TITLE: Discrete Global Grid Systems Standards Working Group Charter

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CATEGORY: SWG Charter

To:  OGC members & interested parties  
  
A new OGC Standards Working Group is being formed. The OGC members listed below have proposed the OGC Discrete Global Grid Systems (DGGS) SWG.  The SWG proposal provided in this document meets the requirements of the OGC TC Policies and Procedures.

The SWG name, statement of purpose, scope, list of deliverables, audience, and language specified in the proposal will constitute the SWG's official charter. Technical discussions may occur no sooner than the SWG's first meeting.  
  
This SWG will operate under the OGC 2007 IPR Policy. The eligibility requirements for becoming a participant in the SWG at the first meeting (see details below) are that:

* You must be an employee of an OGC member organization or an individual  
  member of OGC;
* The OGC member must have signed the OGC Membership agreement;
* You must notify the SWG chair of your intent to participate to the first meeting. Members may do so by logging onto the OGC Portal and navigating to the Observer page and clicking on the link for the SWG they wish to join and;
* You must attend meetings of the SWG. The first meeting of this SWG is at the time and date fixed below. Attendance may be by teleconference.

Of course, participants also may join the SWG at any time. The OGC and the SWG welcomes all interested parties.  
  
Non-OGC members who wish to participate may contact us about joining the OGC. In addition, the public may access some of the resources maintained for each SWG: the SWG public description, the SWG Charter, Change Requests, and public comments, which will be linked from the SWG’s page.  
  
Please feel free to forward this announcement to any other appropriate lists. The OGC is an open standards organization; we encourage your feedback.

# Discrete Global Grid Systems SWG

# Purpose of this Standards Working Group

The purpose of this SWG will be to explore and propose terms for a standard to enable interoperability through the use of Discrete Global Grid Systems (DGGS). The goal of the proponents is not to identify one DGGS, but to increase awareness of the advantages of DGGSs in general, to define the qualities of a DGGS, to make them interoperable – with conventional and other DGGS data sources, and to standardize operations on them. A standard will promote reusability, focus knowledge and experience, and highlight choices.

# Business Value Proposition

**INTRODUCTION**

A promising vision exists of a distributed global information system that uses Earth as its organizational structure [1]. Some challenges of the past - interoperability, semantic representation, and secure authentication [2], are now emerging as standards. Infrastructure required to serve this demanding virtual environment - high speed connections, high performance cloud computing platforms, and immersive 3/4D web interfaces and browsing tools – are generally accessible. There is an explosive growth of both the variety and the volume of interesting data sources along with an understanding of tremendous societal benefit [3]. Sensors swarm around the Earth and connected devices scan our environment. The trend to open data dissemination is another positive development

**CHALLENGES OF GEOSPATIAL INTEGRATION**

Geoscientific data has already exceeded the petabyte-scale barrier and is rapidly heading toward the exabyte-scale barrier. Converting this massive amount of data into timely information and decision support products is dependent on the capacity of the scientist to rapidly analyze this data in a transparent and repeatable fashion. The challenges of high velocity, high volume (> a terabyte per day) data is requiring those focused on combining and using these large data sources to rethink the way they store data in order to make best use of it. These challenges will only grow as requirements to combine these to produce near-real-time decision support information increases.

A new generation of decision-makers are also expecting systems that are not constrained by middle data integrators who post products in anticipation to their questions. These decision-makers have grown in sophistication – navigating time and space, mining the web for interesting information, and sharing their insights with others is everyday business. They are always connected; they are experts that demand choices and control over their own experience; they expect all the information now.

There remains a gap between expectation and the present reality [4]. Combining multiple sources of geospatial information - a necessary key step in the geospatial-intelligence cycle – is a very hard problem. Geospatial data integration on-demand is a grand challenge.

**DISCRETE GLOBAL GRID AS A SOLUTION**

A solution can only be achieved through the conversion of traditional data archives into standardized data architectures that support parallel processing in distributed and/or high performance compute environments. A common framework is required that will link very large multi-resolution and multi-domain datasets together and to enable the next generation of analytic processes to be applied. A solution must be capable of handling multiple data streams rather than being explicitly linked to a sensor or data type [5].

