Enabling the Image Analyst (IA) to use the geodatabase

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• SO CET SE T®: SO CET for ArcGIS®
  • GGI workflow
Introduction
Vision

- IA tradecraft undergoing dramatic transformation as benefits of geographic databases become apparent;
- Geographic databases support:
  - data sharing
  - frequent use
  - constant updates
- These advantages allow a new user community, IAs, to benefit from GIS
Concept

- Connect IA software to ESRI geodatabase
  - Geographic features stored with accurate ground coordinates
  - Information queried and viewed against new imagery, facilitating temporal analysis and change detection
  - Feature attributes populated automatically or manually
Solution

• BAE Systems’ SOCET GXP with SEE
  • Accesses geodatabase using ArcGIS Engine
  • Sensor modeling capabilities position features accurately
  • Supports wide range of government and commercial image sources
Solution … 2

- BAE Systems’ SOCET GXP with SEE
  - Intelligence observations collected over time available to all IAs in organization through shared geodatabase
  - No more sifting through historical textual reports to answer geospatial intelligence questions
  - Uses production tested SOCET for ArcGIS technology
GIS background

- Photogrammetry used to collect information in ground coordinates for 100 years
- Long history of interfaces between photogrammetric workstations and GIS software
  - Simple interfaces to analog instruments in 1970s
  - Interfaces to analytical plotters in 1980s, with some analytical plotters purpose-built as GIS workstations
  - Interfaces to digital photogrammetric workstations in 1990s
- IA software has tendency to collect information in image coordinates
  - Digital equivalent of drawing on transparent overlay with Chinagraph
  - Vectors collected on one image don’t fit to another image
- Little history of interfaces between IA software and GIS software
  - No interfaces to analog light tables and zoom stereoscopes
Enhancing IA tradecraft

• Current textual intelligence approach useful for reporting but not efficient for rapid analysis or collaboration
• Vectors are collected during IA product creation but are not suitable for quick retrieval based on temporal and geographic attributes
• Attributed vectors store detailed information on objects, enabling users to answer intelligence questions such as
  • How many active Surface-to-Air Missiles (SAMs) are within 100 km of a specific location?
  • For a specified date range and region, find all sites where SAMs were deployed
• Store pertinent attributes relating to features, including:
  • Dimensions, history, collection date and time, quality, precision, source, and originator
• IAs from multiple organizations express same requirement for storing intelligence observations as attributed features for subsequent query and analysis
SEE
Solution for the IA
Basics

- Concept based on 2005 paper *Advocating for Spatial Storage*
  - Concept originated by NGA GeoScout GKB-P Program
  - NGA ASDI program implementing SEE concept
- NGA vision: “store basic intelligence data and information in GIS-like (vector) form”
  - Originally known as Palette Driven Exploitation (PDE)
  - Promote vector-based information capture into image analysis workflow
  - Promote collaboration between Geospatial Analysis (GA) and Intelligence tradecrafts
  - Enable various Intelligence tradecrafts to store data via common methods
  - Enable reuse of data to harness synergy that should be occurring between tradecrafts
  - Vector-based intelligence information storage facilitates transformation of current geospatial intelligence capabilities (text reporting)
- IA/GA merge is part of raison d’être of NGA
SEE workflow: geo-registration through triangulation

• To support NGA’s SEE initiative, SOCET GXP performs rigorous geo-registration for accurate collection of features in ground space
  • Automated triangulation for novice user
  • Interactive triangulation for advanced user
  • Triangulation involves rigorous image-to-ground and ground-to-image transformations
  • Allows adjustment of sensor position without warping imagery
• Pre-triangulated images such as CIB®* or DPPDB* can be used as control sources

*DPPDB and CIB® Format Generation
[SOCKET SET Digital Point Positioning Data Base Format Production Module (DPPDB) [which uses MIL-PRF-89034, March 1999 format specifications] and SOCKET SET Controlled Image Base® (CIB) Format Production Module [which uses MIL-PRF-89041, 15 May 1999 format specifications] are currently under U.S. Department of State evaluation for export jurisdiction and are temporarily unavailable for customers outside the United States.]
SEE workflow: geo-registration through triangulation … 2

- Derived from SOCET SET
- User controls adjustment of image parameters
- User specifies control images, control points and terrain files for triangulation
- User controls tie point patterns for automated point measurement
  - Interactive tie point measurement available
- User controls strategies for solution
SEE workflow: geo-registration through triangulation … 3

Control images

Today’s image

Triangulation

Today’s image geo-registered

Accurate products and features

Tomorrow’s image

Triangulation

Tomorrow’s image geo-registered
SEE workflow: feature collection to geodatabase

- Analyst connects to ESRI multi-user or personal geodatabase
  - Also connects to SOCET SET or SOCET GXP feature database
  - Style sheet or ArcMap™ document controls feature properties
- Geodatabase appears in SOCET GXP Workspace Manager
  - User drags feature classes of interest on to images in Multiport viewer
  - Multiple geodatabase connections allowed
SEE workflow: NGA feature extraction specification

