Sensor Web Enablement

Presentation to
Sensor Standards Harmonization Technical Working Meeting
7 March 2006, Huntsville, AL

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OGC Sensor Web Enablement

- Overview of OGC
- Sensor Web Enablement (SWE) Concepts
  - OWS-3 Demonstration Video
- A peek at the Technical Details
  - SWE Information Model
  - SWE Services Model
- What's Next: SWE in OWS-4

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An Overview of OGC

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OGC Mission

Mission

To lead the global development, promotion and harmonization of open standards and architectures that enable the integration of geospatial data and services into user applications and advance the formation of related market opportunities.

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OGC Today

- 310 members worldwide – 31 countries & 5 continents
  - 100 European members
  - 34 Asia-Pacific members
- 90+ Academic and Research Members
- 16 approved, publicly available Implementation Specifications fielded in hundreds of products
- 20+ candidate Implementation Specifications in work
- Significant interaction with ISO and many other standards organizations

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Formal Partnerships and Alliances

- Formal partnerships established to coordinate standards development, position outreach and education, and spur uptake

- Current Alliances:
  - Geospatial Information & Technology Association (GITA)
  - Open Mobile Alliance (OMA)
  - International Organization for Standards (ISO)
  - US Geospatial Intelligence Foundation (USGIF)
  - Association of Geographic Laboratories in Europe (AGILE)
  - International City/County Management Association (ICMA)
  - WebSIM (OGC, Object Management Group, Web3D, and Simulation Interoperability Standards Organization (SISO))
  - National Institute of Building Sciences / IAI
  - IEEE Technical Committee 9 (Sensor Web)

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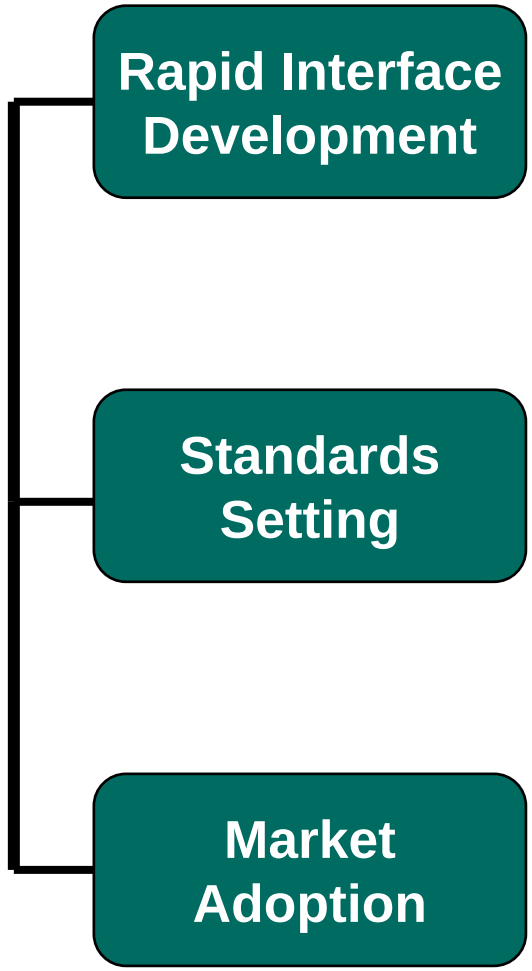
OGC's Approach for Advancing Interoperability

- ***Interoperability Program* (IP)** - a global, innovative, hands-on prototyping and testing program designed to accelerate interface development and validation, and bring interoperability to the market

- ***Specification Development Program*** –Consensus processes similar to other Industry consortia (World Wide Web Consortium, OMA, OMG, etc.).

- ***Outreach and Community Adoption Program*** – education and training, encourage take up of OGC specifications, business development, communications programs



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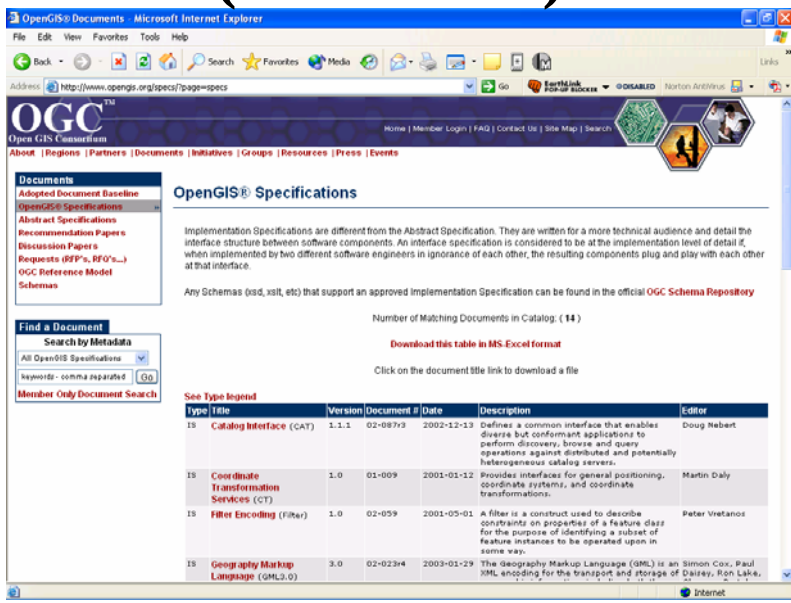
Approved OpenGIS® Specifications

- Tightly coupled:
  - Simple Feature Access – OLE, SQL, CORBA
  - Grid Coverages 1.0
  - GO-1 Application Objects
- Focus on Web Services
  - Catalog 2.0
  - Coordinate Transformation 1.1
  - Web Map Service (WMS 1.3)
  - Web Feature Service (WFS 1.0)
  - Filter Encoding 1.0
  - Geography Markup Language 3.0 (GML)
  - Style Layer Descriptors 1.0
  - Web Coverage Service 1.0
  - Web Map Context 1.0
  - OGC Web Services Common
  - Open Location Service Specification Set 1.0

Available free of charge at
www.opengeospatial.org
(Documents)



OGC Impact on Geospatial & Location Based Technologies

- Several hundred products are implementing OpenGIS Specifications
  - See OGC "Registered Products" List under "Resources" at www.opengeospatial.org
- Compliance is increasing in importance
  - Automated Tests on-line
  - Formal Certification

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Sensor Web Enablement (SWE) Concepts

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Sensors Are Everywhere

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Basic Desires

- Quickly discover sensors and sensor data (secure or public) that can meet my needs – location, observables, quality, ability to task
- Obtain sensor information in a standard encoding that is understandable by me and my software
- Readily access sensor observations in a common manner, and in a form specific to my needs
- Task sensors, when possible, to meet my specific needs
- Subscribe to and receive alerts when a sensor measures a particular phenomenon

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Sensor Web Concept

SWE Architecture

Observations & Measurements

SensorML

Transducer Markup Language (TML)

Sensor Observation Service (SOS)

Sensor Planning Service (SPS)

