

# Civil Commercial Imagery Evaluation Workshop



## **EROS B Satellite – Capabilities and Services**

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**Owners and Operators of the EROS Family  
of High-resolution Imaging Satellites**

# The Remote Sensing Market



Some of them are already in space orbit  
Some of them are still in Power-Point orbit...



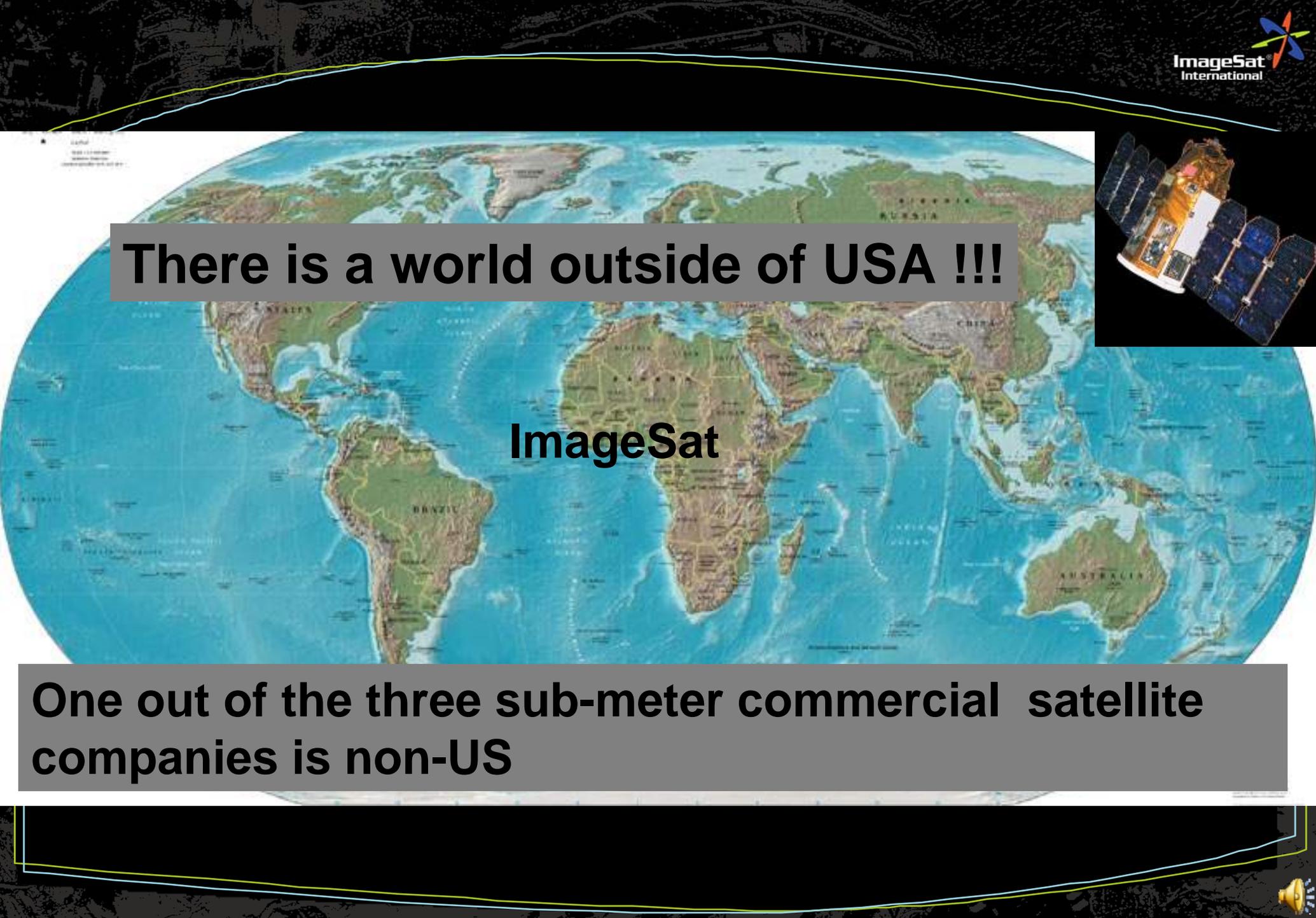
Do you want to know a secret ?

Do you promise ~~not~~ to tell ?



**(The Beatles)**





There is a world outside of USA !!!



ImageSat

One out of the three sub-meter commercial satellite companies is non-US

# The User's Mission

To have sufficient assured access to space-based capability to maximize and sustain **defense effectiveness** across **National security**.

**OR**

To have sufficient assured access to space-based capability to maximize and sustain **civilian applications effectiveness** across the **market**.

# Satellites Classification

Group name	Wet Mass	
■ Large satellite	>1000kg	
■ Medium sized satellite	500-1000kg	
■ <b>Mini satellite</b>	<b>100-500kg</b>	} <b>Small Satellites</b>
■ Micro satellite	10-100kg	
■ Nano satellite	1-10kg	
■ Pico satellite	0.1-1kg	

## Small Satellites

Small satellites have reached  
level of capability which are  
military relevant  
(And civilian market relevant...)

# EROS SATELLITES AT A GLANCE



Parameter	EROS A	EROS B
Sun-synchronous Orbit	~ 500 km	~ 500 km
Spectral Bands	Panchromatic	Panchromatic
Resolution (m)	1.9 m Standard	0.7 m standard
Weight	250 Kg	290 Kg
Launch/Life Expectancy	2000-2010	2006-2016

# EROS B – New Bird in Space

- On April 25, 2006, ImageSat successfully deploy the new very high-resolution commercial imaging satellite – EROS B.



Russian START-1 Launcher



# EROS B



## EROS B



Small and light weight: 2.3 m height, 290 kg.

Launched on April 25, 2006

# EROS B SATELLITE



Hydrazine Thrusters

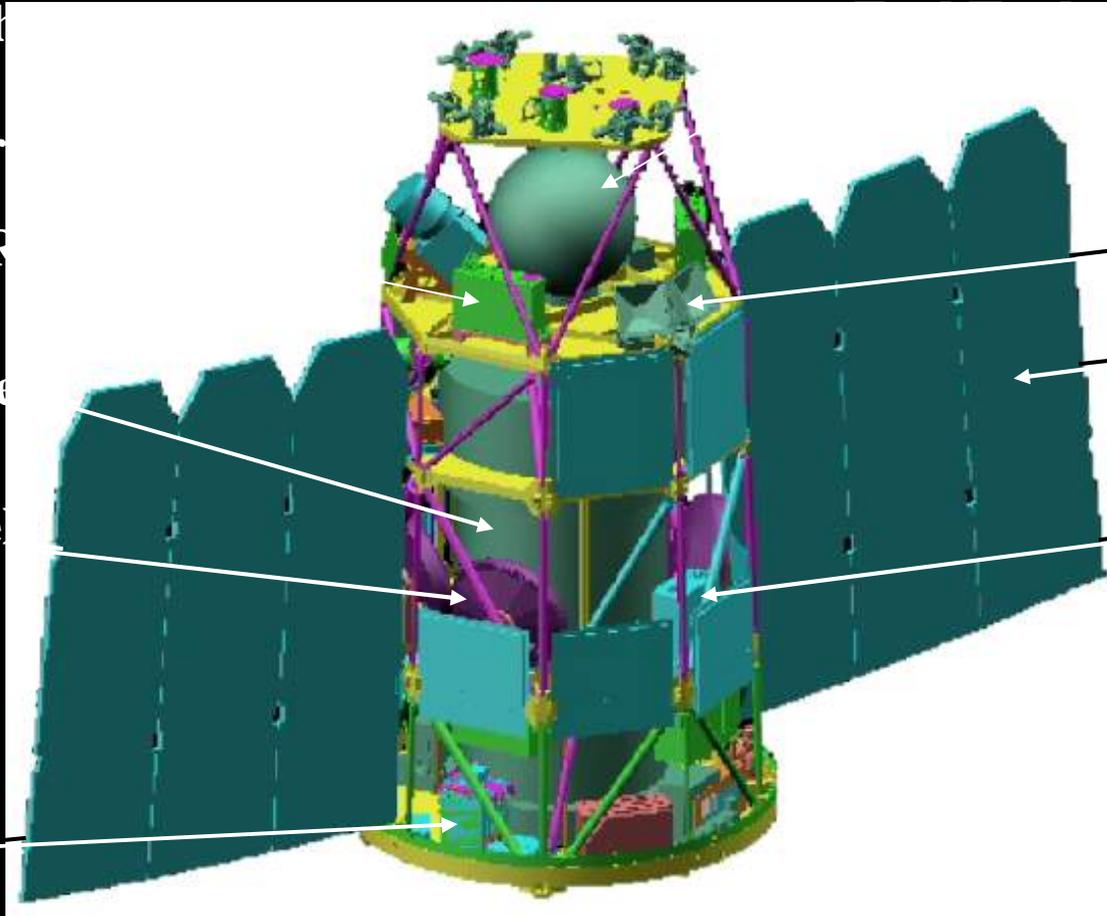
Star Tracker

GPS Receiver

Telescope

Reaction Wheel

Video Transmission Unit



Sun Sensors

Solar Array

Central Computer

Ground Command and Control Antenna

The background of the slide is a composite image. At the top, two satellites are shown in orbit above the Earth's horizon. Each satellite has a bright searchlight beam directed towards the ground, illuminating a specific area. The Earth's surface is visible in shades of blue and white, representing the atmosphere and land. The overall scene is set against a dark, starry space background.