Success has been achieved using a framework called a discrete global grid system (DGGS). A DGGS is a form of Earth reference that, unlike its established counterpart the coordinate reference system that represents the Earth as a continual lattice of points, represents the Earth with a tessellation of nested cells [6]. Generally, a DGGS will exhaustively partition the globe in closely packed hierarchical tessellations, each cell representing a homogenous value, with a unique identifier or indexing that allows for linear ordering, parent-child operations, and nearest neighbour algebraic operations.

While conventional coordinate reference systems are designed to facilitate repeatable navigation, a DGGS is designed to ensure a repeatable representation of measurements – observations, interpretations, and events. Every item of information in a DGGS is associated with an area, and spatial resolution is explicit. This is much preferable to tagging an attribute with a latitude and longitude, since it's never clear what area possesses the attribute, or how accurate the measurement of location is. Combining or integrating layers becomes trivial in a DGGS, because items of information automatically line up. This is much like overlaying information across congruent rasters, and far easier than having to perform overlay using points, lines, and areas.

There are many possible DGGSs, each with their own advantages and disadvantages. There are choice of shape, alignment, and granularity. A DGGS can be optimized to provide statistically valid sampling, rapid storage, processing, and transmission, discovery, visualization, integration, aggregation, processing, analysis, and modelling.modelling. A well-accepted criterion for optimal DGGS design has been proposed [7].

**IMPLEMENTATION OF DISCRETE GLOBAL GRIDS**

There are several working DGGS prototypes that can be used to demonstrate the value of this approach. The PYXIS WorldView client application uses the Icosahedral Snyder Equal Area Aperture 3 Hexagonal DGGS (Snyder Grid). WorldView has been used to successfully demonstrate multi-source on-demand data integration and analysis within several OGC Open Web Services cross-community interoperability test-beds and International Group on Earth Observations GEOSS architectural pilot projects.

The New Zealand government research institute Landcare Research is currently developing an open-source DGGS geographical analysis system for worldwide scientific collaboration called SCENZ-Grid. SCENZ-Grid uses a rectangular DGGS of 3x3 tessellations of the six faces of a Hierarchical Equal Area iso-Latitude Pixelated ellipsoidal cube (HEALPix) designed for use in HPC and cloud architectures which is being developed for inter-disciplinary environmental modelling. HEALPix originated in NASA's JPL for astrophysical analyses of massive full-sky data-sets.

**STANDARDIZATION OF DISCRETE GLOBAL GRID SYSTEMS**

The Open Geospatial Consortium agrees that geosciences can only achieve their potential through the fusion of diverse Earth Observation and socio-economic data and information. In a multiple provider environment, fusion is only possible with an information system architecture based upon open standards [8]. We propose the establishment of a standards working group to explore and propose terms for a standard to enable interoperability between Discrete Global Grid Systems. The goal of the proponents is not to identify one DGGS, but to increase awareness of the advantages of DGGSs in general, to define the qualities of a DGGS, to make them interoperable – with conventional and other DGGS data sources, and to standardize operations on them. A standard will promote reusability, focus knowledge and experience, and highlight choices.

**REFERENCES**

[1] Goodchild M F 1992 “Geographical information science”, International Journal of Geographical Information Systems 6: 31–45

[2] de La Beaujardiere, Jeff, 2000, "Digital Earth Alpha Version," presentation at the First Digital Earth Alpha Version Workshop, Laurel, Maryland, 2000 July 25-26 (http://web.archive.org/web/20060902055648/http://www.digitalearth.gov/alpha/deav1/)

[3] Oxera Consulting ltd 2013, “What is the Economic Impact of Geo Services?” Report published to internet http://www.oxera.com/Oxera/media/Oxera/downloads/reports/What-is-the-economic-impact-of-Geo-services\_1.pdf accessed January 13, 2014

[4] Goodchild M F, Guo H, Annoni A, Bian L, de Bie K, Campbell F, and Woodgate P 2012 “Next-generation digital Earth”, Proceedings of the National Academy of Sciences 109: 11088–11094

[5] Purss, M., Oliver, S., Lewis, A., Minchin, S., Wyborn, L., Gibb, R., Fraser, A., and Evans, B., 2013, “Specification of a Global Nested Grid System for Use by Australia and New Zealand”, 7th eResearch Australasia Conference, Brisbane, Australia, October 20-25

[6] Clarke, Keith C. 2000 "Criteria and Measures for the Comparison of Global Geocoding Systems", International Conference on Discrete Global Grids. Santa Barbara: University of California, Santa Barbara, 2000

[7] Sahr K, and White D, and Kimerling AJ. 2003 "Geodesic Discrete Global Grid Systems." Cartography and Geographic Information Science 121-134.

