Geo/Location Tech Trends impacting Aviation

ATCA Annual Meeting 2019

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Geo/Location Tech Trends impacting Aviation

- Geo/Location, Aviation, OGC
- Standards and Innovation
- OGC Standards Baseline
- OGC Technology Tech Trends

www.ReneMagritte.org

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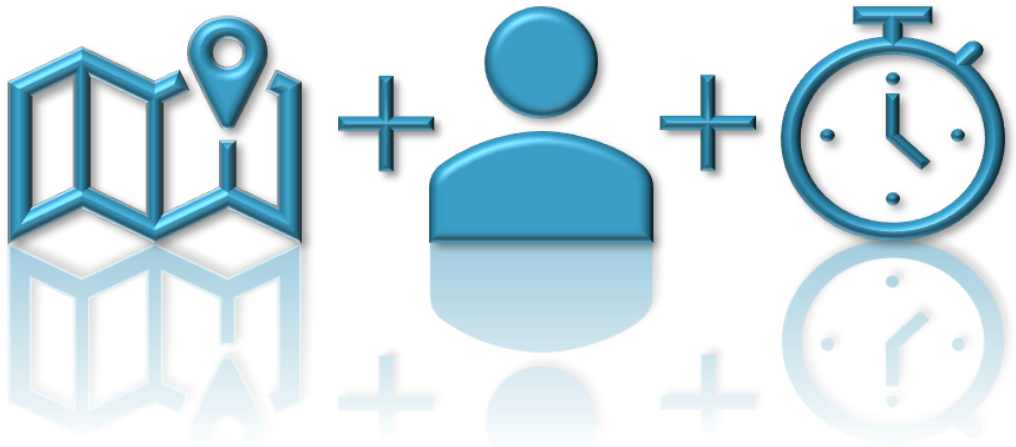
OGC and Aviation Infrormation

Geospatial/
Location

- Findable
- Accessible
- Interoperable
- Reusable

Right Information to the Right Person at the Right Time



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Comprehensive global community-driven forward-looking expertise in location

Using location, we connect people, communities, technology and decision making to create a sustainable future for us, our kids and future generations

- *By specializing in making location more Findable, Accessible, Interoperable and Reusable*
- *Via a proven collaborative and agile process combining standards, innovation and partnerships*

Communities-Tech & Market Domains

Partnerships & Alliances

Process for Standards & Innovation

Standard definitions for location

Methods for specifying altitude of an aircraft

- QFE - Height above the local airport etc. ("home point")
- QNH - Altitude above a mean sea level (MSL)
- Flight Level (FL) - Surface of constant atmospheric pressure relative to a pressure datum, 1013.2hPa (defined as 0FL)

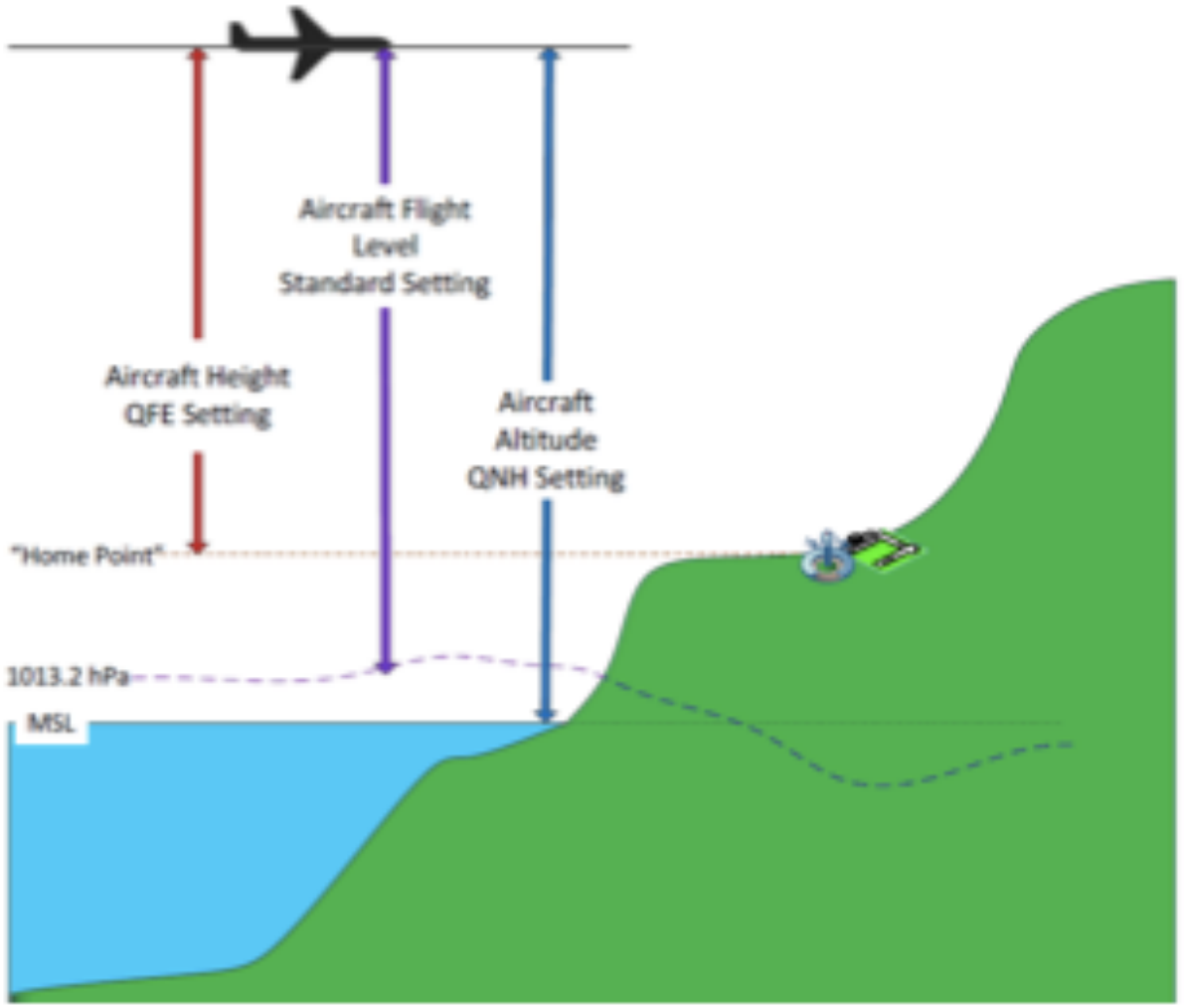

Figure 1 - 3 different height/altitude measurement options

Source: UAS ATM CARS Common Altitude Reference System Discussion Document; EUROCONTROL, 27th November 2018

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What is a Standard?

"*An agreed way of doing something*"

Standards are distilled wisdom of people with expertise in their subject matter and who know the needs of the organizations they represent – people such as manufacturers, sellers, buyers, customers, trade associations, users or regulators.

Standards are knowledge. They are powerful tools that can help drive innovation and increase productivity. They can make organizations more successful and people's everyday lives easier, safer and healthier.

EC: Practical standards guide for researchers - en

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What is an OGC Standard?

*A **document**, established by **consensus** and **approved by the OGC Membership,** that provides rules and guidelines, aimed at the optimum degree of interoperability in a given context.*

- Community requirements
- Member requirements
- Market trends
- Technology trends

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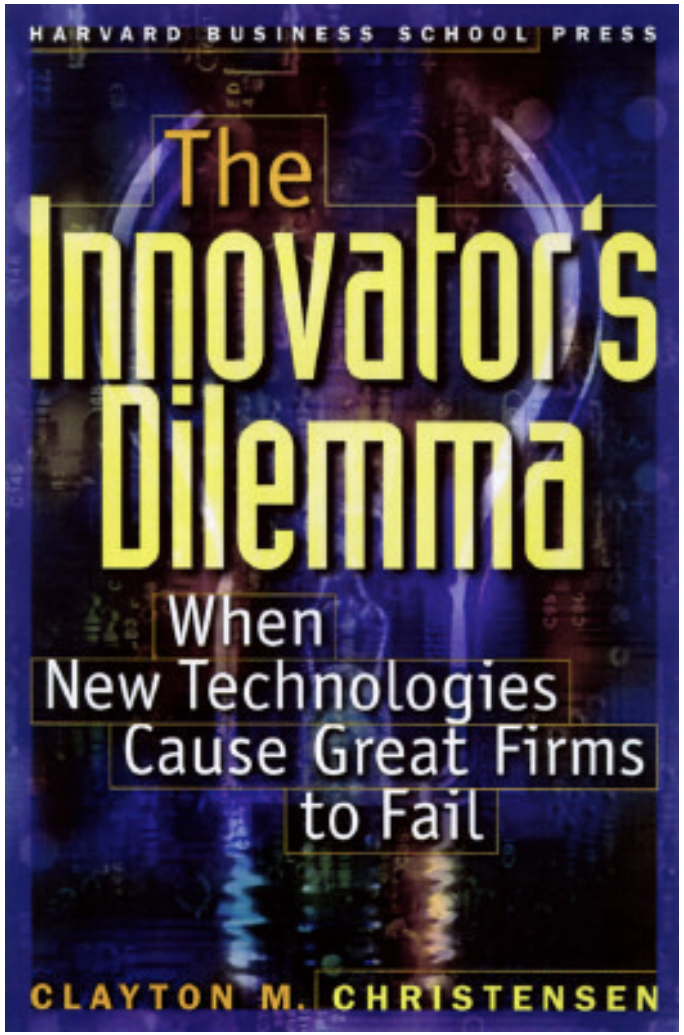
The Innovator's Dilemma



- Tech progress outpaces markets
- Disruptive innovations often initially have worse performance
  - Cheaper, simpler, smaller, and, frequently, more convenient to use
  - Disruptive technologies often overlooked until they make a profit
- How to succeed
  - Identify disruptive technologies early
  - Discovery-driven planning

OGC's response to the Innovator's Dilemma

- Maintain current OGC standards while simultaneously addressing evolution of technology and markets
  - Ensure harmonization in OGC standards

- OGC response to the Innovators Dilemma
  - Extend or adapt the present baseline of standards
  - New standards may overlap or diverge from existing standards; provide guidance to evaluate options
  - Harmonization techniques (brokers, facades) for interoperability
  - Tech Trends driven planning

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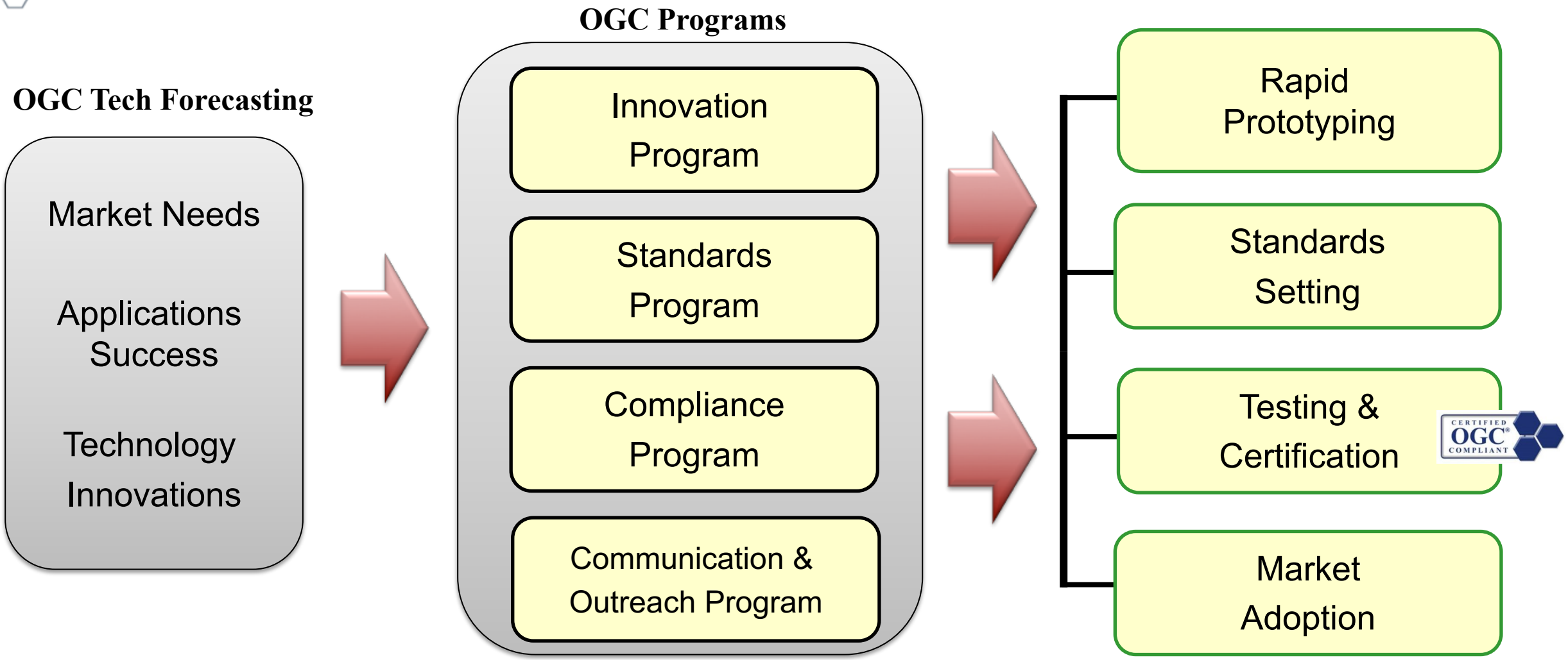
OGC's Approach for Innovation and Standards



