Modernizing SDI: OGC Enabling Data Interoperability for Cumulative Effects Concept Development Study

Outcomes Webinar

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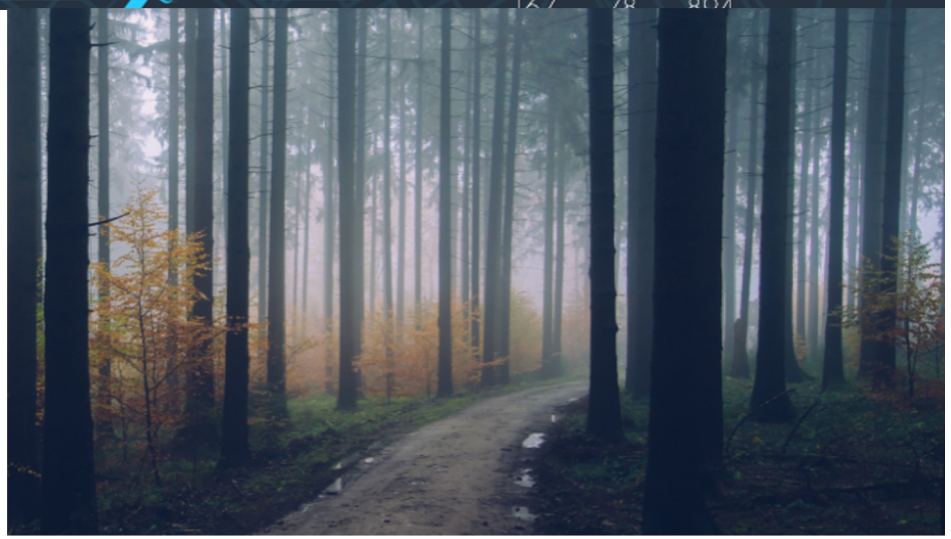
Agenda

- **Welcome!**
- **Part 1:** Introduction to the Modernizing SDI Concept Development Study context, elements, themes
- **Part 2:** Request for Information responses and Validation Workshop outcomes
- **Part 3:** Overall Study results: tracing the themes and design elements of a modern SDI
- **Part 4:** Q&A and open discussion on the future of modern SDI's.

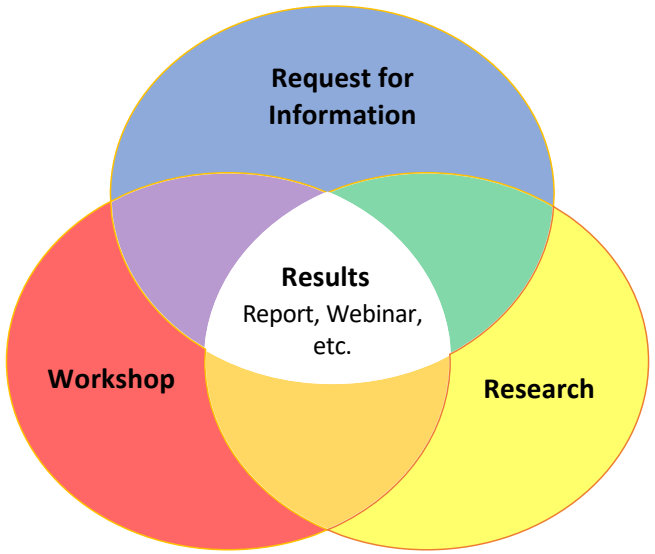
The Concept Development Study (CDS)



- Team
  - Natural Resources Canada (NRCan)
    - Cindy Mitchell.
    - Ryan Ahola.
  - OGC CDS Team
    - Josh Lieberman.
    - Rob Thomas.
    - Marie-Françoise Voidrot.
    - Scott Serich.
- Question:
  - How can an *ocean* of environmental, foundational/framework, biological, socio economic and other data, from multiple different *sources* and *jurisdictions*, and with varying levels of *standardization*, be readily *discovered, consumed, integrated*, and *reused* by *scientists* and *citizens* alike for specific *societal benefits*?

What is an OGC Concept Development Study?

- Early stage of understanding spatial data interoperability challenges and gaps in standards or practices for a domain
- Critical concepts of spatial representation and utilization in domain knowledge, processes, and goals.
- Comprises multiple stages of research, consultation, collaboration, and communication.
- Study elements:



Study Scoping → Background Research → Request for Information → Validation Workshop → Study Report & Communication

Modernizing SDI CDS: Data Interoperability for Cumulative Effects

This CDS seeks to specifically identify emerging **standards-based solutions that can better enable interoperability** and sharing of key environmental data. The scope of this CDS includes:

- Characterizing the **current state of spatial data infrastructures**: their use of current or emerging standards and advanced technology to enable data interoperability; understanding gaps and challenges in their implementation.
- Assessing the **availability and interoperability of geospatial data** across multiple regions or jurisdictions, specifically those needed for regional environment assessments or cumulative effects analysis, as well as the technologies and services currently leveraged by these analyses.
- Exploring and articulating practical means to achieve **modernized, intelligent, inferential, machine-driven solutions** that support and enable improved, efficient, and comprehensive geospatial data interoperability

CDS sponsored by:

Natural Resources Canada

Ressources naturelles Canada

CDS Objective and Use Case

Objective:

- The primary question: “How can an *ocean* of environmental, foundational/framework, biological, socio economic and other data, from multiple different *sources* and *jurisdictions*, and with varying levels of *standardization*, be readily *discovered, consumed, integrated*, and *reused* by *scientists* and *citizens* alike for specific *societal benefits*?”

- The overall objective: Consult communities and inform federal, provincial, territorial and First Nations/Indigenous stakeholders, who are concerned with cumulative effects and regional assessments, on how best to establish consensus and implement common, open-standards-based approaches that leverage emerging technological capabilities, leading to new levels of digital geospatial data interoperability.

Use Case: Cumulative Effects

- In a **cumulative effects analysis use case**, data are sourced from a range of jurisdictions, governments, sectors, domains, over time, and social/community contexts; data are reused as effects predictions for future activities are updated and reconsidered.

- **Cumulative effects** offers a complex but effective and examplary use case. **Data interoperability and reuse** is equally an issue in many other use cases, such as **emergency response or preparedness,** where data must interoperate quickly and easily **across organizations and jurisdictions**.

