



## GeoTime<sup>®</sup> for Analysis of Behavior in Time and Geography

### Introduction

GeoTime is an award-winning, unique tool for displaying and working with data over both space and time within a single, highly interactive 3D view. Seeing events, connections and movements in a combined temporal and spatial view allows analysts to detect, examine and understand patterns much more quickly than with traditional analysis tools. GeoTime operates with Excel or with the ArcGIS 9 architecture and ArcMap, via the ArcGeoTime Connector, to provide complimentary and seamless interaction, data access and analysis capabilities.

### Benefits

With separate time and geographic data analysis tools, it is difficult to get a complete picture across all dimensions. In GeoTime, spatial time tracks make possible the perception of where and when. Intelligence analysts can see patterns of behavior and relationships between seemingly unconnected events and entities. Patterns can be seen that are not otherwise visible. Automated geo and temporal navigation, as well as link connectivity tools, makes GeoTime easy to use.

By integrating with ArcMap as well as Excel, and allowing two-way synchronized operation, existing procedures and data sets can be leveraged to extend the user's comprehension of their data. Detection of patterns is improved. Convergence, velocity, pauses, repetition and other behaviors all become obvious when events are viewed in both space and time. Both analyst-determined patterns and those computed by analytical pattern functions can be seen and compared in the GeoTime context.

### Tasks Supported

#### 1. Loading Data

Data is imported into GeoTime from MS Excel spreadsheets, CSV files or ESRI ArcMap using GeoTime plug-ins. Users can also enter observations and annotations directly into a GeoTime session.

- Rich and Flexible Object Model: enables the representation and analysis of many types of events, entities and transactions.
- ESRI ArcMap Connector: Access map and/or event data from ArcGIS 9.
- Configurable Event Detail: automatically customize the GeoTime display of event and entity data.
- Synchronized Selection: linked data selection flows both ways between GeoTime and ArcMap or Excel.
- .NET API allows integration of GeoTime within a larger enterprise solution.

#### 2. Examination

In addition to interactions such as filtering, zoom-box selection and saved views, simultaneous spatial and temporal zooming allows the user to quickly move to a context of interest. Other examination methods include:

- Fused Time / Map Workspace: see data points in a coordinated representation along timelines projected onto maps.
- Calendar View Mode: emphasizes the temporal domain over the geospatial.
- GeoTemporal Trails: track the movement of people, organizations and objects over time and space.
- Filters: show/hide objects by object type or selection status.
- 3D Terrain: view maps from any angle and depict terrain elevation data.

### 3. Discovery and Comprehension

Animation, charting, aggregation and built-in analysis tools rapidly expose patterns, connections and trends that may not otherwise be apparent.

- Expanding Link Analysis: select an entity and expand outward to see events, places and targets associated with that entity.
- Connected Link Analysis: select two entities and see the events connecting them.
- Direct / Indirect Chain Analysis: select an entity and see other entities that are directly or indirectly connected with it.
- Entity Movement Analysis: select an entity and find all changes of its known location within a specified time range.
- Aggregation: group observations in multiple geographic regions to reveal and compare trends in each region.
- Automatic pattern recognition of geo-temporal behaviors.
- Animation: play back sequences and see how events unfold.
- Charts: display summary metrics for events and entities.
- Tooltips and Drilldowns: see underlying data values and launch related documents / multimedia files.

### 4. Evidence Marshalling

No need to keep separate notes - discoveries, hypotheses and visual annotations are all easily stored within GeoTime for the analyst's ongoing use or for collaboration with other colleagues.

- Group related data objects together to store your discovery results and for single-click control over their display.
- Annotations: create text, objects and drawings directly on the terrain.

### 5. Reporting

Discoveries and conclusions are effectively demonstrated using animation, filtered views and annotated snapshots.

- Reporting Tool: include results in Microsoft Office PowerPoint or Word documents, or place on Wiki pages. GeoTime report snapshots of the results include embedded title and user comments.