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Standards and Innovation: Event Horizons

Now	Next	After Next
Baseline	Develop	Prepare

Now: Established Standard in Operations and Maintenance

Next: Prototyping and Refinement of New Standard

After Next: Identify needs and technology for future standards.

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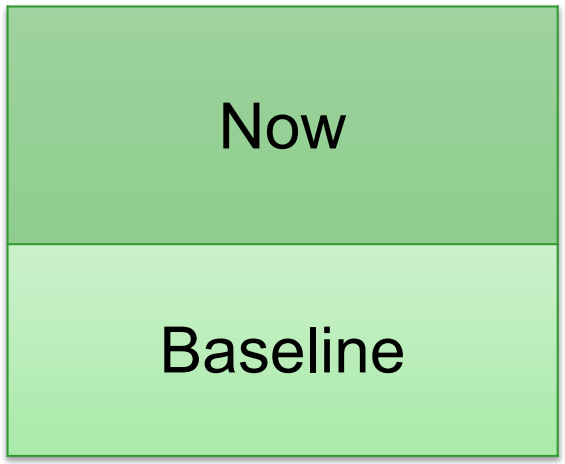
Standards and Innovation: Events Horizon



Now: Established Standard in Operations and Maintenance

Next: Prototyping and Refinement of New Standard

After Next: Identify needs and technology for future standards.

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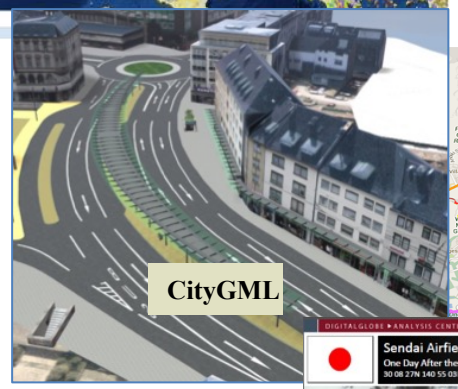
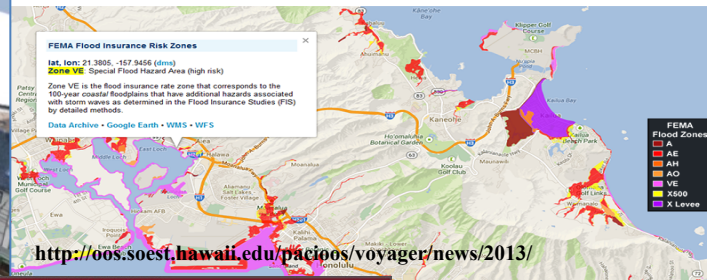
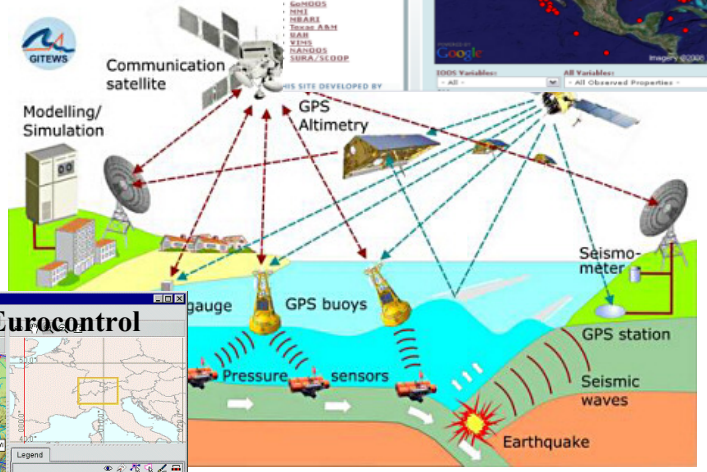
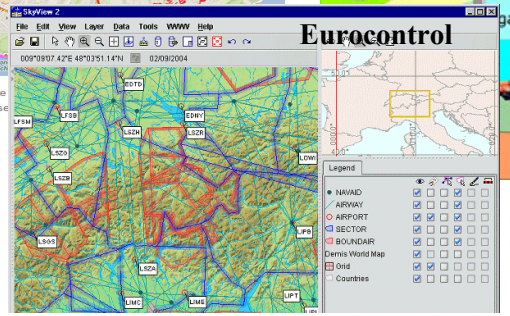
Millions of Geospatial Datasets on >200K Servers

Web Map Service (WMS)
Web Map Tile Service (WMTS)
Web Feature Service (WFS)
Web Coverage Service (WCS)
KML, GML, GeoPackage
GeoTIFF, NetCDF, HDF









Emergency / Disaster Management

Meteorology, Hydrology, Ocean Monitoring

Aviation Flight Information / Safety

Source: GeoSeer spatial data search engine: https://geoseer.net

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ICAO SWIM Concept

Table 1. Global Interoperability Framework - Overview of Functions and Standards

Layer of Framework	Functions or Sub layers	Candidate Standards, models, implementations
SWIM-enabled Applications		ATS, ATFM, Airline Ops
Information Exchange Services	Service Interoperability	No global standards as yet
	Interface Definition	OGC CS-W, WSDL, WADL, WFS, WMS, WCS
Information Exchange Models and Schemas	For aeronautical, MET, and flight information	AIXM, WXXM, IWXXM, FIXM, FIXS, AIXS, WXXS
	Semantic Interoperability	Domain Specific: AIRM General: RDF/RDFS, OWL, SKOS
SWIM Infrastructure	Enterprise Service Management	DDS, JMX, SNMP
	Policy	WS-Policy standards
	Reliability	WS-RM & WS-RM Policy
	Security	WS-Security & SSL
	Interface Management (Service	OASIS/ebXML
	Registration)	
	Data Representation	XML, XSD, GML
	Messaging	SOAP, JMS, DDS
	Transport	HTTP, JMS, MQ
	Boundary Protection	No global standards as yet
	Service Registry	UDDI, work on-going
Network Connectivity	Secure Network Connectivity	IPv4, IPv6
	Naming and Addressing	DNS
	Identity Management	No global standards as yet
	Incident Detection and Response	No global standards as yet

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Digital Weather and Aeronautical Information

"Global Information Sharing:

- To facilitate global information sharing and interoperability, data exchange models are being developed based on Open Geospatial Consortium standards.
- The FAA and Eurocontrol are jointly developing the Weather Information Exchange Model (WXXM) and the Aeronautical Information Exchange Model (AIXM).
- AIXM will be utilized in worldwide ground exchange of AI"

FAA Advisory Circular AC 00-63A – AIXM

https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_00-63A.pdf

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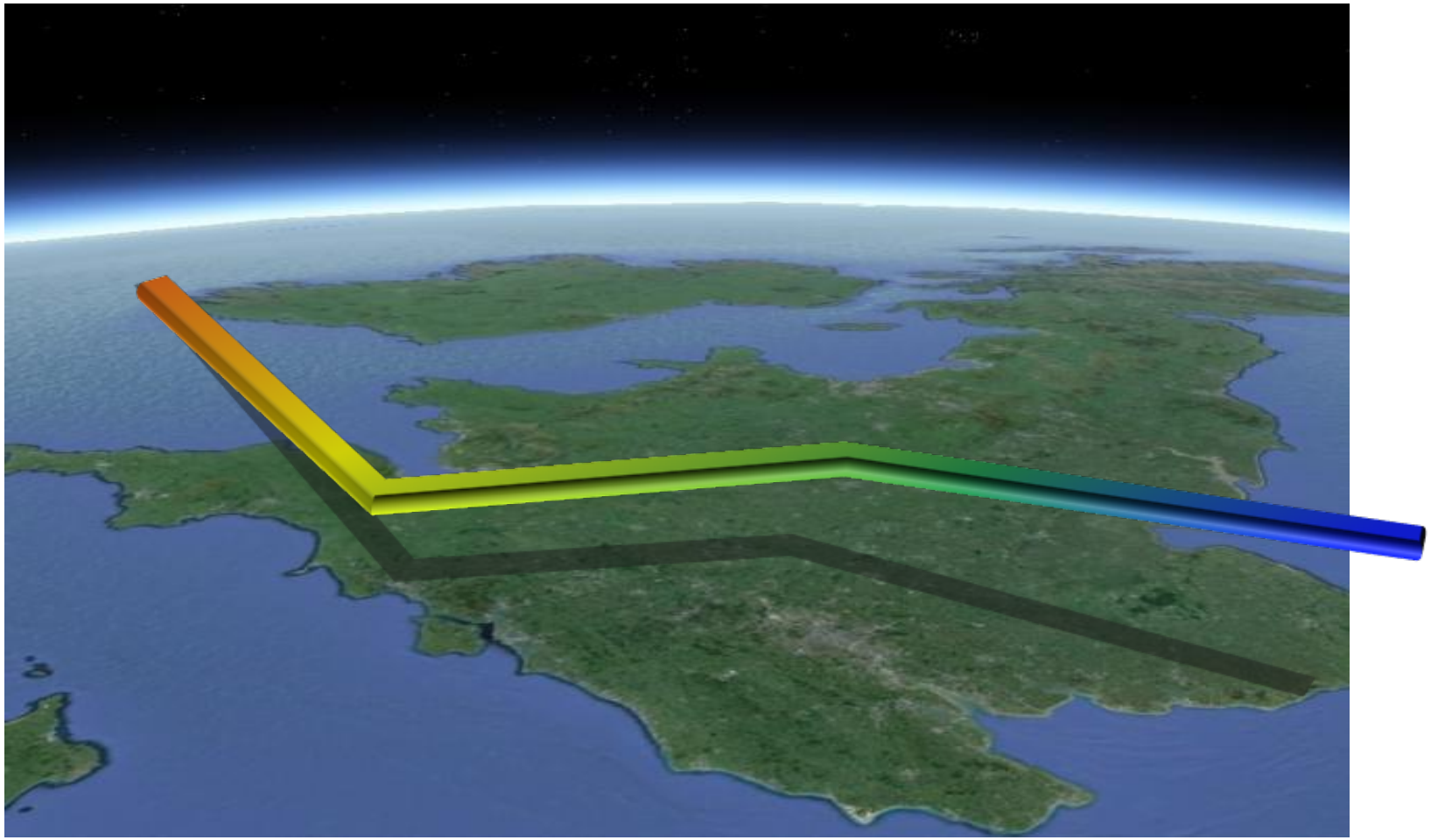
Data along aviation Corridors

