National Snow and Ice Data Center

Supporting Cryospheric Research Since 1976

Arctic Observations and Data: Using and Ecosystem Approach and Systems Science to Enhance Information Flow for Fisheries Research

Peter L. Pulsifer[1,2], Yekaterina Kontar, Paul Berkman

[1]Co-Chair, IARPC Arctic Data SubTeam, Chair, IASC-SAON Arctic Data Committee, Co-Lead GEOCRI

[2]PI, Exchange for Local Observations and Knowledge of the Arctic (ELOKA)

Research Scientist, National Snow and Ice Data Center,

CIRES, University of Colorado

26 October 2017

ARCTICDATACOMMITTEE

Arctic Data: Opportunities, Challenges and the Way Forward

See http://arcticdc.org/meetings/adc-meetings/interoperability-workshop for links to resources

Sustaining Arctic Observing Network (SAON)

SAON Data Management Workshop Report

Developing a Strategic Appr

Prepared By:
Gillian B. Lichota, NOAA Arctic Research Program
Simon Wilson, AMAP

The Importance of the Polar Regions Canada, to

Data Scie

POLAR CONNECTIONS

REPORT OF THE POLAR CONNECTIONS INTEROPERABILITY WORKSHOP AND ASSESSMENT PROCESS

7-10 NOVEMBER 2016

Editors: Peter L. Pulsifer, Julie Friddell, Pip Bricher, Øystein Godøy, Colleen Strawhacker, David Arthurs, Lynn Yarmey, Andrew Fleming

[DRAFT]

International Forum on Data Activities in Global Data Systems Communiqué

ecommendations & Observations Arising From the 'International Polar Data Forum'

15–16 October 2013, Tokyo (Japan)

polaris

High-Level Requirements for the Next Generation of Observing Systems for the Polar Regions

Summary Report

Prepared for: European Space Agency

esa

Prepared by: Polar View Earth Observation Limited

Polar View

Report on
WORKSHOP ON CYBERINFRASTRUCTU
FOR POLAR SCIENCES

TOWARDS AN INTERNATIONAL POLAR D
NETWORK

P L Pulsifer[1]*, L Yarmey[1], Ø Godøy[2], J Friddell[3], W Manley[7], A Gaylord[8], A Hayes[9], S Nickels[10], C

[1]National Snow and Ice Data Center, University of Colorado 80309-0449, USA
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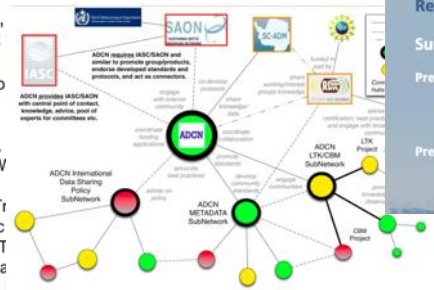
[2]Norwegian Meteorological Institute, Henrik Mohns plass 1,
[3]Canadian Cryospheric Information Network, University of W N2L 3G1, Canada
[4]Research Data Alliance, Rensselaer Polytechnic Institute, Tr
[5]CEN: Centre d'Etudes Nordiques, Laval University, Quebec
[6]NIOZ Royal Netherlands Institute for Sea Research, Texel, T
[7]Institute of Alpine and Arctic Research, University of Colora



Data Management fo. Arctic Observing

sa

Workshop on Arctic Data Coordination at IPY 2012, Montre

to begin to design an Arctic Data Coordination Network will be held at IPY 2012, Montre

A Community White Paper
Prepared for the Arctic Observing Summit 2013

ARCTIC PORTAL CliC IARPC NiPR

Carleton Geomatics and Cartographic Research Centre arcmap

ARCTICDATACOMMITTEE IASC SAON

Polar Knowledge Canada Savoir polaire Canada

IASC

Peter L. Pulsifer[1], Lynn Yarmey[1], Øystein Godøy[2], Julie Friddell[3], Warwick F. Vincent[4], Taco

1 National Snow and
2 Norwegian Meteoro
3 Canadian Cryosphe
4 CEN: Centre d'Etud
5 NIOZ Royal Netherl

Polar Connections

Details

Published: 23 August 2016

Interoperability Workshop and Assessment Process

ARCTICDATACOMMITTEE IASC SAON esa

Polar View EU-PolarNet WMO OMM

Statement of Principles and Practices for Arctic Data Management
April 16, 2013

Response to the

Open Geospatial Consor

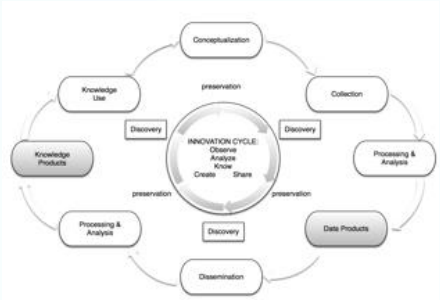
Request for Informatior

Arctic Spatial Data

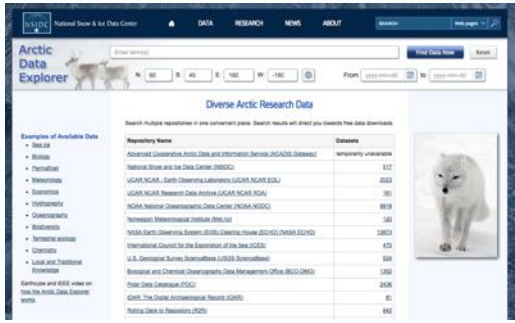
All IASC-endorsed scientific results shall be verifiable and reproducible through ethically open access to all data necessary to produce those results. Data shall be preserved, accessible, and used in accordance with scientific norms of fair attribution and use.

To this end, IASC Council approves the following actions:

1. Endorsement of the Statement of Principles and Practices for Arctic Data

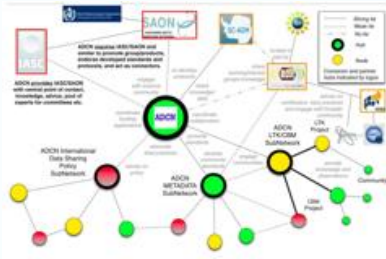


The Data Vision, Challenge

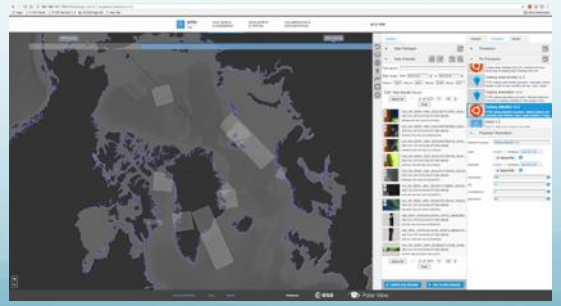


http://nsidc.org/acadis/search/

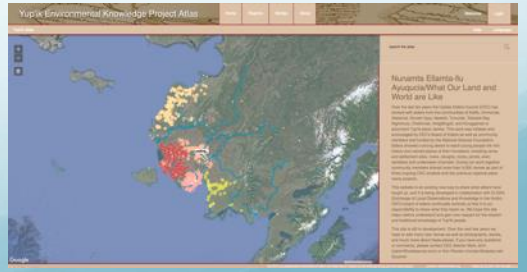
- "Common access, Single Window" to discuss and access data through information technology
- High quality, ethically open data preserved over time (sustainability)
- Data as a service
- Interoperability (share data among various information systems in a useful and meaningful manner)
- Inclusive of Indigenous and local perspectives
- Access to big data and powerful analytical tools (e.g. cloud platforms)
- Cost effective!