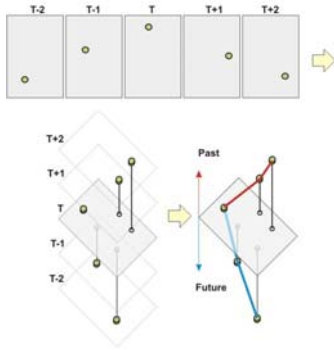
### Applications

- Strategic, Operational and Tactical Intelligence Analysis
- Law Enforcement
- GPS and Location Based Services (e.g. emergency services, asset tracking for fleets)
- Manufacturing Processes Using RFID
- Epidemiology Analysis
- Supply Chain and Logistics Analysis
- Environmental and Urban Analysis and Planning
- Financial Services (e.g. retail branch complaints, credit analysis, fraud analysis)
- Computer Network Alerts

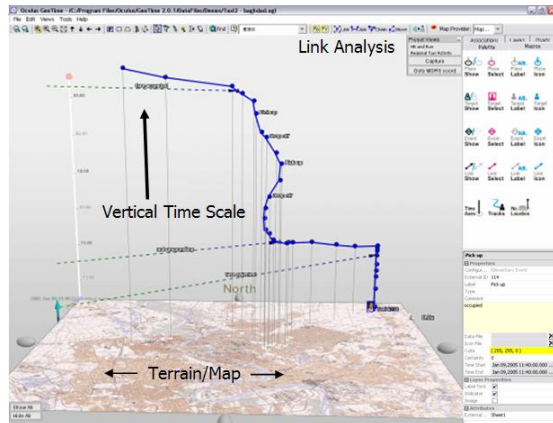
### Conclusion

Through the use of a unique patented interactive visualization paradigm, GeoTime is an effective tool for rapid, high volume spatiotemporal information understanding. GeoTime visualizes situations and information, letting you reduce and focus data to relevant subsets, form hypotheses, and gather supporting or refuting evidence for these hypotheses. Analysts can see the who and what in the where and when.

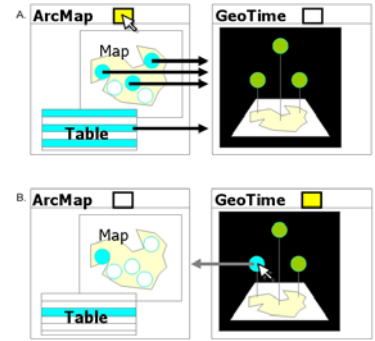
# Illustrations and Screenshots



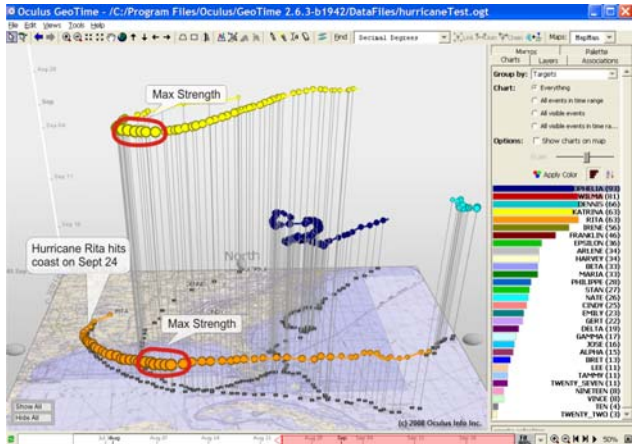
The GeoTime Concept: Individual frames of movement are translated into a continuous spatiotemporal representation.



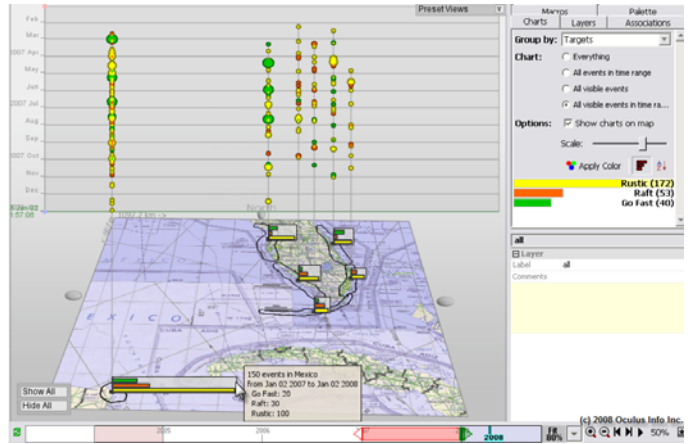
Time is in the vertical dimension.. This blue entity moves a large distance in a short time then slows down. At the bottom, blue moves out quickly and then stops.



