AIXM & WXXM Conference
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"Importing and Exporting from Airport GIS Formats" – Day 3

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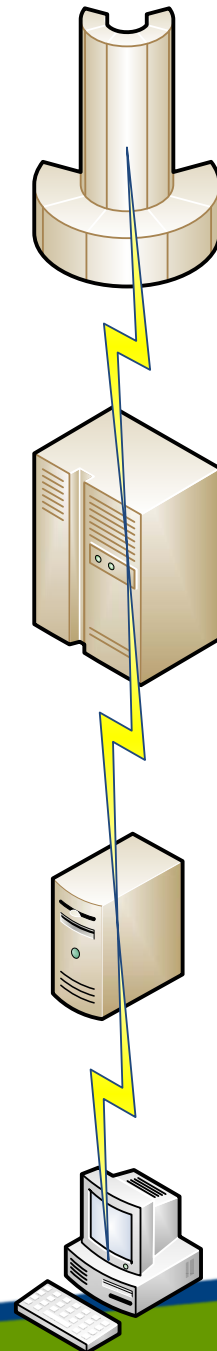
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Who are we, and what am I complaining about?

- GeoEye owns and operates three satellites – IKONOS, OV-2, and GEOEYE-1.
- 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 IKONOS @ 82-cm and GEOEYE-1 @ 41-cm satellites, imaging in Single-Orbit Stereo.
- We have mapped over 2,000 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.

MMTO/TLC

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Topics to Consider

- Problem Discussion:
  - How many standards are there?
  - Why is this a problem?
- A checklist for Data Format Conversion
  1) Physical Database Format changes.
  2) GIS Application upgrades.
  3) Upgrading AMDB Formats in same standard.
  4) Converting Dissimilar GIS formats.
     - **a) Data Conversion Challenges**
     - **b) Data Migration Challenges**
  5) Upgrading Output formats.
  6) Verification & Validation.
  7) Visualization.

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How many standards are there?

Here is a partial list of airport mapping data standards being used, not counting <u>many</u> 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.
- ARINC-816 ADB
- DoD-FLIP Digital Working Group, published by NGA
- SAC Baseline (multiple versions), published by the NGA
- GeoBase/GeoReach, published by USAF
- Spatial Data Standards (SDS) for Facilities, Infrastructure, and Environment (FIE) , published by the ACE

Why is this a problem?

- If everybody was like "Swedish Airports and Air Navigation Services" (LFV), all these issues have been resolved.

- However, across 200 ICAO signatories and some 14,000 airports – there is more work to do.

- After the first 400-500 largest airports in the world – all other airports have only been mapped in some proprietary standard – or not at all.

- So, let's examine a "**Checklist**" approach to managing changes in AMDB formats.

ESSA/ARN

(1)Physical Database Format changes

- Relational Models have some advantages:
  - Enforcing Referential Integrity.
  - Enforcing Parent-Child relationships.
  - Domains of Values.
- Some different formats:
  - ESRI Coverages
  - ESRI File GeoDatabases
  - ESRI Personal (Access) GeoDatabase
  - RDBMS Types:
    - **Microsoft SQL Server 2008/Geometry & Geography**
    - **Oracle Spatial**
    - **IBM DB2 with Spatial Extender**
    - **IBM Informix with Spatial DataBlade**
    - **Postgres SQL with PostGIS**
  - Smallworld GIS
- Migration Challenges – Tables, Triggers, Stored Procedures
  - Numerical Checks for completeness of data content from previous versions.
  - Spatial Checks for coverage of data content from previous versions.
- <u>Use of DO-200A Process(s) helps prevent damage to GIS data!</u>

Database
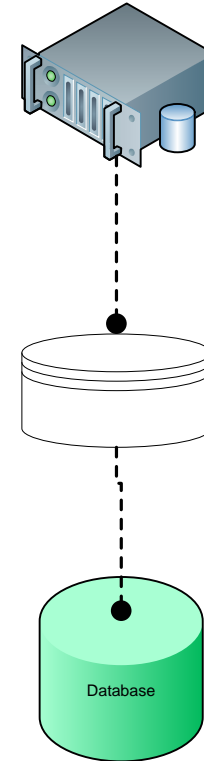
# (2) GIS Application upgrades

- Major Version Changes are not always backward compatible, or backwards compatibility is handled differently:
  - ARC/GIS 8.3
  - ARC/GIS 9
  - ARC/GIS 9.1
  - ARC/GIS 9.2
  - ARC/GIS 9.3

- Error Handling may change.