Access just the right information for the right time along a route



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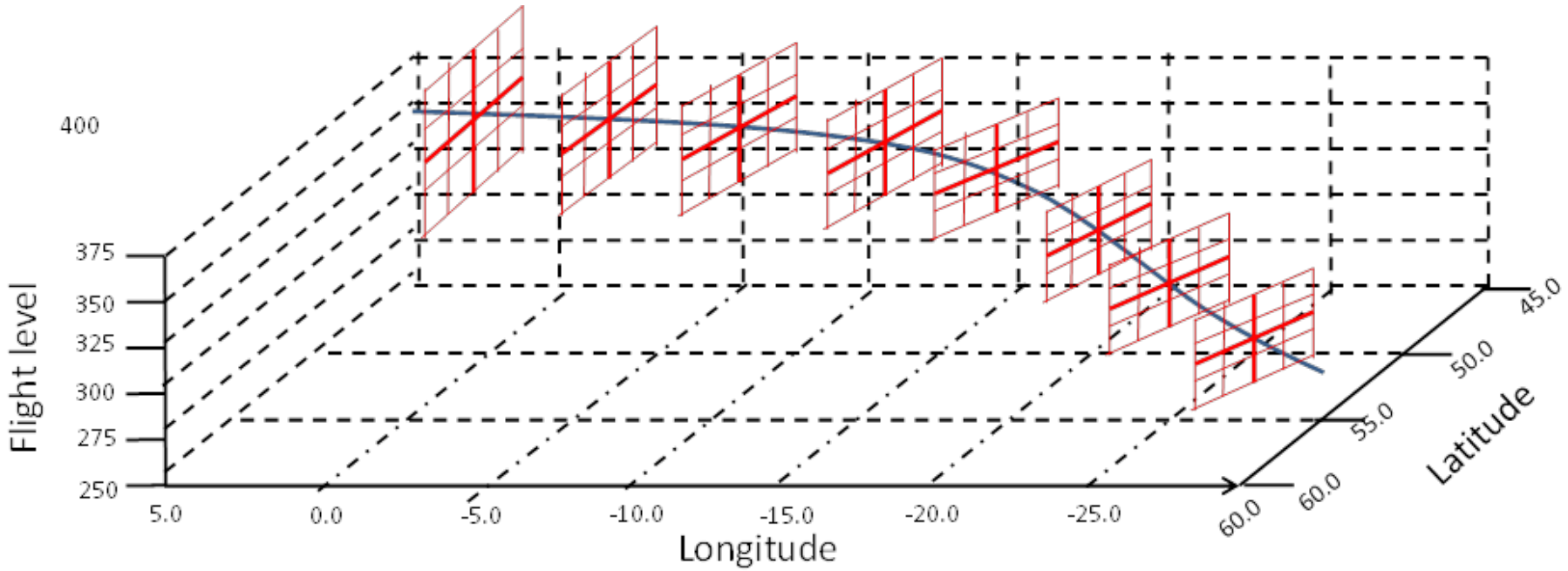
Aviation Route-based weather: WCS MetOcean Profile

- Extract data along a route; only return relevant data to client
  - getCorridor operation in MetOcean profile of WCS2.1



WCS getCorridor Method 5: Corridor grid vertically aligned with Parent Trajectory Grid

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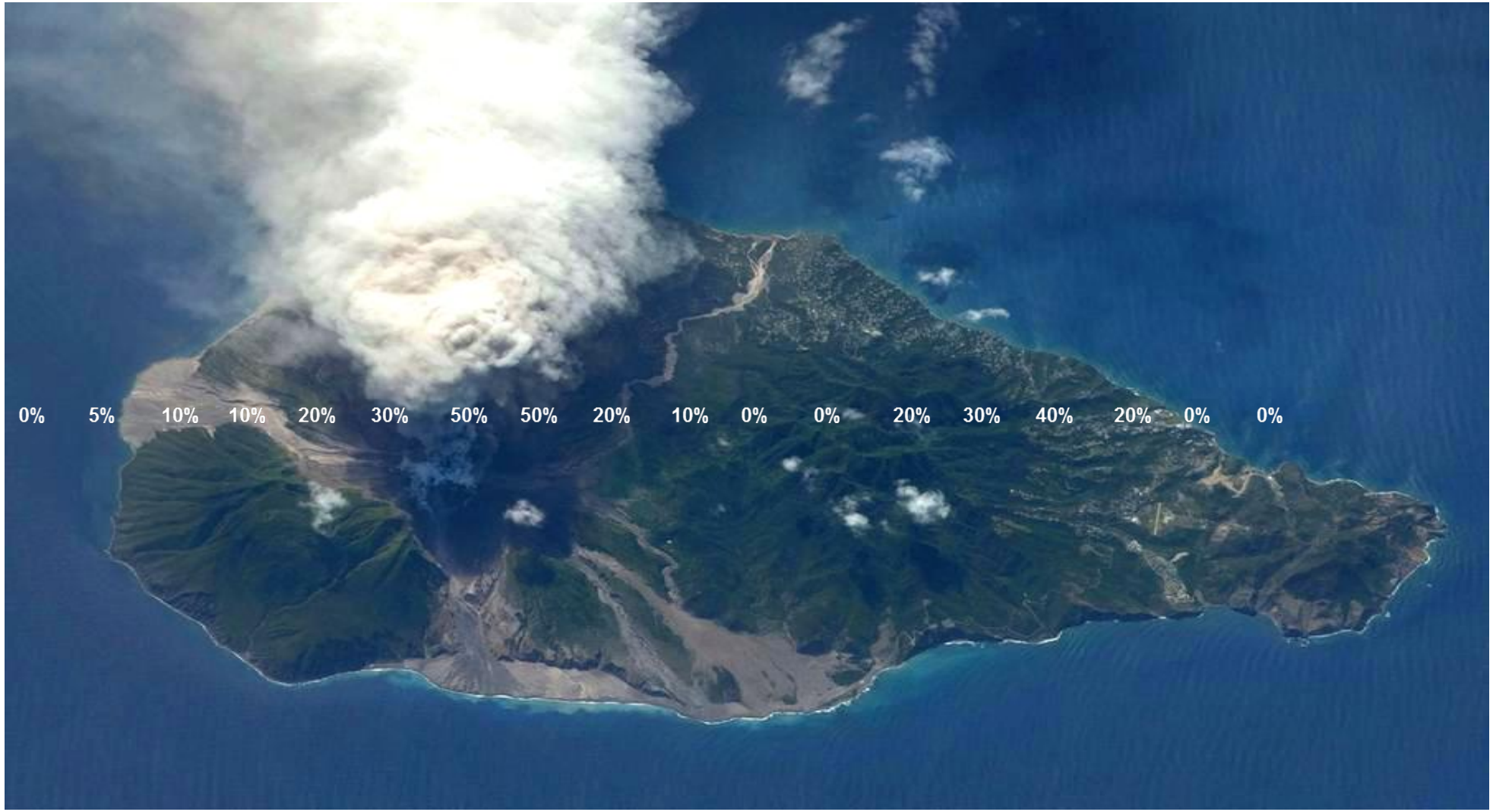
WCS getCorridor Use Case: 4D Volcanic Plume

Measure Volcanic Ash Dispersion in X, Y, Z, T



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Standards and Innovation: Events Horizon

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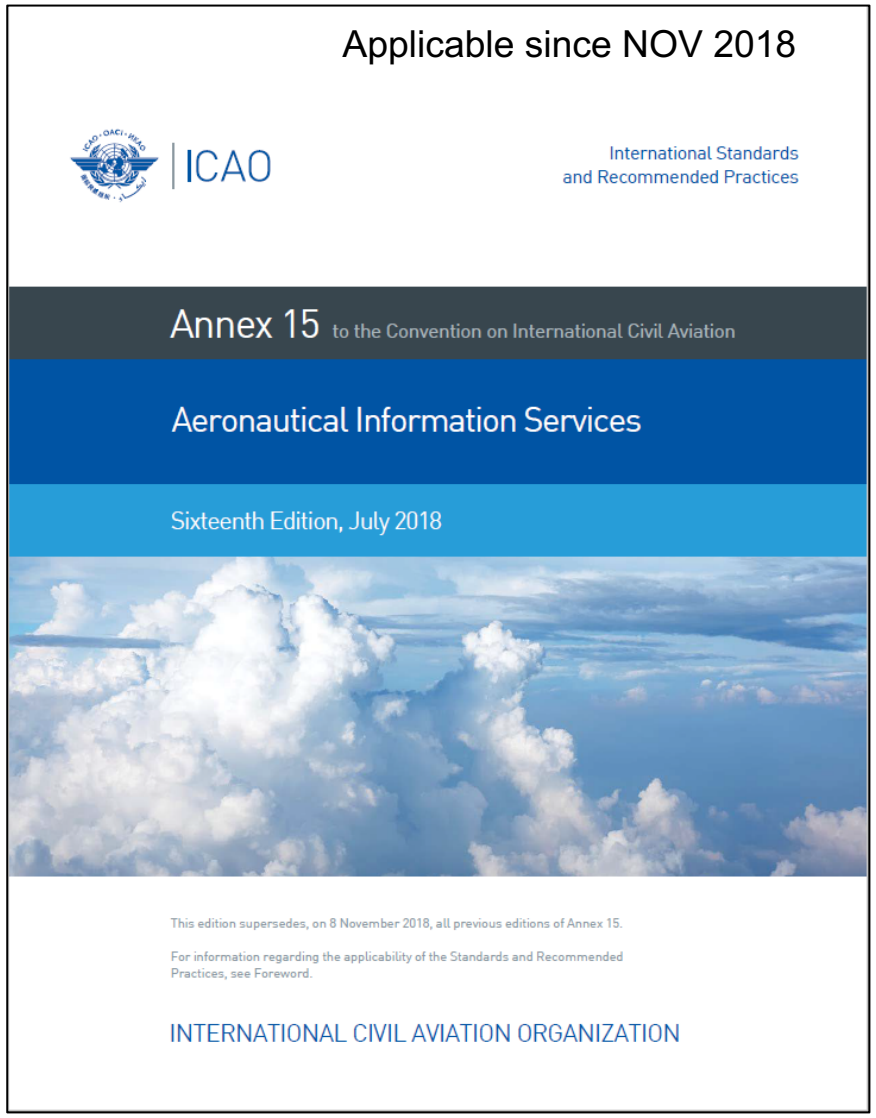
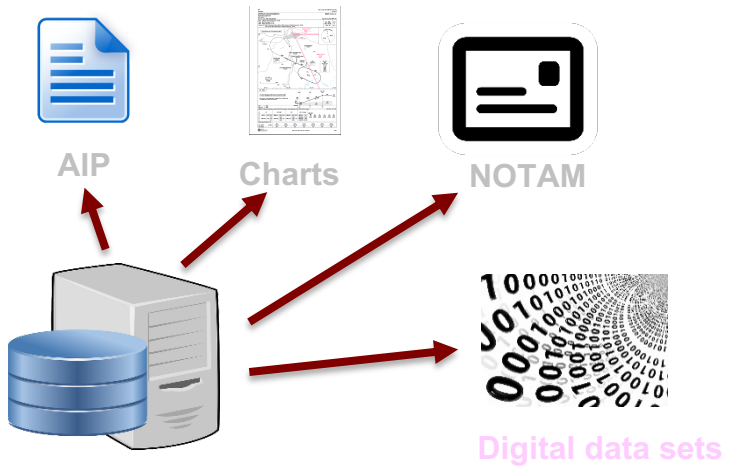
ICAO Annex 15 - AIS



5.1.1 *Aeronautical information…**products** & **services**.*

*5.4.1.3 …**Internet** should, whenever practicable, be employed...*

*5.4.3.1 …digital data sets should be made available through services for **online querying and retrieval***



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OGC APIs

- Modernization of web services
- Open API-based next generation of standards aligned early in their development and sufficiently modular to maximize flexibility
- Implementer friendly
- Starting with WFS (WFS3)
  - In parallel Coverages, Map Tiles, Processing, Common
- OGC API – Features: Part 1 – Core is now officially an OGC standard

