Marine High Density Data Management and Visualization

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Point Clouds

• True 3D volume

• Randomly distributed (X,Y,Z) points

• Applications
  – Modeling vertical surfaces (walls, cliffs)
  – Multibeam
  – LiDAR
  – Laserscan
Our Design Goals

• 3D representation
  – Billions of points
  – High precision
  – Multiple Attributes per point

• Visualization
  – Fast 2D/3D Visualization

• Modifiable
  – Add new points or edit existing ones

• Complex Queries
  – Spatial, attribution
Data Structure

- **Point structure**
  - Double precision spatial position
  - Multiple flags per point
  - Multiple returns per point supported (LiDAR)

- **Multiple levels of resolution**
  - No duplicates

- **Multiple Attributes per point**
  - Attributes grouped into *bands*
  - Bands stored independently to minimize IO for unneeded data
Data Storage

- Implemented using CARIS CSAR system
  - huge data sets (>1 TB)
  - Flexible client-side caching, threaded IO
  - Consistent internal representation
  - Translation to different storage systems
    - Bathy Database proprietary
    - RDBMS tables
    - Oracle Spatial Point Cloud

![Dataflow Diagram]

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Performance test

• **Example**
  – Import bathymetric multibeam from GSF (100s of files)
  – Merge into a single cloud
  – 3 attributes per point

• **Stats**
  – 1.2 Billion points in single cloud
  – 30 GB data file
  – Initial 2D/3D overview: <1.0 sec
Editing and Querying

• Cloud can be modified
  – New points added after initial construction
  – Points can be edited

• Queries using
  – Spatial volumes, Resolution constraints, Attribution
  – Efficient use of spatial organization in cloud

• Selection/Classification using flag word
  – Multiple flags per point
Visualization

Video
Point Cloud Workflows

GSF
LAS
ASCII XYZ
ESRI Arc
Grid
PFM

Contours, Surfaces, Products

Editing/Processing

Grid\TIN

Editing/Processing

Editing/ Processing
Grid and Cloud Processing

- **Cloud Processing**
  - Merge, extract, shift, create TIN, CUBE, Gridding tools

- **Grid Processing**
  - Stored using CSAR framework (50+ billion nodes)
    - Multiple attributes per node
    - Multiple resolution levels
  - Combine, filter, extract, reproject, shift, contour, generate isolines
  - On-the-fly reprojection and resampling of multiple grids
CARIS Bathy Database

- Visualize or process Grids or Point Clouds from database
  - Efficient client-side caching, processing and visualization
  - Data loaded from database to client on-demand, files don’t have to be exported
  - Suitable for low-bandwidth connections

- Version 2.3 (available now)
  - File based storage

- Version 3.0 (Q2 2010)
  - RDBMS/Oracle Spatial storage
  - Will store data as Oracle Spatial GeoRaster, Point Cloud (now being prototyped)
Upcoming work

• Speed Improvements
  – Faster construction
  – Better memory management

• Automatic analysis tools
  – Generate polygons from spatial characteristics
  – Polygon boundary extraction

• Visualization
  – Improve FPS
  – Exploit sub-trees for smooth blending
  – Texture draping