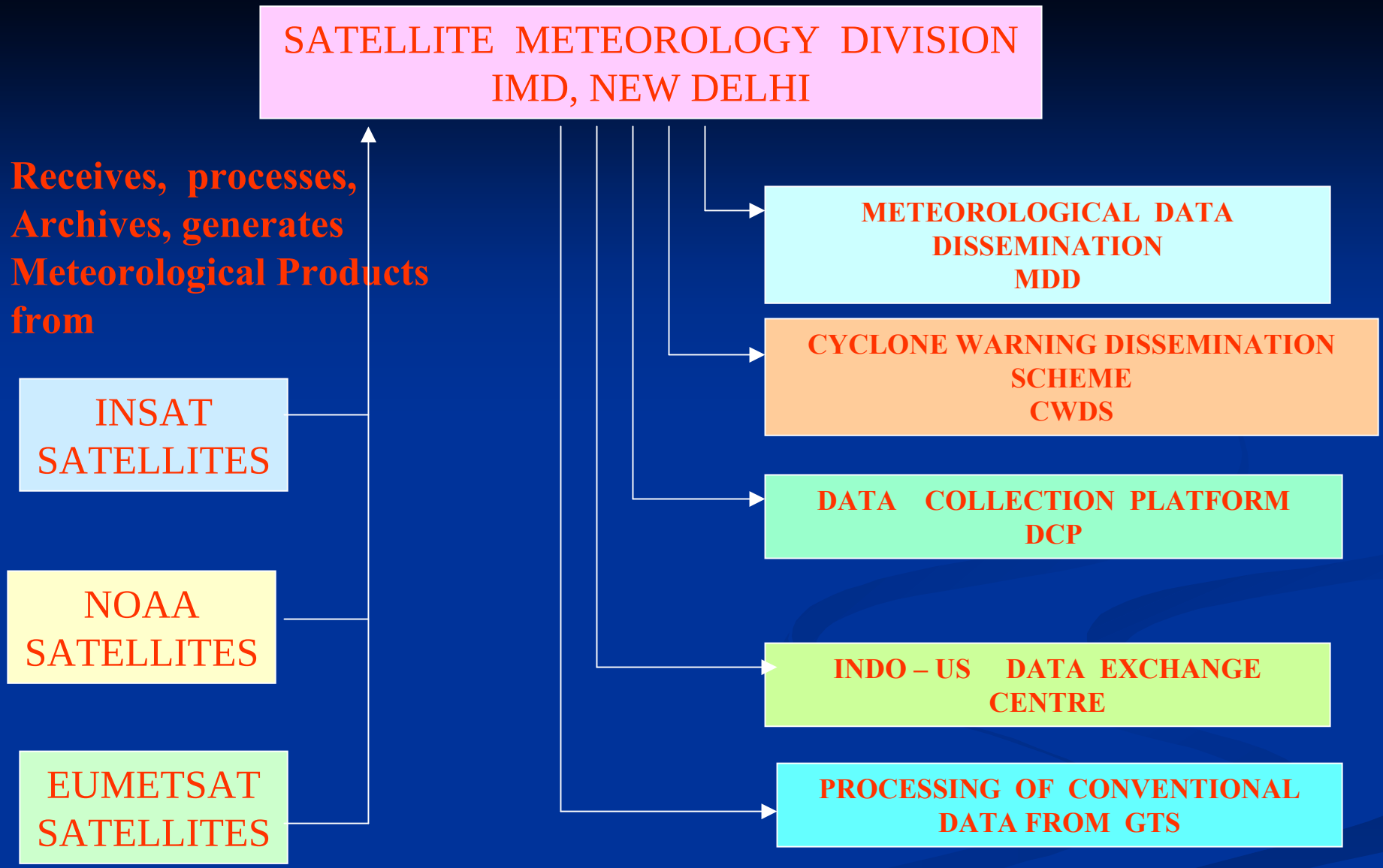
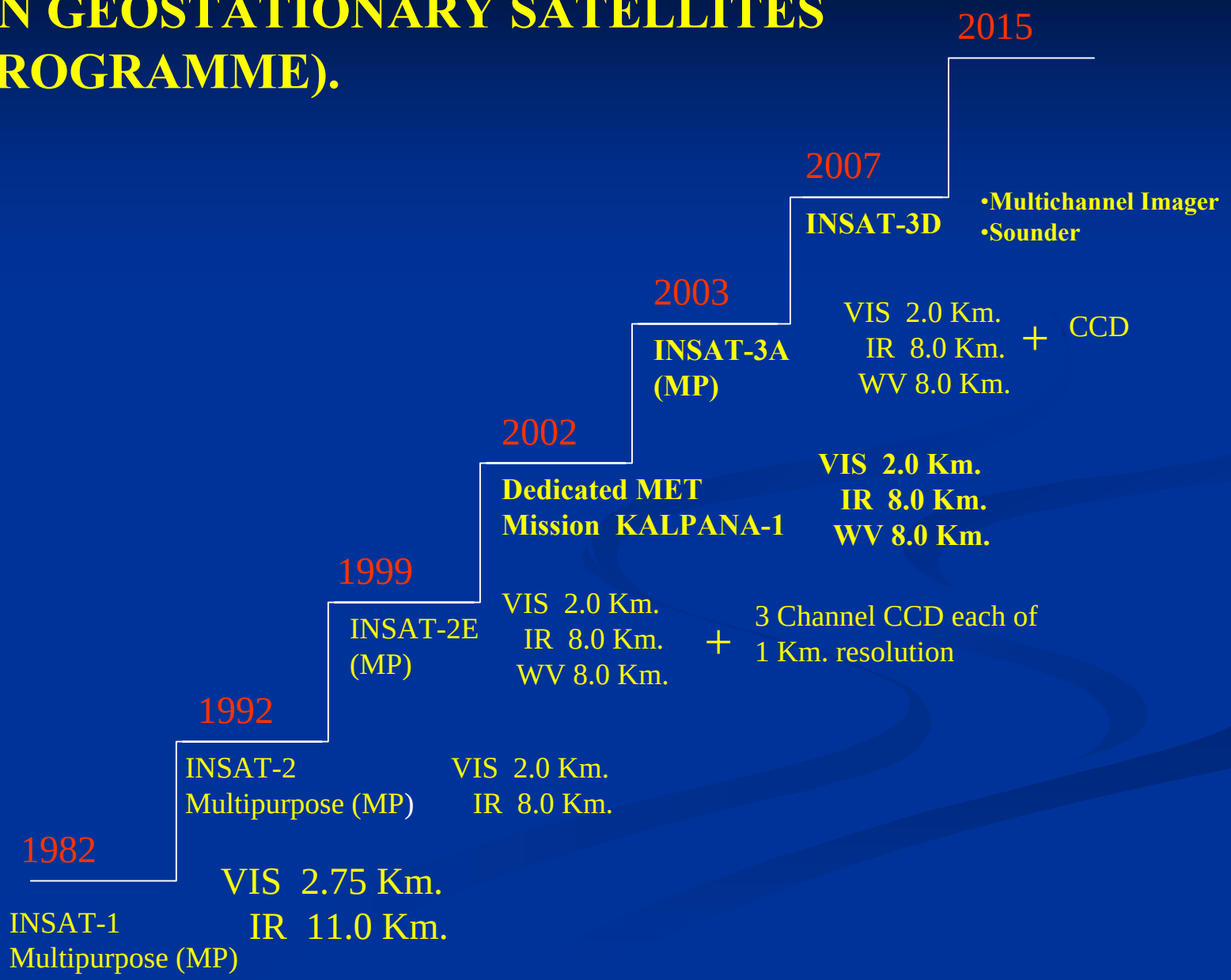
Status Report on current and future Geostationary Indian Satellites