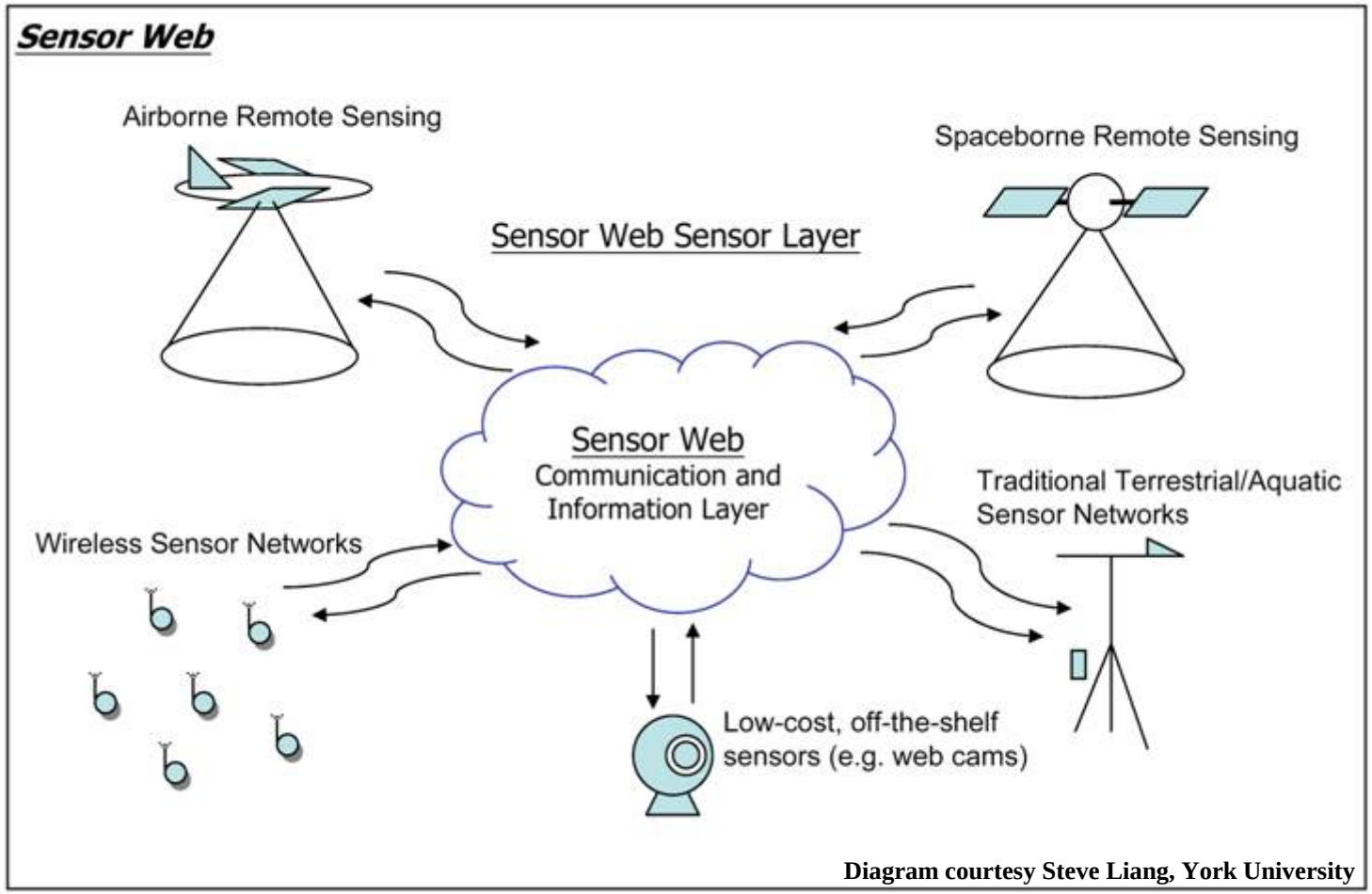

Diagram courtesy Steve Liang, York University

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SWE Specifications

- Observations & Measurements (O&M)
- Sensor Model Language (SensorML)
- Transducer Model Language (TML)
- Sensor Observation Service (SOS)
- Sensor Planning Service (SPS)
- Sensor Alert Service (SAS)
- Web Notification Service (WNS)

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Background

1999

SensorML initiated at Univ. of Alabama

2001

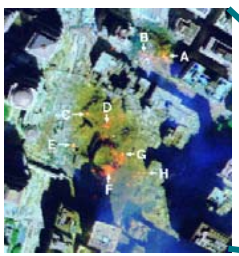
OGC Web Services Testbed 1.1
- Sponsors: EPA, NASA, NIMA
- Specs: SOS, O&M, SensorML
- Demo: NYC Terrorist
- Sensors: weather stations, water quality

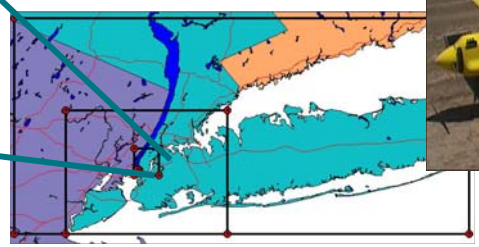
2002

OGC Web Services Testbed 1.2
- Sponsors: EPA, General Dynamics, NASA, NIMA
- Specs: SOS, O&M, SensorML, SPS, WNS
- Demo: Terrorist, Hazardous Spill and Tornado
- Sensors: weather stations, wind profiler, video, UAV, stream gauges

2003-4

- Specs advanced through independent R&D efforts in Germany, Australia, Canada and US
- Sensor Web Work Group established
- Specs: SOS, O&M, SensorML, SPS, WNS, SAS
- Sensors: wide variety





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SWE Status

- OWS-3 Interoperability Testbed
  - advanced the SWE specifications for consensus adoption
  - Completed last quarter 2005
  - Demo
- OWS-4 Interoperability Testbed
  - Implementations
  - Plan to refine specifications
  - To be conducted in 2006
- Specification Program
  - Release for Comment (RFC) process to adopt specification
  - RFC Team, Letter of Intent, Endorsement
  - RFCs ready for SensorML, TML, SOS, SPS
  - O&M - Pending Best Practices
  - SWE Architecture Document Paper

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OGC®

WEB SERVICES

PHASE 3 DEMONSTRATION

DVD VIDEO

Produced by Thirteen/WNET New York with the support of Rossettex Technology and Ventures Group.

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SWE Information Model

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SWE Information Model

- High-level overview
- Common Observation Model Elements:
  - Observation and Measurements (O&M)
  - Sensor Markup Language (SensorML)
  - Transducer Markup Language (TML)
  - IEEE 1451 TEDS
  - ISO 19130 – Sensor and Data Model for Imagery and Gridded Data
- SWE Registry Model Elements
  - Service Descriptions
  - Sensor Descriptions
  - Observation Offerings
  - Observation Dictionary
  - Units of Measure Dictionary
  - Tasking Dictionary

