PRESENTATION AT INTERNATIONAL LIVING WITH THE STAR WORKING GROUP MEETING AT BANFF CANADA 25-26 MAY 2004

BY R S BHATIA

COUNSELLOR SPACE

THE STORY BEGINS

FIRST ROCKET LAUNCH ON 21st NOVEMBER 1963

"THERE ARE SOME WHO QUESTION THE RELEVANCE OF SPACE ACTIVITIES IN A DEVELOPING NATION .....

.....IF WE ARE TO PLAY A MEANINGFUL ROLE NATIONALLY, AND IN THE COMITY OF NATIONS, WE MUST BE SECOND TO NONE IN THE APPLICATION OF ADVANCED TECHNOLOGIES TO THE REAL PROBLEMS OF MAN AND SOCIETY."

THUMBA

AND THE VISION....

INDIAN SPACE ENDEAVOUR

AN OVERVIEW

BUDGET

450 m.US $

APPLICATIONS LEADER SHIP

SPACE ASSETS
Remote sensing & telecom satellite constellations

INDUSTRY

Strategic alliances

HUMAN RESOURCES EXPERTISE

17000 strong

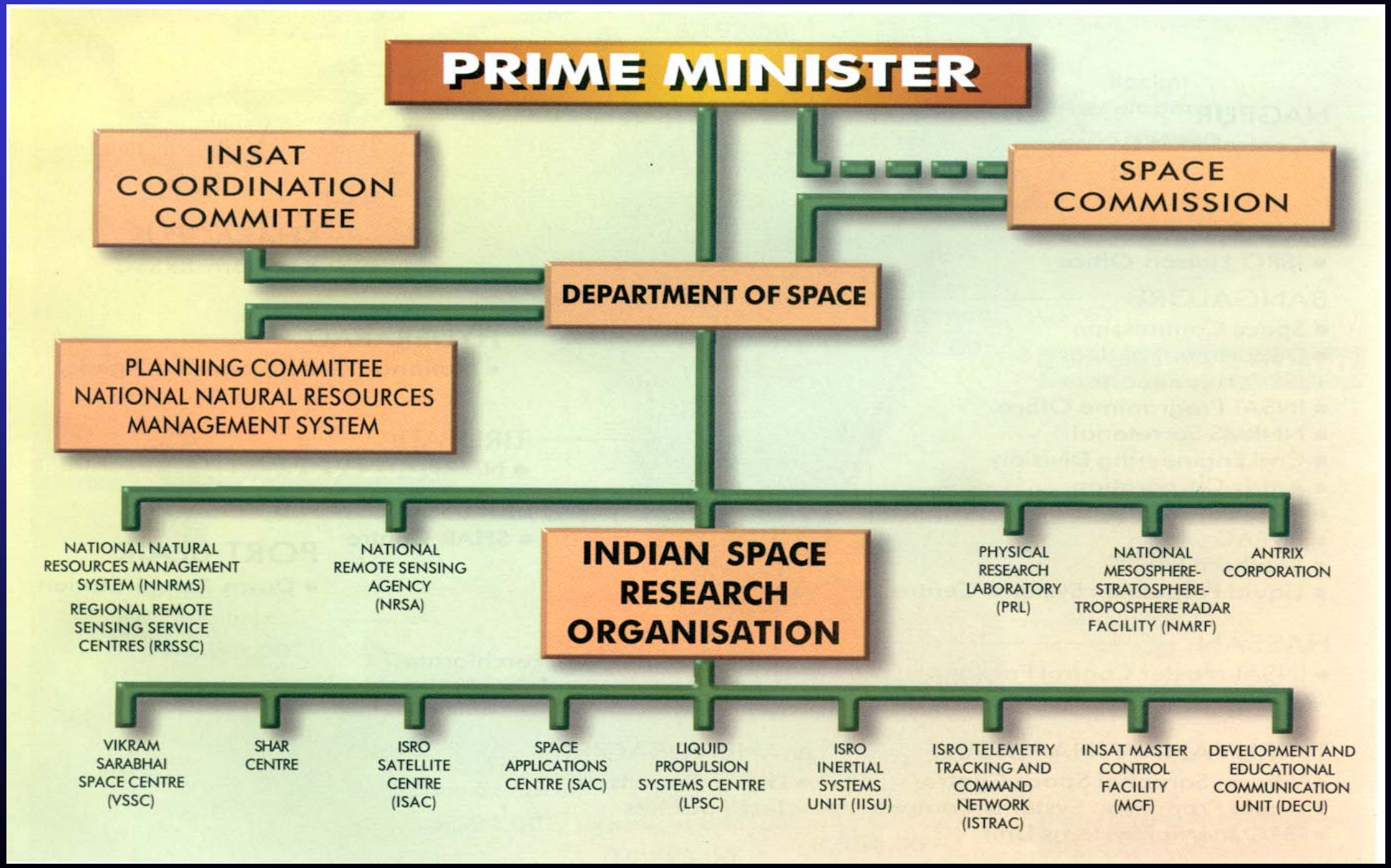
INTERNAT'NAL COOPERATION

LARGE USER BASE

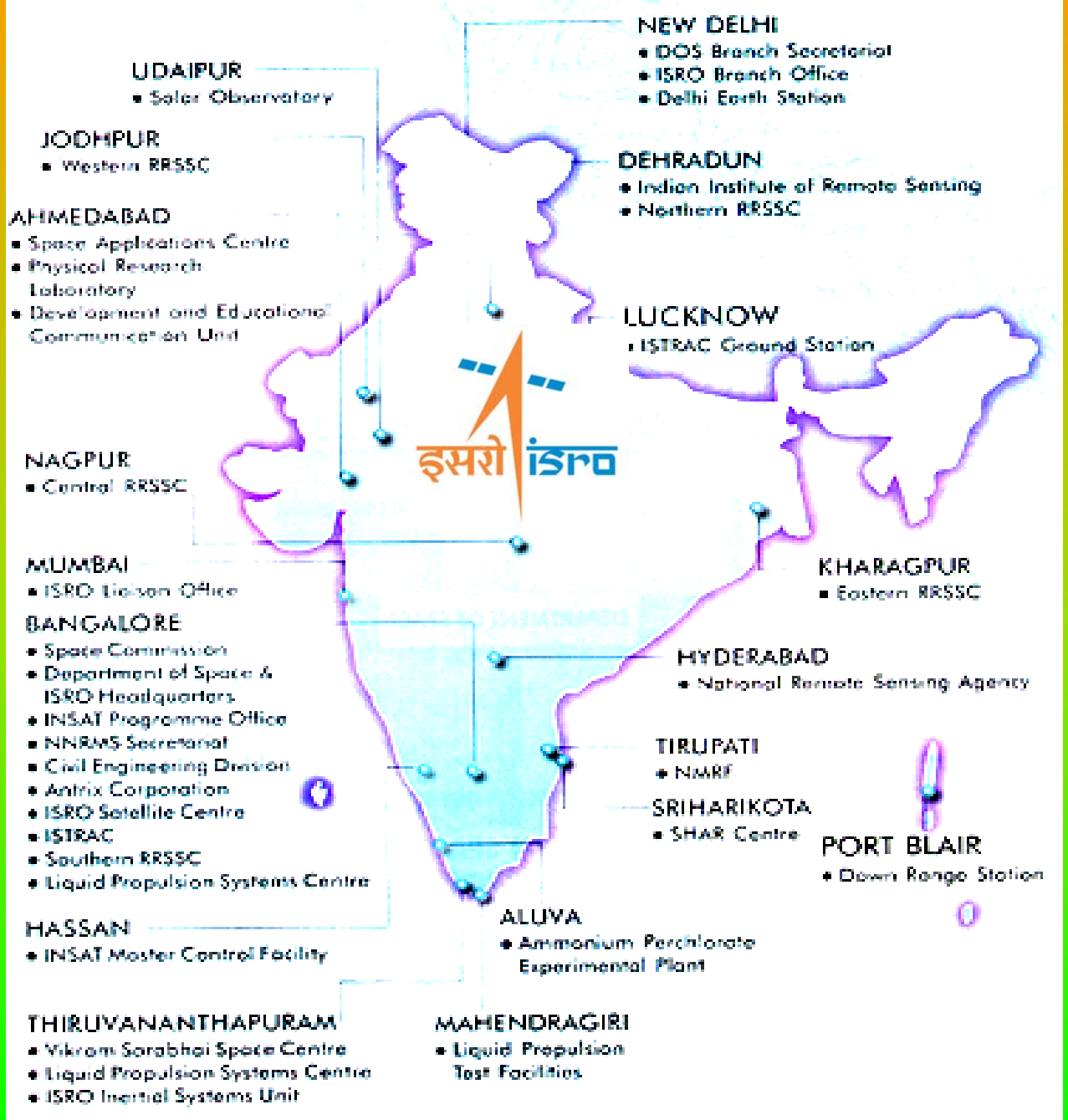
INFRA STRUCTURE
End- to- end capability

STATE OF THE ART TECHNOLOGY

ORGANISATION CHART



SPACE CENTRES AND UNITS IN INDIA