By

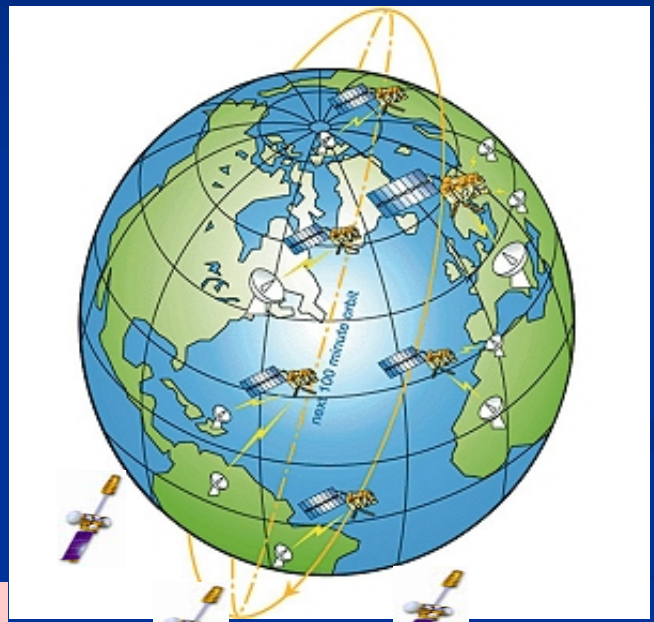
Dr. Devendra Singh
Director
Satellite Meteorology
India Meteorological Department
New Delhi-110003


SATELLITE METEOROLOGY DIVISION
IMD, NEW DELHI
Receives, processes, Archives, generates Meteorological Products from
INSAT SATELLITES
NOAA SATELLITES
EUMETSAT SATELLITES
METEOROLOGICAL DATA DISSEMINATION MDD
CYCLONE WARNING DISSEMINATION SCHEME CWDS
DATA COLLECTION PLATFORM DCP
INDO – US DATA EXCHANGE CENTRE
PROCESSING OF CONVENTIONAL DATA FROM GTS

LADDER OF PROGRESS IN THE METEOROLOGICAL CAPABILITIES OF INDIAN GEOSTATIONARY SATELLITES (INSAT PROGRAMME).



Operational Indian Geostationary Meteorological Satellites



Kalpana-1
74°E

INSAT-2E
83°E

INSAT-3A
93.5°E

Indian Geostationary Meteorological Satellites

S.N.	Name of Satellite	Year of Launch	Position
1.	INSAT-2E	1999	83^{O}E
2.	Kalpana – 1	2002	74°E
3.	INSAT – 3A	2003	93.5°E

Payloads & channel characteristics of Kalpana – 1

S.No	Payload	Channel	Spectral Bandwidth	Resolution
1.	VHRR	Visible	0.55 - 0.75 μ	2 Km. x 2 Km.
		Infrared	10.5 - 12.5 μ	8 Km. x 8 Km.
		Water Vapour	5.7 - 7.1 μ	8 Km. x 8 Km.
2.	DRT	For Collection & Dissemination of AWS data.		

Payloads and channel characteristics of INSAT-2E and INSAT-3A

(i) VHRR

Channels	Spectral Range	Resolution
Visible	0.55 - 0.75 μ	2 Km.
Infrared	10.5 - 12.5 μ	8 Km.
Water Vapour	5.7 - 7.1 μ	8 Km.

(ii) CCD

Channels	Spectral Range	Resolution
Visible	0.63 - 0.69 μ	1 Km.
NIR	0.77 - 0.86 μ	1 Km.
SWIR	1.55 - 1.69 μ	1 Km.

