OGC inputs for WMO eWIS-FutureTech workshop

19 - 20 March 2019

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Open Geospatial Consortium (OGC)

20 March, 2019

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Making location count.

OGC input to eWIS-FutureTech workshop

- **Context and Background**
- Now – OWS Standards
  - OGC OWS Standards are mature and can be used immediately
  - Examples of Operational Met based on OWS
  - Extending OWS for Met/Ocean
- Next – APIs and Async
  - OGC/W3C Spatial Data on the Web
  - OGC APIs for Resources
  - Async services
- After Next - Innovation
  - Testbeds
  - OGC Tech Forecasting

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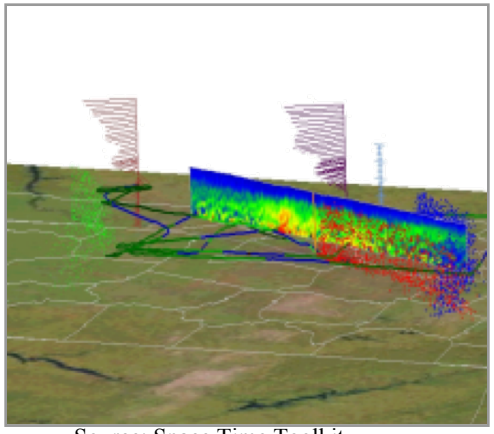
Mission of the Open Geospatial Consortium

Global forum of developers and users of spatial data products and services

Open international standards for geospatial interoperability.



Source: Space Time Toolkit

Source: One Geology

Source: 3d Stadtmodell Berlin

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About the OGC

- OGC is an international industry consortium of over **520** companies, government agencies and universities participating in a consensus process to develop publicly available interface standards
  - Est 1994
  - 100+ standards and profiles
  - 700+ compliant and implementing products
  - 45 countries
  - 60+ working groups
  - 10 key domain areas
  - 11 national and regional forums

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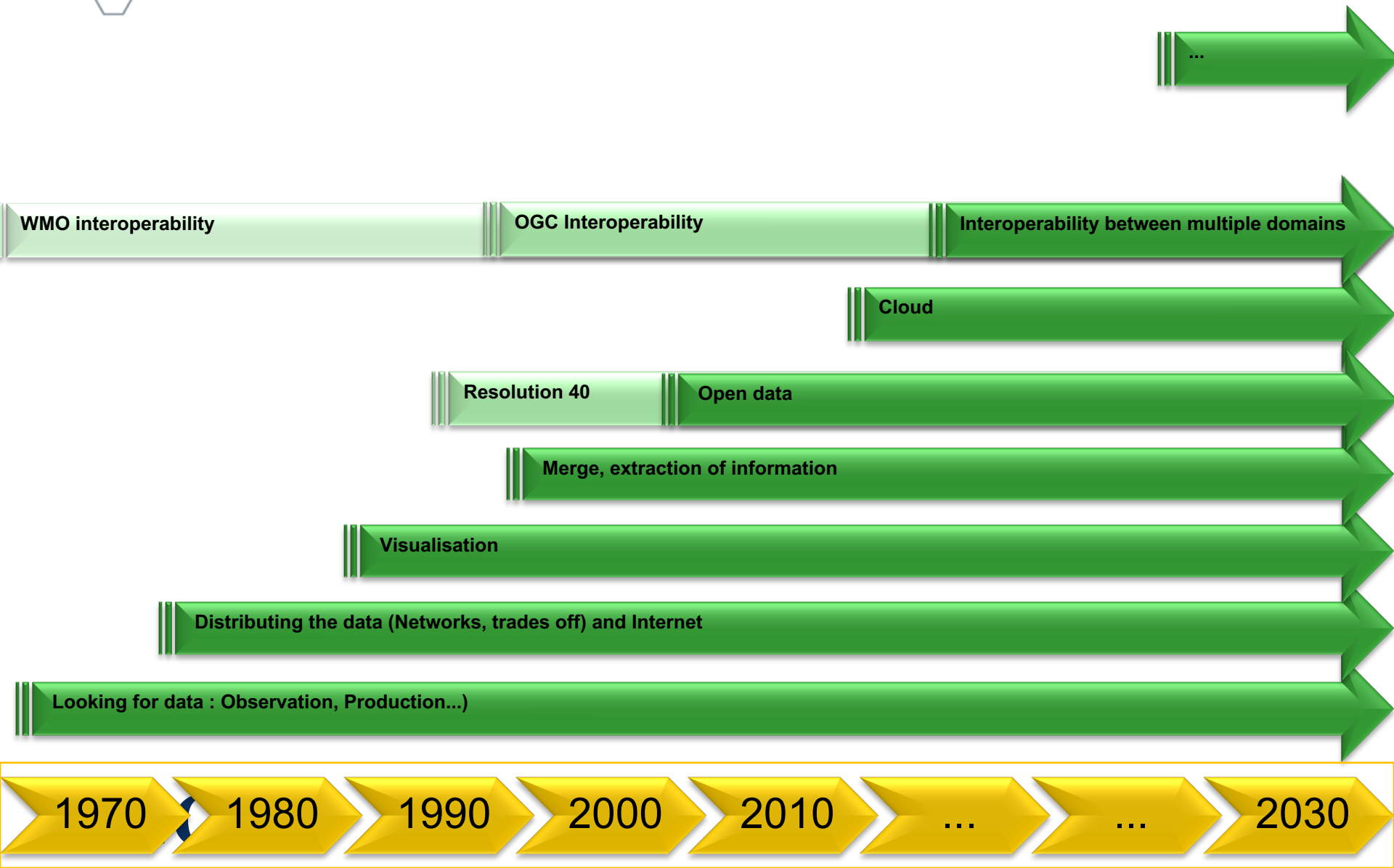
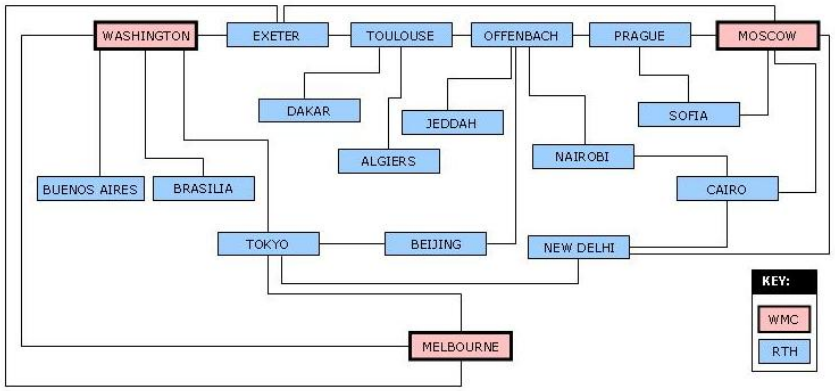
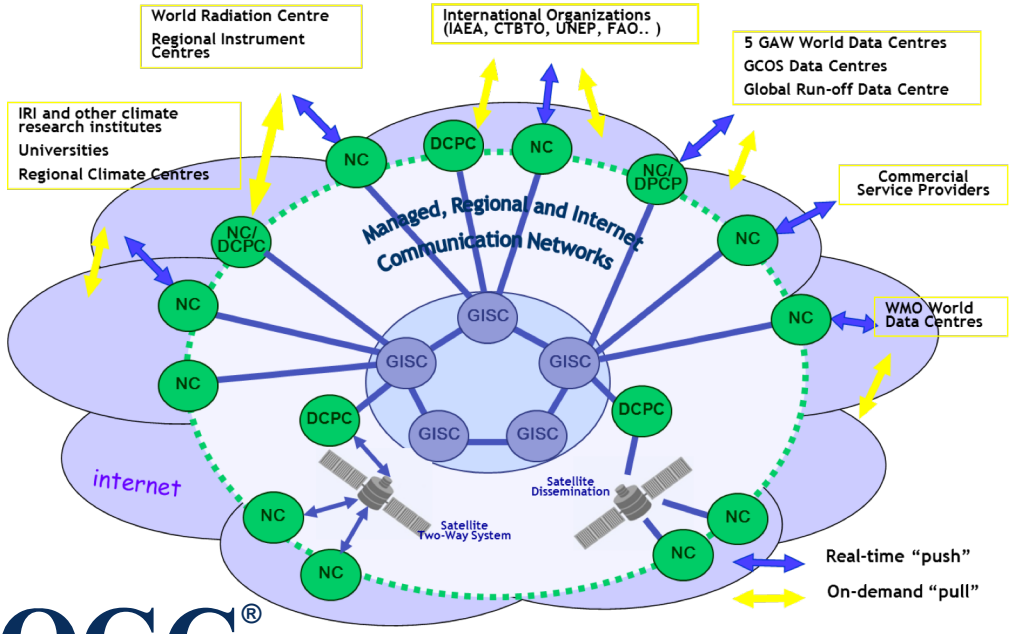
Some milestones



Background: From GTS to WIS a big step



- GTS :
  - Push
  - between Met Services
  - Formats optimised for telecoms



- **WIS :**
  - **Pull**
  - **open to all**
  - **Adding WKN formats**

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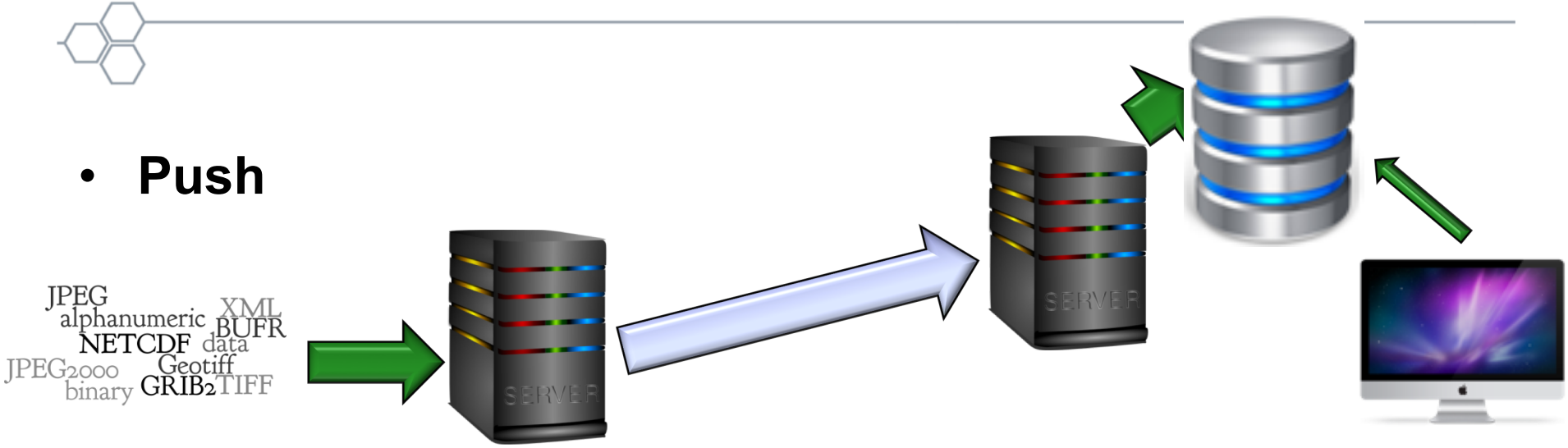
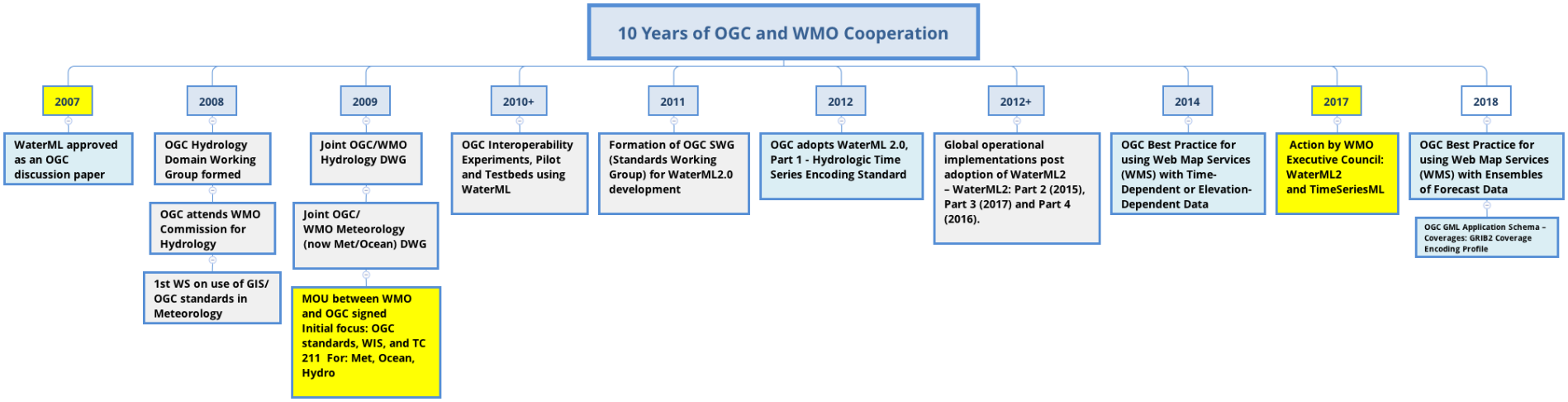
Push or Pull

- **Push**



- **Pull**

10 years of OGC and WMO Cooperation



Work coordination within

Domain Working Groups	Standard Working Groups	Innovation Program
• Hydrology DWG • Met Ocean DWG • …	• WaterML 2.0 SWG • CF NetCDF SWG • WCS SWG • …	• AIP5: • AIP6: Developping support for WaterML within GloFAS • …

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Global trends

- More data
  - **More sources** (Automotive, Crowd sourcing, Drones…)
  - More volumes (increase of resolution of Satellites, Numerical Models…)
- More users
  - Including from other domains
- **Interoperability between domains**
- New expectations
  - **Use the same means as for any other data source**: Mobile, social medias…
  - More value added information than data but with the relevant knowledge about the processing algorithms
  - Quality
  - Security
- Common data sharing plateforms are under construction

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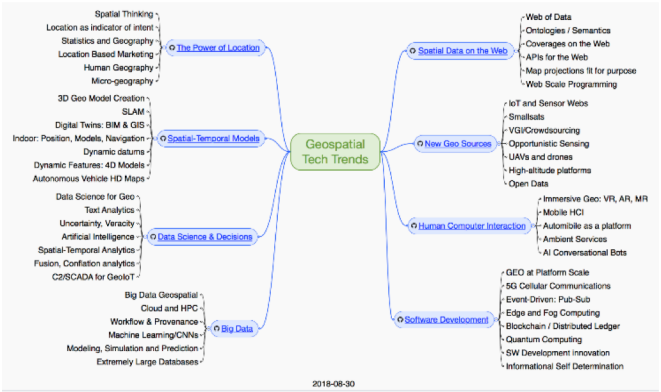
OGC Tech Trends and Roadmapping Process

