AIXM Annual Conference | 2008
Day 2 – March 19th (morning)

“*Migration TO and FROM AIXM from other AMDB Formats*”

Alan Poole/Dejan Damjanovic

GeoEye

Overview

- Background and Problem Definitions.
- IATA AIS Data Pool Vision.
- Data Management / Data Conversion Challenge.
- GeoEye Storage Standards.
- GeoEye Transformations to GML2.
  - Feature Manipulation Engine (FME)
- Example: KATL.
  - GML2 Document Structure
  - Example Feature to GML2.
- Integration.
- AIXM and Future Developments

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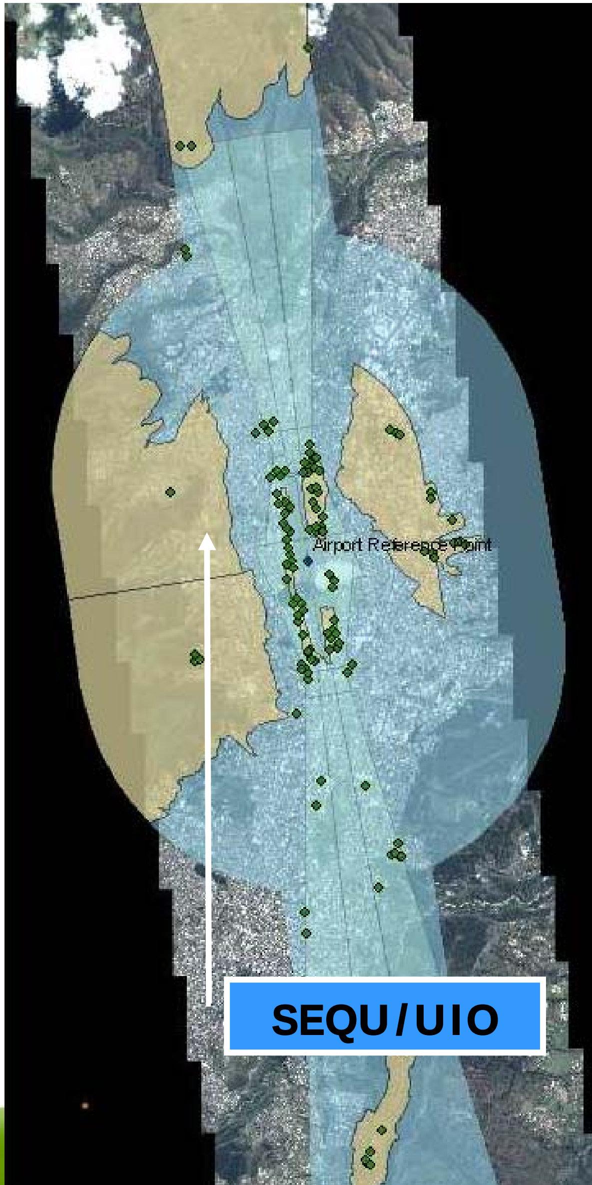
Who are we and why am I talking?

- GeoEye owns and operates three satellites – IKONOS, OV-2, OV-3, and soon to launch GEOEYE-1 in 3Q2008.
- GeoEye is a data originator of Geospatial Aeronautical Information, using an ISO-9001 and DO-200/DO-201 compliant process from all published standards – RTCA/EUROCAE, FAA, USAF, NGA, SAE.
- We build
  - **Airport Mapping Databases** (AMDB), in Shapefile and GML.
  - Airport **Terrain** Databases, in DTED or GeoTiff.
  - Airport **Obstacle** Databases, in Shapefile and GML.
- We construct these using our current (IKONOS @ 1-meter) and future (GEOEYE-1 @ 41-cm) satellites, imaging in Single-Orbit Stereo.
- We have mapped over 1,000 airports to Government, Military and Airline customers.
- We have a strategic relationship with IATA to collect Aeronautical Geospatial Information not available from CAA's at this time.



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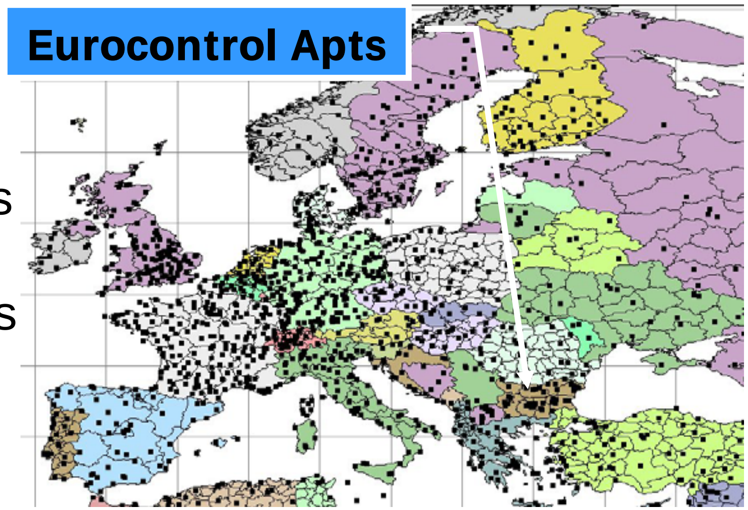
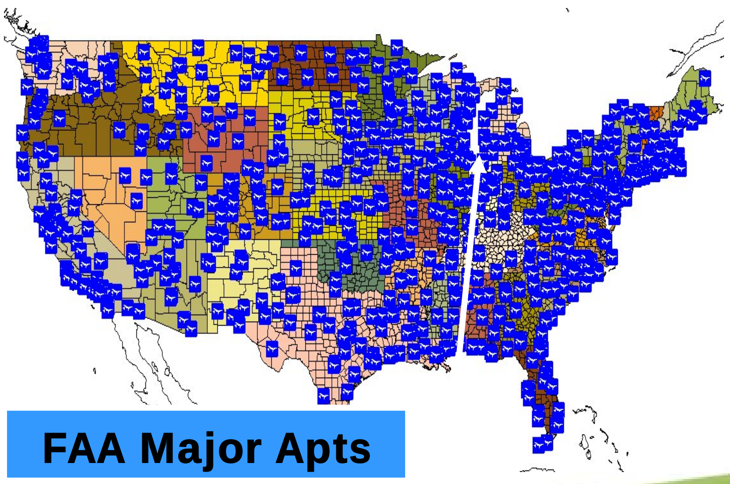
In a perfect world…………….

- There are about **190** ICAO signatory countries, whose land areas hold about **14,000** hard-surface airports.
- They will build AMDB's for all those airports (eventually), and produce Terrain & Obstacle Databases for ICAO requirements Area-1 (by Nov-2008), Area-2 & Area-3 (by Nov-2010).
- Everything will be AIXM 5 and GML-3.xx
- They will keep those updated at some frequency – ICAO Annex 15 AIRAC 28-day, 56-day, 116-day or shorter: **forever**.
- They will find a way to share the cost of construction and updating among all users.
- Cost will not prevent Safety of Navigation under any circumstances.





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In the real world……………

- There is wide diversity of economic realities amongst the **190** countries – and only some have the support of their governments to simply acquire the data directly.
- Many First-World CAA's have made significant inroads in moving to GIS technologies to support interoperability like AIM.
- Fewer Second-World and virtually no Third-World CAA's have such GIS capability.
- All CAA's will deliver what they can, in some format, in some standard. Some will be New Surveys, some will be converted data, some will be missing.
- Most all CAA's are confronted with the huge costs of moving to GNSS/RNP/PBN procedures in the next decade to support growth in air travel – those **14,000** airports have some **50,000** procedures to be deleted or replaced!
- So – how can IATA's member airlines help?