INSAT-3D FEATURES

- INSAT 3D IS A METEOROLOGICAL SPACECRAFT HAVING 6 CHANNEL IMAGER, 19 CHANNEL SOUNDER, DRT AND S A A &R

- IT IS A MOMENTUM BIASED 3-AXIS STABILISED SPACECRAFT USING STAR SENSOR IN THE CONTROL LOOP.

- IMC/MMC PROVIDED FOR REQUIRED PAYLOAD POINTING

- BI-ANNUAL YAW ROTATION IS PROVIDED TO REDUCE THE PATCH TEMP.

- THE SPACECRAFT WILL BE LOCATED AT 82 DEG. E AND SUB-ORBITAL POINT FALLS OVER INDIA.

- THE LIFT-OFF MASS TO THE SPACECRAFT IS 2000KG, WITH A DRY MASS OF 907 KG.

- GSLV LAUNCH(SHAR) EARLY 2007

- 7.7 YEARS LIFE

CRITICAL DESIGN CHALLANGES

Enhancement of Radiometric Performance

- **Requirement much tighter compared to VHRR because of small spectral bandwidth, finer spatial resolution and tighter NEDT specifications.**
- **Planned to be met through**
  - Increased optics size
  - Better detector specifications
  - Lower patch temperature (requires six-monthly yaw rotation)
  - Lower electronics noise density
  - Optimal I/f noise shaping for sounder
  - Tight control on system noise
  - Collecting sounder data for two or four wheel rotations and ground processing to enhance S/N

  Accommodating large number of detectors for signal processing
- **Use of 179 HMCs and eight FPGA to save equivalent of 15 daughter boards and associated weight.**

New Features of imaging payload

1. Modified Blackbody calibration sequence. Here, fresh space clamp values will be acquired before and after Blackbody view to minimize the effect of l/f noise.
2. Faster sampling of SME HK data to incorporate complete SME data in payload data format at 55 ms rate to avoid dependence on 'dwell mode TM' of spacecraft and simplify ground processing and archival.
3. Two flexible modes of operation will be provided instead of three fixed modes of earlier VHRR payloads:

- Full frame mode scans 18 EW x 18 NS covering the entire earth disc and some space around.
- Program mode covering 18 in EW direction NS coverage can be defined in terms of number of lines to be scanned.

INSAT-3D IMAGER CHARACTERISTICS

Band	Freq. In um	Res. in Km.
Visible	0.52-0.75	1.0
SWIR	1.55-1.70	1.0
MIR	3.80-4.00	4.0
WV	6.50-7.00	8.0
TIR-1	10.2-11.2	4.0
TIR-2	11.5-12.5	4.0

KEY FEATURES OF IMAGER (INSAT – 3D)

Telescope Aperture	310 MMϕ
Number of Channels	Six
Channel Separation	Beam Splitter
Channel Definition	Interference Filters
Instantaneous Field of View	28 µrad Vis and SWIR (1km) 112 µrad MIR, TIR1 & TIR2 (4km) 224 µrad WV (8km)
Sampling Interval	1.75 Samples / IFOV for VIS, SWIR, MIR & TIR 1 / 2 3.5 Samples / IFOV for WV

Sampling Interval	**1.75 Samples / IFOV for VIS, SWIR, MIR & TIR 1 / 2** **3.5 Samples / IFOV for WV**
Scan Step Angle	**Linear in E-w Direction (8µR step size)** **Line Step 224 µrad N-S**
Scan rate	**20^0 / Sec +0.2 sec turn around**
Scan Linearity	**56 µR (Peak-Peak)**
Inflight Calibration	**Full Aperture Blackbody and spaceview**
Scan modes	**Full, normal and Programmable sector for Quick Repeativity**
Frame Time	**25 minutes for Normal Mode**
Radiometric Performance	**See Table 3.1.2**
Signal Quantisation	**10 Bits / Sample**
Down Link Data Rate	**4.0M Bits / Sec**