Cumulative Effects Use Case

- **Cumulative effects** (**CE**) are defined as changes to the environment, health, social and economic factors caused by **multiple interactions** between **human activities** and **natural processes** that accumulate **across space and time**
- In Canada, approval of major development projects now requires an **impact assessment** that analyzes all possible **cumulative effects that could impact the environment and the people who live and work in it**, both over time and in combination with other existing or future projects
- **Spatial analysis** is useful for identifying where cumulative effects may occur as a result of the project location in relation to other physical activities; also a means of integrating diverse sources of evidence
- **GIS** is a useful tool to carry out complex spatial applications (e.g. overlays), display the consequences of multiple actions and support mitigation proposals in cumulative effects assessments.
- **FAIR** enough – analysis is facilitated by open, transparent access to diverse data and assessment outcomes.

Example Cumulative Effects Assessment Results*

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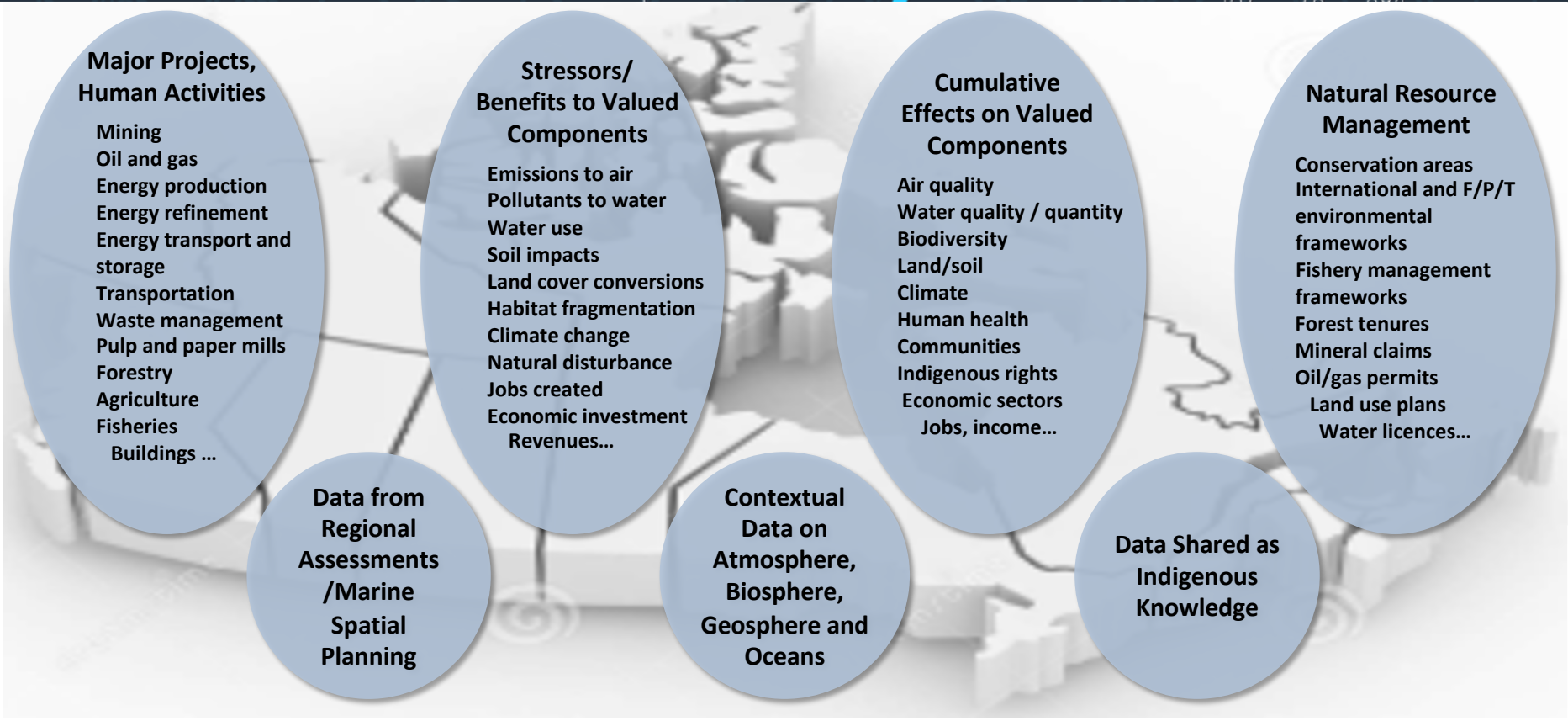
Table 7.3.1 Environmental Cumulative Effects Matrix for the Goliath Gold Project

Valued Components	Potential Effect	Project Stage	Proposed Mitigation	Residual Effects Characterization					Significance of Project Contribution	Likelihood of Occurrence
VC	Potential Effect	Project Stage	Proposed Mitigation	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Significance of Project contribution to cumulative effects (assuming implementation of mitigation)	Likelihood of Occurrence
	Expansion of groundwater drawdown cone could potentially lead to reduced or loss of production in private wells surrounding the mine site.	Operations	Ground water monitoring wells between mine site and private wells will provide early warning if ground water quantity dropping off. Mitigation includes installation of deeper wells for private users or installation of alternative domestic water supply as necessary.	Level III - Residual effect is outside of range of natural variation.	Level III - Residual effect extends into the RSA	Level III - Residual effect is expected to persist, but decrease in intensity for 20 years following suspension of groundwater dewatering efforts.	Level III - Residual effect will be continuous, decreasing in intensity over a period of 20 years.	Level II - Residual effect is partially reversible	Not significant	Level II - Could reasonably be expected to occur
	Slow recovery of groundwater drawdown cone could limit development of private wells surrounding the mine site.	Closure	Mitigation measures implemented during operations will be maintained until dewatering cone reversed.	Level II - Residual impacts would be less than during period of dewatering system operation.	Level II - Residual impacts would extend throughout the LSA for an extended period (up to 20 years).	Level III - Recovery of groundwater elevations in drawdown cone is expected to be up to 20 years.	Level II - Residual effect is expected to decrease over time.	Level I - Effect gradually reverse once mine dewatering ceases	Not significant	Level II - Could reasonably be expected to initially occur but will fully reverse over time.
Wildlife and Wildlife Habitat	Habitat removal	Construction	Minimize project footprint; Minimize activity of project personnel outside of Project areas and infrastructure	Level II - Activity has the potential to affect population abundance and distribution	Level III - Residual effect extends into the RSA	Level I - Residual effect is not measurable beyond construction period.	Level III - Residual effect occurs frequently or continuously	Level II - Residual effect is partially reversible	Not significant	Level III - Will occur.