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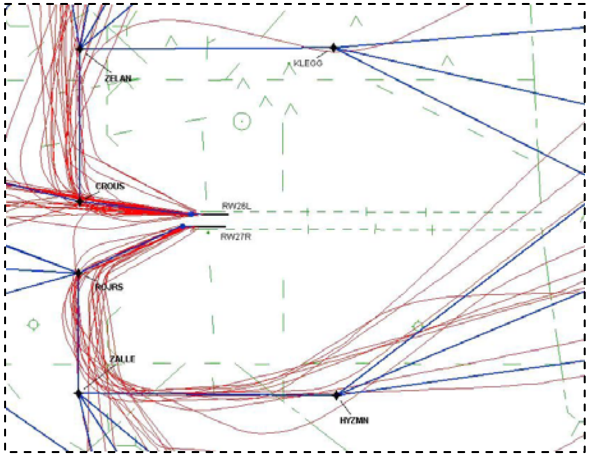
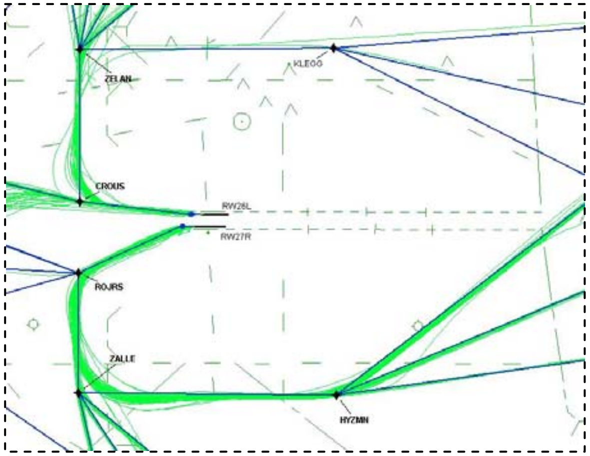
What is driving need for new Data?

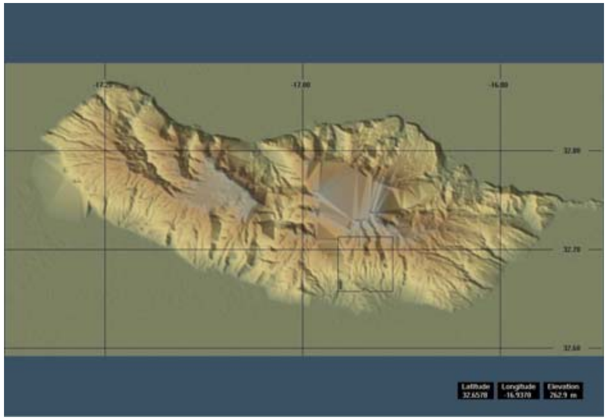
- Migration to RNP Procedures allows more direct routings, increase movements per hour with less separation so as to increase Revenues/Yields in the face of uncontrolled growth in Fuel Costs.
  - Need new Terrain, Obstacles and Airport Maps.
- Increase in Operating Hours resulting from improved Noise Abatement procedures – using “Top of Descent” procedure design.
  - Need new Terrain, Obstacles and Airport Maps.
- Migration to Electronic Flight Bags allows more flexible routings when coupled with CP/DLC and ADS-B ATM command infrastructure.
  - Need new Terrain, Obstacles and Airport Maps.
- CONCLUSION: Airlines will need to support obtaining this information sooner than the CAA’s can provide all this, so that they can take advantage of the above opportunities.





Consequences for IATA Airlines?

- AIXM Data will become available from some CAA's directly, at some cost-recovery or minimal reproduction cost.
- For those CAA's that cannot produce AIXM, or will take longer to produce AIXM data – IATA will need to find a process to produce/collect this information in the interim to keep pace with advances in ATM.
  - Advanced Airlines will be able to receive and ingest this data directly, and not require the need as much for those third-party organizations.
  - Less-Advanced Airlines will still need assistance from more advanced airlines or the third-party companies to ingest this data, and support their flight operations.
- This all results in an increasing need for an Airline (IATA) library of this AIS/AIP information, as a repository of AIXM data available directly from CAA's and for AIXM data produced by commercial data providers to be shared by the airline members.



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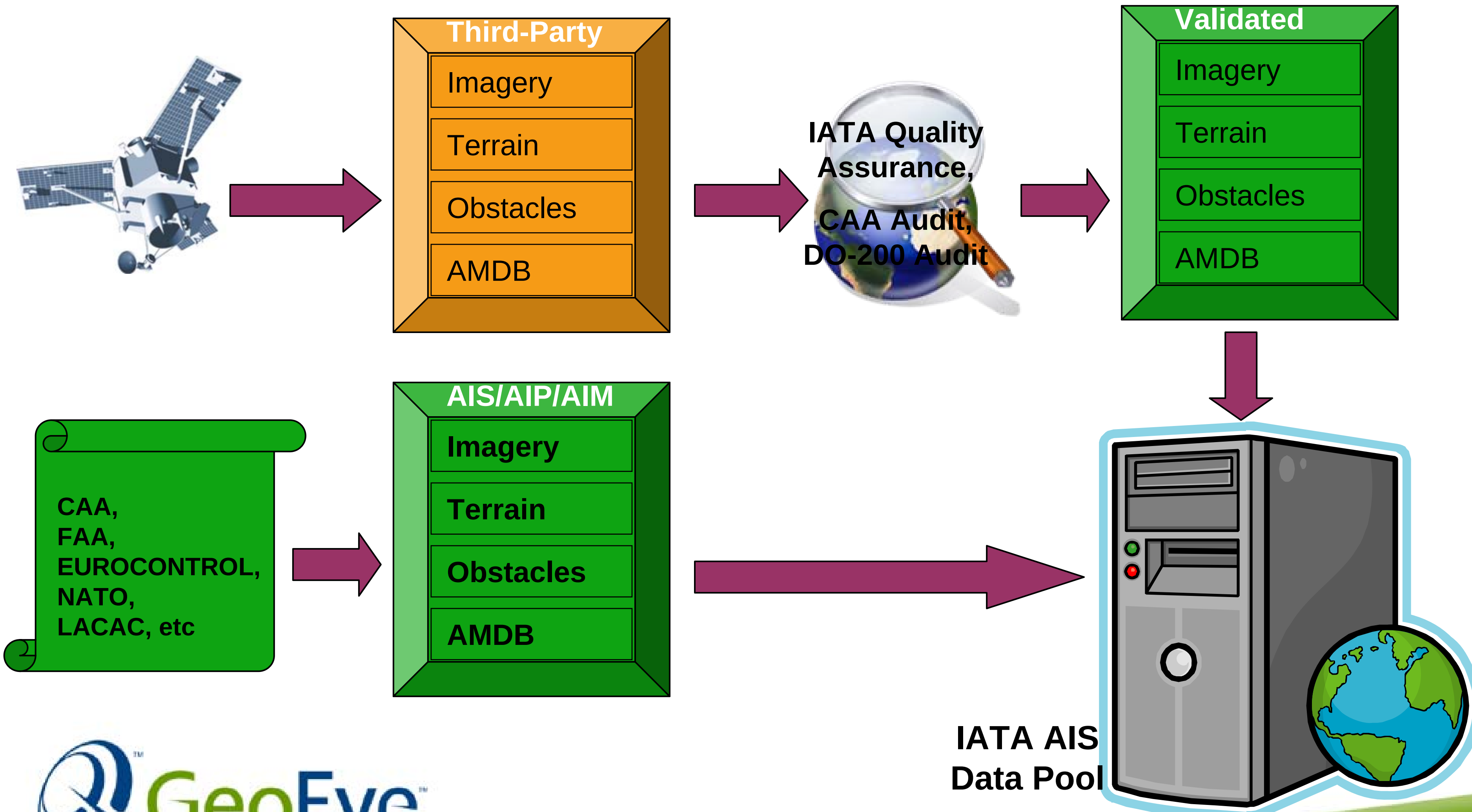
IATA AIS Data Pool (Vision):