TABLE – 3
SPECTRUM AND SENSITIVITY

Channel No.	Centre Wavelength μm (cm^{-1})	Bandwidth μm (cm^{-1})	NEDT at 300 K (typical) K
1	14.71 (680)	0.281 (13)	1.5
2	14.37 (696)	0.268 (13)	1
3	14.06 (711)	0.256 (13)	0.5
4	13.96 (733)	0.298 (16)	0.5
5	13.37 (749)	0.286 (16)	0.5
6	12.66 (790)	0.481 (30)	0.3
7	12.02(832)	0.723 (50)	0.15
8	11.03 (907)	0.608 (50)	0.15
9	9.71 (1030)	0.235 (25)	0.2
10	7.43 (1345)	0.304 (55)	0.2
11	7.02 (1425)	0.394 (80)	0.2
12	6.51 (1535)	0.255 (60)	0.2
13	4.57 (2188)	0.048 (23)	0.15
14	4.52 (2210)	0.047 (23)	0.15
15	4.45 (2245)	0.0456(23)	0.15
16	4.13 (2420)	0.0683(40)	0.15
17	3.98 (2513)	0.0663 (40)	0.15
18	3.74(2671)	0.140 (100)	0.15
19	0.695 (14367) 0.05 (1000) (0.67-0.72)		0.1% albedo

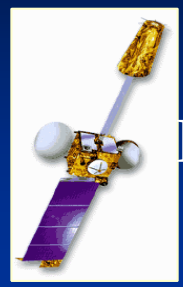
TABLE –4

KEY FEATURES OF THE SOUNDER (INSAT 3-D)

Telescope Aperture	310 MMΦ
No. of Channels	18 Infrared + 1 Visible
Channel definition	Filter Wheel with Interference Filters
Instantaneous field of view	280 µrad x 280 µrad (N-S) (10 km x 10 km)
Sampling Interval	280 µrad E- W /N-S
No. of Simultaneous sounding	4 Per channel
Scan step angle	10 km E-W Every 0.1 Sec. And 40 km N-S After completion of E-W Scan 150µR(RMs)

Step and Dwell Time	0.1, 0.2 and 0.4 Sec.
Turn Around Time	0.1 per Scan
In-flight Calibration	Full Aperture Black Body and Space View
Scan Modes	Options provided to cater to Quick Dynamic Environmental Phenomena
Frame Time	160 minutes for 6000 km 6000 km area Sounding
Radiometric Performance	See Table 3.1.4
Signal Quantisation	13 Bits / Sample
Down Link Data Rate	40 Kbits / Sec
System Power	100 Watts
System Weight	90 Kg (Without Cooler)

Automatic Weather Stations (AWS)



INSAT

UHF UPLINK

Ext - C band downlink

DCPs

Receiver

Work Station

Automatic Weather Stations (AWS)

AWS are installed all over the country to take meteorological observations every hour and transmit it to the satellite.

- The Data Relay Transponder on-board the satellite receives these data and retransmit it to Delhi Earth Station of IMD.
- Satellite Division receives these data and processes it to get meteorological data in the required format.
- Data from remote unmanned stations & ocean buoys is also received.

Meteorological Data Dissemination (MDD)

INSAT

C - band uplink

Satellite Division

Telecom Division

S- band Downlink

MDD Receiving Stations in India and neighbouring countries.

Meteorological Data Dissemination (MDD)

- Processed satellite imagery, analyzed weather charts and conventional synoptic data is uplinked to the satellite in C-band. Satellite broadcasts these data to MDD stations in S - band.

- MDD Stations analyse weather imagery and other data to generate required forecast.

The processing system is also being used for generating analogue type of cloud imagery data which are transmitted through INSAT-3C to field station using S-band broadcast capability of the satellite along with other conventional meteorological data and FAX charts. This scheme is called Meteorological Data Dissemination(MDD).