Pulsifer xxet al. 2014



Screen capture complements of Polar View

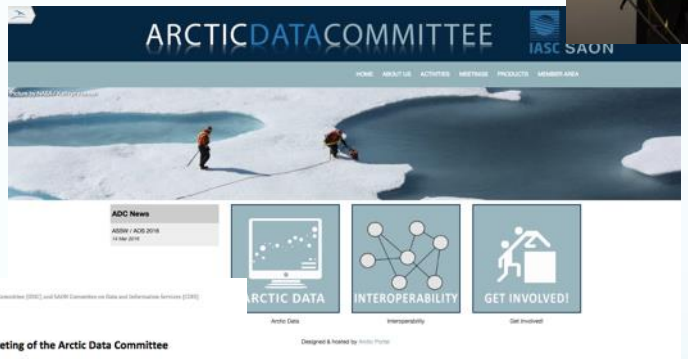


http://eloka-arctic.org/communities/yupik/atlas/index.html

Pulsifer, P. L., Yarmey, L., Godøy, Ø. et al. (2014). Towards an International Polar Data Coordination Network. *Data Science Journal*, 13, 94–102. doi:http://dx.doi.org/10.2481/dsj.IFPDA-16

Arctic Data Committee

- Formed Nov ‘14
- IASC-SAON partnership
- National and voluntary members + Indigenous (2017)
- Promote and enable:
  - **Understanding the system**
  - **Effective data policy**
  - **Infrastructure**
  - **Ethically open access**
  - **Attribution**
  - **Standards and interoperability – <u>FEDERATED SEARCH, SEMANTICS</u>**




Report of the 1st Meeting of the Arctic Data Committee

Meeting Details

/arcticdc.org

Statement of Principles and Practices for Arctic Data Management
April 16, 2013

All IASC-endorsed scientific results shall be verifiable and reproducible through ethically open access to all data necessary to produce those results. Data shall be preserved, accessible, and used in accordance with scientific norms of fair attribution and use.

To this end, IASC Council approves the following actions:

1. Endorsement of the Statement of Principles and Practices for Arctic Data Management;
2. Establishment of an IASC Data Standing Committee;
3. To undertake measures towards adoption of national data policies consistent with

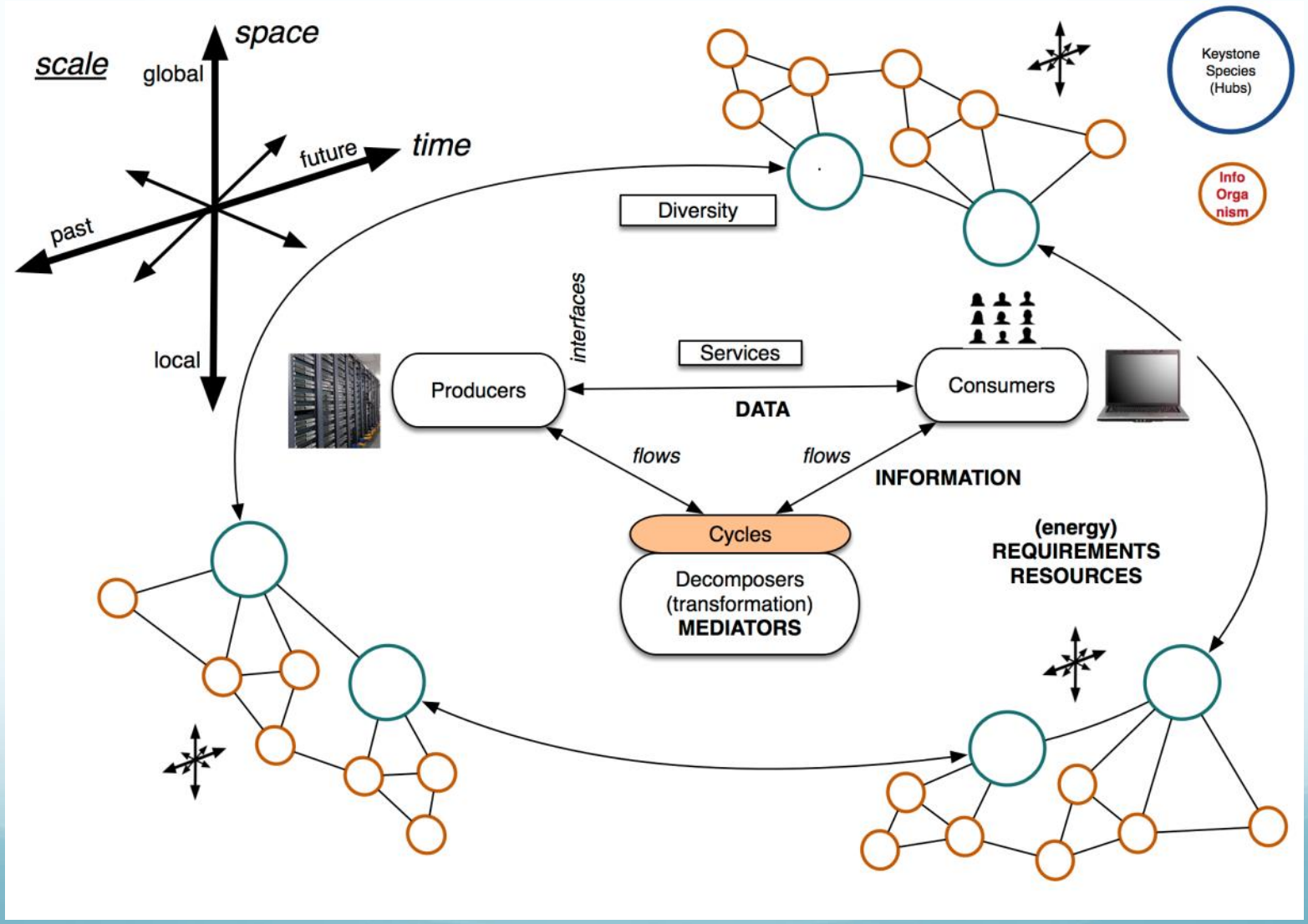
Montreal 16-18 Sept. 2017

https://www.rd-alliance.org/plenaries/rda-tenth-plenary-meeting-montr%C3%A9al-canada

Photo credits: Marten Tacoma

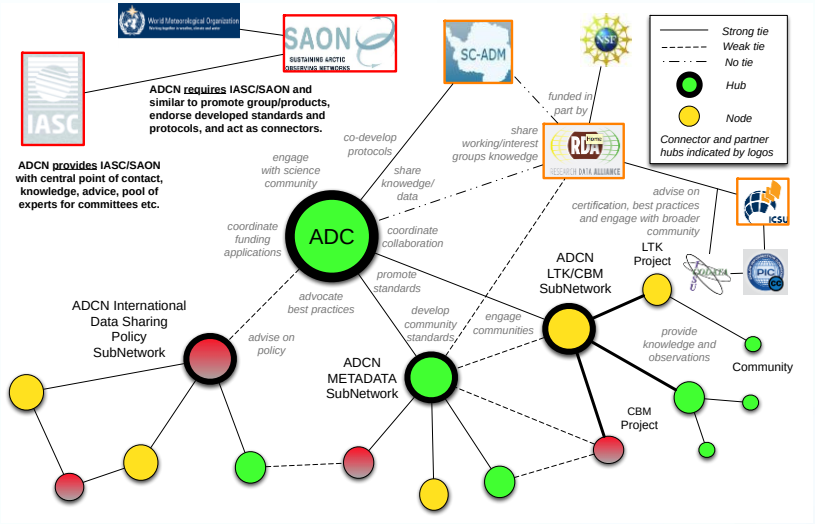
Achieving the Vision: Data as a System

Data Ecosystem

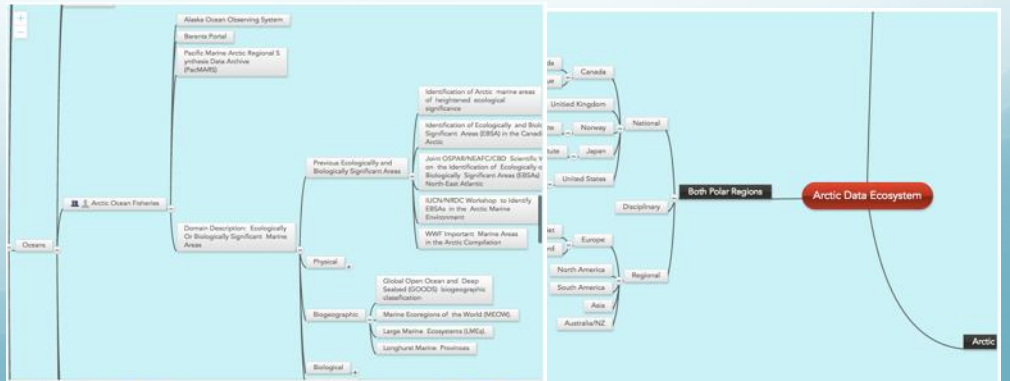


Network Systems Science and the Need for a Distributed System

- Need to guide the design of a robust network that achieves the Vision – pragmatic, Agile
- Robust networks include **multiple** ***hubs*** and less connected nodes – "loose ties" + "hub and spoke (**scale free networks)**"
- **Distributed, multi-scale** system is what we have and what we **want**!
- Strengths: responsive, resilience, diversity, avoids catastrophic failure