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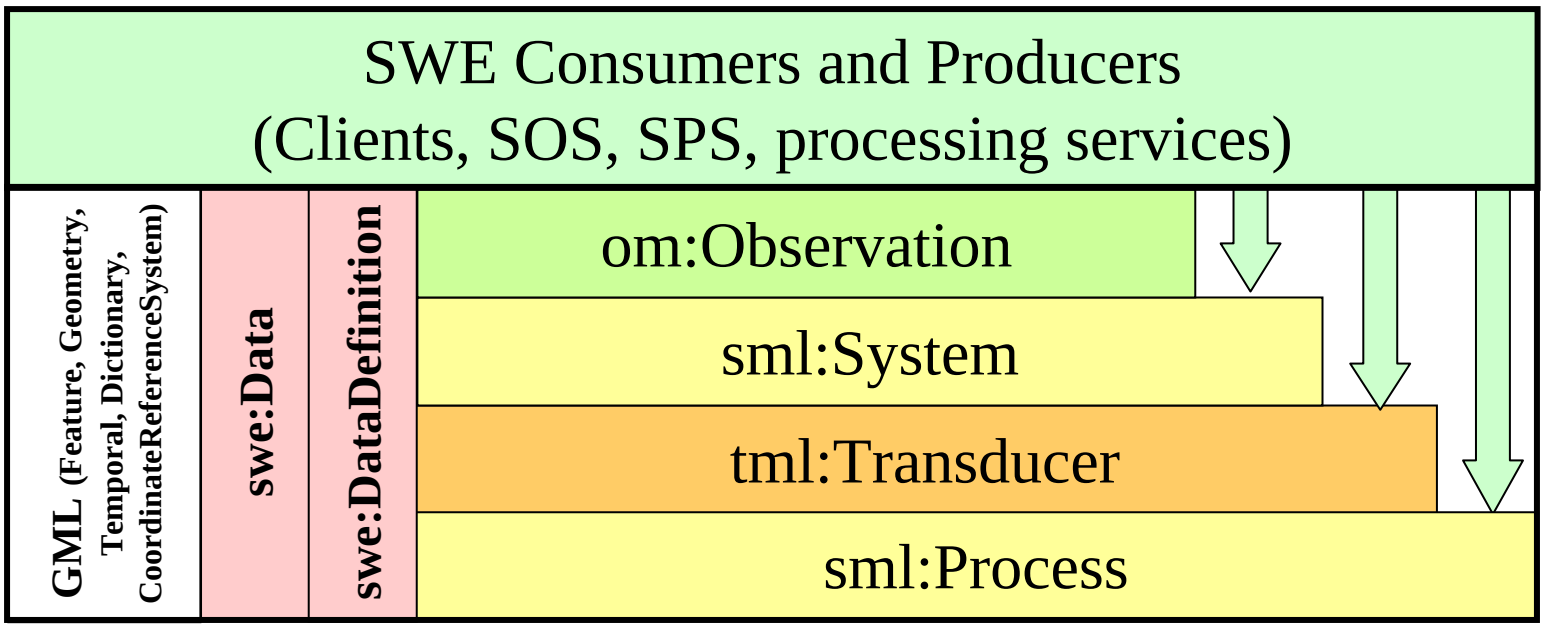
SWE Information Model Layers



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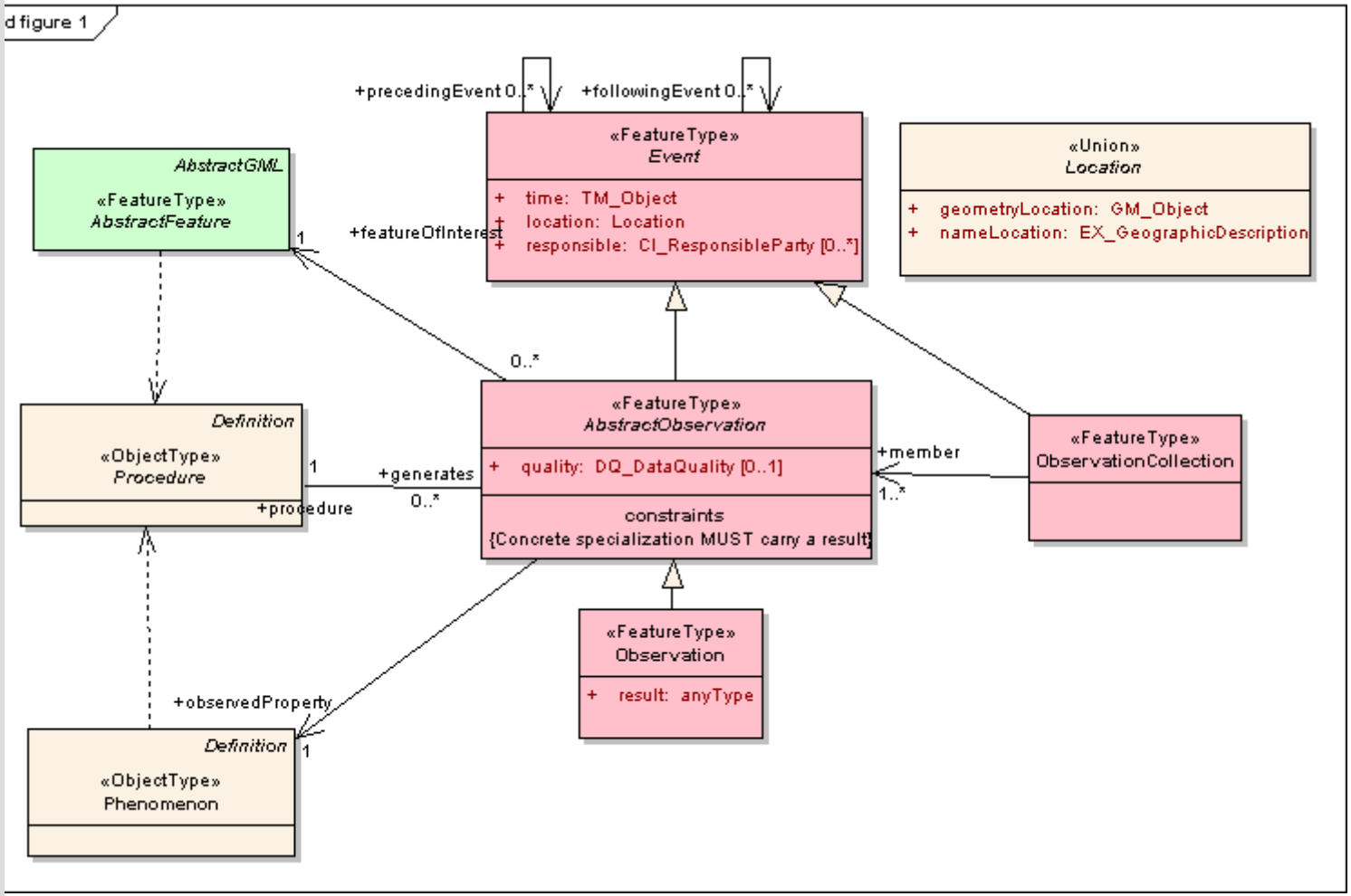
Observation and Measurement (OGC 05-087)

- Observation → Act of estimating a value of a phenomenon, involving a procedure, instrument or algorithm
- Defines the information model for SWE
- Consistent with Measurement Theory
- Consistent with OGC GML and Feature Model



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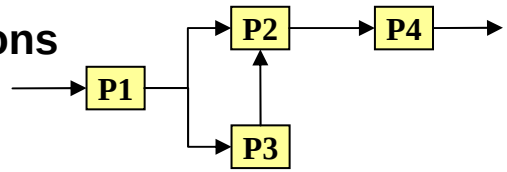
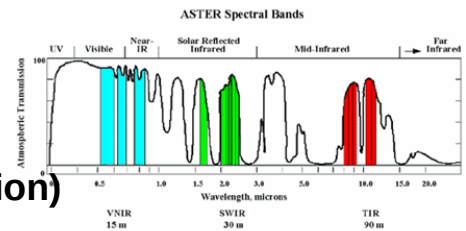
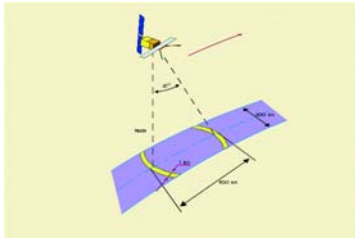
Sensor Model Language (SensorML) (OGC 05-086)

