The Open Navigation Surface Project: A Grid File Format for Hydrography

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Overview

- Background
- Requirements
- An important definition
- Software technology
- File structure
- Access library overview
- Development status
- Results of engineering prototype
- Workflow example
- Summary

Open Navigation Surface Working Group (ONSWG)

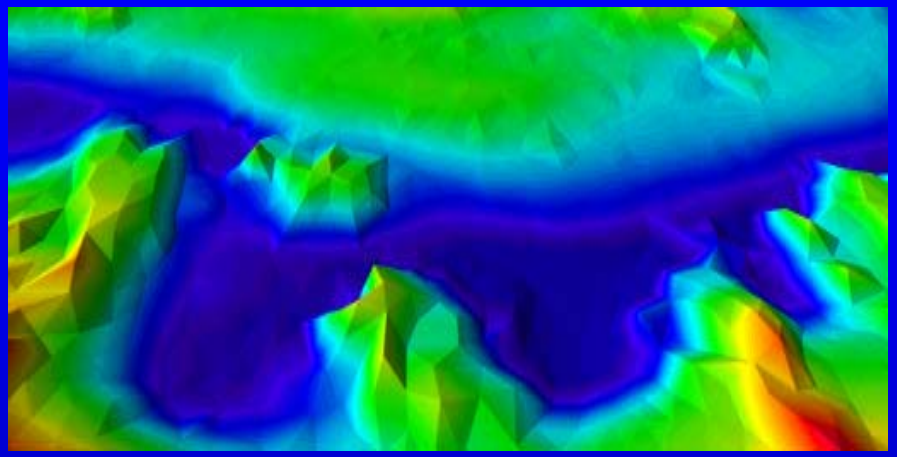
- A working group consisting of representatives from Government, Academia, and Industry
  - Membership and participation supported by contributing organizations
  - Contact information: http://www.opennavsurf.org

ONSWG Objectives

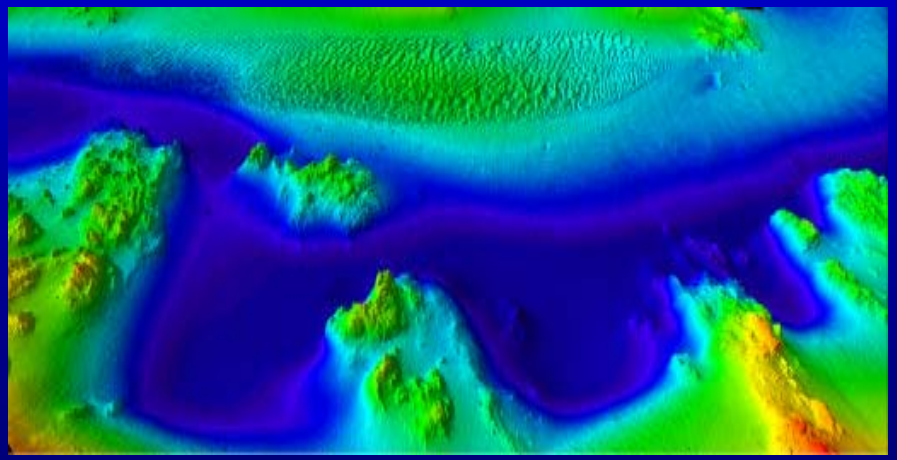
- To develop an open data format
  - For Navigation Surface Objects
  - For non-charting uses of depth and uncertainty
  - For Usage, Archive, and Information Exchange
  - Standards process not precluded
- To develop an open source software library
  - For accessing the file structure
- To provide support and guidance to users
- To promote continual improvement
  - Evaluate requests for modification
  - Manage changes
- To actively encourage participation and receive feedback

Navigation Surface Background

- Developed at UNH CCOM/JHC (Shep Smith, NOAA)
- Source data converted to gridded model
- Model provides best estimate of true depth and depth uncertainty
- Preserves highest spatial resolution of source data
- Supports sparse, and dense datasets



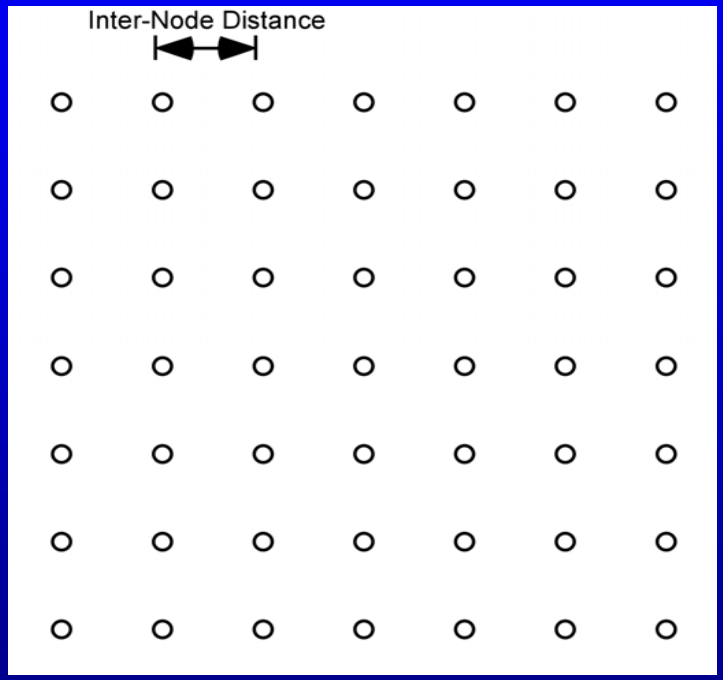
Smooth Sheet Data Density Tin Model



Full Resolution Grid

Yes, We Are Talking About a ***GRID*** However…

- Best estimate of the true depth computed for each node
- **The depth uncertainty is estimated for each node**
- Node spacing is regular, and MUST be selected properly
- The depth is estimated from observations within a radius of influence
- The depth estimation process uses uncertainty of each contributing depth observation
- The depth estimation process tracks and reports ambiguities