Breadth

Identification of Technology Trends

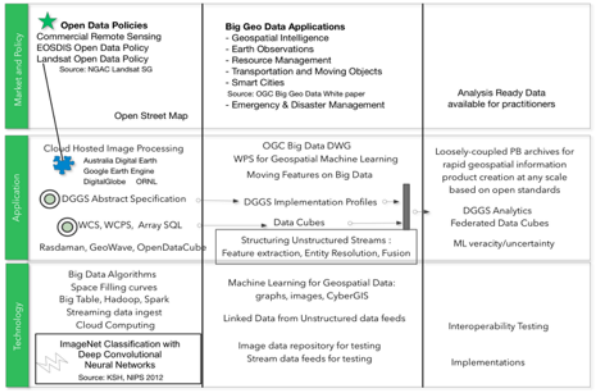
Trends Mindmap



Assessment

Characterize and Prioritize Trends

Technology Roadmaps



Focus

Take Action

- **Innovation Program**
  - e.g. planning Testbeds
- **Standards Program**
  - e.g. Future Directions
- **Communications & Outreach**
  - e.g. Location Powers
- **Member Consultation**
  - e.g. NDA Tailored forecasts/discussion

https://github.com/opengeospatial/OGC-Technology-Trends

MetOcean and Hydro needs standards

Standards need to cover MetOcean and Hydro requirements

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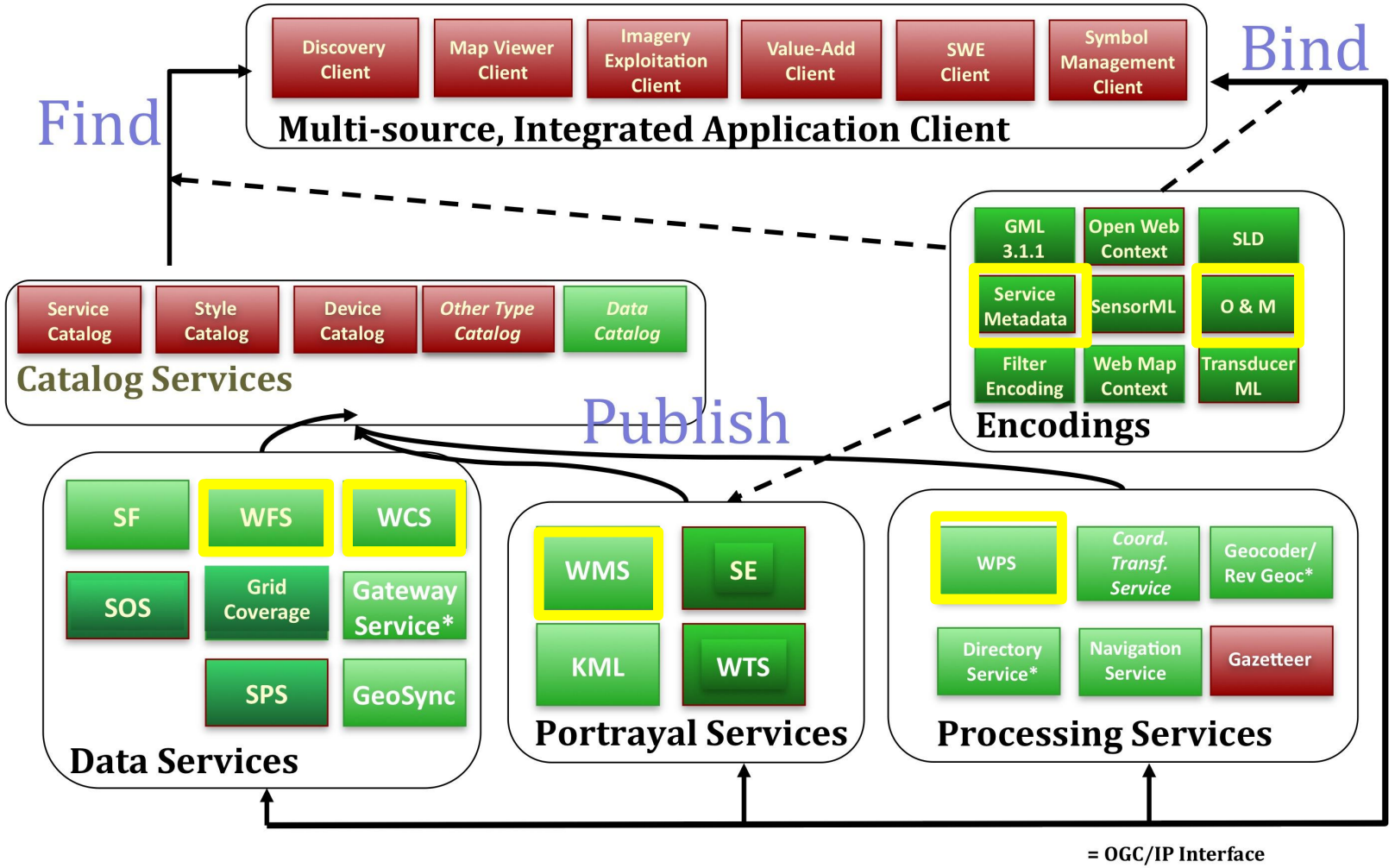
Web Services Framework Of OGC Geoprocessing Standards



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WMO members and ECMWF implementations making data more accessible especially outside Met Ocean domain

WMS: DWD, FMI, KNMI, Météo-France, NOAA, NRCAN, SMHI, UK Met Office, ECMWF (Copernicus CAMS and C3S) …

WFS: DWD, FMI …

WCS: DWD, FMI, KNMI, Météo-France, NOAA, NRCAN, SMHI, UK Met Office, ECMWF (Copernicus CAMS and C3S) …

+ Commercial of the shelf, Open Source Software, Libraries for most popular programming languages

… these are only some examples

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Addressing the Geospatial Interoperability Challenge

1000s of Services, 100Ks Datasets Worldwide using OGC Standards

OGC Web Services

Web Map Service – WMS

Web Feature Service – WFS

Web Coverage Service – WCS

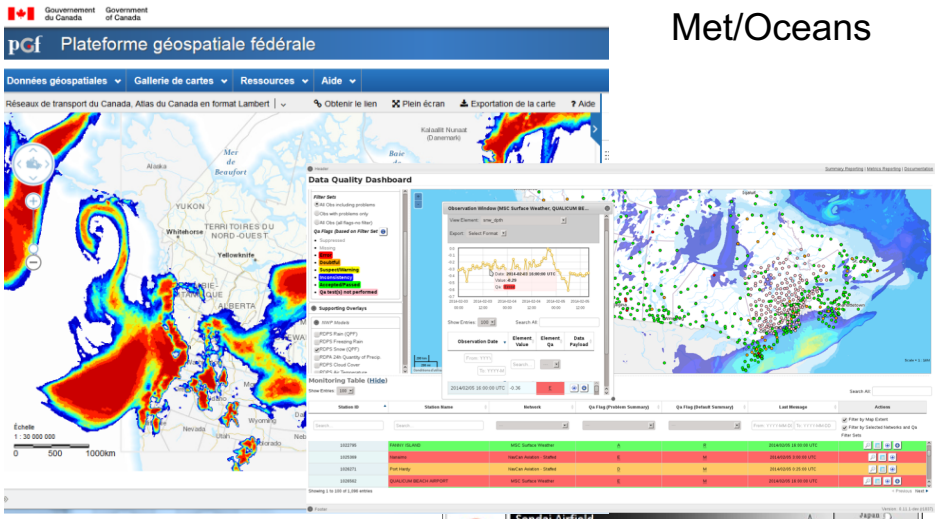
Web Processing Service – WPS

Web Map Tile Service – WMTS

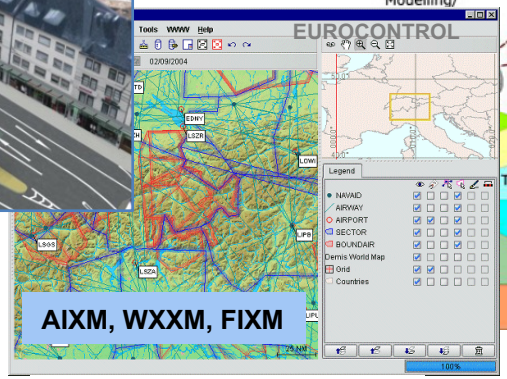
KML, GML, GeoPackage

GeoTIFF, NetCDF, HDF, (WaterML)

Met/Oceans

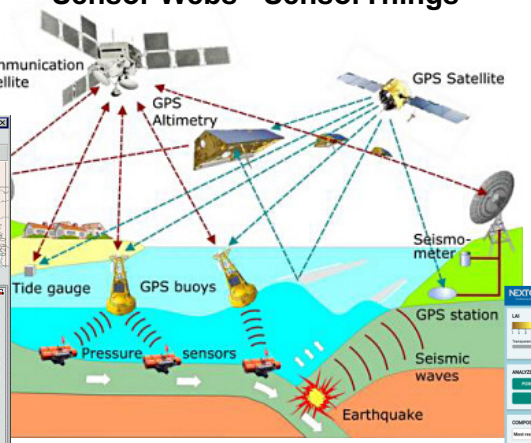


Urban Operations



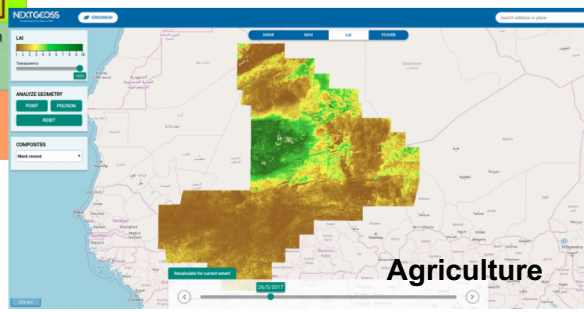
Aviation

Sensor Webs - SensorThings



Met, Hydro, Ocean, Marine

Disaster Management



Agriculture

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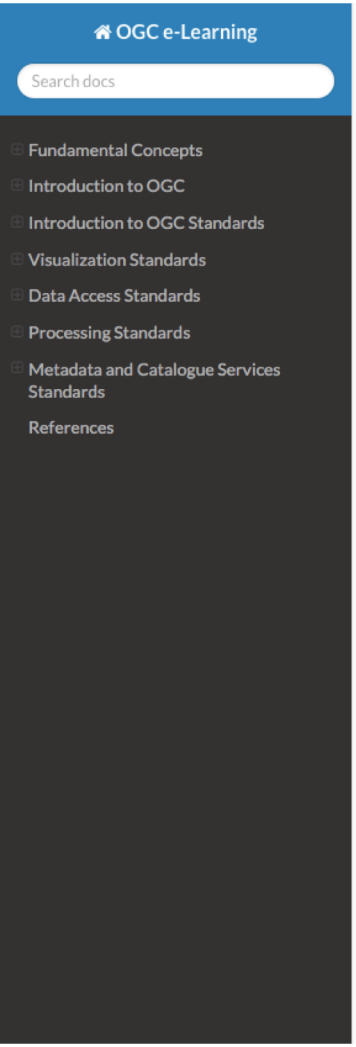
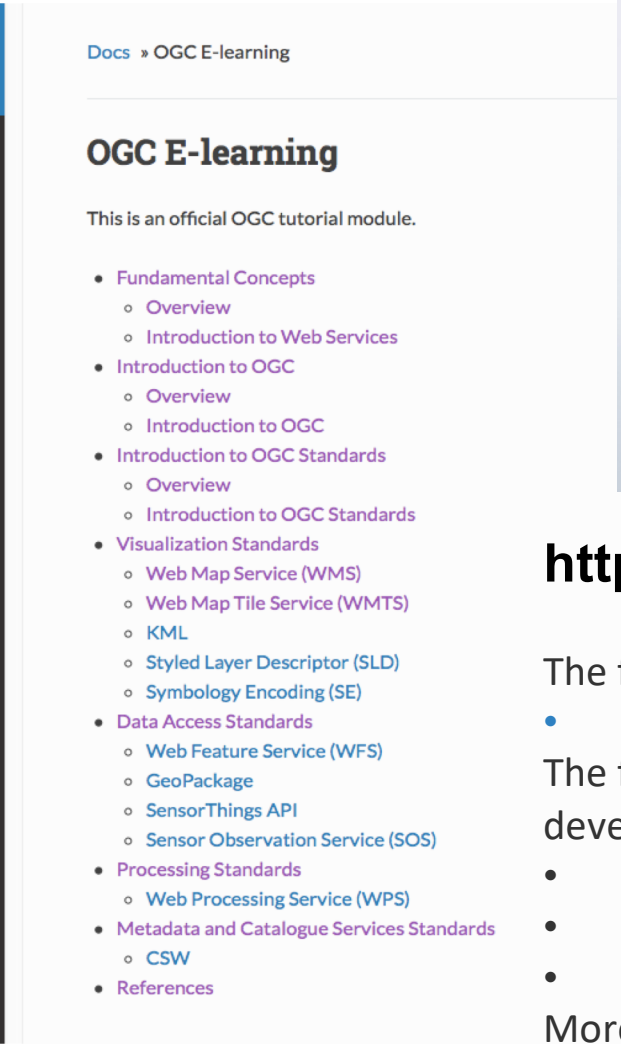
OGC e-Learning program and s certification of successful completion of examinations





http://www.opengeospatial.org/learning

The following exams are currently available:

- Web Map Service (WMS)

The following exams are currently under development:

- Geography Markup Language (GML)
- GeoPackage
- Web Feature Service (WFS)

More exams will be added over time.

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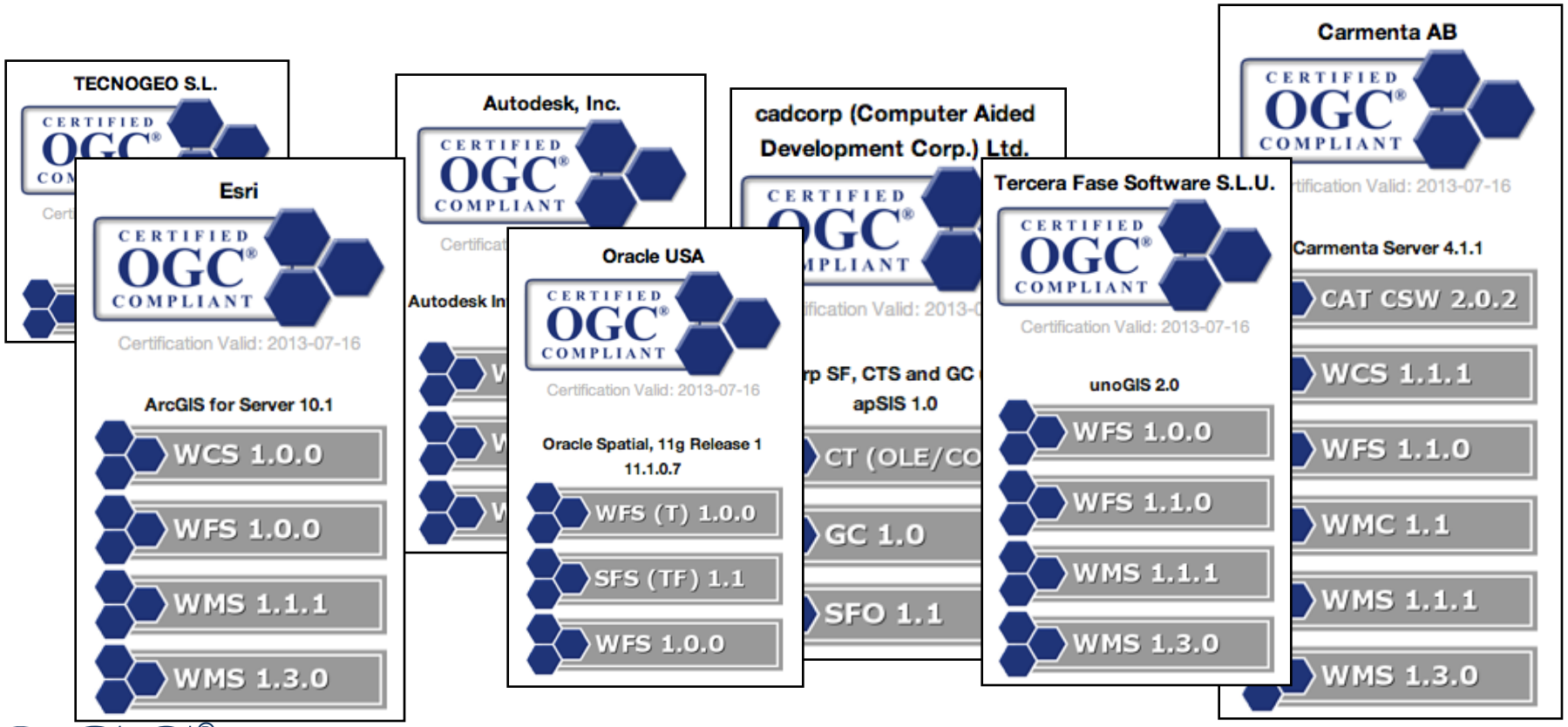
800 implementing products in the market



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http://www.opengeospatial.org/resource/products/compliant

OGC Certified Compliant

Better Assure that an OGC-based product works with other products

Organizations procuring technology solutions

Purchasers of Software

Users of Open Source Software

search

There are: 794 Implementing Products and 210 Compliant Products

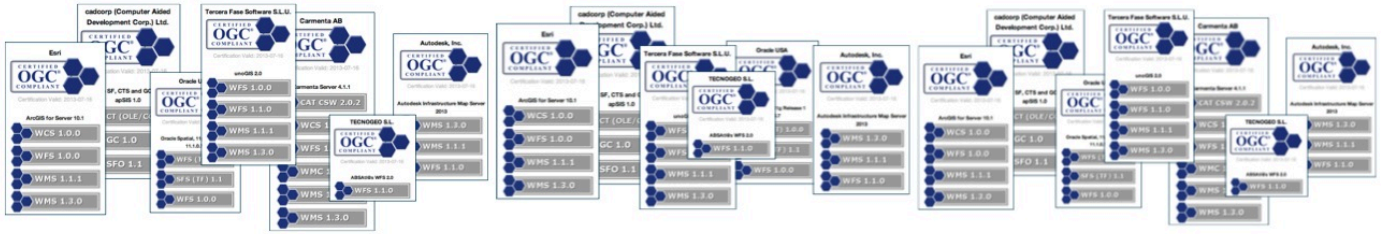
The OGC Implementation database

(www.opengeospatial.org/ resource/products/compliant)

Total = Number of implementations. **Comp** = Number of compliant products.