- Process Model and Process Chains
  - **Framework for process models and chains as serializations of executable components.**
  - **All processes include inputs, outputs, and parameters**



- System Description
  - **System provides connectivity of a process chain to the real-world by including position information.**
  - Geometry Characteristics
    - **Size, shape, spatial weight function (e.g. point spread function) of individual samples**
    - **Geometric and temporal characteristics of sample collections (e.g. scans or arrays)**
  - Documentation
    - **Overall information about the system**
    - **History and reference information**





- Observation characteristics
  - **Physical properties measured (e.g. radiometry, temperature, concentration, etc.)**
  - **Quality characteristics (e.g. accuracy, precision)**
  - **Response characteristics (e.g. spectral curve, temporal response, etc.)**

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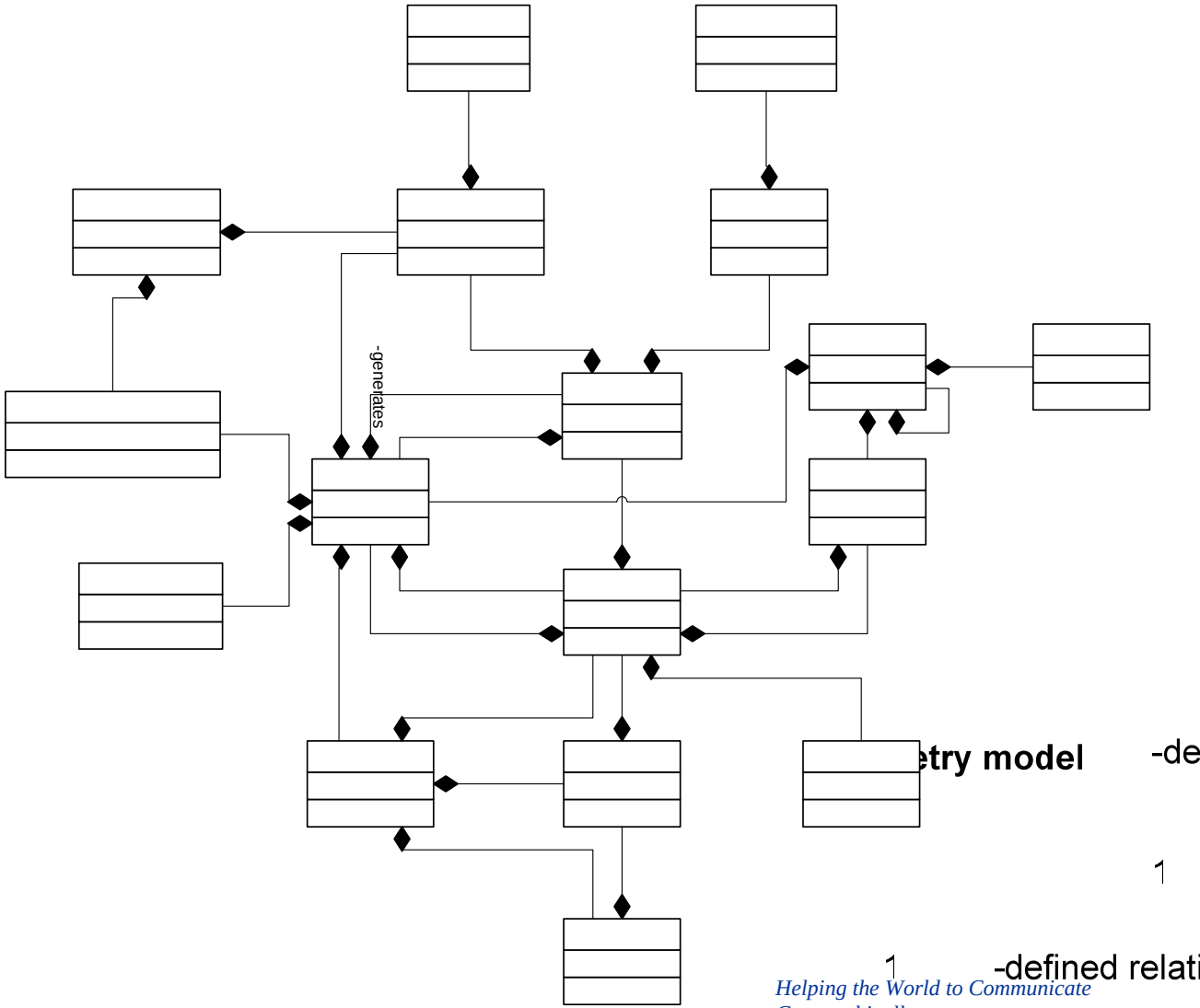
TransducerML (OGC 05-085)

- A language for exchanging sensor data and metadata between a sensor system and a sensor processor based on XML.
- Sensor data requires little or no pre-processing.
- Metadata describes how to process associated data from any sensor.
- Sensor agnostic, uses a common model for describing all sensors.



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TML Concepts: Types of transducers

- All transducers
  - Have response model
  - External geometry
- Remote transducers
  - Have Internal spatial geometry model
- In situ transducers
  - No internal spatial geometry
- Receiving transducers (e.g. Sensor)
  - Input: phenomenon
  - Output: data
- Transmitting transducers (e.g. Actuator)
  - Input: data
  - Output: phenomenon