High Level Requirements

- Interoperability
  - Computer operating system and hardware independent
  - Directly exchangeable between various software products
- Attribution
  - Mandatory metadata describing the data throughout its lifecycle
  - Mandatory bathymetry data
  - Mandatory bathymetric uncertainty
  - Mandatory change tracking
- Access
  - Open, defined format and file I/O software
  - If you want to have it, just ask
- Extensibility
  - Built in structure to allow for expansion to accommodate future needs
  - Expansion elements must be open, defined, and accessible

High Level Requirements

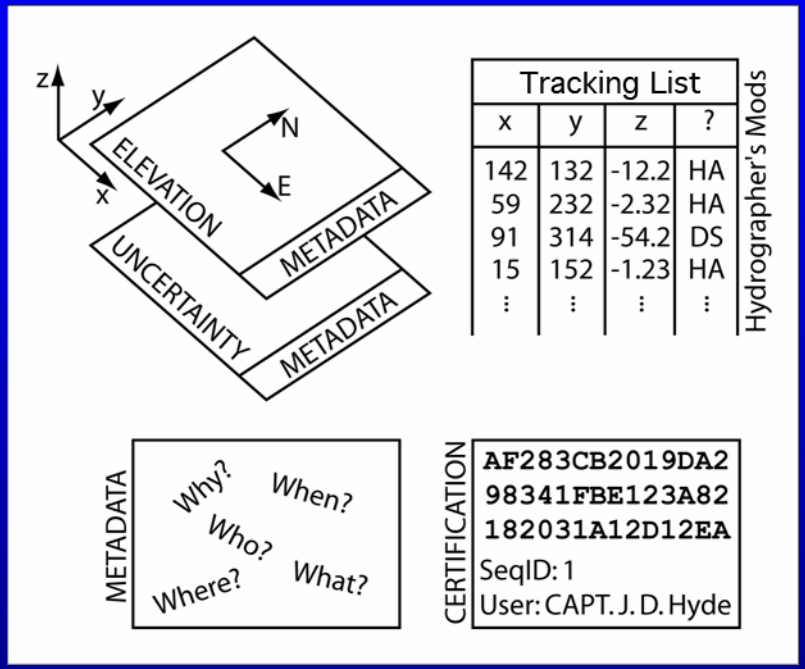
- Independent
  - Does not mandate use of any specific source data processing procedures or policies
- Completeness
  - Mandatory data elements packaged WITHIN the data structure
- Maintainability
  - Open Source environment, represented by multiple organizations
  - Process for reviewing, implementing, and releasing changes
- Digital data security
  - Provide mechanism for digital equivalent of “Hydrographer’s Signature”
    - Authorship, Authority, Authenticity; for an intended use
  - Provide mechanism to ensure nothing has changed since signature (tampering, transmissions errors, etc.)

An Important Definition

- A "**Navigation Surface**" is
  - A single grid, generalized to a particular scale, destined for a single purpose, certified as "Safe for Navigation" by an appropriate authority
- Any other component grid, at any other stage of processing from raw to archive, is a "Bathymetric Attributed Grid" or **BAG**

BAG File Contents and Definitions

- Metric SI units
- Common horizontal & vertical datums
- Positive up elevation
- Times in UTC since Jan 01 1970
- Indexed by row-major order
  - W->E, S->N grids
- Geo-referencing at SW corner, on the node point
- Support for projected X, Y and geographic coordinates
- Physical node location implicit
- Developed in ANSI C
- A BAG has one attributed grid at one data spacing



Software Technology Basis

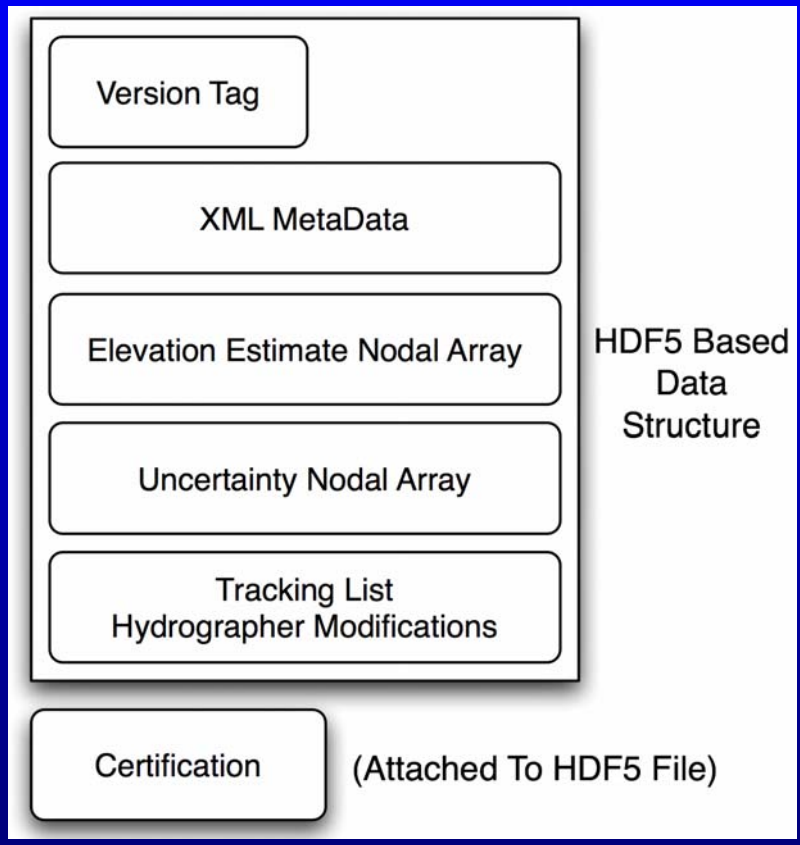
- ONSWG selected HDF-5 for basic data encapsulation
  - **HDF-5 exists**
  - HDF-5 developed to support high density scientific datasets
  - Source code available and distributable
  - Multiple operating systems supported
  - Byte order and floating point type handled within library
  - Large files (the two-gigabyte problem) supported
  - HDF-5 is well used and well supported

