Case Study of IKONOS Stereo Photogrammetry in Support of Aircraft Arrival & Departure Procedures – Enhancing Capacity, Safety and Reducing Fuel Costs.

JACIE - Thursday Mar 22nd 14:00

GeoEye

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Agenda

- Who is GeoEye?
- What is our particular Expertise?
- What projects have we done in the past for other customers?
- What is unique about this project in South America?
- What does this mean for the future of Aviation?

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Who is GeoEye?

- Worlds largest commercial remote sensing company formed as a result of ORBIMAGE's merger with Space Imaging in January 2006.
- A constellation of remote-sensing satellites delivering the highest-quality, most accurate satellite imagery and products.
- International network of regional ground stations, advanced geospatial imagery processing capability and a robust image archive, all of which are unmatched in the industry.
- NASDAQ Traded, 100% US Owned and Operated!

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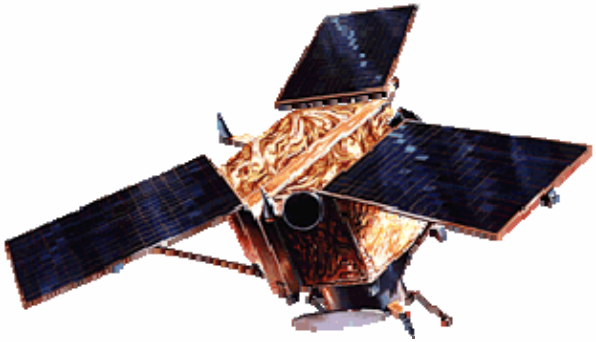
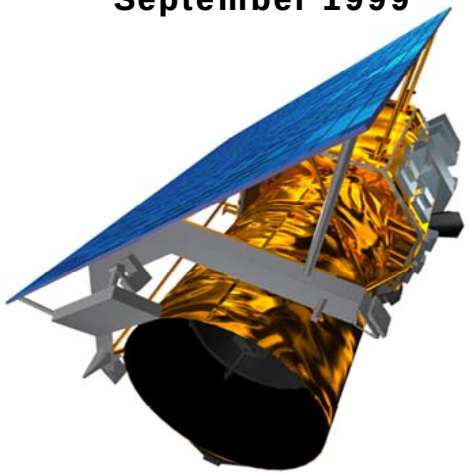
Our Constellation

OrbView-2
August 1997



IKONOS
September 1999

OrbView-3
June 2003



GeoEye-1
Spring 2007

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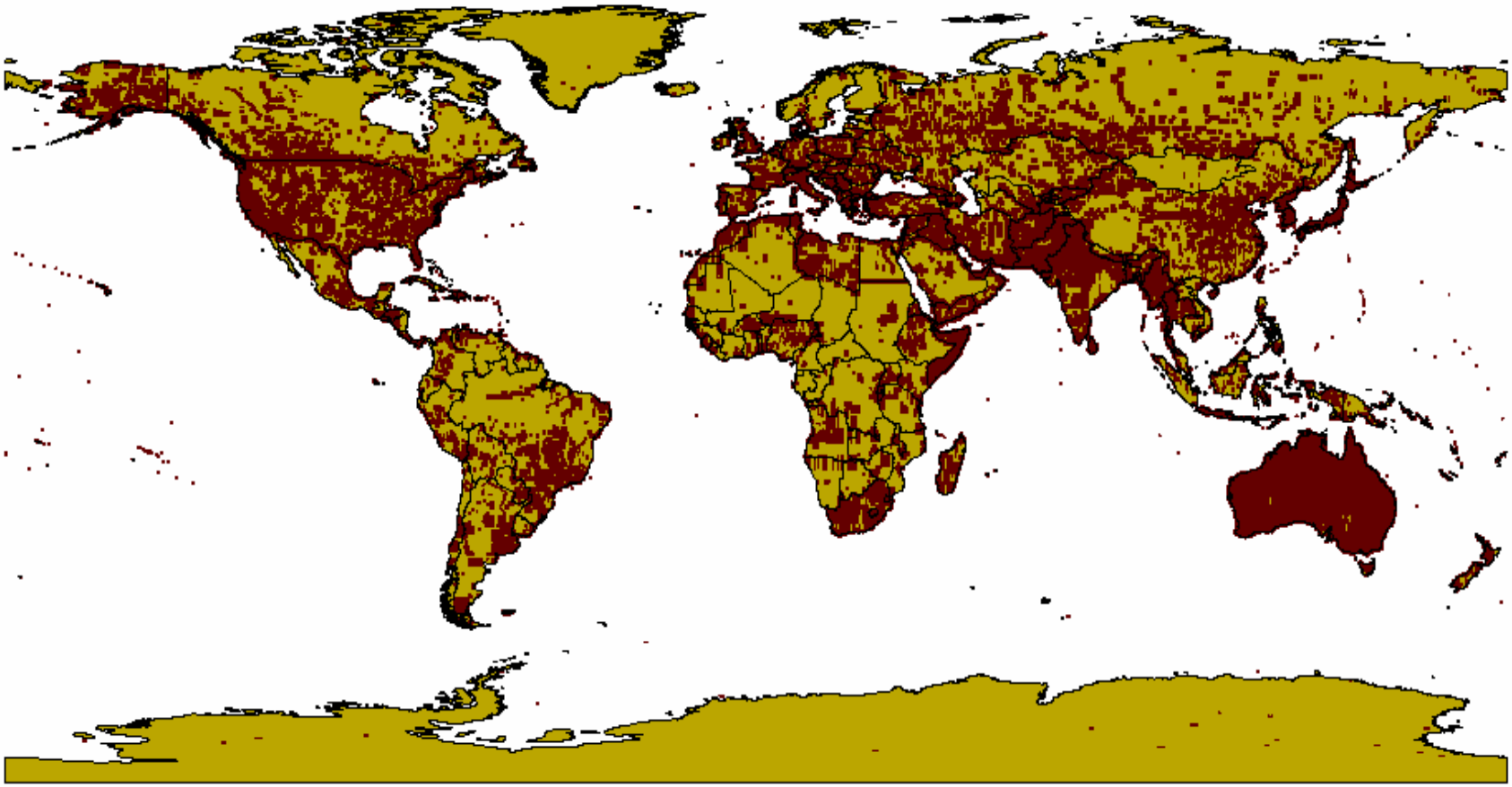
Largest Archive in World



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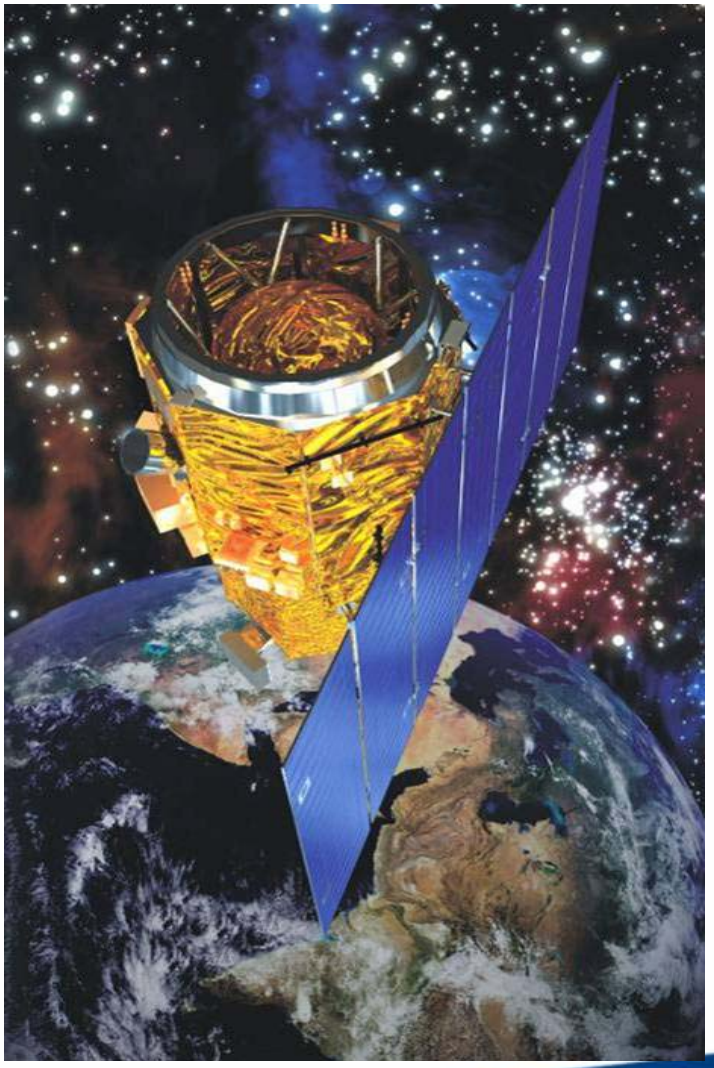
GeoEye-1 Technical Specs

- Resolution/Swath-Width
  - **Pan: 0.41m**
  - **MS: 1.65m**
  - **Swath Width 15.2/ km**
- On-Board 1.0 Terabit Solid Stage Recorder
- 11 Bit Detector Dynamic Range
- Data Rates
  - **700 Mbps**
  - **150 mbps**
- Gimbaled X-Band Antenna
- >700,000 km2 Imaged per Day
- Revisit Time: <3 Days
- Orbit: 97° Sun Sync at 10:30 a.m.
- Altitude: 684 km
- Launch Mass: 2050 kg / 3300 W Power;
  Delta II Launch
- Mission Life: 7 years (Fuel >10 Years)
- Launch March 2007



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What is our unique Expertise?