NATIONAL SPACE SYSTEMS

LAUNCH VEHICLES

INSAT

IRS

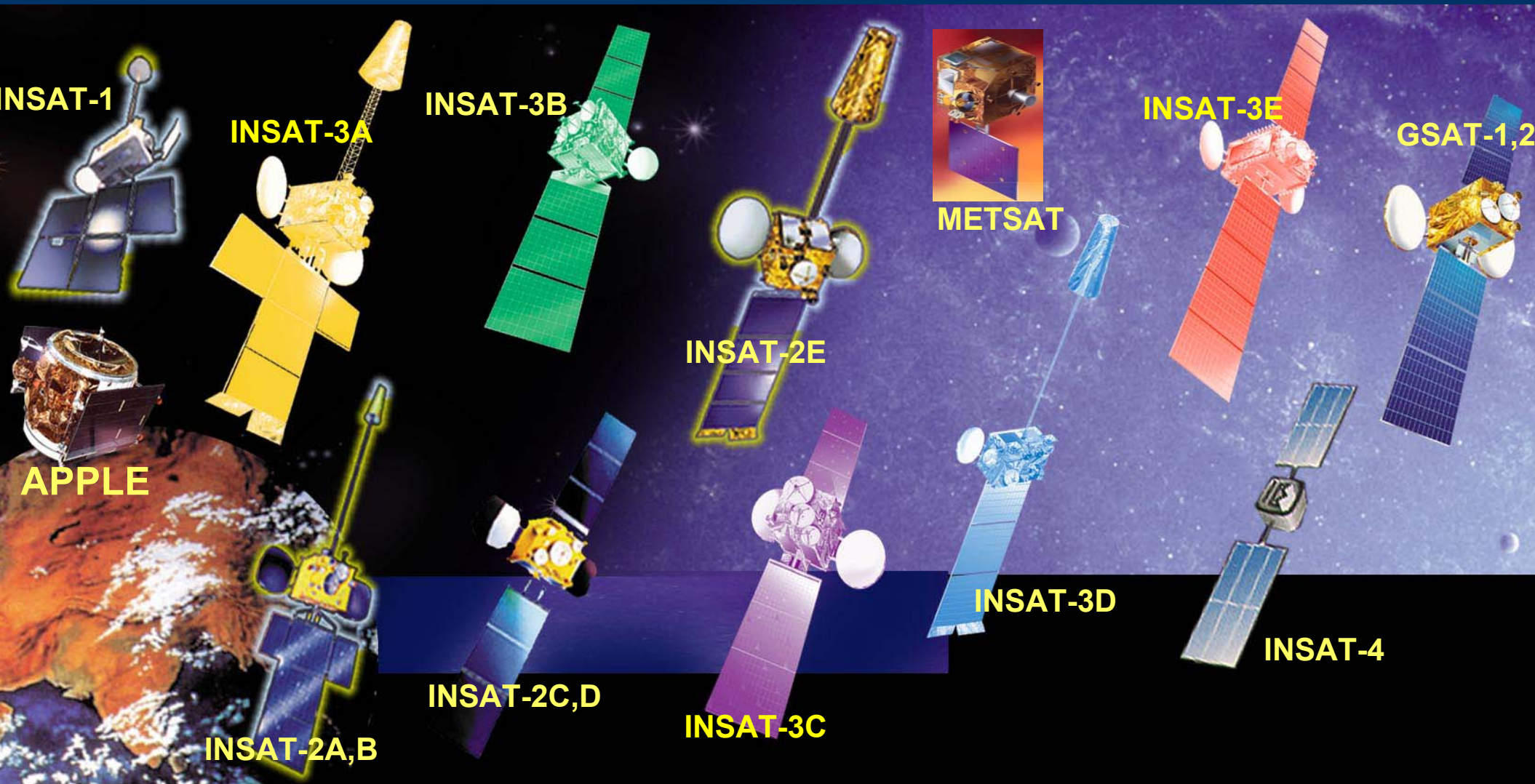
INSAT FAMILY (Communication, broadcasting, meteorology)

APPLE
- 3 AXIS STABILISED
- 1 TRANSPONDER

INSAT-1
- 3-AXIS STABILISED
- 12C, 2S
- 32 dbw (1 kw)

INSAT-2
- 3-AXIS STABILISED
- 12C, 6-ExtC,2S, MSS, Ku
- 36 dbw (1.5 kw)

INSAT- 3 / 4
Multiple configurations



INSAT APPLICATIONS

- SPEECH CIRCUITS ON TRUNK ROUTES
- TV BROADCASTING
- BUSINESS COMMUNICATIONS
- MOBILE SATELLITE SERVICES
- RADIO NETWORKING
- SEARCH AND RESCUE SERVICES
- VSAT CONNECTIVITY
- METEOROLOGY IMAGING
- DISASTER WARNING SYSTEM
- DATA COLLECTION PLATFORMS
- DEVELOPMENTAL COMMUNICATION
- TRAINING

INDIAN IMAGING SYSTEMS

1995/1997

IRS-1C/1D LISS-3 (23/70M, STEERABLE PAN (5.8 M); WiFS (188M)

1996

IRS-P3
WiFS MOS
X-Ray

1994

IRS-P2
LISS-2

1988/91

IRS-1A/1B LISS-1&2 (72/36M, 4 BANDS; VIS & NIR)

1982

RS-D1

1979

BHASKARA

1999

INSAT-2E CCD
(1KM RESOLUTION;
EVERY 30 MINUTES)