Software Technology Basis

- Metadata
  - Selected ISO19115 standard for geospatial metadata
  - Selected the XML encoding of ISO19139
  - Selected the xerces library for parsing the XML data
  - Metadata saved within HDF-5 as an XML encoded string
- Geographic transformations
  - Selected geotrans software package
  - Supports a range of projections and datums
  - Source code provided, supports multiple Operating Systems
- Security
  - Selected beecrypt software library for encryption and signature
  - Source code available, supports multiple Operating Systems

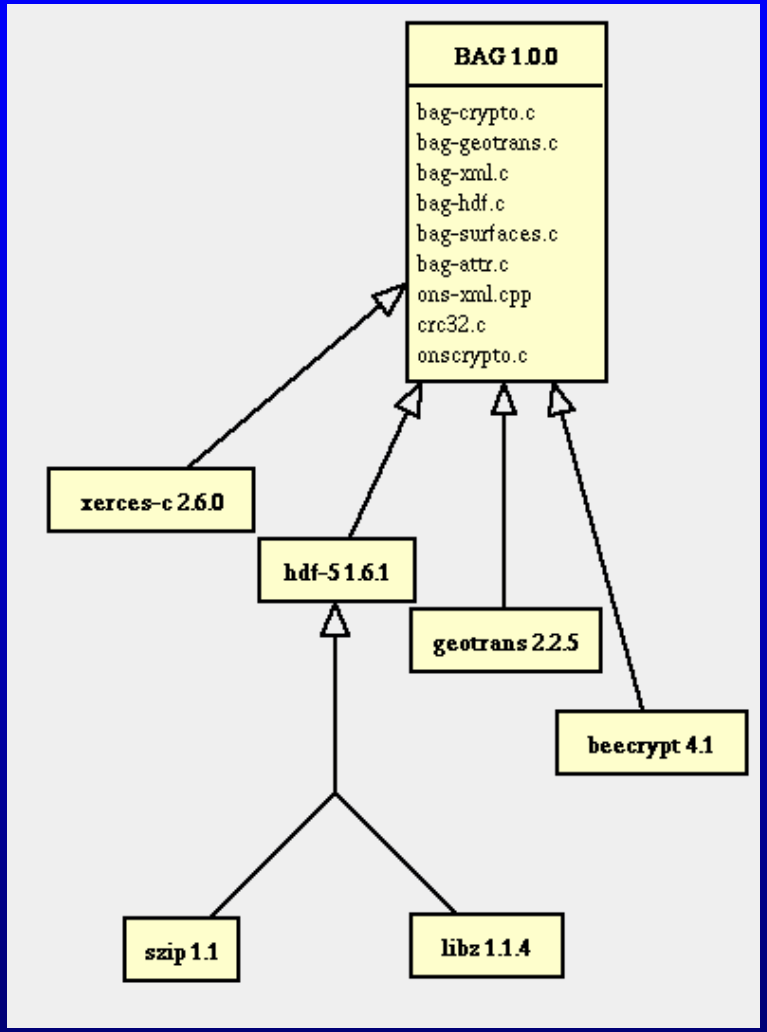
BAG File Structure

- Metadata
  - Provides information about the source dataset
    - Who, when, what, why, where, how …
- Elevation
  - Grid of best estimated elevation values
- Uncertainty
  - Co-aligned grid of bathymetric uncertainty
- Tracking List
  - Record of all changes made to depth, uncertainty pairs & reason for change
- Optional Extensions
  - Once defined, whatever they are
- Certification
  - Bit stream containing file digest, and digital signature



Access Library Overview

- BAG access library developed by members of ONSWG
  - Provides interfaces for accessing BAG files
  - Isolates application developers from details of lower level libraries
- All lower level libraries are fully reused without any change
  - xerces version 2.6
  - hdf-5 version 5.1.6.1
  - geotrans version 2.2.5
  - beecrypt 4.1