There are about 90 MDD receiving stations in the country being operated by different agencies. Two MDD receiving stations are also operating in neighbouring countries at Sri Lanka and male under bi-lateral agreement. In general, the processed images are sent to these stations every three hours, and every hour during cyclone periods. These stations are receiving direct broadcast of cloud imager, weather facsimile charts and meteorological data on an operational basis.

The frequency of transmission from tround to satellite (Uplink is 5899.225 MHz and downlink is at 2599.225 MHz.

Cyclone Warning Dissemination System (CWDS)

INSAT

C band uplink

S- band
Downlink

Earth Station

ACWCs

- Calcutta
- Chennai
- Bombay

Coastal Stations of India

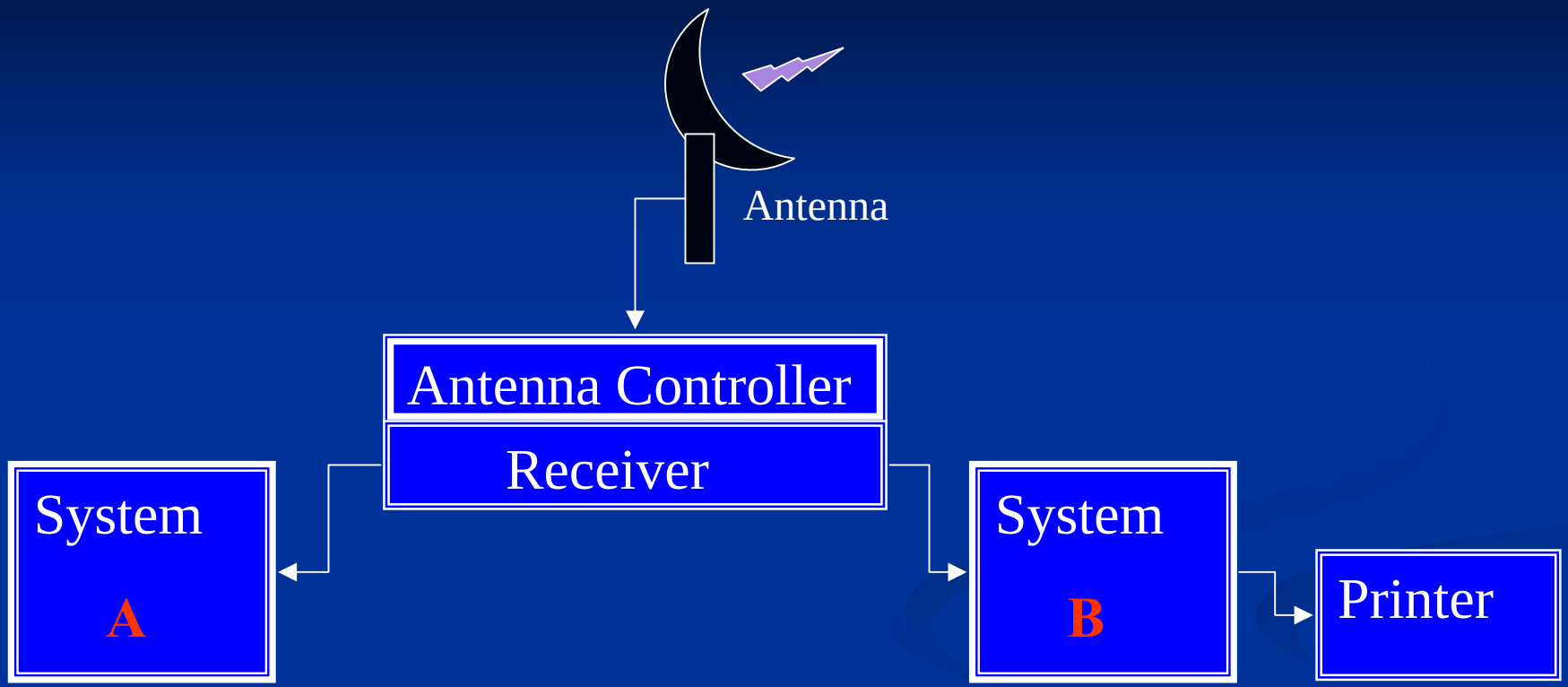
Cyclone Warning Dissemination System (CWDS)

