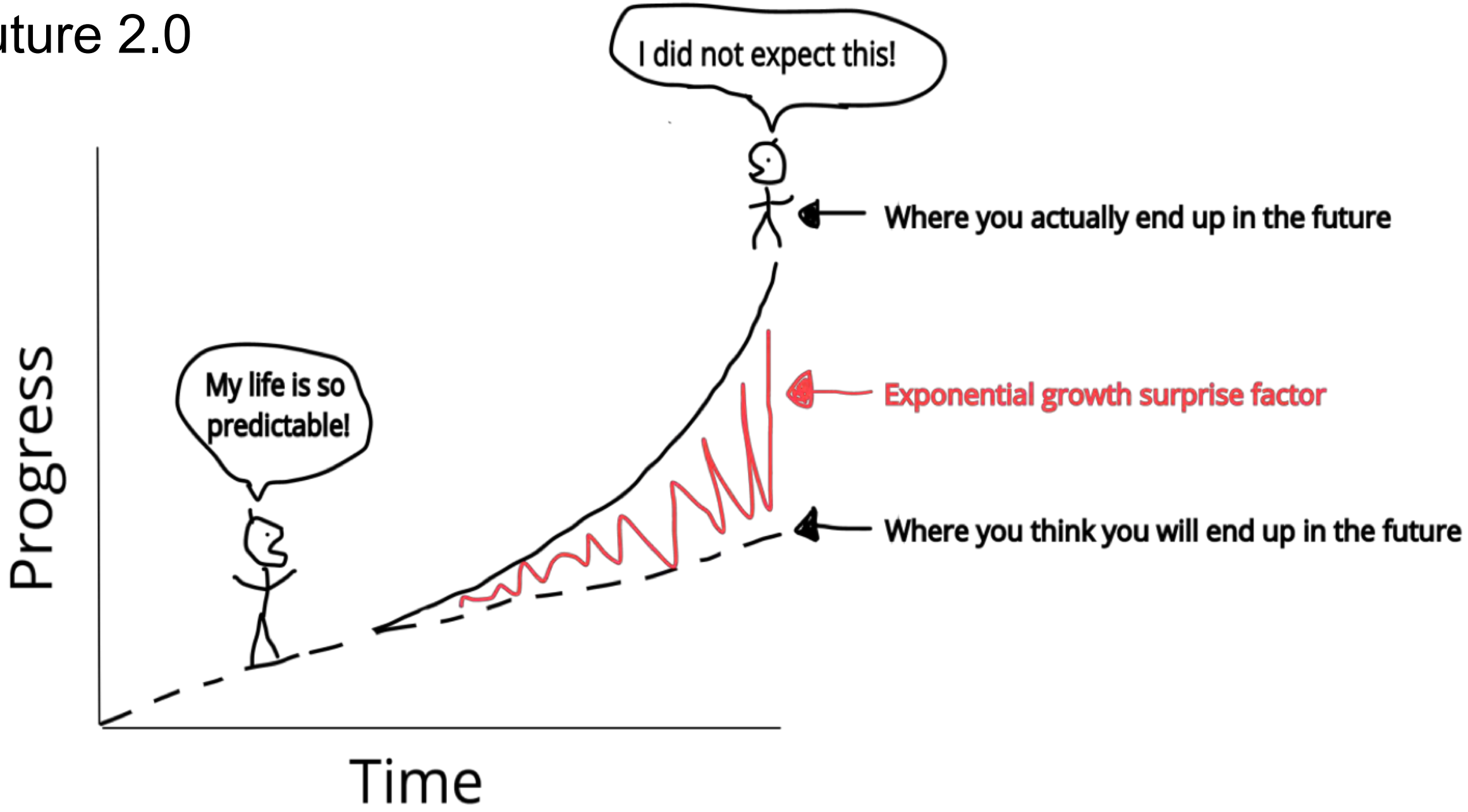
Innovative approach for the success of an Organisation & an Individual

WONDERS OF REFLECTION

WQNDFBS QE BFBFECTLQN

Future 2.0


I did not expect this!
Where you actually end up in the future
My life is so predictable!
Exponential growth surprise factor
Where you think you will end up in the future
Progress
Time