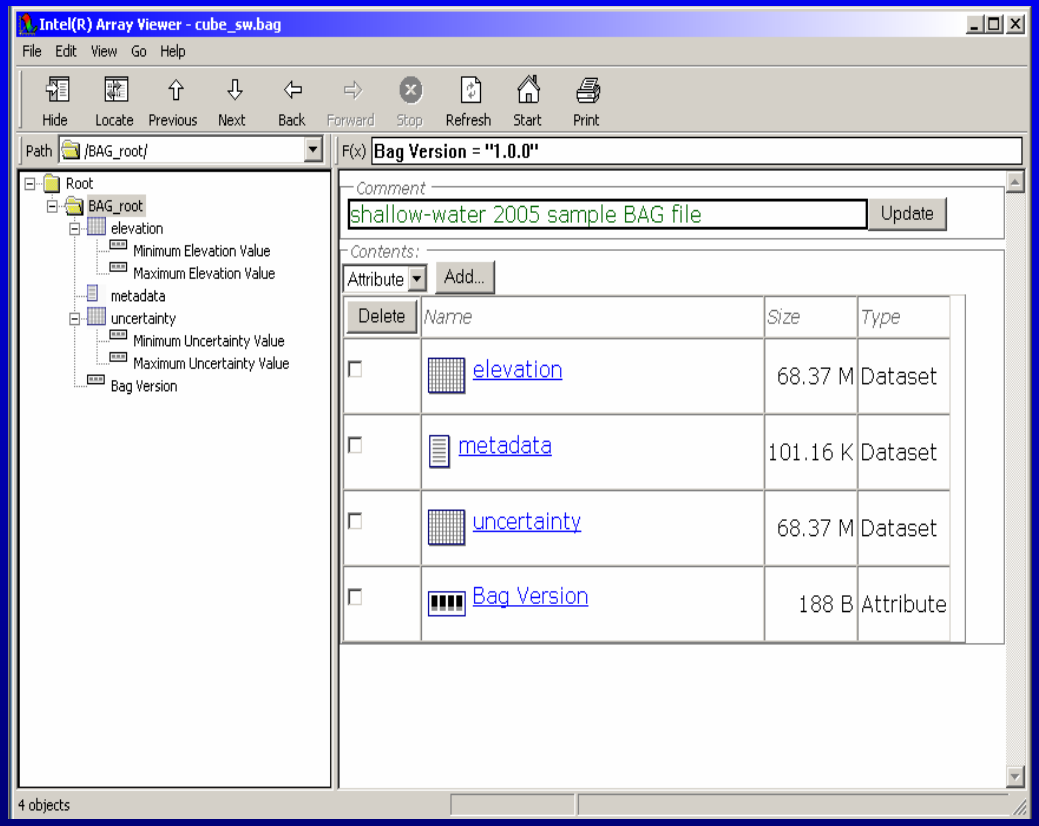
BAG File Metadata

- BAG Metadata
  - Encoded in Extensive Markup Language (XML)
  - Includes all fields mandated by ISO19115
- Example fields include
  - Name, date, ownership
  - Description, purpose, status
  - Spatial extents
  - Coordinate system, datum
  - Rows, columns, resolution
  - Reference point position
  - Constraints
  - Classification/Distribution
  - … and more

```
- <!--
    Sample Bathymetric Attribute Grid Meta data - Created by the Open Naviation Surface Working Group.  Based on ISO19139 schema v1.0
  -->
- <smXML:MD_Metadata>
  - <identificationInfo>
    - <smXML:MD_DataIdentification>
      - <citation>
        - <smXML:CI_Citation>
            <title>Shallow Water Cube Surface</title>
          - <date>
            - <smXML:CI_Date>
                <date>2005-08-03</date>
                <dateType>publication</dateType>
              </smXML:CI_Date>
            </date>
          - <citedResponsibleParty>
            - <smXML:CI_ResponsibleParty>
                <individualName>Name of individual responsible for the BAG</individualName>
                <positionName>Position (title) of responsible individual</positionName>
                <role>principalInvestigator</role>
              </smXML:CI_ResponsibleParty>
            </citedResponsibleParty>
          </smXML:CI_Citation>
        </citation>
        <abstract>Sample Metadata</abstract>
        <purpose>Not for navigation</purpose>
        <status>onGoing</status>
        <spatialRepresentationType>grid</spatialRepresentationType>
        <language>en</language>
        <topicCategory>elevation</topicCategory>
      - <extent>
        - <smXML:EX_Extent>
          - <geographicElement>
            - <smXML:EX_GeographicBoundingBox>
                <westBoundLongitude>-75.0</westBoundLongitude>
                <eastBoundLongitude>-74.0</eastBoundLongitude>
                <southBoundLatitude>46.5</southBoundLatitude>
                <northBoundLatitude>47.5</northBoundLatitude>
              </smXML:EX_GeographicBoundingBox>
            </geographicElement>
          </smXML:EX_Extent>
```