1999

IRS-P4
OCEANSAT OCM, MSMR

2002

RESOURCESAT-1
LISS3 - 23 M; 4 XS
LISS4 - 5.8 M; 3-XS
AWIFS - 70 M; 4-XS

2001

TES

CARTOSAT - 1
PAN - 2.5M, 30 KM,
F/A

2003

2004

CARTOSAT-2
PAN - 1M

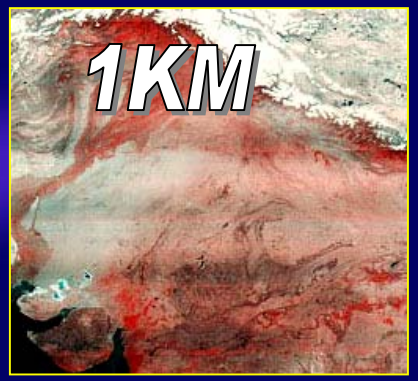
2005

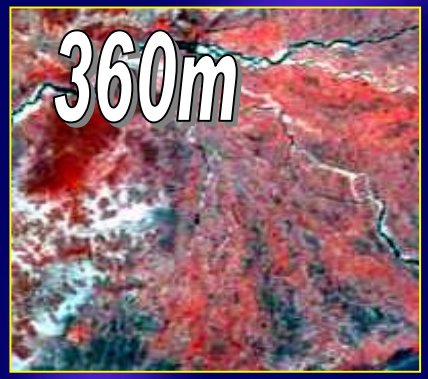
MEGHA-TROPIQUES
SAPHIR
SCARAB &
MADRAS

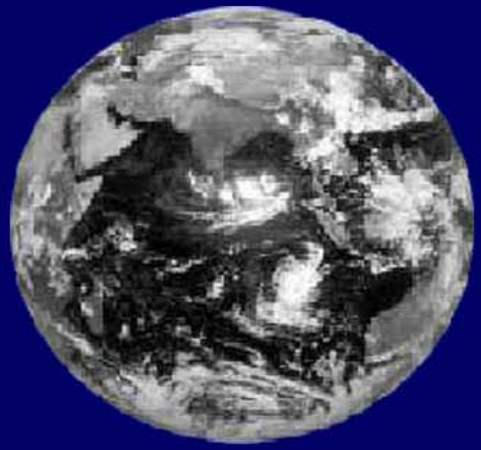
IMAGING IMPROVEMENTS

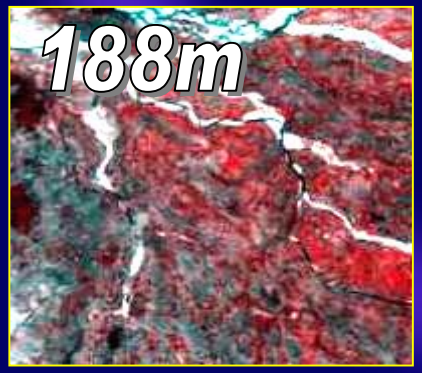
- 1KM TO 1 M RESOLUTION
- GLOBAL COVERAGE
- APPLICATION-SPECIFIC

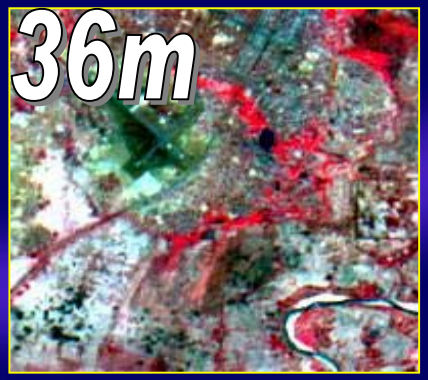
INDIAN IMAGING CAPABILITY











REMOTE SENSING APPLICATIONS

INFORMATION TO SOLUTIONS

- AGRICULTURE & CROPS
- FOREST & BIO-RESOURCES
- WATER RESOURCES
- GEOLOGY
- OCEAN/COASTAL
- ENVIRONMENT
- RURAL DEVELOPMENT
- URBAN MANAGEMENT
- CARTOGRAPHY/MAPPING
- CLIMATE MODELLING
- GLOBAL CHANGE

INTEGRATED MISSION FOR SUSTAINABLE DEVELOPMENT

NATIONAL (NAUTRAL) RESOURCES INFORMATION SYSTEMS

AGRICULTURE

POPULATION	ONE BILLION
AGRICULTURE BASE	70%
GDP AGRICULTURE	27%
AREA	329 M HECTARE
AREA AGRICULTURE	142 M HECTARE
RAIN FED/PROD	100 M HECTARE/90 M TON
IRRIGATED/PROD	40 M HECTARE/120 M TON
AVERAGE	1.6T/HECTARE
DEVELOPED COUNTRIES	5 T/HECTARE

- RAIN AVERAGE 130cm/YEAR
- AREA 329 M HECTARE
- MEANS 1.3 METER WATER
- PROBLEM

  * SPACIALLY AND TEMPORALLY HETROGENIOUS,AND HENCE -FLOOD &DROUGHT
- SOLUTION

  -LAND WATER CONSERVATION

  -WASTE LAND MONITORING &DEV

  -RAIN WATER HARVESTING

  -WATER SHED DEVELOPMENT ETC

FOREST

- 1980 FOR THE FIRST TIME VOICE RAISED AGAINST FOREST DEPLETION
- FOREST DEPARTMENT ESTIMATED 30%FOREST COVER
- CLOSED FOREST ESTIMATED TO BE 11%
- DOS CARRIED OUT DETAILED MAPPING,FOR THE FIRST TIME ACCURATE FIGURES WERE AVILABLE
- SINCE THAN BIANNUAL SURVEY IS CARRIED OUT AND STATISTICS PUT UP TO PARLIAMENT.
- FOREST COVER SUSTAINED AT ABOUT 20%
- SOME BODY IS WATCHING

DISASTER MANAGEMENT

- CALAMITY BY RATING

  FLOOD

  DROUGHT

  LAND SLIDE

  FOREST FIRE /CYCLONE

*45 M HACTARE EFFECTED BY FLOOD/CYCLONE EVERY YEAR

*2/3 COUNTRY IS PRONE TO DROUGHT

*STATES LIKE KARNATAKA EFFECTED BY DROUGHT, 4TH YEAR IN A ROW

FORECASTING AGRICULTURAL OUTPUT USING SPACE, AGROMETEOROLOGY & LAND BASED OBSERVATIONS (FASAL)

- Satellite images
- Agrometeorological models
- Econometric
- Ground data

- Paddy, Wheat, Ragi, Groundnut, Jute
- 12 states
- 4 estimates before harvesting
- Post harvest improvement of estimates

Final Estimate

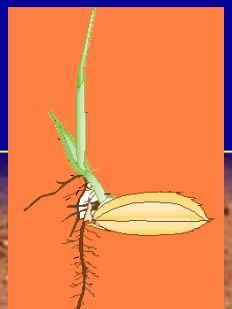
- Integrated Models

Third Estimate

- Space Images
- Meteorological data
- Ground data

Second Estimate

- Space Images
- Ground Data
- Temp./Rainfall



First Estimate

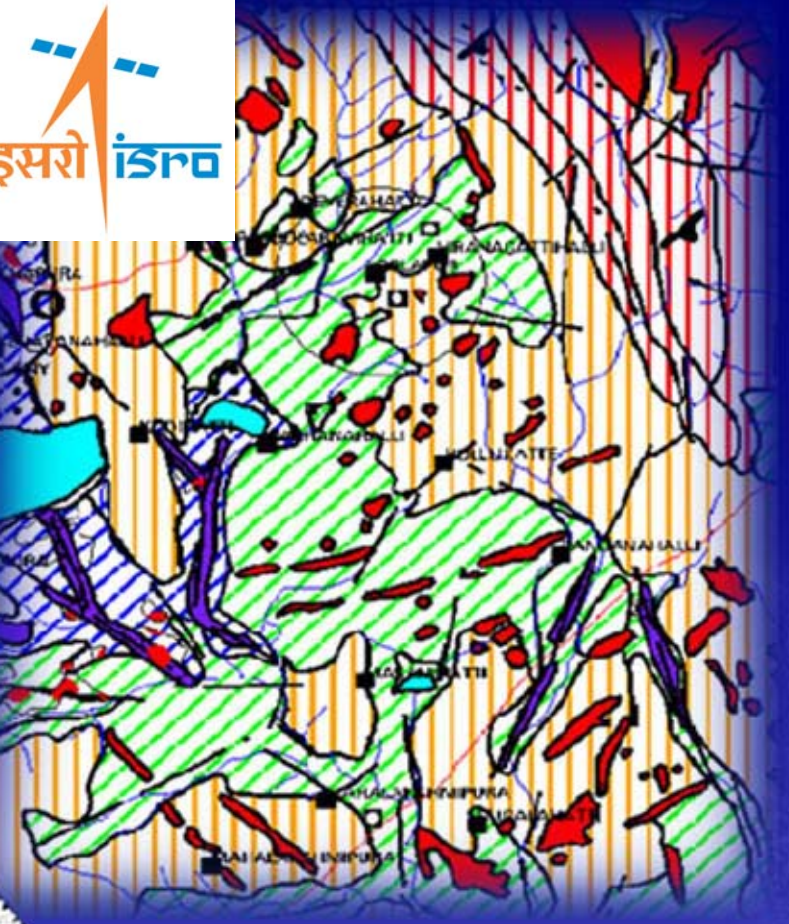
- Market Information

ORISSA – FASAL : 1999- 2000

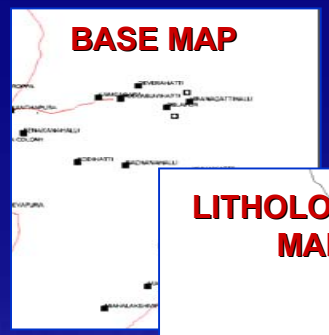
Rice crop Prediction – 5.31 Mt.