Story of a Story

Story of a Story

COLLEGE

In ISRO

Initial success of Chandrayaan-1 Mission

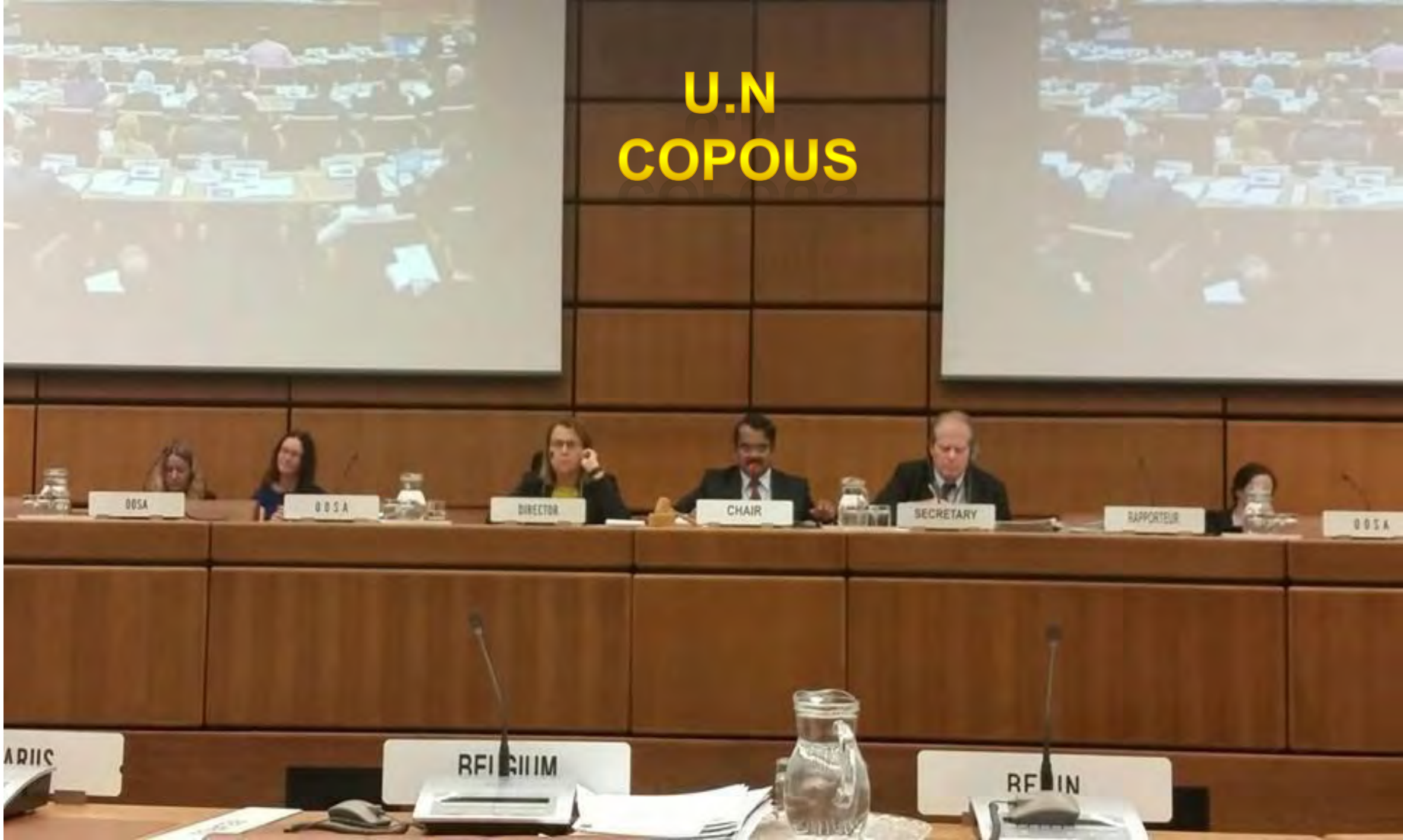
After announcing Discovery of Water on the Moon