- We know all pertinent standards for Airport GIS Databases – NGA, USAF, FAA (RTCA).
- We build
  - **Airport Mapping Databases** (AMDB), in ESRI Shapefile format.
  - Airport **Terrain** Databases, in DTED or other formats.
  - Airport **Obstacle** Databases, in ESRI Shapefile format.
- We construct all of the above using IKONOS or OV-3 single-orbit stereo.
- We are the largest commercial manufacturer of the above in the world, having had delivered over 400 to date, over 600 on firm order.
- No other commercial satellite company has any direct production capabilities in this field.
- Total airports in the world that requires this type of mapping exceeds 10,000 – 15,000.

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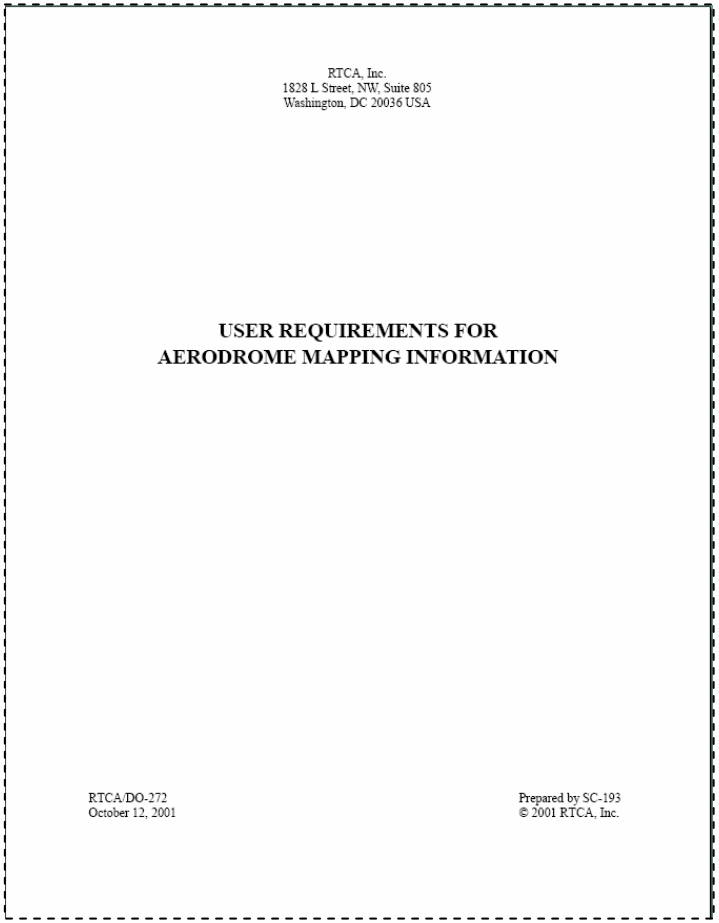
GeoEye Standards Development

- RTCA DO-272
  - Industry best practices for Airport Mapping.
  - Based on FAA and ICAO input
  - Fully Implemented in 2003.
  - Suitable for Certified Cockpit applications
  - DD is Co-Author



RTCA, Inc.
1828 L Street, NW, Suite 805
Washington, DC 20036 USA

USER REQUIREMENTS FOR
AERODROME MAPPING INFORMATION

RTCA/DO-272
October 12, 2001

Prepared by SC-193
© 2001 RTCA, Inc.

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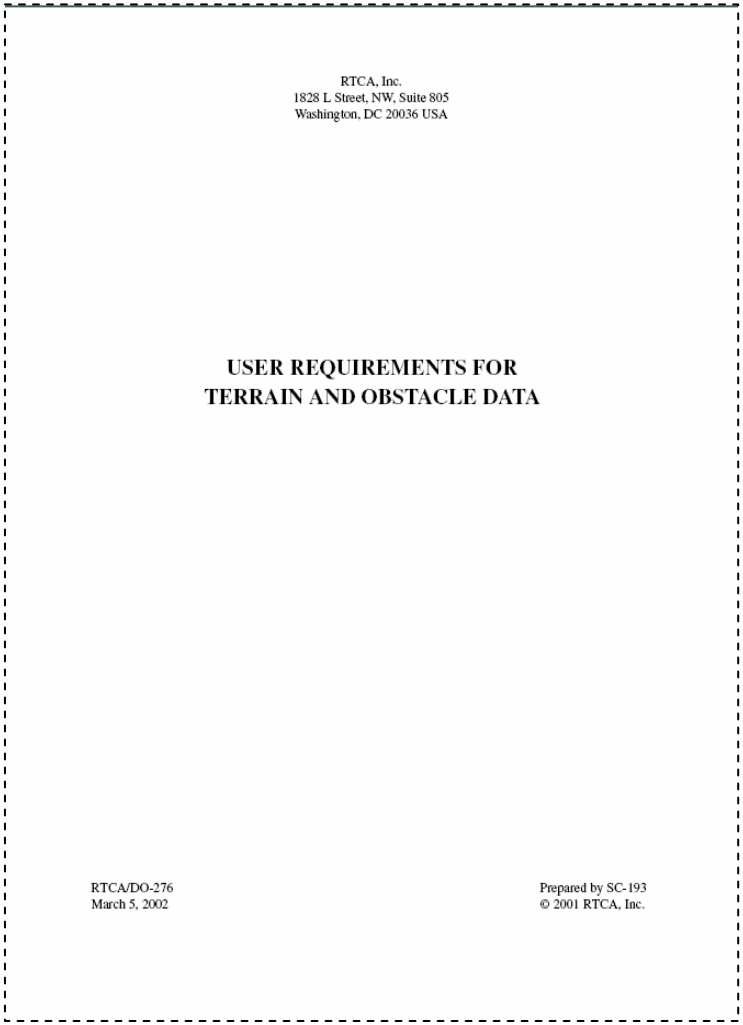
GeoEye Standards Development

- RTCA DO-276
  - Industry best practices for Terrain & Obstacles
  - Based on FAA and ICAO input
  - Fully Implemented in 2003.
  - Suitable for Certified Cockpit applications
  - DD is Co-Author



RTCA, Inc.
1828 L Street, NW, Suite 805
Washington, DC 20036 USA

USER REQUIREMENTS FOR
TERRAIN AND OBSTACLE DATA

RTCA/DO-276
March 5, 2002

Prepared by SC-193
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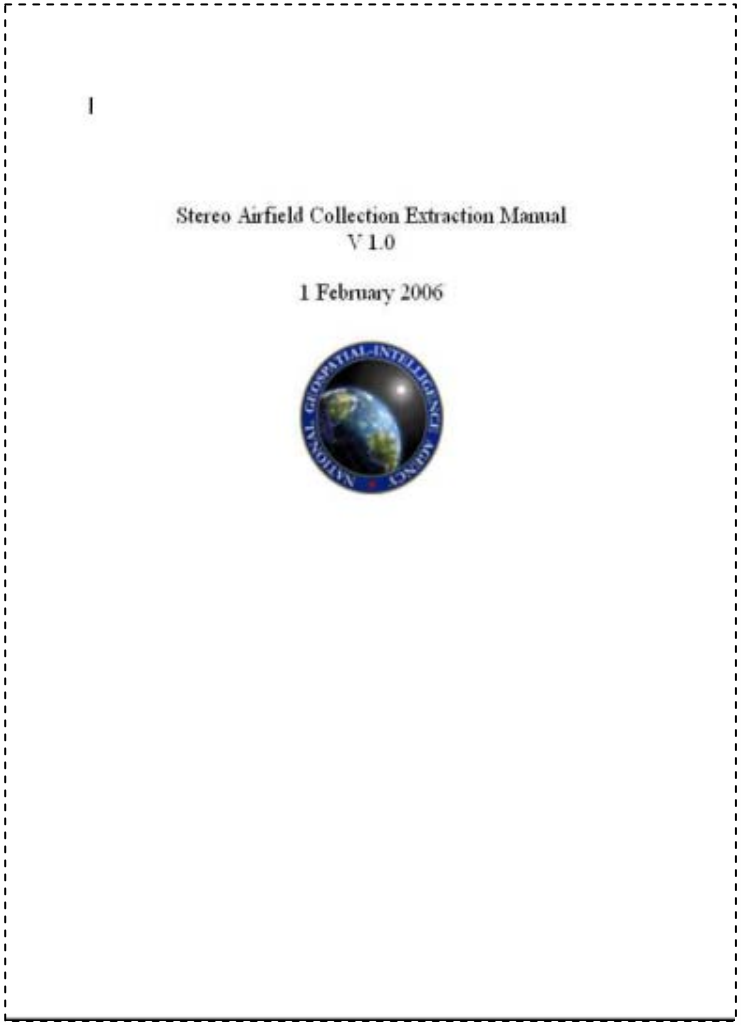
GeoEye Standards Development

- SAC Baseline
  - Current standard for other NGA systems downstream.
  - Requires in-track Stereo Imagery – from NTM or IKONOS.
  - GeoEye was first CLEARVIEW contractor to supply – developed labor cost model.
  - May eventually migrate close to AIXM or to a format where it can be converted into AIXM.