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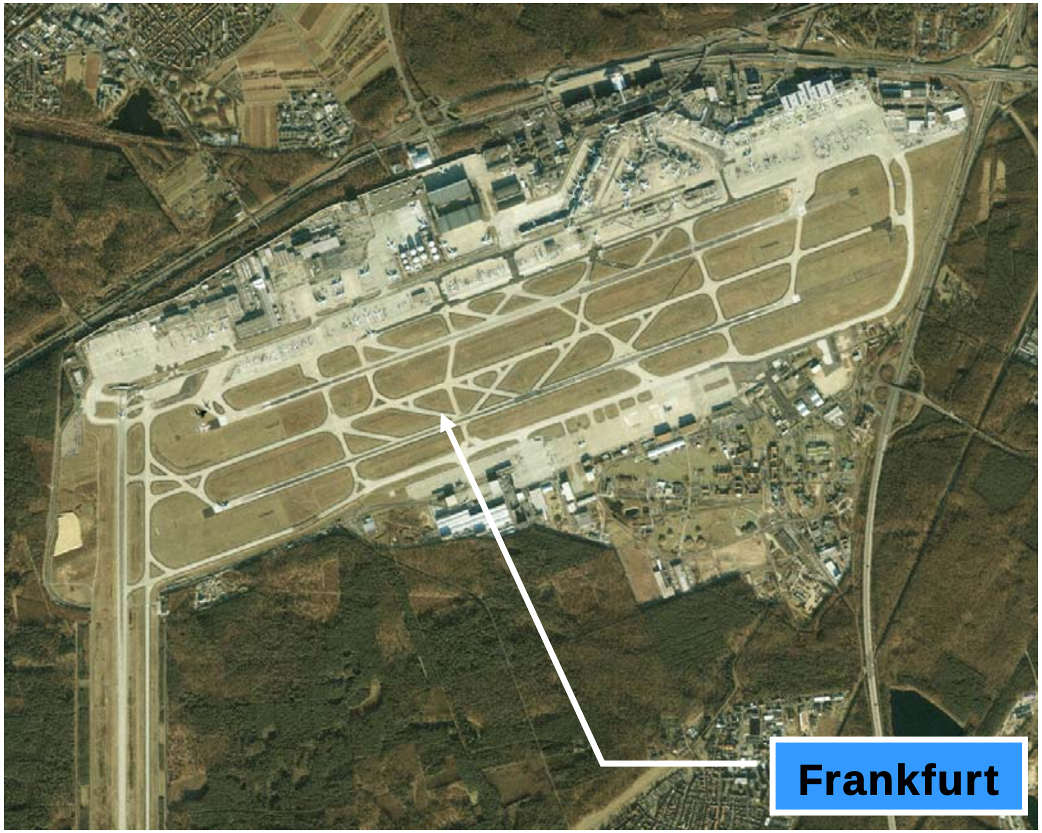
Airport Satellite Imagery

- Global library of airport satellite imagery.
- Online Web applet to browse for any airport in world.
- Pan, Color, Infra-Red (vegetation density).
- May be Electro-Optical or SAR/IFSAR based.
- Stereo Collection for 3D Feature Extraction and Terrain/Obstacles.
- Periodic Updating with newer satellites:
  from 1-meter to ½ meter



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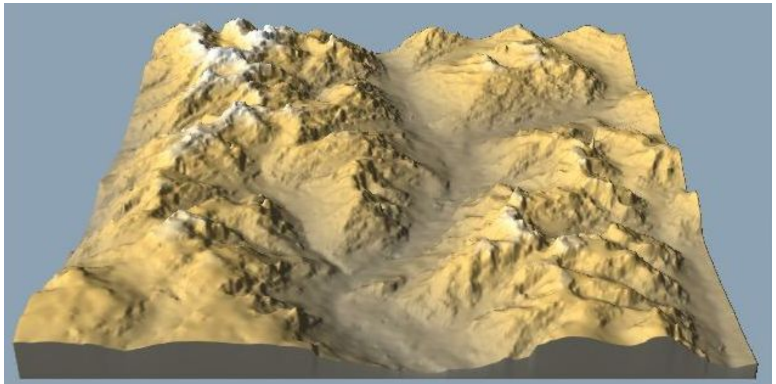
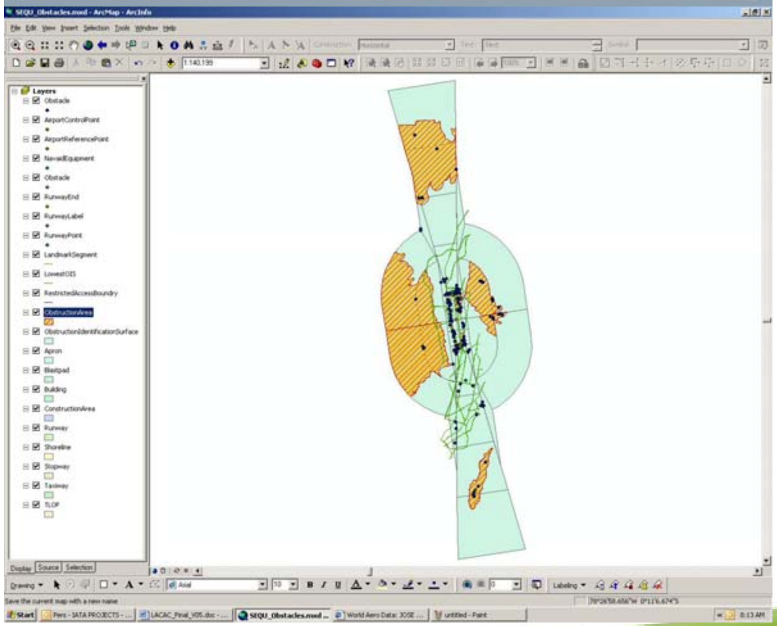
Terrain & Obstacle Models

- Electronic Terrain also known as DEM or DTM.
- Obstacle Databases collected in point, line and polygon.
- Derived from E/O and SAR/IFSAR Stereo Satellite Collection.
- Allows for the extraction of Obstacle Height and Terrain Height for aviation purposes.
- Features and attributes according to DO-276A/ED-98A and extracted according to DO-291/ED-119 harmonised to AIXM 5.
- Collected according to TERPS or PANS-OPS criteria rules.