Implementation Standard [OGC 17-069r1]
https://portal.opengeospatial.org/files/?artifact_id=84541&version=1

OGC API Standards Development

Modular API building blocks; spatially enable Web APIs in a consistent way

- Spatial Data on the Web Best Practices
- Leverages OpenAPI
- Focus on developer experience and usability
- Modular building blocks for access to spatial data that can be used in data APIs,
- Open development; Public GitHub, Early implementations, In-depth validation

OGC API - Features

OGC API - Coverages

OGC API - Map Tiles

OGC API - Processes

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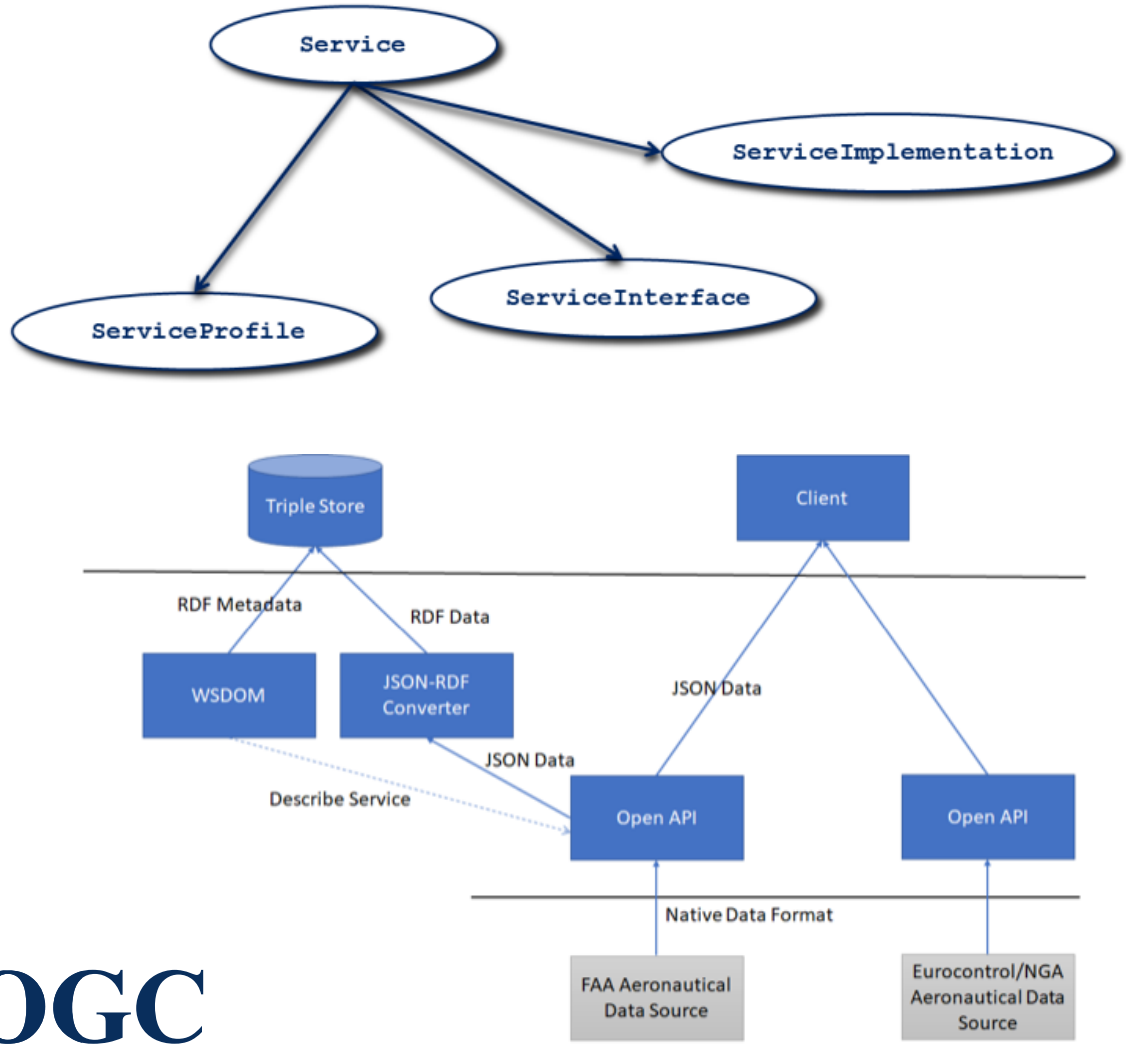
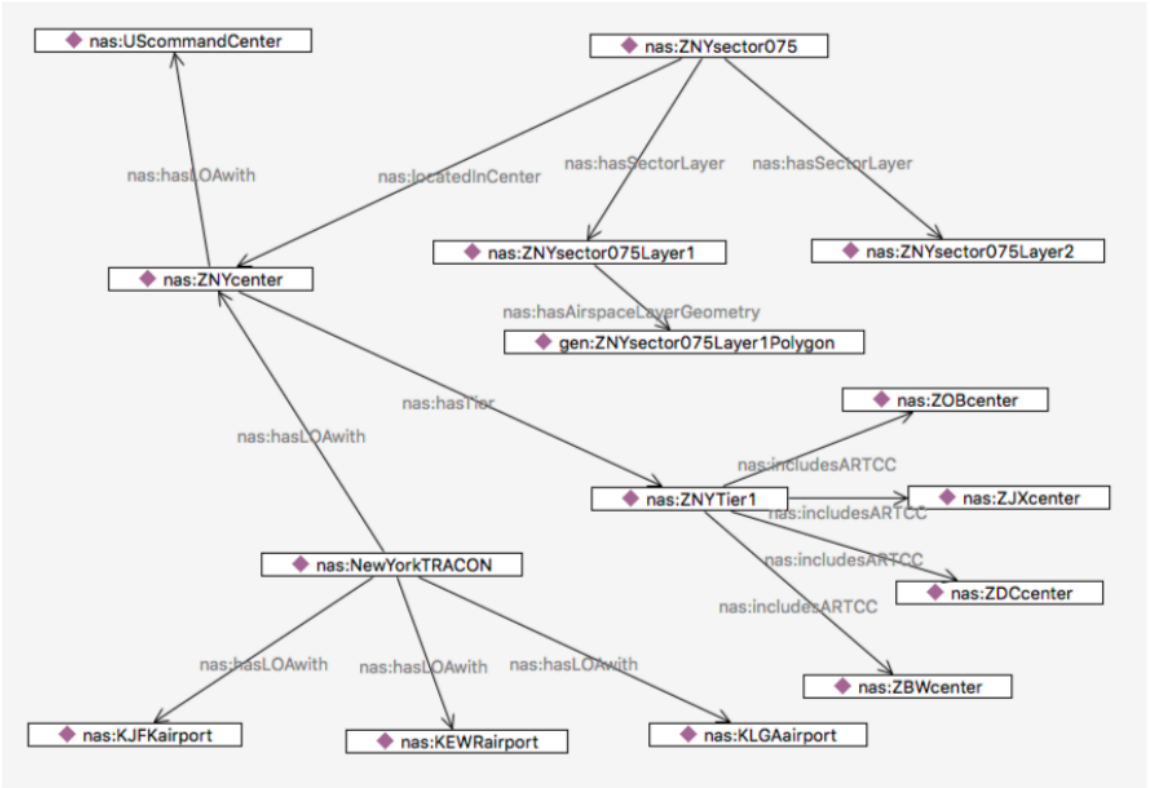
Aviation Semantics as Linked Data

Web Service Description Ontological Model: WSDOM



ATM Ontology- Structure of the NAS



OGC Testbed-14:
Semantically Enabled Aviation Data Models Engineering Report
http://docs.opengeospatial.org/per/18-035.html

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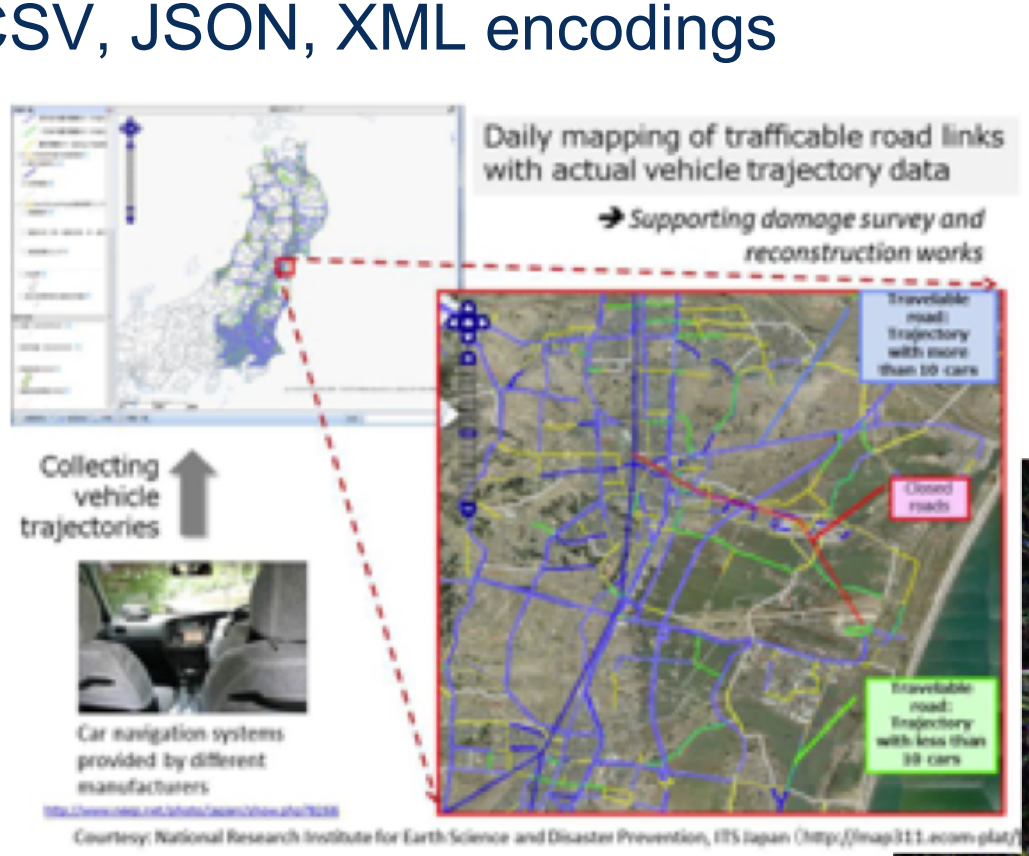
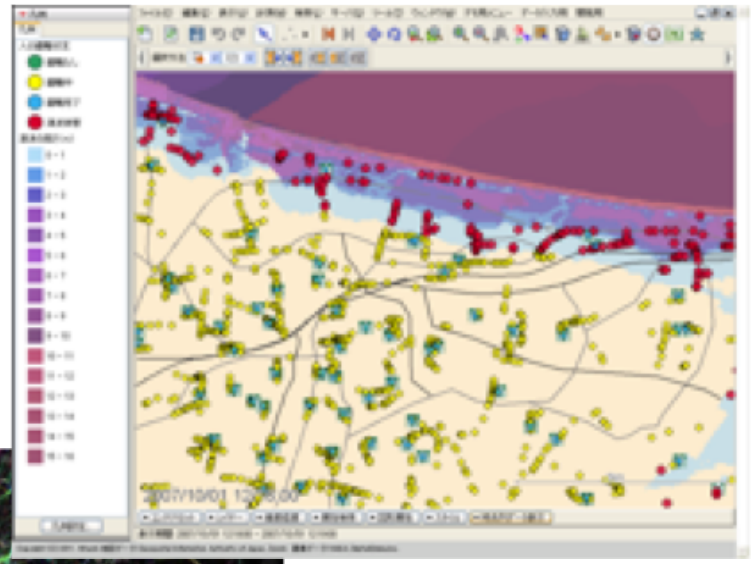
Moving Features

- Moving features, e.g. vehicles, pedestrians, airplanes, ships
- CSV, JSON, XML encodings