Pulsifer, P. L., Yarmey, L., Godøy, Ø. et al. (2014). Towards an International Polar Data Coordination Network. *Data Science Journal*, 13, 94–102. doi:http://dx.doi.org/10.2481/dsj.IFPDA-16

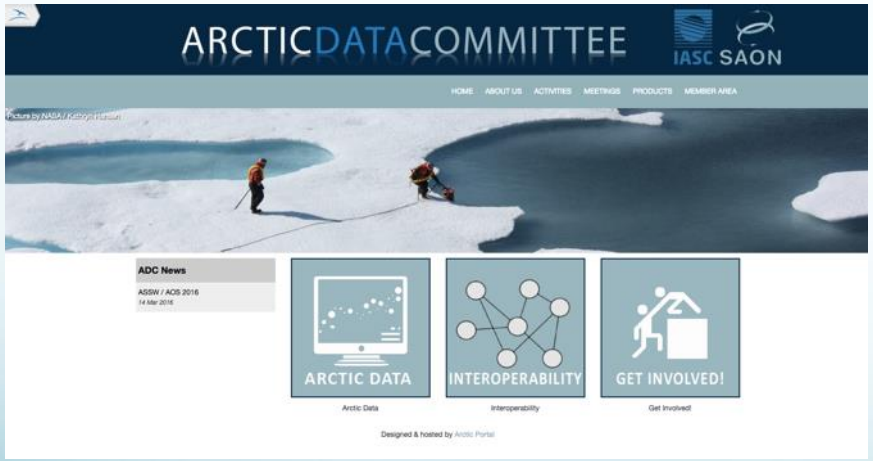


Species (nodes): cyberinfrastructures

- Information environments that support:
  - acquisition,
  - storage,
  - management and curation,
  - integration,
  - mining,
  - visualization,
  - other processing services

Species (nodes): mediator organizations

- Organizations that coordinate and drive collaboration to bring about understanding, agreement and a desired result



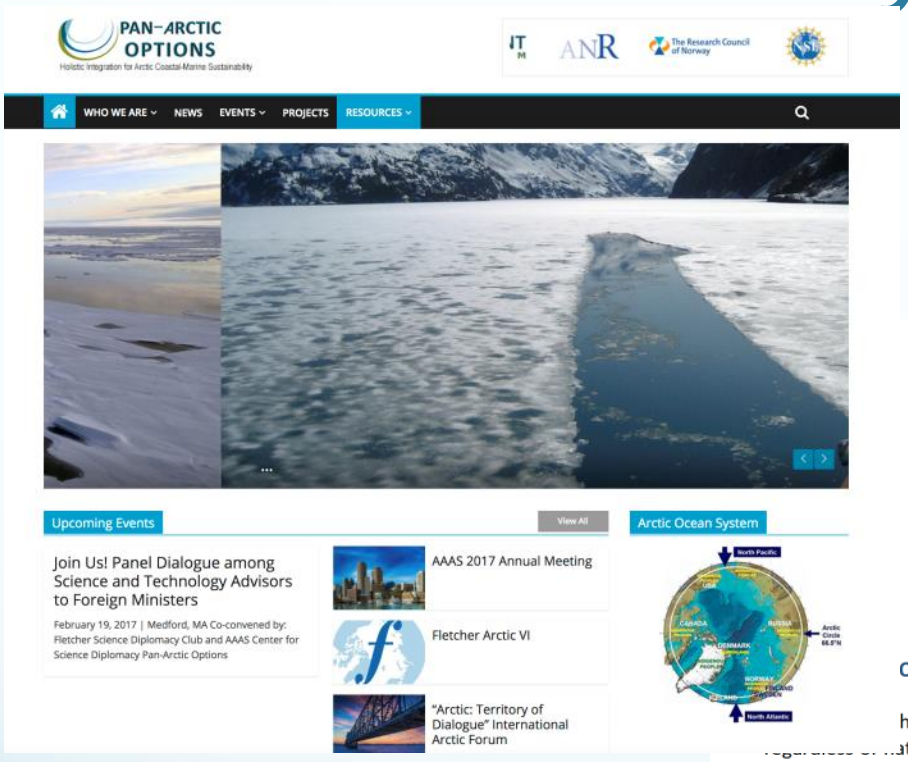
ARCTICDATACOMMITTEE IASC SAON · esa · Polar View · EU-PolarNet · WMO OMM · SCAR Standing Committee on Antarctic Data Management · SOOS · GCW · GEO GROUP ON EARTH OBSERVATIONS · polar tep · YOPP YEAR OF POLAR PREDICTION · AMAP · IARPC COLLABORATIONS

There are many established and emerging mediator organizations

ELOKA

dataARC

Understanding the data ecosystem



Dr. Katia Kontar

Postdoctoral Fellow (*Arctic Data e-Cosystem Scientist*)
Professor Paul Arthur Berkman and Dr. Peter Pulsifer
Fletcher School of Law and Diplomacy, Tufts University
24 Months (with possible extension)

POSTDOCTORAL FELLOW
Arctic Data e-Cosystem Scientist

OF FLETCHER SCHOOL OF LAW AND DIPLOMACY AT TUFTS UNIVERSITY

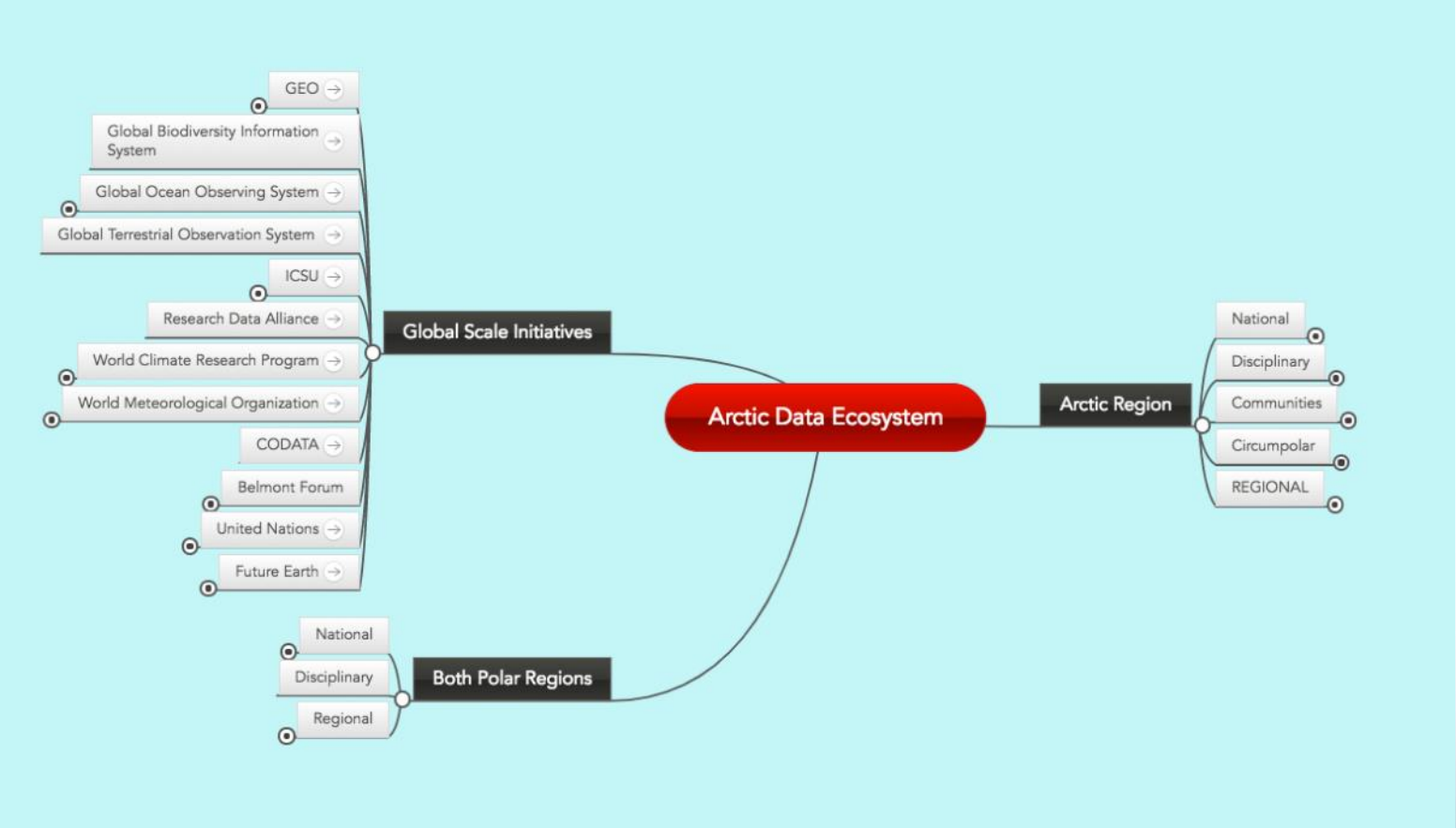
hool is committed to educating in an inclusive and supportive environment that welcomes students
ational origin, religion or citizenship status. At The Fletcher School, for more than 80 years, we have tried to "know the world." Our job is to prepare our graduates to be practitioners in every dimension of international relations: economics, finance, diplomatic history, politics, culture, security and many other disciplines. The challenges we face in this turbulent 21st century quite literally transcend borders – we must be ready to *connect* in every sense of the word.