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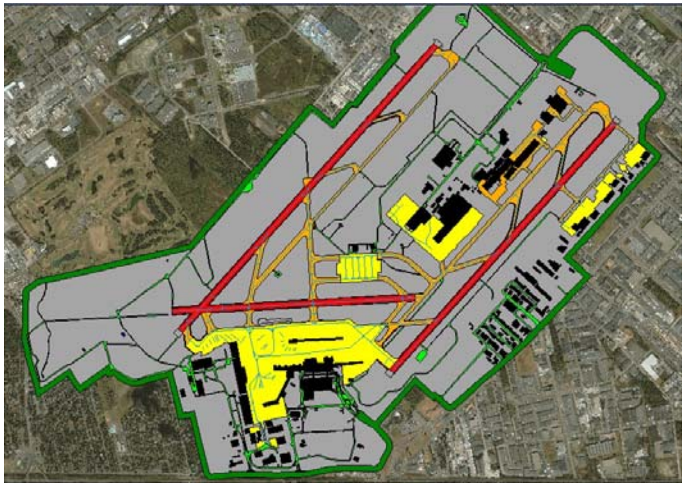
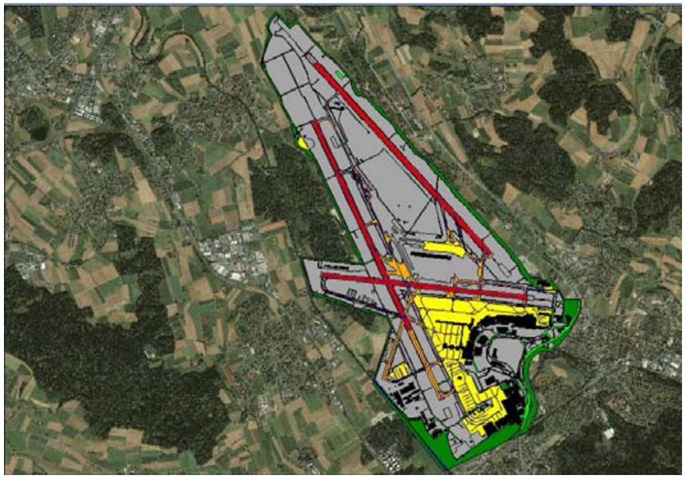
Airport Mapping Databases

- Airport Features collected in point, line and polygon format.
- Features and attributes according to DO-272A/ED-99A and extracted according to DO-291/ED-119 harmonised to AIXM 5.
- Suitable for Airport Surface Map applications for CNS/ATM and EFB.
- Derived from E/O and SAR/IFSAR Stereo Satellite Collection.
- Allows for the extraction of Airport Feature Height for analysis and visualization requirements.





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Imagery+AMDB+Terrain=EFB

- How will the AIS Data Pool assist Airlines in moving to FANS and EFB technology?
  - IATA has formed a working group to collect and share ideas and concepts between airline members to work towards common EFB standards.
  - IATA may work with regulatory authorities in helping them come up with certification pathways – FAA, JAA.
  - IATA is working with airlines looking to develop EFB's to provide guidance and insight into aspects of the EFB that require unique information collection.
  - IATA may work with appropriate regulatory authorities to determine appropriate, suitable manner to Collect this type of Aeronautical Geospatial Information in a manner that meets all ICAO and CAA regulations and requirements.

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So, what’s the big problem?

Here is a partial list of airport mapping data standards being used, not counting many proprietary ones:

- FAA Advisory Circular ″AC-150/5300-18″ for Airport GIS
- RTCA DO-272A/EUROCAE ED-99A for Airport Mapping
- RTCA DO-276A/EUROCAE ED-98A for Terrain/Obstacle Mapping
- RTCA DO-291/EUROCAE ED-119 for Data Extraction
- Geo-Spatial One-Stop AirMAT, published by SAE for the DOT.
- Eurocontrol AIXM Version 5 for AMDB, Terrain & Obstacles.
- DoD-FLIP Digital Working Group, published by NGA
- SAC Baseline (multiple versions), published by the NGA
- GeoBase/GeoReach Common Installation Picture (CIP), published by USAF
- Spatial Data Standards (SDS) for Facilities, Infrastructure, and Environment (FIE) , published by the ACE

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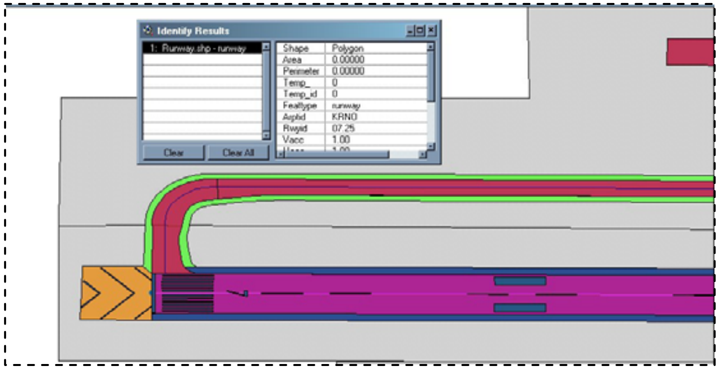
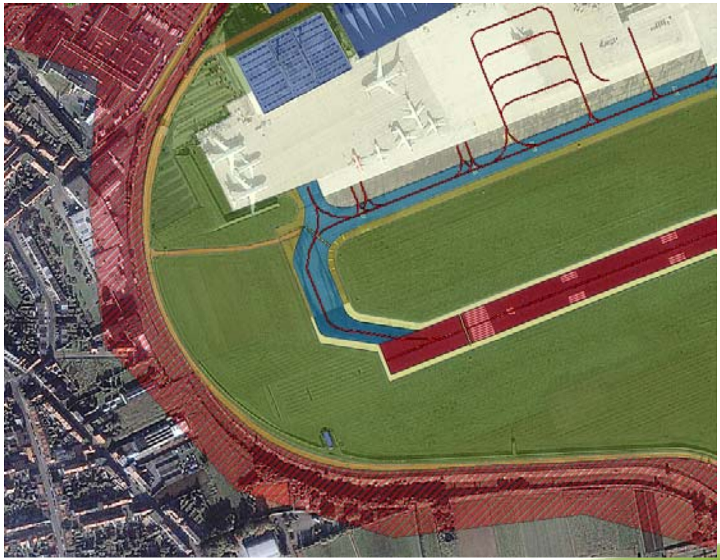
Data Management Challenge:

In order to be successful in working with AMDB data from many sources (Airport Authority, CAA, Air Force, others) we need to find a way to allow for:

- Receiving Data in one format and transforming to AIXM
- Receiving Data in multiple formats and combing into AIXM
- Using Satellites and other sensors to acquire new data, and converting to AIXM.
- Taking Data that is in AIXM and moving back to the legacy formats for maintenance of existing systems and sub-system.
- <u>Maintain AMDB (s) forever!</u>





Data Conversion Challenge:

- Physical:
  - Is the data in the correct NUMERICAL or TEXT formats?
- Logical:
  - Is the data in the appropriate range of frequencies 108-136 mhz?
- Temporal:
  - Is the beginning effective date and ending effective data of the data match the desired target?
- Parent-Child:
  - Does this airport have a taxiway A, B and C?
- Geospatial:
  - Does these runway coordinates fall within a buffer of the ARP?
- Completeness:
  - Did we get all the six taxiways?
- Update Metaphor:
  - Whole AMDB?
  - Parts of AMDB?

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Data Conversion Challenges:

- Device Specific
  - Specific FMS or HUD or EFB device may require additional data per location of some kind.
- Aircraft Specific
  - Specific performance characteristic of A/C may be required (climb performance, turn radius on single engine or RNP for Surface Movements).
- Operator Specific
  - Information regarding Gates or Parking positions only used / owned by specific airline.