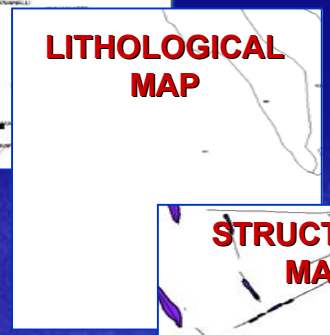
Accuracy – 95%

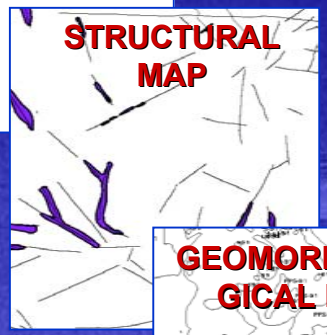
DRINKING WATER FOR NATION

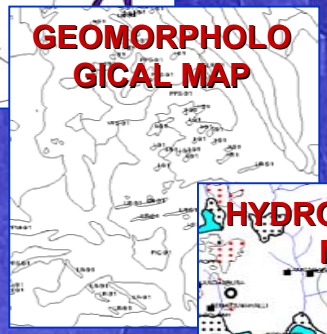


HYDRO-GEOMORPHOLOGICAL MAP









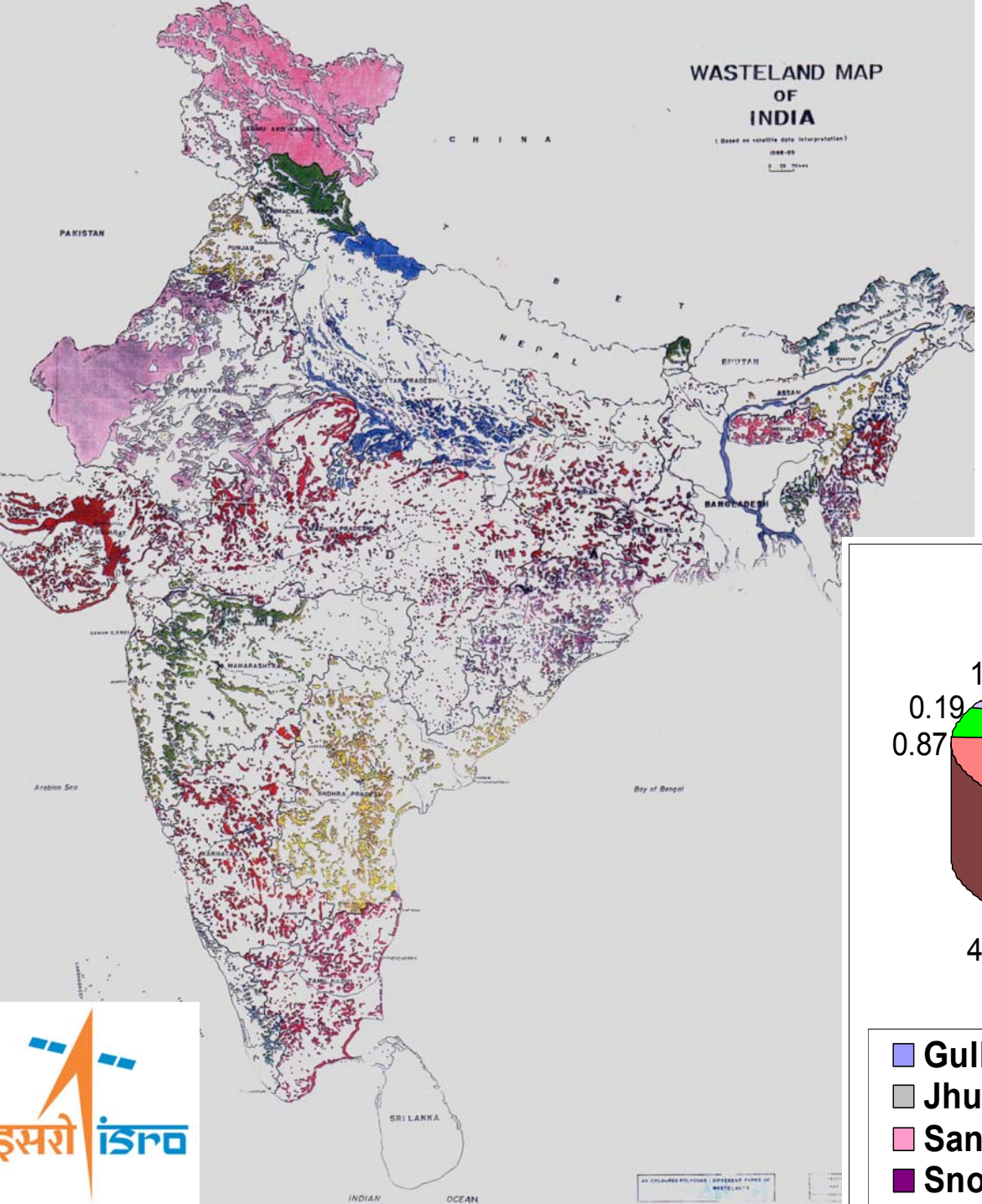
Scientific source

finding approach

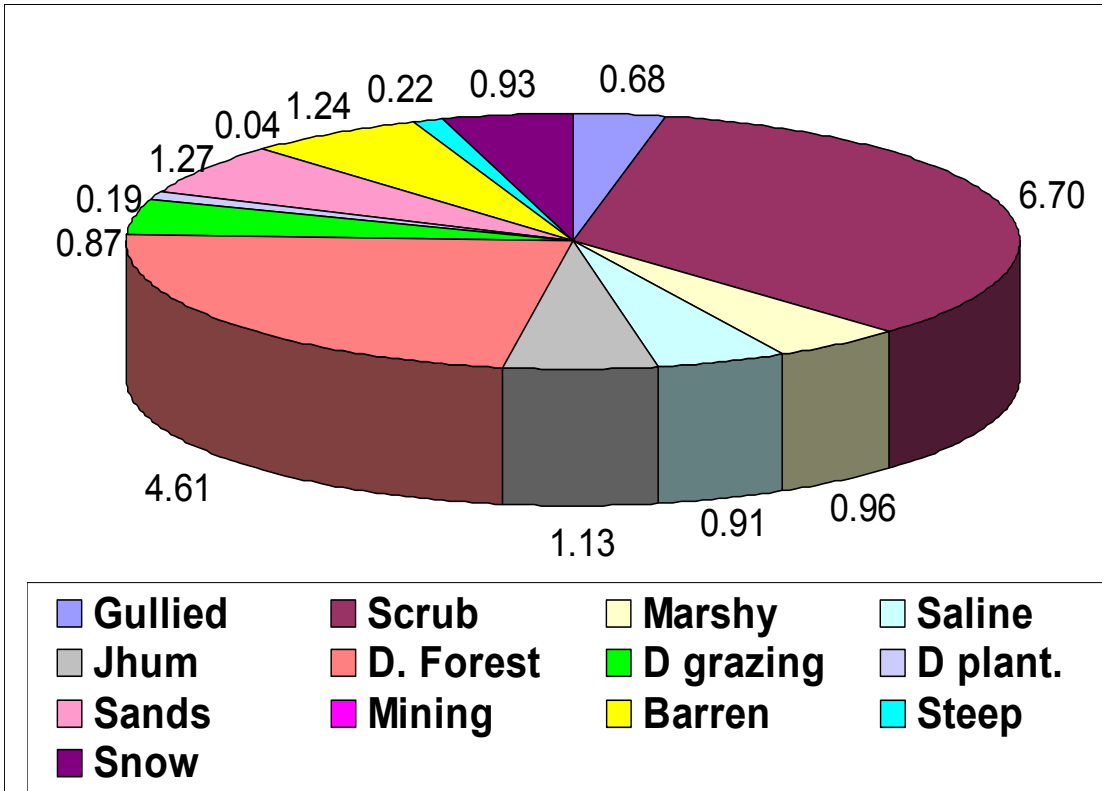
- Success rate for groundwater targeting raised from 45 % to more than 90%
- 160,000 villages with drinking water problem got benefited
- Prospecting and sustainable development

WASTELAND MAPPING OF INDIA

SCALE-1:50,000



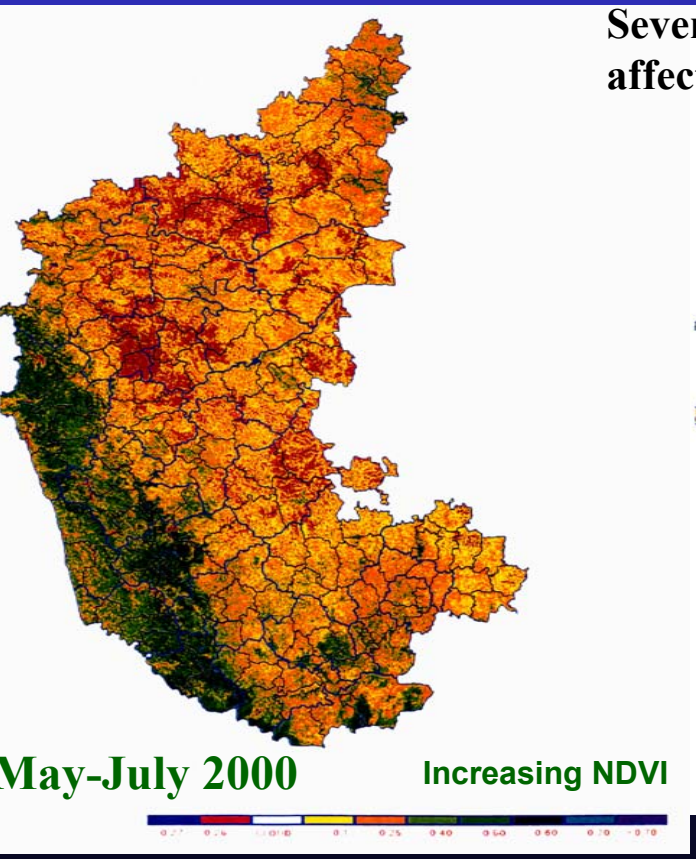
WASTELANDS IN INDIA
(PERCENT WISE)