[8] G. Percivall, “Geodata fusion study by the Open Geospatial Consortium,” Proc. SPIE 8747, Geospatial InfoFusion III, 87470A (May 23, 2013); doi:10.1117/12.2016226

# Scope of Work

The following constitutes the scope of work for the DGGS SWG. The DGGS SWG shall perform the following activities:

The DGGS SWG shall review existing material, e.g. in form of engineering and scientific reports and standards (both OGC and external), consult with domain experts, and collaborate to:

1. Produce a version 1.0 implementation standard that includes:
   1. A concise definition of the term Discrete Global Grid System as a spatial reference system;
   2. The essential properties of a conformant DGGS;
   3. The variability within these properties that classify types of DGGS;
   4. Elements of a Spatial Reference System Identifier suitable for registering specific implementations of a DGGS.
2. Specify interoperable protocols within the standard or through extension documents to:
   1. Get or post data referenced or sampled to a DGGS as individual values, standard feature and coverage encodings, and tiling schemes;
   2. Enable interactions within and between conformant DGGSs via Web Coverage Processing Services (WCPS), and/or other relevant protocols;
3. Develop examples demonstrating the implementation of the standard;
4. Organize, promote, and support test-bed and pilot project activity while it is active to exemplify the value of the standard to content-providers and end-user communities;
5. Address any other technical and/or editorial issues that arise during the review period.

The candidate standard is expected to be ready for review by OGC members within 12 months from the establishment of the DGGS SWG.

Only those functional requirements and comments submitted through the formal process as identified in the Policy and Procedures shall be addressed. Items suggested through emails, vocal discussions, etc. will be outside of the scope of this SWG unless the DGGS SWG decides to include them.

## Statement of relationship of planned work to the current OGC standards baseline

A DGGS is a special case of a spatial reference system that uses tessellations rather than lattice points to encode location. A DGGS is not a map projection that encodes a lattice of points in a regular grid. DGGS are designed to provide a fixed and therefore repeatable location to record and compare measurements of spatio-temporal phenomenon. The atom of a DGGS is its cell.

The unique components of a particular DGGS include the geometry for partitioning the Earth surface into cells with a unique identifier for each cell. The identifier can be a mathematically generated coordinate index (ISO 19111) or a label (ISO 19112). DGGS are often hierarchical and therefore encoding of parent child relationships can be implied in the indexing. A group of cells in a hierarchy can form a tile akin to map tiles (OGC WMTS).

As a DGGS encodes location as a cell area not a point, it is highly associated with imagery or coverage encoding (OGC WCS, ISO 19121, 19129). Extensions for encoding data into coverage (protocol, format, sub-setting, processing, vertical and temporal dimensions) will generally apply directly to the DGGS and will likely be harmonized.

A coverage is intended to provide data values and locate these using a specific grid geometry and spatial reference system. The grid geometry and spatial reference is a product of the data process. Conversely, a DGGS is data agnostic. In other words, the DGGS standard could be used within a coverage encoding as its grid geometry and spatial reference and conversely, a DGGS could be implemented using a particular coverage encoding standard to store data and metadata values. Data values contained in coverage that reference the same DGGS are aligned and thus geospatially integrated or fused.

The primary product of a standard DGGS is therefore the fusion of disparate data on-demand sufficient for spatial analysis and modeling.

Although coverages provide a conceptual link to DGGS, geometric features can also be efficiently encoded to a DGGS (OGC WFS, SOS). The DGGS can then be a universal framework for combining data encoded in imagery and vectors in a similar way that a graphic processor combines information onto the pixels on a computer screen.

As an integration solution, the DGGS is tied closely to client side functionality; more than most OGC standards.

Adoption of a DGGS would advance a new paradigm in geospatial data acquisition and use - a harmonized distributed geospatial database that would utilize and build on interoperability of most OGC Open Web Services (including processing, operations, chaining, catalogues, and packaging) and other service oriented architectures.

## What is Out of Scope?

The DGGS SWG will not include specific DGGS geometries or indexing schemes as a part of the standard.

The DGGS SWG will not include specific DGGS functionality or mathematical operations as a part of the standard.

The DGGS SWG will not work on any change requests or other issues beyond those submitted during the 30 day public comment period.