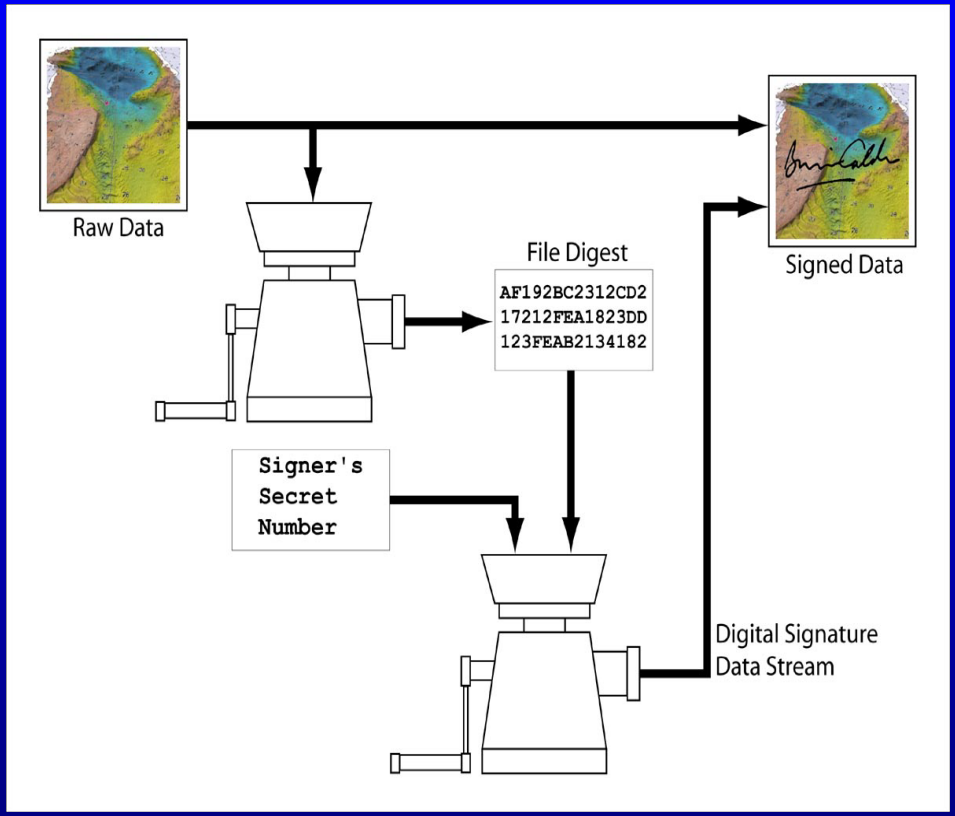
HDF-5 Tools

- Intel viewer shows contents of HDF-5 files
  - Overall file structure
  - Can view specific contents of individual fields & arrays
- Other tools are available with HDF-5
  - Viewing data
  - Exporting data as ASCII



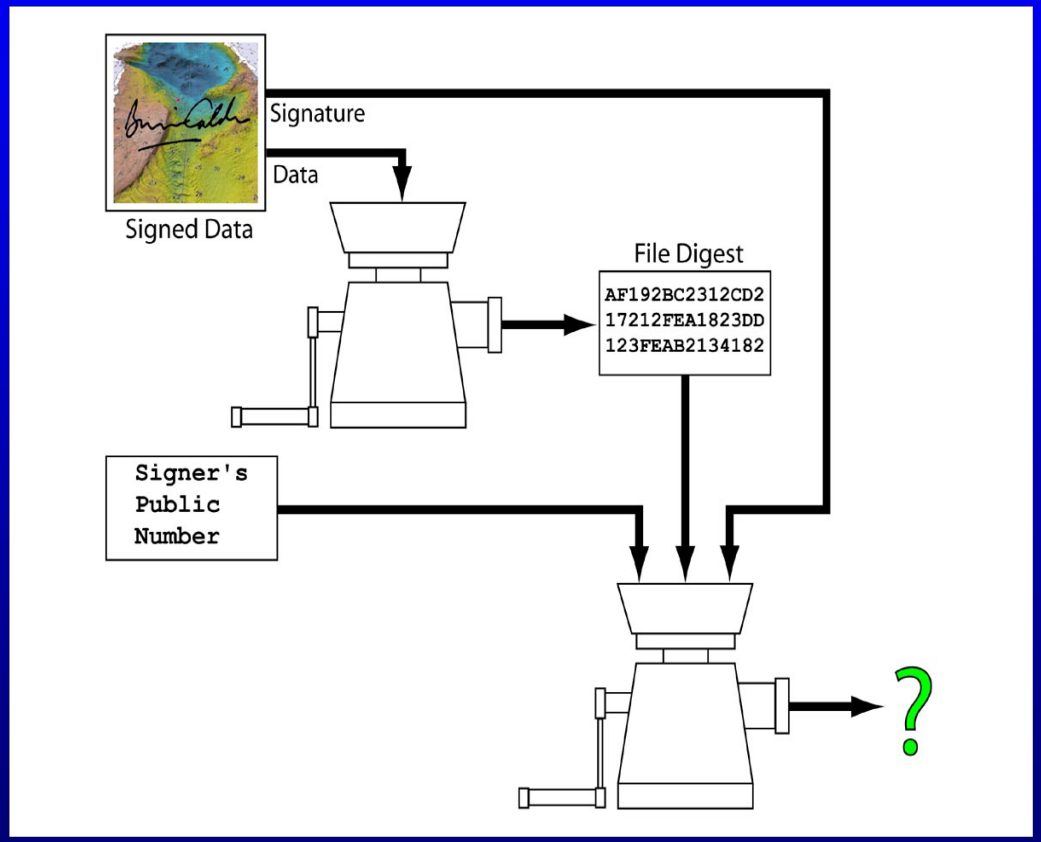
Digital Signatures: Construction

- Allows an authorized agency to digitally sign a BAG as an indication of authenticity for intended purpose.
- File digest is a unique number computed from the contents of BAG.
- File digest is combined with secret key to encode the digital signature.



Verification of Data

- When file is opened by user, test of file digest will indicate if file has been changed since signature.
- The singer's public key are used to validate authenticity of the signature.
- Encryption used is not restricted by export limitations.



