

EOTec



Indian Remote Sensing Satellite Program


Presented by:
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EOTec

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- Heritage of India's Earth Observation Program
 - Current IRS Satellite Constellation
 - Key Applications
 - Plans for the Future
 - Market Trends and Conclusions



Who is EOTec?



- EOTec serves as Managing Agents for Antrix Corporation Limited, the commercial arm of the Indian Space Research Organization (ISRO)
- EOTec's offerings from Antrix include:
 - ◆ IRS Satellite Access
 - ◆ IRS Data Products and Value Added Services
 - ◆ Ground Station Systems
 - ◆ Satellite Launch Services
 - ◆ Space Craft Component manufacturing
- Effective 1 January 2009, EOTec became the exclusive distributors for IRS Data in North America
-  GeoEye is our key partner in the North American market providing:
 - ◆ Data collection and archiving from their Norman, OK ground station
 - ◆ Product processing
 - ◆ On-line catalog support
 - ◆ Customer Services and Technical Support

1995/1997 IRS-1C/1D

LISS-3 at 23/70m,
PAN at 5.8m,
WiFS at 188m

1999

INSAT-2E

1 km every 30 mins.

2003

IRS-P6

"Resourcesat-1"
LISS-3 at 23m,
LISS-4 at 5.8m,
AWiFS at 70m

1996 IRS-P3

WiFS

1999

IRS-P4

OCEANSAT-1

2005

IRS-P5

"Cartosat-1"

Stereo PAN at 2.5m,
30km swath

1994 IRS-P2

LISS-2

3+ DECADES OF INDIAN IMAGING SYSTEMS

1988/91 IRS-1A/1B

LISS-1&2 at 73/36m

2007

IRS-P7

"Cartosat-2"

High-Res 1m PAN

1982

RS-D1

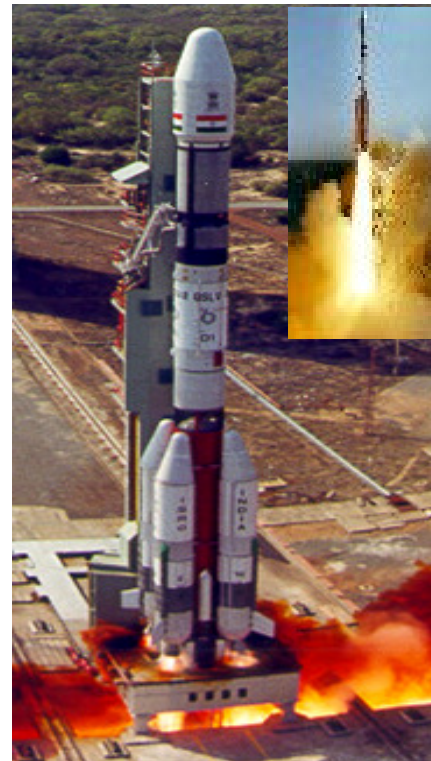
1979

BHASKARA
TV Cameras

BROAD PORTFOLIO OF IMAGING CAPABILITES:

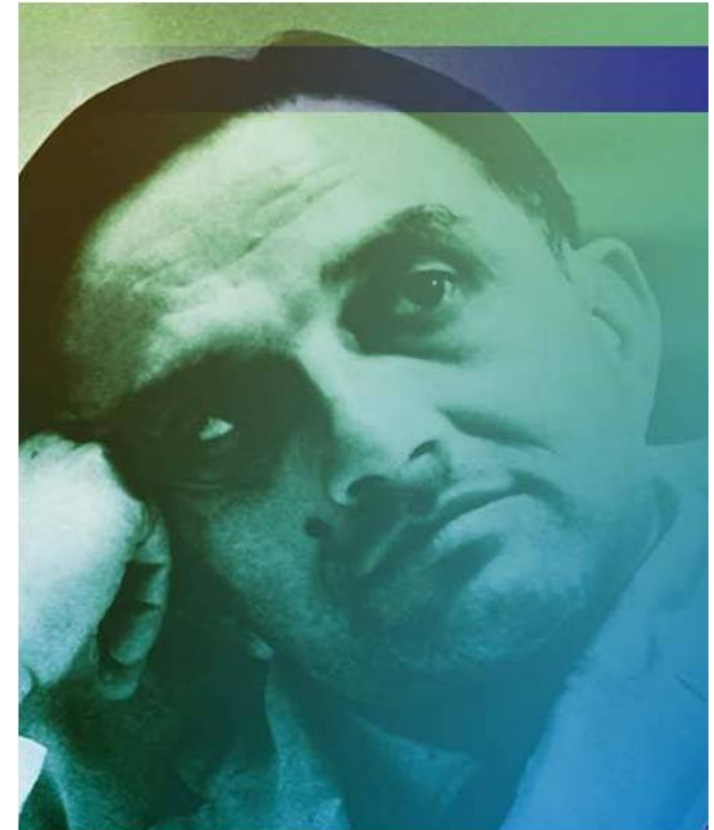
- ◆ Low, Medium and High Resolution
- ◆ Land and Ocean Monitoring
- ◆ PAN, MS and Stereo Sensors
- ◆ Optical and Radar System
- ◆ Repeat Coverage every 5 days