Stereo Airfield Collection Extraction Manual
V 1.0

1 February 2006

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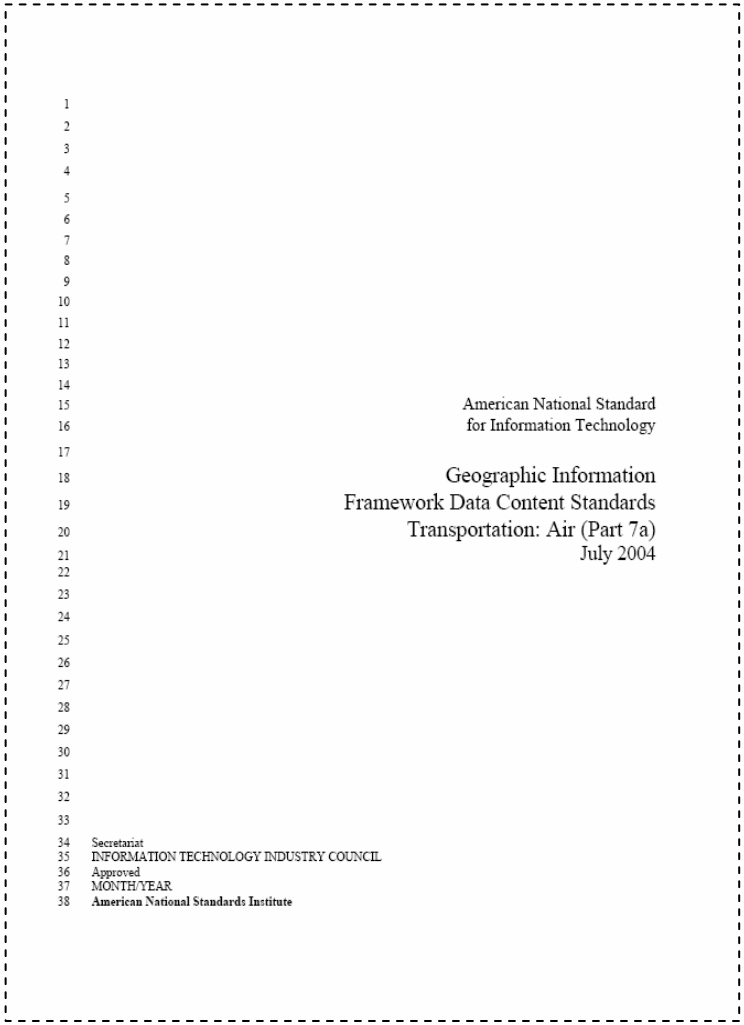
GeoEye Standards Development

- DOT G-O-S AirMAT
  - Driven by needs to supply FGDC with data on all National Geospatial Information
  - Blend of FAA and Industry Teams
  - Similar one for Highway, Rail, Marine, Mass Transit.
  - Airspace is specifically excluded from model.
  - DD is Co-Author



American National Standard
for Information Technology

Geographic Information
Framework Data Content Standards
Transportation: Air (Part 7a)
July 2004

Secretariat
INFORMATION TECHNOLOGY INDUSTRY COUNCIL
Approved
MONTH/YEAR
American National Standards Institute

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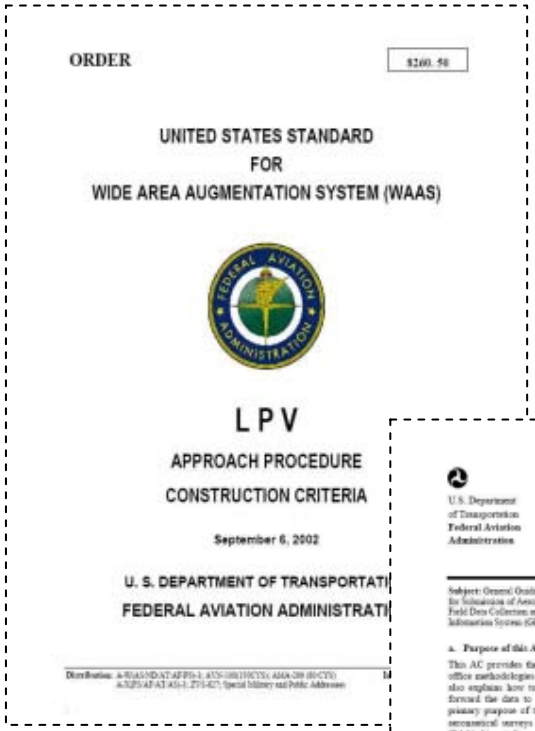
GeoEye Standards Development

- FAA Electronic ALP
  - GIS replacement for the original RTCA AC-150/5300 paper standard.
  - Initial focus is basic Planimetric Features for Airport Master Plans as pair for by FAA Trust Funds.



ORDER

$260.50

UNITED STATES STANDARD
FOR
WIDE AREA AUGMENTATION SYSTEM (WAAS)

LPV
APPROACH PROCEDURE
CONSTRUCTION CRITERIA

September 6, 2002

U. S. DEPARTMENT OF TRANSPORTATI
FEDERAL AVIATION ADMINISTRATI

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: General Guidance and Specifications for Submission of Aeronautical Surveys to NGS: Field Data Collection and Geographic Information System (GIS) Standards

Date: 3/29/2006
Initiated by: AAS-100

AC No: 150/5300-18

a. Purpose of this Advisory Circular (AC).

This AC provides the specifications for the collection of airport survey data through field and office methodologies in support of aeronautical information and airport engineering surveys. It also explains how to submit data to the Federal Aviation Administration (FAA), which will forward the data to the National Geodetic Survey (NGS) for quality control purposes. The primary purpose of these general guidelines and specifications is to list the requirements for aeronautical surveys conducted at airports in support of the Federal Aviation Administration (FAA) Airport Surveying–GIS Program. The FAA's Office of Airport Safety and Standards (AAS-1) administers this program. The surveys covered in this document provide critical information to the operation and safety of the National Airspace System (NAS) and are classified as critical by the International Civil Aviation Organization (ICAO). ICAO defines data as critical when "there is a high probability when using corrupted critical data that the continued safe flight and landing of an aircraft would be severely at risk with the potential for catastrophe." The information furnished under these standards includes runway and stopway data, navigational aid (NAVAID) data, obstruction data, and data on various airport features, including taxiways, aprons, and landmark features. Most of this information is source data, which is acquired by field survey and/or remote sensing methods.

b. Application.

FAA and the NGS Aeronautical Survey Program (ASP) recommend the guidance and specifications in this AC for all airport projects. This AC describes an acceptable means, but not the only means, of collecting and submitting airport survey and Geographic Information System (GIS) data in support of aeronautical information surveys. Airport projects receiving Federal grant-in-aid assistance must use these standards. At certificated airports, the guidance and specifications may be used to satisfy specific requirements of Title 14, Code of Federal Regulations (CFR), Part 139, Certification of Airports.

David L. Bennett
Director, Office of Airport Safety and Standards

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GeoEye Standards Development

- Eurocontrol AIXM
  - Joint European and FAA standard for complete Aeronautical Mapping.
  - Initial Focus is international NOTAMS, expects to become the new standard for all AIS database.
  - Uses XML and GML
  - Version 5 will also include Airport Mapping and Terrain & Obstacle Mapping.
  - GeoEye is participating with FAA and Eurocontrol in implementation testing.

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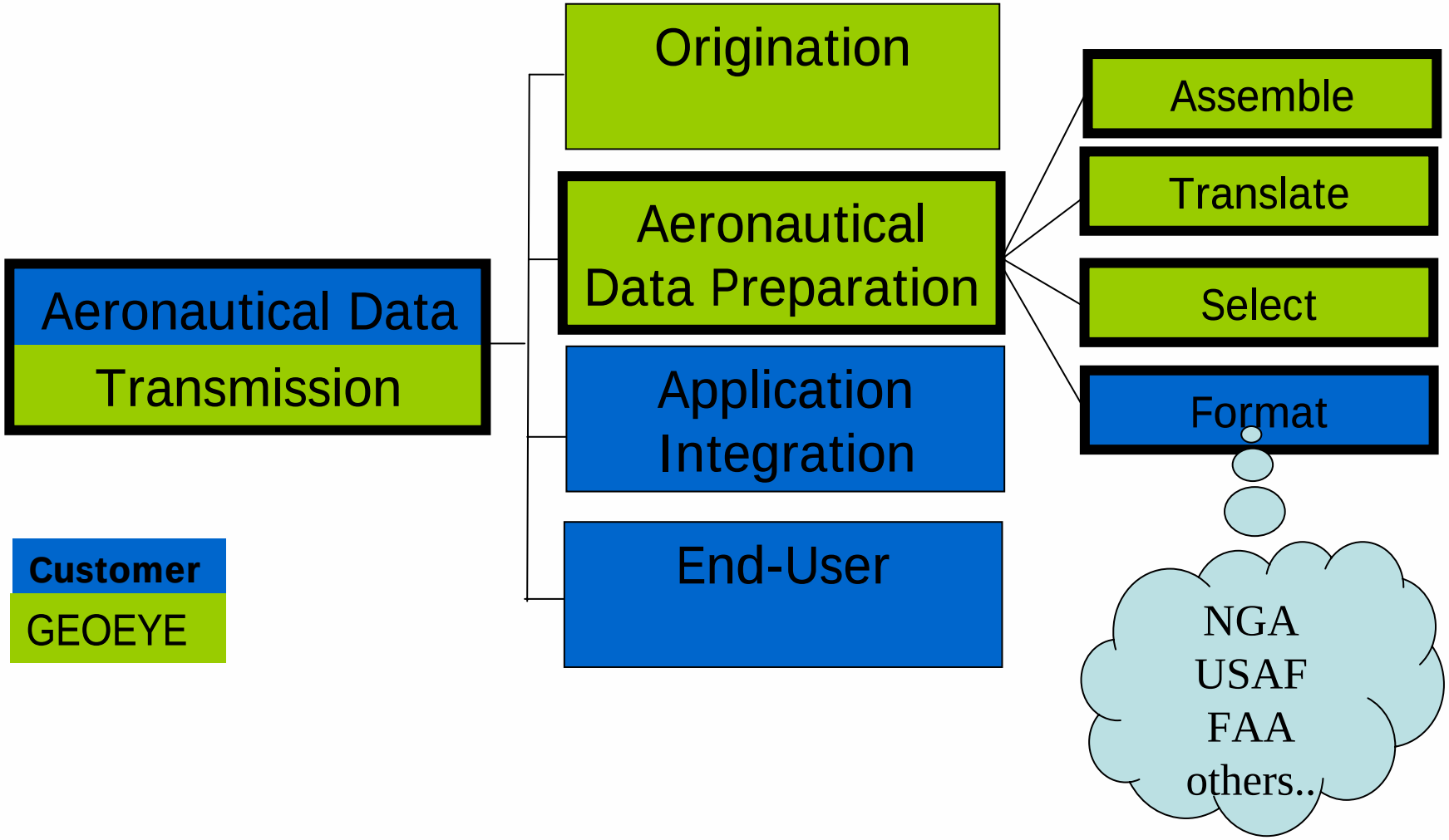
Everything in support of DO-200A!