We seek to build partnerships between nations, government agencies and the public/private sector in order to be ready to shape international issues and events. Our extensive network of graduates today serves in every venue in the global milieu – heads of state and government, political leaders in power and opposition, judges, diplomats, senior military officers, corporate leaders at every level, international bankers, and development officials. The Fletcher School

Focus on Arctic Council Corpus

The Evolving System at Multiple Scales

Preliminary System Model

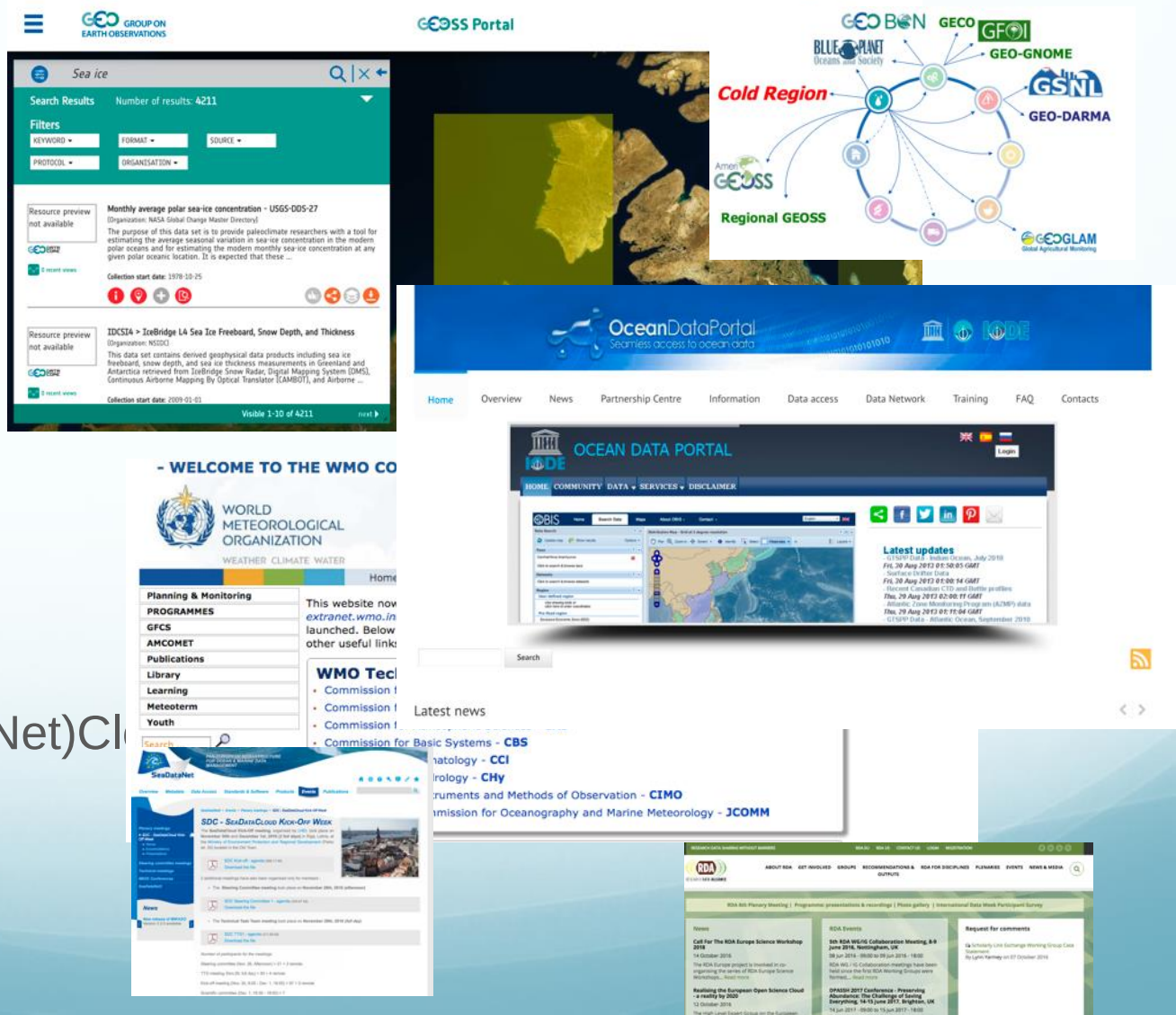