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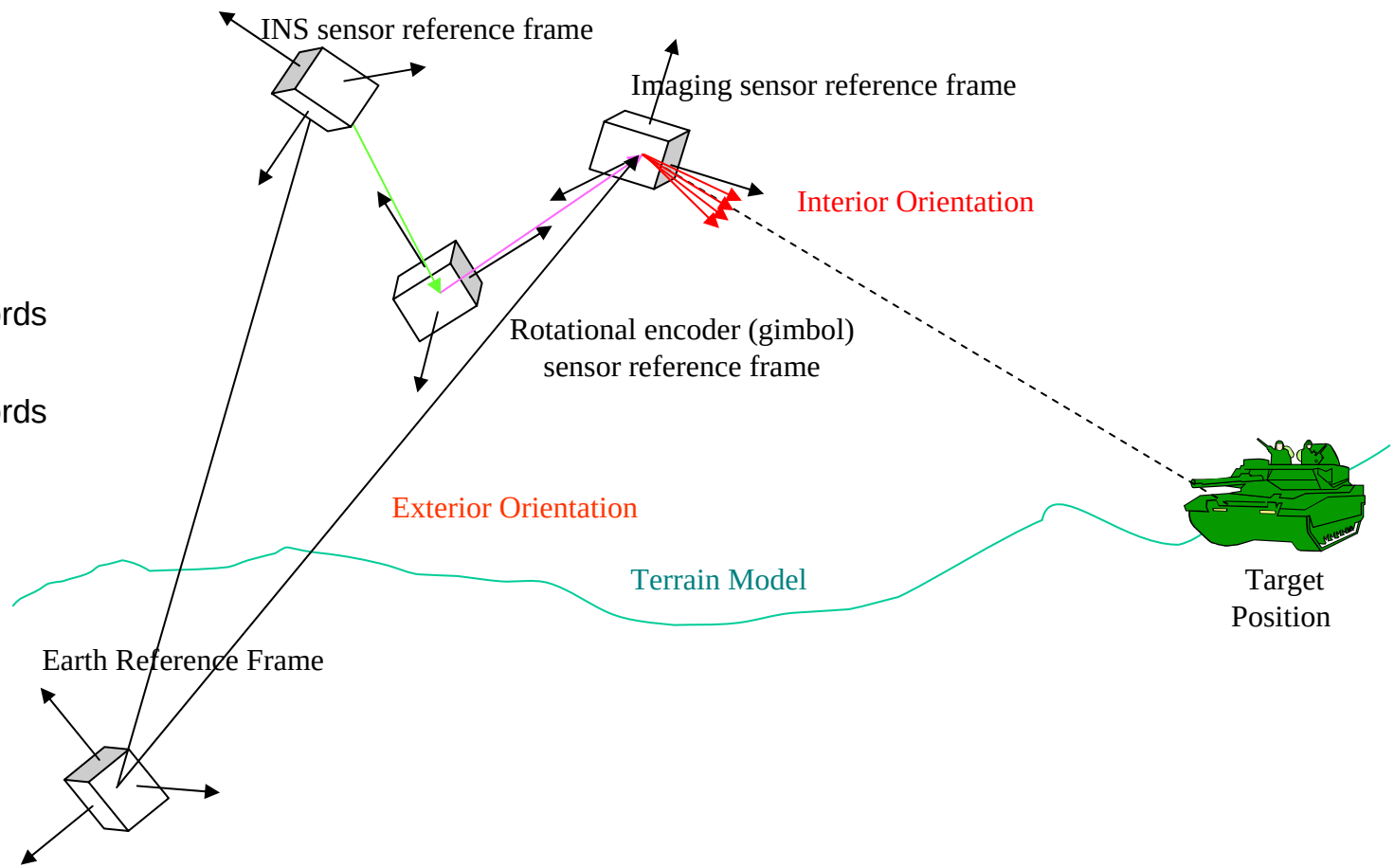
Coordinate Reference Systems and TML

- External
  - Spatial
    - Position
    - Attitude
  - Temporal
- Internal
  - Spatial
    - Sample coords
  - Temporal
    - Sample coords

Geometry Characteristics



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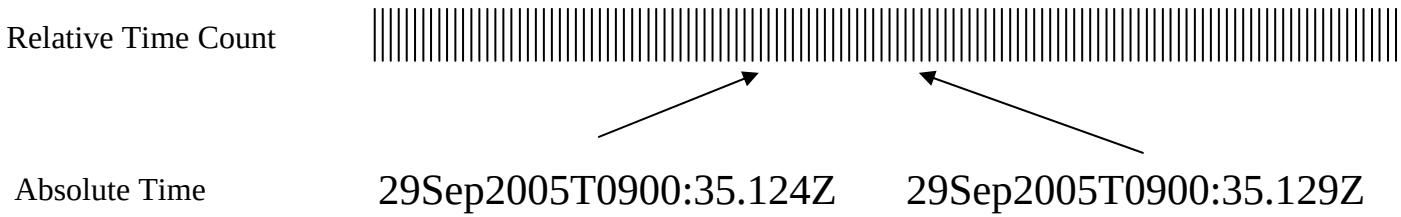
TML Relative/Absolute Time

- Relative Time (Internal)
  - Interior time
  - High resolution system clock
  - Timing models
- Absolute Time (external)
  - Exterior time
  - UTC tag

Time tags are fundamental to TML



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SWE Service Model

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SWE Service Model

- SWE Services
  - Sensor Observation Service (SOS) **actively developed in OWS-3 project*
  - Sensor Planning Service (SPS) **actively developed in OWS-3 project*
  - SWE Registry **actively developed in OWS-3 project*
  - *Sensor Alert Service (SAS)* **actively developed in SAS IE project*
  - *Web Notification Service (WNS)* **not in scope for OWS-3*

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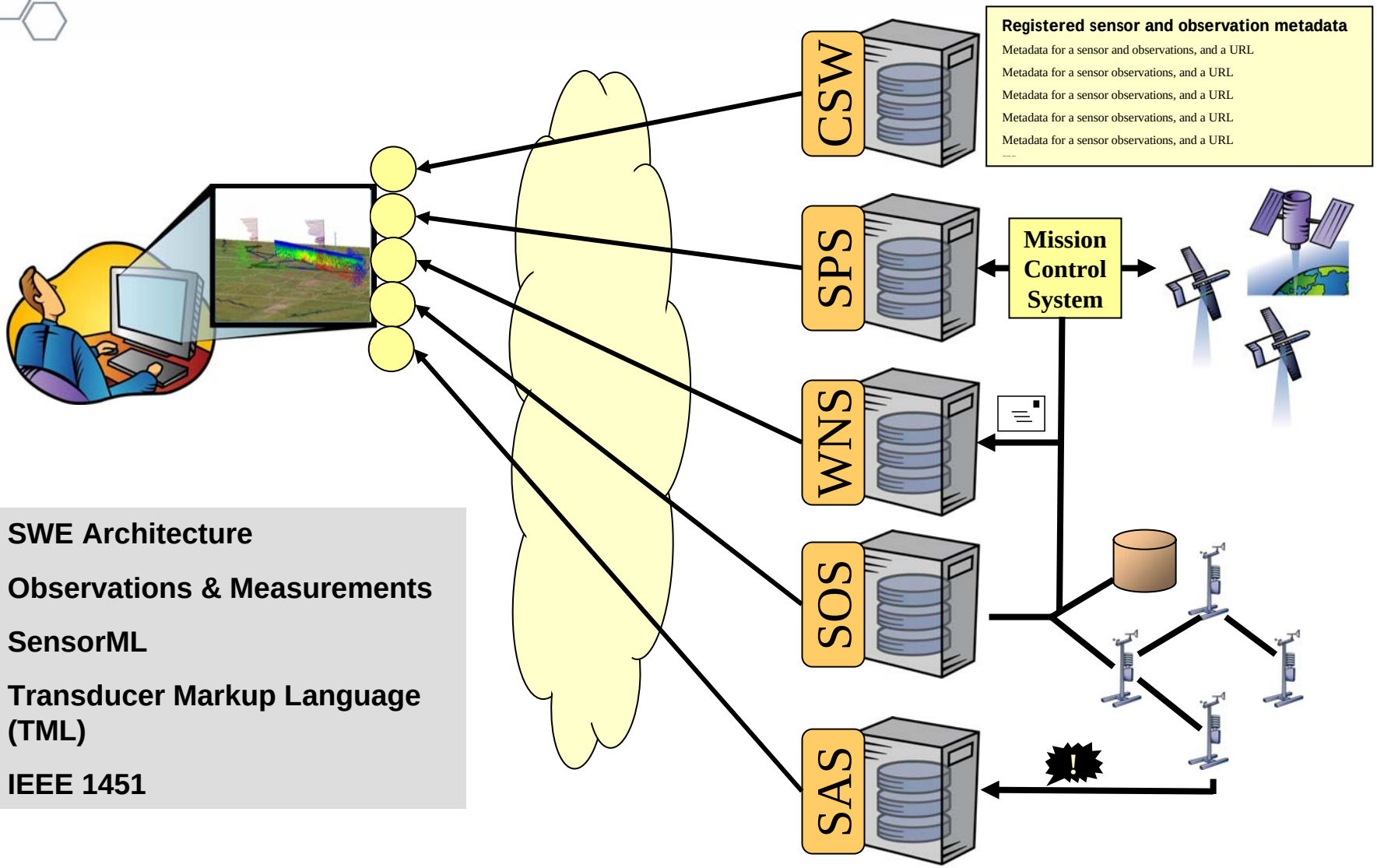
Enabling Sensor Webs with SWE Framework