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• DO-200A Quality Requirements

- Compliance Plan
- Defining Data Quality Requirements
- Aeronautical Data Processing Requirements

1. Process procedures
2. Data Alteration Communication
3. Configuration Management
4. Skills and Competencies
5. Tool Qualification

- Quality Management

1. QM Procedures
2. QM Control
3. Reviews (event driven, periodic)
4. Records
5. Management Reviews

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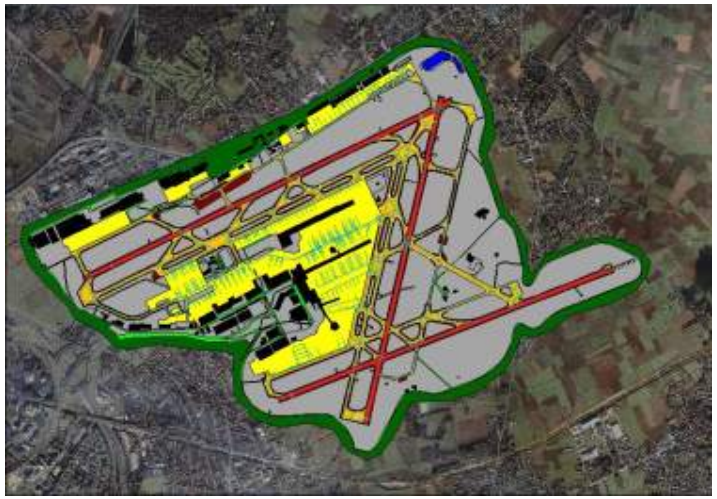
GeoEye Airfield Mapping Projects

- Commercial
  - Jeppesen
  - IATA
  - LACAC
- DoD/Government
  - USAF
  - NGA
  - Australian Air Force
- Total built or under construction in 1Q2007 – **1,000+**



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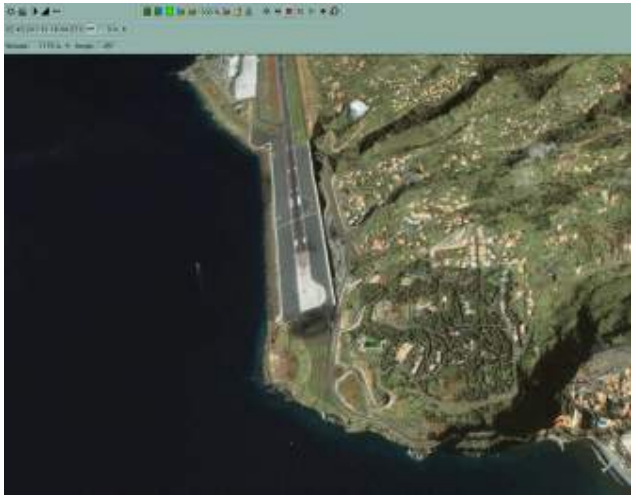
Commercial: IATA

- Project Scope
  - Top 3,000 worldwide
- Project Standards
  - DO-272, E-ALP
- Project Application
  - Electronic Flight Bag, RNP Migration, Taxi Charts, Aerodrome Charts, Vis-Sim, Engine-Out, FOQA



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LACAC Project Details

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What is the problem?

- Commercial Aviation's Global Problem
  - For anyone who has flown on commercial airliners regionally, nationally or internationally in the past decade or more, it is a common occurrence to be involved in delays". While there are a great many complex reasons for "delays," the vast majority can be boiled down to a simple problem – too many aircraft in too small of an area.

- If we look a little bit deeper into this problem, we can quickly segregate that into:
  - "In-Flight Delays" involved in flying from airport to airport.
  - "Ground Delays" involved in taxiing to and from the runway.

- In order to safely allow aircraft (or helicopters) to move on the airport surface or fly in and out of the vicinity of an airport, we need to allocate a certain amount of buffer space known as a "Containment Region", to avoid collisions. The faster the aircraft moves, the larger this containment region needs to be. It's not just avoiding being the same 3D place as the other aircraft, but at the same time in the same 3D place – hence a 4D problem.

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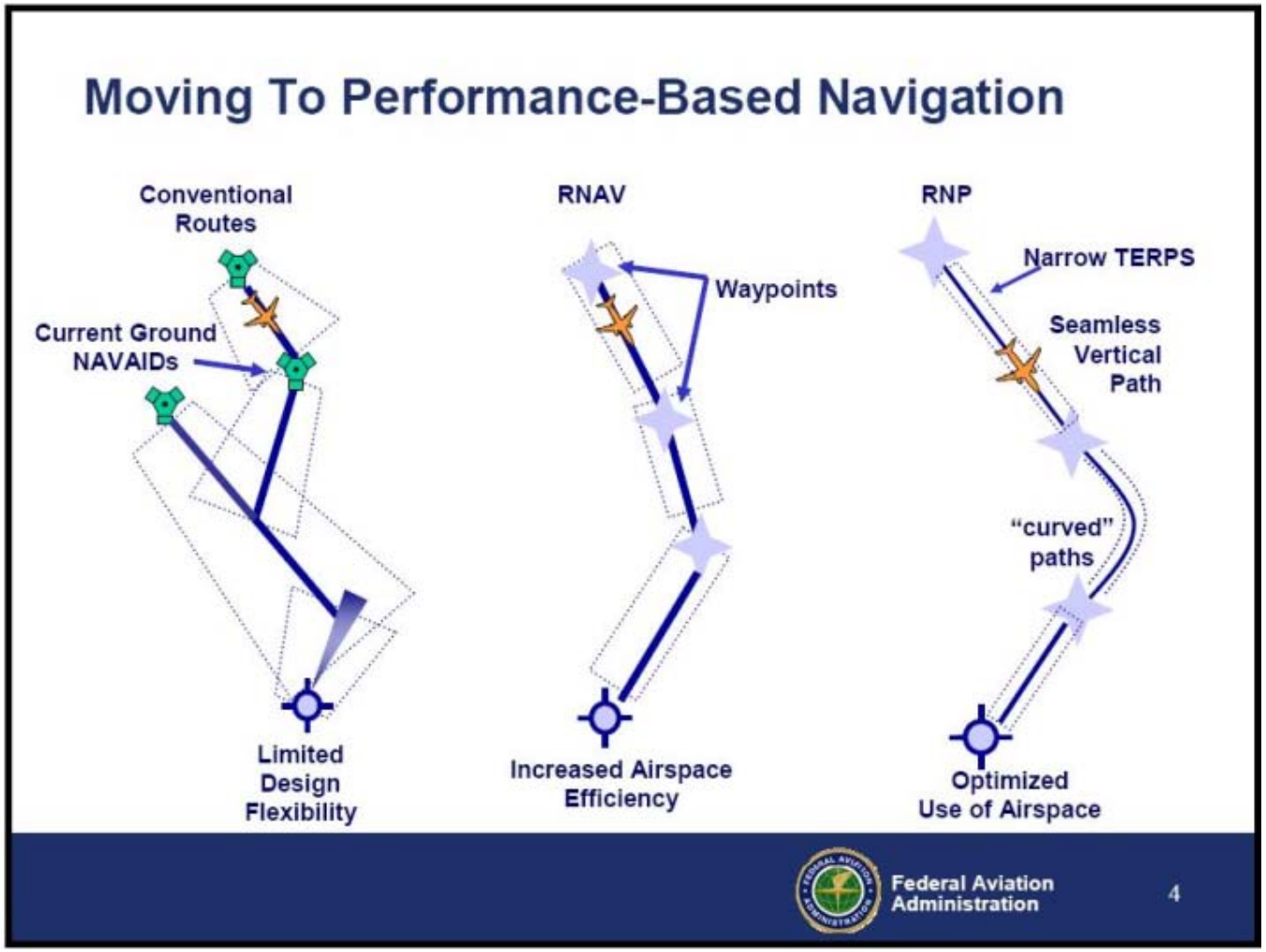
What is the better way?