## *Imaging Capabilities*



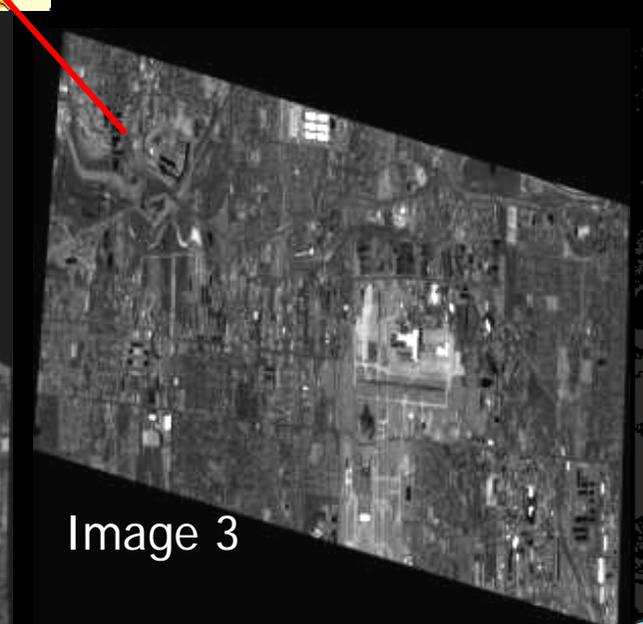
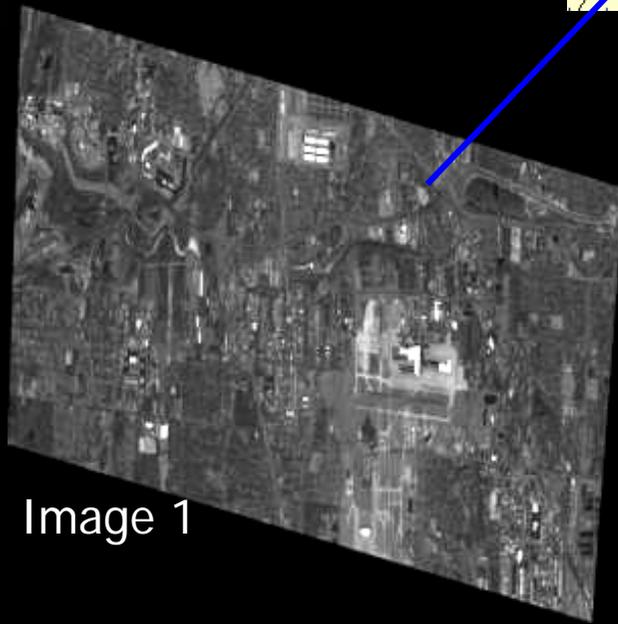
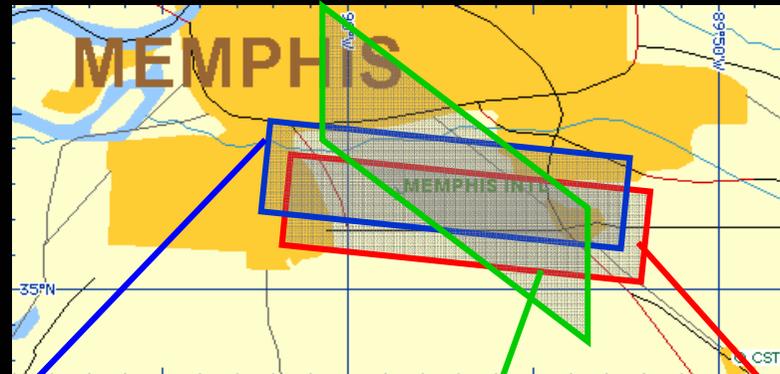
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# SINGLE-PASS STEREO IMAGING