Total	Comp.	Specification / Version	Abrv / Version
502	121	Web Map Service (1.1.1)	WMS 1.1.1
323	66	Web Feature Service (1.0.0)	WFS 1.0.0
320	91	Web Map Service (WMS) Implementation Specification (1.3.0)	WMS 1.3.0
289	0	Web Map Service (1.0)	WMS 1.0
253	54	Web Feature Service (WFS) Implementation Specification (1.1.0)	WFS 1.1.0
252	0	Web Map Service (1.1)	WMS 1.1

verify compliance



http://www.opengeospatial.org/resource/products/compliant

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Meteorological data structures – a challenge

3D ► 4D ►

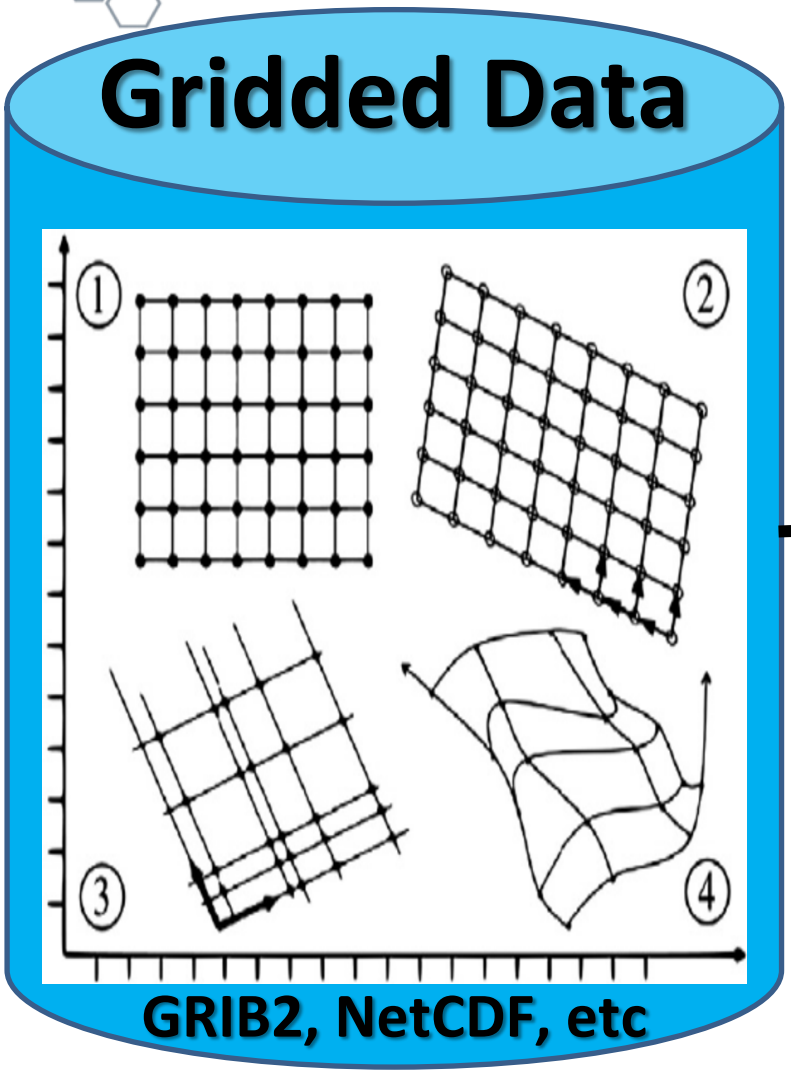
- Large data volumes
- Multi-dimensional
- Lots of metadata
- Heterogeneous (forecast, analysis, etc)
- GRIB data format

MetOcean Application Profile for WCS 2.0
(Pete Trevelyan)

- Definition of "4D coverage" that share horizontal/temporal domains
- Principle of coverage collections

ECMWF

Example: OGC Web Coverage Service (WCS)



Publish as a service with OGC Standards

WCS

Request & Response API's

-GetCapabilities
-DescribeCoverage
-GetCoverage

Returns (respectively):

- Metadata: Service Properties/Offered Data
- Metadata: Info on Specific Coverage
- Queried Data (or Subset)

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So What's the Issue with "Coverages" ?

- **Data Size, Volume, Resolution**
  - *Insufficient* storage, computer resources, bandwidth

  → ***Transfer*** of MetOcean data sets harder to push thru web services

- **Subsetting**
  - Returns only data *necessary* to consumer
  - WCS Core Functionality: Trimming, Slicing, but ***lacking***…

  → *Not* ***tailored*** to specific MetOcean community's needs.

- **Interoperability**
  - *Improvement* between disparate web services. Needed for global cooperation → SESAR & NEXTGEN.

  → Can we ***describe*** MetOcean WCS data in a ***community-based controlled vocabulary ?***

- **MultiDimensionality**
  - MetOcean data inherently ***4D*** (x/y/z/t)
  - WCS Coverages often ***2D*** (x/y)
  - Size & # WCS Requests & Responses w/ 2D Coverages ***unwieldy***

→ ***Need new way of thinking about MetOcean coverages!***

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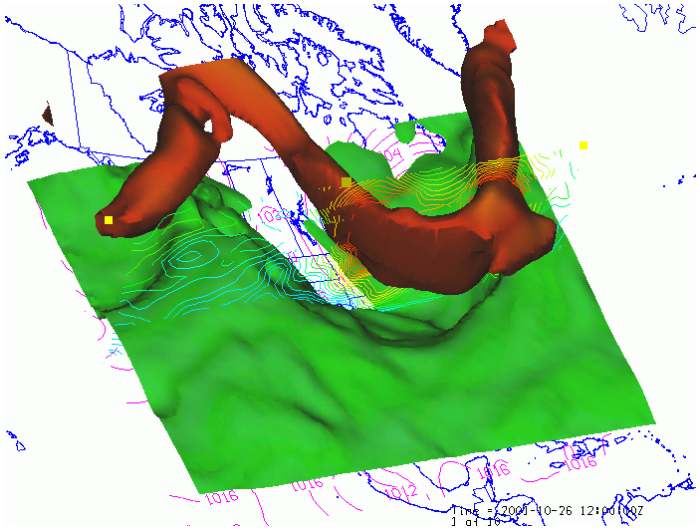
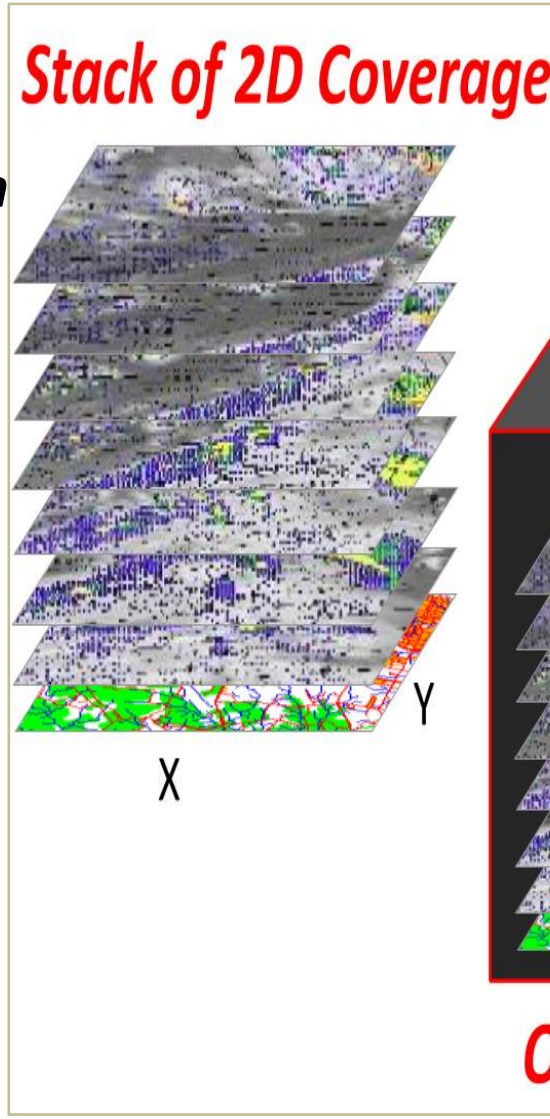
Met Ocean works

- *WCS2.1 Collection Extension allows to handle 4D*
- *Reduces the number of coverages, improves efficien of the number of coverages*
- *New DescribeCoverageCollection Operation*





→ *Allows consumers ability to singularly extract 4D/5D/+ data over geography, time, altitude, & ensembles, +*

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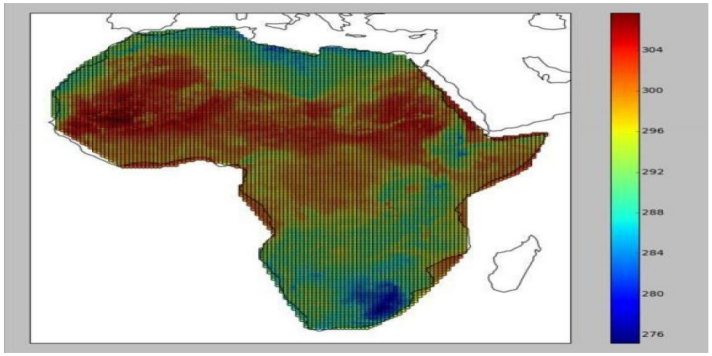
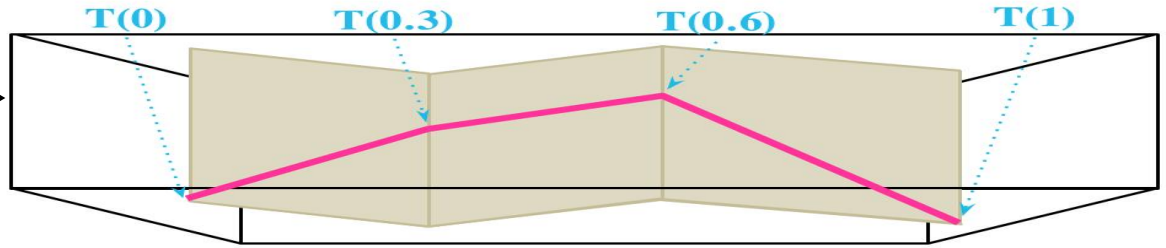
Getting the Data: New Operations to Query MetOcean Coverages

- Complex Data Extraction
  - Derived/Developed from Multi Dimensionality and 4D Coverages
  - Improved Efficiency: User retrieves only the data of interest.
- Tailored to common MetOcean Data Shapes
  - More Explicit than the WCS GetCoverage operation

- GetPolygon →
  - Extract Data over an Area or Volume



- GetCorridor →
  - Extract Data for a Path or Trajectory with Volume



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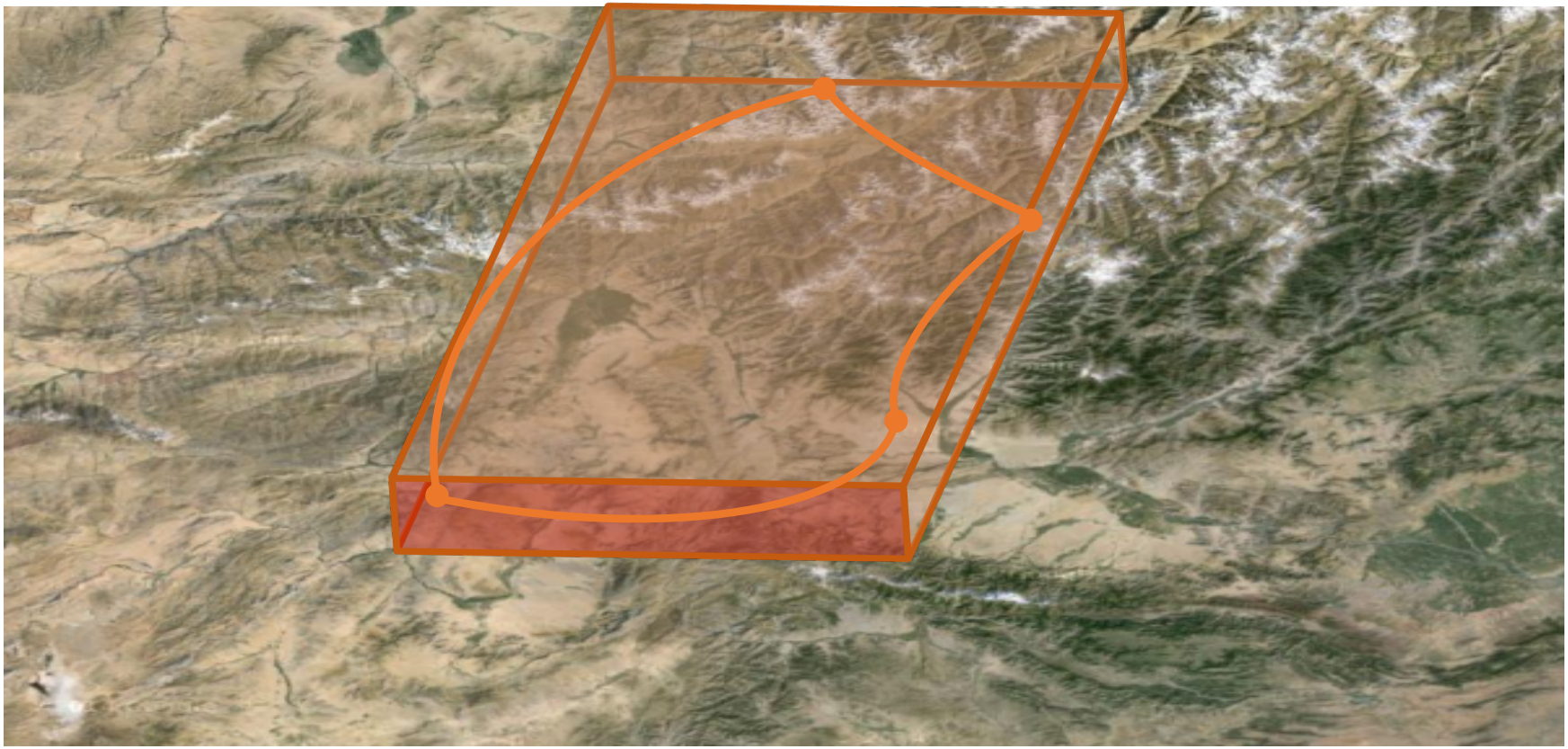
What are Polygons in the MetOcean world ? (More Complex 4D Case)

