SOS Profile for ocean observations
- ***In planning: Expansion of DIF towards IOOS***
 - *Service types (Registry, Catalog, ...)*
 - *Data types (trajectory, unstructured grid, imagery)*
 - *Data providers, data customers*

See <http://ioos.gov/dif/>

The Bigger Picture: Moving to National IOOS Data Management Capability

Federated, Service-Oriented Architecture



IOOS Architectural Layers

and Relationship to IOOS “Subsystems” and ISO Model

IOOS “Subsystems”

ISO 3-Layer Model

(International Organization for Standardization)

Modeling & Analysis

Client Components

User Interface Tier

Utility Services

Business Process Tier

Data Access Services

Data Access Tier

Data Providers

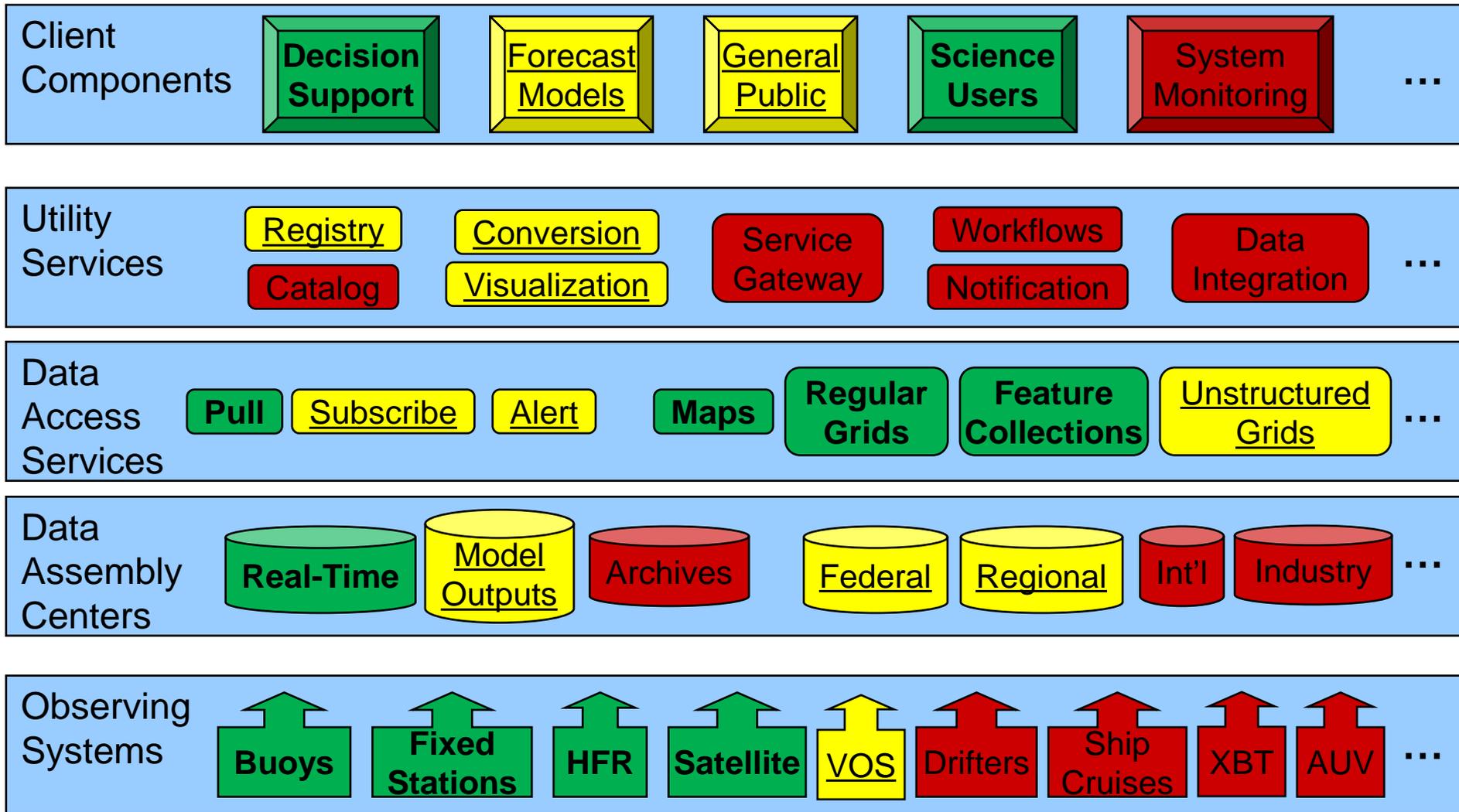
*Data Management
and Communications
(DMAC)*