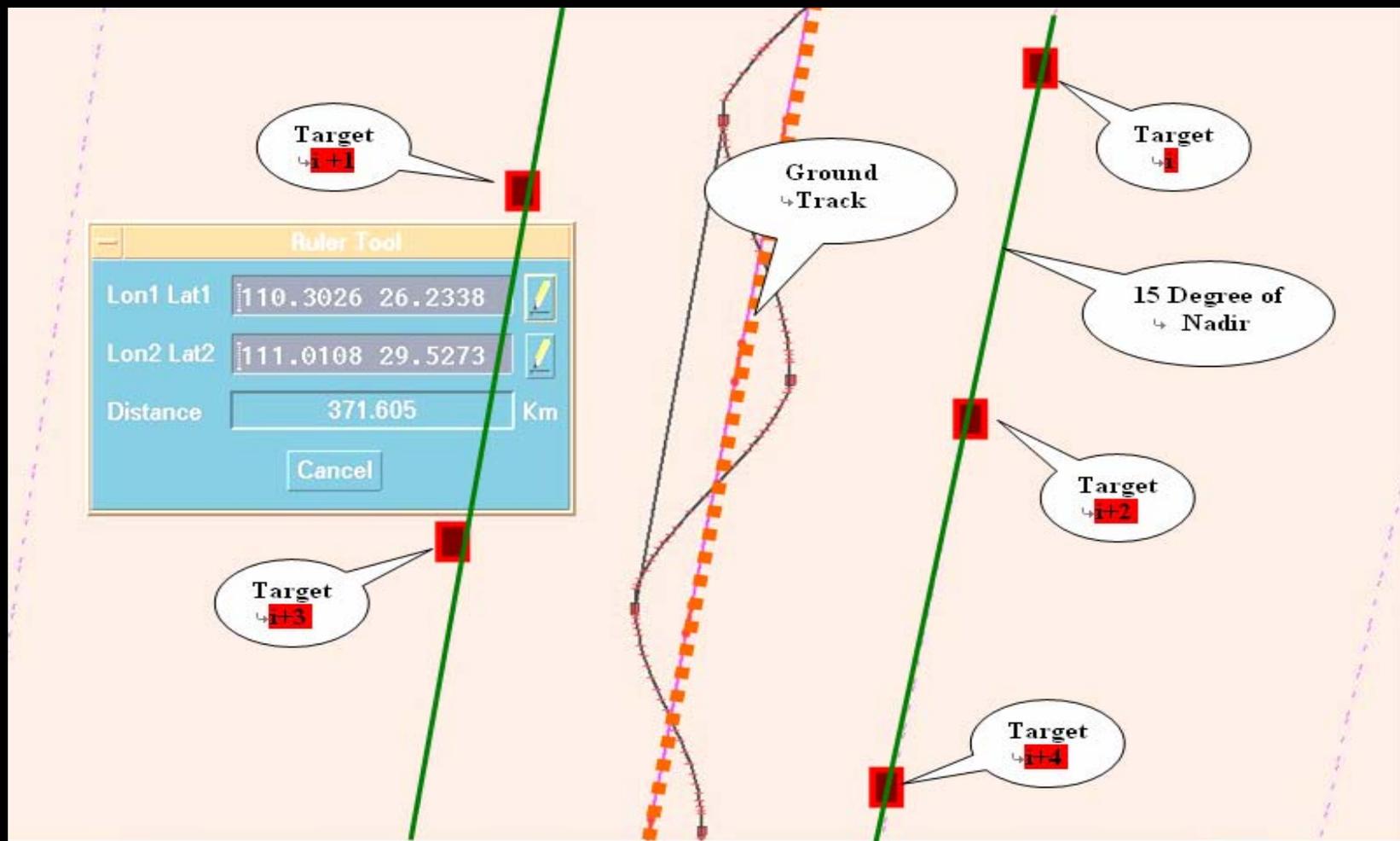
# SINGLE PASS Multi Images



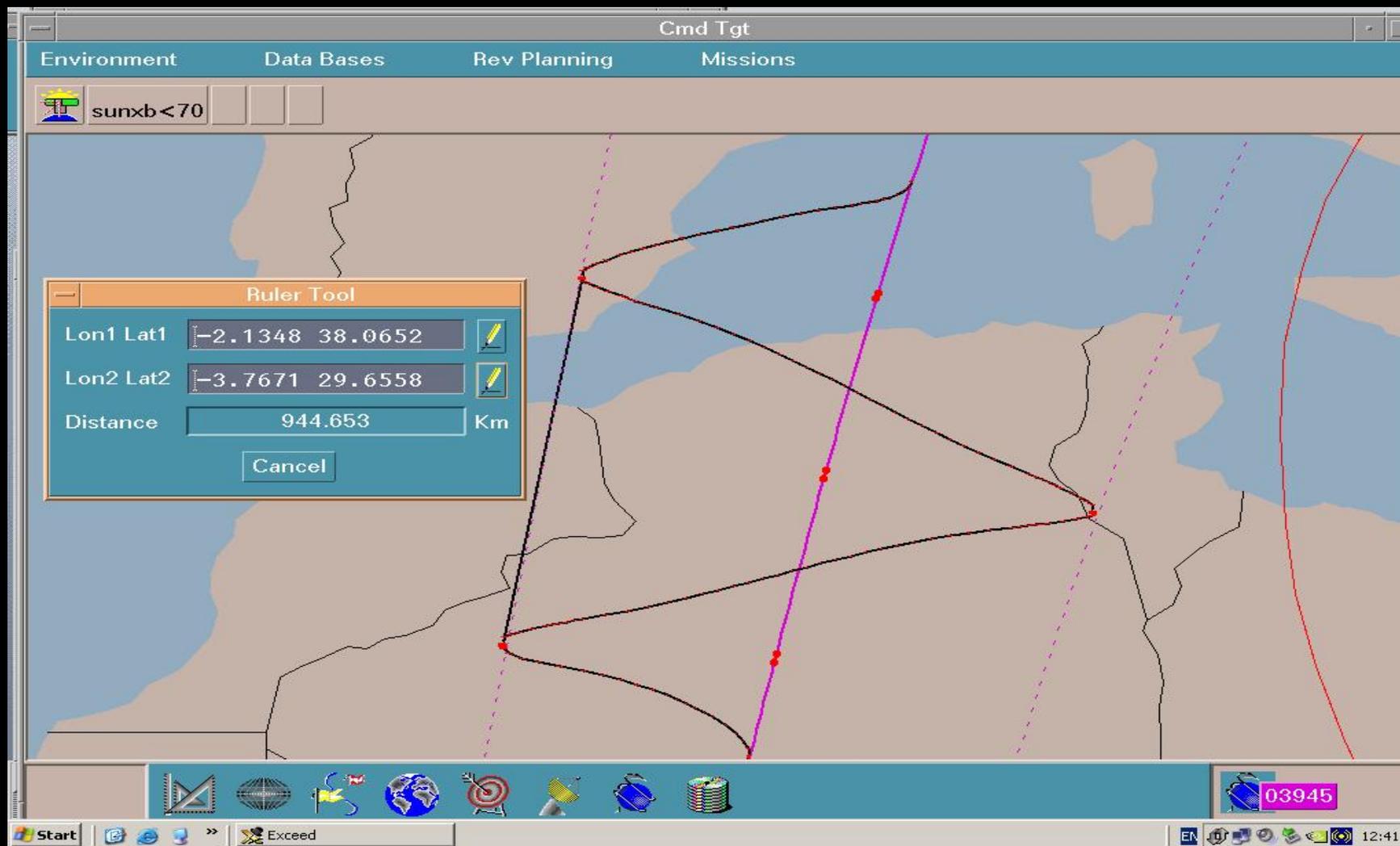
## Imaging Parameters

Scanning	Push-broom, maximum scanning rate of 2400 lines/sec
Imaging sunlight conditions	Sun-over-horizon angle more than 10°
Sensor type	CCD-TDI, Selectable 1,4,8,16,32,48,64,96
Spectral band	0.5 to 0.9 $\mu$
Sampling Depth transmitted	10 bits
Ground Sampling Distance	0.7 m at Nadir from 510 km for TDI stages 1,4
Swath Width	7 km at Nadir from 510 km
Systematic Geolocation Accuracy (CE90%)	Better than 50 meters
Pixel to Pixel relative accuracy (CE90%)	Better than 15 meters within 7x7Kms Scene