Multi-Dimensional Data volumes may be reduced into polygons by a simple sub-set:



Volume = dLat x dLon x dAlt x dTime

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OGC Definition server

- Supporting Semantic Web standards to link resources
- Register of registers
- WMO Essential Variables could be one register,
- Supports triples, APIs providint HTML or JSON-LD, TURTLE… supporting content negociation
- Provides an admin GUI to add or delete entries
- And provide URL redirection to provide stable URLs
- OGC could host WMO essential variables definitions to easy discoverability by other domains applications and experts
- OGC Definition server

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Evolution of OGC Web Services

- Modernized service/resource/REST architecture
- OpenAPI specification and toolkits
- Focus on developer experience
- Modularizes into OWS “building blocks” for reuse in any microservices APIs
- OGC/W3C “Spatial Data on the Web” Best Practices

Open process: all in public GitHub repo, early implementations, in-depth validation, slow release

=> https://github.com/opengeospatial/OGC-Web-API-Guidelines

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Spatial Data on the Web Interest Group

Two standards bodies working **together**

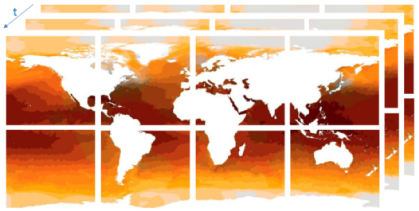
towards a **Web** of **Spatial** and (**Linked**) **Data**

Use cases & Requirements

Best Practices

OWL Time ontology

Semantic Sensor Networks ontology



CovJSON & Coverages in Linked Data Including time series using WaterML 2 Part 1 as an initial basis

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Spatial Data on the Web Best Practices

W3C Working Group Note

TABLE OF CONTENTS

Spatial Data on the Web Best Practices

W3C Working Group Note 28 September 2017

This version:
https://www.w3.org/TR/2017/NOTE-sdw-bp-20170928/

Latest published version:
https://www.w3.org/TR/sdw-bp/

Latest editor's draft:
https://w3c.github.io/sdw/bp/

Previous version:
https://www.w3.org/TR/2017/NOTE-sdw-bp-20170511/

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OGC Document Number:OGC 15-107
Accessible on W3C Website
as a **W3C** Working Group Note and an OGC Best Practice

WFS 3.0 Core - Resources

Table 1. Overview of resources, applicable HTTP methods and links to the document sections

Resource	Path	HTTP method	Document reference
Landing page	/	GET	7.2 API landing page
API definition	/api	GET	7.3 API definition
Conformance classes	/conformance	GET	7.4 Declaration of conformance classes
Feature collections metadata	/collections	GET	7.11 Feature collections metadata
Feature collection metadata	/collections/{name}	GET	7.12 Feature collection metadata
Feature collection	/collections/{name}/items	GET	7.13 Feature collections
Feature	/collections/{name}/items/{fid}	GET	7.14 Feature

information about the API

a dataset with a sub-division into named collections of features

the features

https://cdn.rawgit.com/opengeospatial/WFS_FES/3.0.0-draft.1/docs/17-069.html#tldnr

Only the feature resources are specific to a “feature service”

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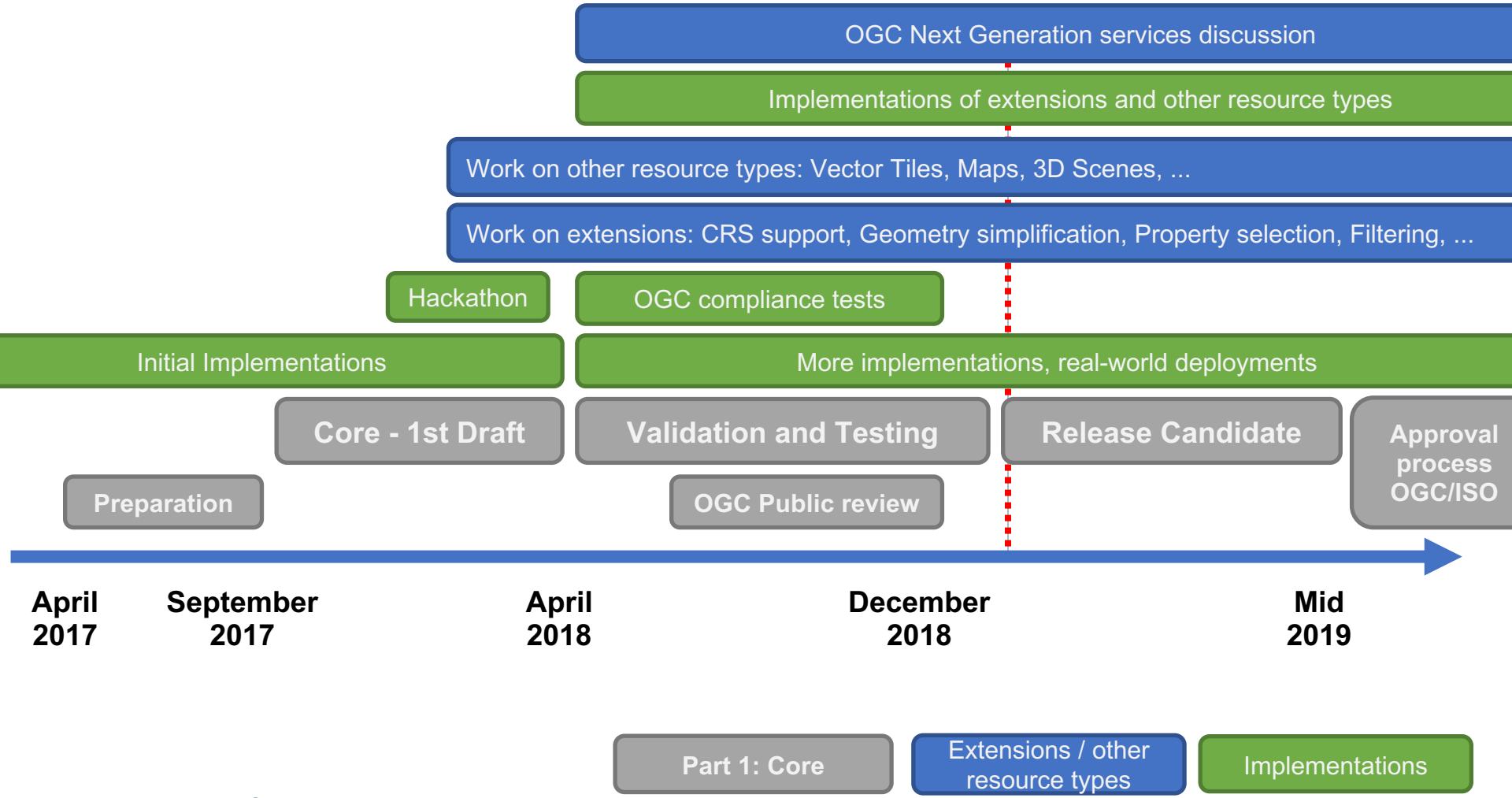
WFS 3.0 – Status and Timeline



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WCS MetOcean Profile and OGC APIs

- OpenAPI on top of WCS2.1 interface abstracts away complexity; specifically built to meet users needs
- WCS2.1 with the MetOcean profile used in an operational context
- System still being built, but a flow of data was established last September and more data being added on weekly basis
- There is a big push to establish a proper set of both “Discovery” metadata as well as supporting NetCDF,GRIB2, plus other formats such as CovJSON.

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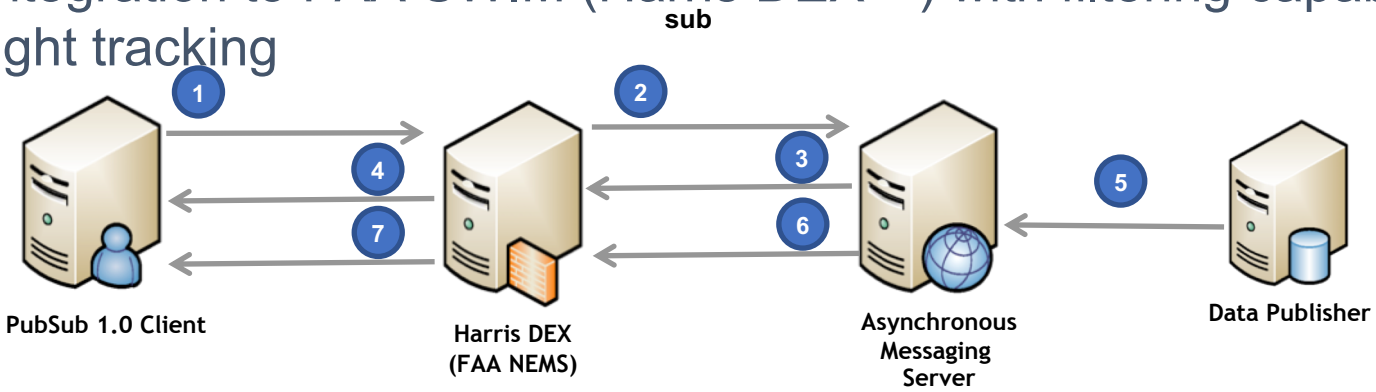
Async services with PubSub

- OGC Web Services (WFS, WMS, WCS, WPS, etc.) are originally request/reply, “synchronous” services
- PubSub 1.0 Specification provides a solution for subscription-based messaging
- OGC Testbed 12 (2016) implemented an Aviation PubSub 1.0 service with integration to FAA SWIM (Harris DEX™) with filtering capabilities for Flight tracking



- OGC Testbed 13 (2017) implemented an Async WFS supporting use cases where the response cannot or should not be delivered immediately (large data sets or delivering data for offline analysis).

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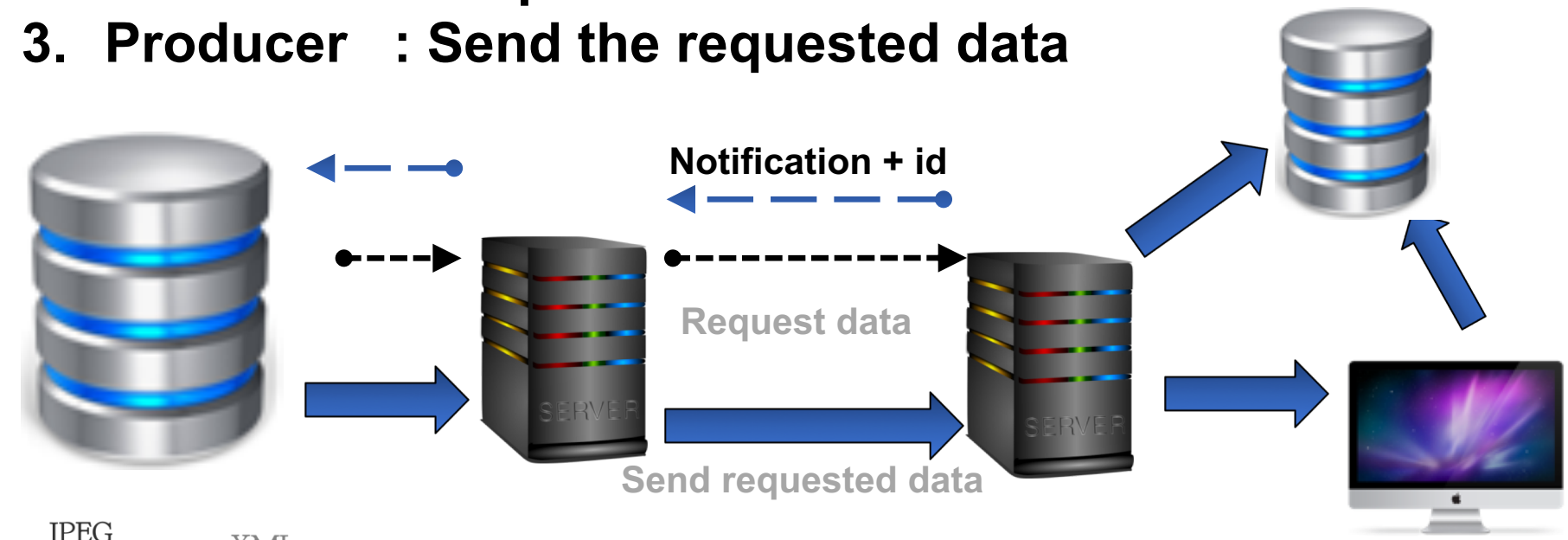
New Implementation of Push and Pull

1. **Producer : Push Notification +Id**
2. **Consumer : Request needed data**
3. **Producer : Send the requested data**