SWE Architecture

Observations & Measurements

SensorML

Transducer Markup Language (TML)

IEEE 1451

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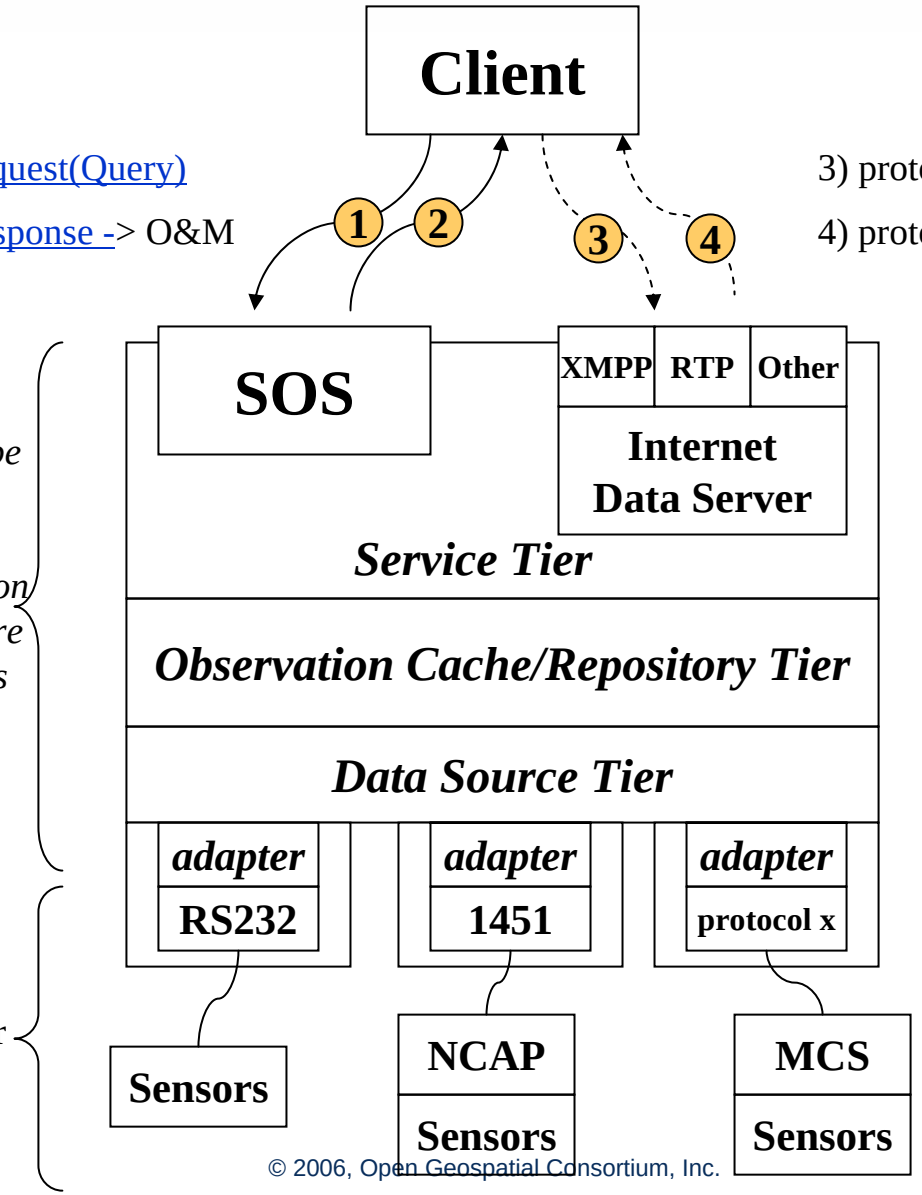
SOS Reference Model

1) http://GetObservationRequest(Query)

2) http://GetObservationResponse -> O&M

3) protocol://request (URI)

4) protocol://data (MIME, other)



Note: All or parts of the components shown here can be separately distributed on networks. Details of this distribution are implementation choices. Italicized elements are abstract and their realizations are opaque to client.

Sensor System Tier

Note: Steps 3 & 4, provisioned by an "Internet Data Server", are optional and only required if Observation returned in Step 2 is of type "ResultPointerObservation" (i.e., out-of-band result).

Note: An Internet Data Server makes different types of data available via a variety of protocols and data representations. Support for Internet standards are critical.

Note: MCS = Mission Control System (e.g., proprietary or legacy); NCAP = IEEE-1451 Network Capable Application Processor

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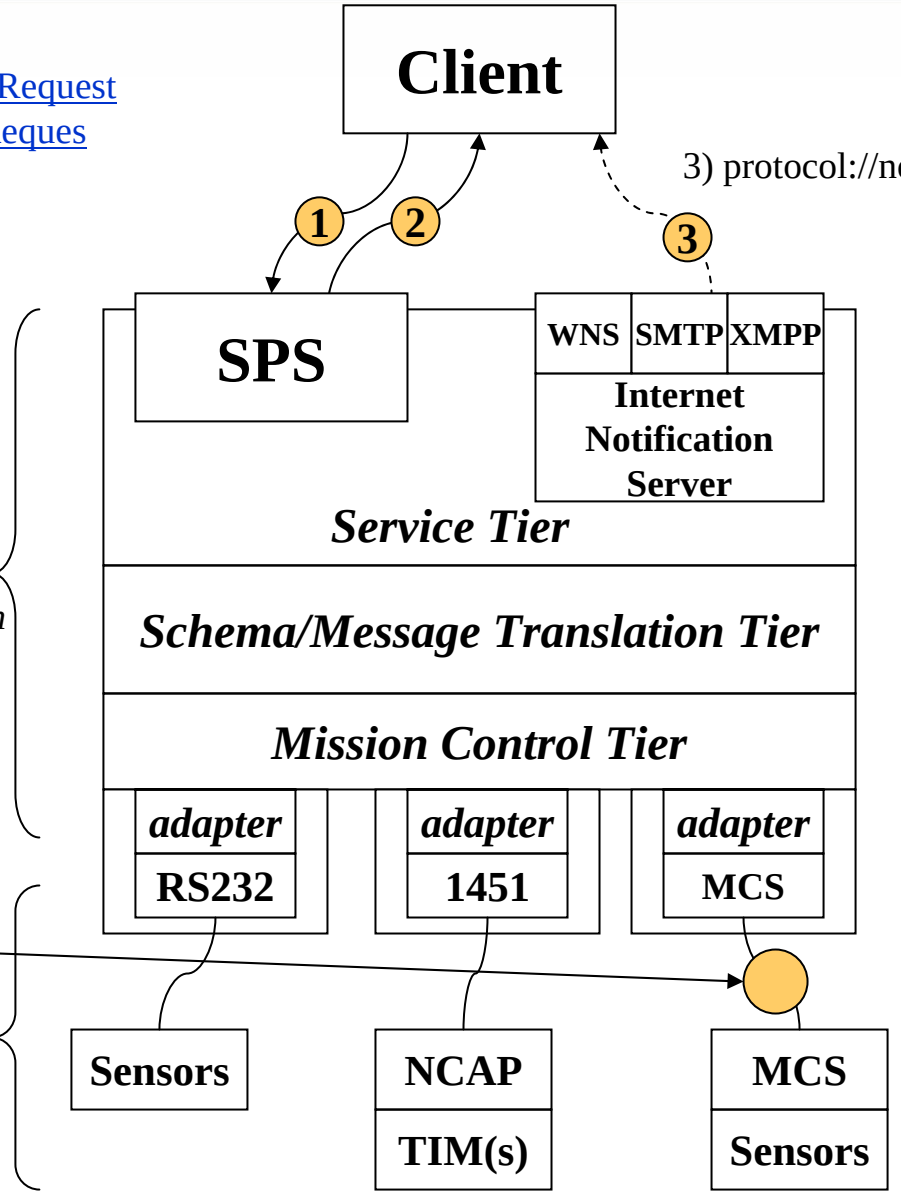
SPS Reference Model