***Treasury Metals Incorporated, Goliath Gold Project, Environmental Impact Statement - Chapter 7 (101513E.pdf); also visit iaac-aeic.gc.ca.**

Priority Data for Cumulative Effects & Regional Assessments



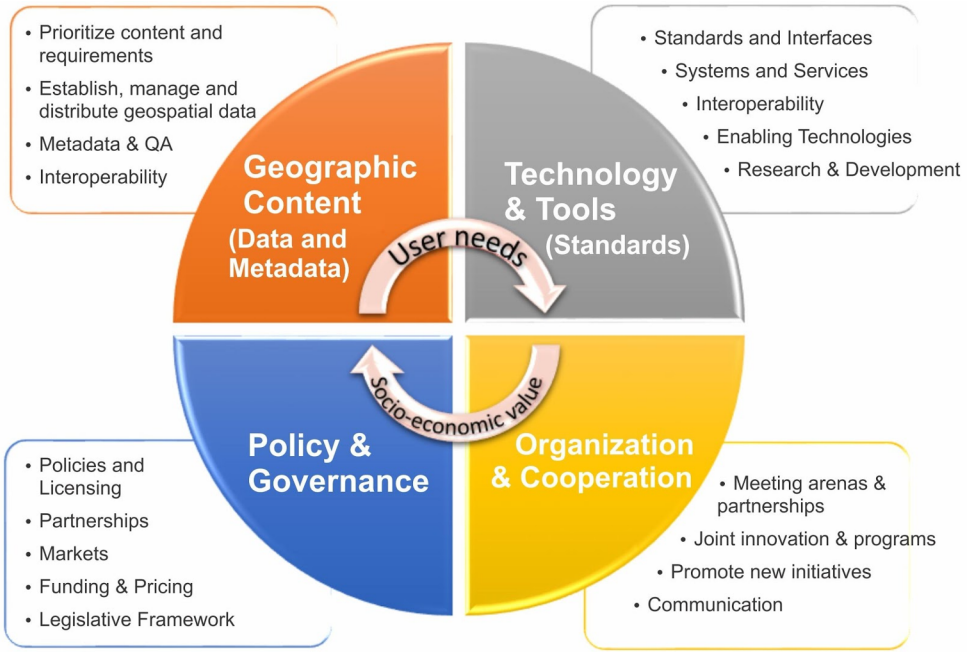
What is a Spatial Data Infrastructure?

- The relevant base collection of *technologies*, *policies* and institutional *arrangements* that facilitate the availability of and access to spatial data. The SDI provides a basis for spatial data *discovery*, *evaluation*, and *application* for users and providers within all levels of government, the commercial sector, the non-profit sector, academia and by citizens in general.

  — *SDI CookBook GSDI*

- Original SDI emphasis on “data-as-infrastructure”.
- Refined as Spatial Information Infrastructure.
- Concepts of Information Infrastructures and Knowledge Platforms have since evolved, widened, and diversified considerably.

National Spatial Data Infrastructure

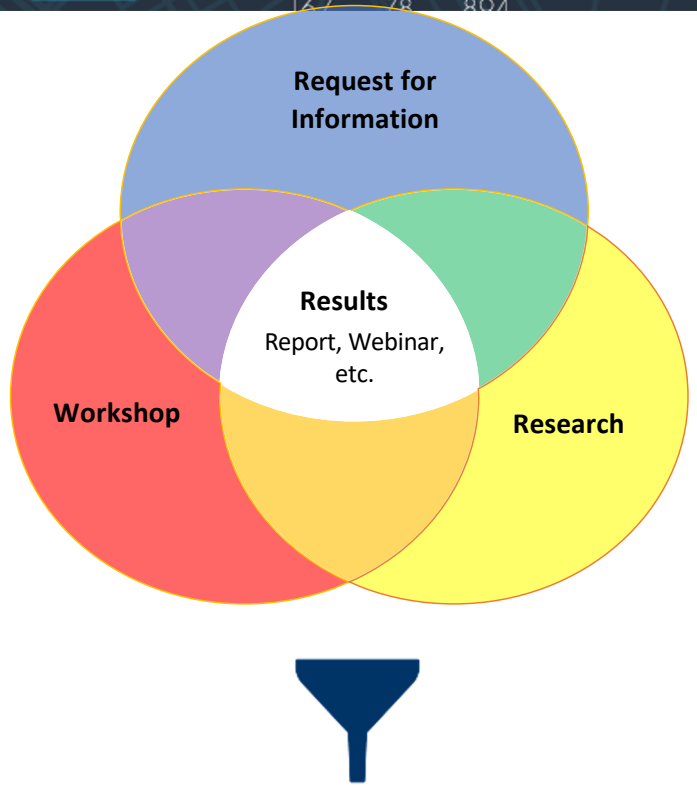


Modernizing SDI: Key Questions

- What are the **new challenges** for SDI's posed by evolving usage?
- What are the **new capabilities** relevant to SDI that are afforded by modern cloud computing?
- How have the **concept and scope** for SDI changed over time?
- How has the **audience** for SDI changed over time?
- What (if any) is the role of SDI **specialization** in specific spatial knowledge domains and communities?
- What are the **gaps and shortcomings in current standards** that stand in the way of SDI modernization?