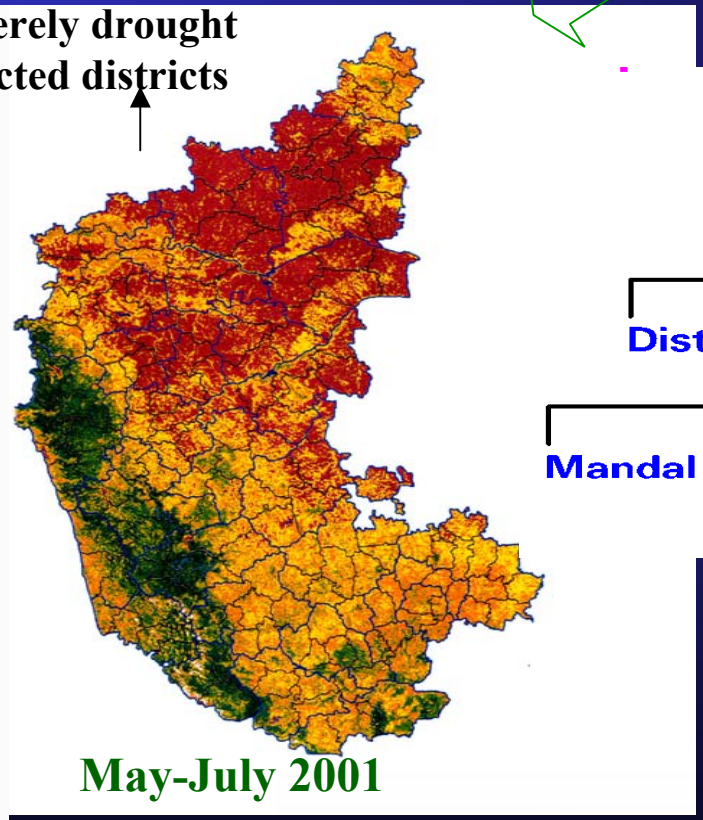
DROUGHT MONITORING

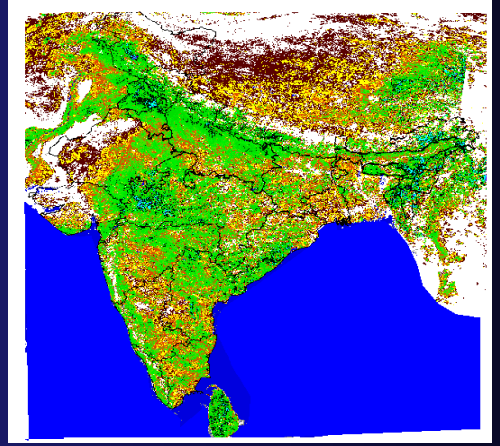
KARNATAKA PROVINCE

IRS WiFS based NDVI

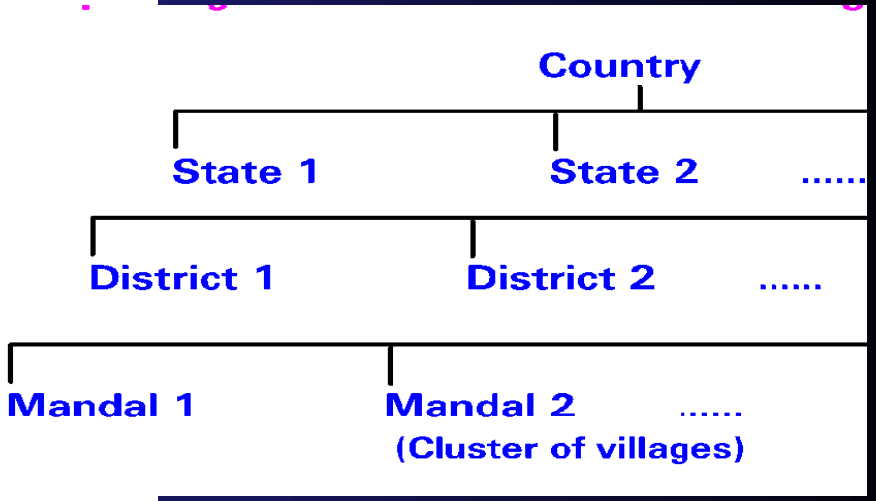


Severely drought affected districts





Reporting hierarchy



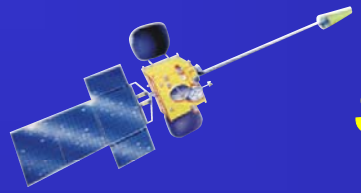
Targeting social safety nets

Relief and Rehabilitation

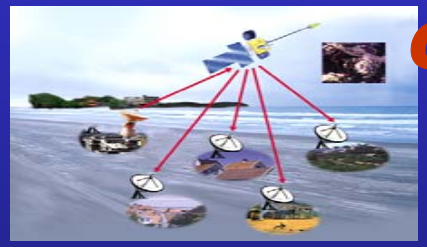
Subsidy and Entitlements

Developmental focus

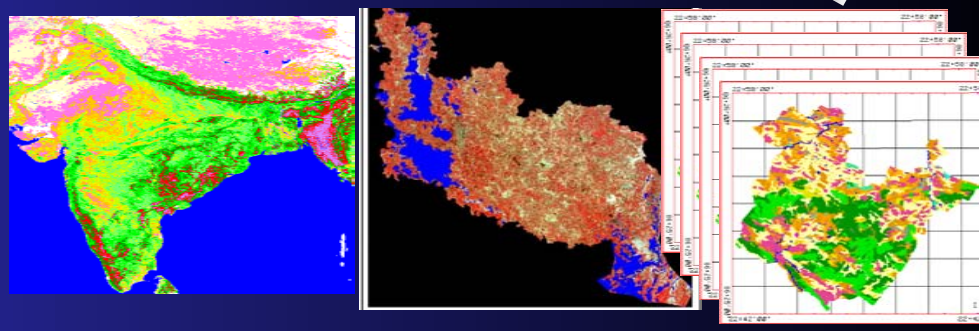
SPACE & DISASTER MANAGEMENT

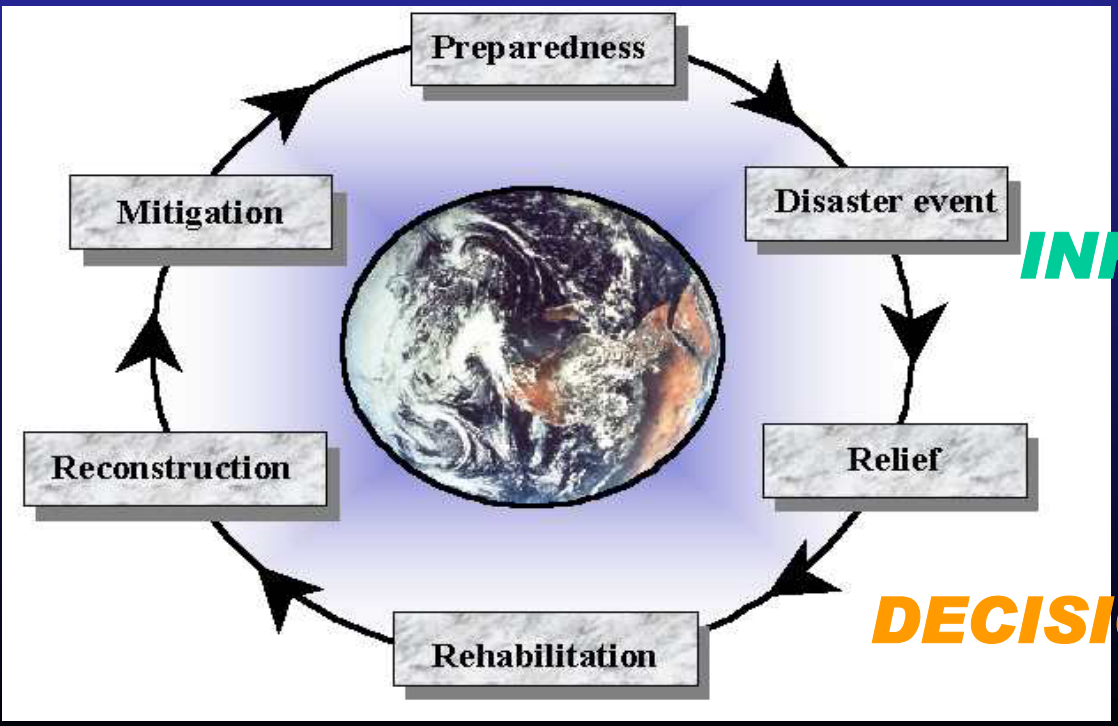