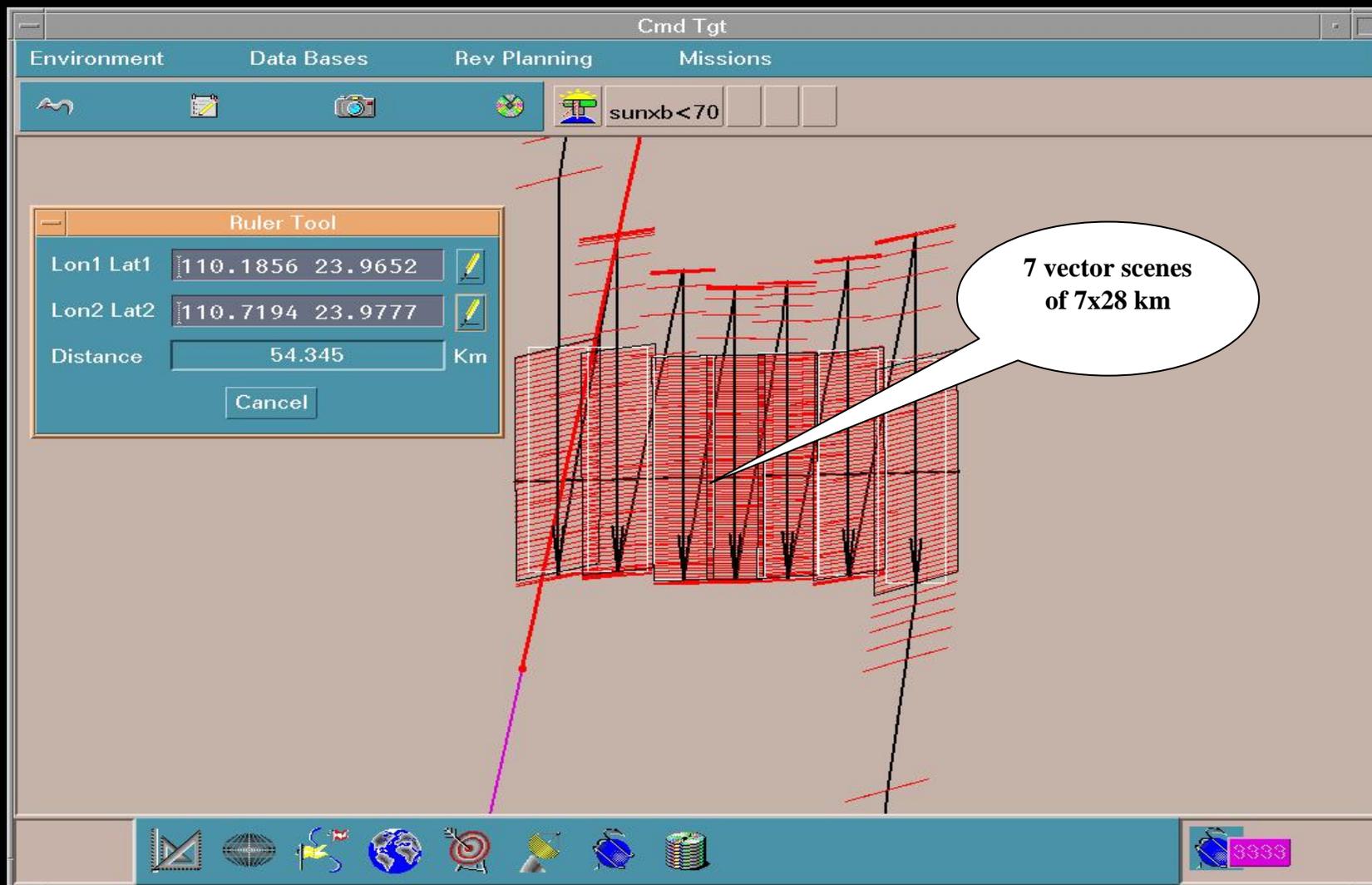
## 21 targets at $\pm 5$ degrees



# 8 targets at $\pm 45$ degrees



# Max. Mosaic- 28x50km@45°

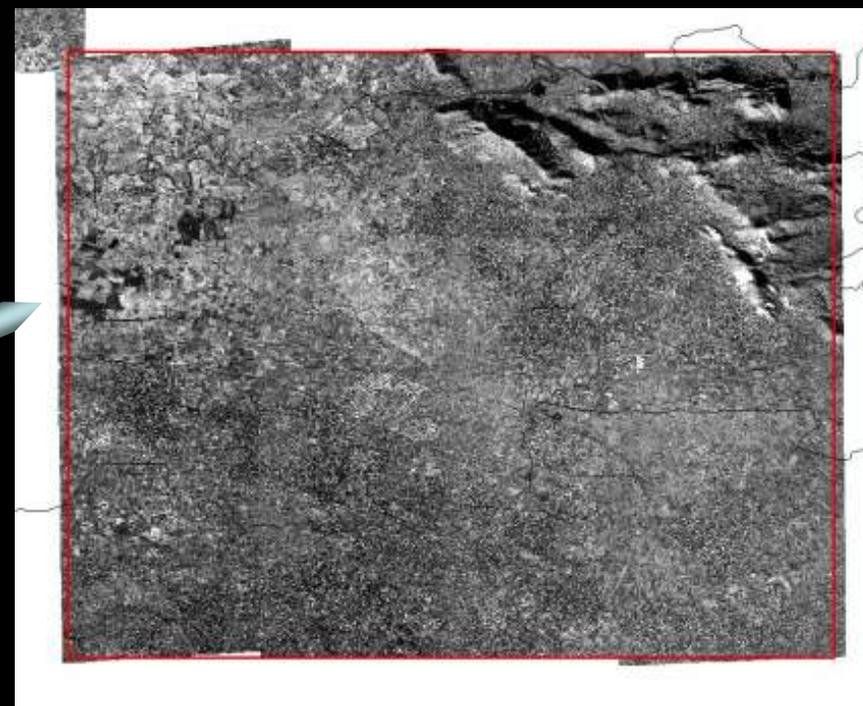
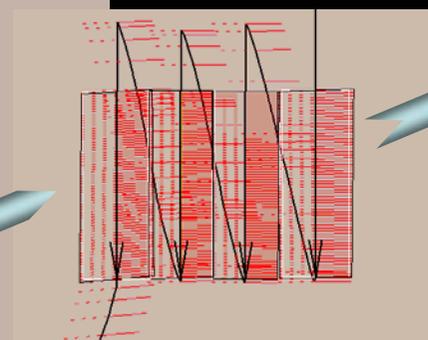
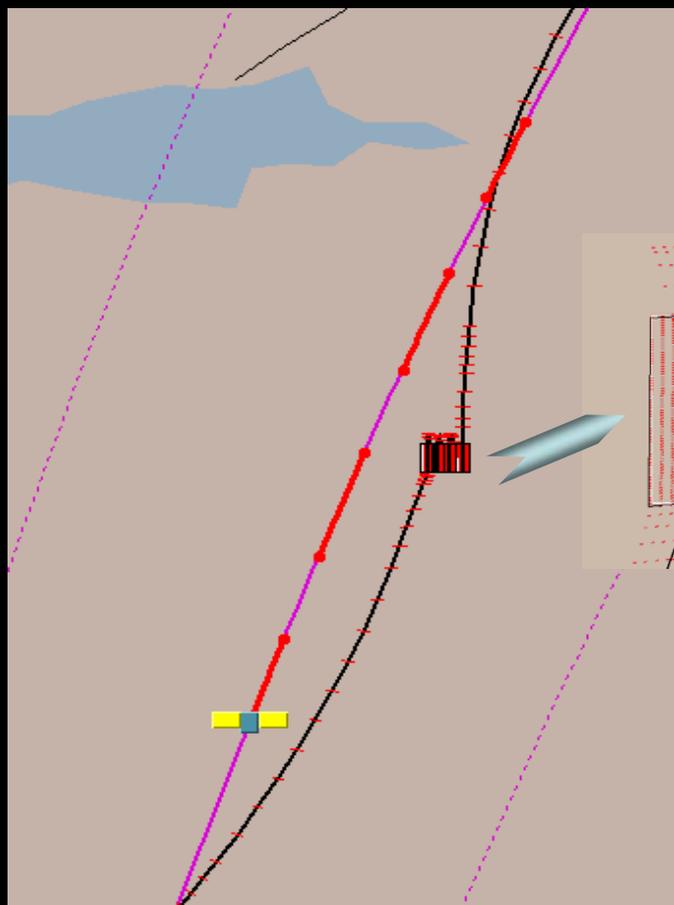


The screenshot displays the 'Cmd Tgt' window in the ImageSat software. The window has a menu bar with 'Environment', 'Data Bases', 'Rev Planning', and 'Missions'. Below the menu bar is a toolbar with icons for environment, data bases, camera, and a satellite icon. The main workspace shows a 3D view of a satellite's path and seven vector scenes, each represented by a red grid. A callout bubble points to these scenes with the text '7 vector scenes of 7x28 km'. On the left, a 'Ruler Tool' dialog box is open, showing the following data:

Ruler Tool	
Lon1 Lat1	110.1856 23.9652
Lon2 Lat2	110.7194 23.9777
Distance	54.345 Km

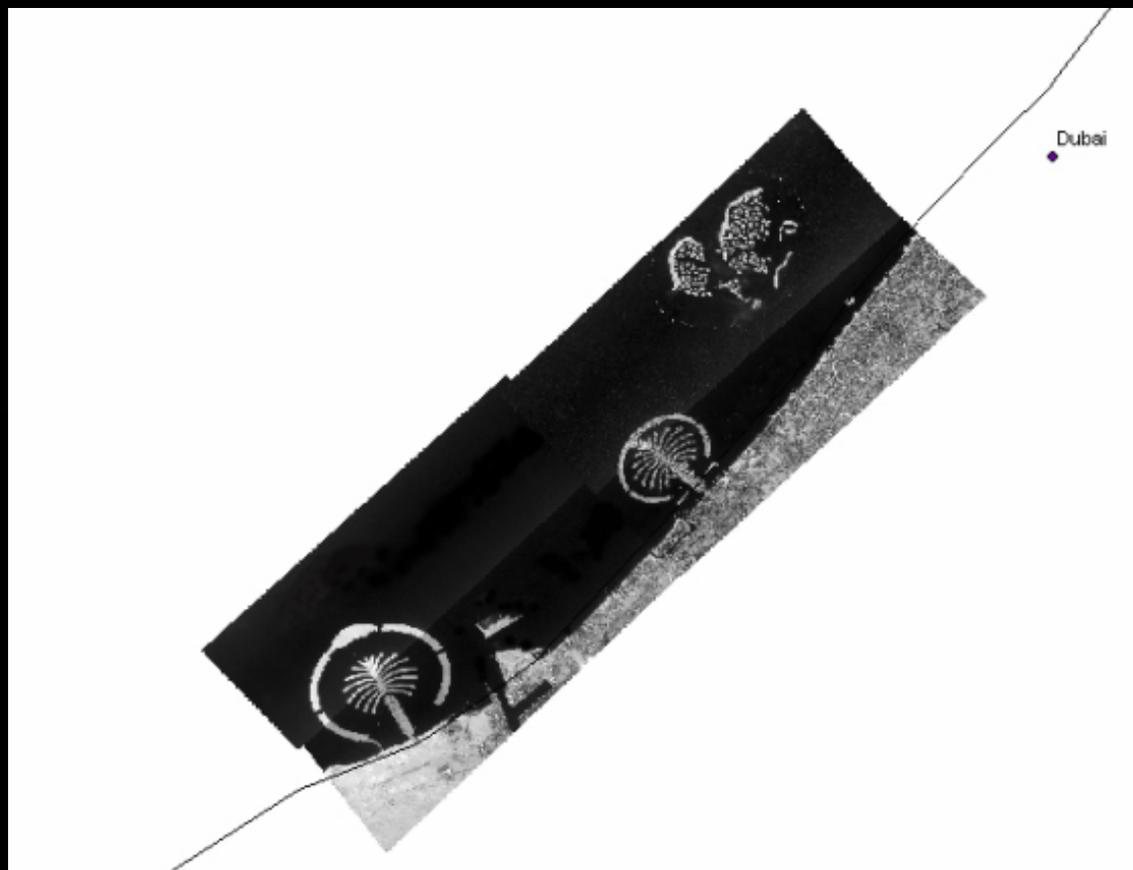
The bottom of the window features a toolbar with various icons, including a ruler, globe, camera, target, and a stack of data. A status bar at the bottom right shows a purple box with the number '3333'.

# Mosaics



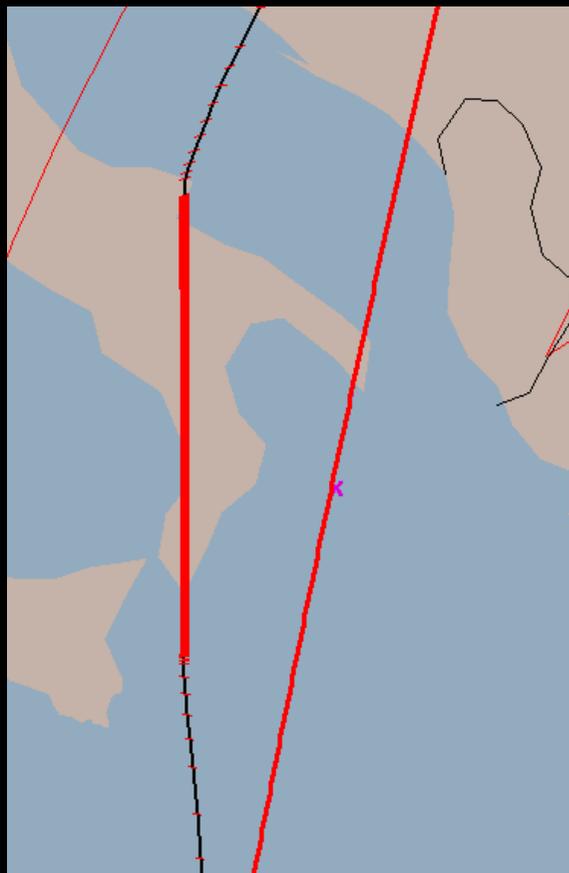
28 km x 27 km Mosaic

## Mosaic example



43.5 km x 13.8 km Mosaic

## Long strip imaging



Italy - 480 km strip

## Revisit

Imaging Angle	Mean response time	Mean Revisit Time
15 deg cone	5.2 days	9.5 days
30 deg cone	2.7 days	3.7 days
45 deg cone	2 day	2.1 days

The background of the slide is a stylized illustration of two satellites in orbit above the Earth. The satellites are depicted with solar panels and are emitting bright blue searchlight beams that illuminate a portion of the Earth's surface. The Earth is shown in a dark, high-contrast style, with the illuminated area appearing in shades of blue and white. The overall scene is set against a dark, starry space background.

## ***Processing Capabilities***



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## IPM – Image Processing Module

- A processing module developed in-house by ImageSat
- The IPM can create images of different processing levels
- The IPM is a simple to use, stand alone program, used by ImageSat personnel as well as ImageSat's customers

# IPM – Image Processing Module



**ImageSat IPM**

Display and input...  
\\CAS-INGAS-1\EROS-B1\2007\02\24\MB  
Browse  
Get INGAS Image Path...