https://arcticdc.org/products/data-ecosystem-map

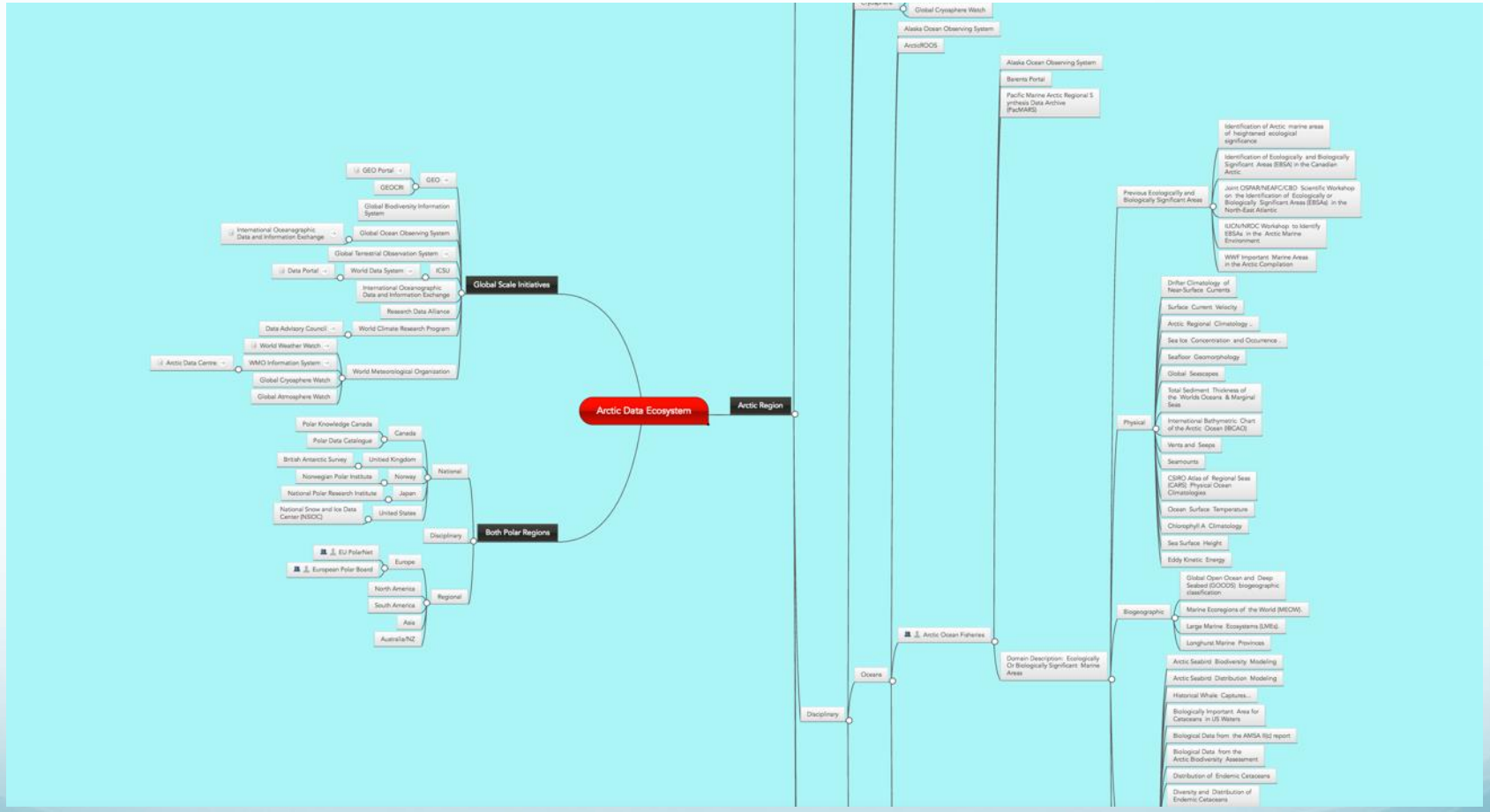
At a high level, the model is quite simple

Global Cyberinfrastructure & Orgs

- WMO
- GEO
- GOOS, IODE
- …
- RDA
- WDS
- CODATA
- IODE (SeaData(Net)Cl



Unpacking the Model

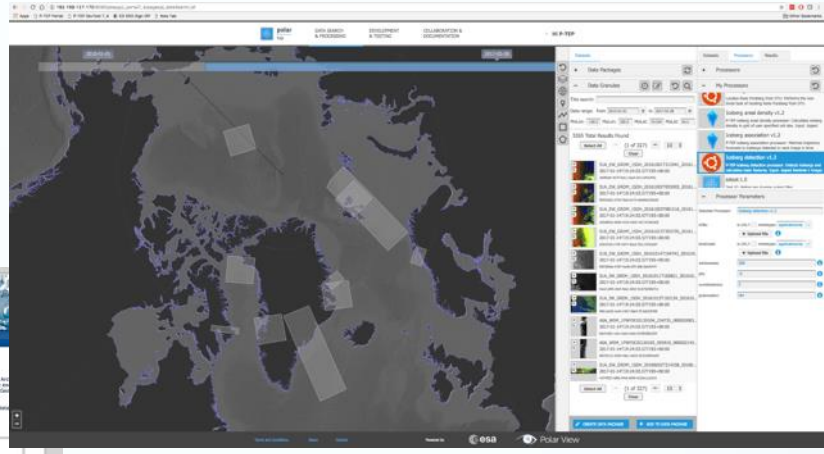


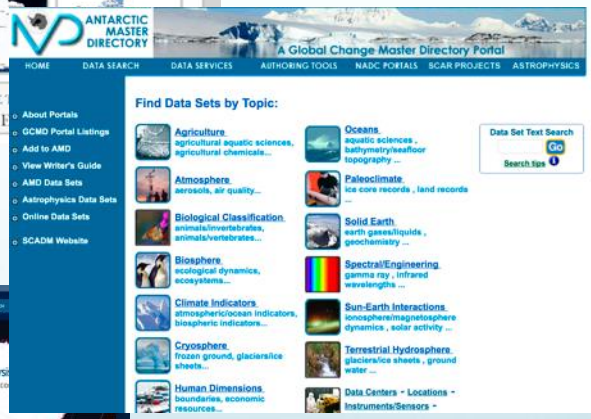
However, further investigation reveals significant complexity

Polar Cyberinfrastructure & Orgs

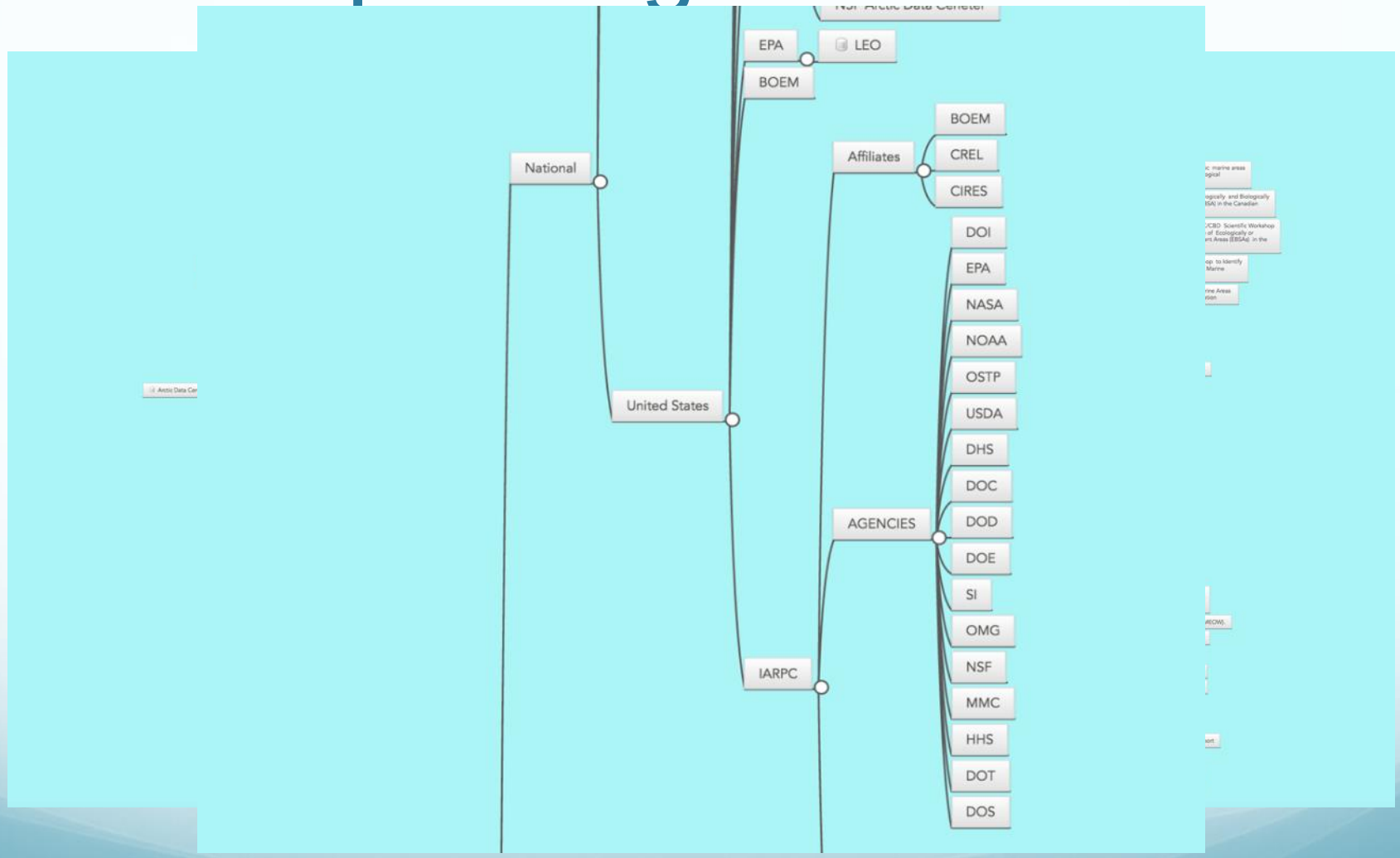
Screen capture complements of Polar View
https://www.polardata.ca/
https://gcmd.nasa.gov/KeywordSearch/Home.do?Portal=amd
http://nsidc.org