Research Sources

- EUROGI *Beyond SDI* series: 17 Perspectives http://eurogi.org/category/beyond-sdi/
- *CGDI User Needs Assessment: NRCan* https://geoscan.nrcan.gc.ca/starweb/geoscan/servlet.starweb?path=geoscan/fulle.web&search1=R=314606.
- From Spatial Data Infrastructures to Data Spaces: A Technological Perspective on the Evolution of European SDIs: European Commission, Joint Research Centre (JRC) https://www.mdpi.com/2220-9964/9/3/176



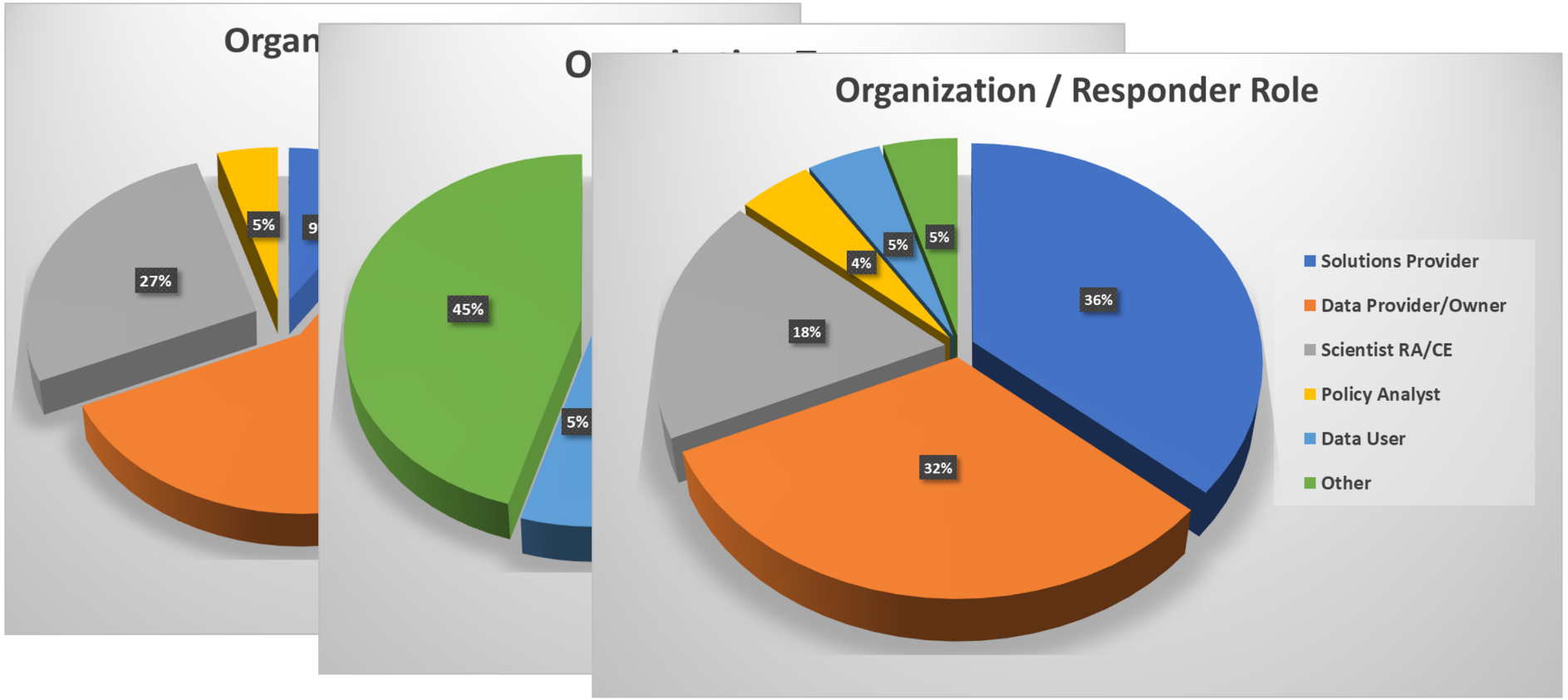
CDS RFI: 8 Categories of Questions

- Stakeholders
- SDIs and Data Architectures
- Data for Regional Assessments/Cumulative Effects Analysis
- Technology and Applications
- Requirements
- Usage Scenarios
- Operation and Organization
- Other Factors

RFI Responders (22)

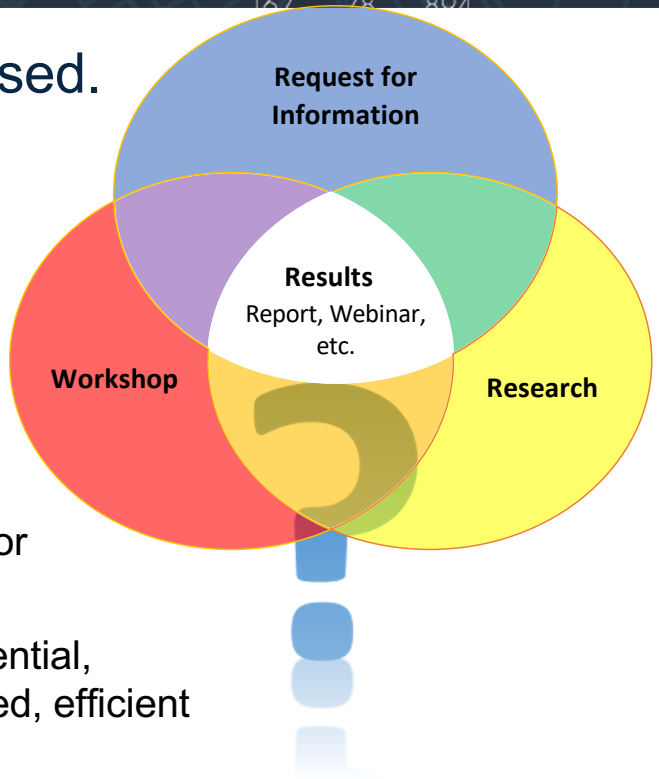
- Arctic SDI (Arctic)
- CRIM, Computer Research Institute of Montreal (Canada)
- CubeWerx (Canada)
- Cyient Limited (India)
- DFO – Flood Observatory, at the University of Colorado (USA)
- Ecere (Canada)
- Esri Canada (Canada)
- Fisheries and Oceans Canada (Canada)
- GeoCat (Netherlands)
- Government of Alberta (Canada)
- Government of Saskatchewan: Saskatchewan Ministry of Environment, Cumulative Impacts and Science
- Geomatys (France)
- Health Solutions Research (HSR) (USA)
- JRC (European Commission)
- KU Leuven Be: Public Governance Institute (Belgium)
- Natural Resources Canada (GeoConnections)
- Netherlands' Kadaster Land Registry and Mapping Agency (Netherlands)
- Nunatsiavut Government (Canada)
- PatternedScience (Canada)
- SensorUp (Canada)
- Skymantics Europe, SL (Spain)
- United Kingdom Hydrographic Office