Images...  
MBT1-e2046348.R0A  
Refresh  
Unselect  
Info...  
1A Preview  
1B Preview  
Anchor

Sat EROS-B1 Image BASIC

Preview  
Resample (m/p) 11.0 Gamma Default

Products generation and output...  
D:\1A&1B  
Browse  
 Write over Same as input...  
 0A  1A  1B  PASS  META  VCP  
 Use BASE  Save BASE  Use GCP for 1B  
GENERATE

Definition...  
 BER estimation LSBit 6 bits 2 grid size 5 mask  
 Fill single missing lines  
 Radiometric correction Gain & Offset  
 Overlap correction  
 Deconvolution

Partial image top left bottom right  
 Use pixels' rearrangement for "NATURAL" 2X HS  
 Interpolate 1A HS image ..... Lateral  
 ...Resample 1A (m) 1.20  
Resample 1B (m) Default Bicubic  
 Resample JPEG (m) 15.0 Bilinear

1A files 1B files  
 JPEG  RAW .1A  JPEG .1B  
 TIFF-8  GEOTIFF-8  
 TIFF-16  gamma  GEOTIFF-16  gamma

Reset Load base Save as... Save

Progress Elapsed

Close

## 0A Processing

- 0A is the raw file format, and is created from the raw telemetry data by the DAPS (Data Acquisition and Processing System).
- The 0A file contains all of the pixels as is, which were sampled by the camera, transmitted by the satellite, rearranged into 16bit/pixel format, and combined in one contiguous pixel stream.

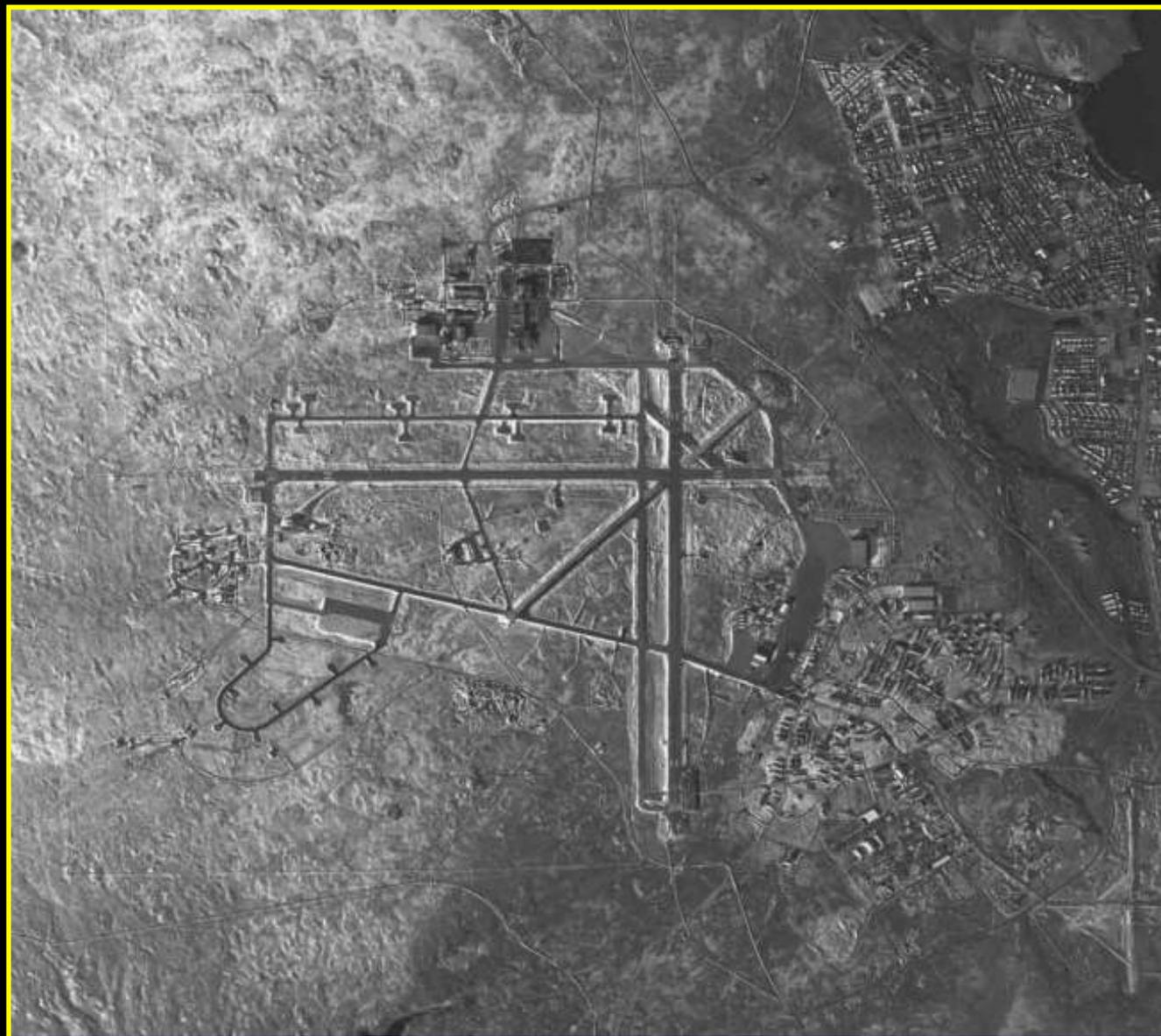
# 0A Processing



## 1A Processing

- 1A Processing “cleans up” the image:
  - Radiometric irregularities of the camera are corrected based on long term statistics of each cell of the sensor
  - Ruler separators and overlapping pixels are removed
  - Camera and Pushbroom deconvolution corrects the camera’s built-in distortion