- Arctic Data Committee
- SCADM, SOOS
- GCW
- GEOCRI
- AMAP, (AC WGs)
- Arctic SDI
- Polar View / Polar TEP (
- EU-PolarNet
- INTAROS
- OGC ASDP
- …



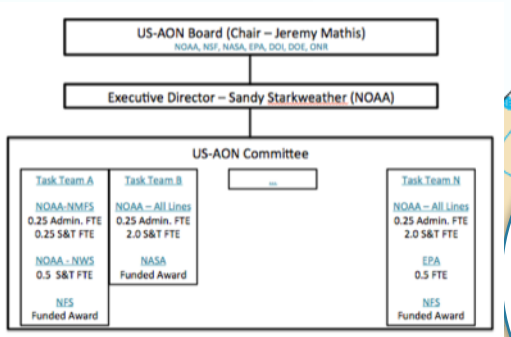


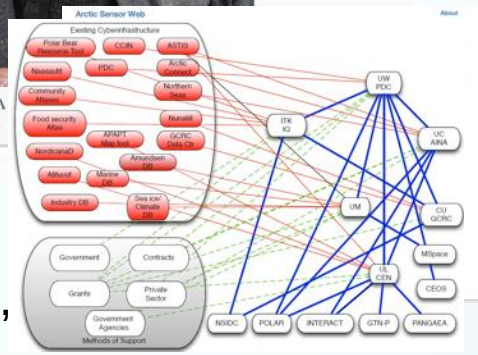
Unpacking the Model



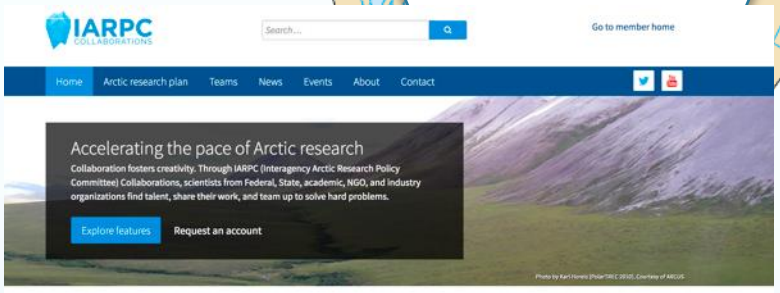
A group like IARPC in the U.S. has its own data ecosystem

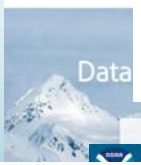
National/Regional Hubs





Many other agencies: **CCADI**, NRCan, EC, DFO, etc.





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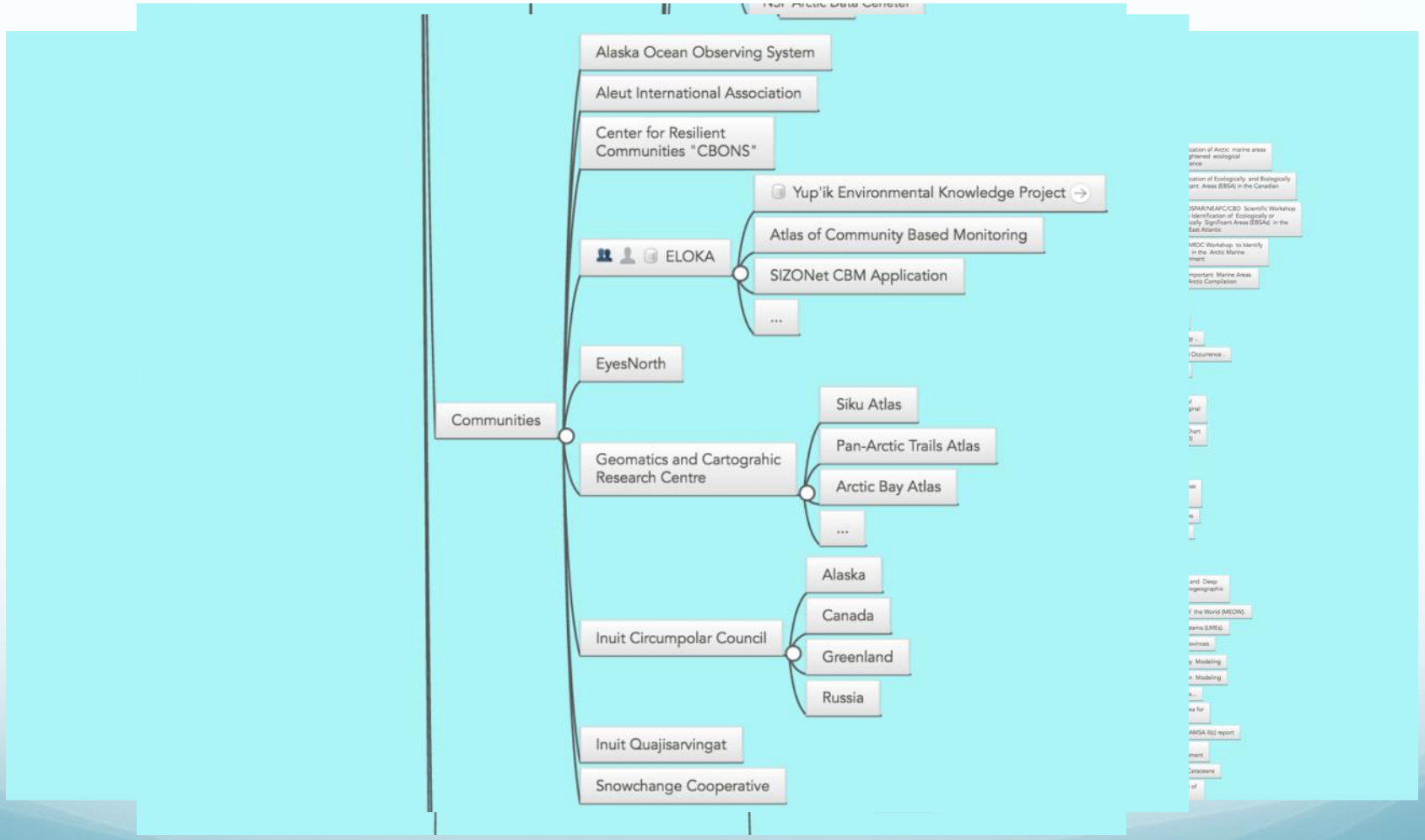
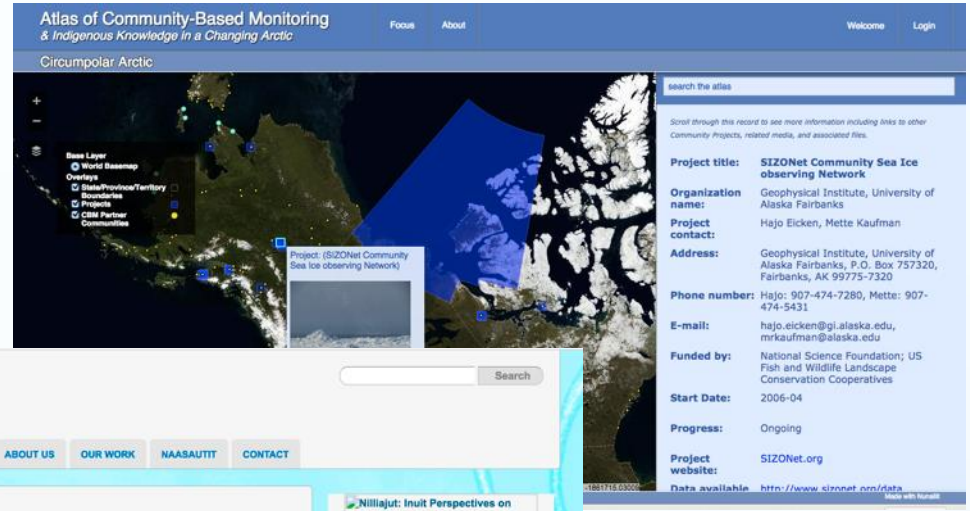