Who Responded to the RFI



Modernizing SDI: Validation Workshop

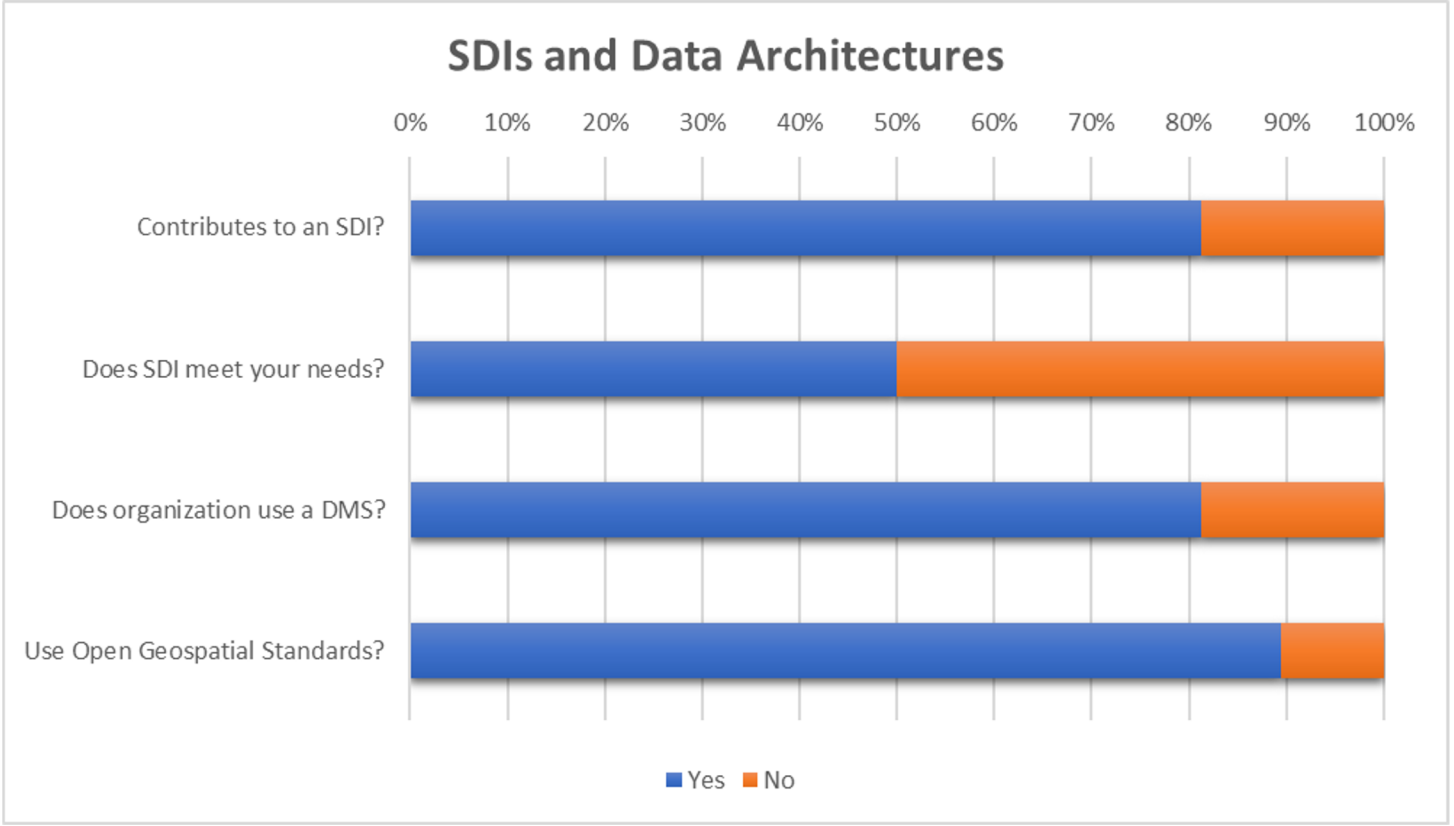
- Key questions that the following panels addressed.
  - Articulating the Challenges to Data Interoperability.
    - What is the current state of SDIs?
    - How is their use of current or emerging standards and advanced technology enabling data interoperability?
  - SDI Vision
    - How will SDI Modernization improve the *availability* and *interoperability* of geospatial data across various regions or jurisdictions?
    - How will SDI Modernization help achieve *intelligent*, inferential, machine-driven solutions that support and enable improved, efficient geospatial data interoperability?



Modernizing SDI: Validation Workshop

- Workshop panel presentations and discussions
  - Panel 1: Drilling Down - Articulating Challenges and Elaborating on RFI responses.
    - Maribeth Murray: Arctic Institute of North America.
    - Souleymane Touré: ECCC / Canadian Wildlife Service.
    - Tyler Amos and Frédéric Dwyer-Samuel: Nunatsiavut Government.
    - Dominique Gauvreau: ECCC / Canadian Wildlife Service.
  - Part 2: SDI Vision - Standards-Based Support for Increased Data Interoperability in an SDI - requirements, testing capabilities, architecture.
    - Dave Blodgett: United States Geological Survey.
    - Tom Kralidis: ECCC / Meteorological Service of Canada.
    - Gordon Plunkett: Esri Canada.
    - Kathi Schleidt: DataCove.eu.

Responses: SDI and Architectures



What we heard: Data Integration Challenges

- Integration of *mass* quantities and *diverse* types of information from *multiple* provincial/state/municipal/territorial stakeholders to create national-level products
- Data discovery and access - existing geospatial services can be difficult to *easily* discover and access
- Significant limitations and restrictions on sharing / integrating *health* data
- Traditional *knowledge* and scientific *data* - western stakeholders' understanding of Indigenous geospatial concepts may be limited
- Standards usage generally remains limited to experts with strong technical knowledge
- Access to training datasets to support transparent machine learning applications is inconsistent
- Geometry / attribute / projection Incompatibility
- Data preprocessing required before use

What we heard: Technologies for Increased Interoperability

- Machine Learning and Cloud Services leveraged against data mined from web services, Open APIs, and other sources, may provide valuable solutions in resolving interoperability challenges.

