Geospatial Indexing Capsule Specification

Purpose and Scope--

This Capsule provides a starting point for applications that need to handle complex geospatial information, with or without time and dynamic characteristics. It will leverage the Multidimensional Indexing and Structure capsules. Note that individual objects may or may not contain the geospatial attributes. They may also be arranged in hierarchical, or other, structures using the Structure Capsule.

The Geospatial index is capable of handling points, lines, vectors, planes, circles, spheres and irregular areas/volumes defined relative to the geometry of the Earth (though it could be used in some astronomy applications). It will use a 0-90 degrees N/S and 0-180 degrees E/W co-ordinate system and spherical geometry, except where explicitly noted.

It is not targeted at handling bitmaps, although the Arrays of Arrays Capsule should be able to provide additional functionality for GIS imaging and raster-to-vector applications. Likewise, registration, projection and other co-ordinate mapping algorithms are to be provided by the developer, rather than this capsule. However, the ability to create multiple GIS indices for a given object (or group of objects) will be very useful to such developers.

Supplementary Capsules------

Supplementary GIS and Geospatial Intelligence handling capsules will support the following characteristics or capabilities:

- Dynamics space and time information related to objects or formations that are in motion.
- Advanced geometric objects such as Nonuniform rational B-splines and polygon meshes.
- Gazetteer a physical and political geographical dictionary and "fact book 1".
- Ontological characteristics such as labeling a body of water as a pond, lake or sea.
- **Geocoding** such as "Find the Latitude/Longitude/Altitude of the windows at the top of the Statue of Liberty National Monument."
- **Geoparsing** converting an arbitrary textual phrase into one or more geocoded locations. The phrase "The center of the City of Jackson" identifies ten possible locations in the USA (assuming that "center" can be defined unambiguously).
- Popular standards such as the OpenGIS standard.

¹ Such as the CIA World Fact Book

Functionality ----

The Geospatial Indexing Capsule supports the object model depicted in Appendix A. An object with geospatial characteristics may be referenced by multiple indices that usually define a position or area and temporal characteristics.

The Geospatial Indexing capsule provides tools or methods for:

- Creating, updating and deleting a scalable, multi-dimensional "GIS" index that handles any of the following keys:
 - Geographic Point Latitude and Longitude {Lat, Long}
 - Line using linear or spherical geometry {Lat_1, Long_1, Lat_2, Long_2}
 - Vector using linear or spherical geometry Origin {Lat, Long} and direction (2D or 3D)
 - Plane using linear or spherical geometry defined by two vectors or an altitude/depth.
 - Geosquare {Lat_1, Long_1, Lat_2, Long_2}
 - Geospherical triangle {Lat_1, Long_1, Lat_2, Long_2, Lat_3, Long_3}
 - Polygonal area {Lat_1, Long_1, Lat_2, Long_2, Lat_n, Long_n}
 - Geocircular area defined by a center {Lat_1, Long_1} and radius.
 - Geospherical area defined by a center {Lat_1, Long_1} and radius.
 - Irregular areas/volumes the user generates a composite key and supplies the position, distance, area/volume and viewing methods for objects using that particular mapping.
 - Altitude (negative for depth) may be combined with any other key, or key component.
 - Date-Time may be combined with any other key, or key component.
- Inserting, updating, deleting and querying GIS index entries. Individual index keys within a multi-field key may be set to Null. This would allow the insertion of a {Lat, Long, Height, Direction_of_Travel, Date-Time} key where the Direction_of_Travel is indeterminate. Arrays may be indexed with minimum and maximum values.
- Using a sample, replaceable placement model (segmenting a GIS index across databases and containers).
- Using the GIS index in support of enhanced object queries.
- Finding all GIS indices that reference an object.
- Finding all GIS indices in a scope (federation, database or container).
- Calculating the length of a line, a degenerate encapsulation of...
- Calculating the shortest distance between any combination of two points, lines, vectors, circles, planes, areas or volumes.

- Calculating the intersection(s) of any combination of two or more lines, vectors, planes, areas or volumes, e.g. a vector and a sphere, a line and an area, or a plane and a volume.
- Calculating the area/volume of a geosquare, circle/sphere, intersected plane, or other area/volume.
- Finding the nearest object to a point, line, vector, plane, circle, sphere or other area/volume.
- Finding all objects within a specific distance, or a range of distances, of a point, line, vector, plane, circle, sphere or other area/volume.
- Displaying objects in a pan/zoom window using a linearly spaced grid or a Mercator projection. This is primarily for developers, rather than end users.

Platforms-and Languages-----

- Windows and Linux.
- C++, Java and C# (later).

Notes for-Developers-

- It would be acceptable to release this capsule in phases, omitting planes and user-defined irregular areas/volumes in the first phase.
- R-Tree and/or quadtree indices could supplement or replace the Multi-dimensional Indexing Capsule if they are able to support all of the above functionality and provide performance or storage benefits.

Suggested-Pricing-----

- Free and open source, but requiring standard Objectivity/DB licenses to be useful.
- Capsules that depend upon this one will be individually priced, possibly in the \$250 to \$500 per developer range.

Appendix A - Object Model for the Geospatial Indexing Capsule ----

This capsule introduces the GIS Index class. It inherits directly from the Index class defined in the Multi-dimensional Indexing Capsule Specification, making it easier to locate index instances that share the same scope as other indices. The other classes are the ones used by that capsule.