SPACE FOR CONNECTIVITY & OBSERVATION



OBSERVATION FOR INFORMATION

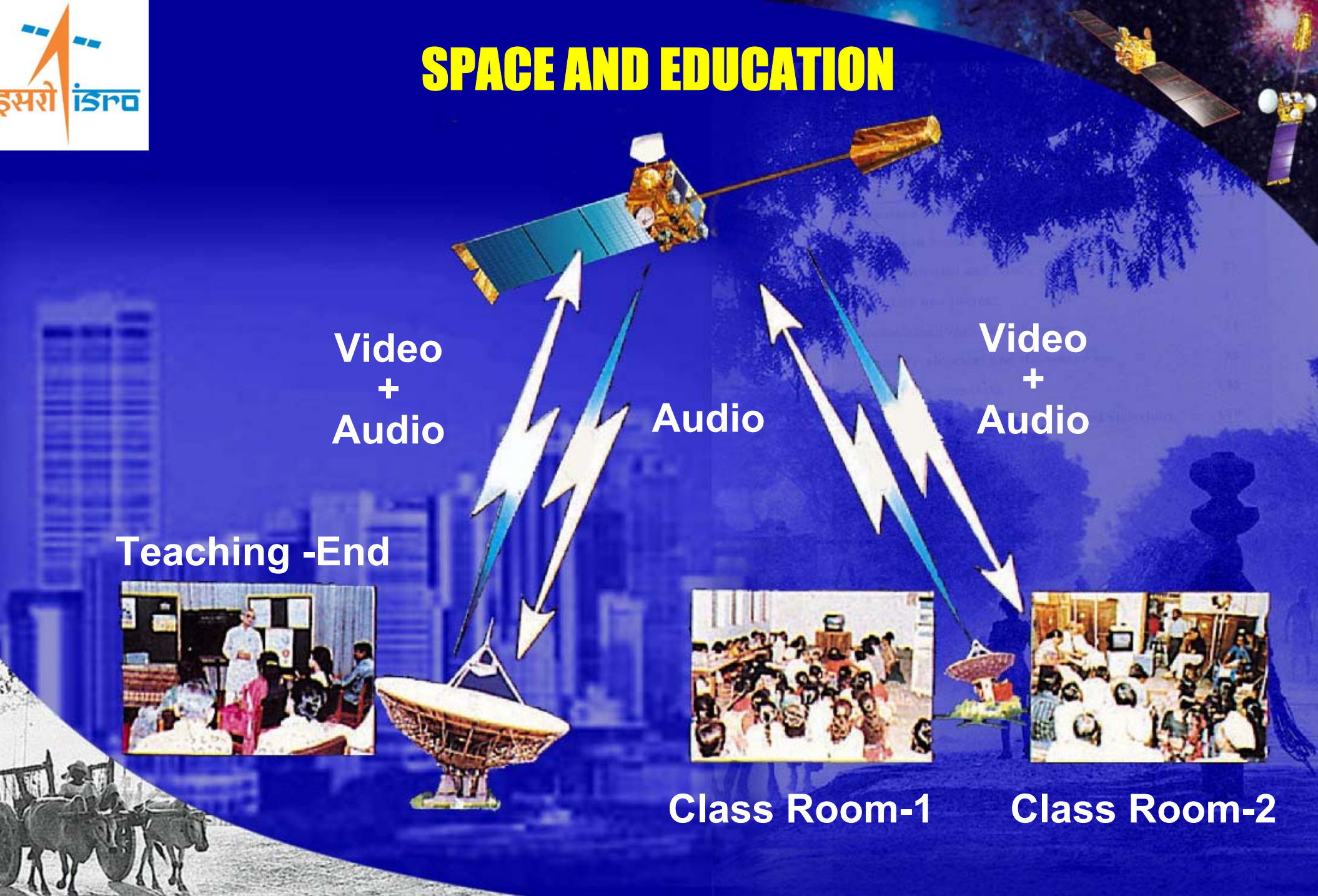




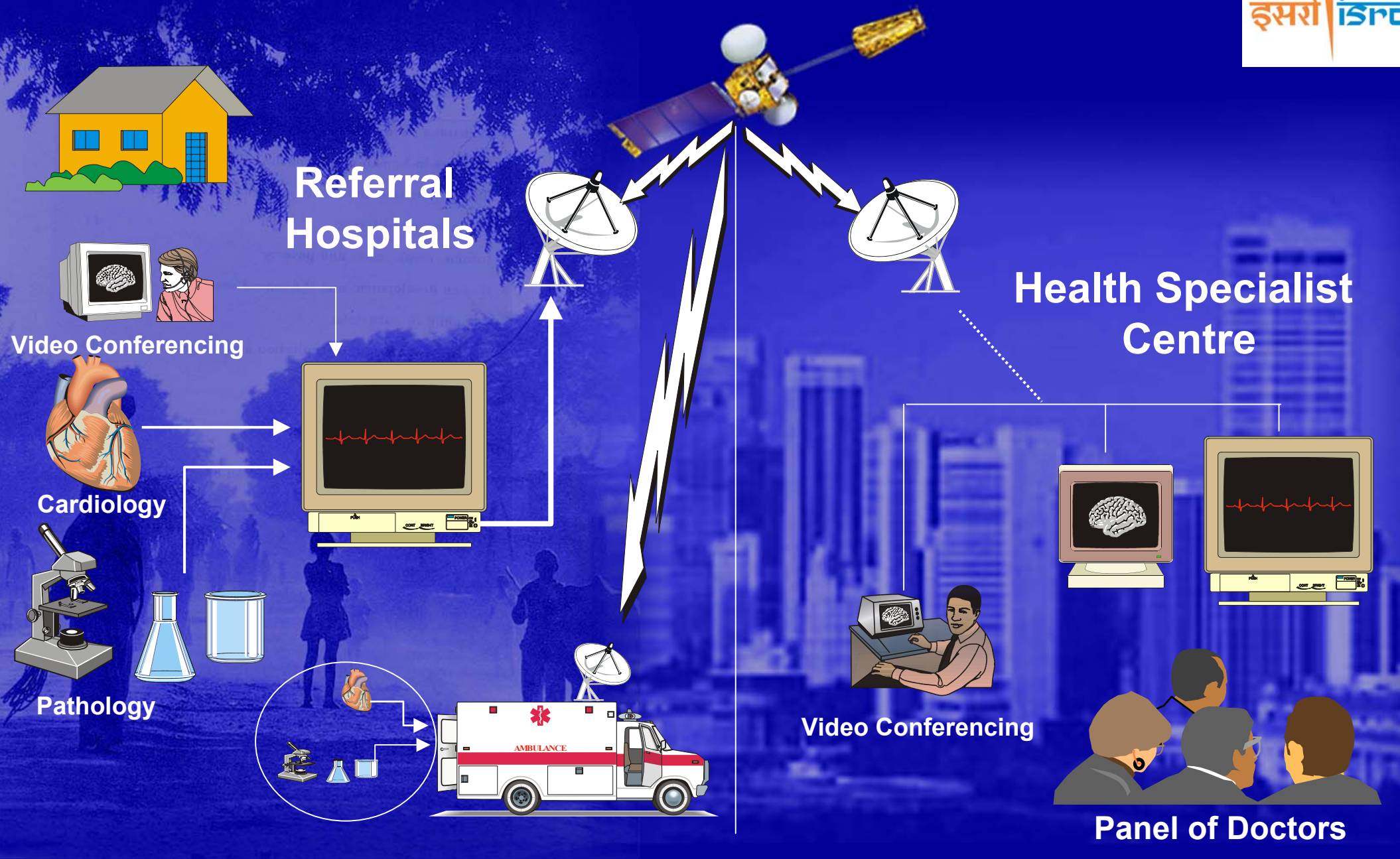
INFORMATION FOR DECISION

DECISION FOR ACTION

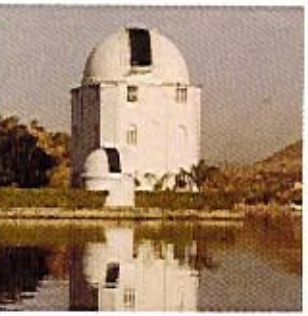
SPACE AND EDUCATION



TELEMEDICINE VIA SATELLITE

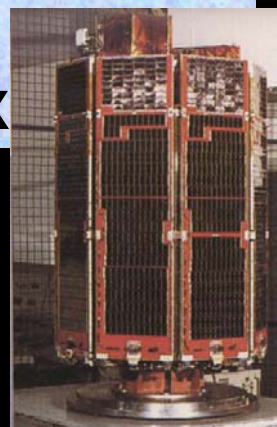


SPACE SCIENCES



- ATMOSPHERIC RESEARCH :
  - NATIONAL MST RADAR
  - LIDAR
  - BALLOON FLIGHTS
  - SOUNDING ROCKETS
- GAMMA RAY DETECTOR AND RPA ON SROSS-C2
- X-RAY ASTRONOMY ON IRS-P3
- GROUND TELESCOPES