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Small Containment, more planes

RNP RNAV Type	Applicability/ Typical Operation	Normal Performance 95 Percent Accuracy (nautical miles)	Airborne Containment Region (nautical miles)	Hazard Class (Misleading Information/Loss of Navigation)
RNP – 2 RNAV	En route	2	± 4	Major / Minor
RNP – 1 RNAV[1]	Terminal Area	1	± 2	Major / Minor
RNP - 0.3 RNAV	Approach	0.3	± 0.6	Major / Minor

- RNP requires aircraft, gps receiver, autopilot, procedure, crew training to all match as a total system with a total navigational "net" performance to achieve the savings in time, and with smaller "containment" regions, more airplanes per hour in the same space.
- Any aircraft that does not meet all of the above will just require more containment, hence fewer per hour at the given airport.

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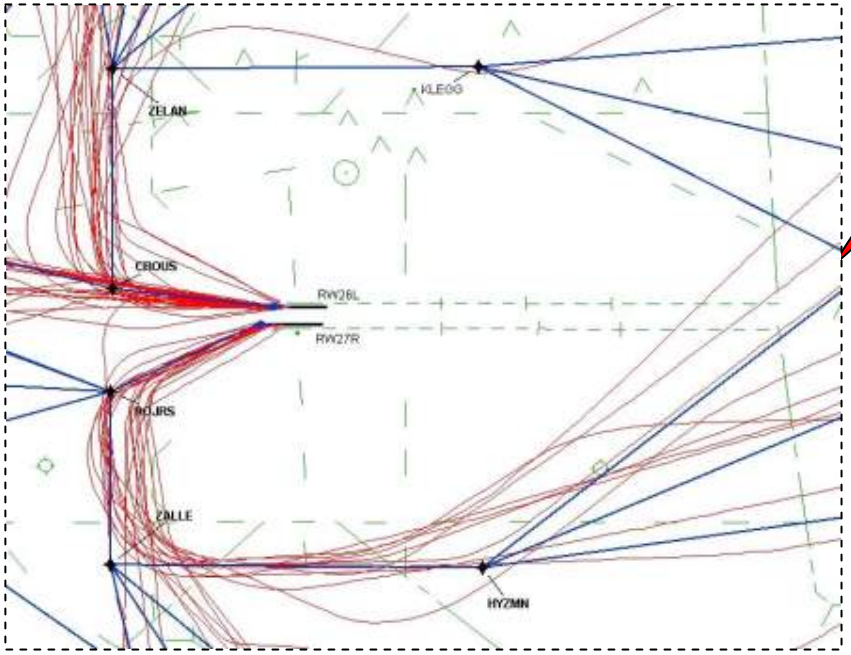
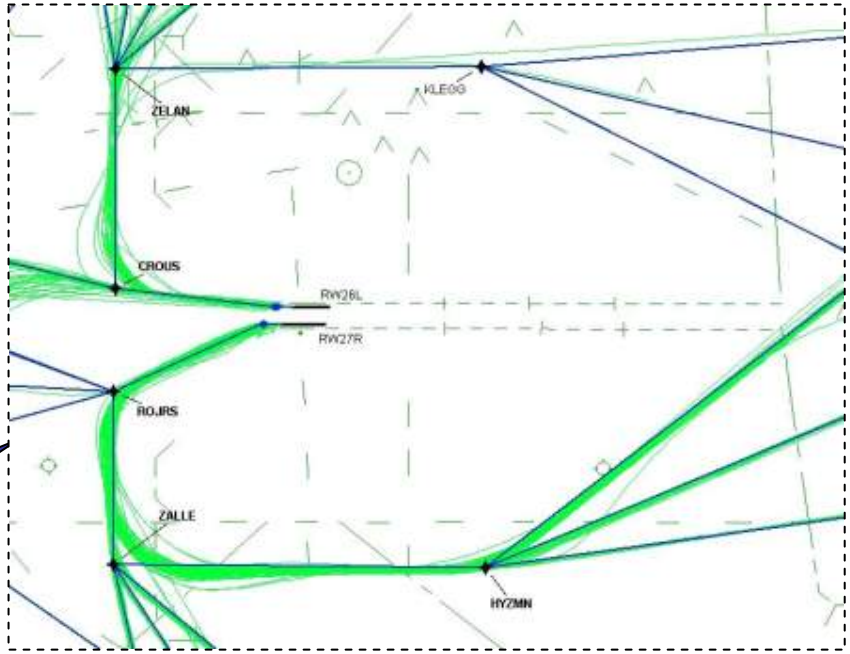
What is the better way?



Old way!



New way!

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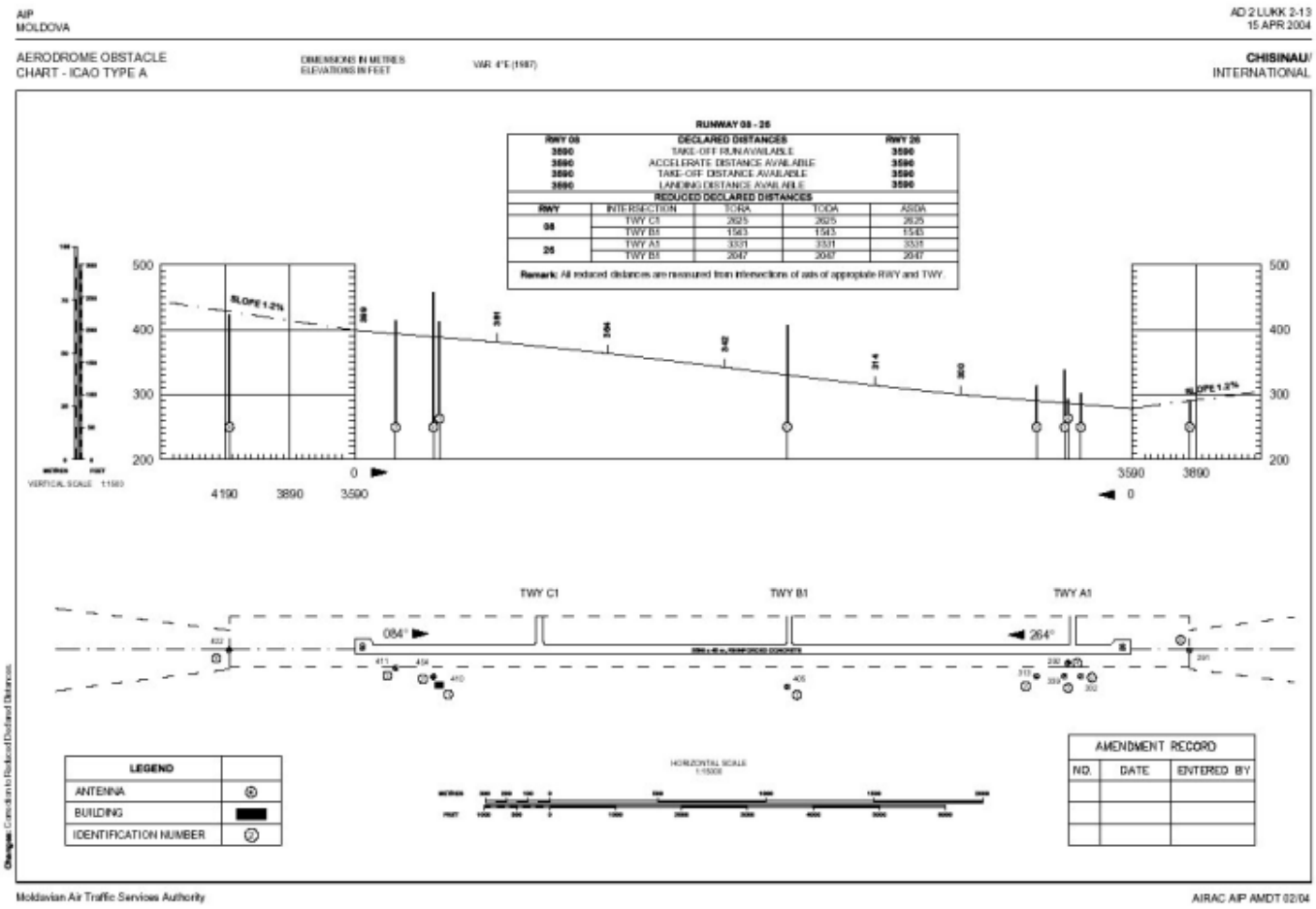
Example of Obstacle Chart



