Request for Information (RFI)
on a
Common Operating Picture (COP)
for Oil Spill Response

RFI Issuance Date: 26 August 2013

Response Due Date: 30 October 2013

The Open Geospatial Consortium (OGC®)

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ABSTRACT

Responding to an oil spill requires access and understanding of many types of information. Effective, coordinated operations for the response are based on a shared, common picture of the situation. Interoperability provides shared situational awareness of the crisis and the response activities. What is needed is a common picture of reality for different organizations that have different views of the spill so that they all have to deal with it collectively.

Recent oil spills have provided lessons learned and recommendations on forming a Common Operating Picture for oil spill response. Through a joint process, industry is responding to the call, moving from recommendations to reusable best practices supported by open standards that can be deployed quickly in any region of the globe.

This Request for Information (RFI) is part of the OGP/IPIECA Joint Industry Process to produce a recommended practice for GIS/Mapping in support of Oil Spill response and for the use of GIS technology and geospatial information in forming a "Common Operating Picture" to support management of the response.

Readers of this RFI are encouraged to respond with your recommendations for procedures, technology and open standards that should be considered in a recommended practice for COP for oil spill response.

Responses to the RFI should describe technologies that your organization sees as feasible in a distributed information environment to respond to an oil spill. The responses will be discussed in two workshops. Results of the RFI responses and the workshops will be documented in a report that can serve as the basis for consensus adoption of an oil spill COP best practice.

Responses to the RFI are requested by 30 October 2013. This RFI includes instructions for how organizations can respond and how to get responses to any question about the RFI.

Interoperability seems to be at first a technical topic, but in fact, it is about organization. Interoperability seems to be about the integration of information. What it's really about is the coordination of organizational behavior. The Oil Spill Response COP project seeks to facilitate the coordination of organizational response to any oil spill in the future.

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1 Introduction

1.1 RFI purpose and scope

This Request for Information (RFI) is part of a process to assess the current state of standards and implementations that could support recommendations regarding a Common Operating Picture (COP) for use during an Oil Spill Response (OSR). Information contained in RFI Responses will be used as input to workshops that will in turn lead to forming a recommended practice.

OGC and Resource Data Inc. are supporting OGP and IPIECA to meet the objectives of the Oil Spill Response Joint Industry Project (OSR-JIP). This RFI is based on a process previously defined and used in the OGC Interoperability Program.

1.2 The organizations issuing this RFI

The International Association of Oil & Gas Producers (OGP)[1] is a unique global forum in which members identify and share best practices to achieve improvements in every aspect of health, safety, the environment, security, social responsibility, engineering and operations. OGP encompasses most of the world's leading publicly-traded, private and state-owned oil & gas companies, industry associations and major upstream service companies. OGP members produce more than half the world's oil and about one third of its gas.

IPIECA[2] is the global oil and gas industry association for environmental and social issues. IPIECA was formed in 1974 following the launch of the United Nations Environment Programme (UNEP). IPIECA is the only global association involving both the upstream and downstream oil and gas industry on environmental and social issues. IPIECA’s membership covers over half of the world’s oil production. IPIECA is the industry’s principal channel of communication with the United Nations. When IPIECA was set up in 1974 the acronym stood for the International Petroleum Industry Environmental Conservation Association. In 2009, recognising that this no longer accurately reflected the breadth and scope of the association’s work, IPIECA stopped using the full title. The association is now known as IPIECA, the global oil and gas industry association for environmental and social issues.

Resource Data, Inc.[3] (RDI) has been supporting the oil & gas industry with information technology for spill response since 1989. RDI brings unparalleled experience to oil spill response, leading the geographic information system (GIS) and database teams for the Exxon-Valdez spill and more recently the GIS response team in the Macondo/Deepwater Horizon spill. RDI has developed numerous spill response data systems, participated in multiple drills, and developed risk analysis systems for major pipeline networks. Our depth and breadth of expertise in spill preparedness and response uniquely positions RDI to assist in the development of a Common Operating Picture for the oil & gas industry.

The Open Geospatial Consortium (OGC)[4] is an international consortium of more than 480 companies, government agencies, research organizations, and universities participating in a consensus process to develop publicly available geospatial standards. OGC standards support interoperable solutions that "geo-enable" the Web, wireless and location-based services, and mainstream IT. OGC standards empower technology developers to make geospatial information and services accessible and useful with any application that needs to be geospatially enabled.

[1] http://www.ogp.org.uk/

[2] http://www.ipieca.org/

[3] http://www.resdat.com/

[4] http://www.opengeospatial.org/

2 Oil spill response joint industry project

The April 2010 Gulf of Mexico (Macondo/Deepwater Horizon) oil spill incident, and the Montara incident in Australia which preceded it, have had far-reaching consequences in prompting the re-examination by industry not only of operational aspects of offshore operations, but also of an operator's ability to respond in the event of an oil spill incident or well blowout.

In response to the foregoing, the International Association of Oil and Gas Producers (OGP) formed the Global Industry Response Group (GIRG), tasked with identifying learning opportunities both on causation and in respect of the response to the incident. Nineteen recommendations were identified and these are being addressed via a three-year Joint Industry Project (JIP) funded by oil industry members[5].

The Oil Spill Response JIP (OSR-JIP) initiated discreet projects or provides support to projects initiated by other trade associations in the nineteen subject areas resulting from the OGP GIRG-OSR project. The OSR-JIP is managed by IPIECA on behalf of OGP in recognition of its long-standing experience with Oil Spill Response matters.

The OSR JIP is composed of several Work Programs (WPs). WP5 - GIS/Mapping and Common Operating Picture is the relevant WP to this RFI. WP5 is to produce a recommended practice for GIS/Mapping in support of Oil Spill response and for the use of GIS technology and geo-information in forming a "Common Operating Picture" for management of the response. The WP5 is to identify:

- What data needs to be available?
- Where does it come from?
- What format should it be in, and to what spatial accuracy?
- How should it be delivered?

The outcomes of WP5 are to align with the Incident Command System (ICS) model.

WP5 is being conducted in close coordination with two other WPs: WP1 - In-Water Surveillance and WP2 – Surface Surveillance of Oil Spills.

3 Responding to this RFI

3.1 General terms and conditions

Responses to this RFI are due by the date listed in the Master Schedule. Responses will be distributed to members of the organizations listed in section 1.2. Submissions will remain in the control of this group and will used for the purposes identified in this RFI.

A summary of the RFI Responses may be made public. If your wish to submit proprietary information, contact (techdesk@opengeospatial.org) in advance of sending the response.

3.2 How to transmit a response

Send your response in electronic version to the OGC Technology Desk (techdesk@opengeospatial.org) by the submission deadline. Microsoft® Word format (Office Version 2003) is preferred, however, WordPerfect®, Rich Text Format, or Adobe Portable Document Format® (PDF) are acceptable.

You are welcome to contact the OGC Technology Office via telephone (+1 812 334 0601) to ensure receipt of your submission.

5 http://oilspillresponseproject.org/

3.3 RFI response outline

Your RFI response must follow the outline listed below. Your response should consider the questions listed as well as providing additional information your organization feels should be considered in establishing an OSR COP best practice

1. Overview and executive summary
   Provide a summary of the most important elements of your response.
2. Elaboration
   - 3.1 Definition of a COP for Oil Spill Response
     Does the COP definition in Section 4.2 match with your experience?
     Are the types of users of a COP adequately covered in Section 4.2?
     Do the scenarios of Section 4.2 illuminate the most important COP usage?
   - 3.2 Geospatial Information for OSR COP
     Does the information identified in Section 4.3 fully define a COP?
     Are you aware of established product specifications for the information in 4.3?
     What other symbol sets might be used in an OSR COP?
   - 3.3 Delivering information for OSR COP
3. Organization description
   Briefly describe your organization and experience relevant to OSR COP.

The Elaboration section should provide a summary of your highest priority comments and contributions. The elaboration should include identification of relevant technology and standards and where new standards might be needed.

Responses are not required to populate each Elaboration sub-section. If a response does not have content for a sub-section, just state "section blank in this response."

Any proprietary information must be contained in a separate document that is clearly marked as containing proprietary information.

Responses to the RFI will be used as input first to a set of workshops and second for consideration as elements in an OSR COP best practice based on open standards.

3.4 Questions and clarifications

Questions and requests for clarification should be sent to (techdesk@opengeospatial.org) **prior to the conference call**.

Questions received as well as clarifications from the RFI developers will be posted publicly at the Oil Spill COP web site: http://www.opengeospatial.org/projects/initiatives/ogpoilspill

An RFI Clarification Conference Call is scheduled for the date shown in the Master Schedule. To join the teleconference, use this link: https://www4.gotomeeting.com/join/286278975

For those who are unable to attend the call, we will post a summary of the questions and clarifications addressed during the conference call the day following.

3.5 Reimbursements

The organizations issuing this RFI will not reimburse submitters for any costs incurred in connection with preparing responses to this RFI.

3.6 Master schedule

The following table details the major events associated with this RFI:

Activity/Milestone	Date
RFI Issued	26 August 2013
RFI Clarification Conference Call	30 September 2013 – 11:00 am to Noon EDT
RFI Responses Due	30 October 2013 – 5:00 pm EDT
Workshop in Europe	December 2013 (To be confirmed)
Workshop in the US	January 2014 (To be confirmed)

4 OSR COP Initial Technical Description

4.1 Introduction

This section provides an initial technical description of a COP for Oil Spill Response. It is the purpose of this RFI to gain community comment on this technical description. The current content of this section should be taken as suggested topic areas or context for your response. Your response may agree or disagree with elements of this section. We want to hear all relevant comments.

This organization of this technical description is loosely based on ISO/IEC 10746, Information Technology — Open Distributed Processing — Reference Model. RM-ODP defines viewpoints that separate the various concerns when developing an information system architecture.

4.2 Enterprise view of oil spill response

4.2.1 Observations about Deepwater Horizon

Accurate, timely, and relevant information is vital to operational and strategic decision making. The Deepwater Horizon incident created an unprecedented need for information on a real-time basis. Barriers to synchronized, total domain awareness during the Deepwater Horizon incident included the:

- Lack of agreement on what data needed to be tracked and transmitted;
- Vast geography of the response area of operations;
- Lack of availability of appropriate interoperable communications technology;
- Limited ability to push real-time data, both vertically and laterally, throughout the response organization
- Different computing standards.