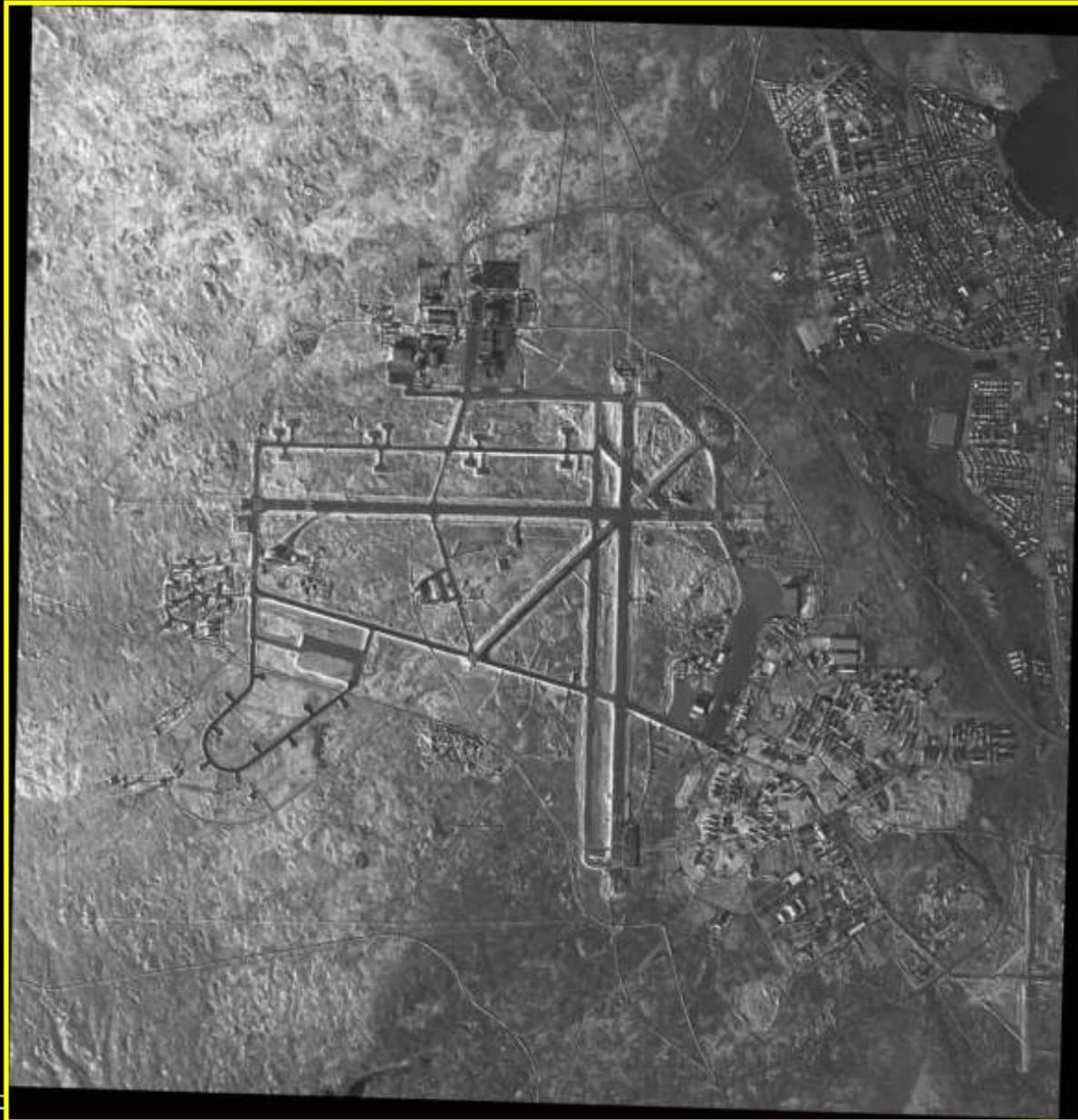
# 1A Processing

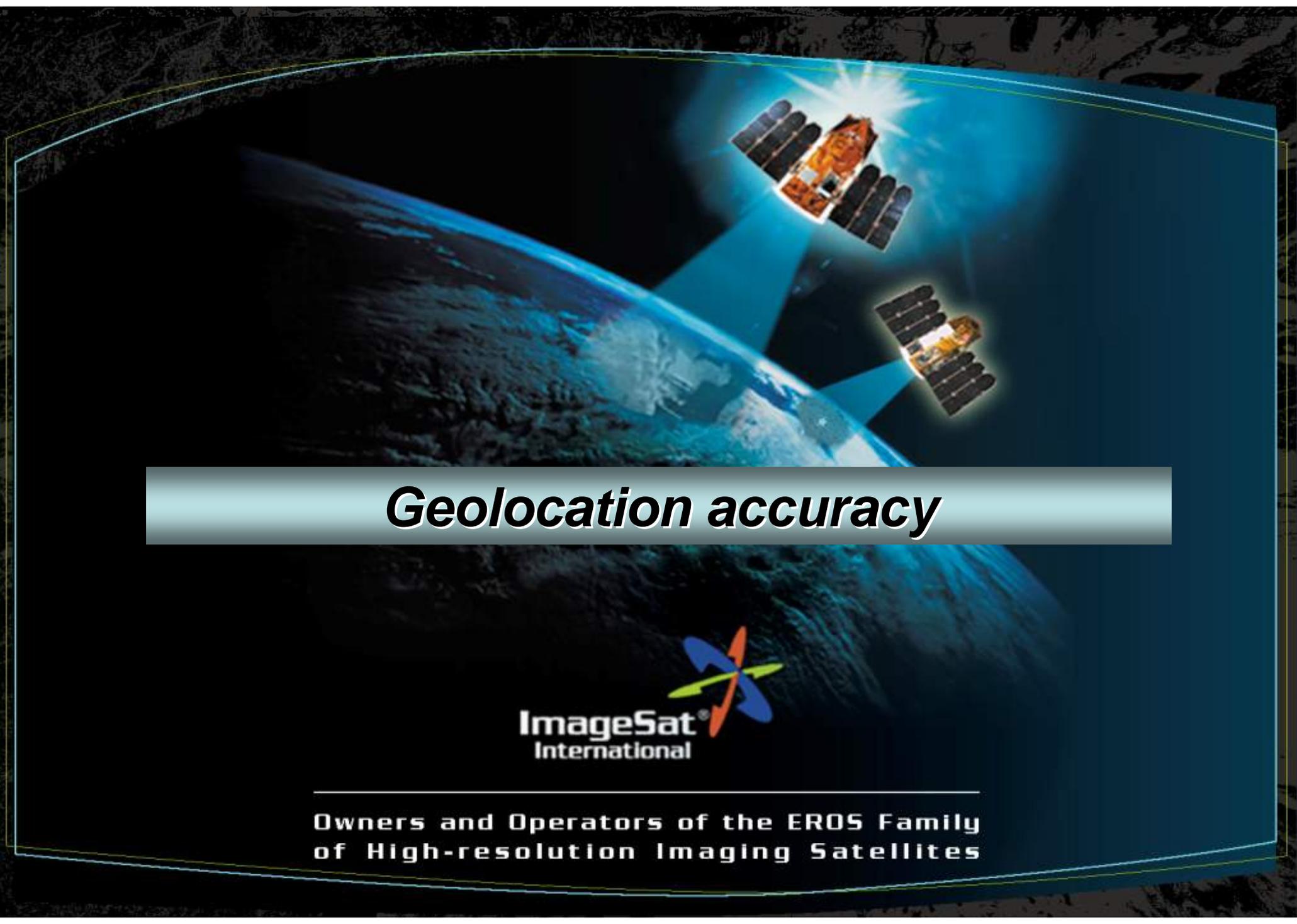


## 1B Processing

- 1B Processing corrects the image geometrically.
- After a 1A image is produced, the processing module resamples each pixel in its proper geographic orientation, based on the WGS84 reference frame.
- A 1B image has its geographic information stored within the image, such that it can be opened with a GIS program in its actual location and orientation.

# 1B Processing



The background of the slide is a stylized illustration of two satellites in orbit above the Earth. The Earth is shown as a curved horizon with a blue and white surface. Two satellites, each with a central body and four solar panels, are positioned in the upper right quadrant. From each satellite, a bright blue beam of light extends downwards, illuminating a specific area on the Earth's surface. The overall color palette is dominated by dark blues, light blues, and whites, with a slight glow around the satellites.

## ***Geolocation accuracy***



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## EROS Metadata

Two kinds of information (about the satellite and camera and about the line-of-sight) are encapsulated in two separate files that together defines the EROS metadata

### Pass file

The data in the EROS metadata file that is associated with the image (like rows and columns) is related to Level 1A processing. The metadata file has the extension “.pass”

### TQR file

Time, Q-vector (quaternions) and R-vector (spatial location of the Satellite).

## EROS Metadata - TQR

- **The TQR file contains at least a number of records equal to the number of rows in the image.**
- **Each record in the TQR file presents the followings:**
  - a) The Universal Time at the sampling moment of the specific row.**
  - b) Reference Coordinate System (RCS), the Q-vector and the Rvector are expressed in. The RCS can be either the Inertial Frame or the WGS84 Frame.**
  - c) DT1 (GMST correction) in seconds used for RCS.**
  - d) Four quaternions presenting the rotation from Camera Frame to RCS at the sampling moment of the specific row.**
  - e) Three Cartesian coordinates (in meters) in RCS presenting the spatial location of the Camera at the sampling moment of the specific row.**

# ImageSat-Company Overview



- **ImageSat International N.V is the owner and the operator of EROS satellites.**
- **ImageSat International is a Netherlands Antilles company**
- **Private company with share holders from Israel, USA and Europe**

The background of the slide is a stylized illustration of two satellites in orbit above the Earth. The satellites are depicted with solar panels and are emitting bright blue searchlight beams that illuminate the Earth's surface below. The Earth is shown in a dark, high-contrast style, with the atmosphere appearing as a thin blue layer. The overall scene is set against a dark, starry space background.