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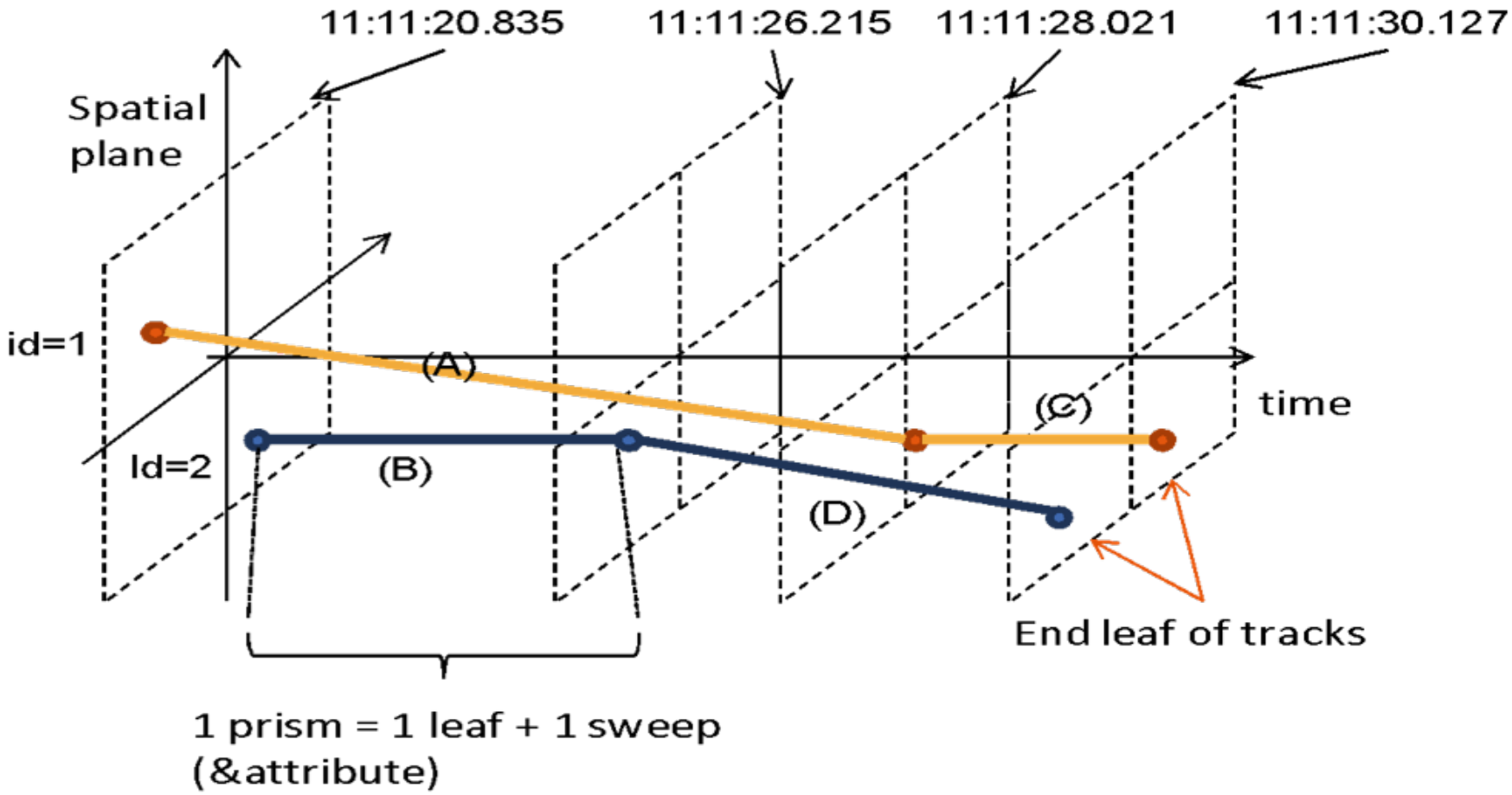
http://docs.opengeospatial.org/is/16-120r3/16-120r3.html

Spatial Temporal Geometry



OGC Moving Features Standard implements ISO 19141

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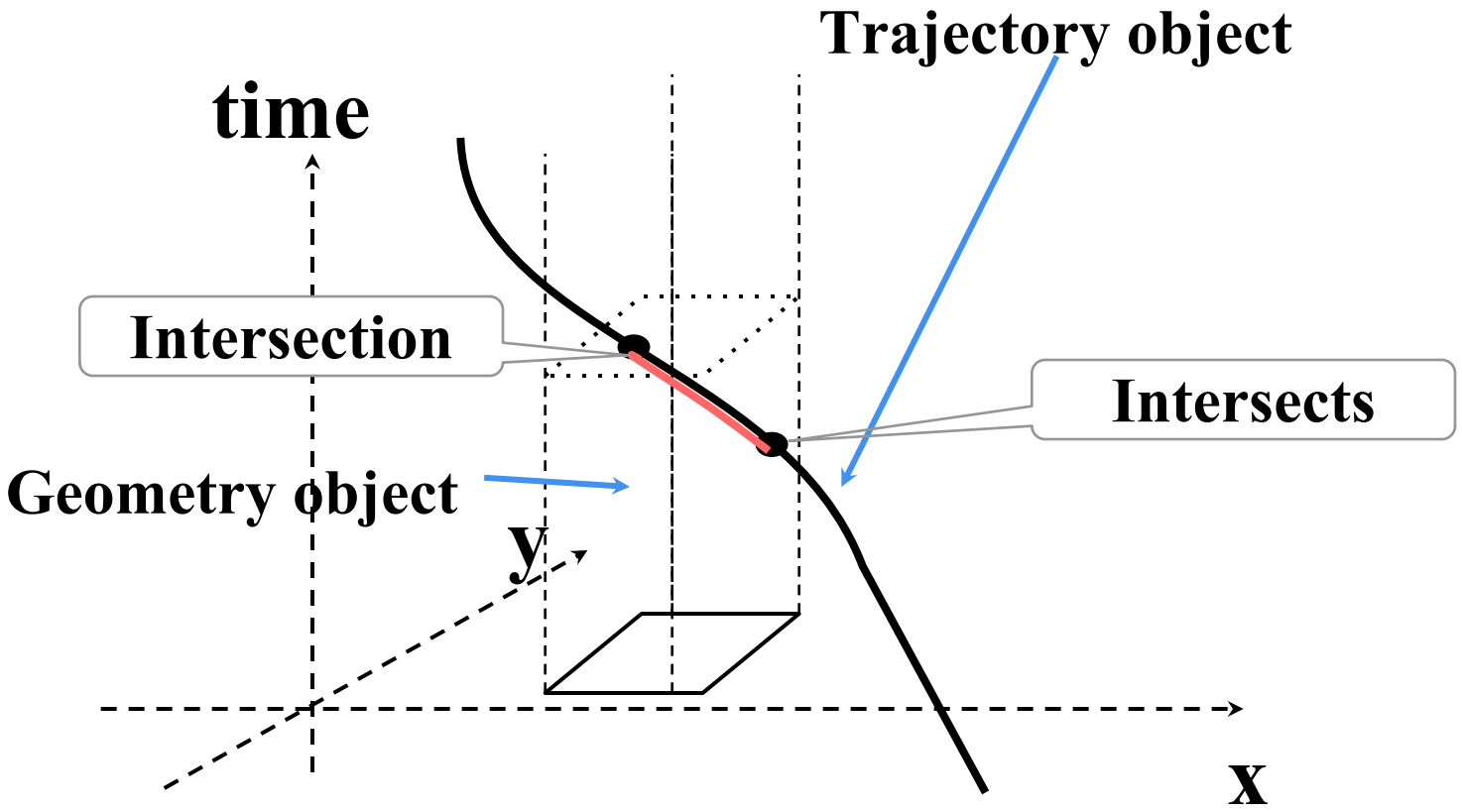
http://docs.opengeospatial.org/is/16-120r3/16-120r3.html

Moving Features: one trajectory, one geometry

Operations between a trajectory object and a **geometry** object of which geometry is stable

Examples:

- ***intersects***
- ***distanceWithin***
- ***intersection***



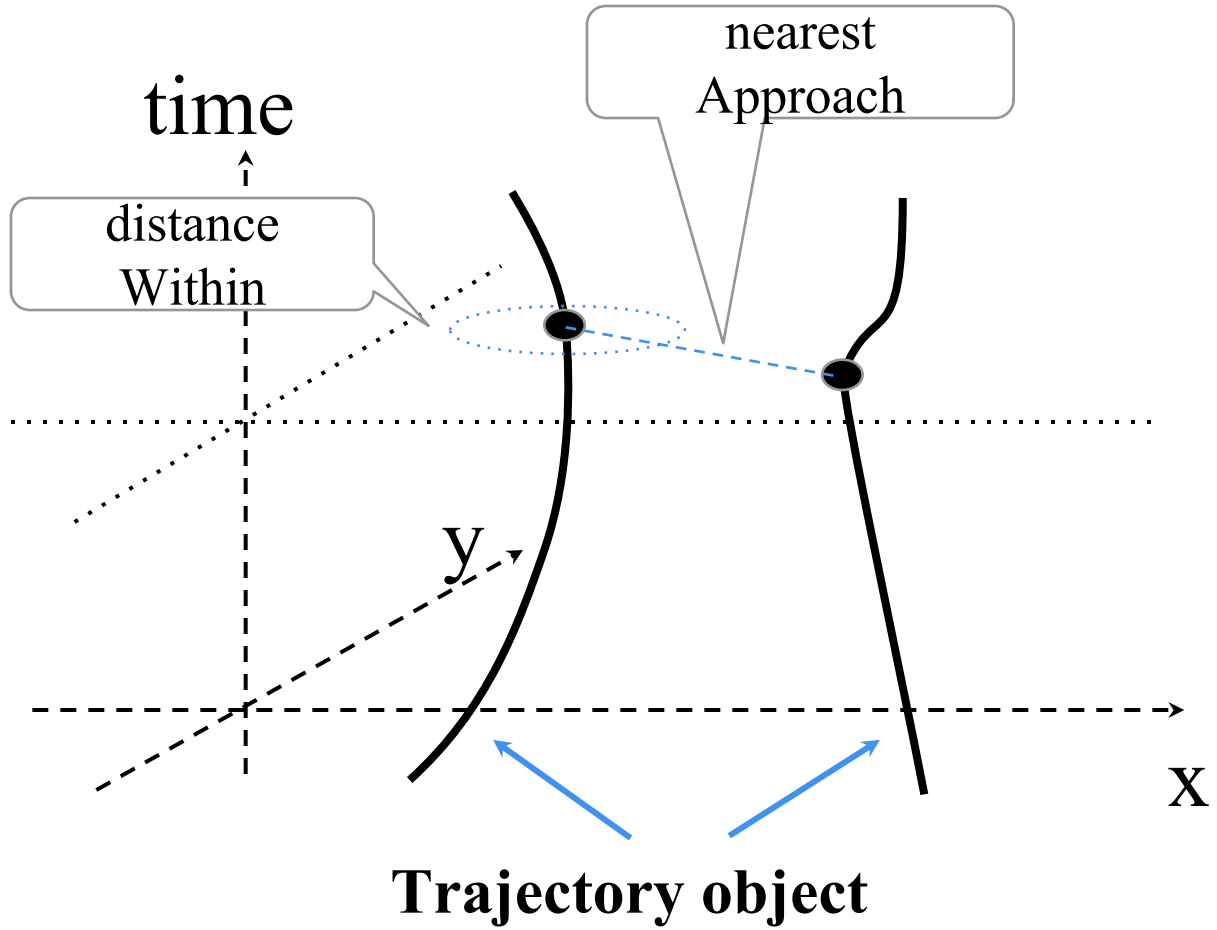
http://docs.opengeospatial.org/is/16-120r3/16-120r3.html

Moving Features: Two trajectories

Operations between two trajectory objects from the spatio-temporal viewpoint

Examples:

- *distanceWithin*
- *intersection*
- *nearestApproach*

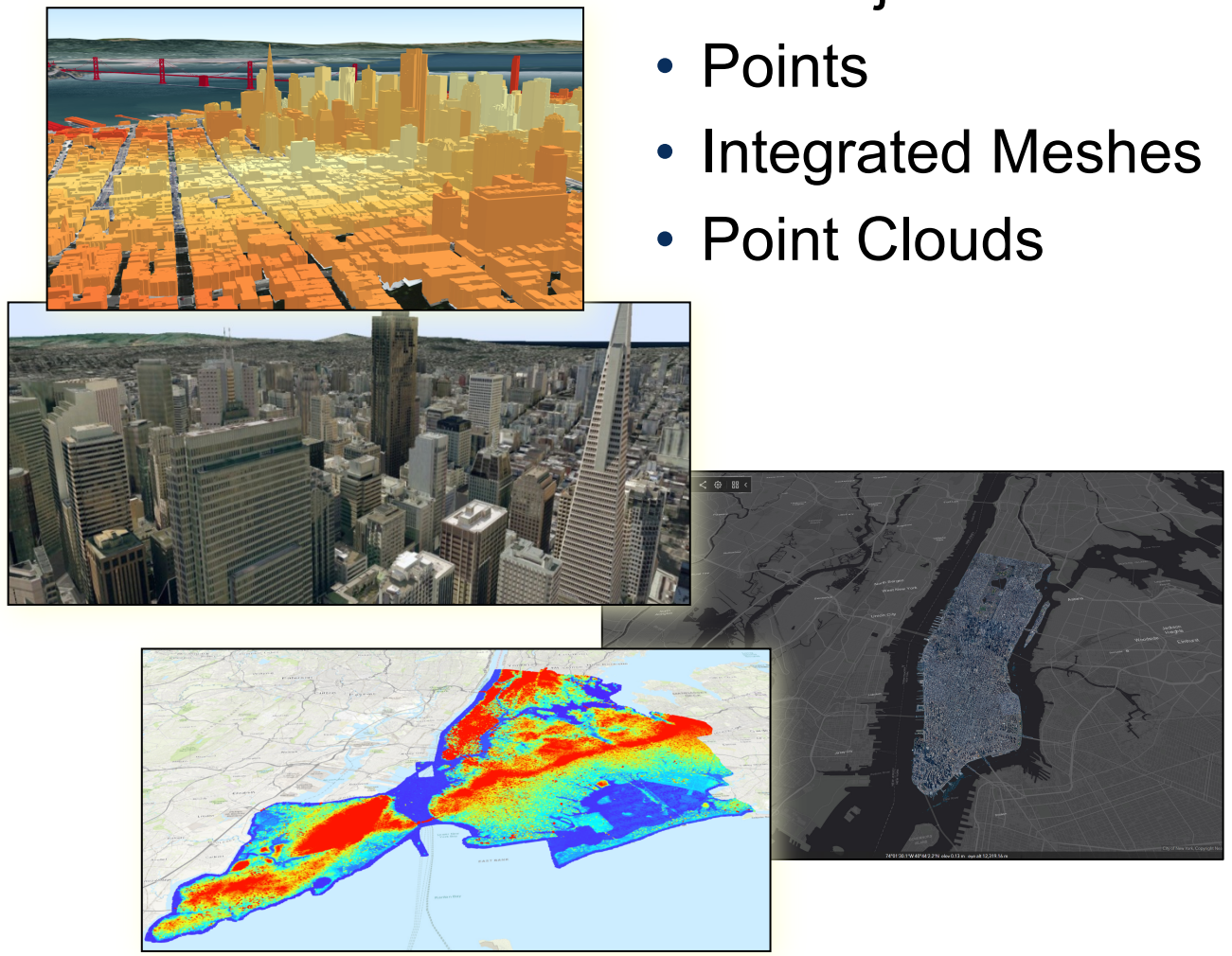


http://docs.opengeospatial.org/is/16-120r3/16-120r3.html

Visualization Advances: Indexed 3D Scene Layer (I3S)

- Storage and transmission of large, heterogeneous 3D geospatial data
- 3D geospatial content, various coordinate systems along with a rich set of layer types
- Expandable to accommodate new data types and access patterns

- Developed by Esri - now also an OGC Community Standard



- 3D Objects
- Points
- Integrated Meshes
- Point Clouds

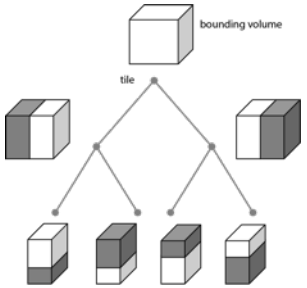
Visualization Advances:

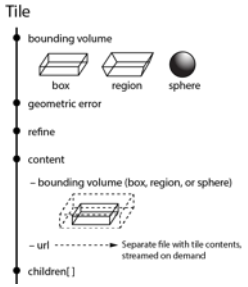
OGC Community Standard

Massive heterogeneous 3D geospatial datasets with semantics

3DTiles

Spatial data structures ✚ glTF ✚ Styling ✚ Metadata






```
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  "show" : "${Area} > 0",
  "color" : {
    "conditions" : {
      "${Height} < 60" : "color('#13293D')",
      "${Height} < 120" : "color('#1B98E0')",
      "true" : "color('#E8F1F2', 0.5)"
    }
  }
}
```
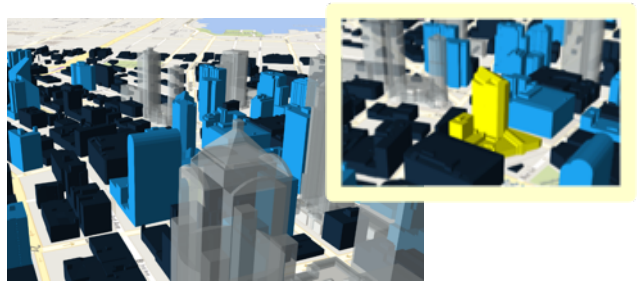
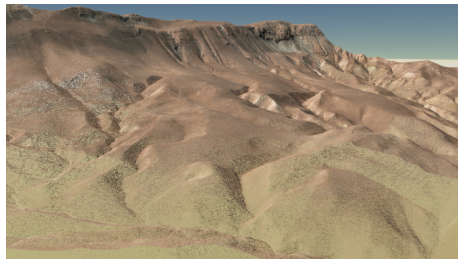
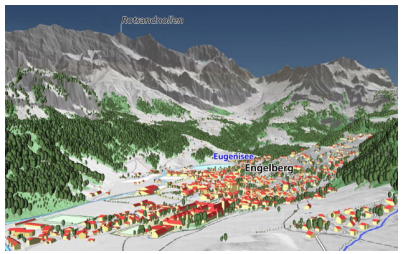



Photogrammetry



Point clouds

3D buildings



Terrain

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KHRONOS GROUP

STANDARDS FOR UAS

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ANSI
Unmanned Aircraft Systems Standardization Collaborative (UASSC)

ASTM International

International Organization for Standardization

RTCA, Inc.

SAE International

Institute of Electrical and Electronics Engineers

Consumer Technology Association

Open Geospatial Consortium

Underwriters Laboratories Inc.

National Fire Protection Association

American Society of Mechanical Engineers

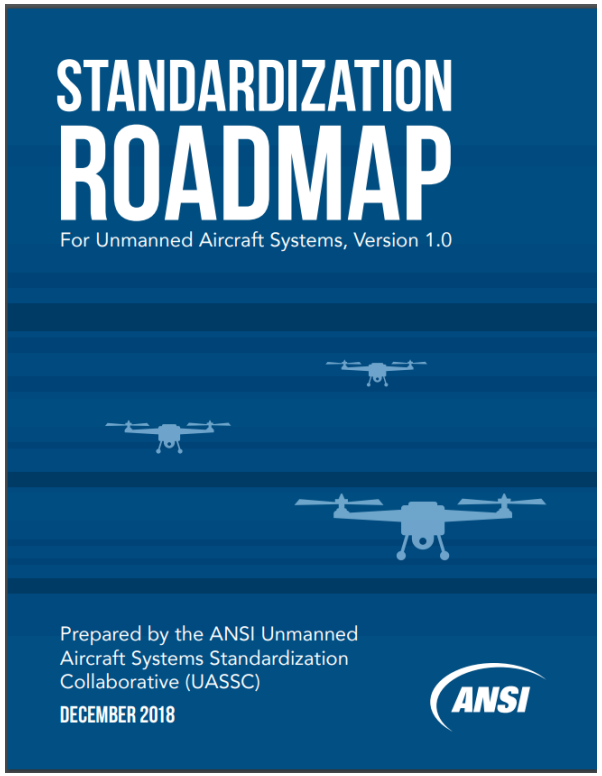
American Society of Safety Professionals

Telecommunications Industry Assn.

ANSI
Unmanned Aircraft Systems Standardization Collaborative (UASSC)

- Over 160 agencies, industry, SDOs, associations involved in v1.0

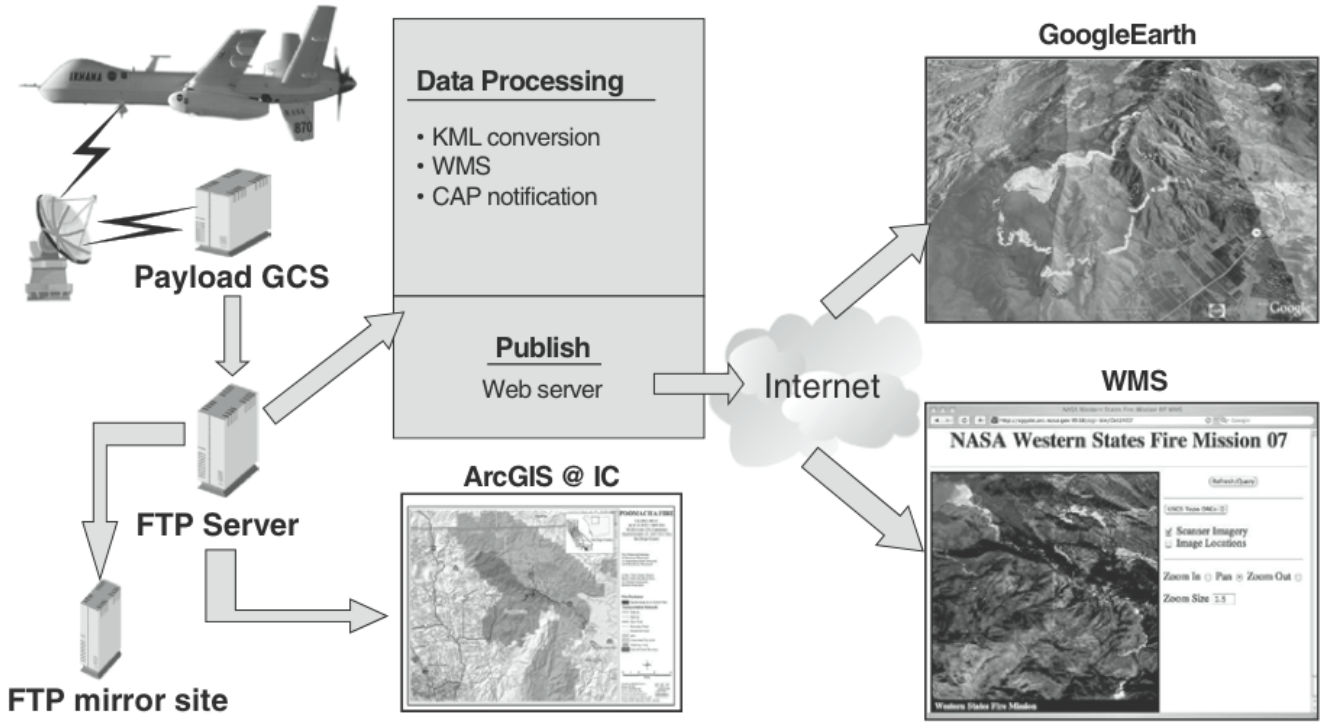
- OGC
  - Championed focus on ***Data Processing and Handling***
  - Contributed OGC Web Services and OGC Sensor Web Enablement standards
  - Supported assessment of key standards gaps:
    - Weather / micro weather for UAS operations
    - GeoFencing



https://share.ansi.org/Shared%20Documents/Standards%20Activities/UASSC/ANSI_UASSC_Roadmap_December_2018.pdf