Observing Systems

Observing Systems

Component Types Needed for IOOS

Computational Viewpoint from Reference Model for Open Distributed Processing (RM-ODP)



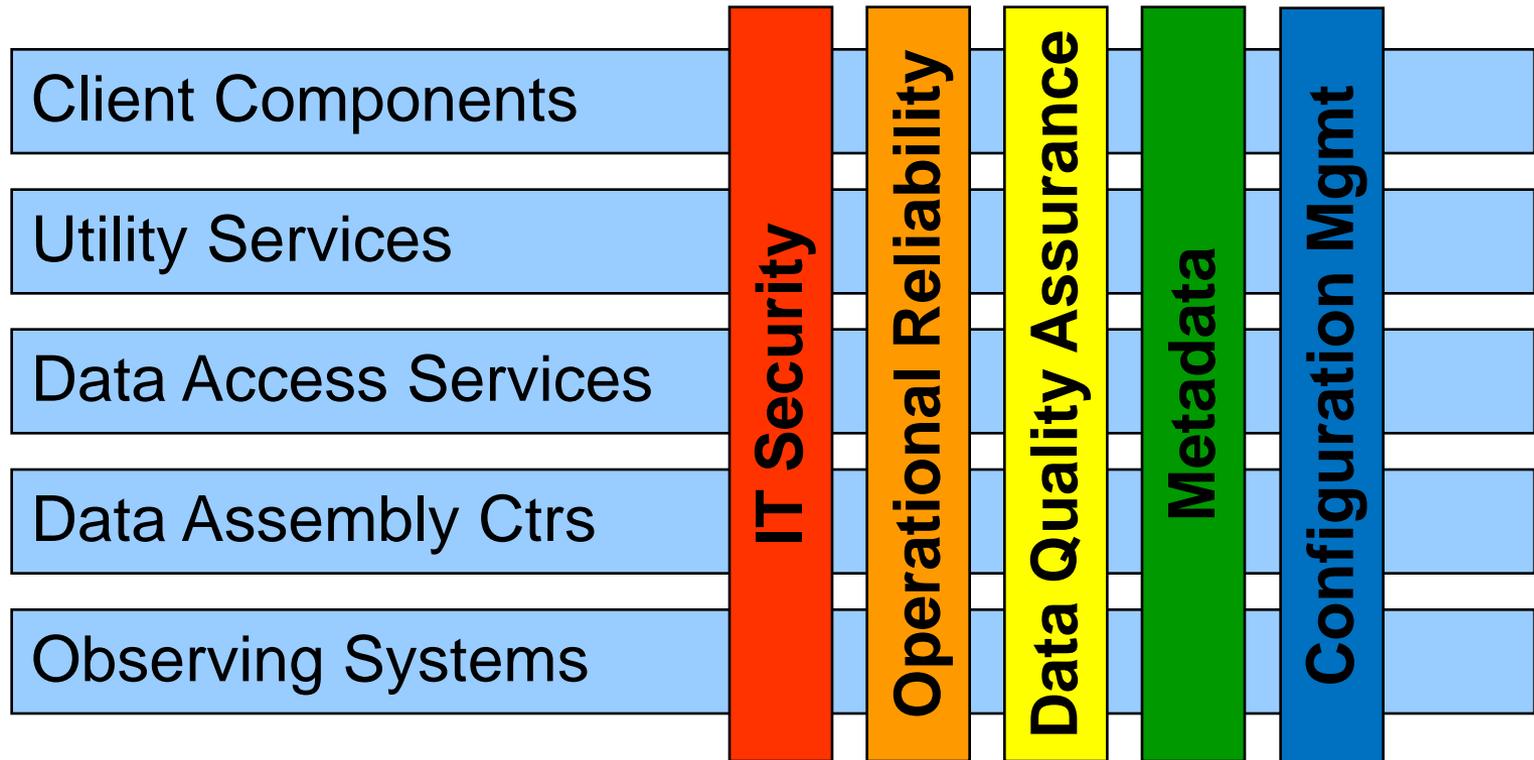
Legend:

Working examples

Starting/partial

Not yet addressed

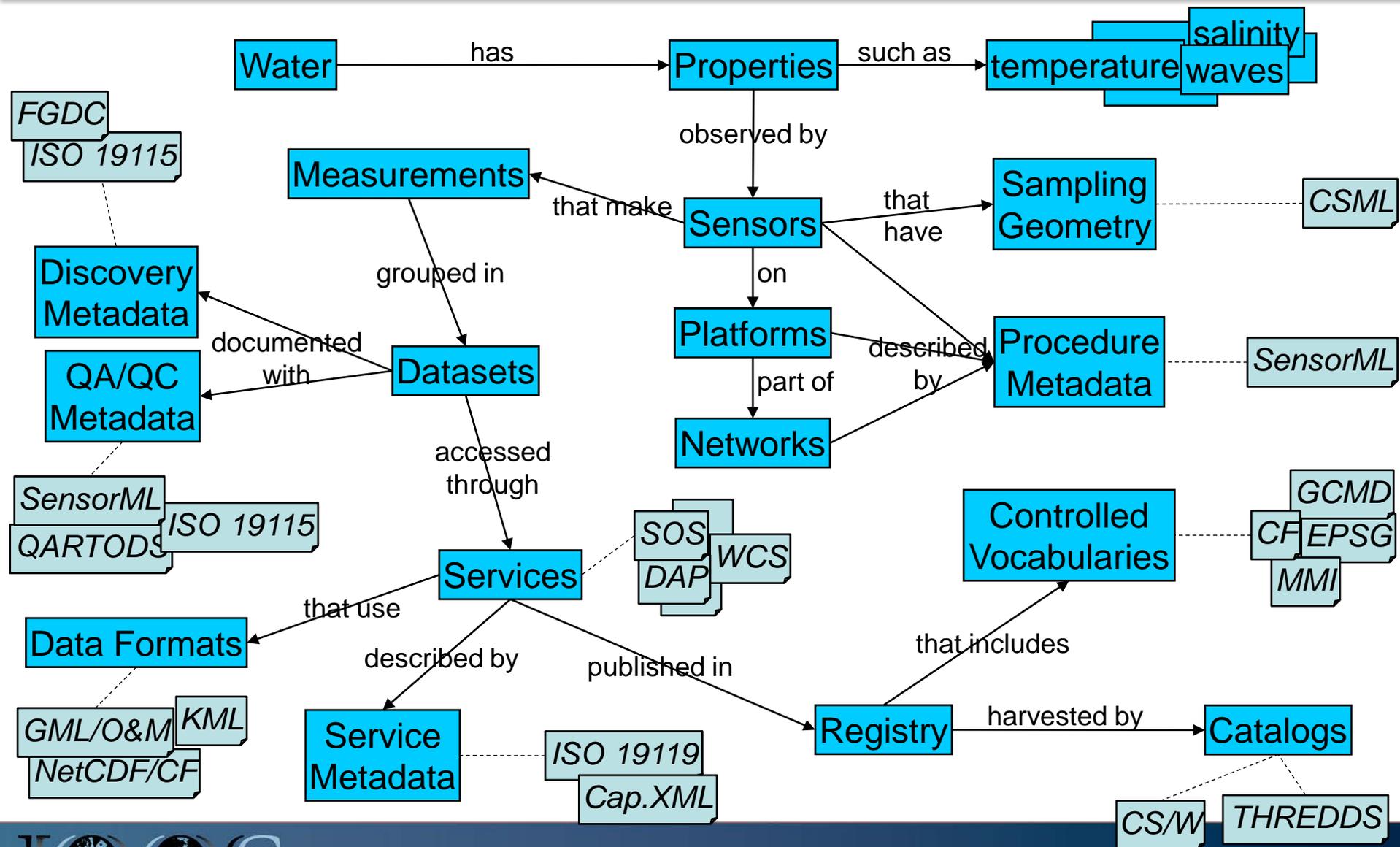
Crosscutting Concerns



Backup Slides

IOOS Data and Metadata

Information Viewpoint from Reference Model for Open Distributed Processing (RM-ODP)



IOOS Data and Metadata Types

Information Viewpoint from Reference Model for Open Distributed Processing (RM-ODP)

Service Metadata

(OWS Capabilities XML, ISO 19119)

Discovery Metadata

(FGDC, ISO 19115/19139)

Controlled Vocabularies

(CF, MMI, OGC, GCMD, URNs)

QA/QC Metadata

(QARTODS/Q20)

Sensor/Platform Metadata

(SensorML)

Data Encoding Conventions

(GML, KML, O&M, SWEC, CSML, NetCDF/CF)