JPEG alphanumeric XML BUFR NETCDF data JPEG2000 Geotiff binary GRIB2 TIFF

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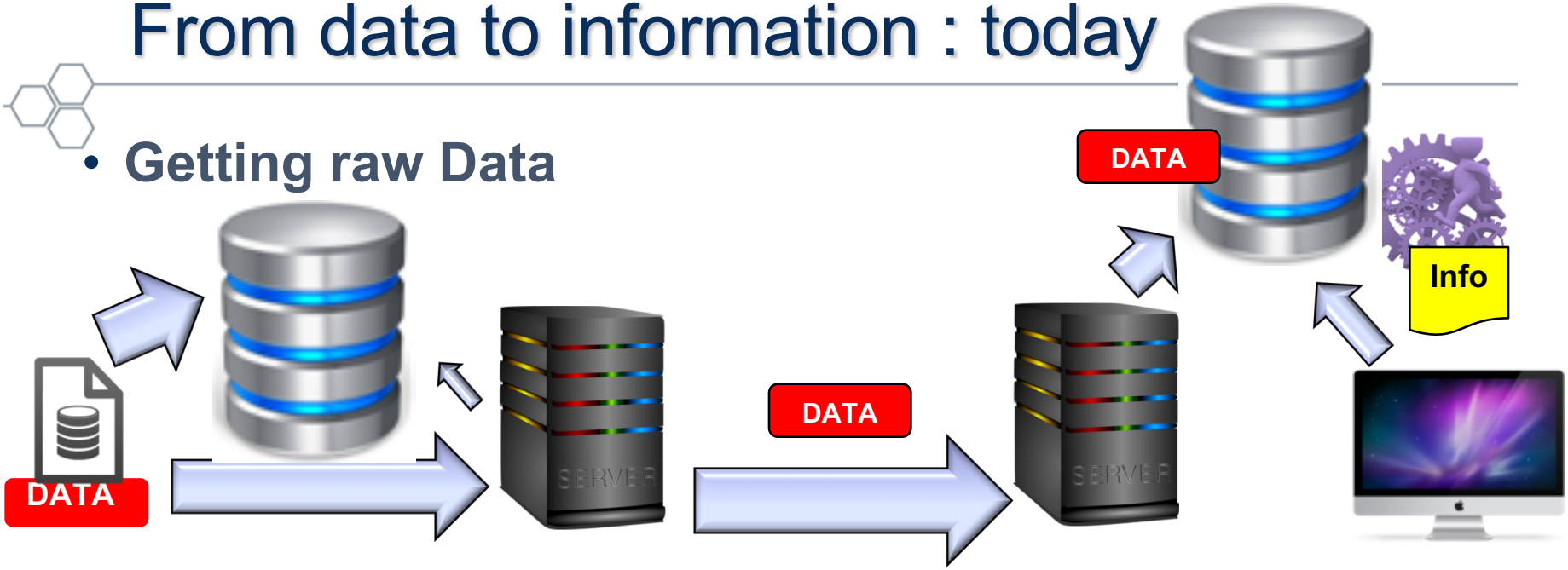
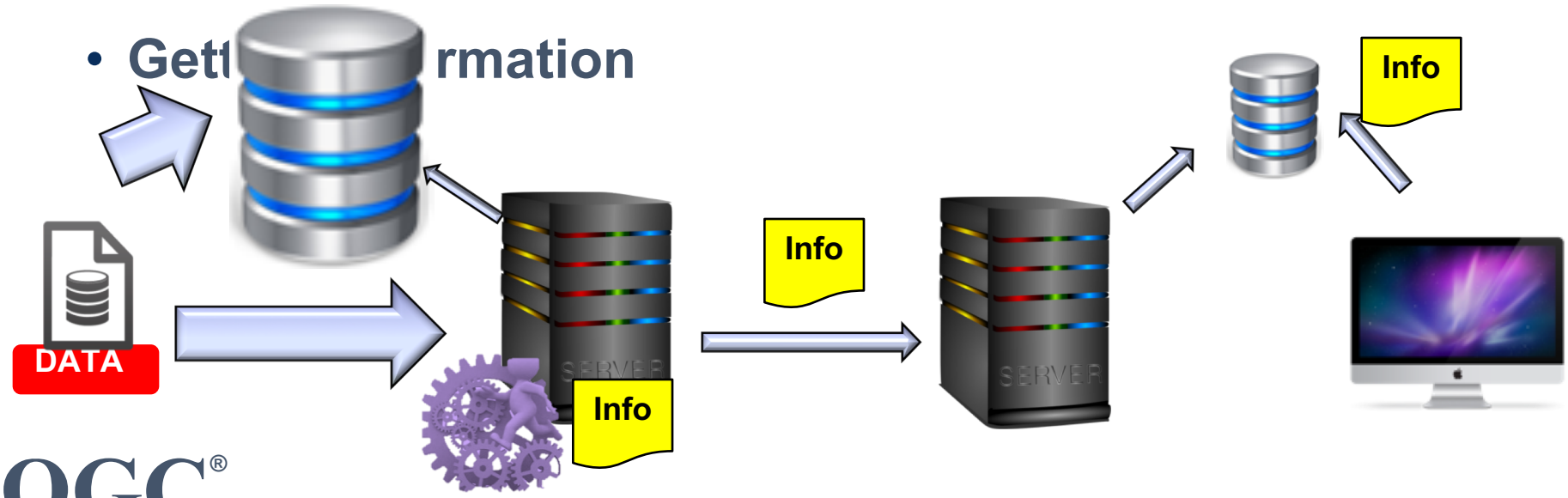
From data to information : today

- Getting raw Data



- Gett rmation



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TT-eWIS/2018
Candidate topics for discussion:

1. Decentralized / federated architecture
2. Telecommunications networks
3. Real-time messaging
4. Web services
5. Cloud
6. WIS Catalogue
7. Search engine integration
8. Data supply chains (distributed data policy enforcement)

Source: TT-eWIS/2018: Technology and Architecture (#5) – Jeremy Tandy

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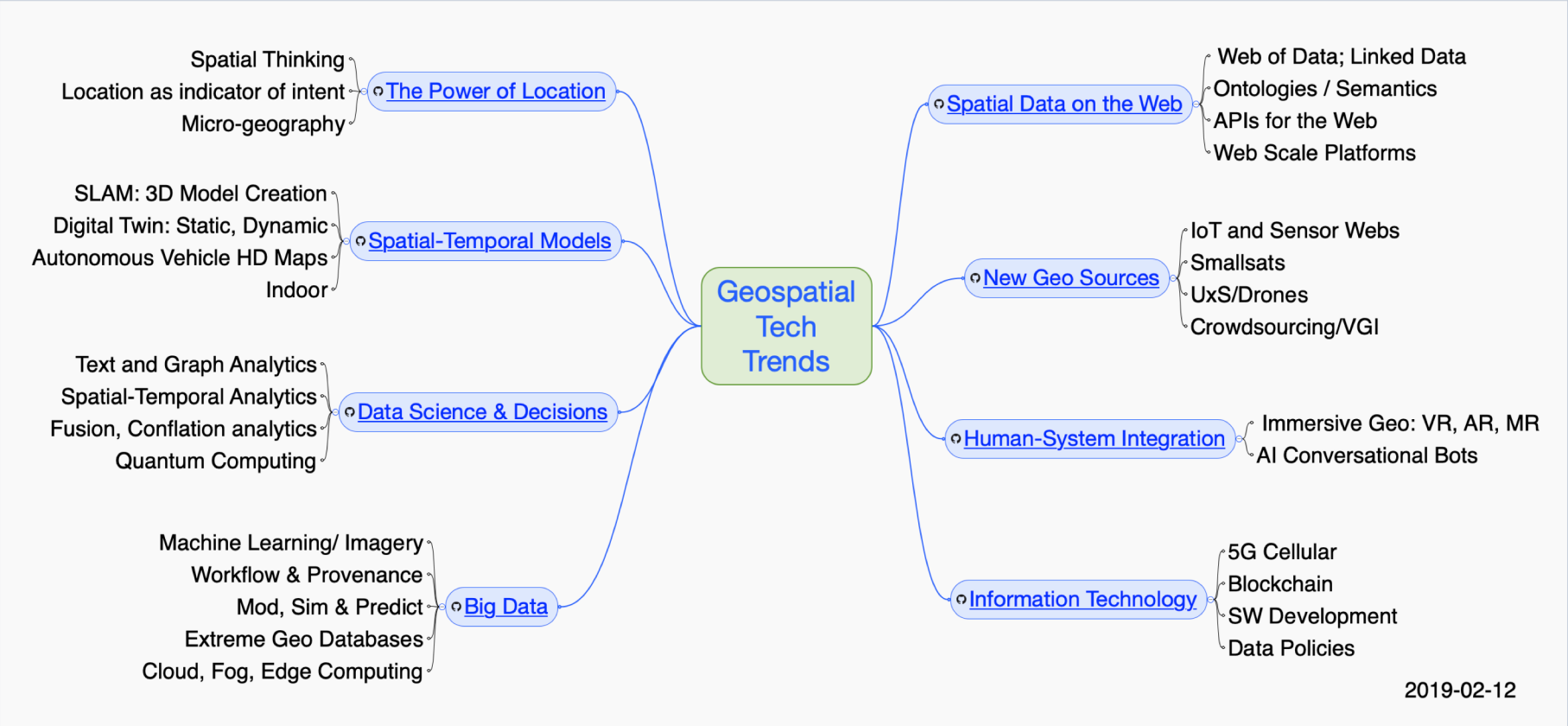
OGC Tech Trends Mindmap



Publicly Available at: https://github.com/opengeospatial/OGC-Technology-Trends

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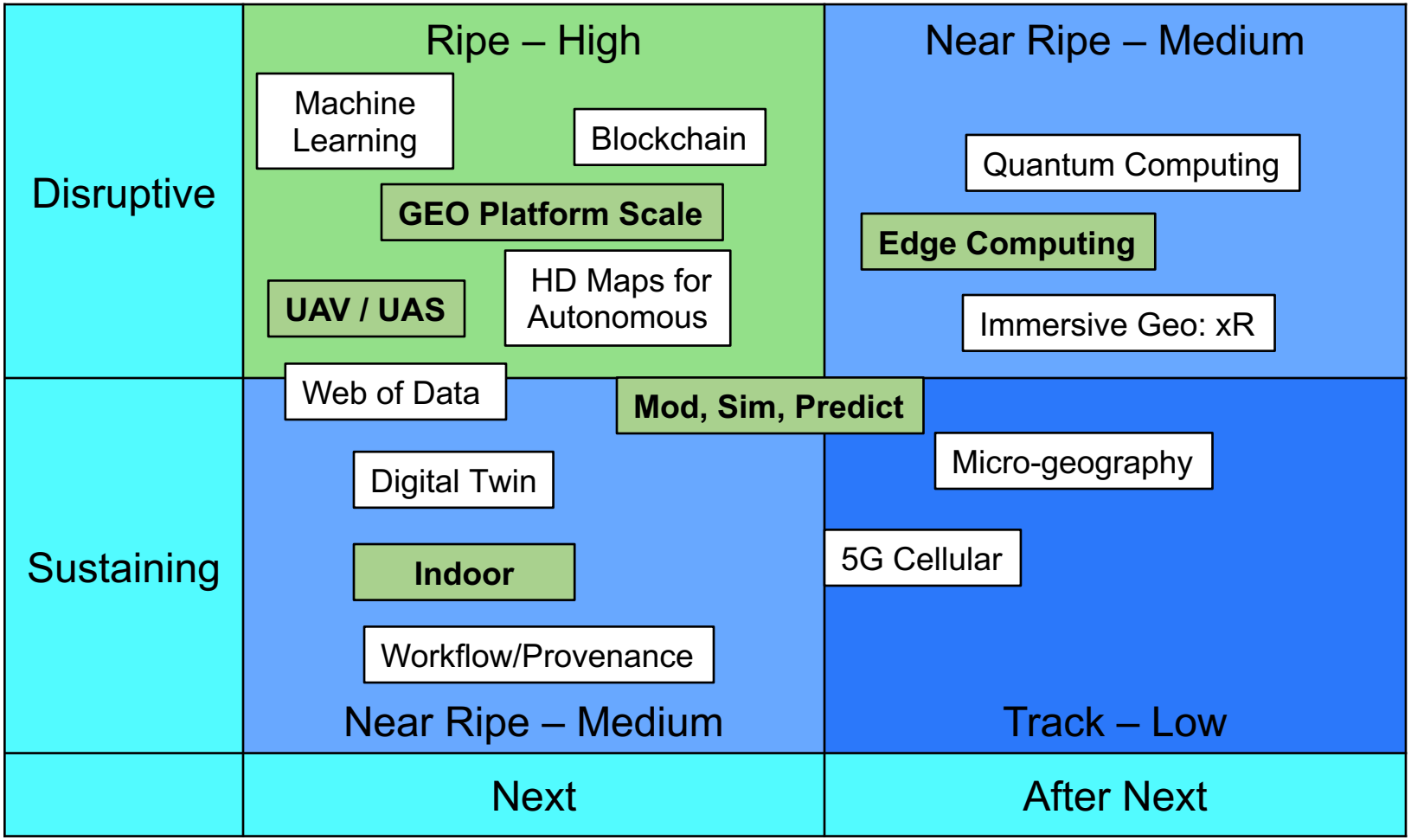
OGC Geospatial Tech Trends Priorities

Publicly Available at: https://github.com/opengeospatial/OGC-Technology-Trends



2019-02-12

= Highest Priority

(MER 2018-11-08)

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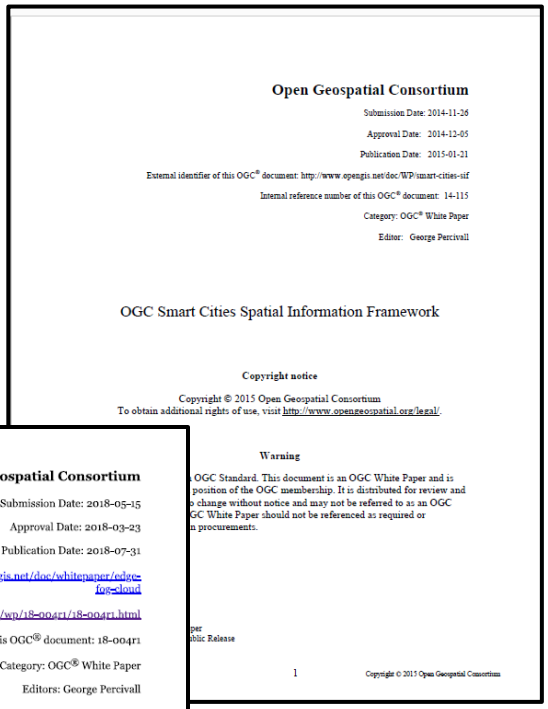
Tech Trends Notes - spuring innovation

Previously Developed

- Smart Cities
- Geospatial Big Data
- Edge and Fog Computing
- GEO API White Paper



Open Geospatial Consortium

Submission Date: 2014-11-26

Approval Date: 2014-12-05

Publication Date: 2015-01-21

External identifier of this OGC® document: http://www.opengis.net/doc/WP/smart-cities-sif

Internal reference number of this OGC® document: 14-115

Category: OGC® White Paper

Editor: George Percivall

OGC Smart Cities Spatial Information Framework

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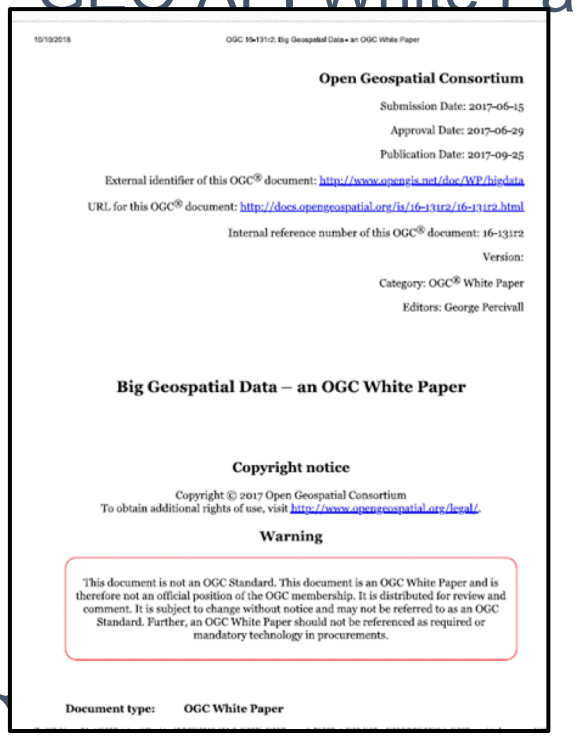

10/10/2018 OGC 16-131r2: Big Geospatial Data – an OGC White Paper

Open Geospatial Consortium

Submission Date: 2017-06-15

Approval Date: 2017-06-29

Publication Date: 2017-09-25

External identifier of this OGC® document: http://www.opengis.net/doc/WP/bigdata

URL for this OGC® document: http://docs.opengeospatial.org/is/16-131r2/16-131r2.html

Internal reference number of this OGC® document: 16-131r2

Version:

Category: OGC® White Paper

Editors: George Percivall

Big Geospatial Data – an OGC White Paper

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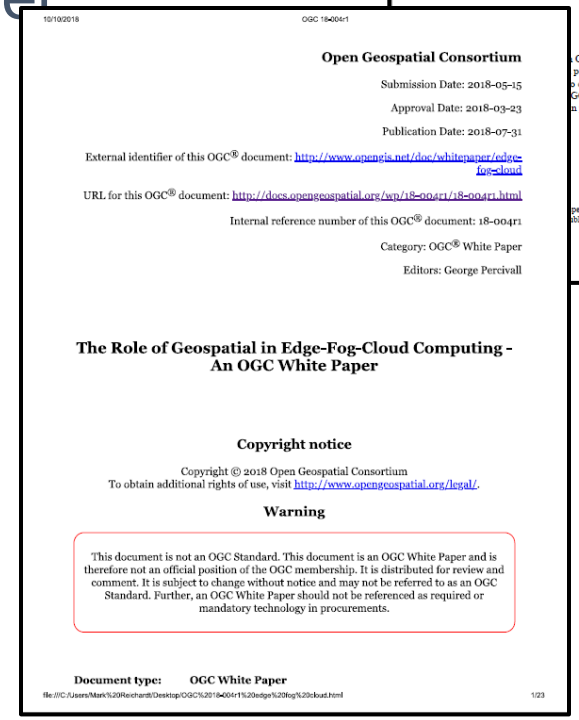
Document type: OGC White Paper