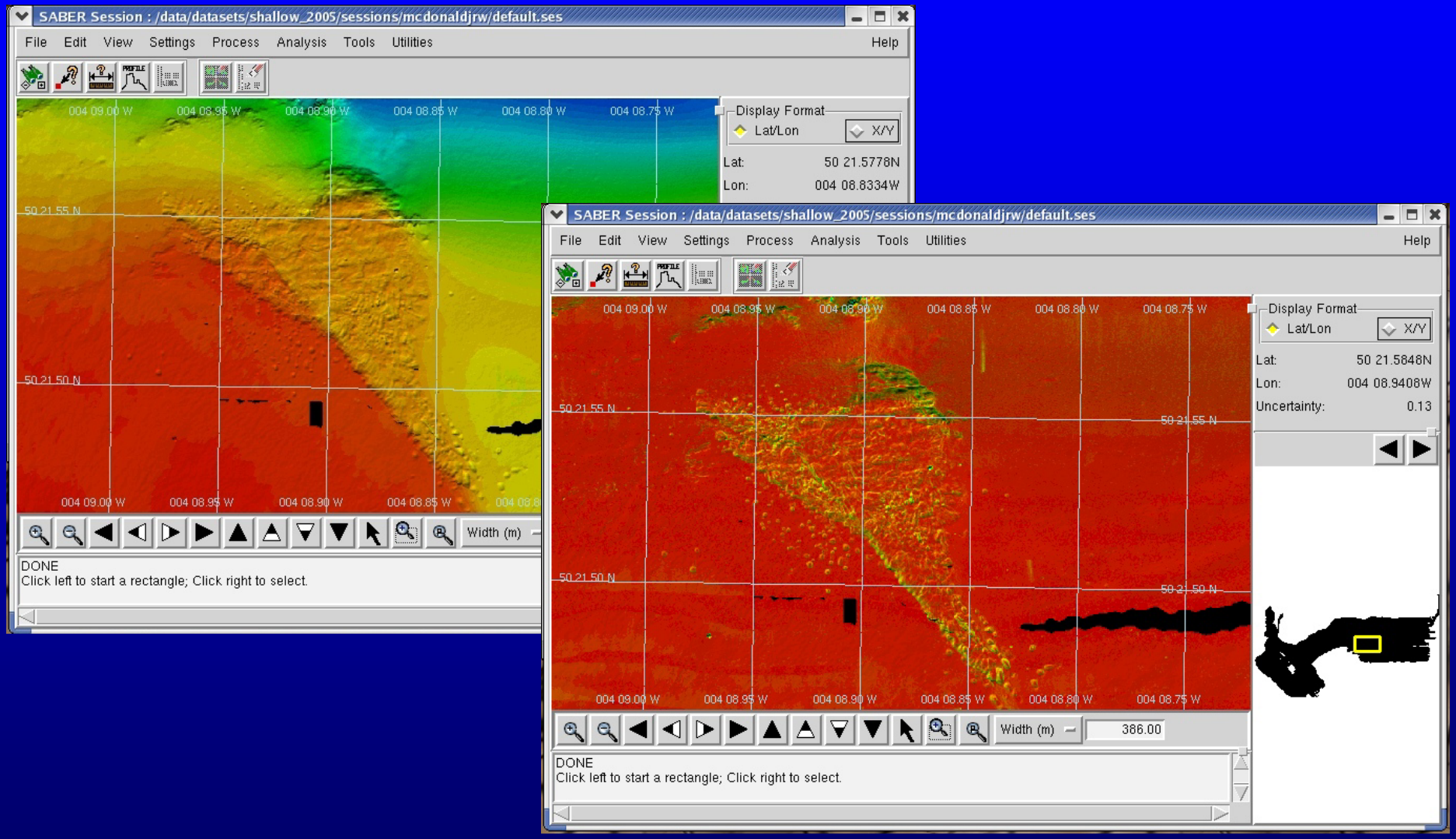
Development Status
Where Are We?

- Base development tree established
- All core libraries and development version of BAG access code build on Linux and Windows platforms
- File definition
  - Metadata: complete
  - Elevation grid: complete
  - Uncertainty grid: complete
  - Tracking list: not complete
  - Optional extensions: none identified yet
  - Digest & signature: complete
- Software development
  - High level interfaces completed
  - Primary access functions completed
  - Several development tasks remain to be completed
  - Test efforts started, but additional work remains