Collection Types

(Time Series, Multi-Station Obs)

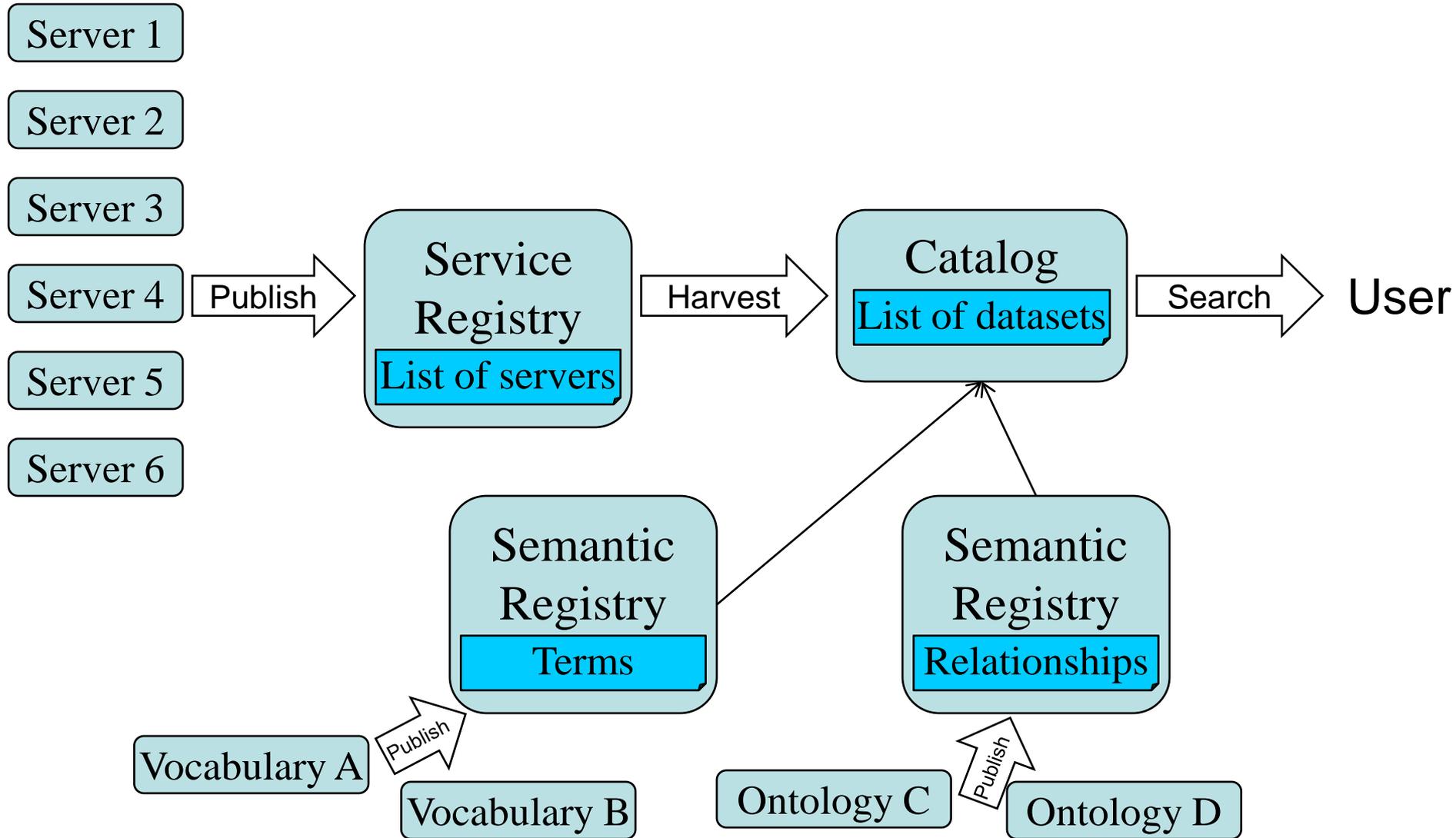
Sampling Feature Types

(Point, Profile, Trajectory, Reg Grid, Unstructured Grid)