10/10/2018 OGC 18-004r1

Open Geospatial Consortium

Submission Date: 2018-05-15

Approval Date: 2018-03-23

Publication Date: 2018-07-31

External identifier of this OGC® document: http://www.opengis.net/doc/whitepaper/edge-fog-cloud

URL for this OGC® document: http://docs.opengeospatial.org/wp/18-004r1/18-004r1.html

Internal reference number of this OGC® document: 18-004r1

Category: OGC® White Paper

Editors: George Percivall

The Role of Geospatial in Edge-Fog-Cloud Computing - An OGC White Paper

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Document type: OGC White Paper

file:///C:/Users/Mark%20Reichardt/Desktop/OGC%2018-004r1%20edge%20fog%20cloud.html 1/23

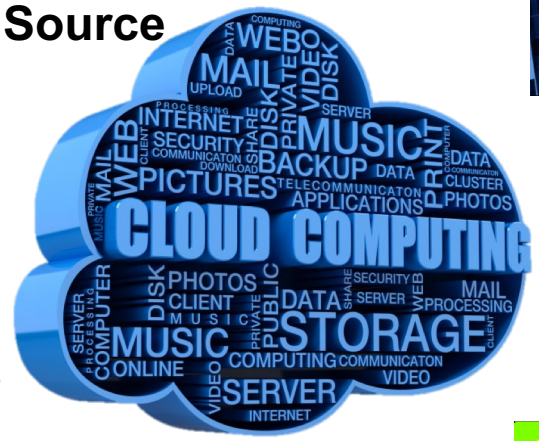
Big Geospatial Data White Paper

September 2017: http://docs.opengeospatial.org/wp/16-131r2/16- 131r2.html

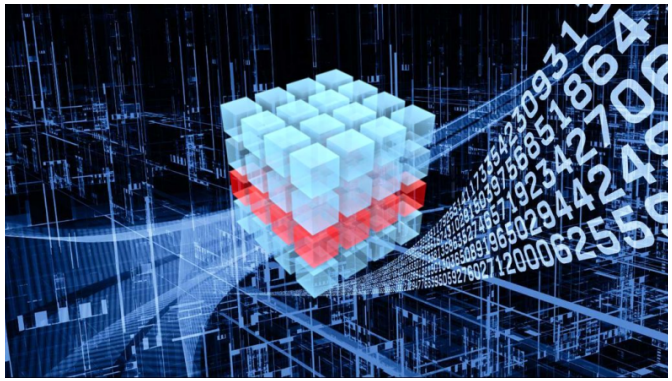
Big Data applications –
Geospatial Data Representations:

- **Geo Features**
- **Geo Coverages**
- **Discrete Global Grids**
- **Linked Data**

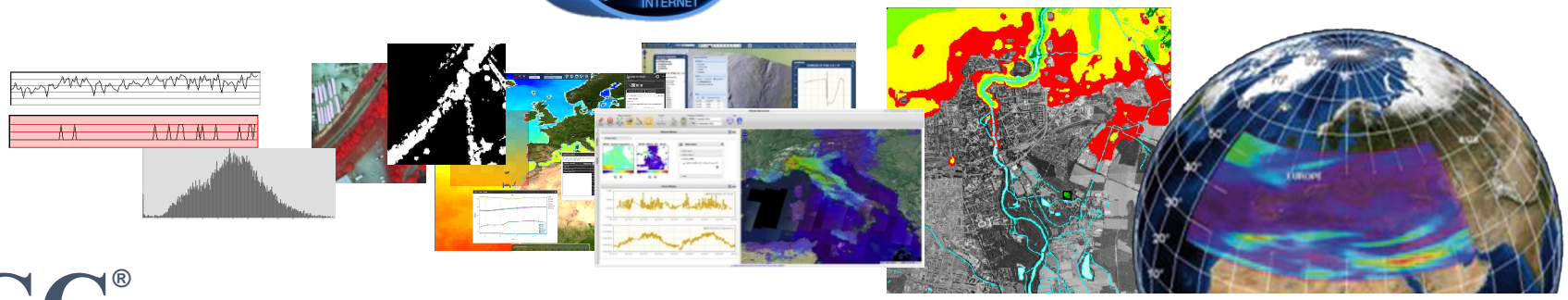
Extend Big Data Open Source



Geospatial Datacubes
massive multi-dimensional array



- **Analysis-Ready Data**
- **Data registration task shifted from user to data provider**
- **Analytics - query language**



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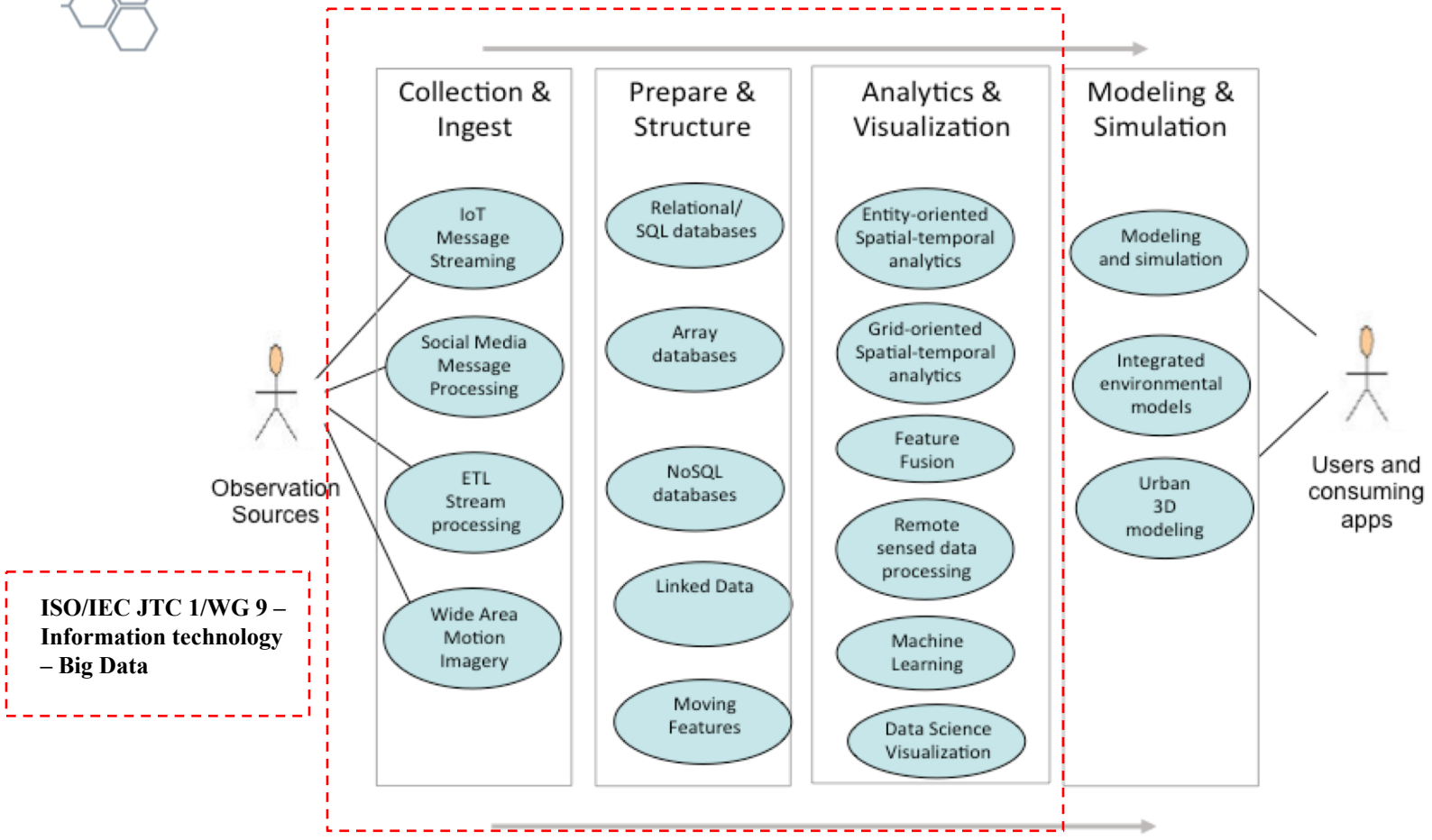
Graphics source: rasdaman

Big Geo Data White Paper



Use cases are presented that demonstrate commonality across applications domains. This commonality reduces the complexity in applying the technology

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Big Geo Data White Paper - Plans

WP identify High priority focus areas for OGC activities.

- Cloud computing for EO data
- Analysis ready data (e.g. Data Cubes)
- Computing with Discrete Grids
- Big Linked GeoData
- Using Big Data Open Source

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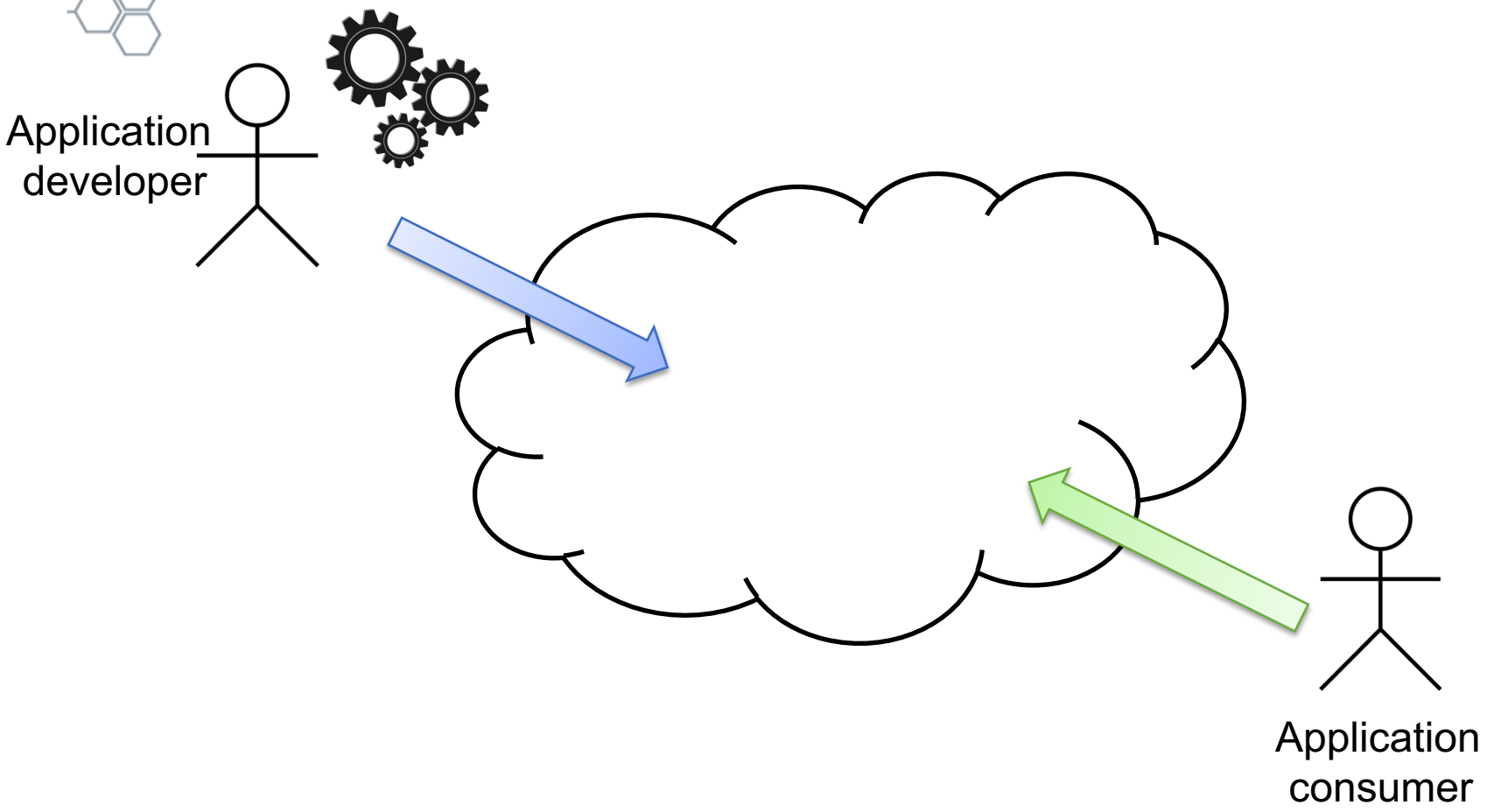
Testbed 13 Cloud Requirements



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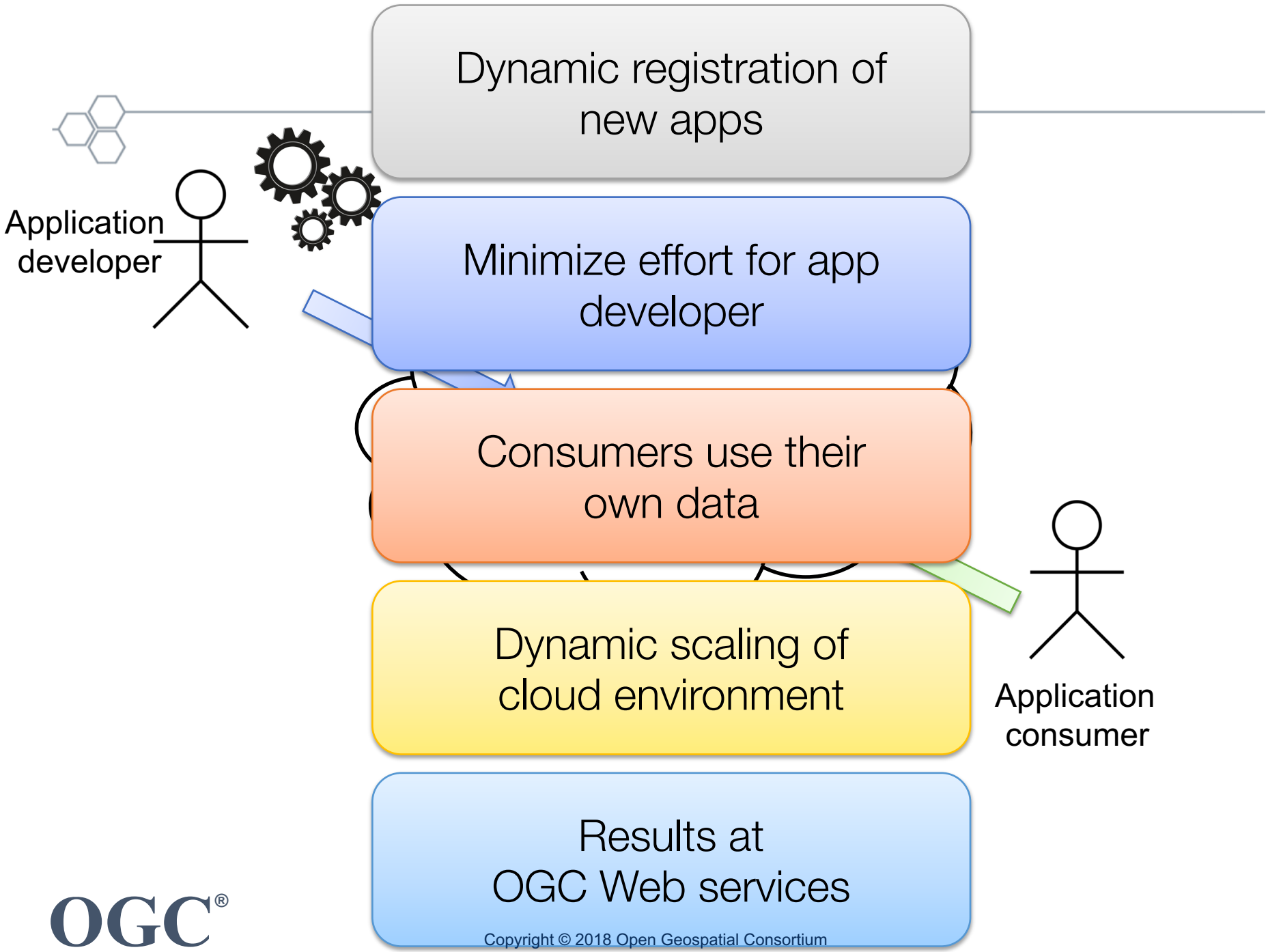