The incompatibility of proprietary databases and software used by the private sector appeared to be a hindrance to developing a universal COP for the response organization. Integrating data from multiple, restricted sources slowed the development of a complete and an accurate COP [ISPR][6].

The evolution of Deepwater Horizon knowledge management eventually provided for a strong COP, more effective communications throughout the response organization, and an efficient information flow that met the needs of both the response organization and senior officials.

Many of those interviewed specifically stated that the National Incident Management System/Incident Command System (ICS) worked as intended. Because NIMS/ICS is scalable, adaptive, and dynamic, responders were able to tailor the response organization according to need. The ISPR provides recommendations that serve to further enhance NIMS/ICS use in future spills [ISPR].

Based on lessons learned from the Deepwater Horizon oil spill response, a Notice To Lessees (NTL) was issued by the Bureau of Safety and Environmental Enforcement (BSEE) providing “Guidance to Owners and Operators of Offshore Facilities Seaward of the Coast Line Concerning Regional Oil Spill Response Plans” [NLT]. The NTL provides clarification, guidance, and information concerning the preparation and submittal of a regional Oil Spill Response Plan (OSRP).

The NTL encouraged lessees to specify primary and alternate communications technology and software for use when coordinating and directing spill-response operations and/or providing a common operating picture to all spill management and response personnel, including the Federal On-Scene Coordinator and participating Federal and State government officials [NLT].

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[6] Document references are show in [brackets] are listed in Section 5.

4.2.2 Definition of COP

4.2.2.1 Value of COP for Deepwater Horizon

As noted in the Deepwater Horizon Incident Specific Preparedness Review (ISPR):

> "The lack of a COP for the first 2 weeks of the Deepwater Horizon incident quickly became both a tactical issue for the response organization and a strategic issue at the national level. ERMA was eventually successful as the COP. However, the lack of a COP for information sharing and response messaging at the beginning of the Deepwater Horizon incident negatively impacted overall situational awareness and led to repeated questions about the transparency of the response organization." [ISPR]

A recommendation from the Deepwater Horizon ISPR:

> "The Coast Guard should build upon the successes achieved through the development of the COP systems used during the Deepwater Horizon incident. The Coast Guard should have a fully operational COP tool that will be available during drills, exercises, and actual events." [ISPR]

4.2.2.2 Candidate definition of OSR COP

This RFI seeks comments on the following candidate definition of a COP [NIMS]:

> "A common operating picture (COP) is established and maintained by the gathering, collating, synthesizing, and disseminating of incident information to all appropriate parties involved in an incident. Achieving a COP allows on−scene and off−scene personnel to have the same information about the incident, including the availability and location of resources, personnel, and the status of requests for assistance. Additionally, a COP offers an overview of an incident thereby providing incident information which enables the Incident Commander (IC), Unified Command (UC), and supporting agencies and organizations to make effective, consistent, and timely decisions. In order to maintain situational awareness, communications and incident information must be updated continually. Having a COP during an incident helps to ensure consistency for all emergency management/response personnel engaged in an incident."

Figure 1 provides a summary graphical perspective of a COP for responding to an oil spill.

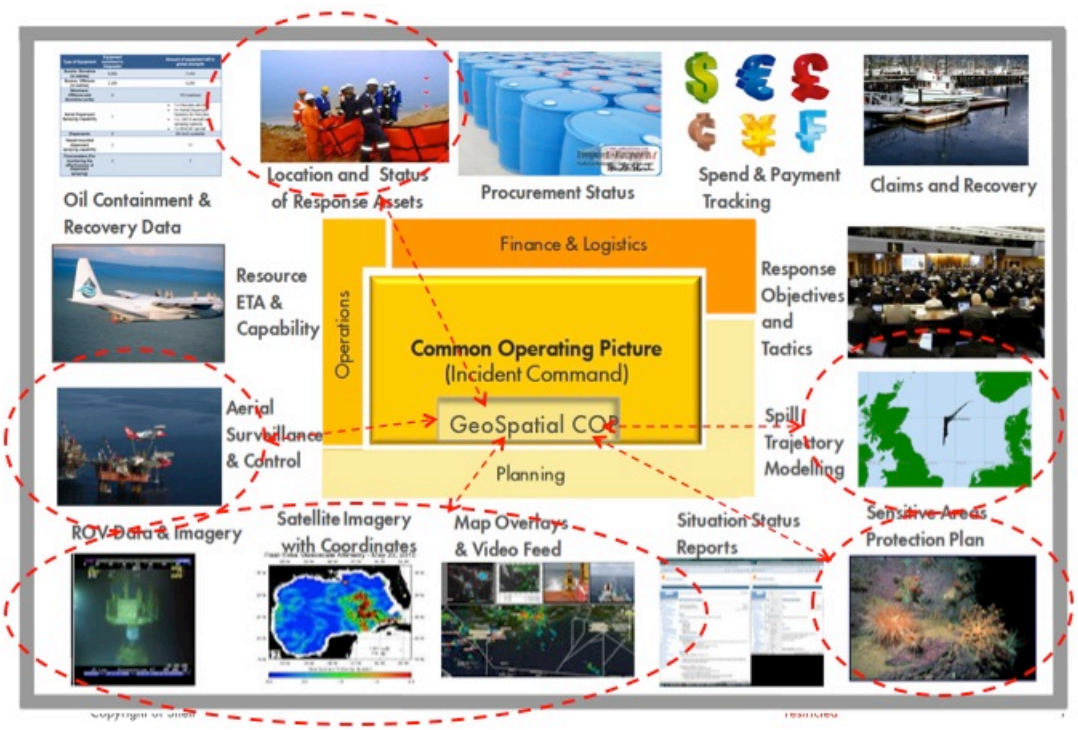

Figure 1. Common Operating Picture, highlighting geospatial information

In addition to the COP, an incident command will use other IT tools and systems to support processes such as equipment and services procurement, internal and external communications, asset management, spend and payments, claims and recovery, reporting and so forth. Such systems are commercially available now and are evolving in capability to include basic COP functionality. Integration of the COP with such systems is encouraged to facilitate information flow and simplify information management processes. However, the need to access high quality, reliable geospatial data from a variety of sources, including data that is proprietary to the oil company or its service providers, may necessitate that the COP is delivered and operated externally to these systems/tools. The interoperability standards that will form part of this guideline are designed to ensure that geospatial data can be integrated, whilst applying appropriate levels of data security.

4.2.3 Users of OSR COP

A COP is established and maintained by gathering, collating, synthesizing, and disseminating incident information to all appropriate parties. A COP potentially allows on-scene and off-scene personnel to have the same information about the incident, including the availability and location of resources and the status of assistance requests.

Below is a list of potential users of a COP, and while the intention is to provide the same basic information for all users, some specific types of information may be available to a limited set of users, managed through the assignment of access privileges.

- Incident Command Center
- Response teams
- Public
- Volunteers
- Vendors (and service providers)
    - Image and data providers
    - Survey services, i.e.,
- Government agencies: multi levels
- NGOs
- Oil Companies
- Industry associations

Establishing an Incident Command System (ICS) is a fundamental element of incident management in order to provide standardization through consistent terminology and established organizational structures [NIMS-ICS]. ICS is a widely applicable management system designed to enable effective, efficient incident management by integrating a combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure. ICS is a fundamental form of management established in a standard format, with the purpose of enabling incident managers to identify the key concerns associated with the incident—often under urgent conditions—without sacrificing attention to any component of the command system. It is understood that the ICS methodology is the industry's preferred approach to managing oil spill response incidents.

4.2.4 Scenarios for use of a COP

The COP will be used by virtually all of the sections of an oil spill response. Below are a few examples of how it is utilized. Within several of the major usage areas defined are Use Case examples, which describe how the COP provides value to the teams responding to an oil spill, with real life example scenarios.

4.2.4.1 Command Section Use

The COP is the primary tool for conducting the daily command briefings during a response. A properly designed and implemented COP will visually show real time or near real time information within the Area of Responsibility (AOR). This will allow command staff to make decisions based upon actual real information from the various sections of the response. The COP will be adapted to meet the particular needs of a response due to the physical environment and political environment. Information present should include any data sets the command wants to see, report on, and discuss. This may include:

- Satellite and aerial information
- ROV and AUV data and video feeds
- Real time vessel locations from Automatic Identification System (AIS) feeds
- Oil plume versus oil trajectory
- Digital geo-tagged photographs of cleanup operations
- Shoreline Cleanup and Assessment Technique (SCAT) data
- Dispersant use data
- Boom locations (planned and actual)
- Skimming data
- In-situ burn information
- Wildlife sightings (dead and alive)
- Anything else Command is interested in seeing

Command also uses the COP as a reporting/analyzing/dashboard tool set. Examples include:

- Percentage of shoreline oiled in a geographic area sorted by oiling density
- Percentage of shoreline cleaned in a geographic area
- Number of individuals working in a geographic area
- Total footage of boom deployed in an area
- Results of a sampling program
- Barrels of oil and oiled material collected in a specific geographic area

4.2.4.1.1 Command Section – Use Case Example

Use Case Name: The Public Information Officer (Command Staff)

Summary: Computer modeling supported by the morning overflight reveals that the oil spill will soon impact the shoreline. The Public Information Officer (PIO) is preparing to brief local media resources on the new situation and turn of events

Actors (Users Involved in This Scenario): The Public Information Officer, Local Media Resources

Preconditions: Maps are used to support talking points during the local media briefing

Description ("Sunny Day Scenario"):

- The PIO uses the digital COP to support the talking points while briefing Local Media Resources. The ability to pan, zoom, and query results in the map information being easily readable to all the audience
- During the Q&A session, the PIO uses the digital COP to support his/her answers; can pan, zoom, and query and focus on current topic of discussion
- A better operation picture is conveyed to the audience

Exceptions ("Rainy Day Scenario"):

- The PIO uses wall-mounted large-format paper maps to support talking points— ideal map scale versus area of coverage results in audience have difficulty seeing map information
- Paper maps leave the local media resources with an incomplete operation picture of the response, risking incorrect or incomplete information delivery to the public

Post conditions:

Use of the digital COP results in the *appearance* of a better informed response organization; a digital COP conveys a rich operational picture to the local media **OR** the Local Media is left to *inferring* facts because of the inherent limitations of paper maps.