1) http://GetFeasibilityRequest
http://DescribeCollectionReques
http://SubmitRequst
http://UpdateRequest
http://GetStatusRequest
http://CancelRequest
2) Request response

Note: All or parts of the components shown here can be separately distributed on networks. Details of this distribution are implementation choices. Italicized elements are abstract and their realizations are opaque to client.



3) protocol://notice (HTTP, SMTP, XMPP)

Note: Step 3, provisioned by an "Internet Notification Server", are optional (only if required).

Note: An Internet Nofication Server makes different types of data notifications via a variety of protocols and representations. Support for Internet standards are critical.

Sensor Collection Task Message (SCTM)

Sensor System Tier

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OWS-4
Sensor Web Enablement

OWS-4 Planning
Sponsor Meeting #2

1 March 2006

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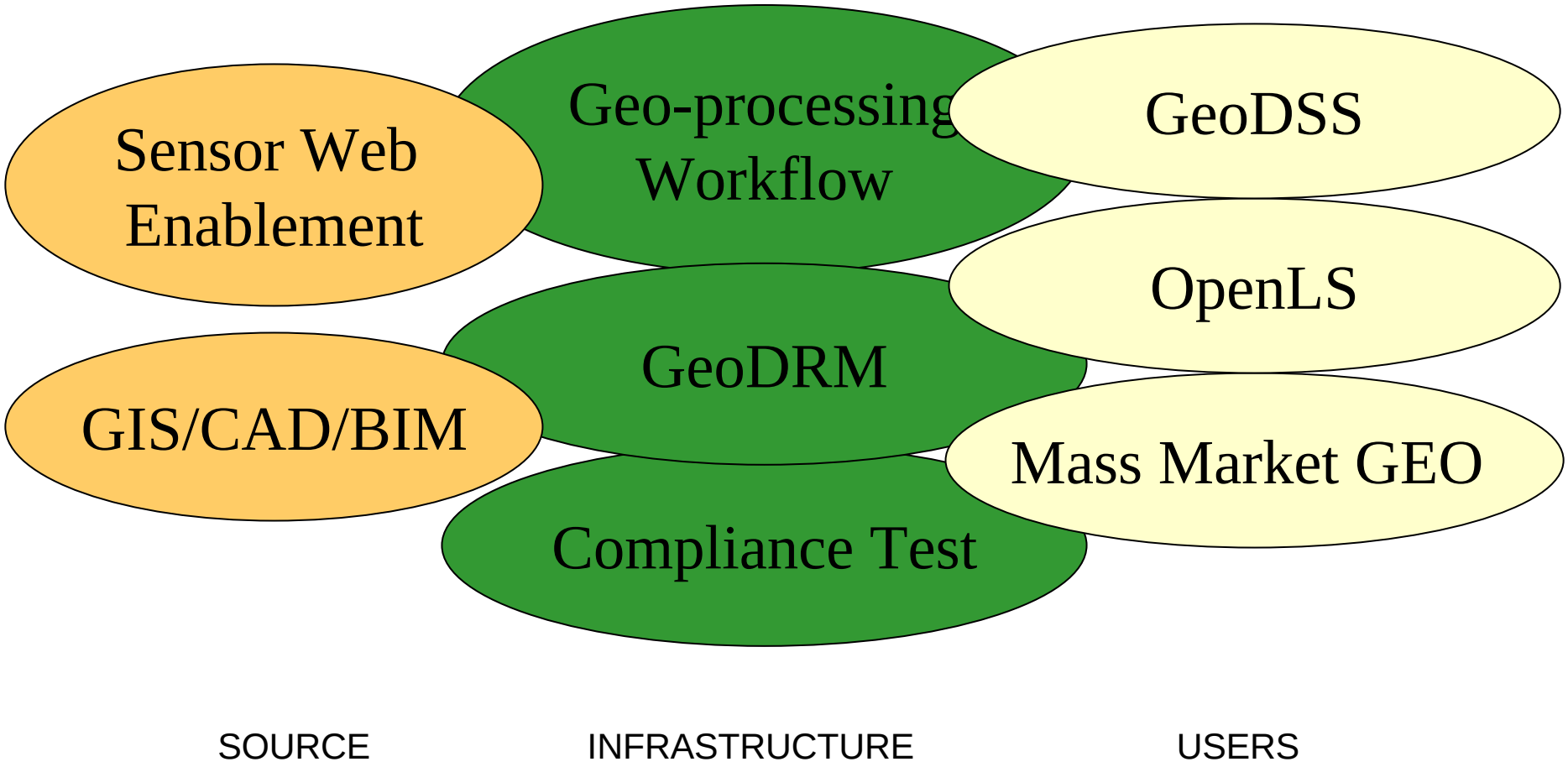
OWS-4 Potential Threads



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OWS-4 SWE - Concepts

- Shift major focus from design to development/implementation
  - Feed into Geoprocessing Workflow
  - Refine SWE architecture to clarify design tradeoffs
- SensorML and TransducerML profiles for sensors and applications
  - Specific sensor instances: Quality, uncertainty of derivations
  - Continue deriving/refining Catalog profiles for discovery in SWE
- Sensor Observation Service
  - Real-time, dynamic observations (non-caching, configurable)
  - Distributed Sensor Communication Networks (DSCN) for In-situ
- Sensor Planning Service
  - Role-based authentication and control (essential for many airborne systems)
  - Test ACTM in SPS (Prepare for field exercise in 2007)
- Alerts Harmonization (SAS, WNS, WFS, CAP/EDXL?)
- Sensor Standards Coordination
  - IEEE 1451, OASIS CAP and EDXL,
  - Program specific efforts
  - DHS, DoD, SEIWG,JPM Guardian, JPEO, etc.
  - European programs for in-situ networks
- Tie into Agency/Sponsor demonstration/exercises (NGA/DOD, DHS, NASA, USDA)