PROGRAMMES:
- IGBP
- IMAP
- ISTEP
- INDOEX

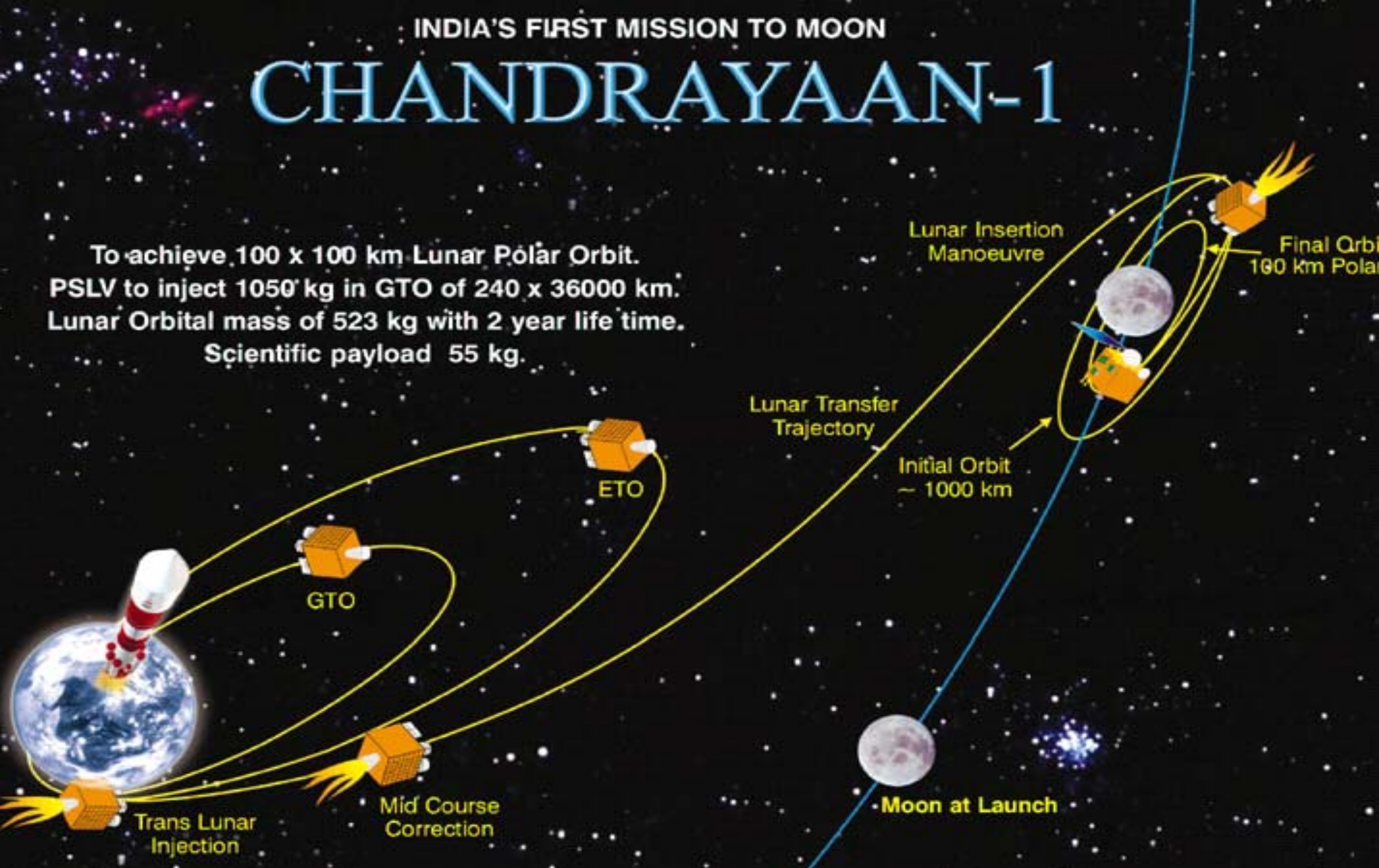


- ASTRONOMY AND ASTROPHYSICS
- PLANETARY ATMOSPHERES AND AERONOMY
- EARTH SCIENCES AND SOLAR SYSTEM STUDIES
- THEORETICAL PHYSICS

INDIA'S FIRST MISSION TO MOON

CHANDRAYAAN-1

To achieve 100 x 100 km Lunar Polar Orbit.
PSLV to inject 1050 kg in GTO of 240 x 36000 km.
Lunar Orbital mass of 523 kg with 2 year life time.
Scientific payload 55 kg.

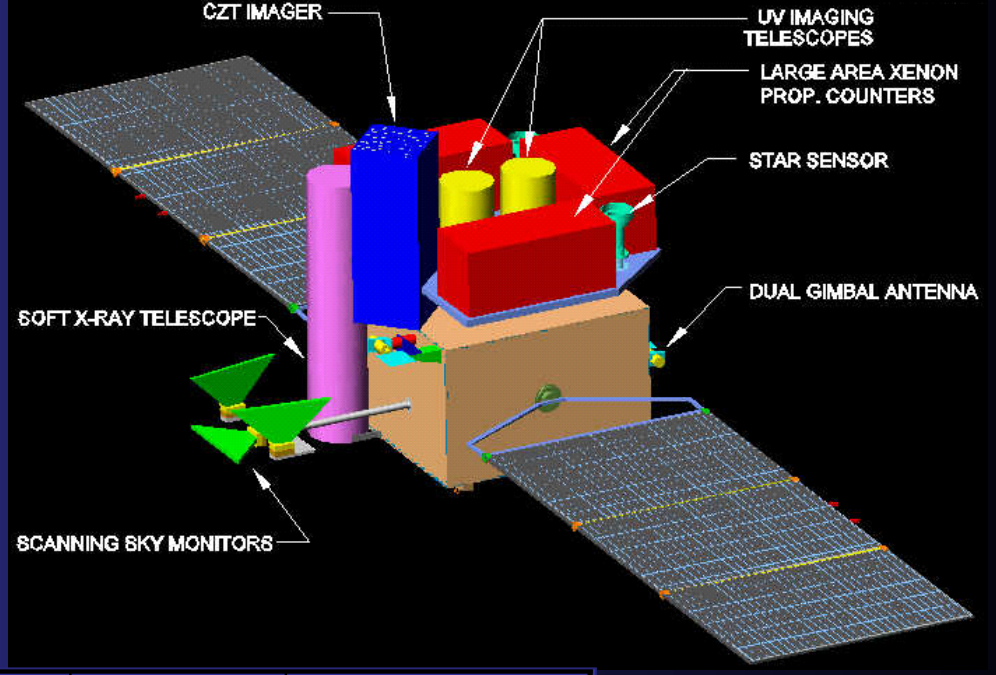


Expanding the scientific knowledge about the moon, upgrading India's technological capability and providing challenging opportunities for planetary research for the younger generation

CHANDRAYANA-1 Scientific Payloads

- **Terrain Mapping stereo Camera (TMC)** – pan. 5m, 40 km swath, to prepare a high resolution atlas of moon
- **Hyper Spectral Imager (HySI)** - 400-900nm range, spectral resolution - 15nm, 80 m, 40 km swat, for mineralogical mapping
- **Lunar Laser Ranging Instrument (LLRI) -** for determining accurate altitude of the spacecraft above the lunar surface (10 m ht. resolution) for topographical mapping
- **Collimated Low Energy** (0.5-10 keV) **X-ray spectrometer (LEX)** for measuring the fluorescent X-rays emanating from the lunar surface having ground spatial resolution of about 10 km, for elemental mapping of Si, Al, Mg,Ca, Fe,Ti
- **Solar X-ray Monitor (SXM)** in 2-10 keV energy range, for solar X-ray flux monitoring
- **High Energy** (10-200keV) **X-ray/g-ray spectrometer (HEX)** having a ground spatial resolution of approximately 20 km, for measuring 210Pb, 222Rn degassing, U, Th etc.