- With SDI modernization, there maybe an opportunity for a more prominent role of data intermediaries that will help bridge the *gap* between the providers, and users, of data.

- Improved Geospatial / Health integration may be possible using improved analytics to bring together digital health records and population health trends with geospatial data (e.g. clusters, hot spots, etc.).

- Discovery of existing geospatial data and services can be improved by using improved data analysis to provide more usable metadata information, e.g. in the form of semantic tagging and linked data.

Modernizing SDI: Stakeholder Needs

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- SDI should foster data integrity and provide stakeholders with secure, appropriate access to the spatial data they need. These data can be static as well as dynamic.
- SDI should support provisioning of data to a variety of devices and platforms including mobile, e.g., smartphones and tablets.
- SDI should allow different stakeholders, at different locations, to access the SDI according to their different roles.
- SDI should allow for data exchange, especially of dynamic data, in an interoperable, appropriate, efficient and secure way.

Modernizing SDI: Key Questions Revisited

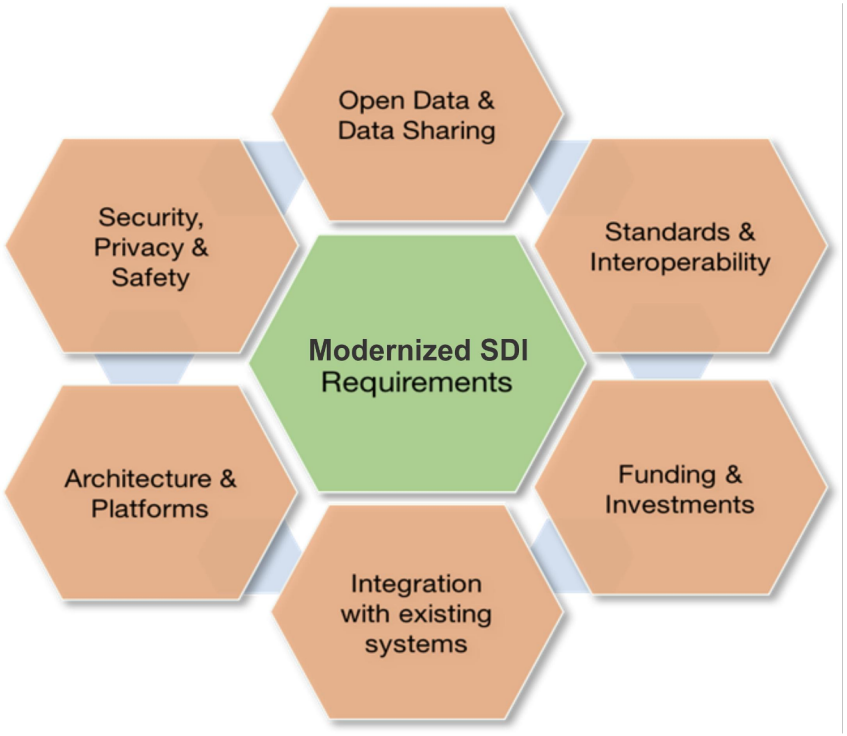
- What are the new challenges for SDI's posed by evolving usage?
  - Data volume / dynamism, SDI popularity, process transparency, analysis and application reuse, democratization.
- What are the new capabilities relevant to SDI that are afforded by modern cloud computing?
  - Flexible capacity / capability, ubiquity, storage<->computing integration and reuse, analysis and application affordance.
- How have the concept and scope for SDI changed over time?
  - Data -> information, single authority -> multiple jurisdictions and levels of confidence, single security domain -> multiple privacy / propriety domains

Modernizing SDI: Key Questions Revisited

- How has the audience for SDI changed over time?
  - Broader, more diverse, less (GIS) expert, more specialized in knowledge and roles, more outcome-focused
- What (if any) is the role of SDI specialization in specific spatial knowledge domains and communities?
  - Interoperability and reuse needs can also be substantive in specific domains and applications (e.g. across studies / roles)
- What are the gaps and shortcomings in current standards that stand in the way of SDI modernization?
  - ML interoperability / transparency, convenience API's, discovery, linking, 3D data, event-driven services, data-centric security, data packaging

Modernizing SDI: System Requirements

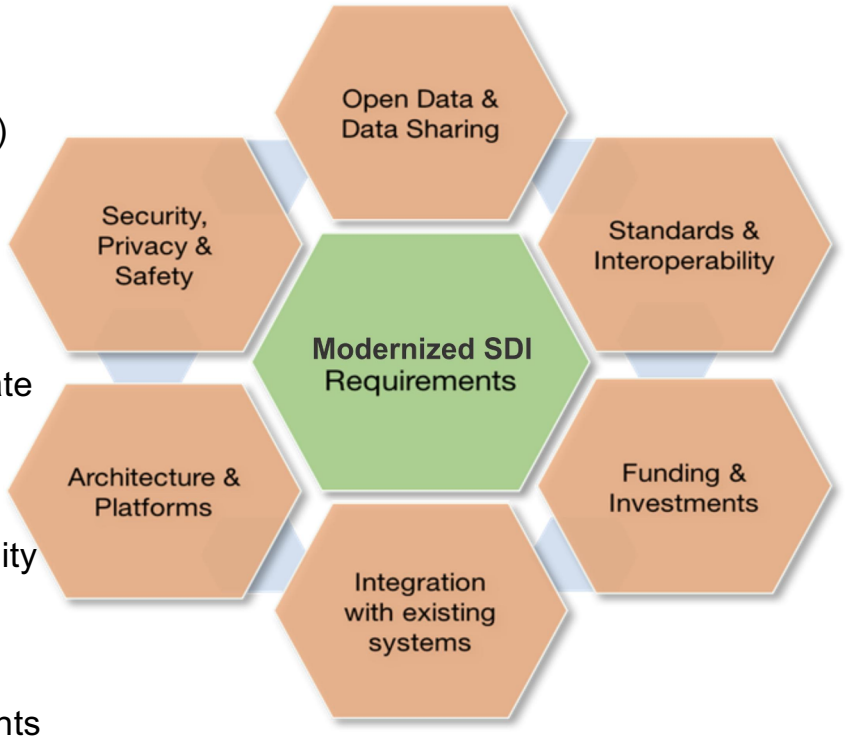
- **Open Data**
  - Government and non-governmental information
  - Near real-time observations from both satellites and in-situ sensors
  - Synthesized data sets (i.e. simulation model outputs)
  - Actionable metadata (for discovery, processing, validation)
- **Standards**
  - Open standard data formats and API's
  - Processing, provenance, result validation
  - Sensitivity and access
- **Funding**
  - SDI data and service "assets"
  - Documentation of benefits and returns
  - Sustainability
  - Cost efficiency