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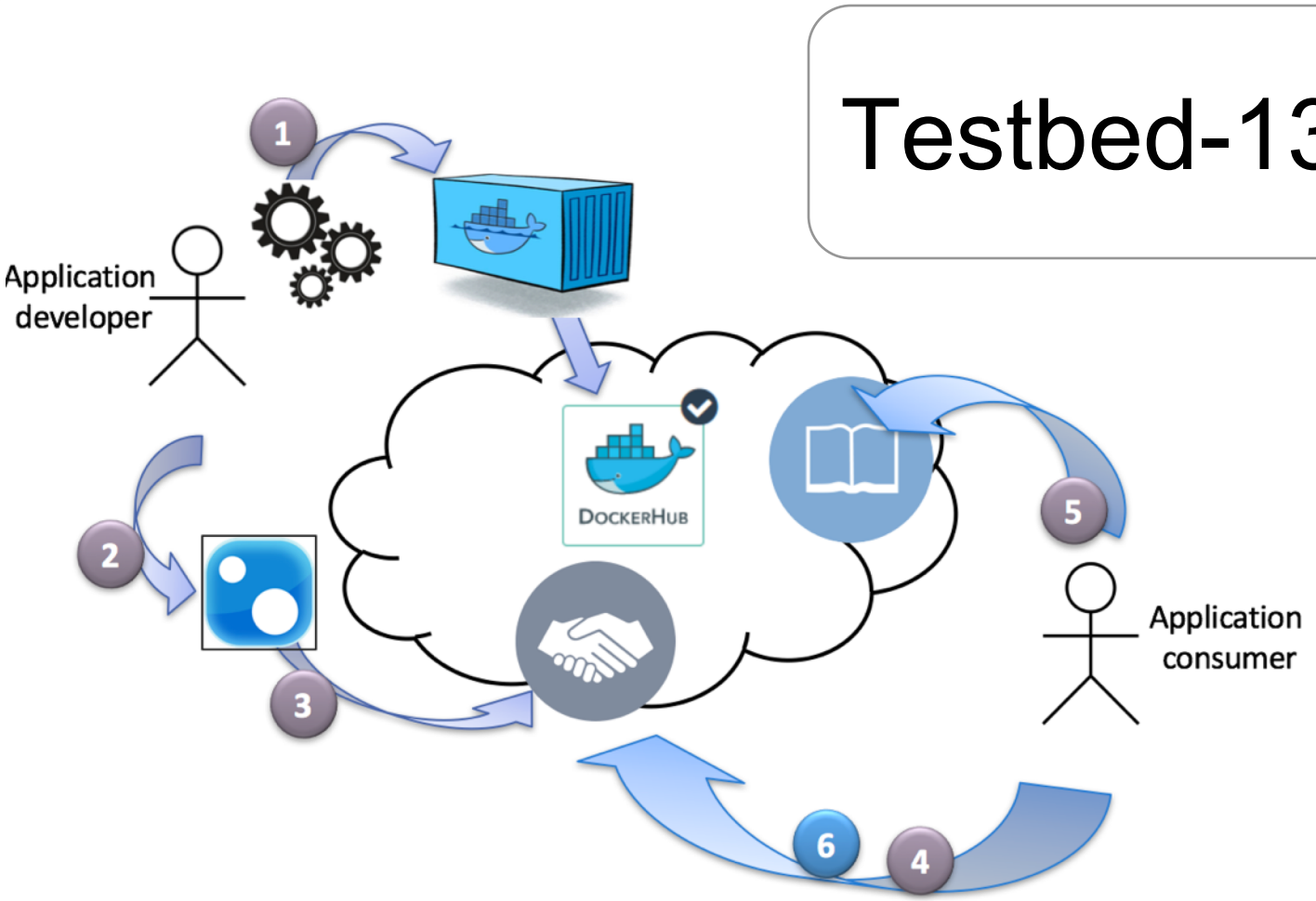
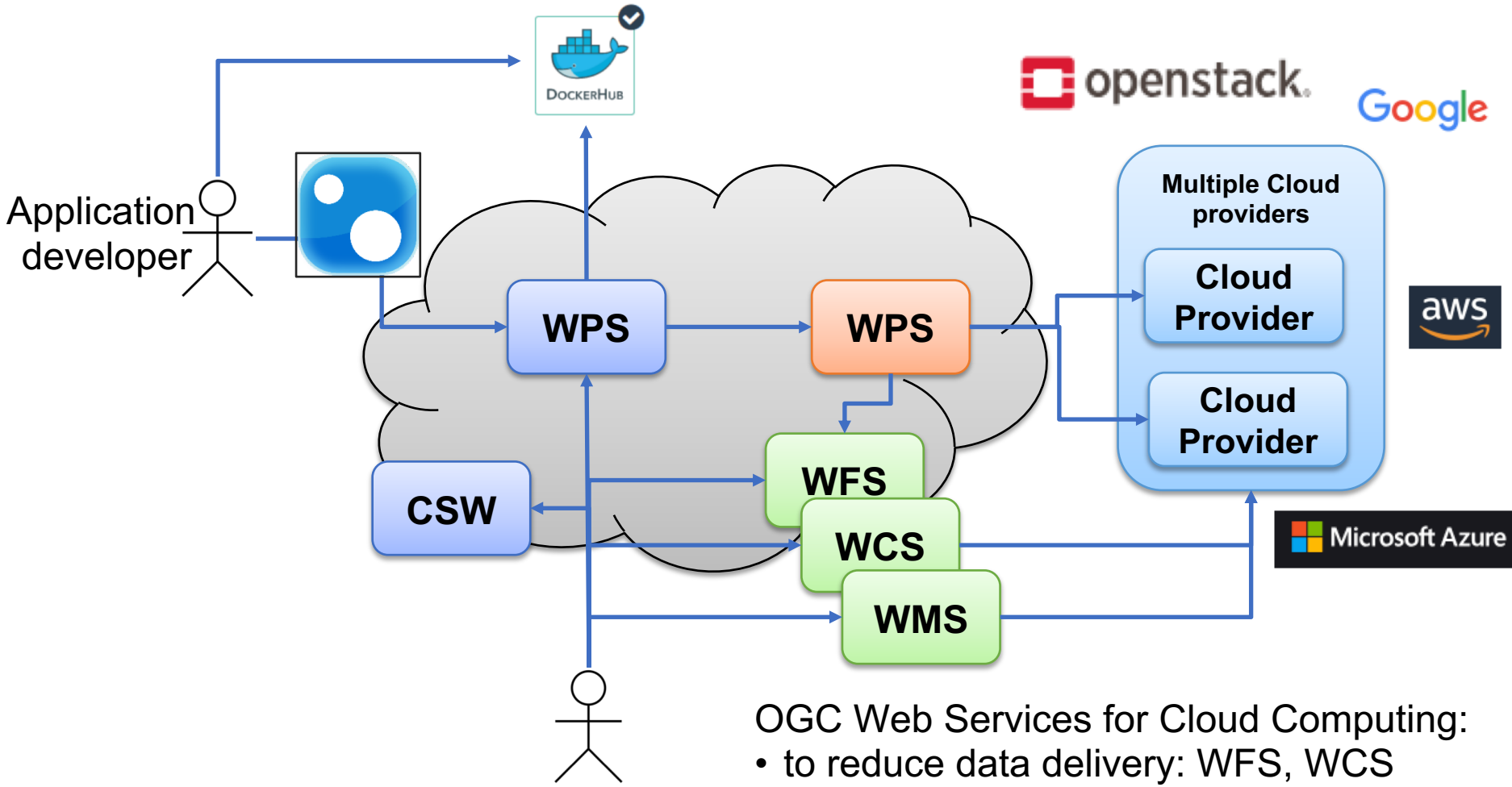
Exploitation Platform



Interoperability and portability between clouds using OGC Web Services



OGC Web Services for Cloud Computing:

- to reduce data delivery: WFS, WCS
- server side portrayal: WMS, WMTS
- server-side processing: WPS, WCPS
- transactional: WPS-T

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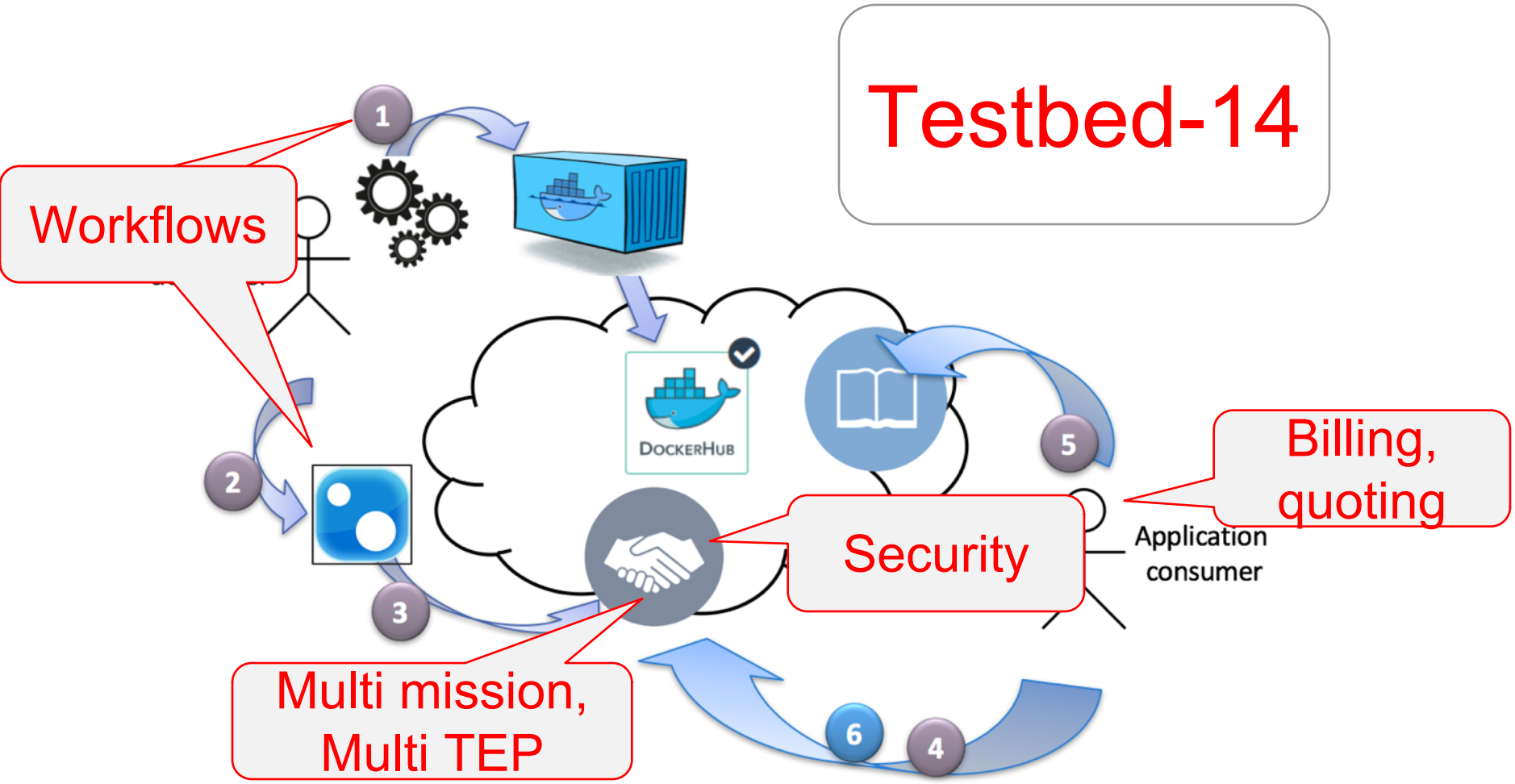
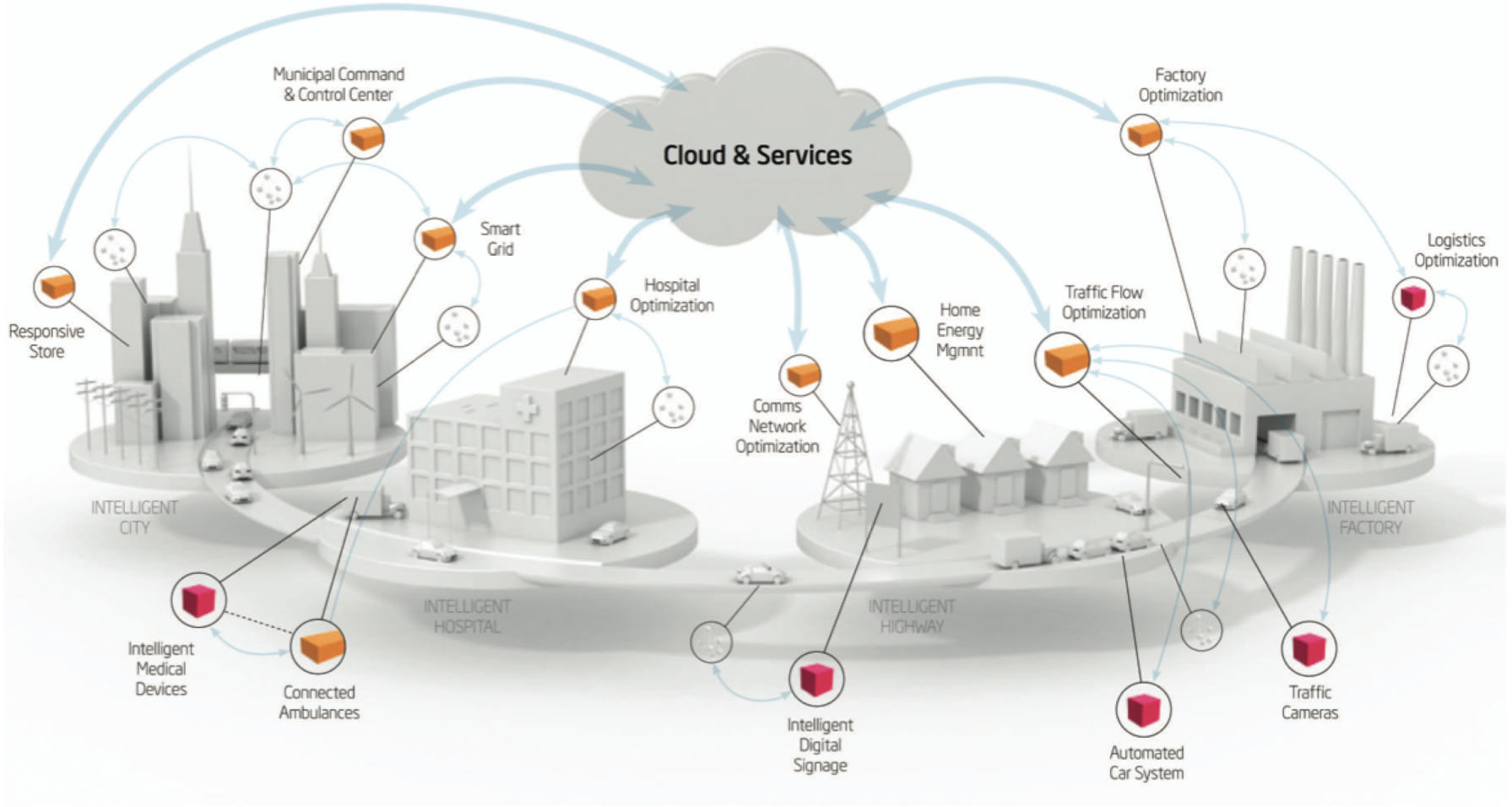
Exploitation Platform