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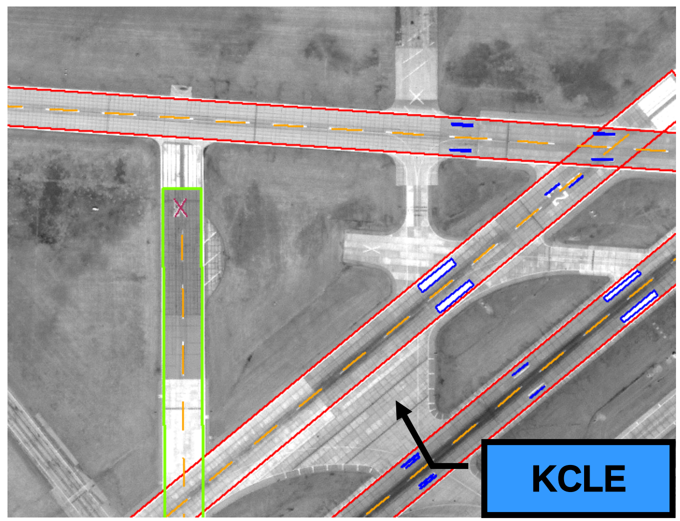
A DO-200A life Cycle for Airport Monitoring

(1) Construct AMDB

(2) Monitor Airports



(3) Update AMDB

(4) Advise all Users

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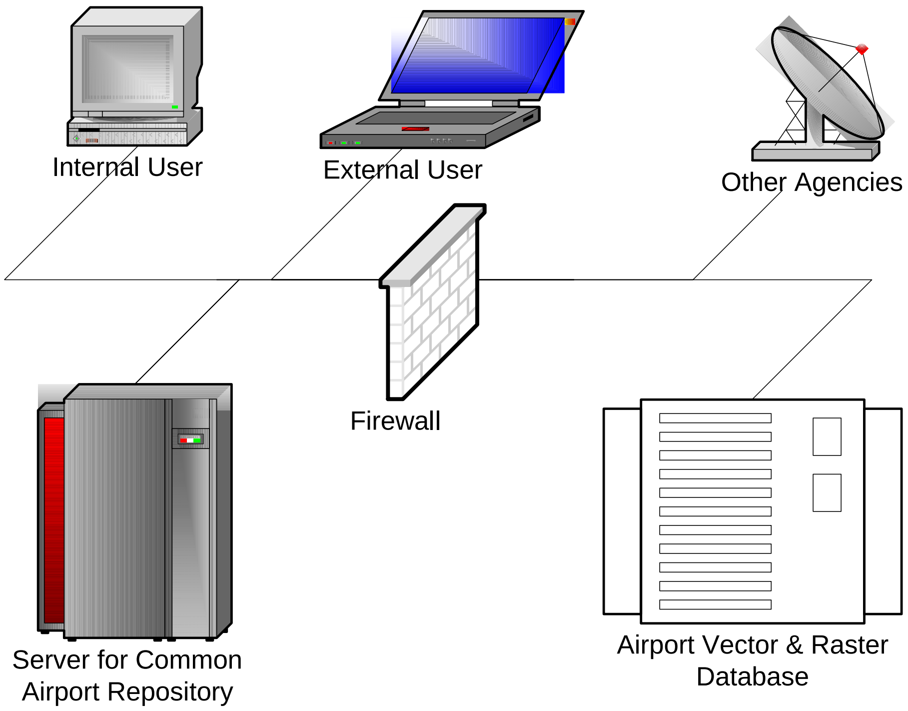
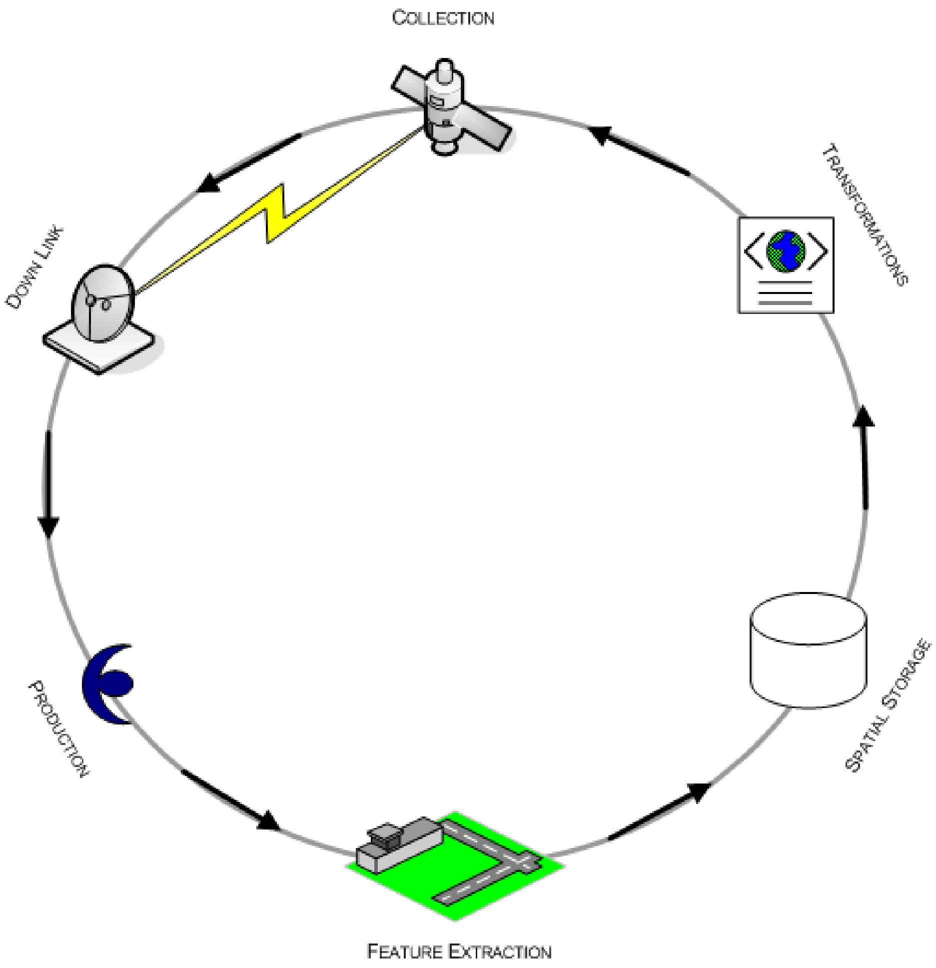
Key Concept – Single *Logical* Repository

- **Do more airport monitoring with less money by:**
- Single logical repository that supports maintenance for multiple formats.
- Single logical repository that collects all appropriate imagery metadata for change history tracking.
- Single Life Cycle process(s) to collect, import, and update Airport Mapping Database in perpetuity for two types of scenarios:
  - Validate known AMDB changes published by CAA or AA.
  - Detect unpublished AMDB changes from routine surveillance.
- Single logical point of notification when changes occur, to all affected parties.



High-Level Process Diagram



1. Collection of Stereo Imagery
2. Production of Stereo and Imagery Data
3. Feature Extraction & Attribute Association
4. Data Storage
5. Transformation

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AMDB Production Process:

- Imagery is collected (DO-200A process) as required by Target Format and/or target Obstacle Requirements:
  - AMDB is usually 10k x 10km over ARP
  - Terrain/Obstacle depends upon TERPS or PANS-OPS criteria being used.
  - Additional area may be needed for special requirements such as Engine-Out.
- We stores extracted features, attributes, metadata, and imagery (DO-200A process).
  - ESRI Shapefiles
  - GeoEye Airport Geodatabase
  - Custom Formats such as MID/MIF, AUTOCAD, Micro-Station.
- We extract for customer delivery (DO-200A process) the list of airports, and convert if necessary into GML or other deliver formats.