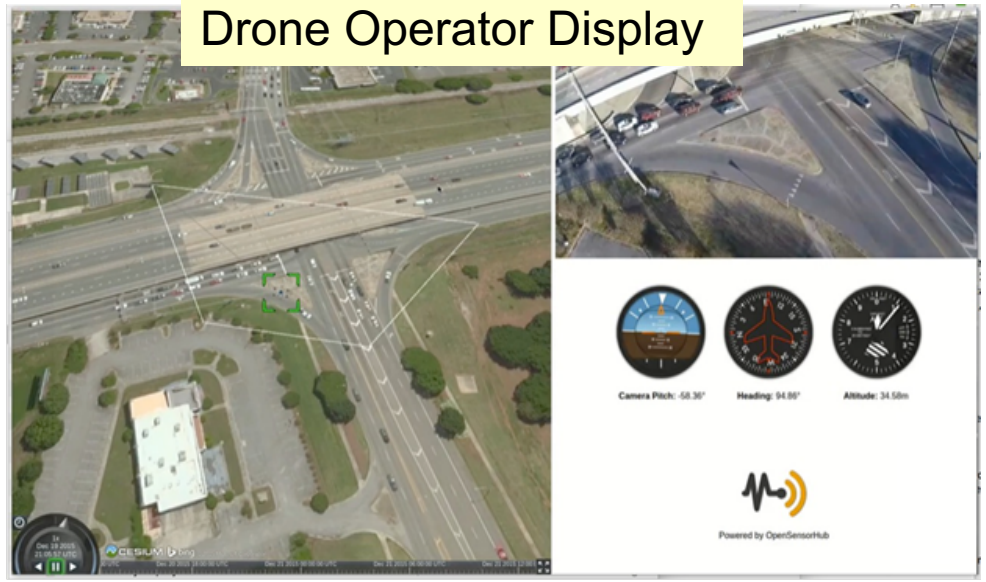
NASA and US Forest Service UAS

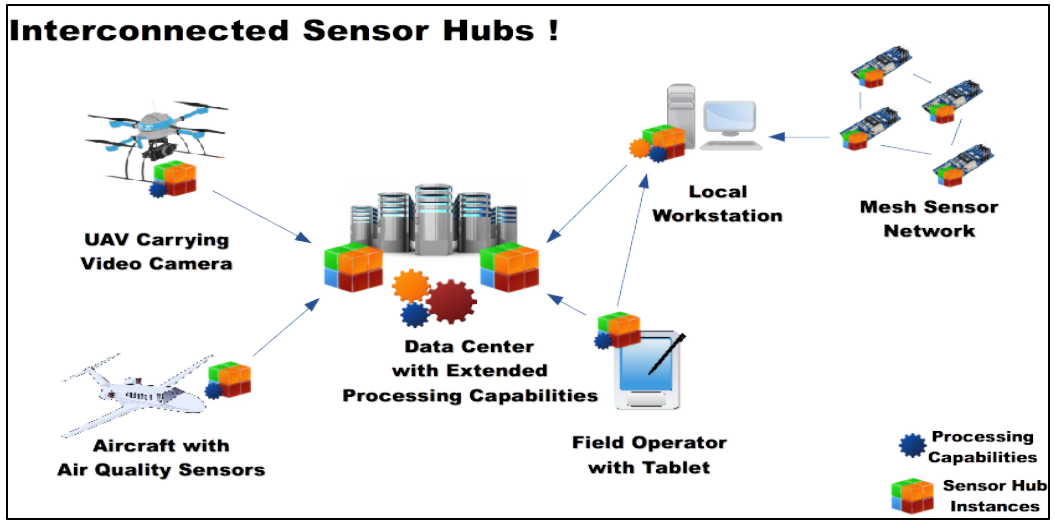
- Ikhana UAV with multispectral sensor
- Fire intelligence to management teams
- Web access to geospatial processing via open



Source: Ambrosia, G., Sullivan, D., Buechel, S., GSA Special Paper 482 , 2011

DHS - Incident Management Information Sharing (IMIS) IoT Pilot





OGC Standards Used in IMIS IoT Pilot

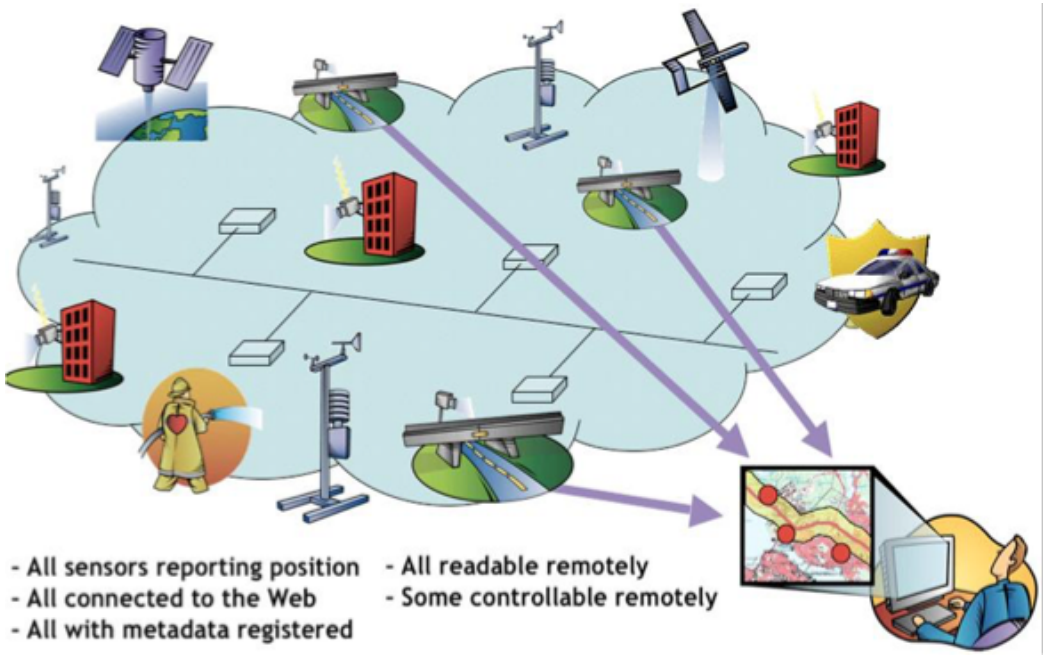
- Sensor Observation Service
- Sensor Planning Service
- SensorThings
- Web Processing Service
- Catalog
- OWS Context
- Web Feature Service
- Web Map Service

Live demonstrations in multiple sites in 2016

https://www.dhs.gov/publication/incident-management-information-sharing-imis-internet-things-iot-extension-engineering

OGC Sensor Web Enablement Standards

SWE Standards for Discovery and Tasking Sensors; Access and Process Observations



- Sensor Model Language (SensorML)
- Observations & Measurements (O&M)
- Sensor Planning Service (SPS)
- Sensor Observation Service (SOS)
- Catalogue Service
- Sensor Alert Service (SAS)
- PUCK

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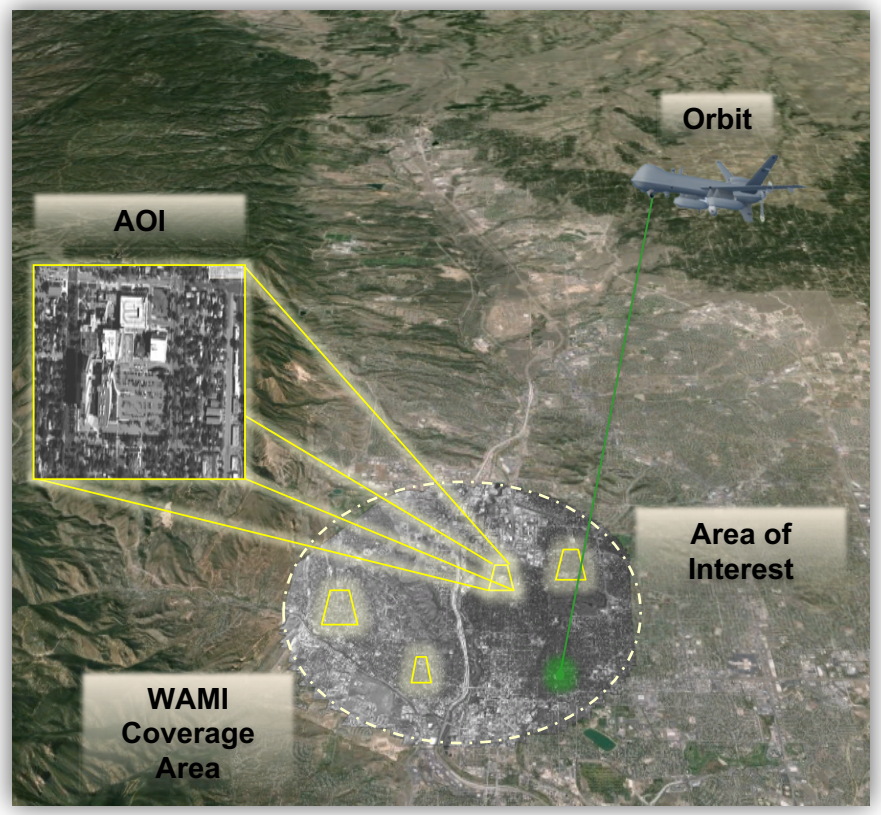
OGC WAMI Specification

- Wide Area Motion Imagery
  - An OGC Best Practice
- Motion Imagery
  - Video where each image in the video is spatio-temporally related to the next image
- Two required services
  - Collection Service (CS): What do I have?
  - Image Service (IS): Delivers an images and metadata across time



Also referred to as

Persistent Wide Area Surveillance

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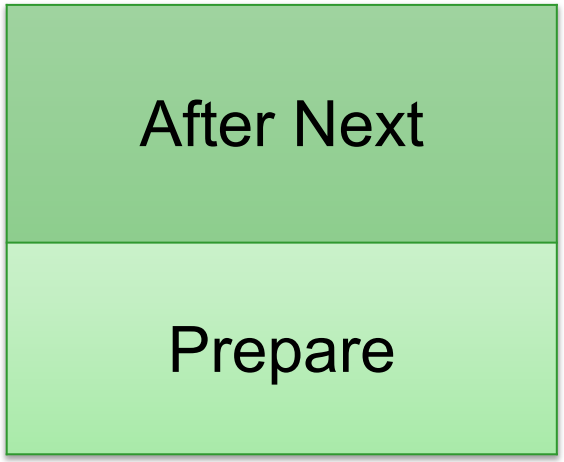
Standards and Innovation: Events Horizon



Now: Established Standard in Operations and Maintenance

Next: Prototyping and Refinement of New Standard

After Next: Identify needs and technology for future standards.