• User community can define a geodatabase schema specific to intelligence reporting needs or use existing schemas
  • NGA ASDI and GKB-P defining schemas for the IA user
• Geodatabase and schema can be created by administrator for IAs or alternatively, use existing
SEE workflow: NGA feature extraction specification … 2

- SOCET GXP and SOCET SET provide FACC+ schema and new NGA NFDD and DFDD schema
- DFDD information at [https://www.dgiwg.org/FAD/](https://www.dgiwg.org/FAD/)
- As in SOCET SET, new schemas can be created in SOCET GXP that comply with NGA specifications
SEE workflow: feature creation and attribution

- Using ArcGIS Engine, users attribute features directly within SOCET GXP without using ArcMap canvas
- IAs record intel observations by adding new features or editing existing ones
  - User simply selects desired feature class and draws it
SEE workflow: feature creation and attribution … 2

- Feature appearance controlled by style sheets
- Features are drawn on image with automated attribution
  - Attributes can also be added manually
- Attributes can be queried to answer intel questions, for example
  - Facility outlines, harbors, beach landing zones, and mobile assets are recorded to geodatabase
SEE workflow: product generation

- Standard annotated IA template products created in many formats
  - NITF, GeoTIFF, GeoPDF, JPEG formats
- Features collected by IA go directly into ESRI geodatabase for enterprise sharing and query
- Attributed shapefiles can also be created for those with no GIS access
- Analysts query geodatabase to view only features of interest
SEE workflow: Google™ Earth connection

- Selected features with attributes are transferred from SOCET GXP into Google Earth as KML features
- Current imagery also sent into Google Earth
- Attributed features can also be sent to Google Earth using attributed shapefiles if ESRI geodatabase is unavailable
- Promotes enterprise sharing of image and attributed feature data via Google Earth
SEE workflow: attribute query

- To access the power of the geodatabase, the IA has to be able to query the data in a flexible manner
  - Answer intel questions using queries
- Attribute, spatial, and temporal queries can be combined
- Query on any feature attribute for a class
- Results loaded in Results list tab and SOCET GXP workspace for easy visualization
SEE workflow: spatial query

- Query based on defined area
- Spatial tab allows specification of boundary
  - Draw boundary on image
  - Use images as boundaries
  - Use current view of image
  - Use feature to define boundary
SEE workflow: temporal query

- Visualize changes over time
- Select Temporal tab
  - Date Range
  - On or Before a date
  - On or After a date
- Features that match temporal criteria can easily be visualized on image
SOCET for ArcGIS
Solution for the GA
SOCET for ArcGIS for the GA

- Used by NGA and its GGI contractors to collect 3D features from stereo imagery into ArcGIS efficiently
- User can exploit ArcMap ArcEditor™ tools or SOCET SET tools for feature collection and editing
- ArcGIS users see practically no photogrammetry once system is initially set up
- Extends 2D ArcGIS into true 3D environment
- Tools optimized for 3D feature extraction, editing, and automatic attribution
SOCET for ArcGIS: components

- **ESRI ArcMap**
  - ArcMap edit tools

- **SOCET SET**
  - Stereo viewing and accurate geopositioning
  - SOCET SET Sketch edit tools
  - Processing for database entries such as topology
  - Functions that interact with geodatabase store/retrieve

- **Geodatabase**
SOCET for ArcGIS: feature extraction

- 3D features collected from SOCET SET stereo viewport directly into ArcGIS geodatabase

- All ArcMap ArcEditor tools including customer tools work within this true 3D environment
SOCET for ArcGIS: feature extraction tools

- A rich set of tools for 3D feature extraction, editing, and automatic feature attribution
SOCET for ArcGIS: example of GGI workflow

• Uses versioned SQL database with ArcSDE® connection to SOCET for ArcGIS
• Each extractor populates same geodatabase with QC in place
• Database is populated by SOCET for ArcGIS in tandem with ESRI PLTS and other QC tools
  • Can auto populate angle of orientation (AOO)
  • Can populate height automatically using a DEM
SOCET for ArcGIS: advantages of GGI workflow

- Database such as Oracle or SQL Server does not limit database size
- ArcSDE connection allows for versioning
  - Dataset can be worked by multiple users at the same time
  - Instrumental in shortening QA/QC timelines
  - Data does not have to be completed before checks and edits can be made
  - Edge-matching issues greatly reduced due to multiple users viewing dataset in its entirety at the same time
- Dataset whole from beginning to completion of the project — no merging
- Finishing procedure time reduced due to elimination of data migration — no merging
SOCET for ArcGIS: GGI workflow — quality control

• SOCET for ArcGIS opens up new QA/QC capabilities that SOCET SET Feature Extraction alone does not possess
• QC scripts run by individual extractors on limited portions of dataset or by production manager on entire dataset
• Eliminates finishing and QA/QC limitations associated with isolated databases
SOCET for ArcGIS: GGI workflow – conclusions

• Production times greatly reduced
• Extractors receive more timely feedback on their data, improving their error ratios
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