- A cyclone warning is generated based on the observation from satellite imageries.
- The cyclone warning is uplinked to the INSAT Satellite in C-band.
- Satellite broadcassts this warning to the coastal stations in their regional languages.
- Warning is selective and will be received only by the affected stations.
- It is a very useful system and has saved millions of lives & enormous amount of property from the fury of cyclones.

For quick dissemination of warning against impending disaster from approaching cyclones, IMD has installed specially designed receivers within the vulnerable coastal areas for direct transmission of warnings to the officials and people in general using broadcast capability of INSAT satellite. IMD's Area Cyclone Warning Centres (ACWC) generates these special warning bulletins and transmits them every hour in local languages to the affected areas. IMD in the field areas has installed 250 such receivers. CWDS has proved very effective system of warning people during the cyclone affecting the coastal areas. For this service the frequency of transmission from ground to satellite (uplink) is 5859.225 MHz and Downlink is at 2559.225 MHz.

Recently, a digital CWDS scheme has been implemented in Andhra Pradesh. One hundred digital receive stations with an uplink station at IMD, Chennai have been installed. These have shown good results.

Block Diagram for HRPT System



TeraScan HRPT Acquisition and Processing System

1.2m HRPT Tracking Antenna

Antenna Pedestal

Optional Items

Color DeskJet Printer

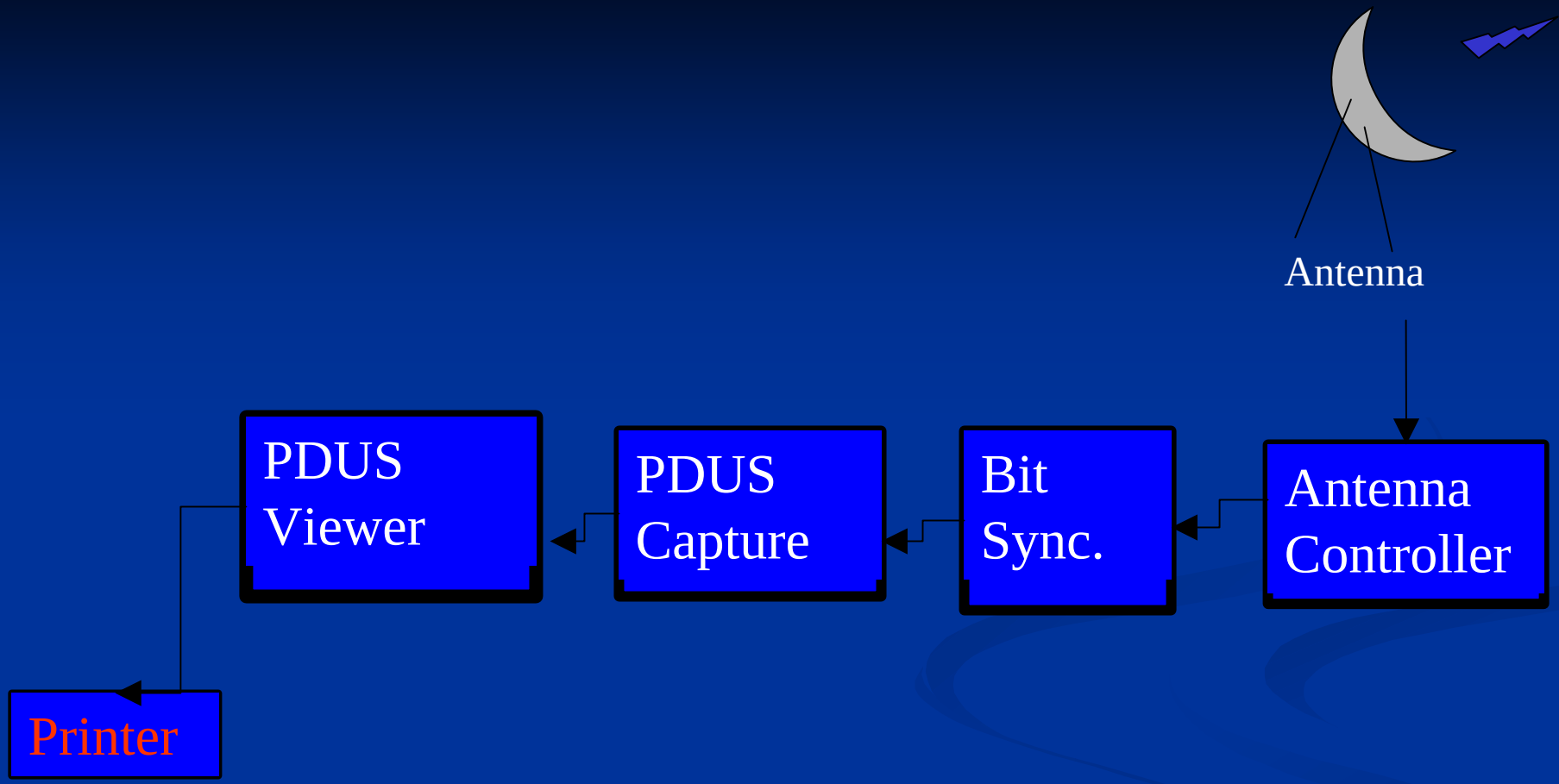