Future Missions:
MEGHA-TROPIQUES
SAPHIR, SCARAB,
MADRAS & RISAT



	PSLV-Std PSLV-CA & PSLV-XL	GSLV	GSLV MkIII
Weight (T)	294	400	629
Payload (Kgs)	1,500 SSO	2,250 GTO	4,000 to 4,500 GTO
Launches	15 (1994 – 2009)	5 (2001-2007)	--

- Why has India invested so much in Earth Observation and other space technologies?
- To understand why, we have to look at India's history
 - ◆ Vikram Sarabhai's vision
 - "India must use technology whenever possible to solve the problems of man and society and to expand the national economy of India"
 - ◆ Since their independence India has had a lot of "down-to-earth" problems of development
 - ◆ To assure its development, India views science and space technology as a crucial apparatus for its socio-economic development - not a display of its might
- Each IRS satellite built by India is designed to meet a national need first
 - ◆ Commercial and other objectives are second place
- History explains why India's space program is so deeply rooted in Indian society



*Dr. Vikram A. Sarabhai
Father of India's Space Program*



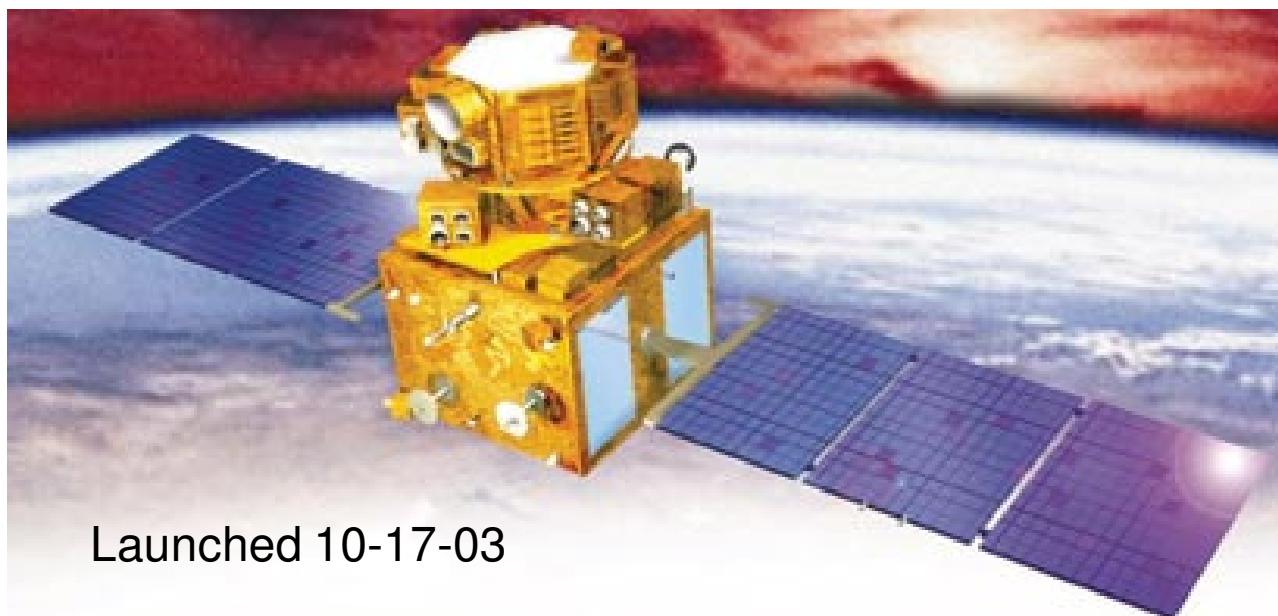
Current IRS Constellation

Resourcesat-1

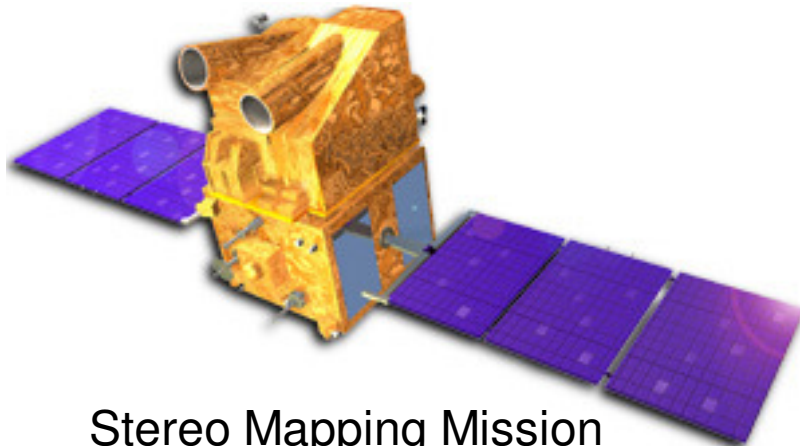
Cartosat-1

Cartosat-2

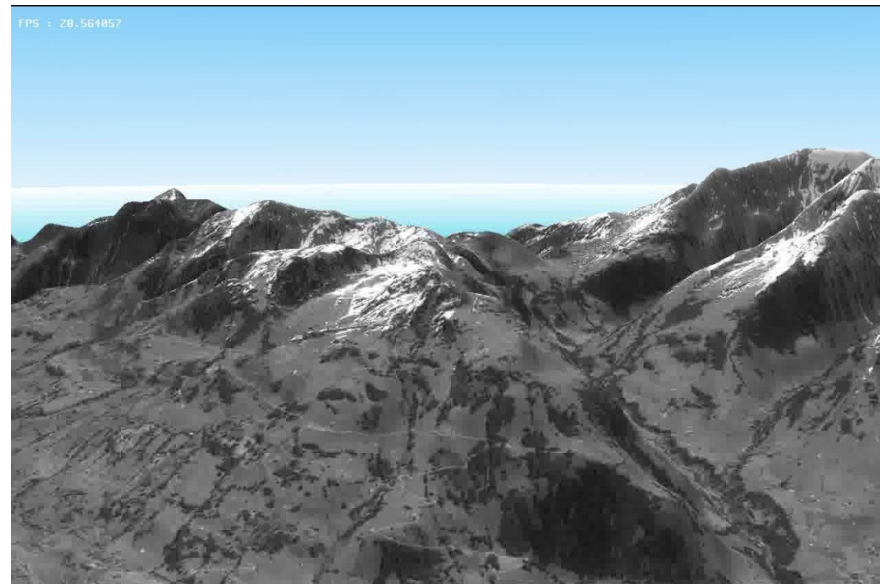
Oceansat-2



PAYLOADS		AWiFS	LISS-III	LISS-IV
Resolution (at nadir)		56m	23.5m	5.8m
Swath		740 km (5 day repeat coverage)	141 km	23.9 km (MX mode) 70.3 km (PAN mode)
Spectral Bands	Band 2 (Green)	520-590 nm	520-590 nm	520-590 nm
	Band 3 (Red)	620-680 nm	620-680 nm	620-680 nm
	Band 4 (NIR)	770-860 nm	770-860 nm	770-860 nm
	Band 5 (SWIR)	1550-1700 nm	1550-1700 nm	
Quantization		10 bit	7 bit	7 bit
Array Width		6,000 pixels/band	6,000 pixels/band	12,000 pixels/band



