Geospatial Dynamics Capsule Specification

Purpose and Scope

This Capsule provides a starting point for applications that need to handle complex geospatial information with dynamic characteristics. It will leverage the Multi-dimensional Indexing, Geospatial Indexing and Structure capsules. Note that individual objects may or may not contain the geospatial and temporal attributes. It deals with single objects, groups and formations of objects in motion. It allows for both planned and actual positions and velocities[1].

Functionality

The Geospatial Dynamics Capsule supports the object model depicted in Appendix A. It supplements the object model defined for the Geospatial Indexing capsule. The Geospatial Dynamics capsule provides tools or methods for:

- Creating and manipulating the following kinds of object:
  - **Geodynamic Vector** - a vector (magnitude and direction) with a geospatial origin and a date/time stamp. The magnitude may be an absolute, perceived or relative speed.
    - Absolute speed is calculated by measuring the position of an object at two times. The absolute speed is calculated by dividing the distance between the two positions by the difference between the two times. An aircraft that drops steadily from a height of 3 miles to an airport that is 4 ground miles away actually moves five miles[2]. If it takes five minutes it has been moving at an absolute speed of 60 miles per hour.
    - A perceived speed is calculated by dividing the distance between two points by the time taken to move between them. In the above example, the aircraft covers 4 ground miles in 5 minutes, so its perceived (ground) speed is 48 miles per hour.
    - Expressed another way, the velocity of the aircraft along the ground plane is 48 miles per hour. The velocity of the aircraft along the hypotenuse of the triangle is 60 miles per hour.
    - A relative speed is calculated by measuring the distance between an object and another object at two times. The relative speed is the difference in distance divided by the difference in time. A glider released from the above aircraft at the start of the descent might take ten minutes to reach the airport. The aircraft's absolute and perceived (ground) speeds were 30 and 24 miles per hour, respectively, as calculated by the other pilot as the glider lands. Before the glider lands the relative ground speed of the aircraft

[1] Velocity = Speed in a particular direction. It can be expressed in terms of a speed (magnitude) and a vector.

[2] Plus a correction for the curvature of the Earth, which slightly increases the absolute speed.

is 24 miles per hour. Immediately after the aircraft lands its relative air speed is -30 miles per hour and its relative ground speed is -24 miles per hour, as calculated by the glider pilot. After the glider lands the relative speed is zero.

    - If relative speed is used, a Geodynamic Vector may be defined using its origin and the position of another object.

- **Geodynamic Varray** - a variable length array of Geodynamic Vectors. It might represent the planned or actual position and direction of an object at different times (a track). It may also define an area or volume, rather than a track.
- **Geodynamic Group** - a collection of objects or other groups that may or may not be arranged in a geometric or temporal pattern.
- **Geodynamic Formation** - a group whose members are arranged in a geometric or temporal pattern, e.g. an aerobatics team flying in close formation, or three buses following the same route but spaced at five minute intervals.
    - The situation where a group becomes a formation and then reverts to a group can be handled by creating a linked list of objects of the correct type.

- Creating, updating and deleting a scalable, multi-dimensional geodynamic index that handles all of the above data types, objects and collections.
- Inserting, updating, deleting and querying geodynamic 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 currently indeterminate, or is computable. Geodynamic VArrays may be indexed with minimum and maximum values.
- Using a sample, replaceable placement model (segmenting a geodynamic index across databases and containers).
- Using the geodynamic index in support of enhanced object queries.
- Finding all geodynamic indices that reference an object.
- Finding all geodynamic indices in a scope (federation, database or container).
- Calculating the shortest distance between any combination of two Geodynamic Vectors, VArray elements, or Group/Formation members.
- Calculating the intersection(s) of any combination of two or more Geodynamic Vectors, VArray elements, or Group/Formation members.
- Calculating the length/area/volume defined by a Geodynamic Vector, Group or Formation.
- Finding the nearest object to a Geodynamic Vector, VArray, Group or Formation at a particular time, or between two times.
- Finding all objects within a specific distance, or a range of distances, of a Geodynamic Vector, VArray, Group or Formation at a particular time, or between two times.

- Determining the position (actual or intended), speed and direction of a geodynamic entity at a particular time.
  - In the case of a group or formation, there should also be methods for returning the OIDs of the nearest and furthest objects at a particular time. These distances are measured relative to a geospatial point (usually an origin or destination).
  - "Position" means the geometric centroid for a Geodynamic Group or Formation.
  - The weighted average direction of travel of a group will be computed by using the relative speeds to weight the directions before producing an average.
  - A formation, by definition, moves according to the specifications of a single Geodynamic VArray.
- Displaying geodynamic objects in a pan/zoom window using a linearly spaced grid/cube/cuboid or a Mercator projection. This is primarily for developers, rather than end users.

Platforms and Languages

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

Suggested Pricing

- $500 per developer seat, plus standard Objectivity/DB licenses to be useful.

Appendix A – Object Model for the Geospatial Dynamics Capsule

This capsule introduces the Geodynamic Index class. It inherits directly from the Geospatial Index class defined in the Geospatial Indexing Capsule Specification, making it easier to locate index instances that share the same scope as other indices. In addition:

- The group of "Key" classes is the one used by that capsule (and the Multi-dimensional Indexing Capsule).
- Geodynamic Vector and Geodynamic VArray are attributes, not classes.
- Geodynamic Item inherits from the Structure Capsule Item class.
- The Members and Leaders links on the Geodynamic Item are actually the Down and Up Structure Capsule links.