4.2.4.2 Planning Section Use

The Planning Section of a response will use the COP to communicate planned activities out to other teams on the response. This may include planned in-Situ burns, planned boom deployments, planned skimming operations, planned beach cleaning methods, response areas on environmental hold, or fishing closures. The Planning Section also uses the COP to report on activities such as SCAT surveys, oil plume trajectory, results of an over flight survey, areas on environmental hold, wildlife hazing activities, wildlife deaths, sampling activities, and others. The COP provides an enhanced situational status map since information is real time or near real time and it doesn't become static like a paper map.

4.2.4.2.1 Planning Section – Use Case Example

Use Case Name: Situation Unit Lead (Planning Section)

Summary: Computer modeling supported by the morning overflight reveals that the oil spill will soon impact the shoreline. The Situation Unit Lead is preparing to give a situational update to the Unified Command during the Command and General Staff Meeting

Actors (Users Involved in This Scenario): Situation Unit Lead, Unified Command (UC)

Preconditions: Maps are used to support talking points during the briefing

Description ("Sunny Day Scenario"):

- The Situation Unit Lead uses the digital COP to support his talking points to the Unified Command
- In response to questions from the UC, the Situation Unit Lead can pan, query, and zoom to various response areas in the COP to support the answers

Exceptions ("Rainy Day Scenario"):

- The Situation Unit Lead uses large format paper maps hung on the wall to support his talking points to the UC
- Ideal map scale versus area of coverage *always* results in information being left off the map
- Multiple maps are needed
- Use of paper maps require time for preparation and printing
- Necessitates the use of paper resources

Post conditions:

- Use of a digital COP results in a better-informative Unified Command. The sharing of information is efficient and is support by reliable, up-to-date, spatial information **OR** use of paper maps may result in The Unified Command having an incomplete operational picture

4.2.4.3 Operations Section Use

Operations will use the COP to communicate planned activities to the actual field crews completing the tasks. The benefit of the COP is that it provides real time access location information on assets such as task forces, major vessels, and current and predicted weather information. Operations will also use the COP to communicate completed activities such as actual deployed boom, completed In-Situ burn operations, skimming locations and results, and others. Typically operations are fully photographed, and the resulting images are then immediately available for others in the response.

4.2.4.3.1 Operations Section – Use Case Example

Use Case Name: Operations Section Chief

Summary: Computer modeling supported by the morning overflight reveals that the oil spill will soon impact the shoreline. The Operation Section Chief is racing against time to have cleanup crews deployed before spill reaches the shoreline

Actors (Users Involved in This Scenario): Operations Section Chief, Branch Director for Shoreline Protection

Preconditions: Maps are used to support decision-making

Description ("Sunny Day Scenario"):

- A digital Common Operating Picture (COP) is available throughout the Incident Command Post
- An newly acquired remotely sensed image, included in the COP, is used for identifying best access points to the shoreline and possible staging areas by the Operations Section Chief and the Branch Director for Shoreline Protection

Exceptions ("Rainy Day Scenario"):

- A digital Common Operating Picture is not available
- Paper maps are used to identify access points and staging areas. A crew chief out in the field later reports that a new housing development impedes the designated staging areas and access points. Must now find other suitable locations, resulting in the loss of valuable response time

Post conditions:

- Decision making is efficient and is support by reliable, up-to-date, *shared* spatial information **OR** decision making is based on various sources of spatial information—some conflicting—which contributes to a slower, more inefficient response

4.2.4.4 Legal Team Use

The COP may be used in long-term litigation support. Typically legal teams start well after a response is underway, which means they need a way to visually see what happened during a response to come up to speed. The COP must provide all historical response data to fill this requirement. It must be designed to comply with legal hold orders, which means all data must be entered with date and time information. As this information is edited and deleted the underlying databases store all transaction information with each feature. This allows the legal team to go virtually back in time and see what operations and plans were in place on a particular day. Digital geotagged photographs are often in high demand by legal teams. A typical query is “show me all of the digital photographs on a certain date in a particular geographic area”.

4.3 Geospatial information in the OSR COP

4.3.1 Geospatial information

Geospatial Information is defined as information pertaining to the geographic location and characteristics of natural or constructed features and boundaries. It is often used to integrate assessments, situation reports, and incident notification into a common operating picture and as a data fusion and analysis tool to synthesize many kinds and sources of data and imagery [NIMS].

The use of geospatial information should be tied to consistent standards, as it has the potential to be misinterpreted, transposed incorrectly, or otherwise misapplied, causing inconspicuous yet serious errors. Standards covering geospatial information should also enable systems to be used in remote field locations or devastated areas where telecommunications may not be capable of handling large images or may be limited in terms of computing hardware. Such standards will include:

- Coordinate reference system
- Metadata (e.g. ISO 19115)
- Cartographic symbolization
- Scale of use, and accuracy
- Data structure and format

4.3.2 Considerations for COP geospatial information

Several important considerations should be noted in the review of potential geospatial information to be included in a COP. All of these considerations must be evaluated in the process of defining COP requirements.

4.3.2.1 Origin of Spill

An oil spill may originate at the wellhead, but could also originate from a pipeline, infrastructure (such as a refinery or terminal), or a vessel such as a tanker. As such, the generic COP must account for a variety of possible origin points.

4.3.2.2 Land-based vs. Marine

Existing COP implementations presume the occurrence of an oil spill in a marine environment. It is likely that this presumption is based on the potential for widespread damage from a spill occurring in a marine environment as opposed to a land-based spill. However, COP information requirements should properly account for the unique characteristics of both marine and land-based spills.

4.3.2.3 Arctic vs. Temperate, Desert or Tropical

Multiple unique challenges (and unique information requirements) are represented based upon the setting of a spill incident. Specifically, consider a spill occurrence in Arctic climate. In this setting, information that would be unnecessary in an incident occurring in temperate areas could become critical. Specifically, additional information relating to ice, operational safety considerations, and other elements would become both relevant and significant to the spill response effort in such a scenario.

4.3.2.4 Scope – Tiered Response

IPIECA defines a multi-tiered model for preparedness and response to an oil spill incident, as follows:

> "*Conventionally the concept has been considered as a function of size and location of a potential oil spill, with three tiers typically defined. Tier 1 spills are operational in nature occurring at or near an operator's own facilities, as a consequence of its own activities. The individual operator is expected to respond with their own resources. Tier 2 spills are most likely to extend outside the remit of the Tier 1 response area and possibly be larger in size, where additional resources are needed from a variety of potential sources and a broader range of stakeholders may be involved in the response. Tier 3 spills are those that, due to*

their scale and likelihood to cause major impacts, call for substantial further resources from a range of national and international sources." [IPECA V14]

This tiered model may provide a valuable framework for the definition of requisite, important and desirable geospatial information sets to be included in a COP. For example in a Tier 3 spill, the scope of information requirements is likely to be much greater than the information necessary in a spill of smaller magnitude.

4.3.2.5 Private (Operator sensitive) vs. Public

The organization and security applied to geospatial information within the COP should clearly delineate between information sets that are accessible to the Operator and its direct constituents, as opposed to information that may be published for external (public) use.

4.3.2.6 Spill Location

The availability of geospatial information may be heavily dependent on the location of an oil spill incident. For example, in North America, a wide array of government, commercial and environmental organizations may provide reference and/or operational information. In other geographies, it may not be possible to obtain the same wide array of information from these organizations.

4.3.3 Organization of geospatial information

4.3.3.1 Categories of geospatial information

For clarity in the ongoing management and maintenance of geospatial-related information, the proposed COP implementation distinguishes two distinct sets of information, including:

- Base map and reference information: this information typically exists in some form prior to the occurrence of a spill incident, and may be gathered and updated routinely as newer information becomes available. Base map and reference information may not be pertinent to a specific incident.
- Incident-specific information: this includes all of the relevant information that is generated following a spill incident, and pertains specifically to that incident.

Examples are provided for each category of information.

4.3.3.2 Maps and cartographic symbols

In order to present the geospatial information to the end users in a coherent fashion, a series of map templates will be required providing selected sets of information for specific purposes. Examples (based on proposals kindly provided by ESRI) are:

- Facility Map: providing a recognized view of the operating facility/control center and surrounding area within the drill/incident
- Resource Allocation Map: for identification of resources needed / available / at risk within an incident.
- Incident Map: a high-level view of the incident, intended for the general public or others who need a broad overview.
- Situation Map: is more detailed than the Incident Map; it is intended to for real-time vessels, weather, and currents as well as regularly updated over-flight data.
- Tactical Planning Map: is the most detailed of the set – and addition to the geospatial information in the Situation Map, it will identify risks and threats within the area of interest.

Such map templates should be available as a display within the COP (See Section 4.4.2.1) and available as large-format printed wall maps (See Section 4.4.5.2).

Cartographic symbols used in web maps and printed maps should make use of community and international standards, examples of which include:

- ICS map symbology [Deal]
- Environmental Sensitivity Index mapping standards [IPIECA-477]
- The Shell Standard Legend (oil and gas cartographic symbols)
- OGP Seabed Survey Model (http://info.ogp.org.uk/geomatics)
- UK Government- Civil Protection Common Map Symbology (https://www.gov.uk/government/publications/emergency-responder-interoperability-common-map-symbols)

There is a recognized need to establish or adopt cartographic symbology standards to support the COP.

4.3.4 Base map and reference information

Base Map and reference information includes the following data sets:

4.3.4.1 Background

Background data contains the information (data sets) utilized to present a base map. A base map is generally a non-editable data set that provides background information pertinent to the geographic area of interest. It is typically designed to provide a visual reference for other information to help orient the user(s) of the map. Base map background information may be provided by any of the following source data sets:

- Google Maps
  - Hybrid
  - Streets
  - Physical
  - Satellite
- Bing Maps
- Open Street Maps
  - Local
  - General
- Aerial Photography
- Satellite Images

4.3.4.2 Administrative Boundaries & References Information

Administrative Boundaries and References Information provide contextual overlays to the base map background. Among the information that may be included in this section are the following information sets:

- Geopolitical Boundaries (states or provinces, counties or parishes, tribal lands, congressional or other governmental districts),
- Governmental Agency Regions & Offices
- Place Names & References (special geographic features, GNIS),
- Marine Jurisdictions including the following:
  - Exclusive Economic Zones
  - Country or State/Province Waters
  - Unique marine protected areas

4.3.4.2.1 Geopolitical Boundaries

Any and all administrative entities representing country, state/province, county and city (or similar geopolitical boundaries) within the region(s) of interest should be represented in this set of information. This information may be obtained from sources ranging from the United Nations Second Administrative Level Boundaries database [SALB], to city data contained in the Global Administrative Areas (GADM) information sets.