NASA- Houstan Control centre

Kodhavady to Houstan

Happy New Year 2018

ISRO SATELLITE CENTRE
BANGALORE


U.N
COPOUS
OOSA
OOSA
DIRECTOR
CHAIR
SECRETARY
RAPPORTEUR
OOSA





36 Yrs farewell




After superannuation travelled more than 150,000kms and met more than 200,000 students and young scientists & Technologists

The gravitational force experienced by the body is $F = \frac{GMm}{R^2}$ where M is the mass of the earth. From Newton's second law of motion,

Force, $F = mg$

Equating the above two forces,

$$F = \frac{GMm}{R^2} = mg$$

Therefore, $$g = \frac{GM}{R^2}$$

This equation shows that 'g' is independent of the mass of the body 'm' but, it varies with the distance from the centre of the Earth. If the Earth is assumed to be a sphere of radius R, the value of 'g' on the surface of the Earth is given by

$$g = \frac{GM}{R^2}$$

3.9.5. Mass of earth

From the expression $g = GM/R^2$, the mass of the Earth can be calculated as follows:

$$M = \frac{gR^2}{G}$$

$= 9.8 \times (6.38 \times 10^6)^2 / 6.67 \times 10^{-11}$
$= 5.98 \times 10^{24}$ kg.

Science today

Chandrayaan

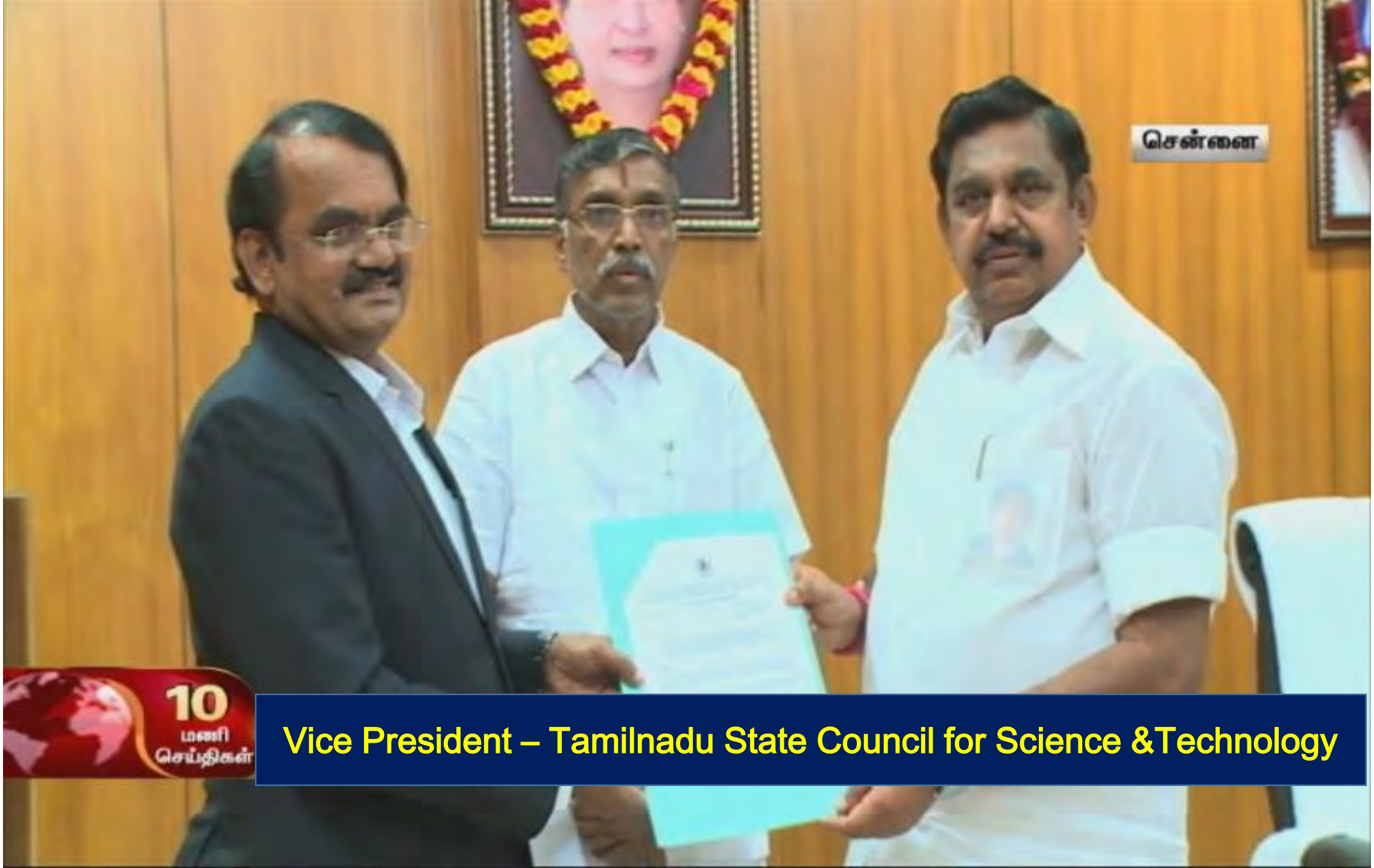
Chandrayaan-1 is a moon-traveler spacecraft vehicle. It was Indian's first unmanned lunar probe. It was launched by Indian Space Research Organization in October 2008 from Srihari Kota in Andhra Pradesh and operated until August