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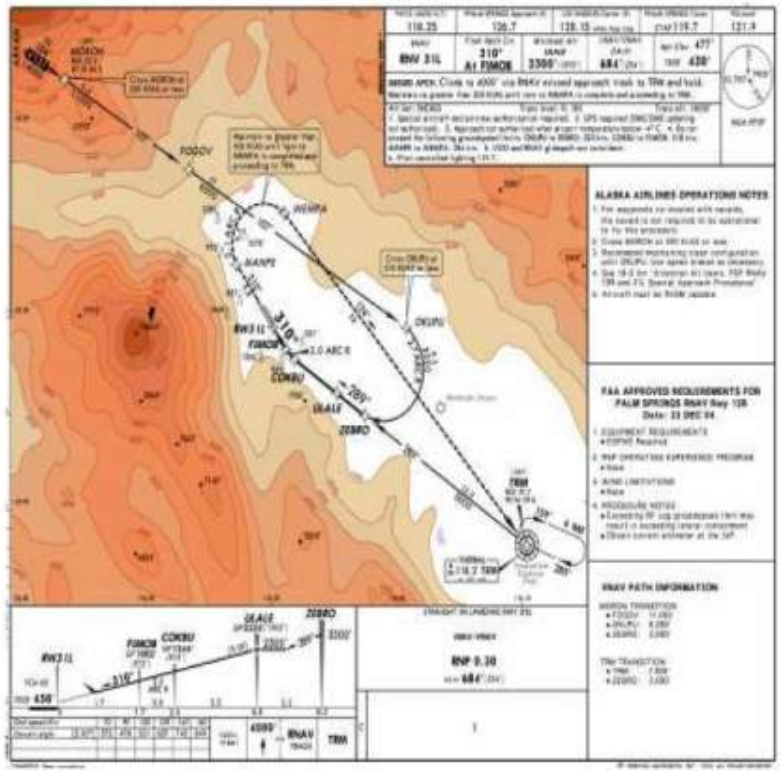
Example of RNP Procedure

Palm Springs RNP SAAAR Approaches (31L, 13R)
(January 2005)



- Replaces non-precision approach into the valley with mountainous terrain
- Safety enhancement, with guided, stabilized 3D path to runway
- Reduced time & distance (30-40 miles)
- "VOR or GPS B" minima is 2300 - 3
- RNP SAAAR minima 684 - 1
- Cancellations and diversions avoided
  - 24 flights diverted/cancelled in 6 weeks before implementation
  - 20 "SAVES" since implementation
    - A SAVE is a flight that would have been canceled or diverted if the RNP procedure was not available

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Overview

- Project Region
  - South America
- Project Standards
  - DO-272, E-ALP
- Project Locations
  - 13 Hazardous Airports in South America for Latin American Civil Aviation Commission *(LACAC).
  - Baranquilla, Bogota, Cali, Cartagena, Medillin,Guyaquil, Quito, Montevideo, Asuncion, La Paz, Santa Cruz, Lima, Trujillo.

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Project Short-Term & Long-Term

- Partners are American Airlines, ISI, IATA and GEOEYE
- Initial Funding by US Trade & Development Agency (USTDA).
- GPS/GNSS Airport Surveys – will allow implementation of GPS/RNP/VNAV approaches!
- Uses GeoEye Product Family:
  - (1) Stereo Imagery
  - (2) Digitial Elevation Models (DEM)
  - (3) Airport Mapping Databases (AMDB)
- Eventually some 75-100 airports all over South America could qualify for this type of effort.

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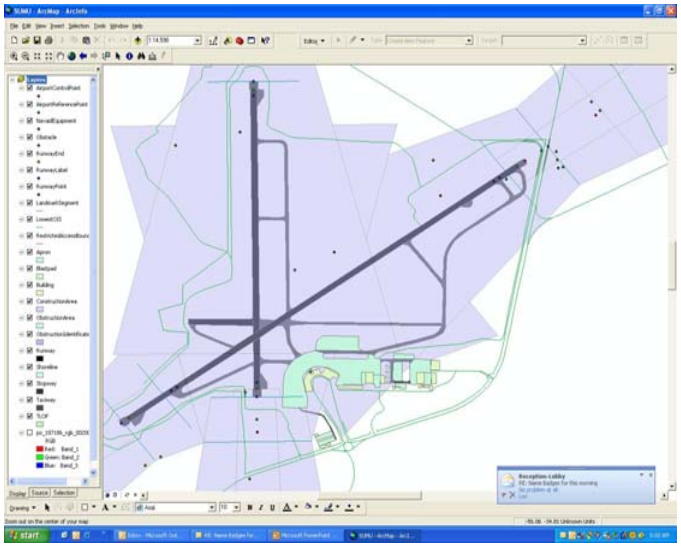
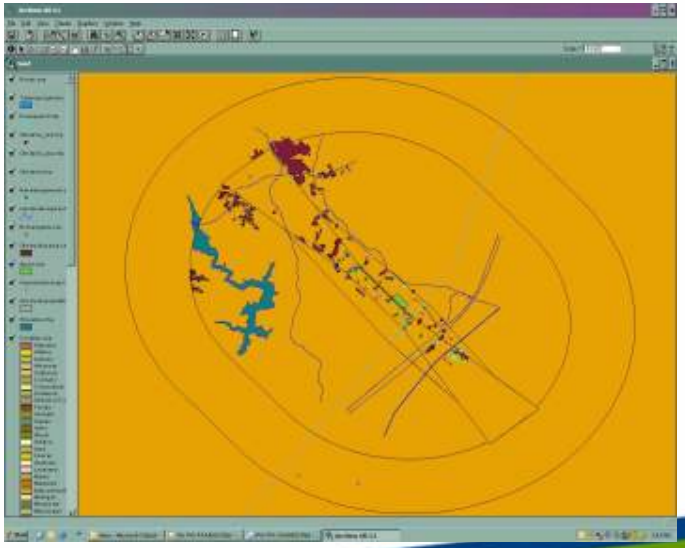
Commercial: LACAC

- Sequence of Events:
  - Ground Control of Runway Ends
  - Stereo Photogrammetry collection with IKONOS
  - Block Adjustment of Imagery to Gronud Control points.
  - Digital Elevation Model creation with SOCET SET. Headsup Digitizing with SOCET SET of airport features.
  - Obstacle Analysis with CLEARFLITE extension to SOCET SET.
  - Review of all data by Procedure Designer to determine suitability.
  - Development of GPS or RNP Procedure by Procedure Designer.
  - Flight Testing by local Civil Aviation Authority or Airline.
  - Publication into national Aeronautical Information Publication (AIP) for ICAO regulation compliance.





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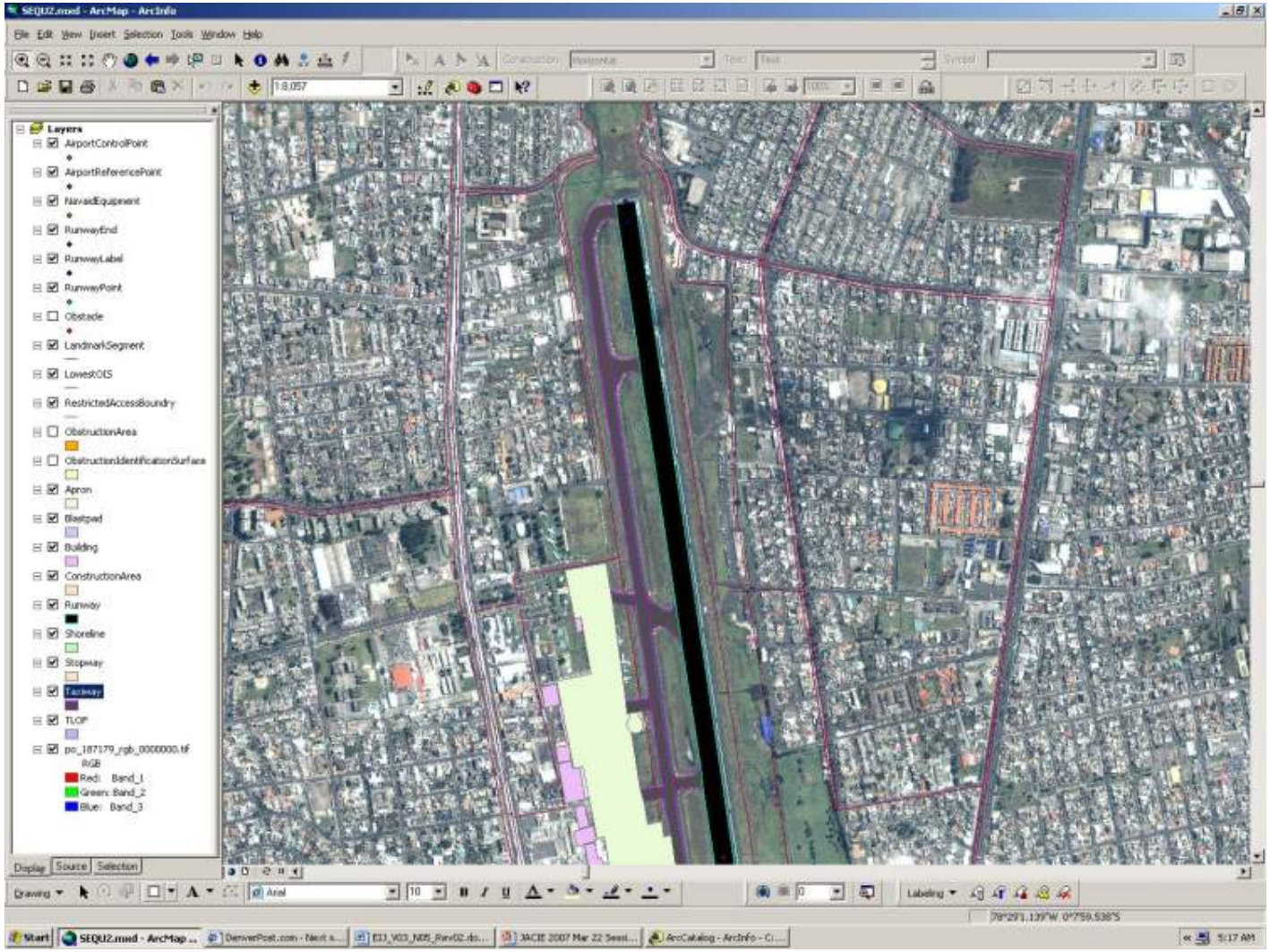
SEQU – Quito, Ecuador