Stereo Mapping Mission



<p>Payloads</p> <p>Instantaneous Geometric Field of View (IGFOV)</p> <p>Swath</p> <p>Spectral Band</p> <p>Data rate</p> <p>Solid State Recorder</p>	<p>: Two PAN Cameras (PAN fore mounted with a tilt of +26 deg and PAN aft mounted with a tilt of - 5 deg from the yaw axis to generate stereoscopic imagery)</p> <p>: < 2.5 m</p> <p>: 30 km</p> <p>: 0.50-0.85 Micron</p> <p>: 105 Mbps for each camera</p> <p>: 120 GB capacity for image data storage</p>	<p>CARTOSAT-1 PAN camera</p>
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Resolution/Swath:

Panchromatic at 0.81m; 9.6km Swath

Solid Stage Recorder:

64 GB; 138 Images of 9.6km X 9.6km

10 Bit Detector Dynamic Range**Max Data Rate:**

105 MBPS / X-Band Downlink

Maximum Area Imaged per 12 min Pass:

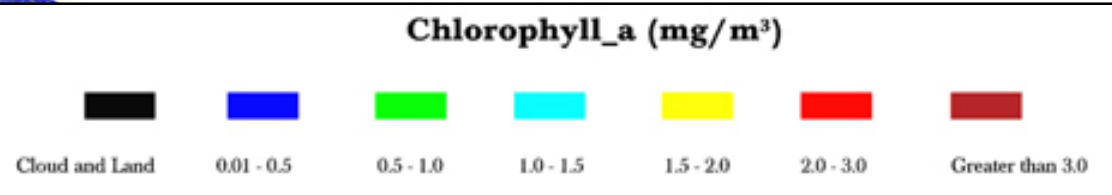
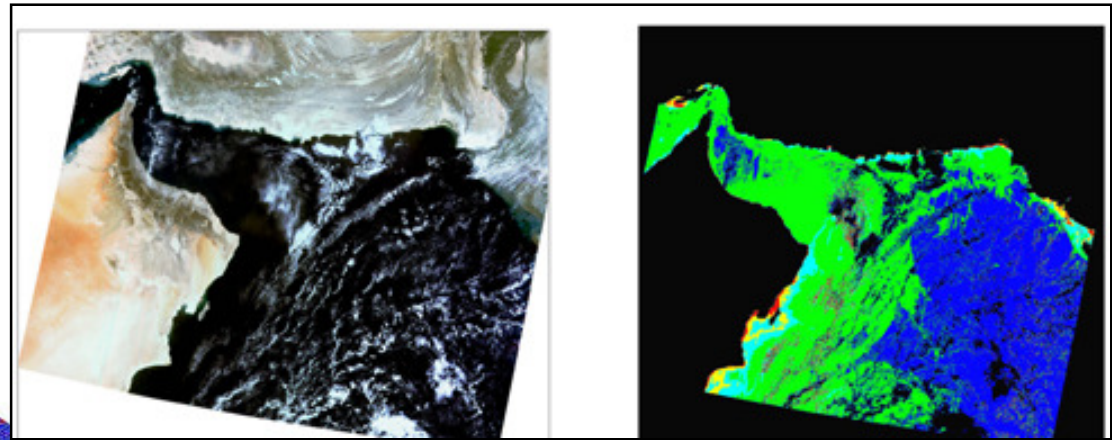
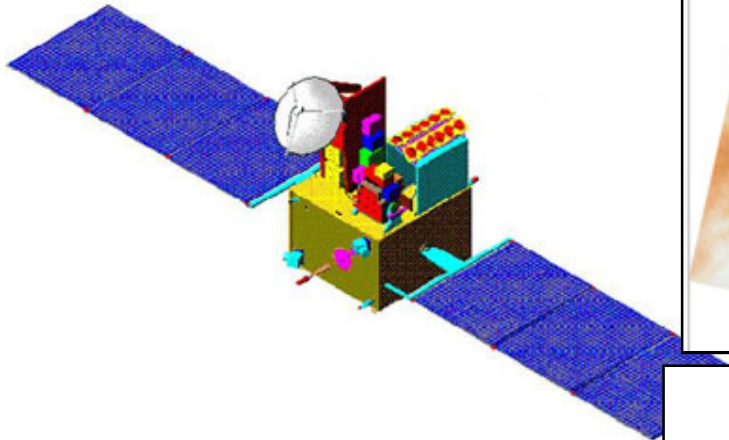
0.82m GSD (Mono): 8832 km²