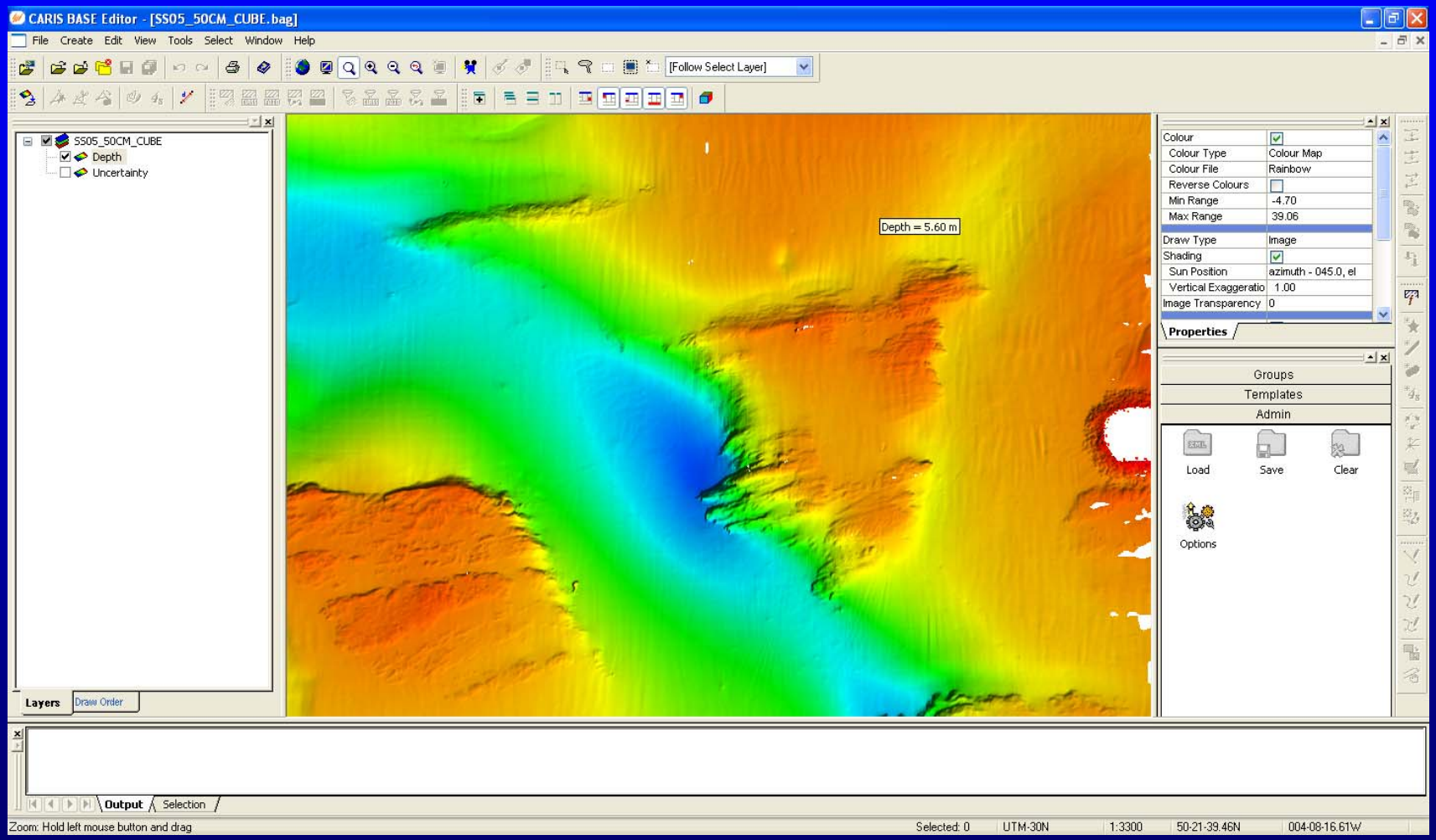
Development Status
Prototype BAG

- 8125 from 2005 Common Dataset
  - UNH/CCOM ran through CUBE
    - Node spacing of 0.5 meters
    - Grid of 3152 rows by 5686 columns on a UTM projection
    - ASCII X, Y, Z, U file exported from CUBE results
- Prototype BAG constructed by SAIC from CUBE results
  - Prototype BAG (sw05.bag) is apx. 150 megabytes
  - BAG (SW05.bag) provided to working group
  - File imported into three software packages as engineering test case