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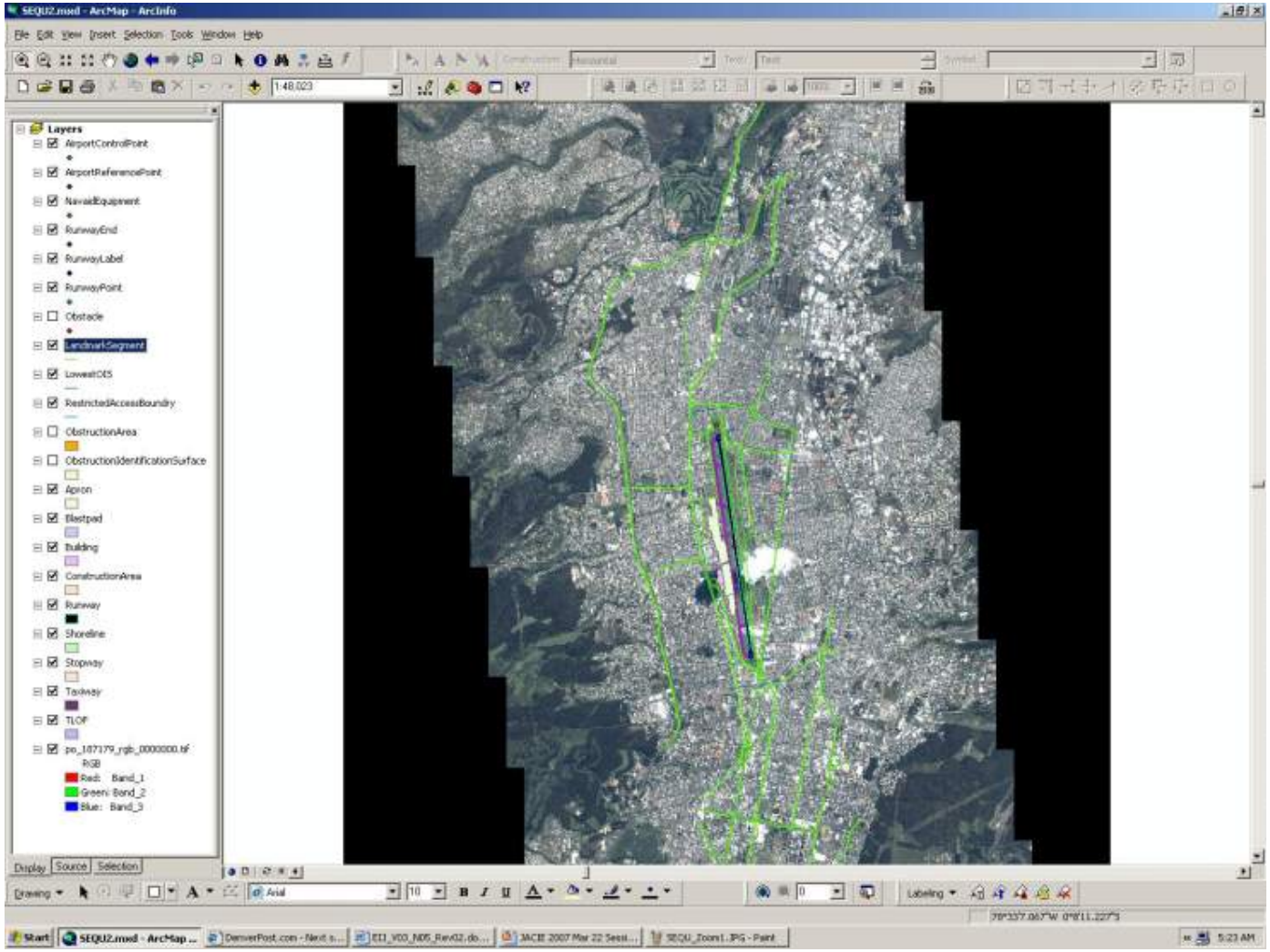

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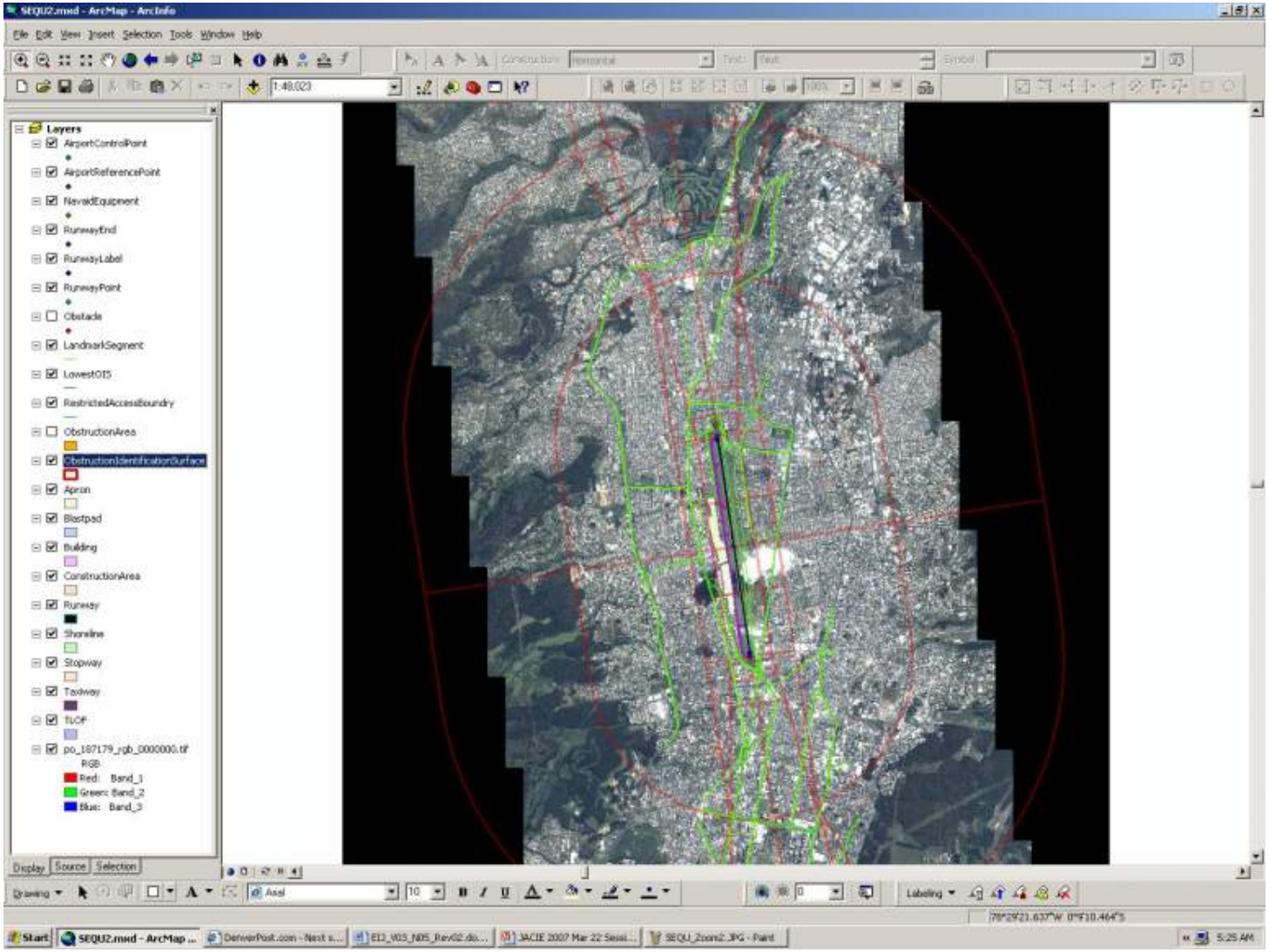