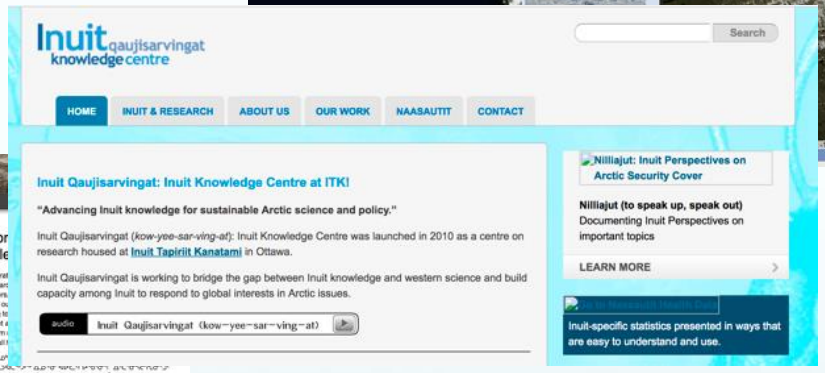
As does the community of groups working with community-based data

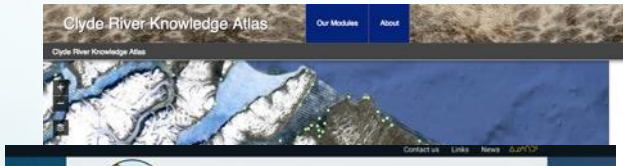
Local Community Hubs and Nodes

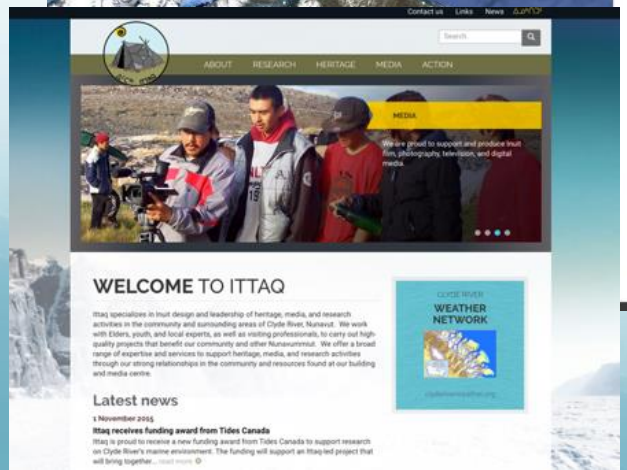
http://www.arcticcbm.org/index.html
http://www.inuitknowledge.ca/
https://toolkit.climate.gov/tool/atlas-community-based-monitoring-and-traditional-knowledge-changing-arctic
http://ittaq.ca/
http://prodgis02.utep.edu/BaidCommunityPlanningTool

- Focus on Community Based Monitoring
- **Inuit Knowledge Centre, ICC, ELOKA, DataArc, EyesNorth, GCRC and others**

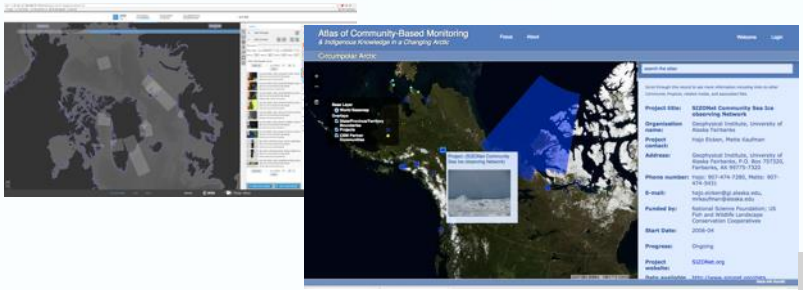








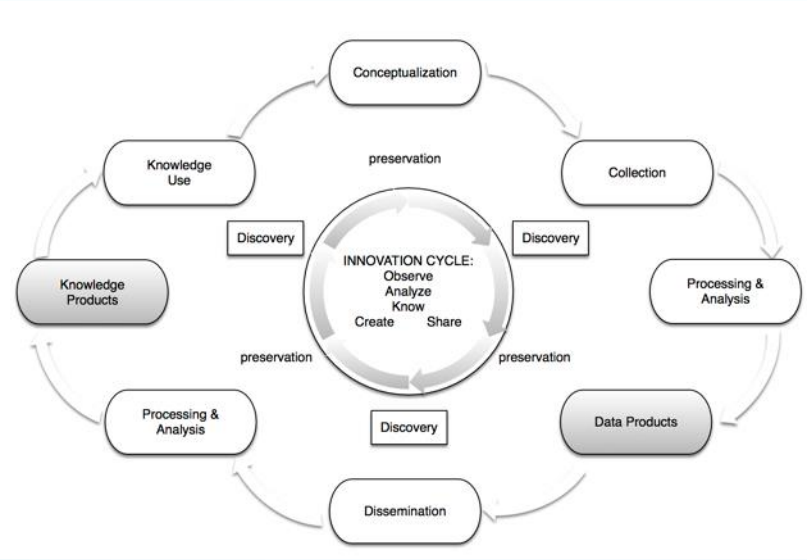







An Arctic Data Ecosystem is Emerging. What can we promote to guide it?

Infrastructure Thinking

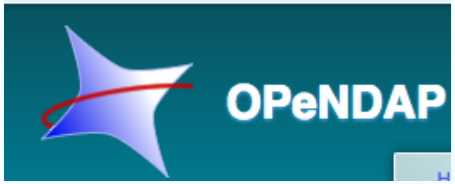


- "Data as available as electricity" (Parsons)
- Infrastructure implies a view of data as **foundational** and necessary for contemporary research, livelihoods, policy, sustainability etc.
- Data has a lifecycle, but **not all parts are infrastructure** (preservation vs. visualization)
- Applications built on top of infrastructure
- Infrastructure can be designed and funded differently
- **Sustainability** is key

Interoperability

- The capability to share data and function among various information systems in a useful and meaningful manner
- Users require little or no knowledge of system specifics
- Many standards already in place!
- Semantics (vocabularies) remain a challenge

- **Fundamental** to creating a **connected, integrated system** (network)