# *Services Overview*



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# ImageSat Services

**Exclusive services**  
**Tailor made services**

**SOP**



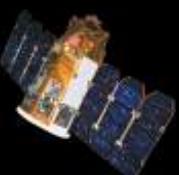
**EPOD**



**PAS**



**New acquisitions**

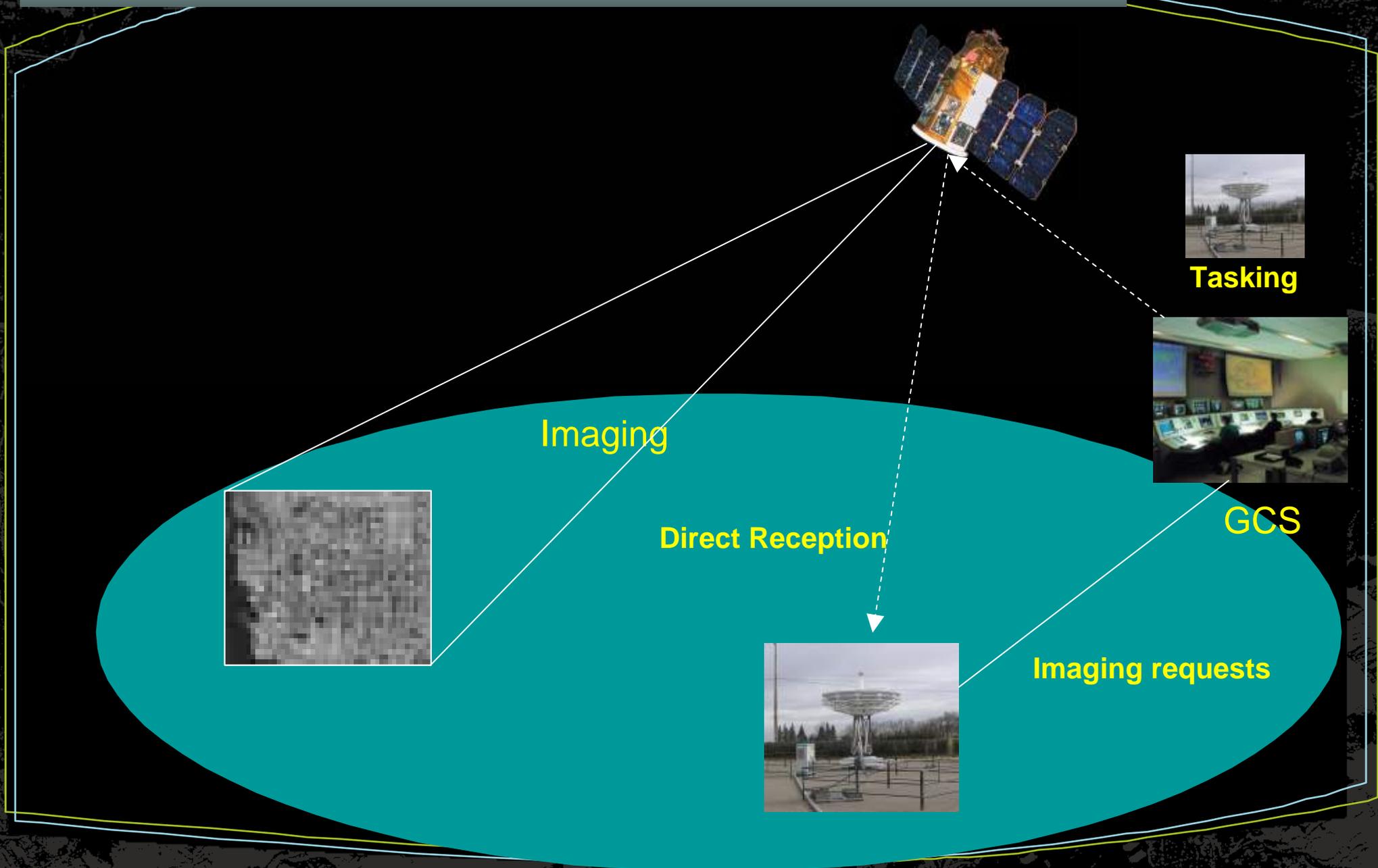


**Archive**

## Improving the “user access” to the products and services

- Enabling the user to operate the satellite (to control the camera) in a defined area (might be limited or worldwide). Give him direct access to the satellite and the data.
- Enabling the user direct reception of the data to his ground station.

# PAS Program-Direct Reception



## Direct Reception-Priority Acquisition Service (PAS)

- **Real Time** imagery reception
- **High priority** in Acquisition
- **Imaging opportunities** controlled by Customer
- **Notification** on each acquired image
- **Exclusivity** on Imagery (upon request)

# Real Time data for tactical use



## RAPIDS - Special Forces Exercise (6 Nov. 2004)

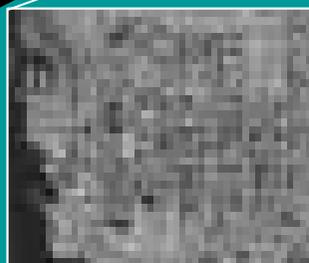


## Direct access to the satellite

- The “Satellite Operating Partner” (SOP) model
- The Exclusive Pass on Demand (EPOD) model



Imaging



Direct Tasking

Direct Reception



# SOP/EPOD Concept

- **Sole operator** of the satellite/s over a defined geographic area (Footprint)/ or within a selected passes.
- **Autonomy** - Local uplink capability for command & tasking of the satellite camera
- **Secrecy and image Ownership** - Exclusive license
- **Imaging Flexibility** and priority **Control**
- **Real-Time** imagery reception