Spatial Data Infrastructures: "Cookbook" - modified)

Modernizing SDI: System Requirements

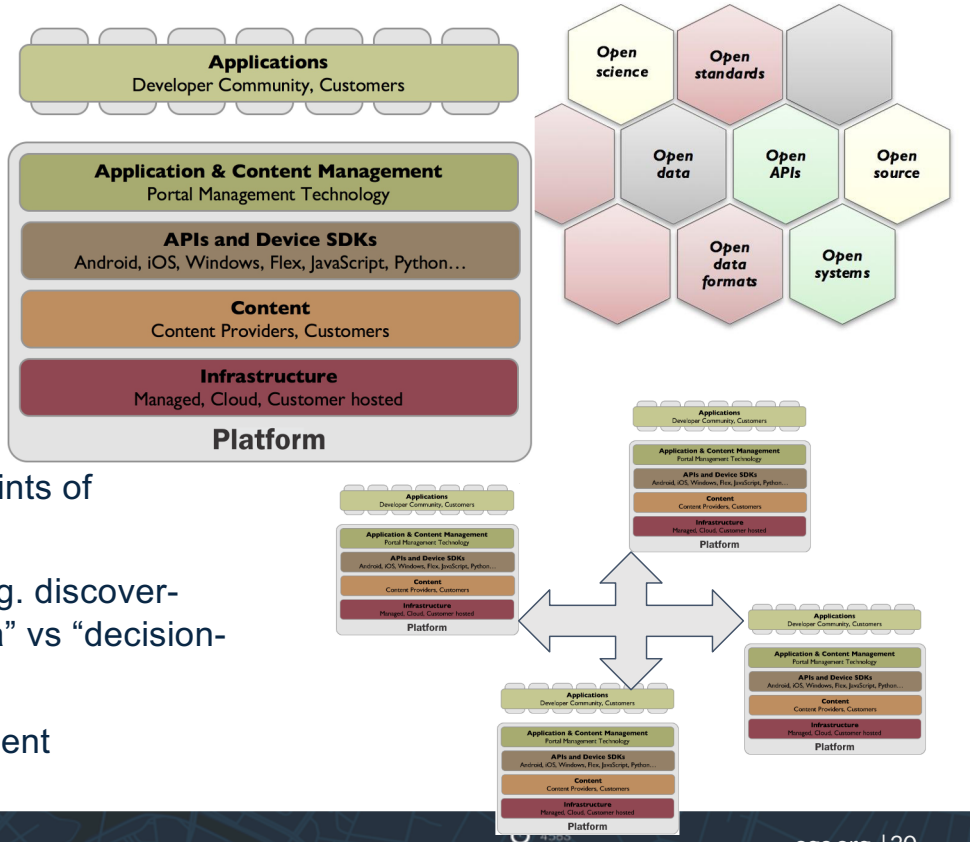
- **Integration**
  - Coordination between international, national, regional SDI's
  - Integration of EO data streams (space-based and other)
  - Integration with spatial analysis and geographic information tools (especially web-based)
- **Architecture**
  - Support for both tightly and loosely coupled standards-based components
  - Applications-to-the-data design pattern where appropriate
  - Support for resource-constrained and offline usage
  - Preservation of the national language, support for multilingualism, and indigenous requirements
  - Strong registry capabilities for discovery and sustainability
- **Security**
  - Maximal openness (FAIR)
  - Physical, syntactic, and semantic data integrity
  - Support for multiple security / access levels and segments
  - Federated and data-centric security capabilities



Spatial Data Infrastructures: "Cookbook" - modified)

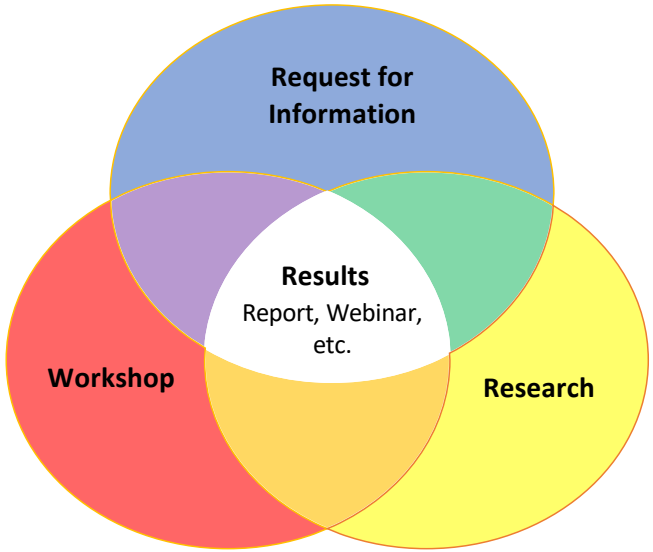
Modernizing SDI: Reference Architecture

- Repeatable **design patterns** for interoperability and reusability in a dynamic computing environment
- Tension between **integrated** platform and **federated** system approaches
- Tight coupling between the “work” and the “paperwork” - **metadata** artifacts and **registry** mechanisms
- Uniform support for **heterogeneous** environments, e.g. open vs privileged, static vs dynamic, high confidence vs provisional, integrated vs decentralized governance
- Minimum **Interoperability** Mechanisms and Pivotal Points of **Interoperability**
- Support for generalized and specialized **workflows**, e.g. discover-find-bind vs analytical procedures, “analysis-ready data” vs “decision-ready data”
- Sustainable support for **change** and change management