Mylsamy Annadurai was born on 2nd July 1958 at Kodhavadi, a hamlet near Pollachi in Coimbatore District. Mylsamy and Balasaraswathy are his parents. His father served as a teacher in an Elementary school. Panchayat Union Elementary School in Kothavadi was Mylsamy Annadurai's first school, where he studied from I to V stds. He then moved to Government and Aided schools in and around his native place for continuing and completing his school education upto XI std. His educational journey continued. He finished his PUC in NGM College, Pollachi and B.E degree at Government College of Technology, Coimbatore. In 1982 he pursued his Higher Education and acquired the M.E degree in PSG College of Technology, Coimbatore and the same year he joined in ISRO as a scientist. And later he got Doctorate in Anna University of Technology, Coimbatore..

Annadurai is a leading technologist in the field of satellite system. Currently Annadurai serves as the Project Director of Chandrayaan-1 and Chandrayaan-2. He has made significant contribution to the cost effective design of Chandrayaan. Through his inspiring speeches he has become a motivating force among the Indian students.

- 10th standard science text book

- On the walls of Tamilnadu Schools



Vice President – Tamilnadu State Council for Science &Technology

Learn to Adapt & Grow → Moon+Mars

3months into ISRO

Crazy idea : S/W satellite simulator

Prof UR.Rao:

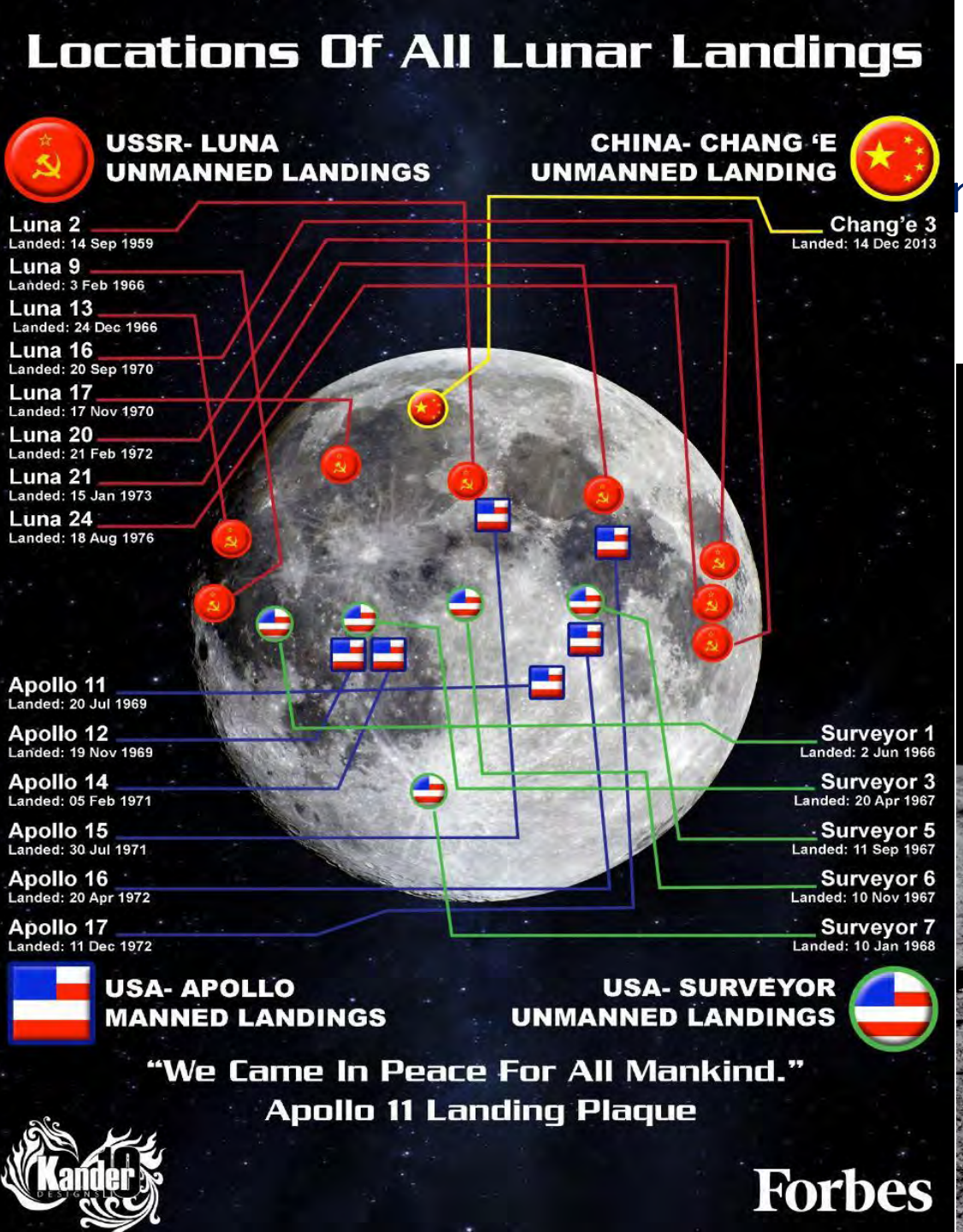
“You take the responsibilty and do it”.