ASTROSAT

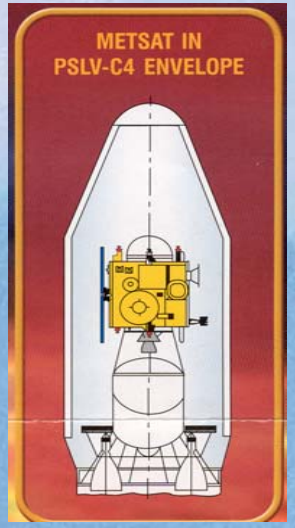


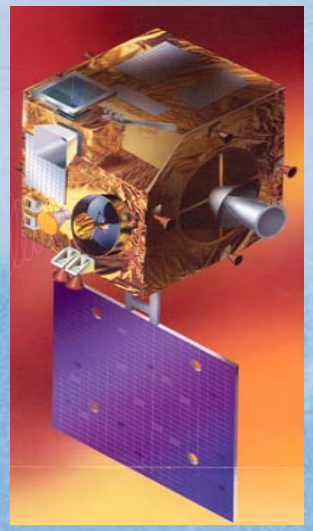
	Energy range	Description	Angular resolution	sensitivity
SXT	0.3 – 8 keV	Focussing X-ray mirror + CCD (39 shells) FOV=42’	3 – 4 arcmin	~0.01milliCrab (10,000 sec)
LAXPC	2 – 80 keV	Large proportional counters (3)	~5arcmin (scan mode)	0.1 milliCrab (1000 sec)
CZT-imager	10 – 150 keV	CZT array (hard X-ray imager)	8 arcmin	0.5 milliCrab (1000 sec)
SSM	2 – 10 keV	All sky monitor (3) on a boom	5 – 10 arcmin	30 milliCrab (300 sec)
UVIT	1300 – 3000 Ang	Twin RC telescopes – 40 cm each (NUV, FUV)	1 arc sec	21-22 magnitude (1800 sec)

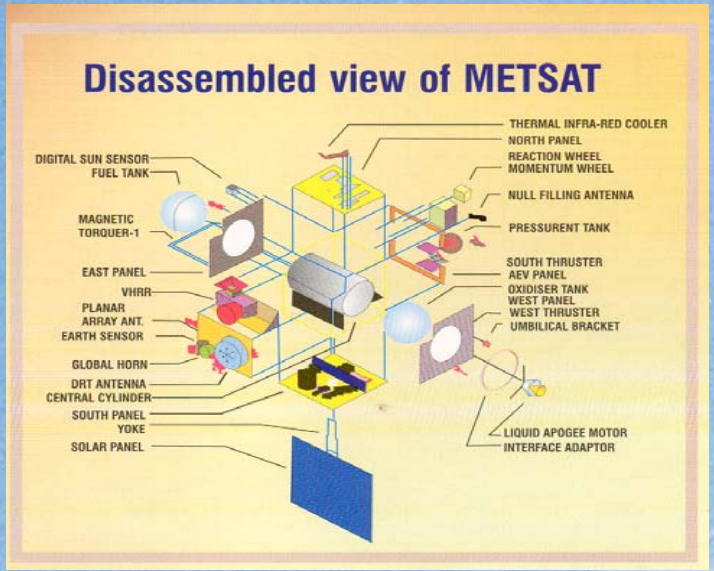
PSLV- C4 / METSAT MISSION

The Seventh flight of PSLV, successfully carried 1055 kg METSAT into Geo-Synchronous Transfer Orbit (GTO)

12 September 2002







ISRO LAUNCHERS

	PSLV	GSLV	GSLV-MkIII
WEIGHT(t)	294	400	629
PAYLOAD (kg)	1200 SSO	1800 GTO	4000 GTO
FLIGHTS	7 (93 –02)	1 (2001)	--

ACCOMPLISHMENTS

- WORLD-CLASS SATELLITES FOR COMMUNICATION AND REMOTE SENSING
- OPERATIONAL LAUNCH CAPABILITY FOR REMOTE SENSING SATELLITES
- GSLV TO LAUNCH COMMUNICATION SATELLITES
- TWO OPERATIONAL SPACE SYSTEMS,INSAT & IRS
- BRINGING THE BENEFITS TO GRASS-ROOT LEVEL
- PROVEN INSTITUTIONAL MECHANISMS FOR INTERFACES WITH EXTENSIVE USER COMMUNITY
- EXCELLENT INTERFACE WITH INDUSTRY AND ACADEMIA
- COST-EFFECTIVE APPROACH AND ENTRY INTO GLOBAL SPACE MARKET

35+4 SATELLITES **16 LAUNCHES**

JUNE 2002

9TH PLAN		10TH PLAN					PART - 11TH PLAN		
MISSIONS	**2001-02**	**2002-03**	**2003-04**	**2004-05**	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**
INSAT	3C(P)	3A(P)	3E(P)	4A(P)	4B(P)	4C	4D 4E	4F	4G
TECHNOLOGY/ EXPERIMENTAL	GSAT-1	GSAT-2	GSAT-3	SRE-1	GSAT-4 Smallsat	SRE-2 Smallsat	GSAT (MKIII)	ACTS(P) GSAT (MKIII)	GSAT (MKIII)
METSAT		METSAT-1		INSAT-3D	METSAT-2			METSAT-3	
IRS	TES	Resourcesat-1	CARTOSAT-1	CARTOSAT-2	RISAT-1	Oceansat-2	Resourcesat-2		RESOURCE-3
SPACE SCIENCE /ENVIRONMENT.		CRABEX / SOX			ASTROSAT	MEGHA-TROPIQUES	Planetary Mission		
PSLV	C3	C5 C4	C6	C7	C8 C9 C10	C12 C11	C14 C13	C15	C16
GSLV – MKI & II	D1	D2	D3	C1	C2	C3	C5 C4	C6	C7
GSLV - MKIII							D1	D2	C1

(P) - PROCURED LAUNCH

MISSION PROFILE 2001-10

(Excluding user funded missions)

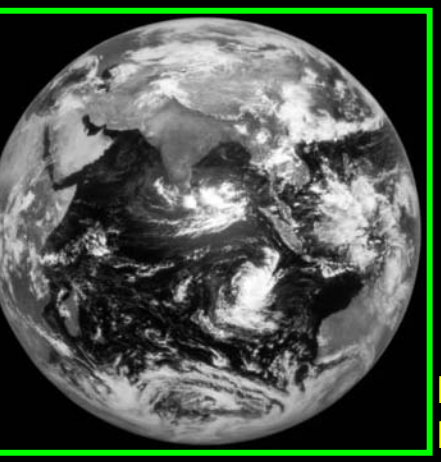
RISAT-Radar Imaging Satellite; SRE-Space Capsule Recovery Experiment ; TES-Technology Experiment Satellite ; ACTS-Adv. Communication Tech. Satellite

INTERNATIONAL DIMENSIONS

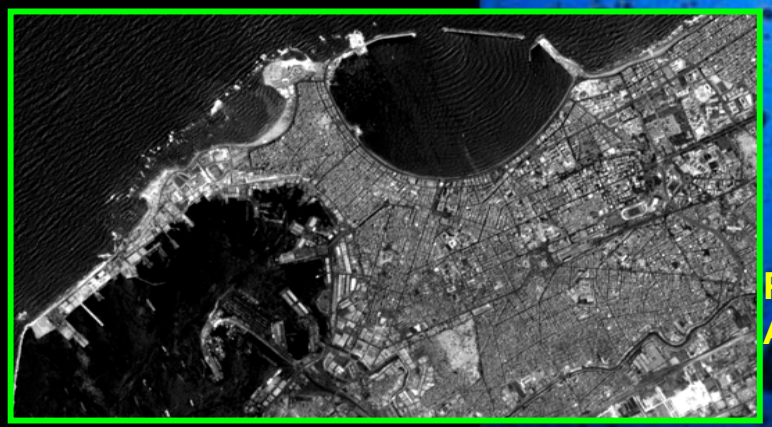
INSAT-2E WIDE BEAM COVERAGE

TWO-WAY COOPERATION WITH MAJOR SPACE PLAYERS & INTERNATIONAL BODIES

CANADA, CHINA, ESA, FRANCE, GERMANY, HUNGARY, INDONESIA, ITALY, NORWAY, PERU, RUSSIA, The NETHRLANDS, USA, UK, UN, ESCAP...



METEO DATA EXCHANGE



PAN IMAGE OF ALEXANDRIA

POKERFLAT
FAIRBANKS
NORMAN
ECUADOR
SVALBARD
BEARSLAKE
WEILHAM
NEUSTRELITZ
SAUDI
DUBAI
HYDERABAD
ROK
KUMAMOTO
TAIWAN
BANGKOK
BIAK
MAURITIUS
HARTEBEESHOEK

★ TTC STATIONS

● IRS DATA RECEPTION

Thank You