# The Mission

**To Give the Exact Information to the Exact Level at the Exact Time**

» Theatre

» Corps

» Division

» Brigade

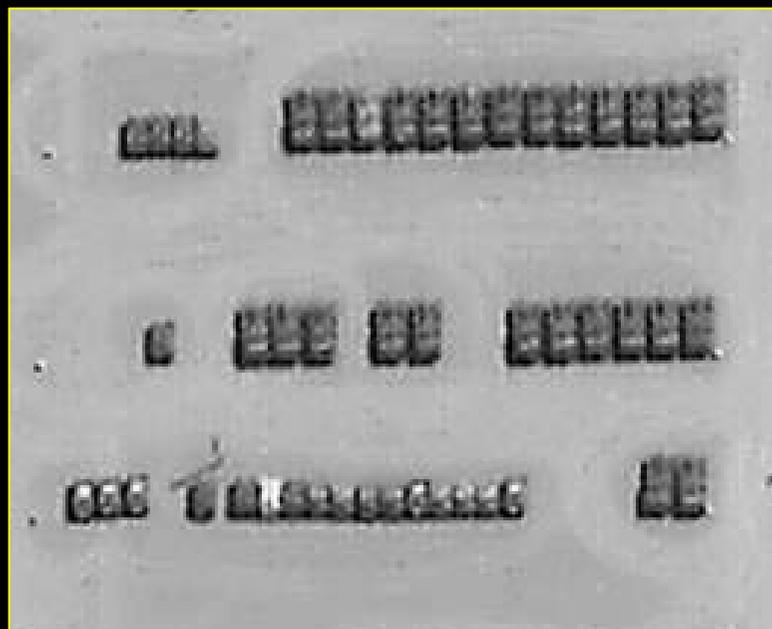
» Battalion

» Platoon

» Squad



## Ground forces



## Navy



## Air force



EROS B



# Barcelona A/F – Venezuela



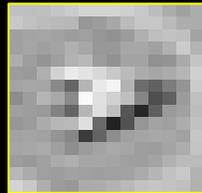
**SU-30**

Feb 2007

# Airbase Facilities and Aircraft



F-14



F-16



EROS B

# Ramenskoye Flight Test Center - Russia



EROS A/B



# Yingchengzi S.A.M Base - China



EROS A  
Nov 02



EROS B  
June 06

# Yingchengzi S.A.M Base - China

## S.A-2 Battery

## S.A-10 Infrastructure

Fan Song radar

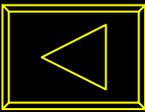
Launcher

EROS A  
Nov 02

EROS B  
June 06



# Yingchengzi S.A.M Base - China



# No-dong, North Korea Missile Launch Facility

## Comparative Analysis / change detection



4 – Administrative/Support Area

3 – Launch Pad

July 03<sup>ed</sup>, 2006

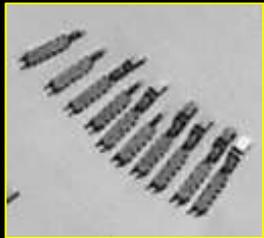


4 – Administrative/Support Area

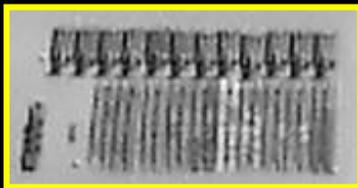
3 – Launch Pad

June 16<sup>th</sup>, 2006

# Armored Vehicles in Garrison



Armored Vehicle Transporters



Minefield sweepers



Tanks & APC



## Flooding in the US (Oct. 12 2006)



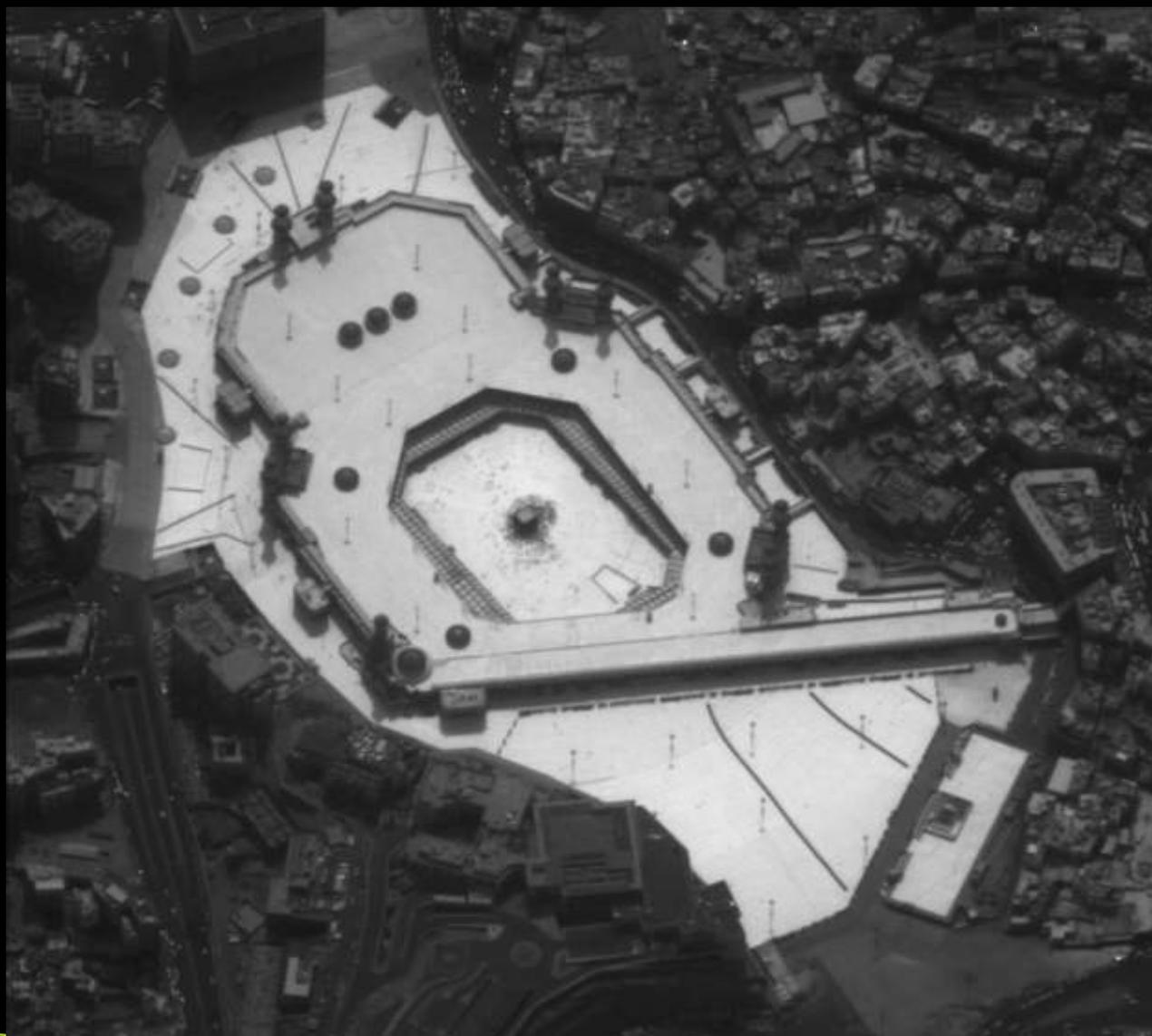
EROS B



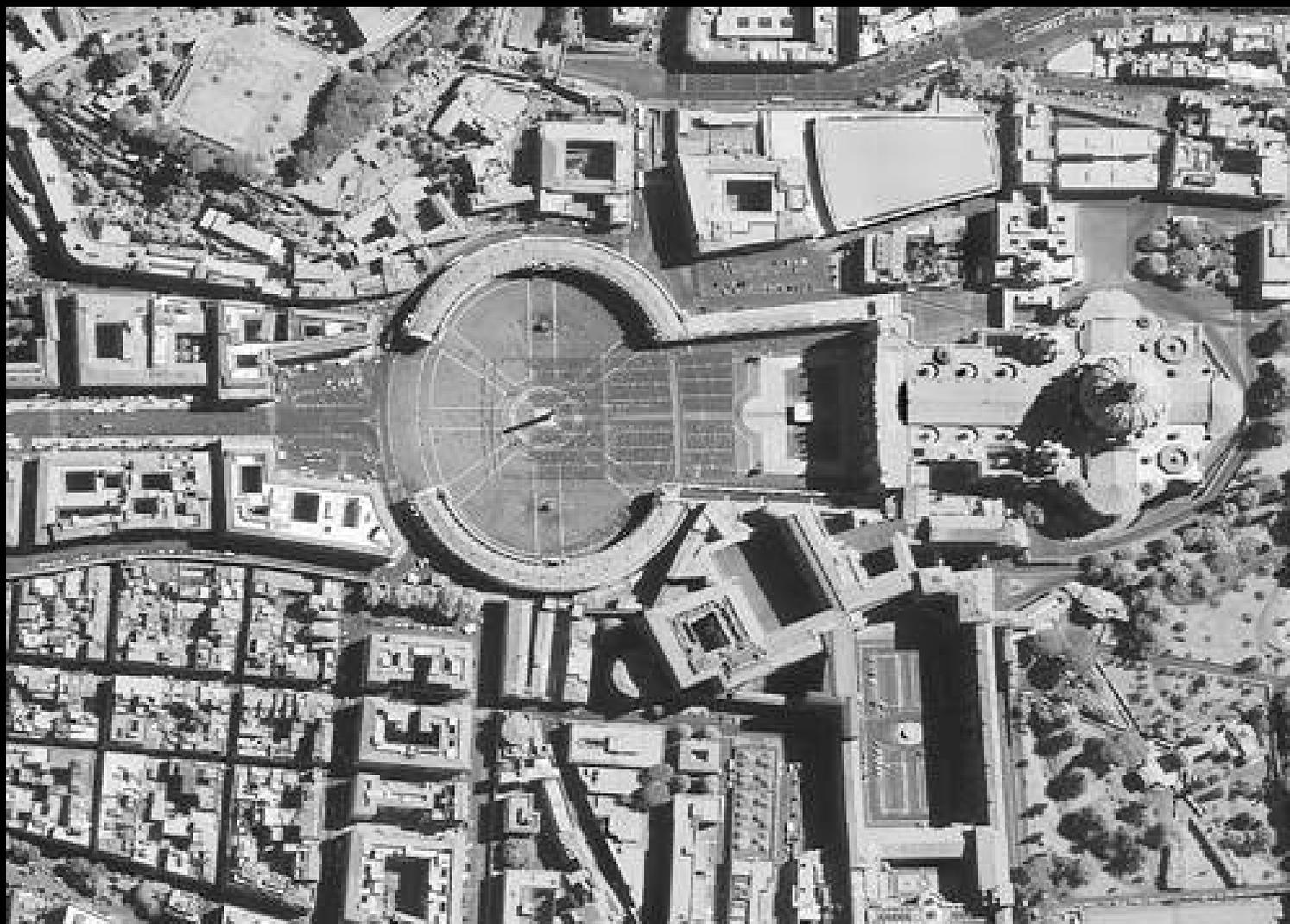
# Tornado Damage, Lady Lake - Florida - USA



# Mecca



# The Vatican



## Soccer game in Australia



EROS B

# Karthala Volcano - Comoro Islands



Crater Lake



Dry Crater Lake

FEB 5, 07

EROS B



# Arroyito - Argentina

Heavy Wa

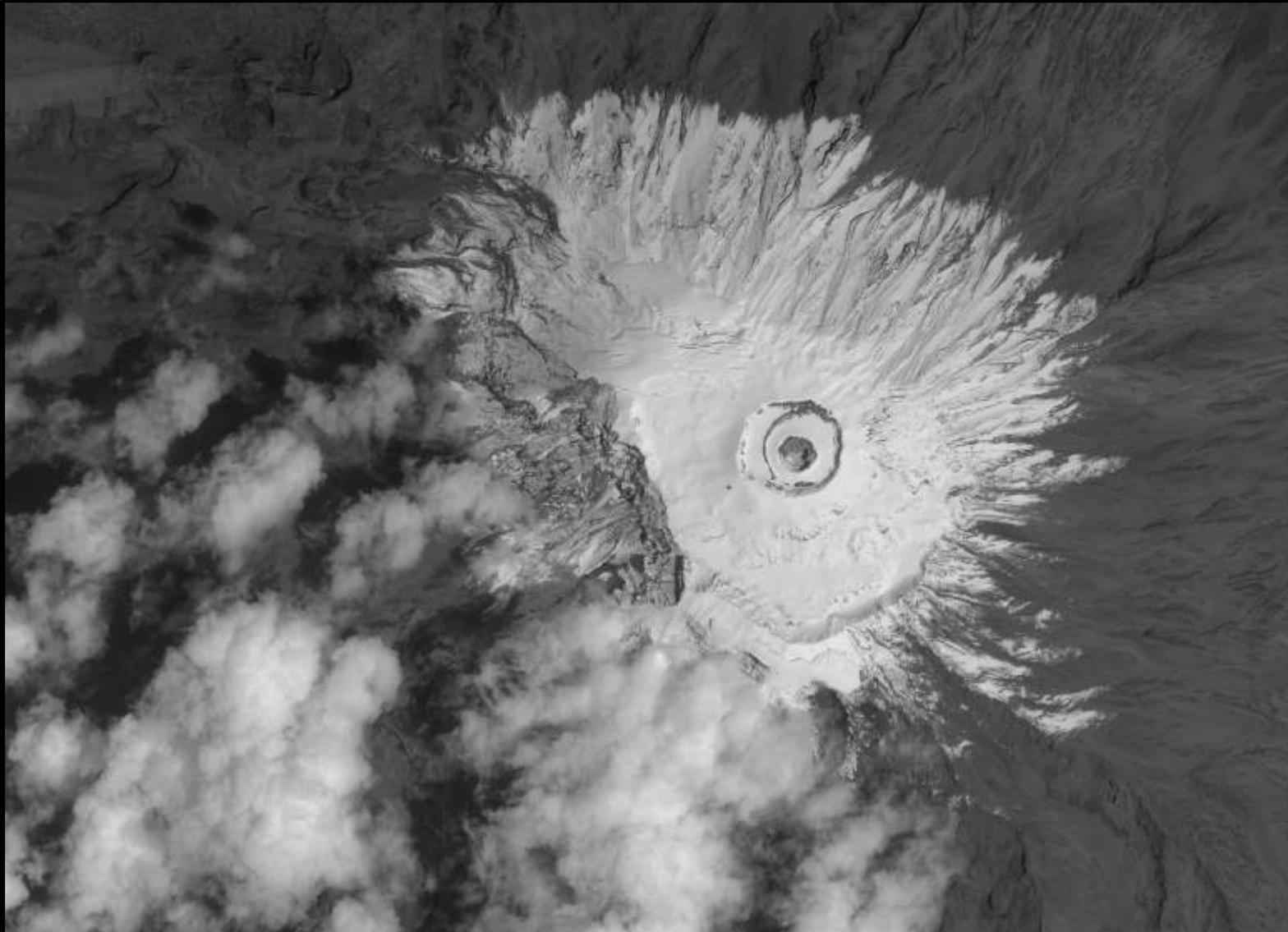
ant

ic Dam



EROS B

# Mount Kilimanjaro - Tanzania



EROS B

# Washington D.C - Capitol Building - U.S.A



EROS B



# Hassan II Mosque, Casablanca – Morocco



EROS B



## MILLAU BRIDGE - FRANCE





EROS B



# Stromboli Volcano - Italy





**THANK YOU**

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