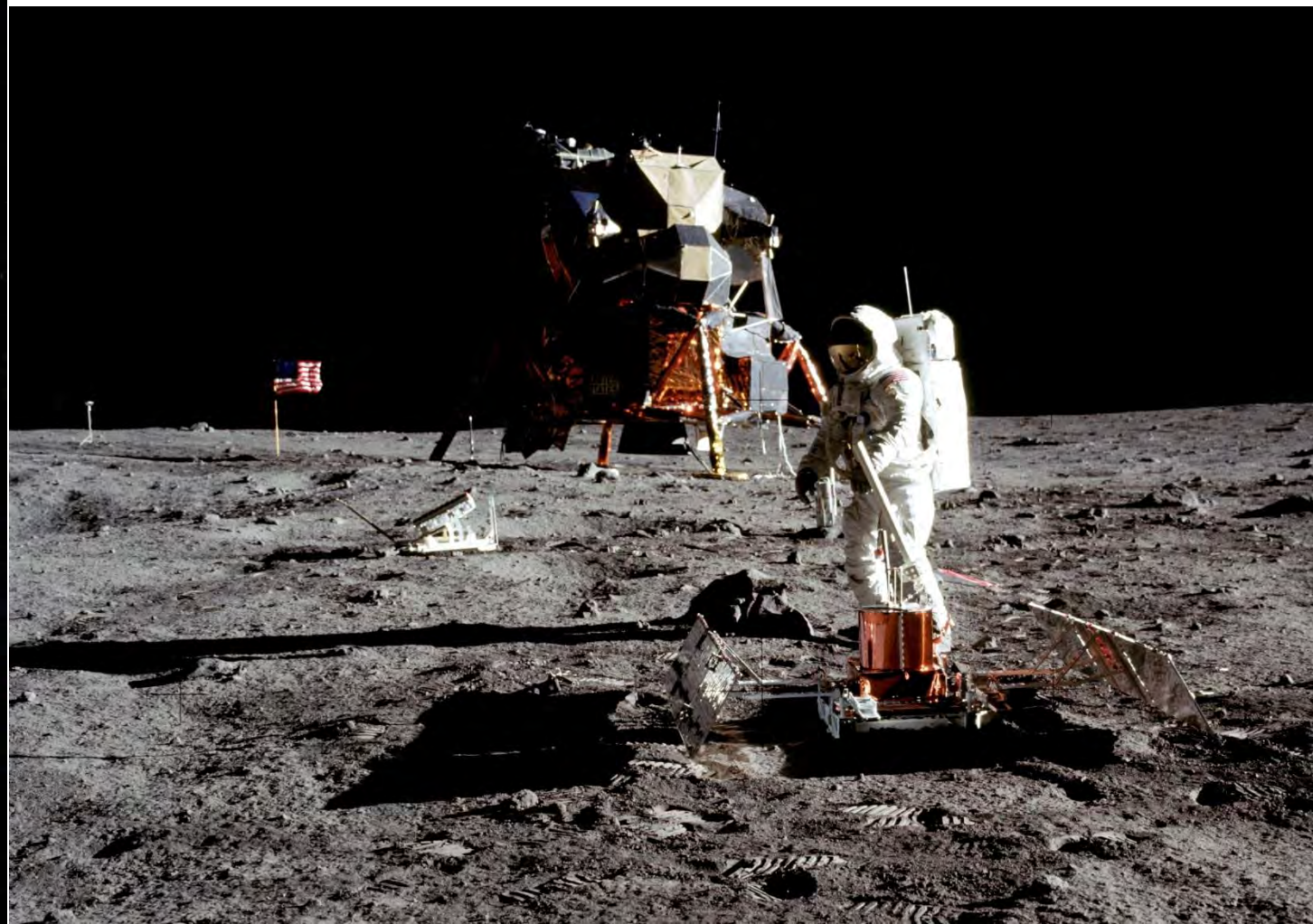
4 years of systematic work :System understanding

satellite Control Centre

S/W satellite simulator

n Missions : America & Russia



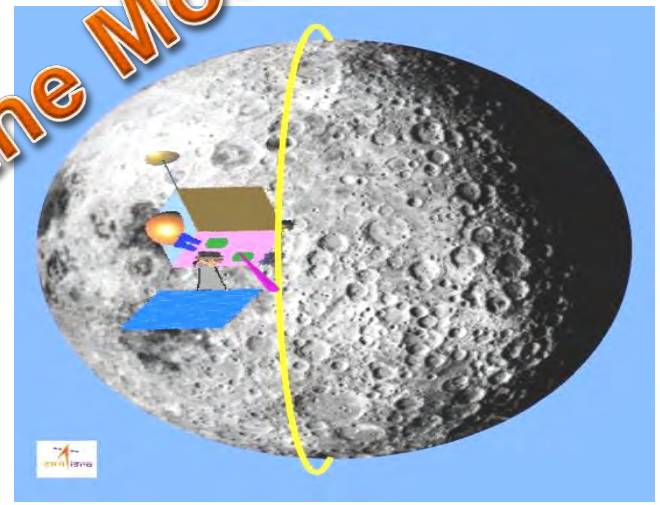


Presence of Water??