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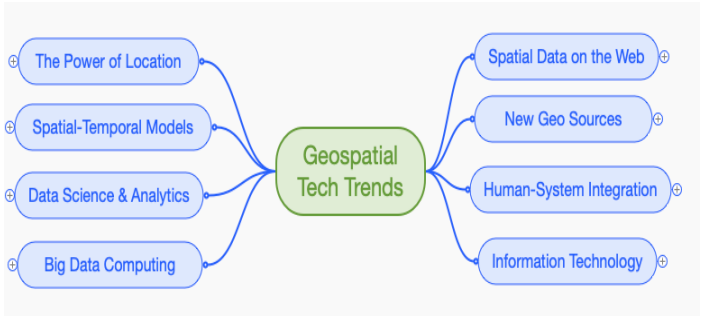
OGC Technology Trends

Breadth

Identify and Characterize Trends

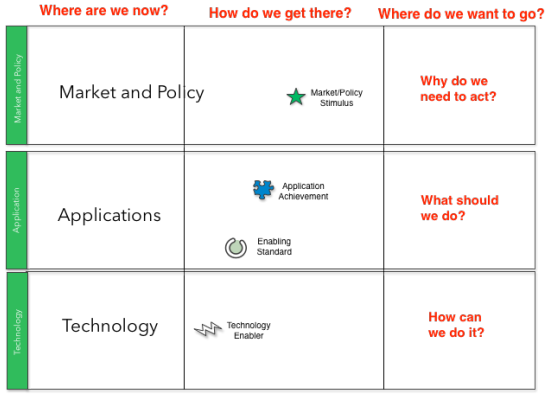
Trends Mindmap



Assessment

Prioritize and Evaluate Trends

Technology Roadmaps



Focus

Take Action

Innovation Program

e.g. planning Testbeds

Standards Program

e.g. Future Directions

Communications & Outreach

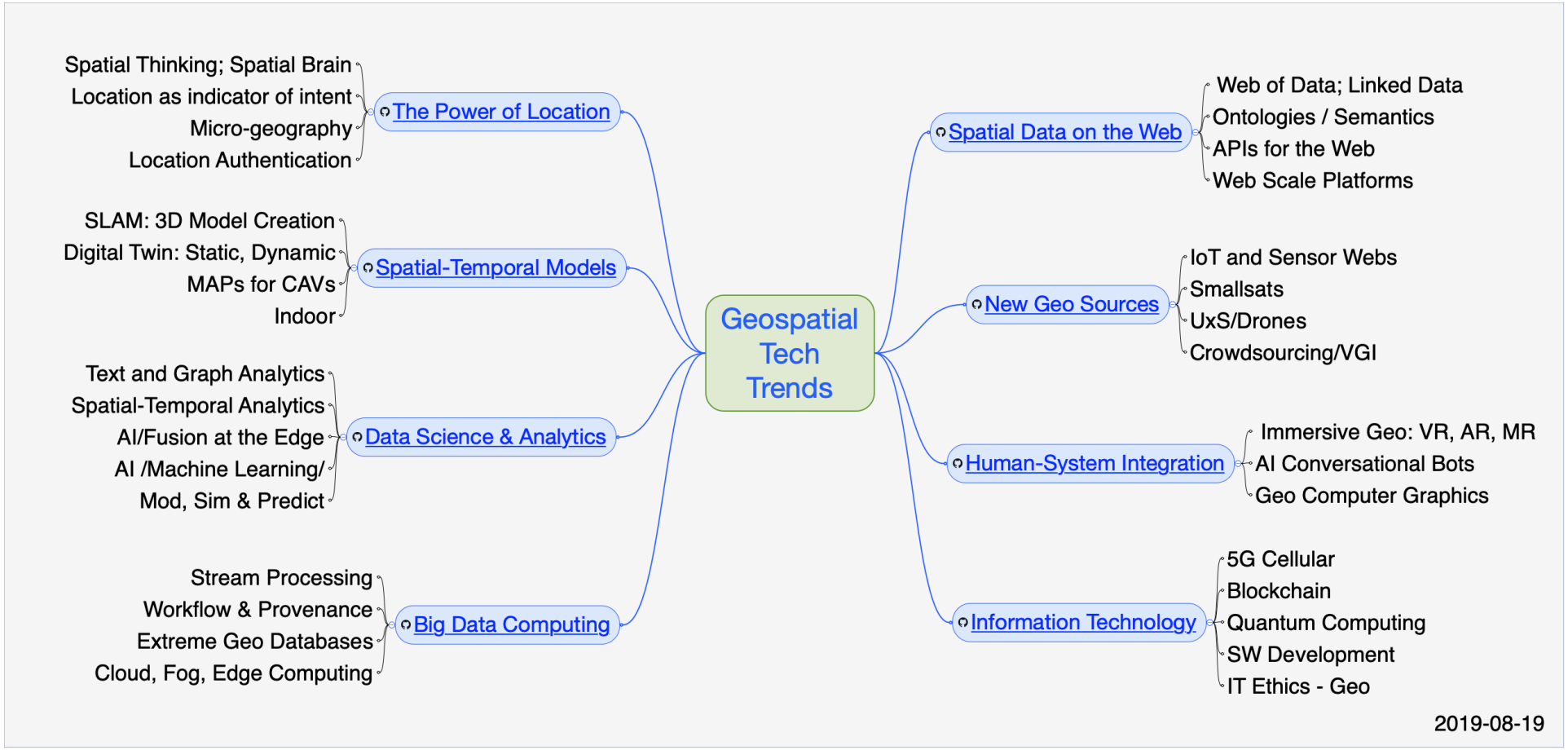
e.g. Location Powers

Member Consultation

e.g. NDA Tailored forecasts/discussion

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

OGC Tech Trends Mindmap



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

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OGC Trends Assessed in 2019

- 2019Q1
  - Indoor
  - UAV/UAS/UxS
  - Blockchain
  - Immersive Geo: AR, VR, xR
  - Mod, Sim, Predict – Digital Twin
- 2019Q2
  - Digital Twin: Static and Dynamic
  - Web of Data: Linked Data, GQL
  - Machine Learning
  - Quantum Computing & Sensing
- 2019Q3
  - Edge Computing: AI/ML, VR
  - Maps for CAVs
  - Geo IT Ethics
  - Data Science: AI/ML
- 2019Q4
  - Scaling to 100,000+ sources
  - Geospatial Technology Basemap

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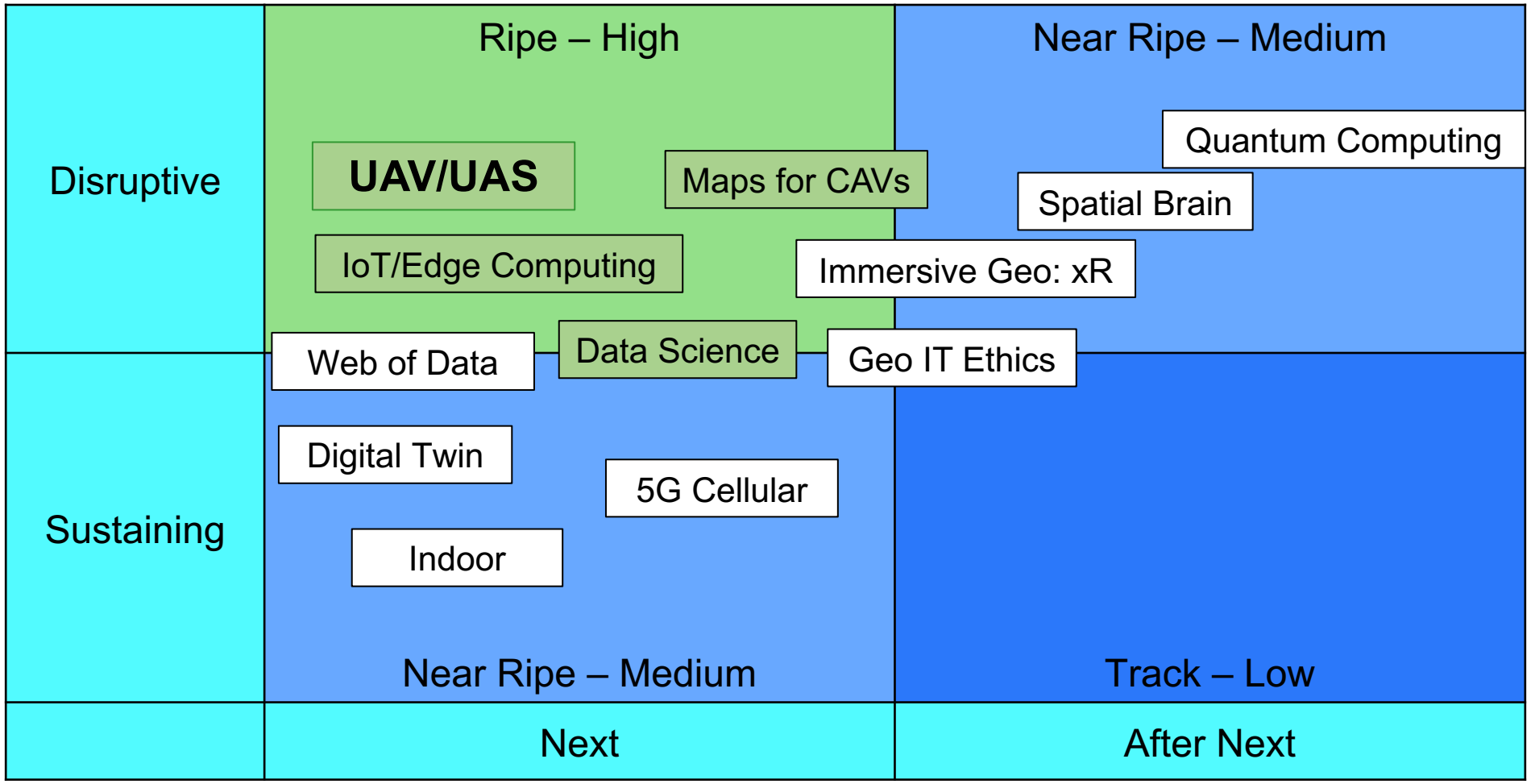
Priority Tech Trends



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For More Information

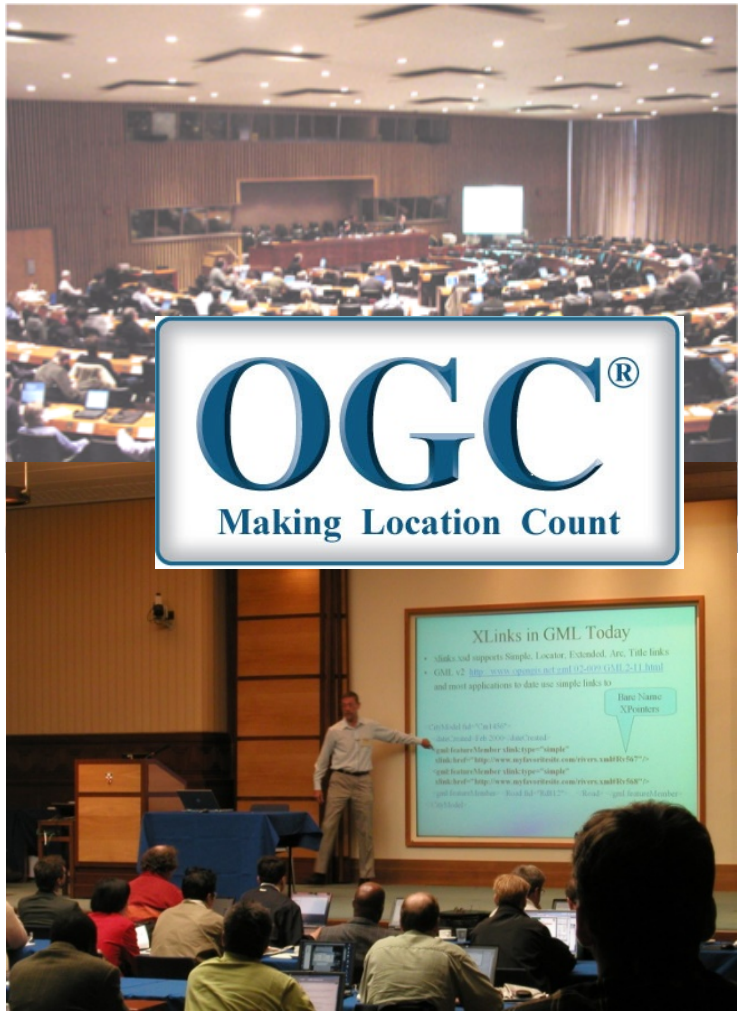
Open Geospatial Consortium
www.opengeospatial.org

OGC Standards - freely available
www.opengeospatial.org/standards

OGC Standards Program
Committees / Working Groups
http://www.opengeospatial.org/projects/groups

OGC Innovation Program
http://www.opengeospatial.org/ogc/programs/ip

OGC on YouTube
http://www.youtube.com/user/ogcvideo



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