- Application Language Support changes over time as new languages arise or gain in popularity.

- Ability to handle specialized data such as Imagery changes over time.

- Temporal Handling & Versioning changes.

- Multi-User functionality (Job Tracking).

- <u>Use of DO-200A Process(s) helps prevent damage to GIS data!</u>

(3) Upgrading AMDB Formats same standard

- RTCA DO-272/EUROCAE ED-99 "Baseline" published 2001
  - 10 Runway Features
  - 3 Helipad Features
  - 7 Taxiway Features
  - 6 Apron Features
  - 3 Vertical Structures
  - Construction Areas
  - Quality Data
- RTCA DO-291/EUROCAE ED-119 published in 2004
- Revision (A) published in 2005
  - Integration with Annex-15 Ammd-33, AIRAC accommodation, Geometric Relations and Constraints formally listed, Data Content & Capture Rules strengthened, Service Roads & Thresholds added, Clearways removed.
- Revision (B) published in 2008
  - New Features of Blastpad, Water, Hotspot, Aerodrome Surface Lighting, Attribute idnumbers added, Rules clarified, number of attribute changes, changes to Codelists, further harmonization with ARINC-816 and AIXM.
- <u>Use of DO-200A Process(s) helps prevent damage to GIS data!</u>

(4) Converting Dissimilar GIS formats

- 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.

- Maintain AMDB (s) forever!

- <u>Use of DO-200A Process(s) helps prevent damage to GIS data!</u>

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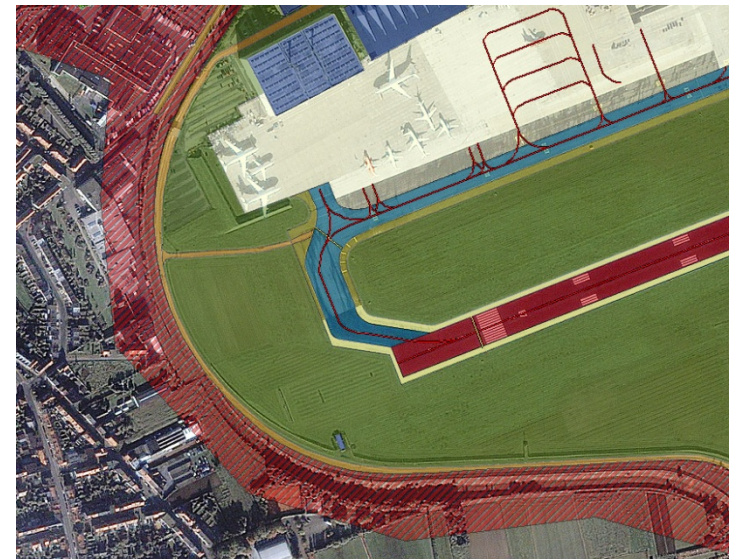
Data Conversion Challenge:

- **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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(5) Upgrading Output formats

- Common Output Formats:
  - Geographic Markup Language
    - **Version 1.x with**
      - Object-Property-Value Rules,
      - Remote Properties via rdf.resource
      - Application Schemas
    - **Version 2.x**
      - XML Schemas
    - **Version 3.x**
      - GML & G-XML harmonization
      - ISO TC/211 harmonization
  - Autocad DWG
  - Microstation DGN
    - **Earlier Intergraph DGN or ISFF**
    - **V8 DGN**
- <u>Use of DO-200A Process(s) helps prevent damage to GIS data!</u>

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(6) Verification & Validation

- Critical to develop tools at every step of each process, to ensure data integrity, quality, and adherence to published rules.

- Need to be able to record execution of rules, and maintain history of rules with versions of AMDB that may have changed.

- Need to consider when format transformations occur (e.g. Shapefile to GML), what additional toolsets are needed to ensure same data fidelity.