Revisit Time: 4/5 days at equator**Orbit:**

630km, Sun Synchronous at 9.30 AM Local time

Launch Mass: 680 Kgs**Launched Date:** January 10, 2007**Design Life:** Minimum 5 years

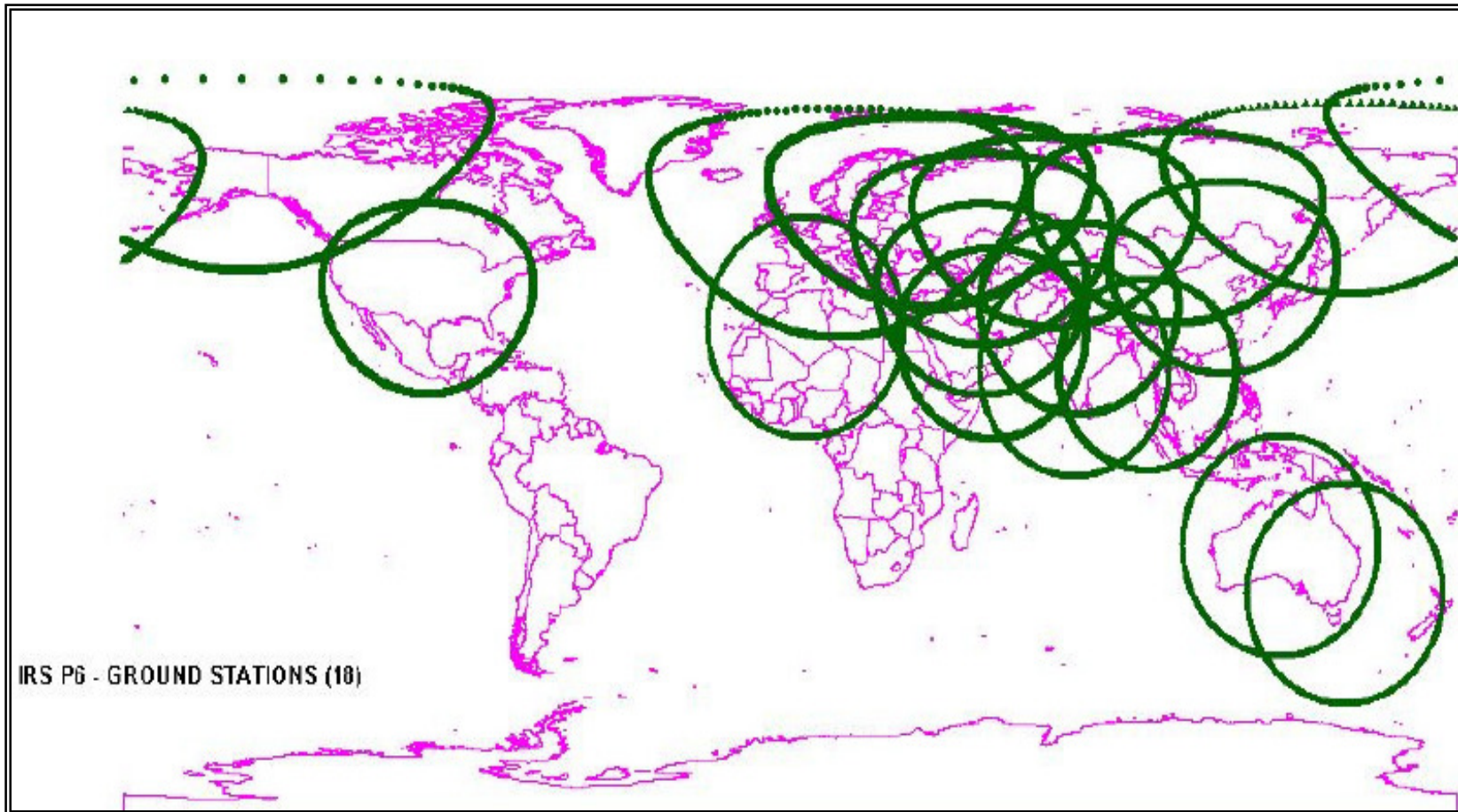
High-Res Mapping Mission



MISSION:

- Study of surface winds, ocean chlorophyll concentrations, coastal phytoplankton blooms, water sediments and atmospheric aerosols
- Payloads:
 - Ocean Color Monitor (OCM)
 - KuBand Pencil Beam Scatterometer
 - Radio Occultation Sounder (ROSA)

- **Agriculture**
 - ◆ Crop monitoring and condition assessment
 - ◆ Crop canopy water stress
 - ◆ Crop yield estimates
 - ◆ Damage assessment
- **Forestry**
 - ◆ Inventory and updating
 - ◆ Encroachment
 - ◆ Habitat analysis
 - ◆ Fire damage
- **Environmental Monitoring**
 - ◆ Land use
 - ◆ Soil contamination
 - ◆ Desertification analysis
 - ◆ Oil Spills and disaster monitoring
 - ◆ Environmental impact assessments
- **Geology and Exploration**
 - Rock type mapping
 - Mining pollution assessments
 - Coal fire analysis
 - Landslide vulnerability / risk
- **Infrastructure and Utilities**
 - Road networks
 - 3D city models
 - Structural and hydrological inventory
 - Utility corridor mapping
 - Change detection
- **Cartography / Mapping**
- **National Security**



- 15 active stations now collect Resourcesat data



Future IRS Missions

Resourcesat-*n*

Cartosat-*n*

Radar

HSI

- **Resourcesat-2**

- ◆ Launch scheduled for Q3- 2010
- ◆ Virtually identical to Resourcesat-1 (with miniaturization)
 - Improved solar array and power handling system
 - Radiometric resolution will be improved
 - OBSSR will be increased in size for better global coverage
- ◆ ***Assures data continuity through at least 2016***

- **Cartosat Series:**

- ◆ Increased resolution and more spectral bands:
 - PAN at 0.5m resolution
 - Addition of 4 MSI bands at 2-4m
 - Possible addition of HSI at 8m, ~200 bands
 - Swath at 8-10km

- Resourcesat-3 series

- ◆ Increased resolution, more spectral bands, wider swath
 - AWiFS (A & B) improved to 25m resolution, 600km swath
 - LISS-III will include 2 additional bands
 - Thermal at 70m resolution is under consideration
 - LISS-IV will have large swath width
- ◆ Possible addition of new sensors with 25km swath:
 - Hyperspectral at 25m resolution (~200 Bands)

- Resourcesat-4 series

- ◆ Addition of new sensors with 12.5km swath based on 500mm optics:
 - LISS-IV_n at 2.5m, 3-4 bands, 5 day revisit
 - LISS-V_n at 1.25m PAN, 5 day revisit
 - HSI_n at 12.5m, 200 bands, 5 day revisit

- **RISAT – First IRS SAR system**

- C-Band SAR
- 10km swath in Spot mode, 240km swath in Scan mode
- Resolution at 1m to 50m
- Single/Dual polarization
- Schedule for launch in 2010

Mode	Look	Resolution	Swath	Polarization
Coarse Resolution Mode	2-4	50m	240km	Single or Dual
Medium Resolution Mode (MRS)	1-2	25m	120km	Single or Dual
Fine Resolution Striping Single Mode (FRS-2)	9-12	30m	Quad	
Fine Resolution Strip Map (FRS-1)	Single	3-6m	30km	Single or Dual
High Resolution Spot Mode (HRS)	Single	1-2	10 x 10km	Single or Dual

Single Polarization	VV/HH/HV/VH
Dual Polarization	HH & VV/VV & VH
Polarimetric	HH & VV & HV & VH

- Regardless of market trends, India is dedicated to providing IRS data continuity through at least 2018
- Availability of key components (e.g., optics) was previously a limiting factor
 - ◆ Previous restrictions by DoS /ITAR
 - ◆ International cooperative programs are already underway
 - NASA, Germany, France, Italy, Japan, others
- Large Data User (including USDA and ESA) have already provided their inputs to ISRO on future missions
 - ◆ Inputs on desired resolution, additional bands, orbits, etc.
 - ◆ This is a rather unique opportunity for YOU to let your desires be heard too!



Thank you!

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