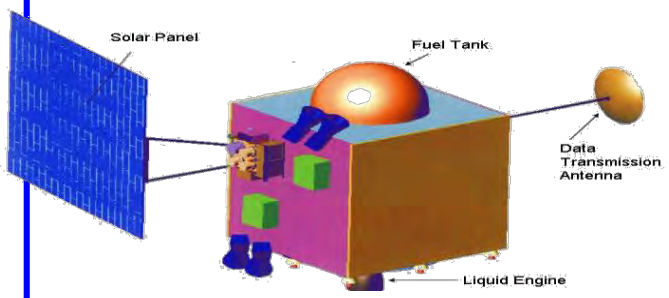
Chandrayaan-1 Mission

Configuration : 100 km polar orbiter

Observation Period : 2 years – 12hrs per day



Decisive answer for Water on the Moon



- Hyper Spectral Imager (HySI) (0.4-0.9µm)
- Terrain Mapping Camera (TMC)
- Laser Ranging (LLRI)
- Low energy X-ray spectrometer (LEX) (1-10KeV)
- High energy X-γ ray spectrometer (HEX) (10-200KeV)

Announcement of Opportunity for one additional science instrument

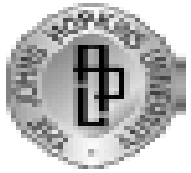
Dr. Carle Pieters

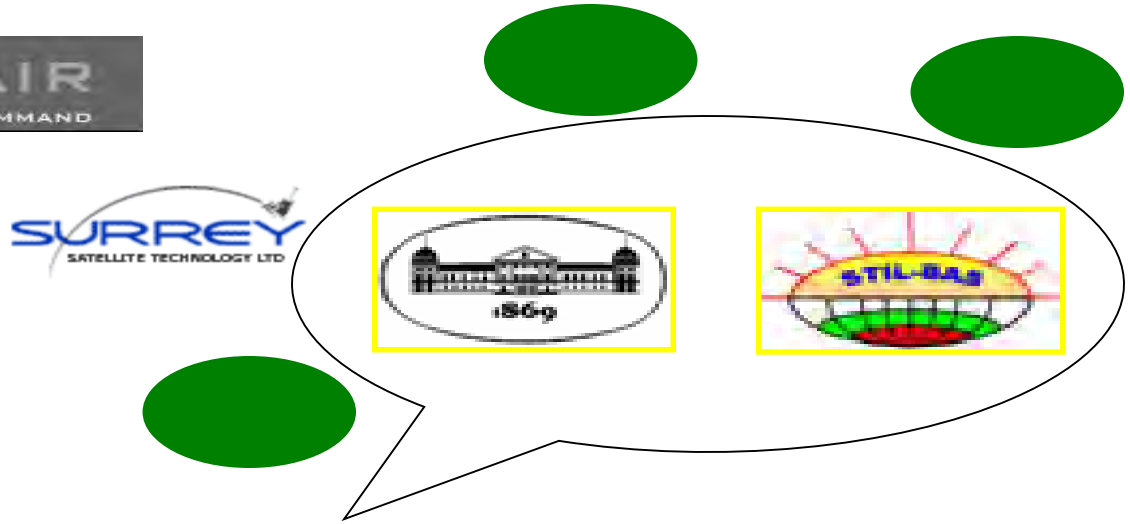
Dr.Paul Spudis


Are U
Crazy?
Are U
Crazy?
Are U
Crazy?

Innovative thinking as a team

Chandrayaan-1 : International Participation

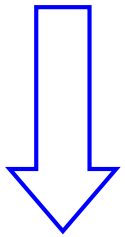




International Lunar Conference – 20-23 Nov 2004

Dr.Kalam

- Land on the moon
- Try to reach the moon

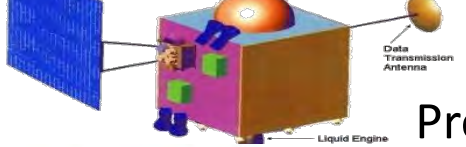


- Configuration Re-look

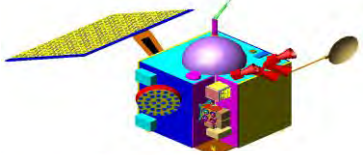
Team Meeting :Configuration Re-look!!