- <u>Use of DO-200A Process(s) helps prevent damage to GIS data!</u>

Geospatial Constraints & Capture Rules

- **Geometrical constraints** ensure connectivity between features on a spatial level. Compliance to geometrical constraints leads to graphical consistency of AMDB features with respect to the spatial connections observed in the real world.

- Basic relationships between point, line, and polygonal features.

- Implementation:
  - NGA SAC "Baseline" Format
  - USAF GeoBase/GeoReach Format
  - RTCA DO-272 (initial)
  - Revision (A)
  - Revision (B)
  - Revision (C) in current development

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RTCA DO-272 Charted Constraints

Black cell : geometrical connection is recommended and explicit rule is given below	**White cell : geometrical connection is not recommended**	**Yellow cell : geometrical connection is possible without specific recommendation**

Matrix legend (row label → column: value), values denote the explicit rule number for black cells:

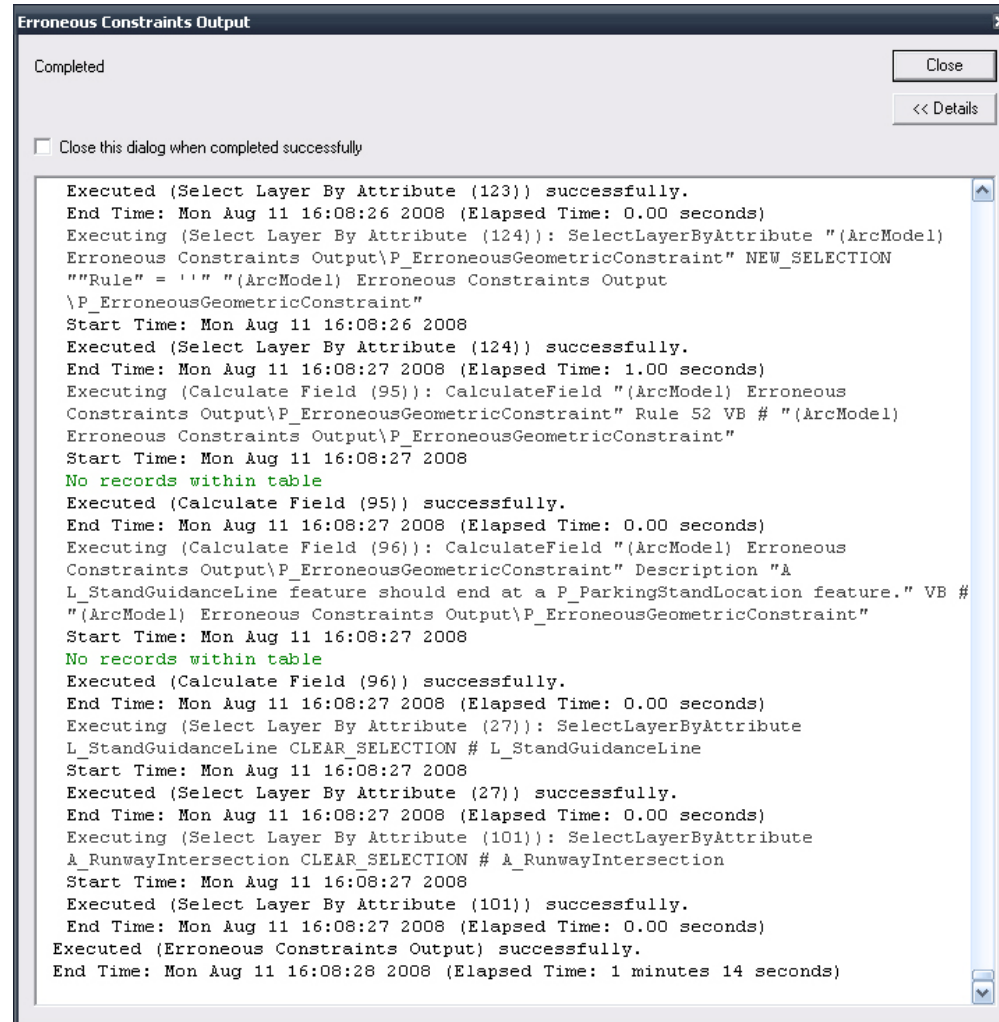| Row	Entries
Polygons	
RunwayElement	(diagonal)
RunwayIntersection	RunwayElement: 1
RunwayDisplacedArea	RunwayElement: 2
RunwayShoulder	RunwayElement: 3, RunwayIntersection: 3, RunwayDisplacedArea: 3, RunwayShoulder: 3
Stopway	RunwayElement: 4, RunwayIntersection: 4, RunwayDisplacedArea: 4, RunwayShoulder: 3
RunwayMarking	RunwayElement: 5, RunwayIntersection: 5, RunwayDisplacedArea: 5, RunwayShoulder: 3, Stopway: 5, RunwayMarking: 7
TaxiwayElement	RunwayElement: 6, RunwayDisplacedArea: 8, TaxiwayElement: 15
TaxiwayShoulder	TaxiwayElement: 16, TaxiwayShoulder: 25