50 billion Internet-connected things by 2020

Sensors Everywhere

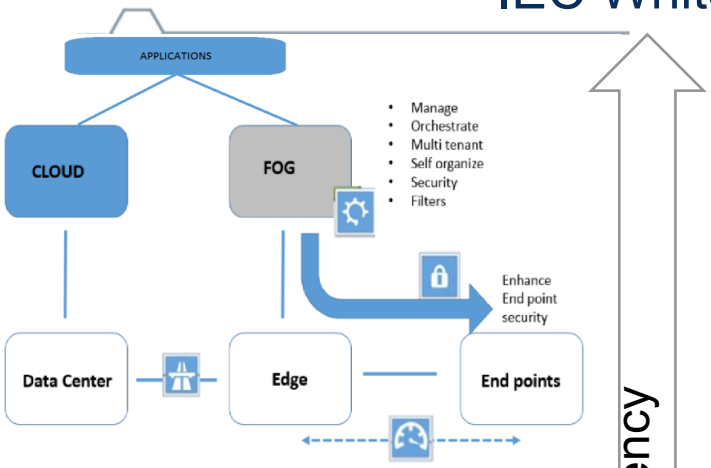
(Things or Devices)

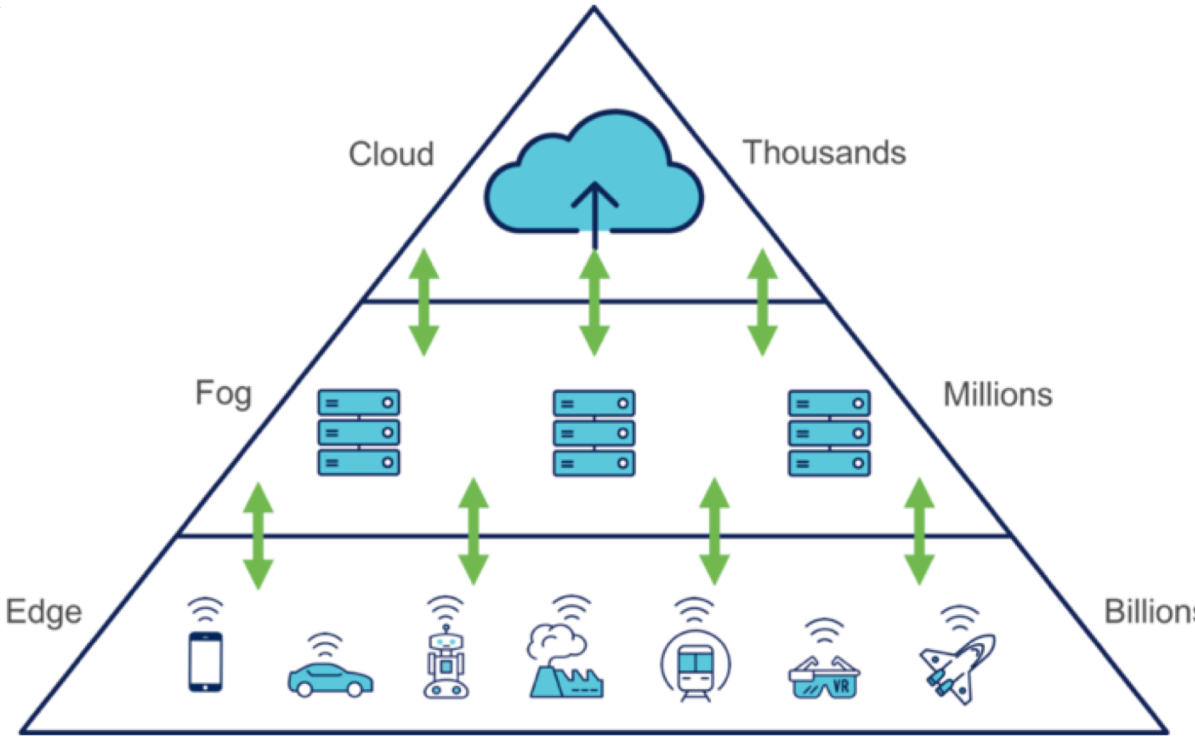


Slide source: Steve Liang, Univ. Calgary

“The cloud is dead – long live the cloud!”

IEC White paper on Edge Intelligence





Driven by IoT, Edge-Cloud computing extends data processing to the edge of a network in addition to computing in a cloud or a central data centre.

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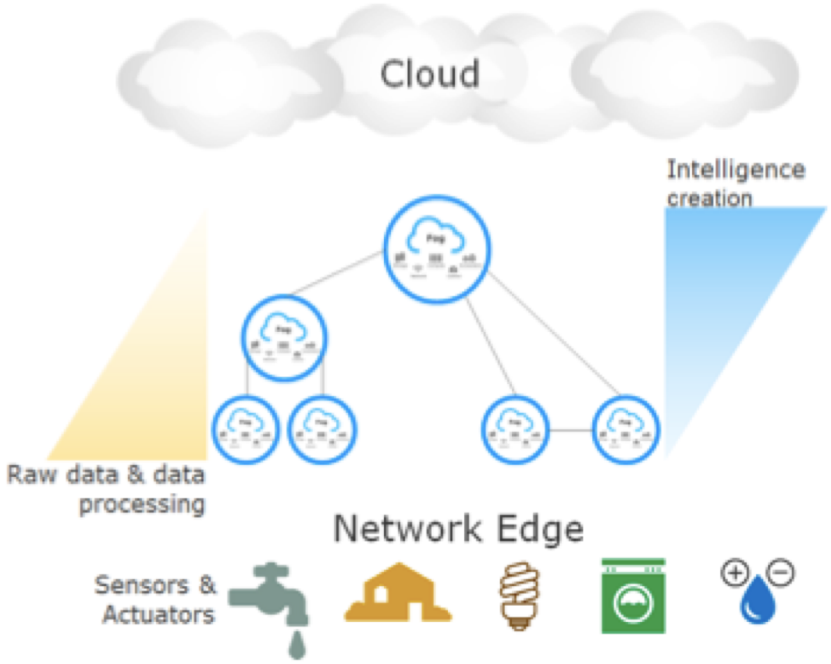
Intelligence creation across Cloud-Fog-Edge



- Address proliferation of sensor types and platforms
- Feature detection and tracking at Edge; in Fog
- Machine learning as commodity in Edge/Fog
- Autonomic decision and tasking in Edge/Fog
- Linked Geodata across Edge-Fog-Cloud continuum

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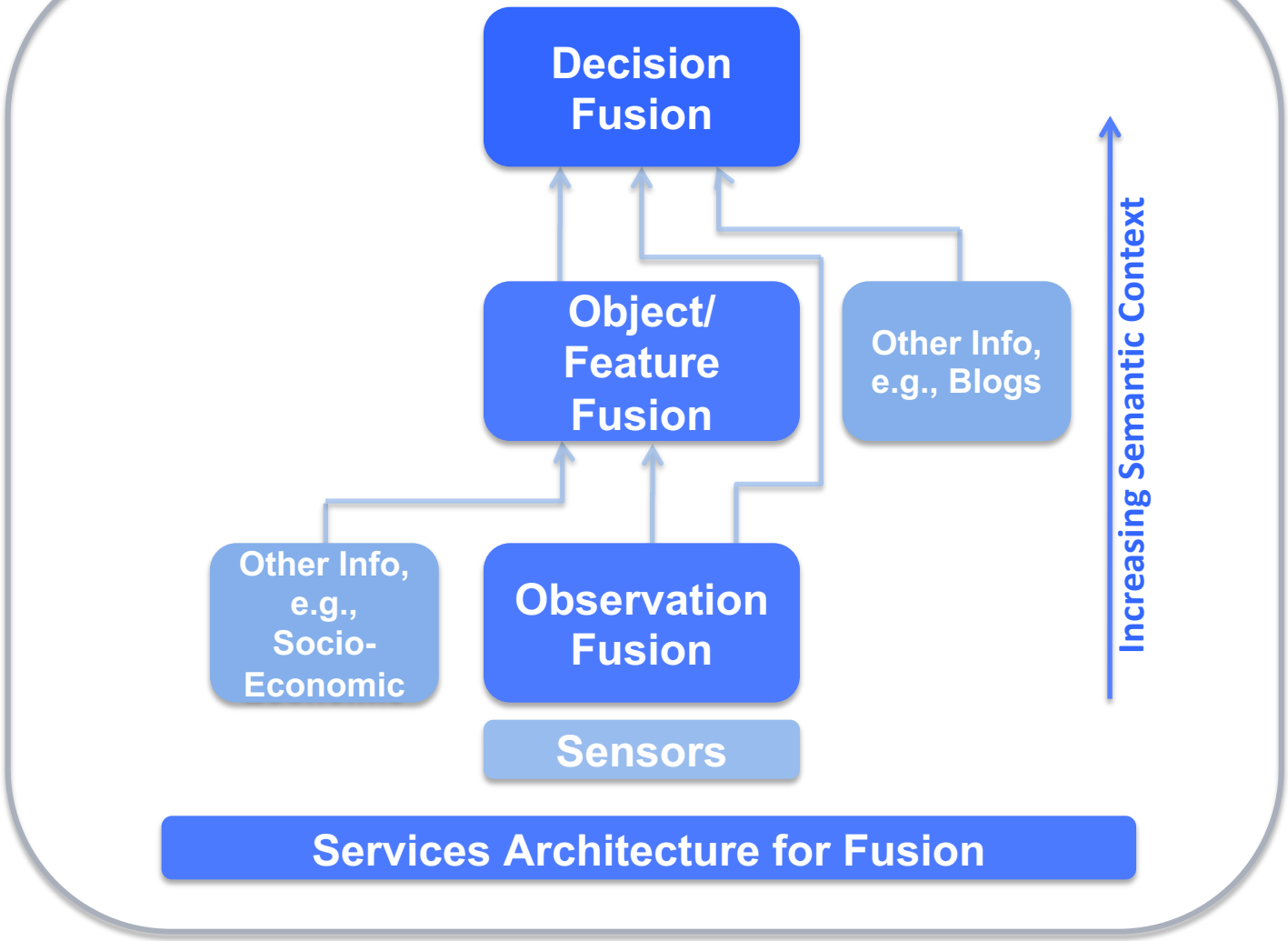
Geospatial Fusion



“Tech Trend Notes” Next

Geo Data Science

- Increasing data sources and volumes
- Geospatial coverages and analytics
- Semantics and linked data
- Cloud computing
- Machine learning

Mod/Sim and Prediction

- Convergence of Mod/SIM and Predictive Modeling
- Automated Model creation
- Consumer HW/SW
- Integrated models spatial & temporal scale matching
- Convergence of simulation & data-driven computation
- Exa-scale modeling

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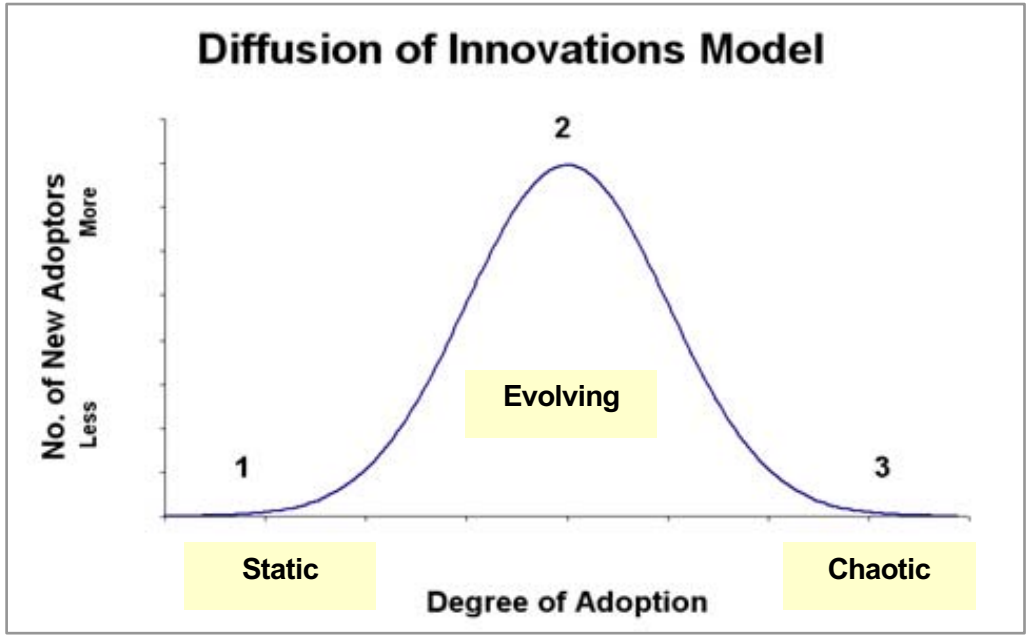
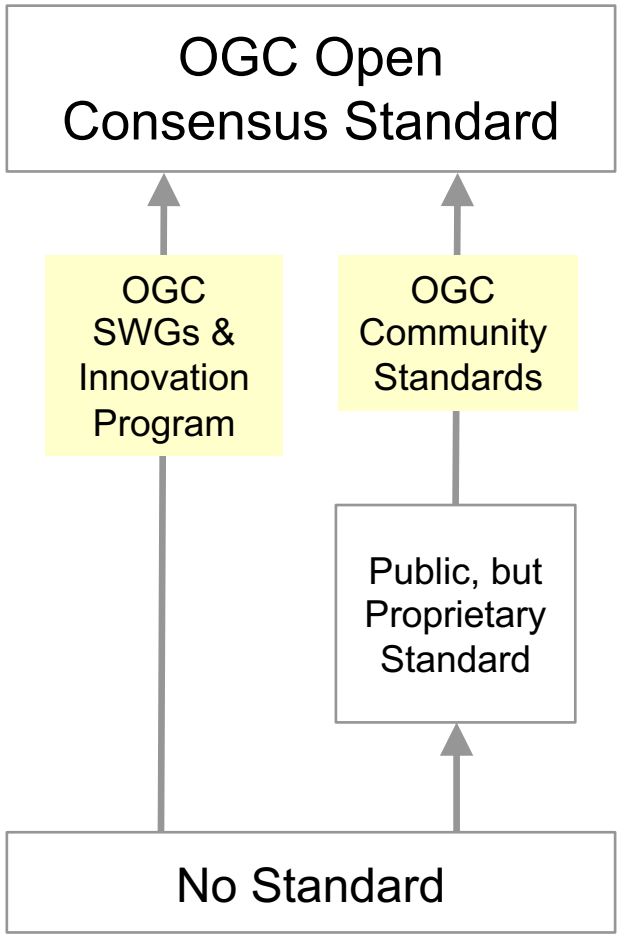
Innovation and Standards

"Innovation is only possible with stable forms that are Standards"*



* Paraphrasing Herbert Simon, The Architecture of Complexity

Processes for Standards to Emerge



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Standards and Innovation as Complex Adaptive Systems
http://www.opengeospatial.org/blog/2559

CALL TO ACTION

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Call to action

- Now: OWS standards can be included in WIS2 procurements,

- Participate in OGC API development including application to Met/Ocean needs/data types

- Review WIS2 architecture and needs in the OGC Met/Ocean DWG

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