4.3.4.2.2 Government Agency Regions & Offices

Administrative boundaries for governmental agencies may also be included in reference information. Some possible examples of this information include the following:

- Environmental department boundaries
- Coastguard AORs [areas of responsibility]
- National Park Service Boundaries
- Port jurisdiction zones
- Coastal Wetlands
- Wildlife Refuges or managed areas

4.3.4.2.3 Marine Jurisdictions

Marine jurisdictions encompass the collection of marine boundaries and limits used to delimit the extent of a nation's sovereignty, exclusive rights, jurisdiction, and control over the maritime areas off its coast. Examples include the following:

- Marine Jurisdictions
- Continental Shelf Boundary
- US Maritime Zones/Boundaries

4.3.4.3 Bathymetry & Hydrography

Key to any marine-based oil spill, bathymetry information provides reference material containing measurements of water depth (or depths of other major bodies of water) relative to a specific vertical datum. A wide range of bathymetry information is available from multiple sources and different formats, including national hydrographic services or re-sellers of digital chart data, port services, and other suppliers.

In addition, oil company operators will normally have detailed bathymetry measurements of their operating areas obtained from vessel-based geophysical and hydrographic surveys. This will almost certainly be available in the vicinity of any oil spill incident.

Bathymetry data may be delivered in different data structures such as raster images (scanned charts), as digital terrain models, or as data points (soundings) and vectors (contours or isobaths). The most accurate/reliable information shall be used, from the best available source and suitable for the scale of use.

In addition, this section may include Shoreline information sets, representing the most recent available data to depict shoreline boundaries, including both seaside and inland (estuary) borders.

The Seabed Survey Data model is an industry standard being promoted for the delivery of bathymetry and other seabed data.

4.3.4.4 Topography

Topographic information (height above a vertical datum) may also be required for coastal regions impacted by the spill, and may be available from local topographic maps, digital terrain models or from aerial surveys, or from site-specific oil company surveys.

4.3.4.5 Imagery & Remote Sensing

Surveillance products ,are important geospatial information that will be used during an oil spill event, both to provide eye-in the sky overview imagery of impacted areas and to quantify spill areas. The data is collected as satellite remote sensing imagery, airborne-based aerial photographs, as well as from in-water and surface deployed sensors and platforms. Remote sensing imagery may also be obtained from sensors deployed on land, vessels or offshore structures, or from tethered balloons (Aerostats).

Accurate geo-referencing of such imagery to a common coordinate reference system is essential. In addition aerial photographs may need to be orthorectified (the orthorectification process adjusts images to correct for terrain displacement and camera tilt).

The OSR JIP Work Program1 (In-Water Surveillance) will provide a detailed overview of the types of in-water and surface deployed platforms and sensors and the geospatial information available and their use in detecting and monitoring of marine oil spills.

The OSR JIP Work Program 2 (Surface Surveillance) will provide a detailed overview of the types of remote sensing geospatial information available and their use in detecting and monitoring of marine oil spills.

The COP will need to have the capability to handle and display any type of remote sensing imagery providing clear metadata to describe its source/origin, temporal characteristics, and so forth.

4.3.4.6 Natural Resources, Habitats, & Managed Areas

Natural Resources, Habitats & Managed Areas provide a wide range of information about habitat areas for wildlife in the area of interest, as well as areas defined as environmentally sensitive or protected.

In each sub-section of this category, multiple subcategories may be required to organize the extensive array of wildlife and natural resource data.

Within each of the Habitat Areas, the subcategories for different species of wildlife and vegetation may be further detailed. Typically this information includes such examples as nesting, breeding and migration pattern data for the respective wildlife species, and coverage of submerged and shoreline vegetation.

A few specific examples of the information sets in this hierarchy are the following:

- Sediments
- Deep Sea Corals
- Benthic Habitats
- Artificial Reefs
- Cold-Water Coral Habitats

4.3.4.6.1 Critical Habitat and Essential Fish Areas

Critical Habitat information may be required in a geographic region containing threatened and endangered species as designated by the country or state/province laws. In addition, Essential Fish Habitat information may be required in a geographic region including aquatic habitat for managed species where fish spawn, breed, feed, or grow into maturity.

4.3.4.6.2 Environmentally Sensitive Index (ESI)

Environmental Sensitivity Index (ESI) maps provide summary information pertaining to coastal resources that are at risk in the event of an oil spill. At-risk resources may include biological resources (such as birds and shellfish beds), sensitive shorelines (such as marshes and tidal flats), and human-use resources (such as public beaches and parks).

The potential exists for such mapping to be available in all areas where oil & gas exploration production takes place and for it to be maintained at a regular frequency (say 5 yearly updates). However it is recognized that this would be a significant undertaking and would require a coordinated industry approach.

In response to an oil spill, ESI maps can help responders by reducing the environmental consequences of the spill and the cleanup efforts. Additionally, ESI maps can be used by planners to identify vulnerable locations, establish protection priorities, and define cleanup strategies.

Some examples of specific information gathered for ESI analysis include the following:

- Bird Habitat,
- Breakwaters,
- ESI Index,
- Fish Habitat,
- Hydrological Classification
- Invertebrate Habitat,
- Management Areas,
- Marine Mammal Habitat,
- Reptile Habitat,
- Socioeconomic (line),
- Socioeconomic (point),
- Shoreline Classification (line),
- Shoreline Classification (poly),
- Terrestrial Mammal Habitat,
- Vegetation,

Environmental Sensitivity Index (ESI) maps should utilize the standard symbology defined by IPIECA [IIECA-477]. The symbol library for ESI maps is presented in Figure 2 - Symbols for the Mapping of Sensitive Biological Resources.

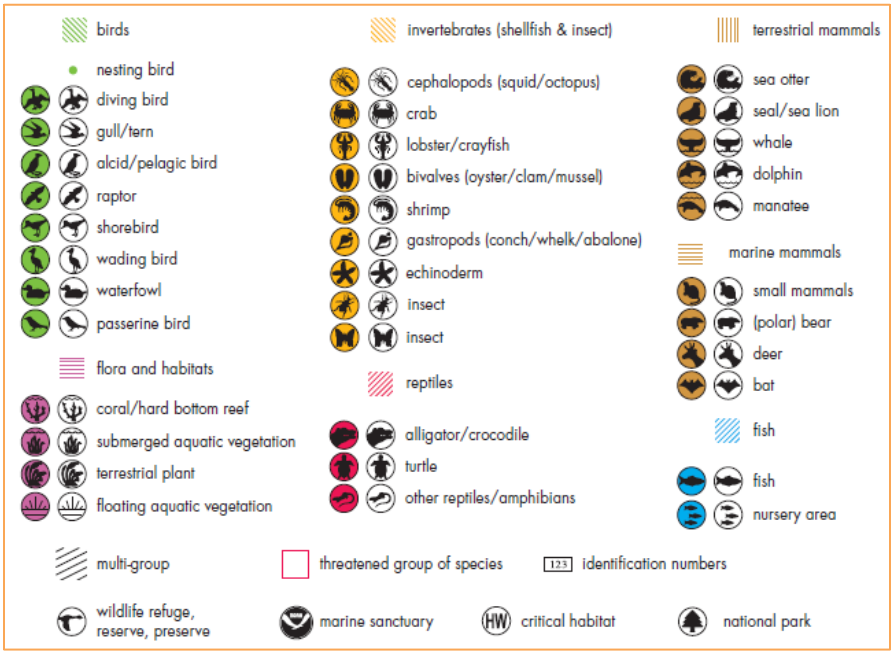

Figure 2. Symbols for the Mapping of Sensitive Biological Resources

4.3.4.6.2.1 Shoreline Classification

Shoreline classification typically incorporates the use of the Environmental Sensitivity Index (ESI), which can be adapted for each country. The ESI, ranging from 1 (low sensitivity) to 10 (very high sensitivity), considers the following attributes:

- Shoreline type (including grain size and slope) which evaluates the capacity of oil penetration, movement and/or burial on the shore
- Exposure to tidal energy (waves) which ascertains the natural persistence time of oil on the shoreline
- General biological productivity and sensitivity

A standardized color-coding methodology for shoreline classification should be implemented, based upon OGP Report Number 477, “Sensitivity Mapping for Oil Spill Response”. This color-coding methodology is presented below in Figure 3, Color Code of Environmentally Sensitive Index.

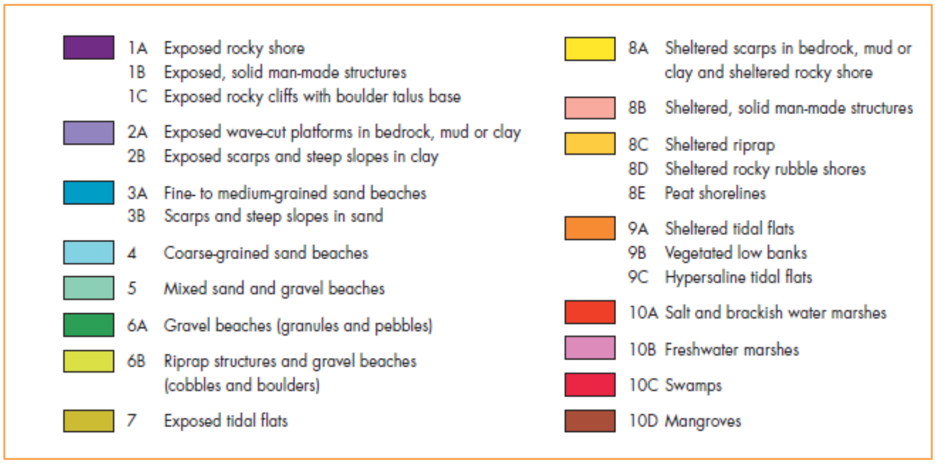

Figure 3. Color Code of Environmentally Sensitive Index

4.3.4.6.2.2 Socioeconomic Data (ESI)

This information includes human-use resource data for airports, archaeological and historic sites, beaches, boat ramps, state borders, bridges, and marinas for a given region, such as a state. Location-specific type and source information are typically stored in relational data tables designed to be used in conjunction with this information.