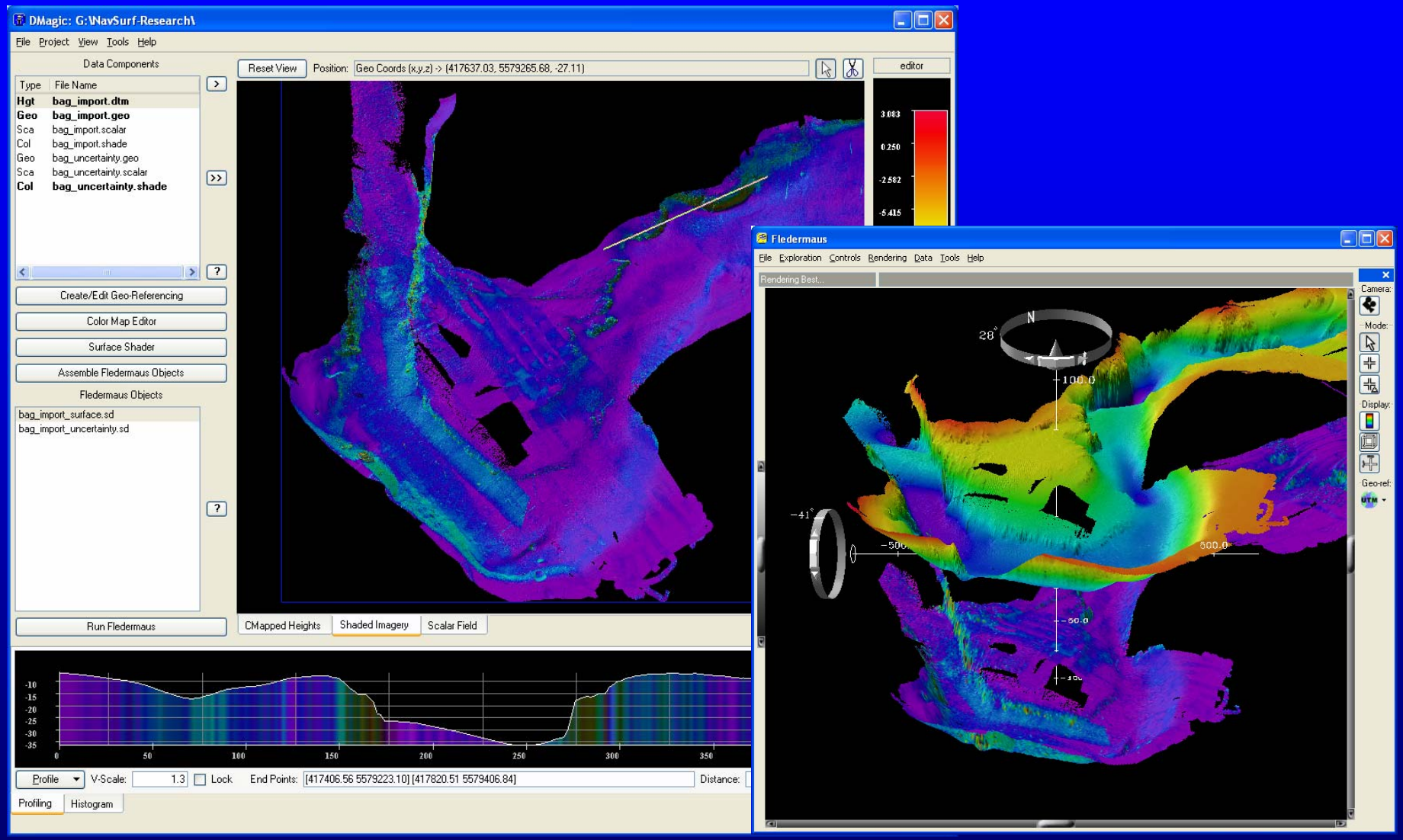
SAIC SABER Showing BAG



CARIS BASE Editor Showing BAG



IVS 3D Fledermaus Showing BAG

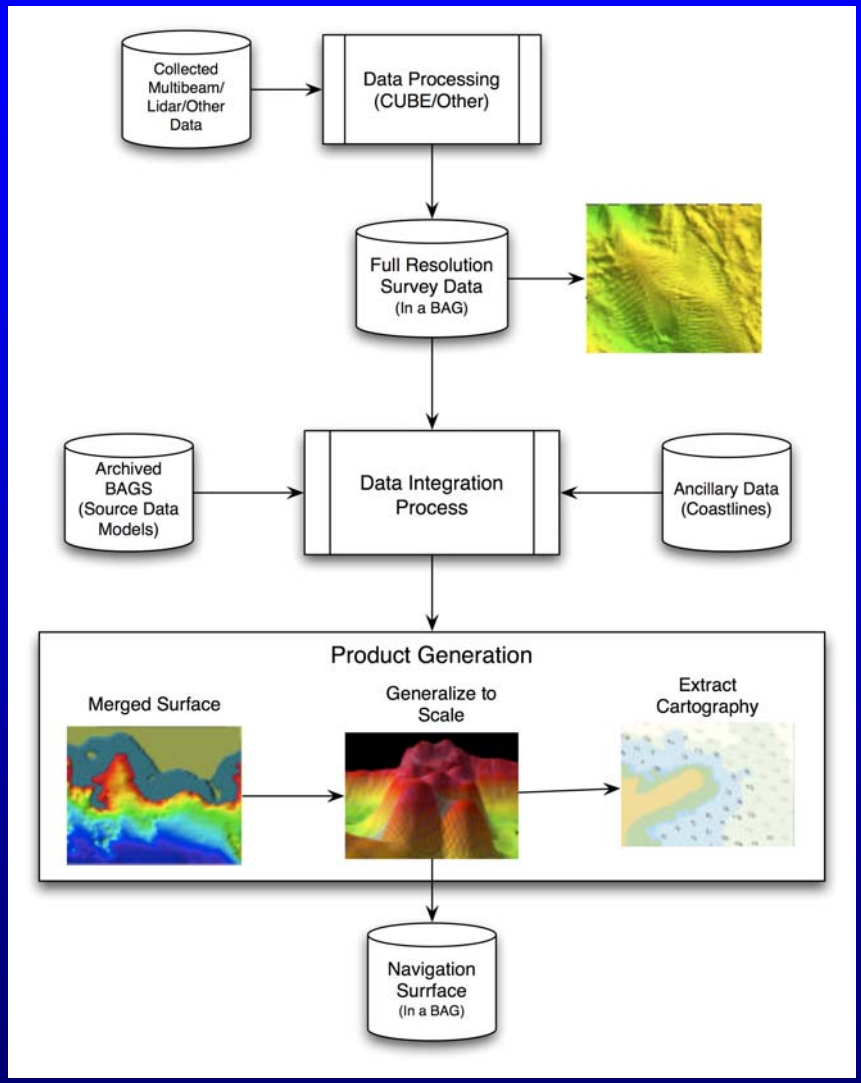


Overall Status

- Tasks remaining to be completed
  - Tracking list
  - Some additional support functions to be developed
  - Testing
  - Documentation
- Schedule
  - “Candidate” release planned for January 2006
  - Version 1.0.0 release planned for March 2006
  - Integration with commercial packages to follow based on their release schedules

Where a BAG fits in the Workflow

- Survey data processed for typical corrections & QA/QC
- Survey data processed through CUBE
  - grid of depth and depth uncertainty at full resolution
- Full resolution grid available for storage in BAG
- If appropriate, analyze contacts, assign features
  - Update the BAG
- If appropriate, generate Navigation Surface
  - NS stored within BAG structure



Summary

- BAG provides a data format ***for the community by the community***
- BAG provides interoperability without format conversion
- Improve ability to support different data uses from one survey (Hydrographic Charting, Military, Commercial, Fisheries, Geophysical, etc.)
  - Change data product from selected sounding data density to fundamental spatial resolution
    - Requires hydrographic decision making
- A Navigation Surface can be encapsulated in a BAG, but only after specific processing by an appropriate authority
- Not all BAGs are Navigation Surfaces

Questions?