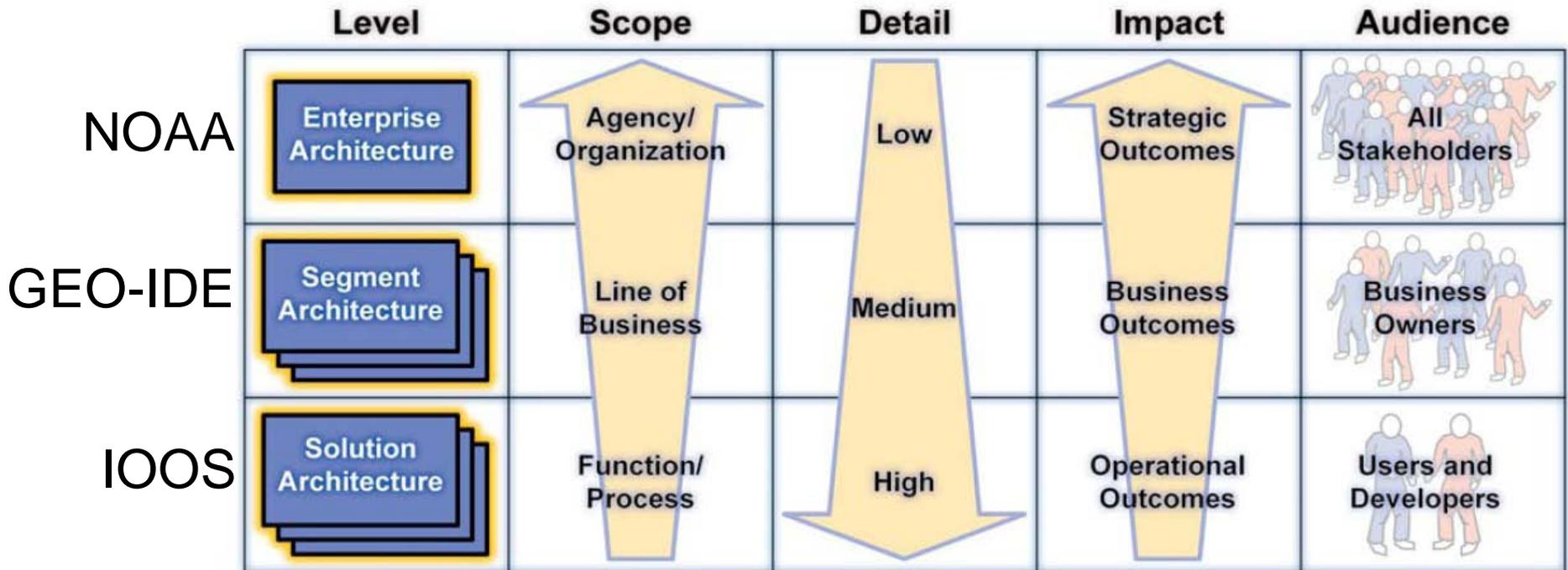
Ocean Properties

(Temperature, Salinity, Currents, Waves, Chlorophyll)

Registry and Catalog Concept



NOAA EA, GEO-IDE and IOOS are complementary



Source: US OMB, Federal Enterprise Architecture Program Management Office, *FEA Practice Guidance* (2007), figure 1-3

Strategic Direction and Drivers

- **Strategic direction:**
 - DIF Master Plan
 - NOAA IOOS Strategic Plan
- **NOAA IOOS Goals addressed by DIF:**
 - Improve access to high-quality, integrated data
 - Enhance data products and decision-support tools
 - Support NOAA and regional ocean observation capability
- **Other drivers**
 - NOAA is lead agency in Integrated Ocean Observing System
 - “Leadership” includes technical guidance
 - Must assess feasibility and value of IOOS
 - IOOS must link to other initiatives
 - GEO-IDE, GOOS, RCOOSs, GEOSS
 - Must harmonize services, data, technology

Value of Integrated/Interoperable Data

- "Performance Layer" of DIF EA

- **Improve access to high-quality, integrated data**
 - Standardized access services
 - Standardized data encodings
- **Enhance data products and decision-support tools**
 - Enable integration of data from multiple sources
 - Improve metadata and quality-control information
 - Meet functional requirements of identified customers
 - While not ruling out other customers
- **Support NOAA and regional ocean obs capability**
 - Coordinate standardization among NOAA providers
 - Fund and guide Regional Coastal Ocean Observing Systems

Business Layer

- **Assess and recommend technologies and standards**
- **Coordinate technology choices with stakeholders**
 - Working groups
 - DMAC Standards Process
- **Reduce interoperability barriers**
 - Apply targeted funding
- **Assess technology and customer improvements**
 - Decide to expand/maintain/discontinue DIF
 - Determine path towards operational IOOS