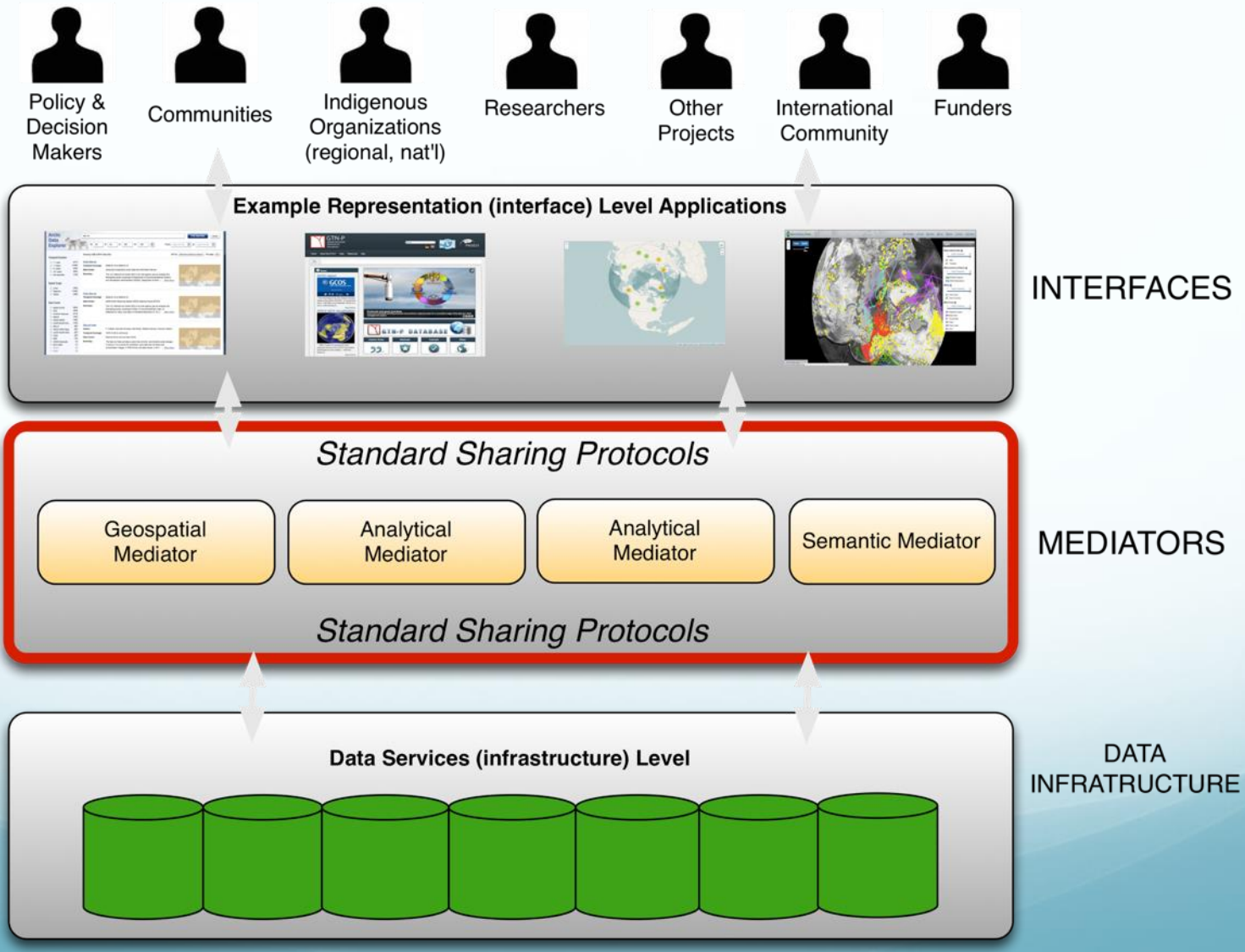
many more …

Mediators

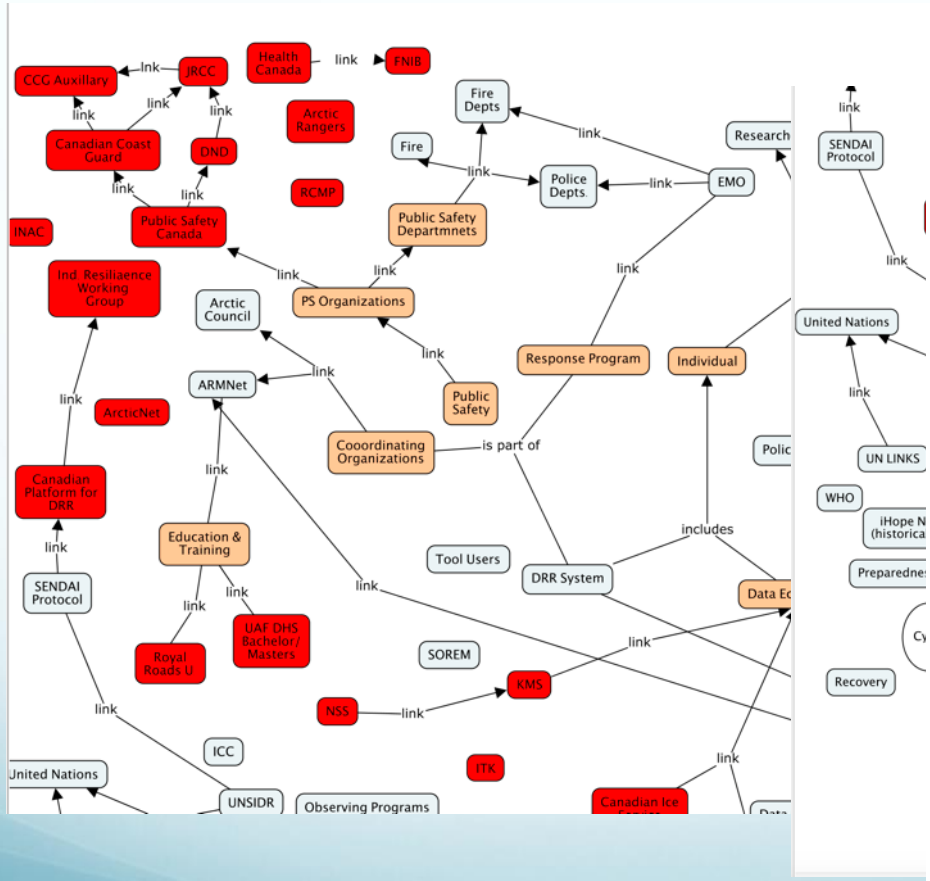
- Full standardization across different communities is difficult
- **Mediators (human and technical)** can aggregate, transform, re-distribute in support of re-use & sharing
- **Mediators** use infrastructure and can be developed and funded separately
- E.g. **Brokering** is emerging as a potential solution to some interoperability issues

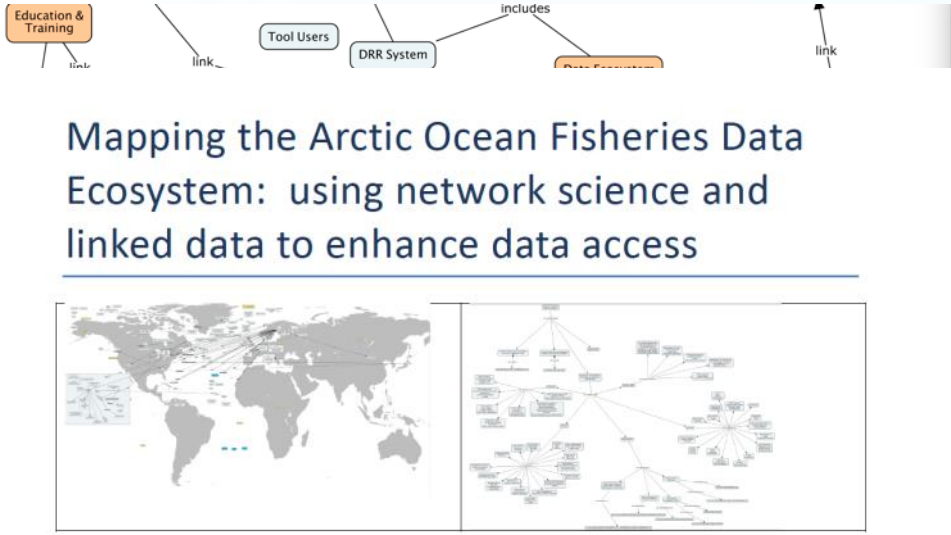
http://gtnp.arcticportal.org/
http://www.esrl.noaa.gov/psd/iasoa/
http://www.arcticobservingviewer.org
https://ace.arsc.edu/
http://eloka-arctic.org

Mediation for a Modular, Cost-Effective System



Case Studies: Many "CoSystems"





Draft Concept Paper Submitted to the *Third Meeting of Scientific Experts on Fish Stocks in the Central Arctic Ocean*

Location: Montlake Laboratory
Northwest Fisheries Science Center
2725 Montlake Boulevard East
Seattle, WA

Dates: April 14– 16 2015

Submitted By:

Peter L. Pulsifer, PhD
Research Scientist, National Snow and Ice Data Center, University of Colorado
Chair, IASC-SAON Arctic Data Committee

“Polar Data Planning Summit”

Enhancing polar research and decision making: advances in international data sharing through active collaboration

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- Evolved through SAON retreat June 2017
- Aims to bring together practitioners and signing authorities from funded DM efforts, cyberinfrastructures
- Focus on a specific, bounded case study
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Concluding Points

- **Situating** the system
- **Understanding** the system
- **Coordination** in an increasingly complex system – building on existing cybr**infrastructures** and mediator technologies and organizations
- **Connecting and sharing across different knowledge domains** (mediation, semantics etc.)