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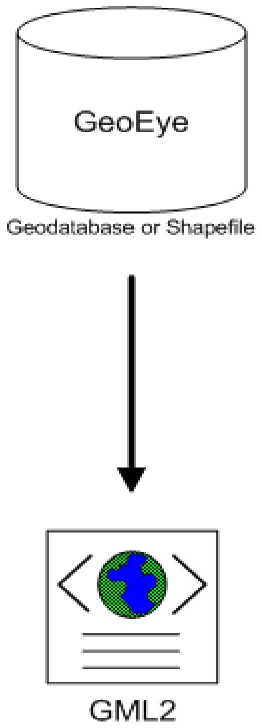
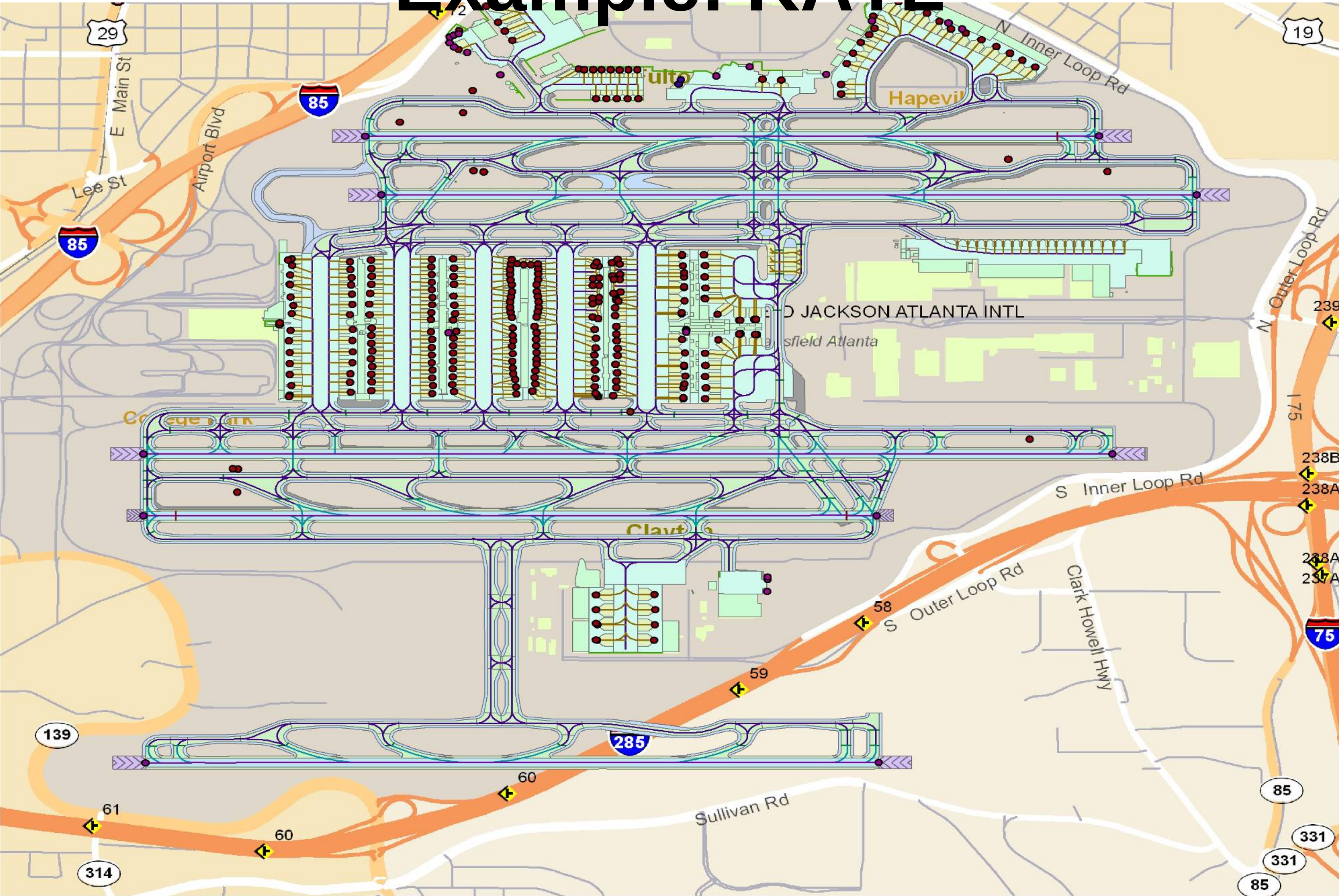
Transformation to GMLxx

- GeoEye stores spatial airport mapping data in a nonspecific fashion
- Transformations are made to the spatial content and can be extracted to:
  - ESRI Shapefiles
  - ESRI Geodatabases
  - GML2 (2007)
  - GML3 (2008)
- Based on customer requirements, attribute and spatial content are exported from central data
  - Gives GeoEye ability to conform to different airport standards upon request from customer