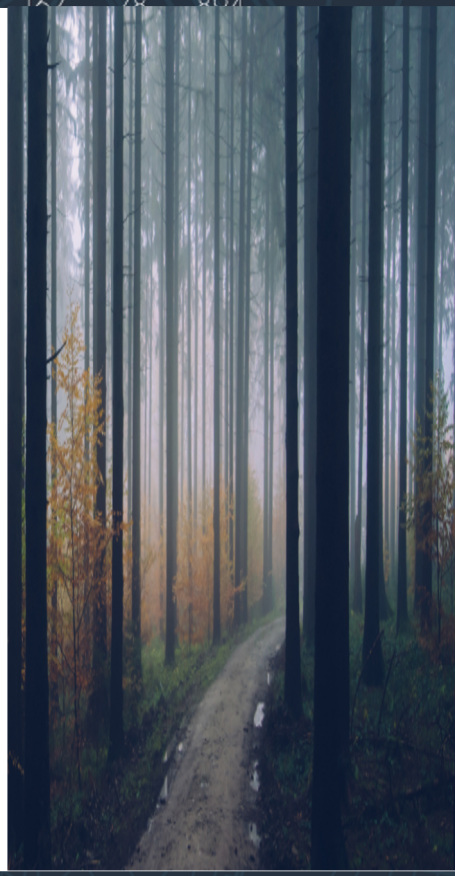
Modernizing SDI: Study Report Components

1. Background
2. RFI questions and responses
3. SDI definitions and stakeholders
4. Current and emerging standards
5. Current and emerging technologies
6. Architectural challenges and requirements
7. SDI architectural and technology approaches
8. Reference architecture for RA / CE
9. Findings and recommendations
10. Future work



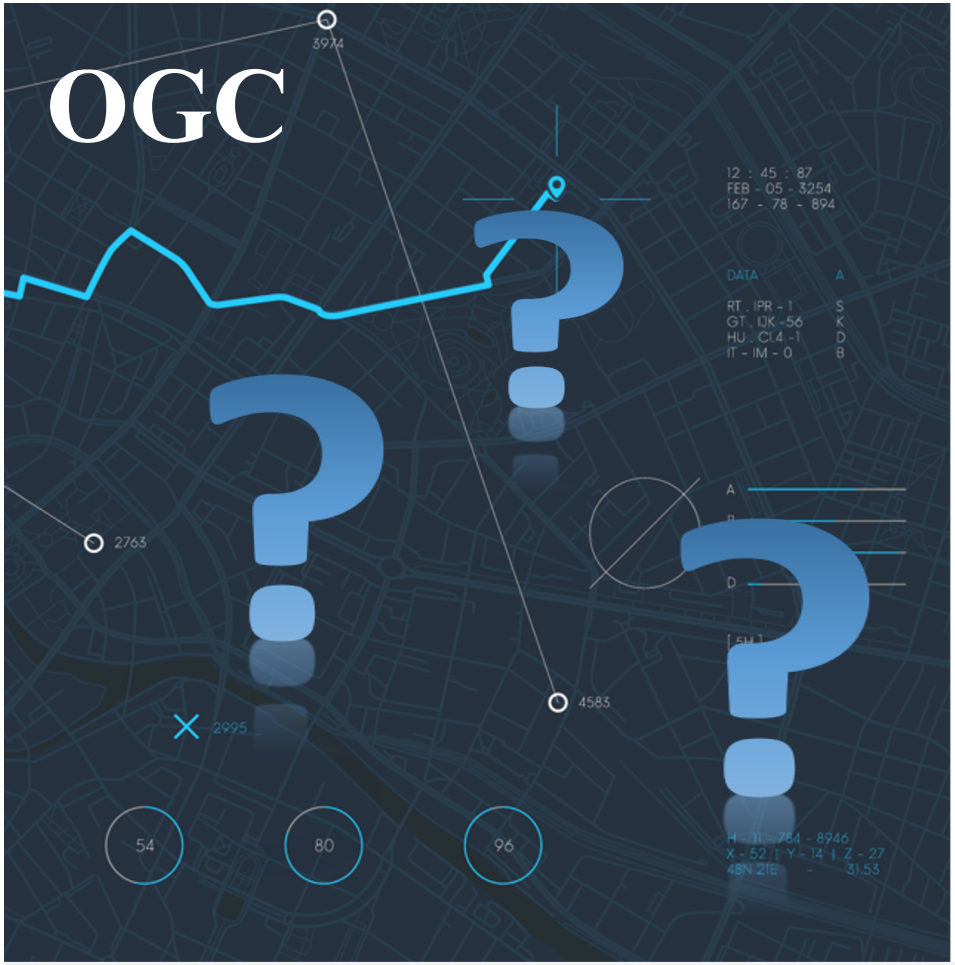
Modernizing SDI: Outreach and Next Steps

- These webinars
- Study report publication and publicity
- Outreach to various OGC groups at the Spring 2021 Members Meeting
- Elaboration of relationships between modern SDI's, cloud platforms, and digital twin models
- Innovation Program prototype implementation of RA / CE and other domain SDI's (e.g. energy, marine)
- Creation & publication of modern SDI reference architecture toolkit
- Identification and/or development of critical standards
- Other research, organizational, and planning imperatives for realizing and sustaining modern SDI's.



Contact Information

- Ongoing CDS news updates (including links to the final slide decks) will be provided on the Modernizing SDI CDS initiative page:
  - https://www.ogc.org/projects/initiatives/modernizingsdi .
- Government of Canada approach to addressing Cumulative Effects:
  - https://www.canada.ca/en/services/environment/conservation/assessments/environmental-reviews/environmental-assessment-processes/cumulative-effects.html (English).
  - https://www.canada.ca/fr/services/environnement/conservation/evaluation/examens-environnementaux/processus-evaluation-environnementale/effets-cumulatifs.html (French).
- General information about Canadian federal and provincial geospatial data:
  - https://open.canada.ca/en/open-maps .
- General information about the OGC: https://www.ogc.org .



Thank You!

Modernizing SDI CDS Webinar Team

Web : **ogc.org/mod-sdi**