FrequencyArea	(yellow)
ApronElement	TaxiwayElement: 17, ApronElement: 26
ParkingStandArea	TaxiwayElement: 18, ApronElement: 27, ParkingStandArea: 33
DeicingArea	TaxiwayElement: 19, ApronElement: 28, DeicingArea: 36
VerticaPolygonalStructure	ApronElement: 29
ConstructionArea	(yellow)
FinalApproachAndTakeOffArea	
TouchDownLiftOffArea	FinalApproachAndTakeOffArea: 40
ServiceRoad	
Lines	
ArrestingGearLocation	RunwayElement: 10, RunwayDisplacedArea: 10, RunwayShoulder: 10
PaintedCenterline	RunwayElement: 11, RunwayIntersection: 11, RunwayDisplacedArea: 12, RunwayShoulder: 12, ArrestingGearLocation: 43
LandAndHoldShortOperationsLocation	RunwayElement: 9, ArrestingGearLocation: 44
TaxiwayGuidanceLine	TaxiwayElement: 20, ApronElement: 30, DeicingArea: 37
TaxiwayIntersectionMarking	TaxiwayElement: 21, TaxiwayGuidanceLine: 47
TaxiwayHoldingPosition	TaxiwayElement: 22, TaxiwayGuidanceLine: 48
RunwayExitLine	RunwayElement: 13, RunwayDisplacedArea: 13, TaxiwayElement: 23, TaxiwayGuidanceLine: 45, TaxiwayIntersectionMarking: 49, TaxiwayHoldingPosition: 51
StandGuidanceLine	TaxiwayElement: 24, ApronElement: 31, ParkingStandArea: 34, DeicingArea: 38, TaxiwayGuidanceLine: 50
VerticalLineStructure	(yellow)
Points	
RunwayThreshold	RunwayElement: 14, RunwayDisplacedArea: 14, RunwayShoulder: 14, ArrestingGearLocation: 46
ParkingStandLocation	ApronElement: 32, ParkingStandArea: 35, DeicingArea: 39, StandGuidanceLine: 52
VerticalPointStructure	(yellow)
SurveyControlPoint	(yellow)
AerodromeReferencePoint	(yellow)
HelipadThreshold	FinalApproachAndTakeOffArea: 41, TouchDownLiftOffArea: 42