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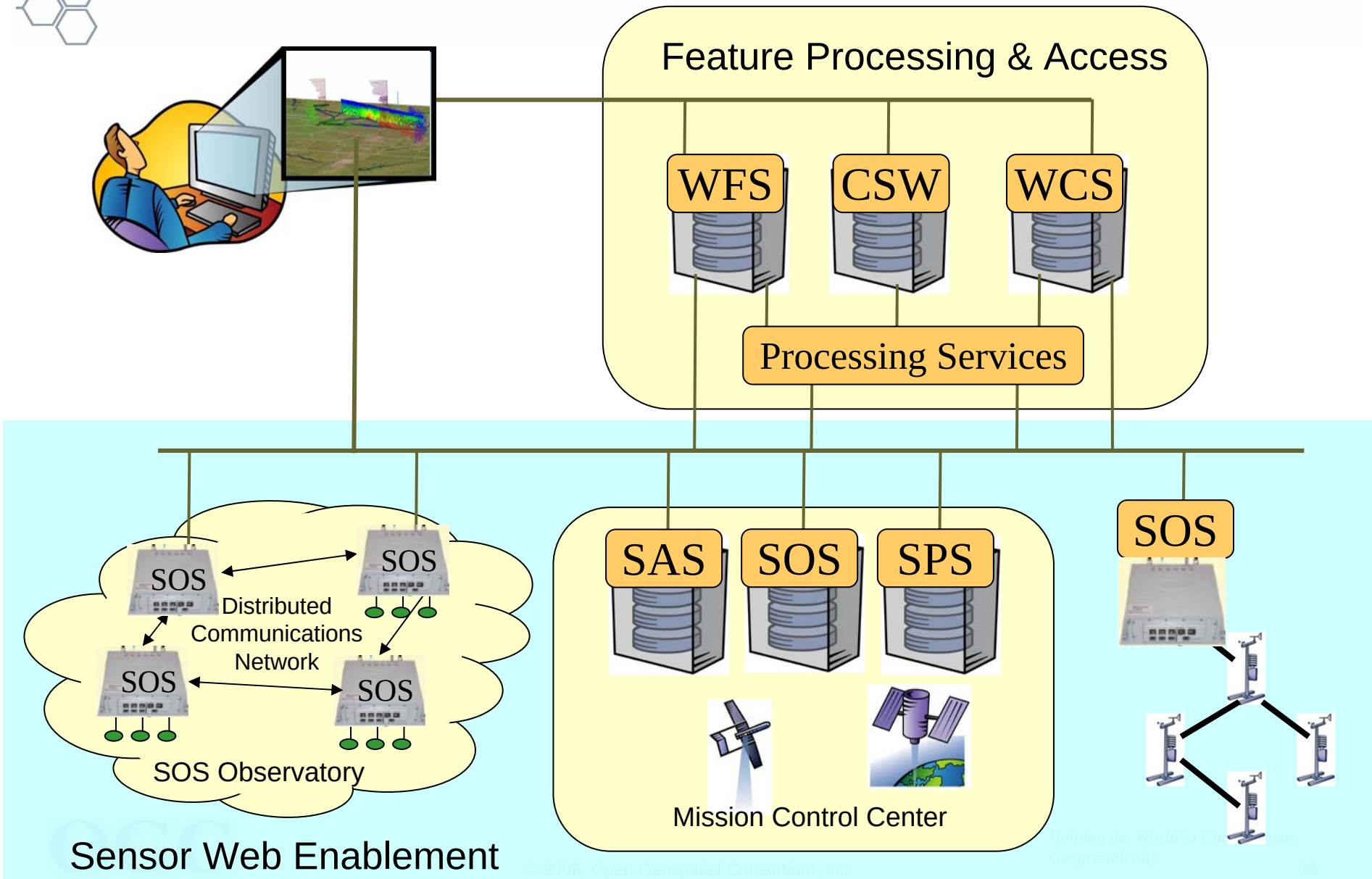
SWE and Geo-Processing Workflow



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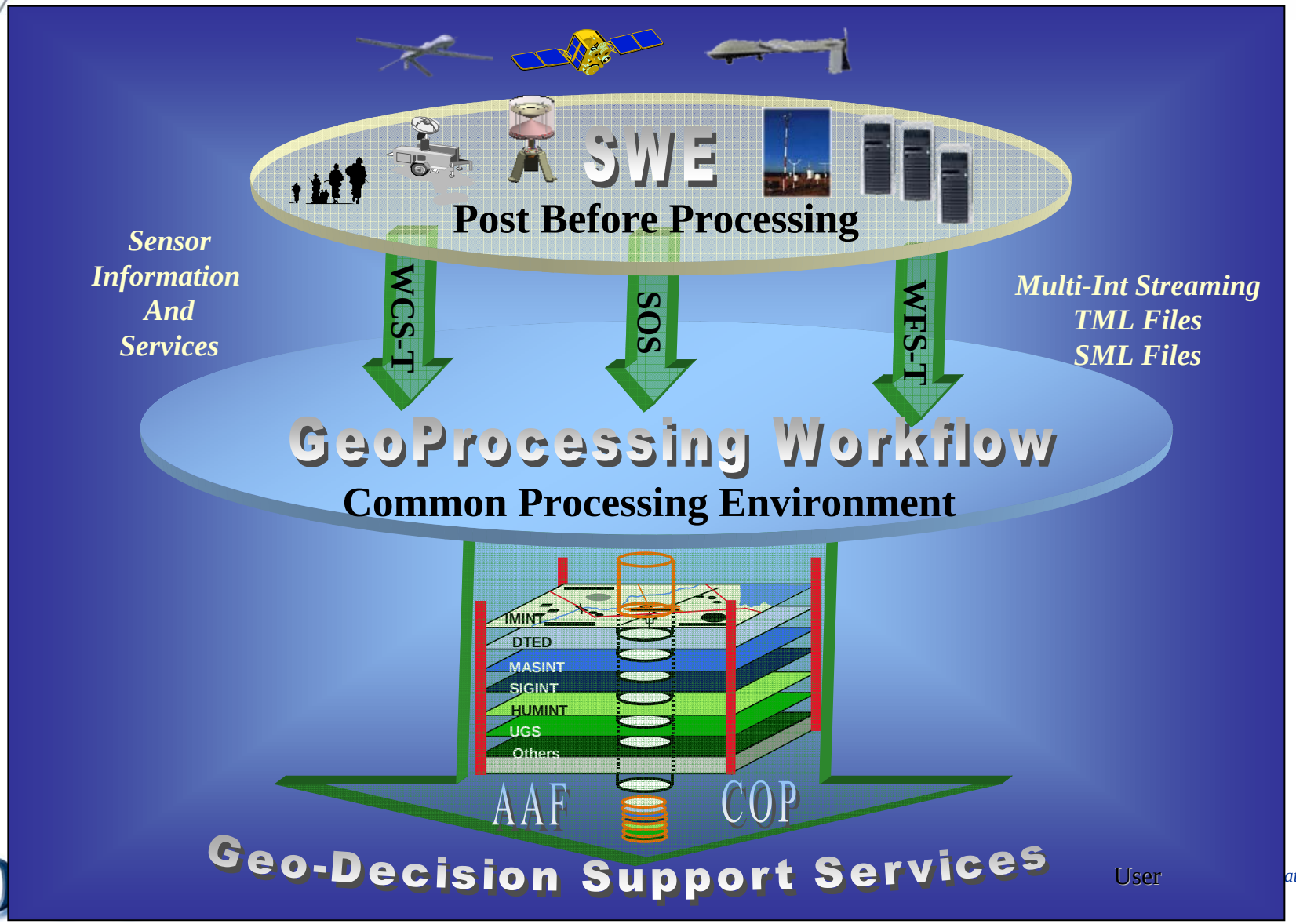
OWS-4 Data Flow



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