In mapping socioeconomic information, the objective is not to identify all places of business and activity in a comprehensive fashion, but to locate the activities and the areas which have the potential to suffer the greatest impact in the event of a spill incident.

Environmental Sensitivity Index (ESI) maps should utilize the standard symbology defined by IPIECA[10] for relevant socioeconomic sites. The symbol library for socioeconomic sites of interest is presented in Figure 4, Symbols for the Mapping of Sensitive Human Use and Activities.

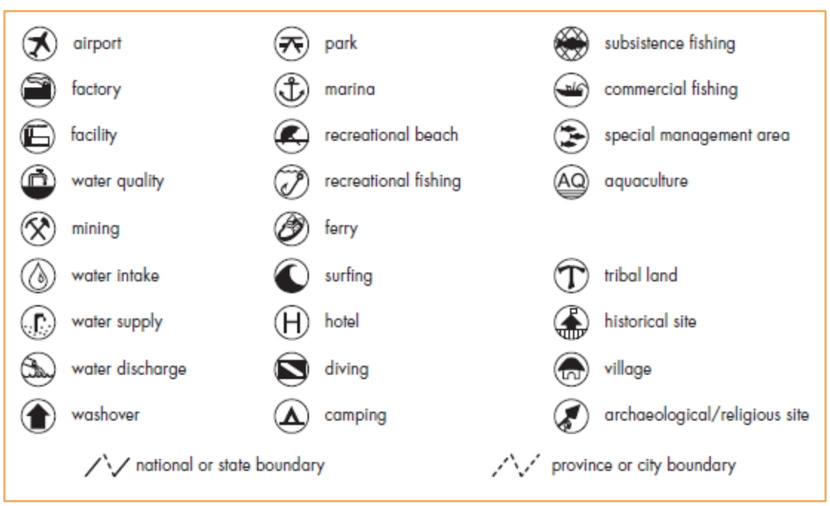

Figure 4. Symbols for the Mapping of Sensitive Human Use and Activities

4.3.4.7 Navigation & Marine Infrastructure

Navigation & Marine Infrastructure layers include information such as:

- Electronic navigation charts
- Vessel traffic zones and shipping lanes

- Vessel tracking feeds (typically updated on a continuous basis)
- Marine infrastructure including (but not limited to)
  - Ports
  - Ferries
  - Marinas
  - Boat launches
  - Aids to navigation

Some examples of actual Navigation and Marine Infrastructure information include the following:

- Maritime Collision Regulation Lines f
- Anchorage Areas
- Shipping Lanes
- Precautionary Areas for Navigation
- Restricted Areas
- Dredge Disposal Areas
- Wrecks, debris and archaeology sites

4.3.4.8 Public Safety & Terrestrial Infrastructure

Public Safety & Infrastructure information include public safety data such as:

- Critical infrastructure
  - Hospitals
  - Police stations
  - Water intakes
  - Fire stations
  - Power generation facilities
    - Power lines and substations
- Transportation infrastructure
  - Roads
  - Bridges
  - Railways
  - Airports

4.3.4.9 Oil and Gas Infrastructure

- Oil and Gas infrastructure including, but not limited to:
  - Wells
  - Offshore Pipelines
  - Subsea facilities and flowlines/umbilicals
  - Platforms, FPSO's and drilling rigs
  - Onshore oil and Gas transmission lines
- Normally such information will be provided by the Oil and Gas operator on the basis of accurate as-built surveys obtained after construction activities or as a result of routine maintenance operations.

4.3.4.10 Response Planning

Response Planning information include hazard response planning details, including both natural hazards such as severe storms and floods, as well as man-made hazards such as oil and chemical spills.

A section for natural hazard response planning should include the following data sets:

- Severe weather response plans, such as:
  - Evacuation routes
  - Contra-flow routes
  - Flood control maps

The Oil and Chemical Spills subsection includes Area Contingency Planning data including, but not limited to:

- Sensitive Sites
- Geographic Response Plans
- Shoreline Response Strategies
- Divisions and Segments

In addition to the above information, this subsection may contain additional data for government environmental agency facilities, response plans, and risk management plans.

4.3.4.11 Restoration

This information represents spatial locations and other details related to coastal and marine habitat restoration projects implemented historically, and is not related to current spill incidents.

4.3.4.12 Weather, Oceanography & Natural Hazards

This category covers a wide range of information including, but not limited to the following information sets:

- Real-time data feeds and forecasts for weather
    - Precipitation forecasts
- Oceanographic conditions
- Natural hazards such as earthquakes, tsunamis, and hurricanes
- Buoys & Gliders
- Radar
- Sea surface temperature
- Current and predicted wave heights
- Current and predicted wind velocities
- Tides
- Water levels
- High frequency (HF) radar

4.3.5 Drill and incident specific information

Drill and Incident Specific information may be logically grouped in a hierarchy containing the following primary categories:

1. **Abstract, Spill Summary & Reporting**
    a) Incident Abstract
    b) Wellhead Surface Location (or alternate spill origin details)
    c) Wreckage Details
    d) Summary Reports & Findings
2. **Damage Assessment**
    a) Imagery and Remote Sensing
    b) Damage assessment organization data
    c) Overflight Observations
    d) Trajectories & Extents
    e) Wildlife Observations
3. **Oil Spill Response Operations**
    a) Areas of Operation
    b) Operations Implementation
    c) Response Sampling & Monitoring
    d) Closures (Fisheries, etc.)
4. **Operator Services & Support**
    a) Community Support

For legal purposes, all information collected in the Drill & Incident Specific hierarchy should be retained and archived, and changes to information in this hierarchy should be properly journalized (track changes), to allow post-incident review and timeline analysis. Refer also to Paragraph 4.4.6.

4.3.5.1 Abstract, Spill Summary & Reporting

In a generic COP, this portion of the Incidents & Drills hierarchy would contain the basic details of the incident or drill, including the following information:

4.3.5.1.1 Incident Abstract

A high-level summary of the incident, including basic attributes such as the Operator, Rig, Well(s), Origin Country/location, and an initial assessment of the scope based upon the IPIECA multi-tiered model [IPECA-V14].

The Incident Abstract should also take into account the possibility of a spill originating from a ruptured pipeline, as opposed to a spill originating from a well.

4.3.5.1.2 Wellhead Surface Location (or alternate spill origin details)

In a spill incident originating from a well, the specific details of the wellhead location are critical to both the damage assessment and operational response activities to follow. If multiple wellheads exist, the location of adjacent wellheads should also be detailed, with information about the location, purpose, function and current operating status of adjacent wellheads included. This section should accommodate details for other spill origins as noted above, such as pipelines, infrastructure, or vessels.

Such information will be supplied by the oil and gas operator.

4.3.5.1.3 Wreckage Details

In a spill incident originating from a marine-based well in which rig wreckage occurs, the details of the wreckage must be captured to mitigate the risk of possible damage to marine-based operations in the vicinity of the wreckage, if such wreckage exists. As noted above, this section should accommodate details for other spill origins as well.

4.3.5.1.4 Summary Reports & Findings

Summary reports and release information updating the status of the spill incident would be presented in this section of the hierarchy.

4.3.5.2 Damage Assessment

In a generic COP, this portion of the Incidents & Drills hierarchy would contain all of the subcategories relating to assessments, evaluations and observations of the damage resulting from an oil spill. These subcategories are further defined below.

4.3.5.2.1 Imagery and Remote Sensing

This subcategory includes imagery and remote sensing of the actual spill incident, and impact area of the spill. The data comes form in-water and surface deployed platforms and sensors as well as aerial and satellite platforms. OSR JIP Work Program1 (In-Water Surveillance) provides guidelines for in-water and surface deployed platforms and sensors and their use in detecting and monitoring of marine oil spills. OSR JIP Work Program 2 (Surface Surveillance) provides detailed guidelines about the use of remote sensing techniques for surface surveillance of oil spills.

Aerial observation is typically the primary element of effective response to marine oil spills. It is used to assess the location and extent of oil contamination, and to confirm predictions of the movement and outcome of marine oil spills. Aerial observation provides information that aids in the planning of operations at sea, the timely protection of locations along the threatened shorelines as well as the preparation of resources for the cleanup of affected coastline. Dedicated remote sensing aircraft frequently have built-in downward looking cameras to accurately geocode photographs of an impact area.

Aerial observations typically utilize the ITOPF (International Tanker Owners Pollution Federation) [ITOPF] estimation of the quantity of oil spilled or Bonn Agreement Oil Appearance Code [Bonn] to evaluate the appearance of oil slick areas identified in the observation process.

In addition to aerial observations, radar and satellite imagery should be used to understand the speed and directional patterns of a spill for the prediction of future movement of the spilled contaminants.

For ease of incorporating data interpreted from remote sensed imagery into the COP, avoiding the need for manual digitizing or re-formatting, industry standards for acquiring and encoding the data are sought.

4.3.5.2.2 Damage assessment organization Information

This portion of the hierarchy includes workgroup analysis and study information typically included in the preliminary assessment and restoration planning for injured natural resources, and lost use of public properties. Among the typical assessments included in these information sets are the following:

- Sample stations: identification of sampling locations, purpose of sampling and attributes relating to the obtained sample materials
- Cumulative oiling: measures of potential cumulative surface oil exposure in the vicinity of a spill
- Sediment chemistry: location and chemical attribute analysis of sediments obtained from various sampling locations
- Oil chemistry: location and chemical attribute analysis of spilled oil obtained from various sampling locations
- Tissue chemistry: location and chemical attribute analysis of organic tissue obtained from various sampling locations
- Water chemistry: location and chemical attribute analysis of water obtained from various sampling locations
- General Environmental Quality: includes additional sampling and analysis information for specific conditions, such as establishing baseline conditions in water chemistry, bottom sediments, and aquatic invertebrates prior to landfall of the oil spill

4.3.5.2.3 Overflight Observations

When an oil spill occurs, information collected from helicopter or plane flights over the spill area helps responders assess the extent of the spill. The location of the oil, along with detailed observations about its appearance, is recorded onto an overflight map. Photos taken during the overflight may subsequently be associated to the overflight map, based on coordinates obtained at the time the photo is taken.

Overflight paths, information and photos are another important resource for operations planning in an oil spill incident.