Examples of RTCA Rules:

- A **Runway Intersection** feature should be <u>attached</u> to all corresponding **Runway Element** features (Rule 1).
- A **Runway Displaced Area** feature should be <u>attached</u> to the corresponding **Runway Element** feature (Rule 2).
- A **Runway Shoulder** feature should be <u>attached</u> to the corresponding **Runway Element** feature and/or **Runway Intersection** feature and/or **Runway Displaced Area** feature and/or **Stopway** feature and/or **Runway Shoulder** feature and/or **Runway Marking** feature (Rule 3).
- A **Stopway** feature should be <u>attached</u> to the corresponding **Runway Element** feature or **Runway Intersection** feature or **Runway Displaced Area** feature (Rule 4).
- A **Runway Marking** feature should be <u>contained</u> in a **Runway Element** feature and/or a **Runway Displaced Area** feature and/or a **Stopway** feature and/or a **Runway Intersection** feature (Rule 5).
- A **Taxiway Element** feature adjacent to a Runway Element should be <u>attached</u> to the corresponding **Runway Element** feature (Rule 6).
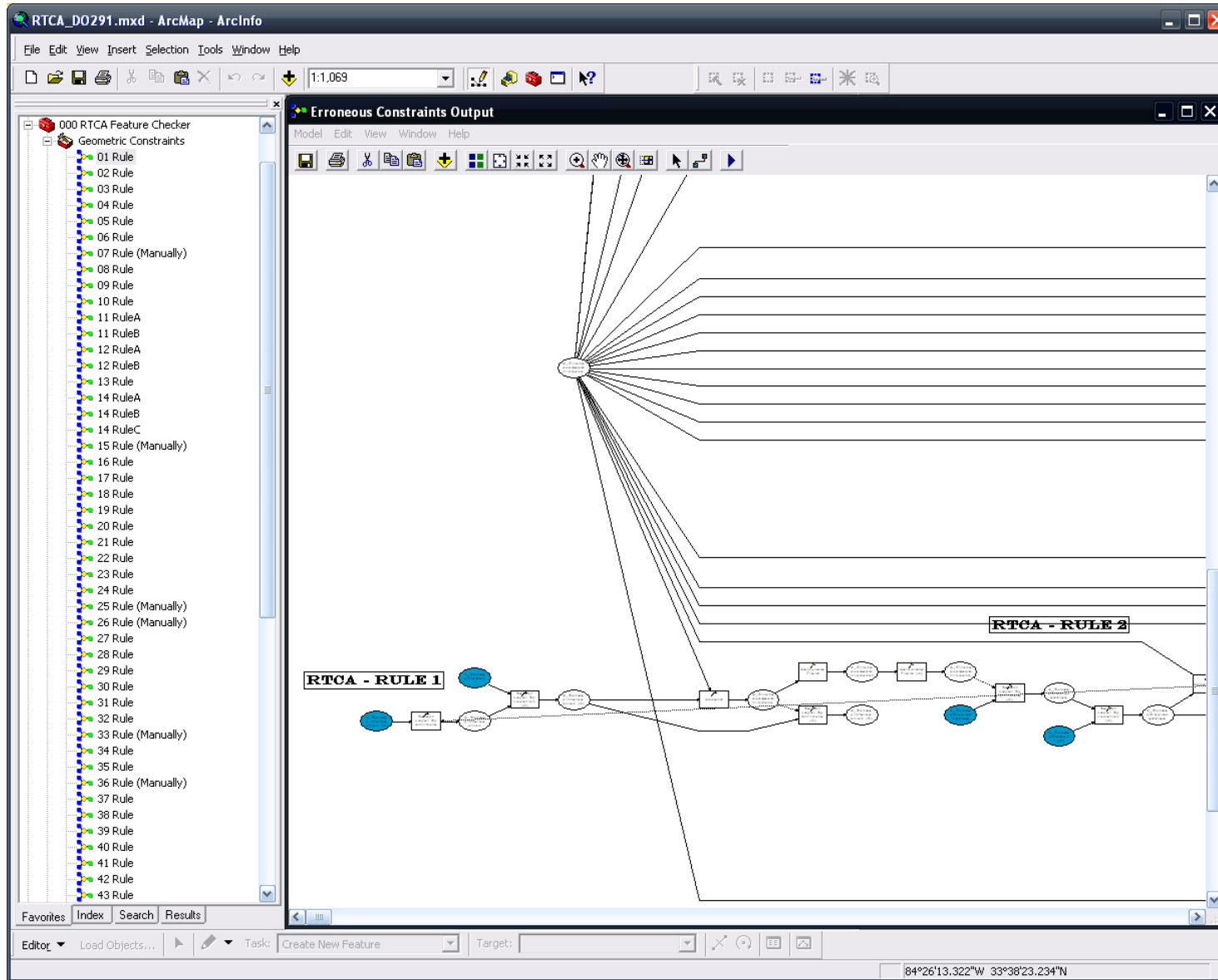
ESRI Arc Modeler (Python Script)

Geoprocessing

Visualization of Geometric Constraints

Visualization

Questions?

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