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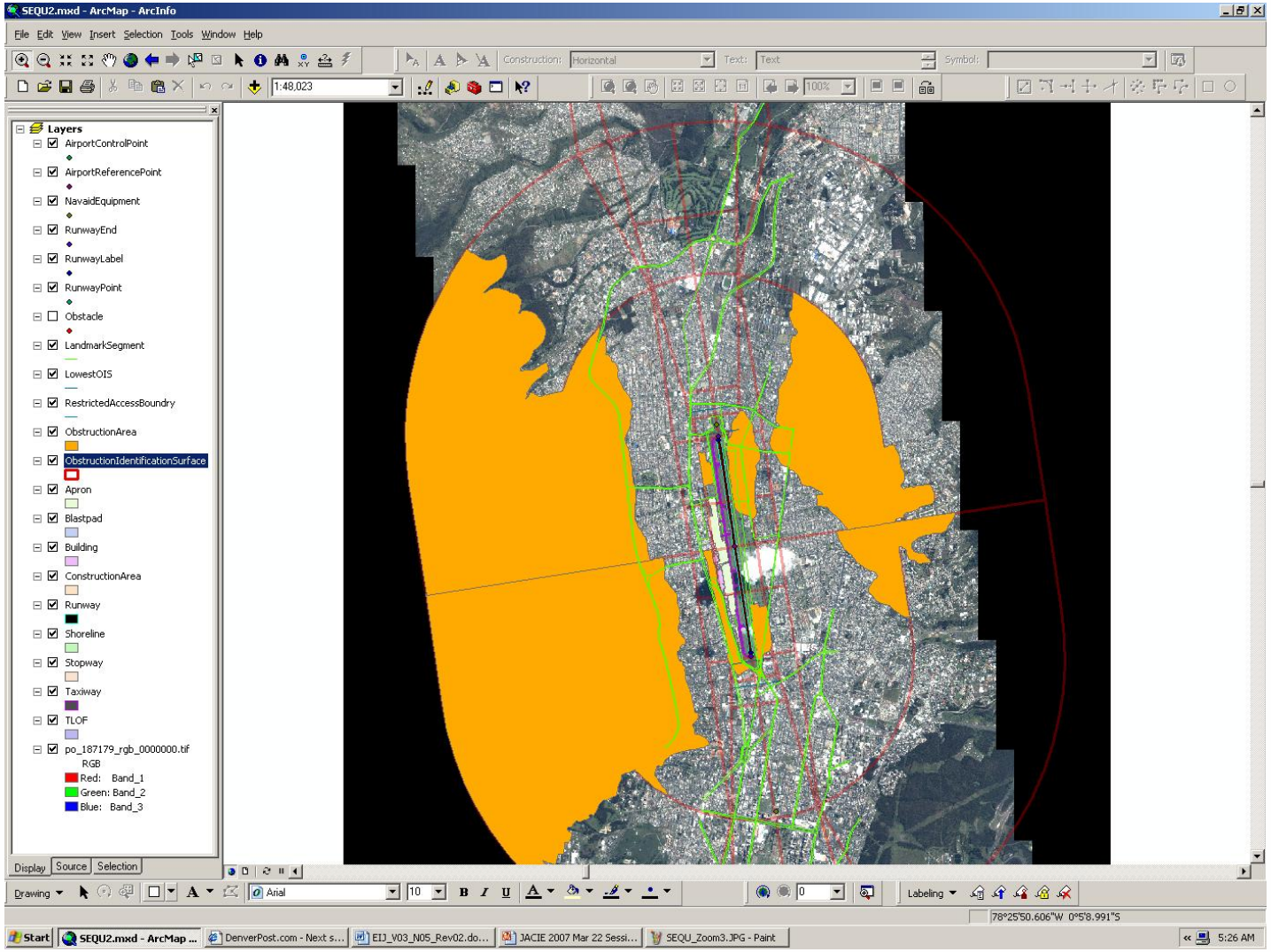

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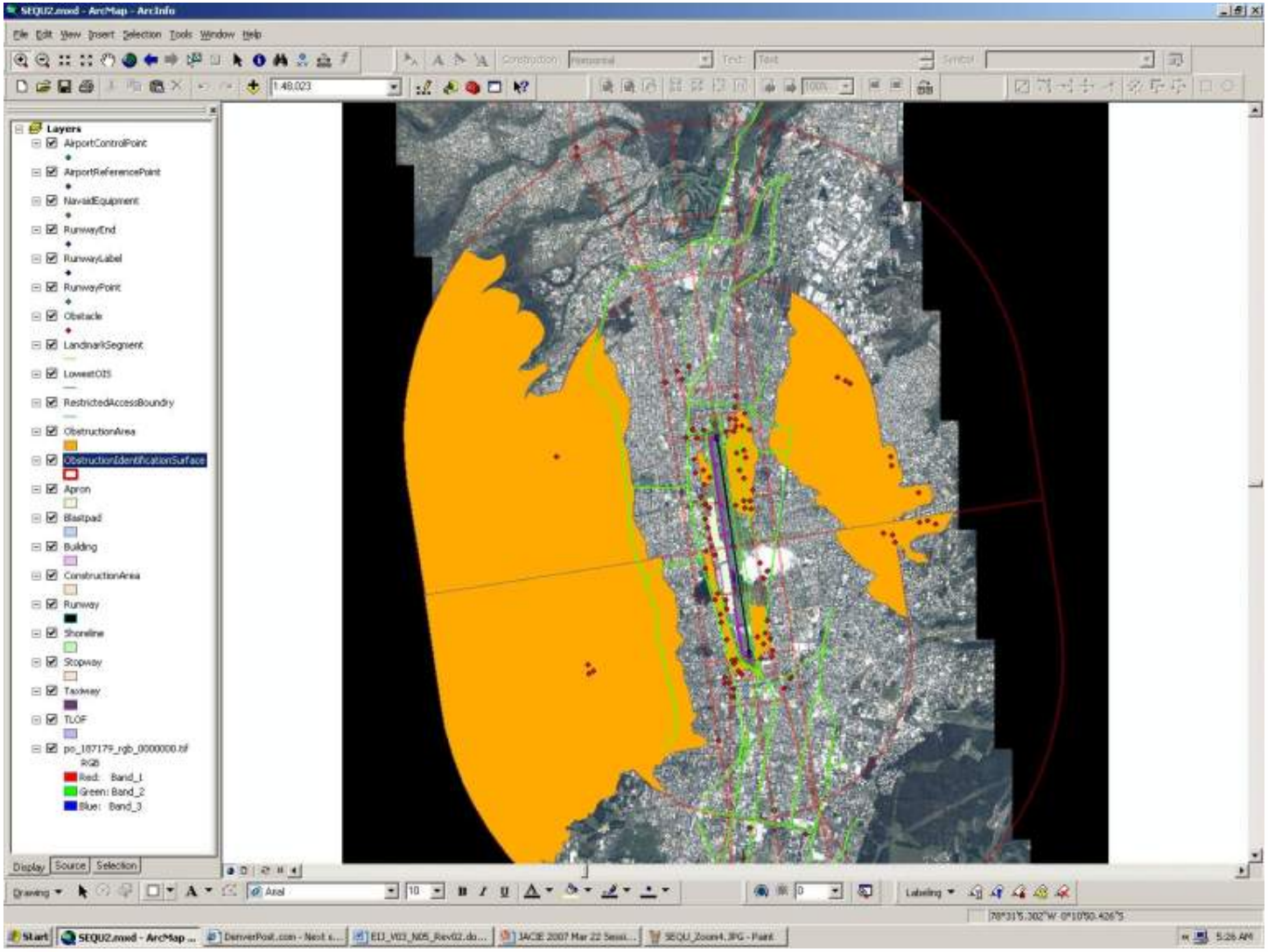

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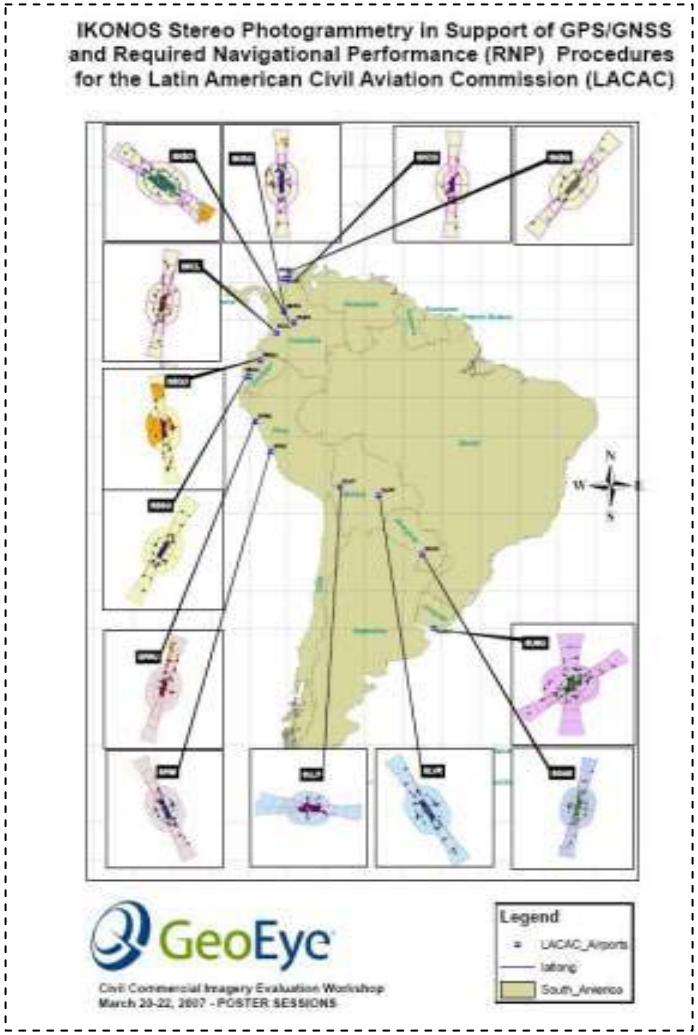
Lessons Learned

- Ground Control is essential to obtain sub-meter geolocation of runways.
- WGS-84 local implementation is sketchy in some countries.
- Challenging Terrain requires significant editing to complete DEM.
- Satellite resolves cloud issues by frequent revisit to obtain Stereo Imagery to fit required area of interest.



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