4.3.5.2.4 Trajectories & Extents

Trajectories & Extents present snapshots of the directional flow/movement, concentration and range of the spill, for the purpose of planning spill response efforts. Trajectories should provide information to perform the following post-spill analyses:

- Oiling Analysis – evaluation of how a given location would be affected by the flow or movement of spilled oil based on current trajectories
- Response Time Analysis – evaluation of where and when response actions must be taken to mitigate the impact of possible oil arrival
- Shoreline Impact Analysis – evaluation of what shoreline areas are likely to be affected based on the spill trajectory

Oil spill trajectory information is normally obtained from specialized modeling software either operated by a regulatory body, the oil and gas operator, or by an independent specialist organization. Industry standards for encoding the trajectory information for ease of incorporation in the COP are sought,

4.3.5.2.5 Wildlife Observations

This portion of the Damage Assessment category allows for the tracking of specific wildlife groups that may be impacted by a spill incident. Several examples of wildlife observations include the following:

- Bird observations: includes information pertinent to the date and location of the observation, oiling characteristics, condition of the animal(s), count of animals observed at the location, species and observation details
- Reptile observations: Examples include sea turtles and other amphibious reptiles
- Marine mammal observations: Typically reported as marine mammal strandings, where stranding is defined as a dead or debilitated animal that washes ashore or is found in the water

4.3.5.3 Oil Spill Response Operations

In a generic COP, this portion of the Incidents & Drills hierarchy would contain all of the subcategories relating to response operations related to the oil spill. These subcategories are further defined below.

4.3.5.3.1 Areas of Operation

This portion of the Response Operations subcategory includes the areas of operation as defined by the response organization. Areas of operation would include (at a minimum) the following information sets:

- Access Points: identification of physical shoreline locations providing access for various forms of operational response equipment and personnel
- Base Locations: identification of the Tier 1 (small bases typically used to store equipment such as boom and skimmers), Tier 2 (designed for larger equipment levels, and typically accommodating increased personnel), and Tier 3 (intended to deal with large incidents where the equipment and supplies are managed by a group of commercial and/or governmental organizations)
- Command Locations: identification of the locations designated by the response organization as primary, division and branch operational sites
- Decontamination sites: locations designated by the operations organization for decontamination of equipment and materials (such as retrieved boom) used in the spill response
- Shoreline divisions: designating areas of operation for Shoreline Cleanup and Assessment Technique (SCAT) surveys and related response activities
- Staging areas: locations designated by the operations organization for staging of response equipment and personnel

4.3.5.3.2 Operations Implementation

This portion of the COP information hierarchy covers all aspects of operations related activities that are initiated to mitigate the impact of the oil spill.

4.3.5.3.2.1 Boom Deployment & Retrieval

Boom is a common type of oil spill response equipment, normally used to protect shorelines or sensitive locations by acting as a barrier to spilled contaminants and to gather oil on the water to improve the recovery effectiveness of skimmers or other response operations. Boom deployment information should include the type of boom deployed (solid boom, fire boom [used in conjunction with in-situ burning], sorbent boom and snare boom), boom configuration and the location of the deployment. In some cases, such as the use of solid flotation curtain boom that is towed for the purpose of concentrating oil for skimmer recovery, the information requirements would include links to the vessel tracks for the towing vessels. As boom is sometimes recovered from a location and re-deployed, information relating to retrieval of the boom should also be gathered if possible.

4.3.5.3.2.2 Dispersant Applications

Dispersants accelerate the natural decomposition of oil, removing it from the surface of a body of water into the water column. Dispersants can quickly and effectively minimize the impact of oil on animals present at the surface, including birds and coastal plant life such as mangroves.

All dispersant applications must be closely tracked in a spill response, due to the environmental considerations of the dispersant applications, and potential health impact on the personnel involved in dispersant deployment. Additionally, the types of dispersants used in a spill response must be closely managed and monitored, as dispersant products approved in one country or region may not be approved in another.

In all dispersant applications, delivered from both aerial and surface methods, the type of dispersant used (dispersant classification), application method, amounts of dispersant (application rate), and the area covered by the dispersant application must be tracked. In addition, the COP should ensure that tracking of personnel involved in dispersant applications is performed, to properly monitor post-application health considerations.

Additional information that is dependent on the application method may be required. Specifically, the application methods to be considered include:

i) Aerial Dispersant Applications
ii) Surface and Sub-surface Dispersant Applications
iii) Shoreline Applications

4.3.5.3.2.3 Hesco Basket & Sand Bag Deployment

Hesco baskets, named after the company that makes them, look like wire trashcans lined with fabric. The baskets come in 15-foot-long sections that collapse down to 4 inches tall. The baskets can be quickly positioned and filled with sand to provide shoreline protection from oil spill residue.

Operational/response information in the COP portfolio should include tracking of Hesco basket installations (and re-installations if the baskets are later moved to a different location).

Sand bag deployments should also be tracked in similar fashion, to identify shoreline or other locations that have been protected from oiling by the installation of sand bags.

4.3.5.3.2.4 In-Situ Burning

In-situ burning, or ISB, is a procedure sometimes used as a remediation technique in an oil spill. In-situ burning involves the controlled burning of oil that has spilled, at the location of the spill. When conducted properly, in-situ burning significantly reduces the amount of oil on the water and minimizes the adverse effect of the oil on the environment. In addition, in-situ burning may avert or reduce the extent of shoreline impacts, including exposure of sensitive natural, recreational, and commercial resources.

Operational/response information in the COP system should include tracking of in-situ burning operations, capturing available in-situ burn monitoring information (such as camcorder or camera recording of the burn), as well as sampling performed as a result of the in-situ burn activity.

4.3.5.3.2.5 Operations Equipment/Resource Tracking (including AIS)

Operations Equipment and Resource Tracking is another key requirement during the cleanup and remediation efforts in an oil spill scenario. This functionality should capture information about equipment and other assets used, to provide both current and historical tracking of the equipment and other assets, and the work performed by the respective equipment.

To improve the tracking of operational assets, it is strongly recommended that smart tags (such as RFID transmitters) and other supply chain and asset management technologies be implemented to facilitate identification and tracking of equipment and asset use.

The Automatic Identification System (AIS) is an automatic tracking system used on ships and by vessel traffic services (VTS) to identify and locate vessels by electronically exchanging information with other nearby ships, AIS Base stations and Satellites. AIS information collection may be utilized to provide current and historical tracking of vessels such as skimmer boats and other vessels used in oil spill response efforts. Where possible, a standard AIS protocol should be implemented among all vessels and vessel traffic services used in the oil spill response effort. (See also Section 4.4.4.)

4.3.5.3.2.6 Operations Clean-up [SCAT/STR]

Shoreline Cleanup and Assessment Technique (SCAT) is a well-defined and documented process used in performing surveys of an affected shoreline in an oil spill incident. SCAT uses standardized terminology to collect information on shoreline impact due to oiling and provides support for operations directors evaluating priorities for shoreline cleanup.

During the operational phase of an oil spill response, the SCAT process will be used to review existing shoreline, define boundaries or segments of shoreline, and assign teams and conduct surveys of the shoreline sections. Reports from the SCAT process are used to develop cleanup plans, and subsequently monitor the effectiveness of the cleanup process.

Collection and reporting of SCAT surveys is an essential part of the spill response process, and all planning, surveys and reporting of the SCAT process should be managed within the COP system.

4.3.5.3.2.7 Personnel Tracking

The safety of the general public and responders is assigned the highest priority during spill response operations. Within the COP, personnel tracking must be implemented to properly ascertain any potential health risks and exposures to responders in a spill incident. For example, detailed records should be maintained for all personnel involved in the delivery of dispersants, or exposed to residue from in-situ burning activities. Increased information gathering and collection regarding personnel, the activities they perform and any potential health-related exposures from their activities can significantly reduce the long-term risk and liability to responsible parties involved in a spill incident.

4.3.5.3.2.8 Restricted Areas

To facilitate operations planning, the COP should track areas designated as restricted, including flight restrictions over the operations area, as well as restrictions of marine vessels to operate in areas adjacent to the spill origin, commonly implemented for safety reasons.

4.3.5.3.2.9 Sorbent Materials

Sorbent materials, including organics, inorganics, and synthetic materials such as polypropylene, may be used to recover oil in situations that are unsuitable for other recovery techniques. Operational/response information in the COP system should include tracking of sorbent materials used in the cleanup of a spill, as the sorbent materials present a waste disposal issue after use. Information relating to the type of sorbent used (bulk, enclosed, continuous, loose) as well as the material (organic, inorganic, synthetic) should be tracked, along with the location(s) and disposal methods utilized for the sorbent materials.

4.3.5.3.2.10 Skimming Operations

The primary method utilized for recovery of oil in a marine-based spill is the use of skimming equipment. Typically recovery is accomplished using booms to collect oil, with the skimmer recovering and storing the oil for later processing or disposal. Within the COP, tracking of skimmer operations and their performance should receive high priority. All skimmer operations tracking should include the coverage area of skimming operations, including links to vessel tracking information if available. In addition, the information collected should include the volume of oil recovered, and details relating to the disposition of the recovered fluids. Ideally in the tracking of vessels used for skimming operations, the prevailing conditions such as wind, currents and sea levels should be monitored, as this information can be useful in evaluating the performance of skimming operations in varying conditions.

4.3.5.3.3 Response Sampling & Monitoring

Response Sampling & Monitoring information represents an array of information collected during the operations phase of a spill response. This information may include any or all of the following types of sampling information:

- Conductivity, Temperature & Depth information, collected by vessels during response activity
- Dissolved Oxygen information
- Fluorometer information, which identify the presence and amount of oil in water through light wavelength analysis
- Sediment Sampling (Fingerprinting) information
- Location information, indicating sampling zones and buffer areas, including wellhead buffer
- Seafood sampling
- Snare Sentinel monitoring & analysis
- Sorbent probe observations, in which probes are deployed from vessels and absorb subsurface oil if present
- VIPERS analysis information, which collects samples in trawl nets to determine if suspended or submerged oil exists
- Water quality sampling information

4.3.5.3.4 Closures (Fisheries, etc.)

This portion of the Oil Spill Response Operations hierarchy includes information representing areas designated as closed to commercial and/or recreational activities, and subsequent re-openings. Typically this information would include any of the following:

- Fishery closures & re-openings
- Shrimping, crabbing, shellfish closures & re-openings

Closure information may exist at varying governmental levels, including national and state/province level.