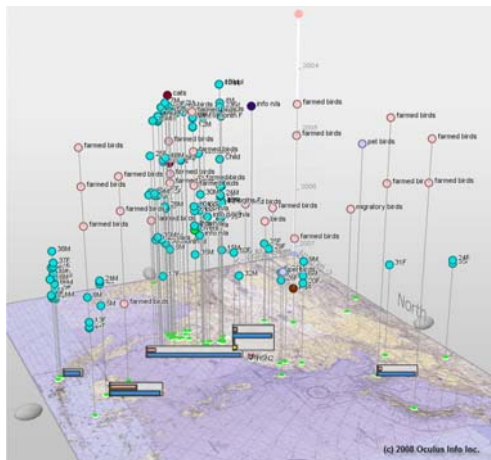
GeoTime-ArcMap Synchronization: A. Select data points in ArcMap for spatiotemporal display in GeoTime; B. Select data points in GeoTime and see the same selection in ArcMap.



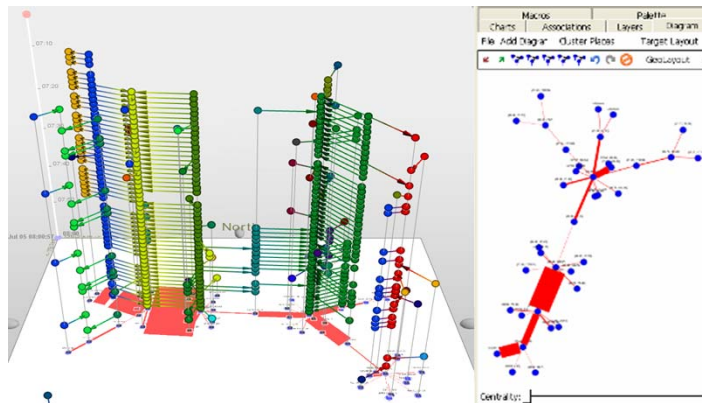
Symbols can be sized to reflect data properties. In this case, hurricane strength. Analysts can annotate the data and make observations in the time-space coordinate system.



GeoTime won the VAST 2008 Grand Challenge Award for Support of Diverse Analytic Techniques. Here is one of the VAST tasks having to do with illegal immigration. Method of transport and number of people is shown by time and by location.



Summary charts are shown on the map in this Asian Avian Flu study.



GeoTime can also work with arbitrary diagrammatic contexts. Here network attacks are shown over time. Compare the 2d to the 3d view to asses when in time events occurred.

## GeoTime References

The following published, peer-reviewed scientific and technical papers are available.

- **Configurable Spaces: Temporal Analysis in Diagrammatic Contexts**, T. Kapler, R. Eccles, R. Harper, W. Wright, IEEE VAST 2008.
- **nSpace and GeoTime - VAST 2006 Case Study**, Proulx, P., L. Chien, R. Harper, D. Schroh, T. Kapler, D. Jonker and W. Wright, IEEE Computer Graphics and Applications, 2007.
- **Stories in GeoTime**, Eccles, R., T. Kapler, R. Harper, W. Wright, IEEE VAST 2007, Best Paper Award.
- **GeoTime Information Visualization**, T. Kapler, W. Wright, paper first published IEEE InfoVis 2004. More complete paper published in the Information Visualization Journal, 2005.
- **Correlating Events with Tracked Movements in Time and Space: A GeoTime Case Study**, T. Kapler, R. Harper, W. Wright, Mitre Intelligence Analysis Conference, May 2005, Short Paper, Best Poster Award.
- **Avian Flu Case Study with nSpace and GeoTime**, P. Proulx, D. Schroh, R. Harper, W. Wright, IEEE VAST 2006.

## About Oculus

Oculus is a leading provider of innovative business visualization software solutions for federal government agencies, the Fortune 500 and third party software companies. We engage with industry leading partners and customers to collaborate on tough problems and develop new ways to generate business value. Making new technologies work in business requires a creative solution-based approach. Appropriate visual artifacts have profound effects on people's abilities to explore large amounts of data, assimilate information and understand it, and to create new knowledge.