Sun Ultra-10 Acquisition and Processing

HRPT Receiver

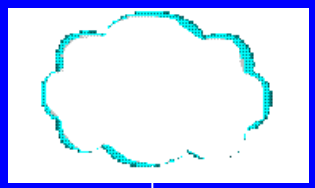
DAT Drive

UPS

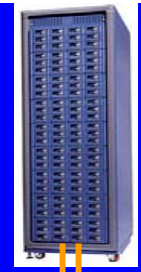
Block Diagram for PDUS : METEOSAT-5



National Satellite Data Center



RAID DISK ARRAY



Tape Library

Origin 3400[8p

Tape Library

Origin 3400[8p]

Firewall

8-Port
Fiber Channel

Main Server[s]
[In Failsafe]

Web Server A

DLT Drive
CD-Writer

Web Server B

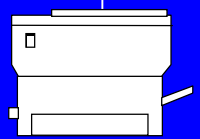
4mm DAT

2x24 port
SWITCH

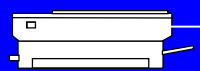
CONSOLE A

Dot Matrix Printer

CONSOLE B



Color Laser Printer



BW Laser Printer

Workstation C

4mm DAT
CD-Writer
8 mm EXABYTE

Workstation B

4mm DAT
CD-Writer
DLT Drive
8 mm EXABYTE

Workstation A

CD-Writer
DLT Drive
DVD RW
Bar Code Reader

Ingest Server A

4mm DAT
CD-Writer
DLT Drive

Ingest Server B

4mm DAT
DLT Drive

CMC Limited
Your IT Partner

National Satellite Data Center (NSDC)

- *Ingests image data and derived products from various units of satellite division*
- *Transcoding of input data format to Standard output data format*
- *Creates data catalogues based on the metadata*

Archiving and retrieval of ingested data

- *Provides search features on its database via Web interface*
- *Supports Web based imagery and product ordering*
- *Data manipulation and product creation with GUI*
- *Export of data in different formats and media*

International TOVS Study Conference, 14th, ITSC-14, Beijing, China, 25-31 May 2005. Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center, Cooperative Institute for Meteorological Satellite Studies, 2005.