4.3.5.4 Operator Services & Support

In a generic COP, this portion of the Incidents & Drills hierarchy would contain all of the subcategories relating to the operator and support capabilities provided by the operator, as related to the oil spill. These subcategories are further defined below.

4.3.5.4.1 Community Support

Includes the following:

- Administrative Centers: operator offices in the surrounding area that may be used to provide administrative support for the spill response
- Claims Centers: locations of operator claims centers offering assistance to individuals and organizations affected by the oil spill
- Community Outreach Centers: locations of operator centers designated to disseminate information and provide a meeting location for communities affected by the spill

4.4 Delivering Geospatial Information for the OSR COP

4.4.1 Interoperability architecture

Effective incident response activities rely on flexible communications and information systems that provide a COP to users. Incident communications are facilitated through use of common communications plans and interoperable communications equipment, processes, standards, and architectures [NIMS]. Several existing, standards-based COP systems are deployed and operational for oil spill response. The architecture in this section was developed by reviewing operational and development systems that deliver a COP for oil spill response using open standards ([ERMA], [CleanSeaNet], [GEOSS], [OWS-8]).

Delivering geospatial information for an OSR COP requires the following functions:

- Provide continuously updated overview of an incident
- Support a historical record compiled over an incident's lifecycle
- Access geospatial information from multiple organizations
- Integrate diverse information based on location and other elements
- Handle multiple coordinate reference systems (CRS)
- Create a composite map of the incident by overlay of multiple map layers
- Support customization of maps appearance as determined by the user, e.g., symbols
- Deliver COP information via the WWW and for disconnected operations
- Receive near real-time oil spill observations and trajectory predictions
- Receive near-real time position of maritime vessel traffic
- Receive near real-time information for tracking of resources in the response
- Receive alerts

The OSR COP Web Architecture (Figure 5) identifies a set of components and interfaces between the components. The architecture approach for this best practice will identify standards for the interfaces. This will allow many providers of the components, which implement the interface standards. Specific providers of components will not be listed in the final architecture for the best practice.

Figure 5 shows the COP composed of geospatial layers present on the User's Computer in a client application. The user's computer may be of several types: a mobile handheld device, a laptop computer, or a computer driving a wall-size display in an Incident Command Center. The information for the layers in the COP may come from many different locations. The Client Applications may be of several types, e.g., web browser or an enterprise GIS.

A key requirement is that the architecture allows the COP to be viewed in a consistent manner by all users. In order to achieve this requirement the interfaces between the components in Figure 5 need to be identified based on open standards. This approach allows for any software on the client or server side of the interfaces to participate in creating the common COP.

Implementations of Figure 5 for a specific response may include a mix of interfaces using open standards and proprietary specifications. One outcome of this RFI process may be the recommendation to create open standards from existing proprietary specifications in order to meet the objective of allowing OSR COP information to be most widely available

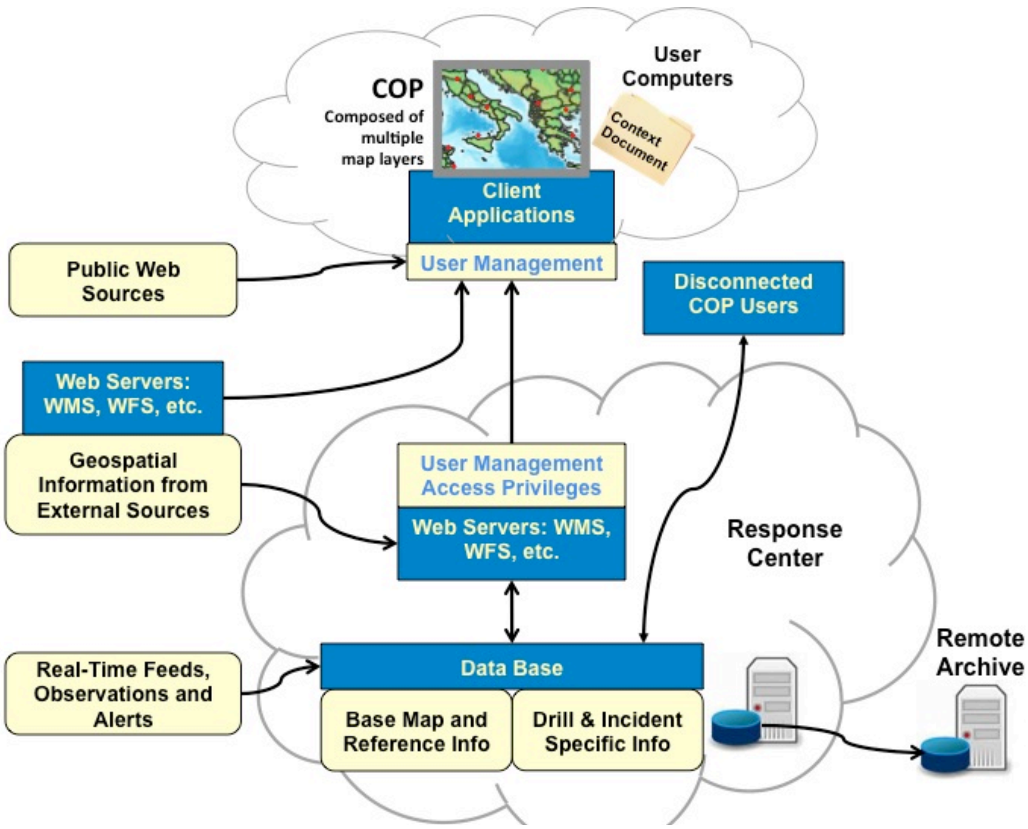

Figure 5. OSR COP delivery architecture

4.4.2 Web service delivery to users

4.4.2.1 Context sharing

A COP contains a set of information collected for an incident. In order to manage the assembled set of information for a given context, an information container is needed. A context container can be used within one client for multiple incidents. A context container can be passed between clients in order to share and recreate the same information content in multiple clients.

Figure 5 includes a Context Document used by the Client Applications to view a COP through web services architecture. The OGC Web Services Context Document (OWS Context) allows a set of identifiers for web accessible information resources to be passed between applications (but also in-line content). The goal is to support use cases such as the distribution of search results, the exchange of a set of resources in a COP. Multiple encoding formats for OWS Context have been developed (ATOM, JSON).

In order to present the geospatial information to the end users in a coherent fashion, a series of map templates will be required providing selected sets of information for specific purposes (See Section 4.3.3). Such map templates should be available as a display within the COP architecture, e.g., as pre-established OGC Context Documents.

4.4.2.2 Web mapping services

Web map services dynamically produce spatially referenced maps portraying geographic features. A map service provides operations to retrieve a description of the maps offered by a server, to retrieve a map, and to query a server about features displayed on a map

The OGC Web Map Service (WMS) Implementation Specification, also published as ISO 19128, provides three operations (GetCapabilities, GetMap, and GetFeatureInfo) in support of the creation and display of registered and superimposed map-like views of information that come simultaneously from multiple remote and heterogeneous sources.

The OGC Web Map Tile Service (WMTS) provides for serving spatially referenced data using tile images with predefined content, extent, and resolution. WMTS trades the flexibility of custom map rendering – as provided by WMS – for the scalability possible by serving a fixed set of tiles.

The OGC KML Standard defines an XML grammar used to encode and transport representations of geographic data for display in an earth browser. Put simply: KML encodes what to show in an earth browser, and how to show it.

4.4.2.3 Portrayal and symbols

The OGC Styled Layer Descriptor (SLD) Profile of WMS explains how WMS can be extended to allow user-defined symbolization of feature and coverage data. This profile defines how the Symbology Encoding standard can be used with WMS. SLD is used in combination with Symbology Encoding (SE) Standard. SLD allows for user-defined layers and named or user-defined styling in WMS. If a WMS is to symbolize features using a user-defined symbolization, the source of the feature data must be identified. The features may be in a remote WFS or WCS, or from a specific default feature/coverage store. WMS servers using remote feature data are also called Feature Portrayal Services (FPS), while those using remote coverage data are Coverage Portrayal Services (CPS).

The OGC Symbology Encoding (SE) Implementation Standard specifies the format of a map-styling language for producing georeferenced maps with user-defined styling. SE is an XML language for styling information used to portray Feature and Coverage data. SE may be used together with SLD. As SE is a grammar for styling map data independent of any service interface specification it can be used flexibly by a number of services that style georeferenced information or store styling information that can be used by other services.

Figure 6 shows an example of displaying the same geospatial information in different maps using different symbols. The figure shows three different symbol sets overlaying unchanged base layers. Flexibility to use different symbols in a COP is important when different communities use the COP. Cartographic symbols standards are listed in Section 4.3.3.2.

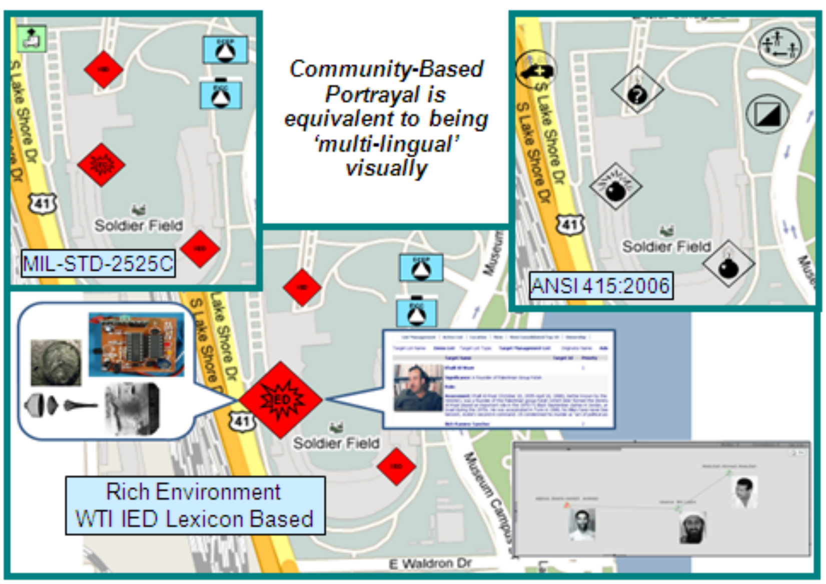

Figure 6. Community/user-defined symbology (Source: TBS)

4.4.2.4 Access to features and coverages

Only a limited number of users get access to features and coverages. Editing of features would not directly be made part of COP.