Example: KATL



GML2 Document Structure


```
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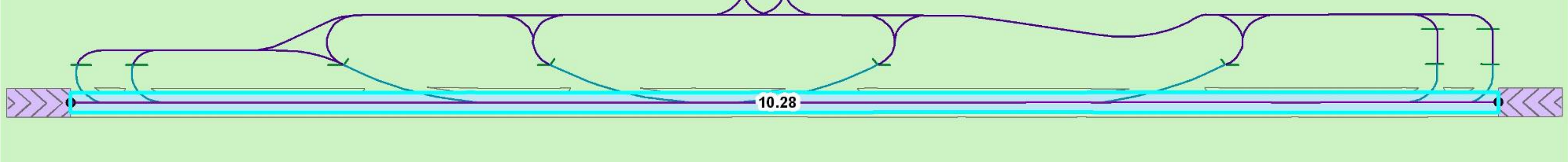

Example Feature

Runway Element 10.28


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GeoEye

Example Feature:

VerticalPolygonalStructure


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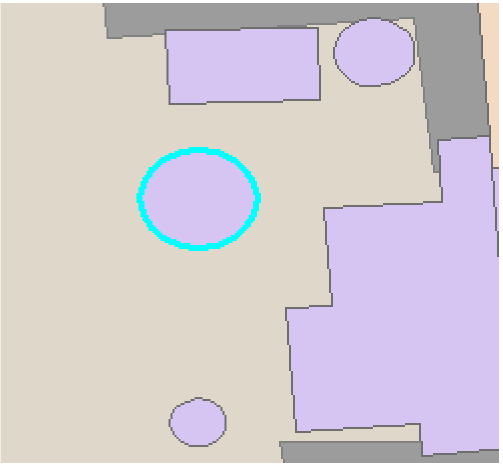
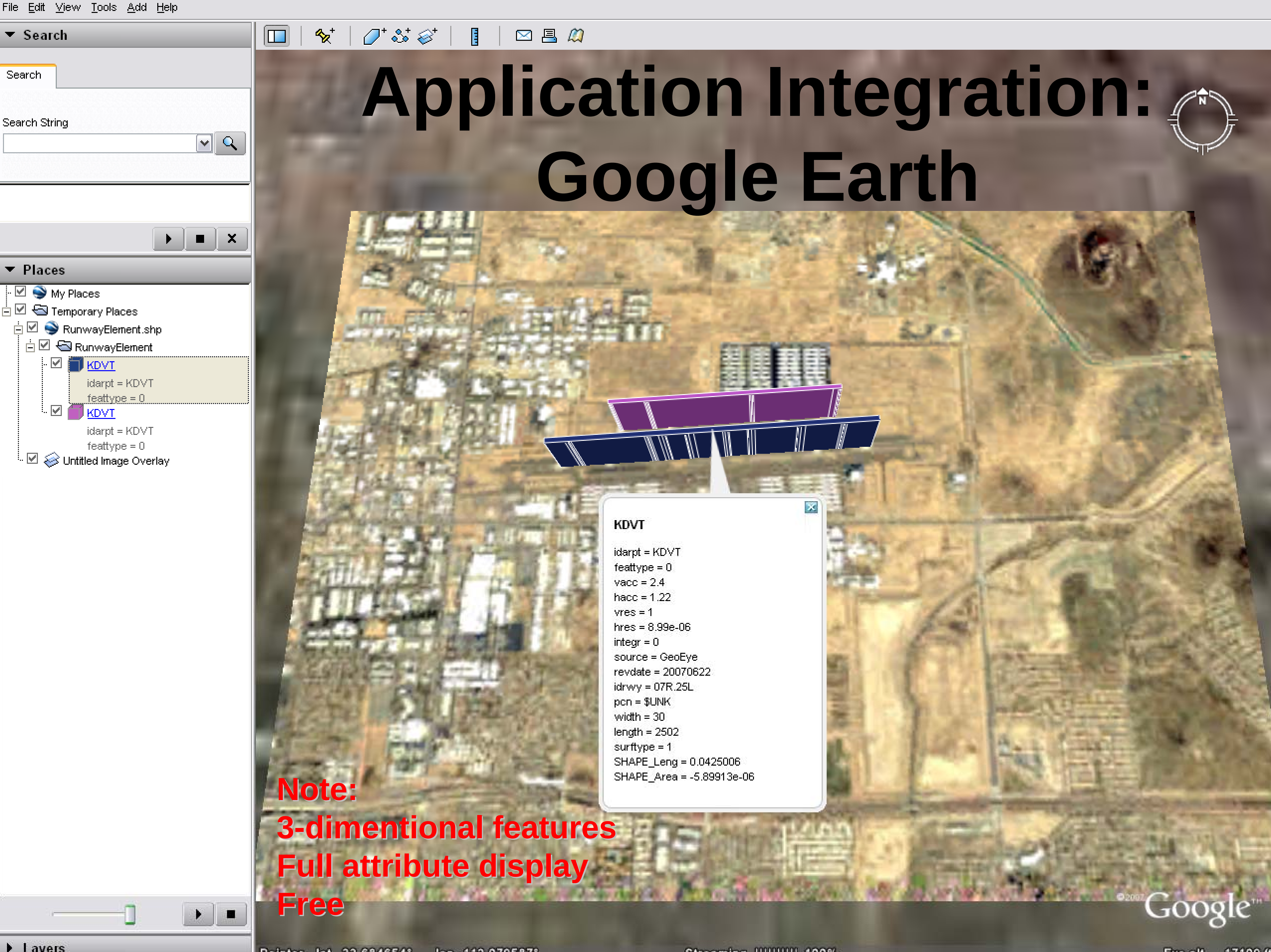
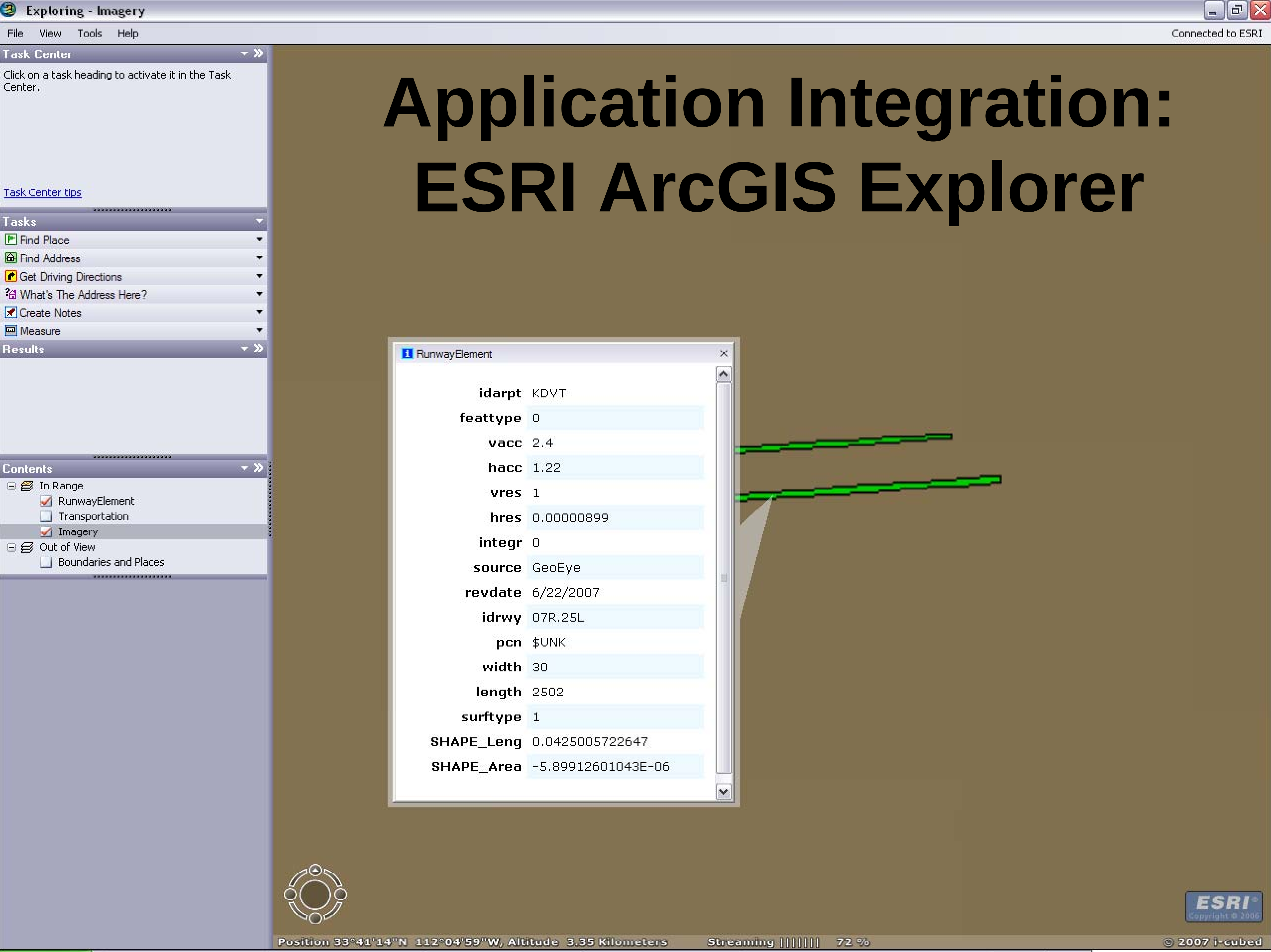


Application Integration: Google Earth



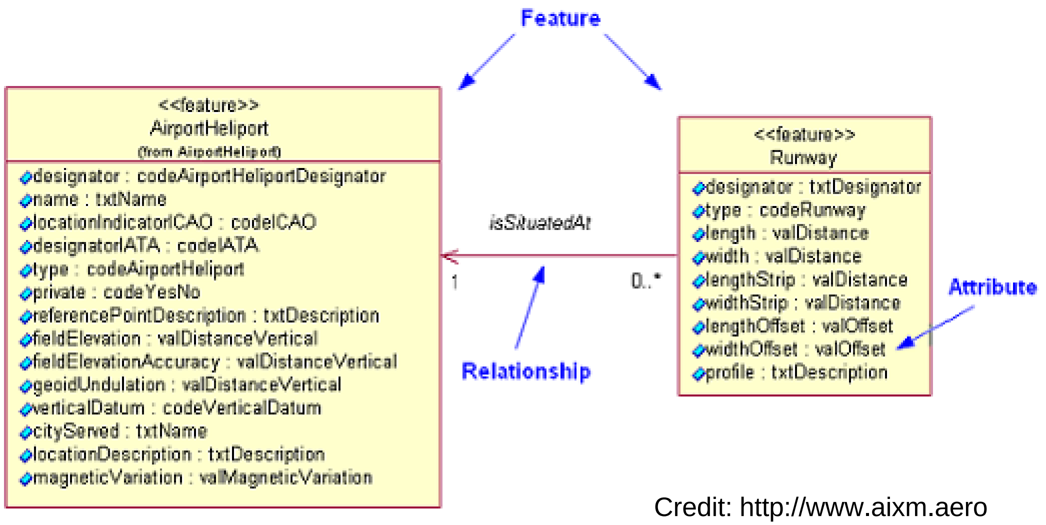
Note:
3-dimentional features
Full attribute display
Free

Application Integration: ESRI ArcGIS Explorer



AIXM Evolution

- Development History:
  - DO-272 (2004)
  - DO-272A (2006)
  - DO-291 (2007)
  - AIXM 5 (2008)
- Advantages
  - Easy integration
    - Into system
    - With future FAA aero-spatial data
  - Subset of industry GML standards
  - “Simple” transformation from SHP > GML > AIXM



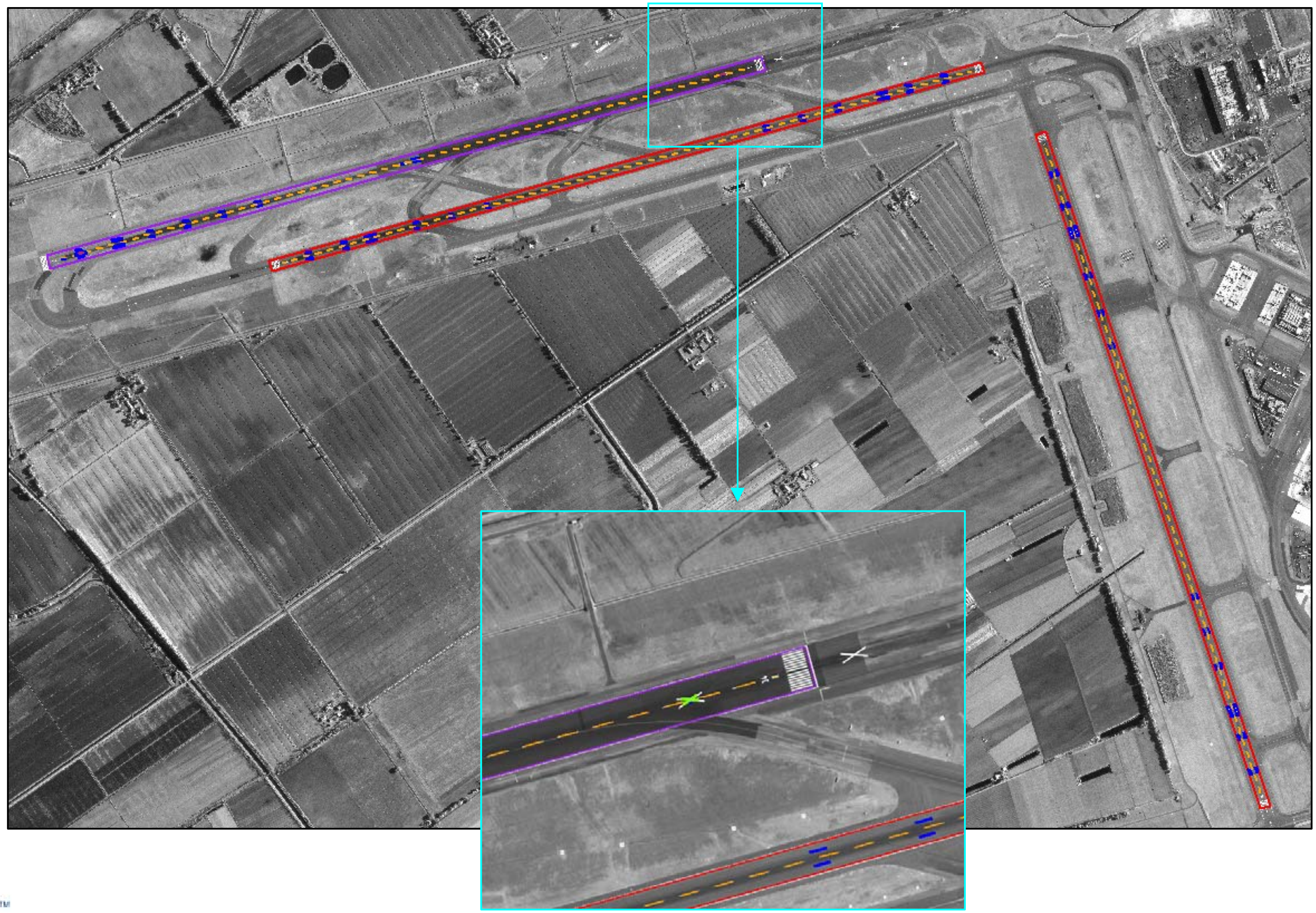
Credit: http://www.aixm.aero

Integration

- Visualize and Analyze
  - ESRI Platform
    - ArcMap
    - ArcGIS Explorer (free)
  - Google Platform
    - Google Earth (free)
  - Additional Platforms
    - ERDAS…
- Process
  - Image Processing
    - 3D extraction
    - Stereo visualization
  - Image Analysis
    - Raster change detection
  - Routing Algorithms
  - Custom client applications
  - Vector Analysis
    - Vector change detection

GeoEye

Vector-to-Vector Change Detection:



Questions:

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GeoEye

Technology Definitions

- GeoEye Products
  - Optical-imagery currently at 1-meter resolution
  - Same-orbit Stereo Collection
    - 3-dimentional Feature Extraction
- ESRI Shapefiles
  - A vector data format for storing location, shape, and attribute information
- GML
  - OpenGIS Geography Markup Language (GML) is an OGC encoding standard for geospatial information
  - Safe Software
    - Spatial Extract/Translate/Load (ETL) Toolset in the Feature Manipulation Engine (FME)
      - Shapefile features to GML2
  - GML2 currently in use by GeoEye
    - Previous versions ETL did not include Z axis for coordinates
- AIXM
  - "The Aeronautical Information Exchange Model (AIXM) is designed to enable the management and distribution of Aeronautical Information Services (AIS) data in digital format." – http://www.aixm.aero
  - AIXM describes the extensible markup language (XML) used in description, storage, transfer, and use of aeronautical information.
  - AIXM is quickly becoming the global standard for aeronautical data, used by ICAO, FAA, NGA, Eurocontrol, and others as their standard language.

GeoEye