## Specific Contribution of Existing Work as a Starting Point

The DGGS SWG will begin with a review of existing literature on DGGS forms. There are presently no preexisting formal standards that the members are aware to serve as a starting point.

## Determination of SWG Completion

The DGGS SWG will dissolve after the following milestones have been achieved:

* 1. The DGGS SWG has completed evaluation and incorporation into the candidate standard of all comments received during the 30 day public comment period.
  2. The DGGS SWG approves the Conceptual Model and Encodings documents for submission to the TC for approval as an adopted standard.
  3. The candidate standard has been approved by the OGC Technical and Planning Committees as an Adopted OGC standard.

## Is this a persistent SWG?

Yes ☑ No

# Description of Deliverables

There shall be at least two deliverables:

1. Conceptual Model: A document describing the core qualities of DGGSs and their role in enabling interoperability using the OGC Architecture.
2. Encodings: A document describing how DGGSs under this standard relate to and can use the functionality of OGC Web Services and other relevant protocols and bindings to support interoperability between DGGSs. At least one such document will be produced by the SWG.

# IPR Policy for this SWG

☑ RAND-Royalty Free. RAND for fee

# Anticipated Participants

Those involved with the design, development, implementation or use of Discrete Global Grid Systems. This includes, *inter alia*, participants from the geospatial, geoscience, geodetic, geophysics, earth observation, climate change, environmental monitoring and applied modelling communities.

# Other Informative Remarks about this SWG

a. Similar or Applicable Standards Work (OGC and Elsewhere).

The following Published OGC Standards, *inter alia*, have relevance to the work of the DGGS SWG:

* NetCDF
* Sensor Web Enablement
  + Observation and Measurements (Earth observation Metadata profile of Observations & Measurements Standard)
  + SensorML
  + Sensor Observation Service
* Web Coverage Processes
* Web Coverage Processing Services
* Web Map Tile Service
* Geography Markup Language (GML Application Schema – Coverages)
* Ordering Services Framework for Earth Observation Products Interface Standard

The following SWGs, *inter alia*, have relevance to the work of the DGGS SWG:

* CF-NetCDF 1.0 SWG
* EO Product Metadata and OpenSearch SWG
* Web Coverage Service (WCS) SWG
* Web Processing Service (WPS) SWG

The following DWGs, *inter alia*, have relevance to the work of the DGGS SWG:

* Coverages DWG
* Coordinate Reference Systems DWG
* Earth Systems Science DWG
* Sensor Web Enablement DWG

Other data interoperability activities that may have relevance to the work of the DGGS SWG:

* GEOSS Standards & Interoperability Forum (<http://seabass.ieee.org/groups/geoss/index.php>)
* Belmont Forum e-Infrastructure Project ([www.bfe-inf.org](http://www.bfe-inf.org))
* NSF EarthCube (<http://www.nsf.gov/geo/earthcube/index.jsp>)

b. Details of the First Meeting  
The first meeting of the DGGS SWG will be held at the OGC TC meeting at Arlington, Virginia, USA, 24-28 March 2014. Call-in information will be provided to the DGGS SWG email list and on the portal calendar in advance of the meeting.c. Projected On-going Meeting Schedule  
The work of the DGGS SWG will be carried out primarily via email and conference calls every two weeks. Face-to-face meetings with optional attendance via conference call will coincide with OGC TC quarterly meetings.

d. Supporters of the Proposal  
The following people support this proposal and are committed to the Charter and projected meeting schedule. These members are known as SWG Founding or Charter members. Once the SWG is officially activated, this group is immediately “opted-into” the SWG and have voting rights from the first day the SWG is officially formed. Extend the table as necessary.

|  |  |
| --- | --- |
| Name | Organization |
| Matthew Purss | Geoscience Australia |
| Perry Peterson | PYXIS Innovations |
| Robert Gibb | Landcare Research NZ |
| Simon Oliver | Geoscience Australia |
| Faramarz Samavati | University of Calgary |
| Robert Woodcock | CSIRO |
| Ben Evans | National Computational Infrastructure, Australian National University |
|  |  |

e. Convener(s)  
Name of individual(s) who started the SWG process. Could be the lead for an RFC submission, an OGC staff person, or an individual who believes it is time for a revision to an adopted standard.

Matthew Purss – Geoscience Australia

Perry Peterson – PYXIS Innovations

Robert Gibb – Landcare Research NZ