The OGC Web Feature Service (WFS) Implementation Specification, also published as ISO 19142, allows a client to retrieve and update geospatial data encoded in Geography Markup Language (GML) from multiple Web Feature Services. The specification defines interfaces for data access and manipulation operations on geographic features. Via these interfaces, a Web user or service can combine, use and manage geodata from different sources. A Transactional WFS (WFS-T) includes an optional Transaction operation to insert, update, or delete a feature.

The OGC Web Coverage Service (WCS) Implementation Specification supports electronic retrieval of geospatial data as "coverages" – that is, digital geospatial information representing space/time-varying phenomena. WCS provides access to coverage data in forms that are useful for client-side rendering, as input into scientific models, and for other clients.

4.4.2.5 Catalog/registry services

Interoperability standards for catalog search are key to service oriented architectures. The OGC Catalogue Service for the Web (CSW) is a binding defined in the OpenGIS Catalogue Services Implementation Standard (CAT). The Catalog standard defines common interfaces to discover, browse, and query metadata about data, services, and other potential resources for several bindings, including a geospatial extension to OpenSearch.

4.4.2.6 User identity and management services

User management services provide the authentication and authorization capabilities in a service oriented architecture. This section describes Authentication Protocols and User Management Protocols for the purpose of user registration, user single sign-on (SSO), and user data access and use metrics.

The US Government has been working on approved authentication systems known as ICAM and has some trusted frameworks and specific providers identified. OpenID is recommended for use by government agencies that seek to connect and register users with a 'low' level of trust. This can be used for open systems that need only tracking, not full or tiered access control. There are a few commercial providers, including Google, who are 'trusted' and support the government profile:

- http://www.idmanagement.gov/custom-block/approved-identity-provider-list
- http://www.idmanagement.gov/documents/icam-openid-20-profile

For higher-level 'moderate' access, the SAML 2.0 protocol and messages are recommended for government users with primarily government clients. This will be the basis for SSO between the data.gov, the Geospatial Platfork, ArcGIS Online, and the CKAN common catalog solution. GSA is running the ID Manager/Provider for this coordinated project - and it may in the future include additional existing Departmental SAML providers to allow employee access.

- SAML documentation: http://www.idmanagement.gov/documents/security-assertion-markup-language-saml-web-browser-single-sign-sso-profile

OAuth is an open protocol that enables websites or applications to access protected resources from a web service, without disclosing usernames and passwords. Instead of forwarding usernames and passwords, OAuth uses tokens generated by the Service Provider. The tokens are granted access to a specified resource for a specified duration.

OGC User Management for Earth Observation Services Best Practice describes how user and identity management information may be included in the protocol specifications for OGC Services. The use cases addressed reference to EO services, for example catalogue access, ordering and programming.

4.4.3 Information schemas, metadata and encodings

4.4.3.1 Application schemas

To ensure that both computer systems and users will understand information, the structures used in access and exchange must be adequately specified. An application schema provides the formal description of the structure and content required by one or more applications. An application schema for geographic information contains the descriptions of both geographic features, as well as related information. The feature is a fundamental concept of geographic information.

The purpose of an application schema is twofold:

- To provide a computer-readable data description defining the structure, which makes it possible to apply automated mechanisms for data management
- To achieve a common and correct understanding of the data, by documenting the content of the particular application field, thereby making it possible to unambiguously retrieve information from the data

Feature modeling is specified in ISO 19109:2005, "Geographic information - Rules for application schema." Conceptual schemas define abstract feature types and provide the process for domain experts to develop application schemas that are used to encode content describing feature instances. The developer of an application schema may use feature definitions from feature catalogues that already exist.

Application Schemas relevant to oil spill response include:

- OGP Seabed Survey Data Model (SSDM) is a specification used in the oil and gas exploration & production (E&P) industry in handling the delivery of various seabed survey datasets in GIS data format
- OGC maintains an informal list of all known GML Application Schemas. These schemas are not necessarily approved or endorsed by the OGC
- CleanSeaNet has defined two types of information from satellite images that are delivered as features in GML: oil spills and vessels
    - Oil spill schema: http://www.emsa.europa.eu/schemas/csndc/Features/csndc_os.xsd
    - Vessel detected schema: http://www.emsa.europa.eu/schemas/csndc/Features/csndc_ds.xsd

4.4.3.2 Metadata

Metadata is used in several ways in a distributed information system. Encodings include metadata along with the data. Catalogues provide metadata about the resources of interest. Metadata is needed to maintain long-term archives of the COP information.

The main international standard for metadata about geographic information is ISO 19115:2003 – Geographic Information – Metadata. Profiles of ISO 19115 provide metadata specific to the domain of application. Energistics is developing an Energy Industry Profile of ISO 19115-1.

4.4.3.3 Encoding formats

Open standards for encoding feature data include OGC Geography Markup Language (GML).

Open standards for encoding coverage data include NetCDF, HDF, GRIB, BUFR and TIFF.

4.4.4 Inputs to the response center

4.4.4.1 Real-time feeds

The Response Center receives real-time feeds, stores those in the response center database and makes them available for the COP. Real-time feeds include weather conditions and forecasts and vessel tracking (AIS)

Automatic Identification System (AIS) is an automatic tracking system used on ships and by vessel traffic services for identifying and locating vessels by electronically exchanging data with other nearby ships, AIS Base stations, and Satellites. When satellites are used to detect AIS signatures then the term Satellite-AIS (S-AIS) is used. Web delivery of AIS to the response center can be an input to the COP. Historical tracks of AIS may be stored by the response center. AIS is discussed in Operations Equipment/Resource Tracking (including AIS) (Section 4.3.5.3.2.5).

4.4.4.2 Sensor observations including imagery and video

Real-time and near-real-time sensing of the spill incident provides situational awareness for the response center. Examples include video from Remotely Operated Vehicles (ROVs) and images from remote-sensing instruments on airborne and space-borne platforms. To be useful the sensor data must typically be processed and interpreted by experts. The resulting derived products may then be made part of the COP. Suppliers of the information as well as the Response Center process the sensor observations. The processing and workflow history, i.e., provenance, must be understood and retained.

The OGC Sensor Observation Service (SOS) Implementation Standard defines a web service interface for requesting, filtering, and retrieving observations and sensor system information. Observations may be from in-situ sensors (e.g., water monitoring devices) or dynamic sensors (e.g., imagers on Earth-observation satellites).

The OGC Sensor Planning Service (SPS) Implementation Standard defines an interface to task sensors or models. Using SPS, sensors can be reprogrammed or calibrated, sensor missions can be started or changed, simulation models executed and controlled. The feasibility of a tasking request can be checked and alternatives may be provided. The OGC SPS Earth Observation Satellite Tasking Extension supports the programming process of Earth Observation (EO) sensor systems used by many satellite data providers.

The OGC Ordering Services for Earth Observation Products supports ordering of EO data products either from previously identified data set collections via a typical catalogue interaction or from future acquisitions specified via a Programming service. The service describes an interface that can be supported by many data providers (satellite operators, data distributors, etc.), most of whom have existing (and relatively complex) facilities for the management of these data.

4.4.4.3 Alerts

The response center may receive alert messages from various sources. The center may also be a source of alerts. The alerts or incident exchanges contain a description of the situation and identify the geographic area of interest. Alerts may be exchanged by various protocols including Pub/Sub and RSS.

The Common Alerting Protocol (CAP) is an XML-based data format for exchanging public warnings and emergencies between alerting technologies. CAP allows a warning message to be consistently disseminated simultaneously over many warning systems to many applications. CAP is part of the Emergency Data Exchange Language (EDXL) maintained by OASIS and is under consideration for adoption as an ITU recommendation.

4.4.5 Disconnected user operations

4.4.5.1 Mobile unit provision

COP users with mobile devices may be disconnected from communications for extended periods of time. Before deployment the mobile device is provisioned with COP information. During deployment the COP information is used in the operation and must support queries on the COP while disconnected. Updates to the COP may be made while disconnected. Once communication has been reestablished the disconnected device must be synchronized with the Response Center including updates to the main response database.

For provisioning a mobile device before deployment, the previously mentioned OWS Context Document can be used to define views on the COP. To provide the underlying information for the COP while disconnected, the OGC GeoPackage can be used to provision the mobile device with features, tiles and other geo-information.

4.4.5.2 Printed map capability

It is envisaged that there will be a need for the COP to produce large format printed maps at regular intervals, and printing/plotting facilities will need to be available at the Response Center. Standard map templates and format are desirable, ensuring that the map meets minimum technical standards and provides clear and unambiguous cartographic symbols. In addition the maps should be saved as snapshots in a reproducible format, such as PDF, and archived as part of the record retention process.

In order to present the geospatial information to the end users in a coherent fashion, a series of map templates will be required providing selected sets of information for specific purposes (See Section 4.3.3). Such map templates should be available to be printed as large-format wall maps and for maps that can be taken by disconnected users.

4.4.6 Records retention and provenance

Information available during the incident response needs to be retained for activities after the incident. Activities include maintaining accurate and comprehensive incident files, including a complete record of the major steps taken to resolve the incident as well as storing incident files for legal, analytical, and historical purposes. As the COP information is part of the incident files, it too must be retained.

ICS [Deal] recommendations include forming a Documentation Unit in the Response Center. The Documentation Unit is responsible for collecting pertinent documents, ensuring that any documentation received by the Unit is accurate and complete, seek approval before releasing any documentation, and establishing incident files and a filing system to ensure continuity to avoid confusion later on, and attend the meetings of the response unit. These responsibilities for the Documentation Unit need to be extended to include the retention of electronic archives.

"Snapshots" of the COP and the response center database need to be made on a periodic basis and transferred to a location remote from the Response Center. The information to be retained is described in Section 4.3. One guide might be to retain all records needed to recreate COP after the fact to understand the basis for a decision. Another approach is to keep everything forever.

Records retention is vital to understanding the provenance of the information including the chain of custody of samples and of data files. Documenting the provenance of information makes use of metadata (See Section 4.4.3.2). Provenance is a form of metadata. Provenance is information about entities, activities, and people involved in producing a piece of data or thing, which can be used to form assessments about its quality, reliability or trustworthiness. The W3C provenance (PROV) family of specifications may be applicable to OSR COP.

5 References

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