Innovative thinking as a team

Chandrayaan-1 Config Updates



Pre 2004



2004

2005

2006

2007

2008

PSLV –XL Capability

Trade Off Study

18m DSN

Schedule vs system maturity

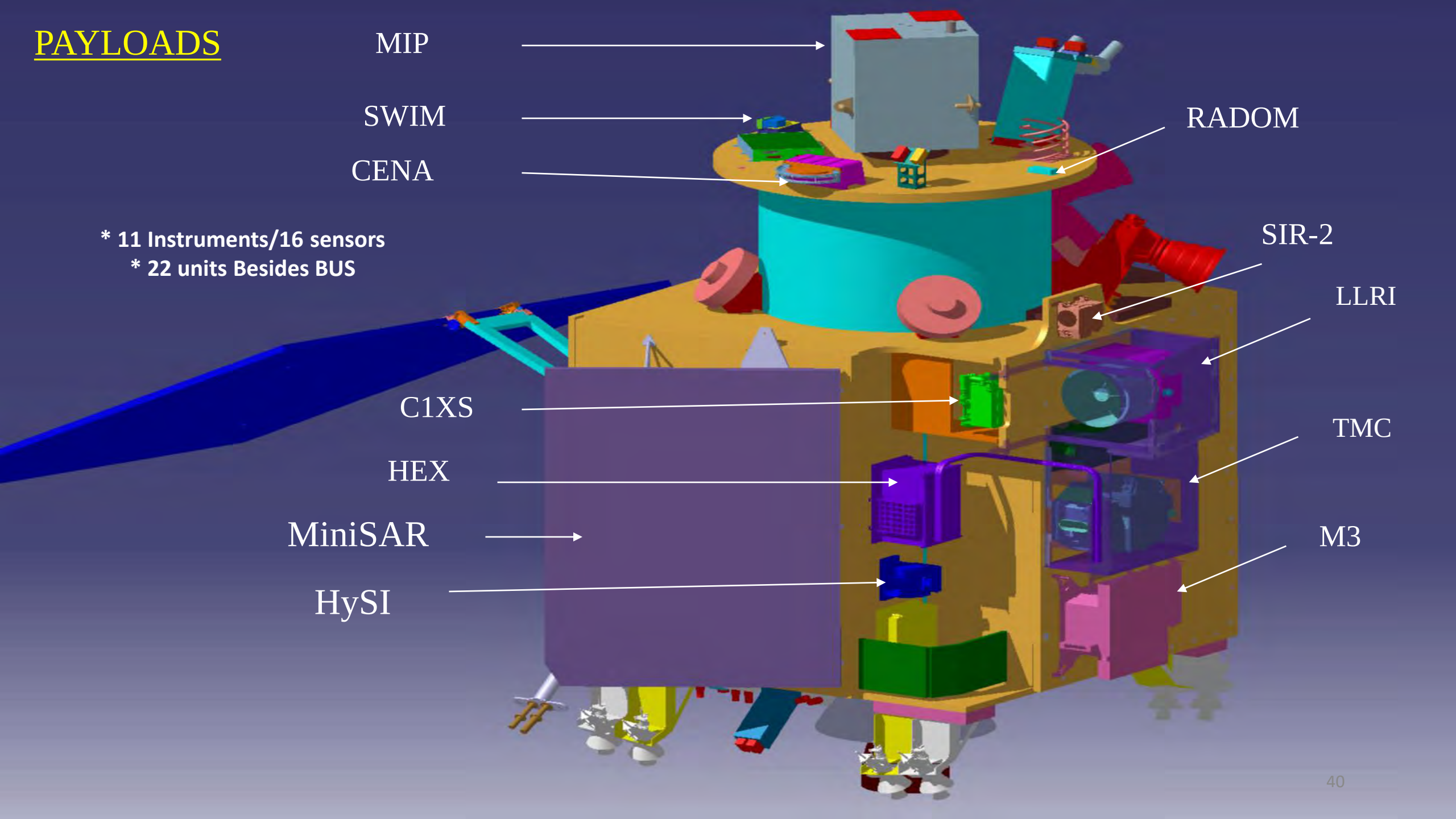
Increased P/L mass & Diff.Reqr

Interoperability

Data Policy

Budget

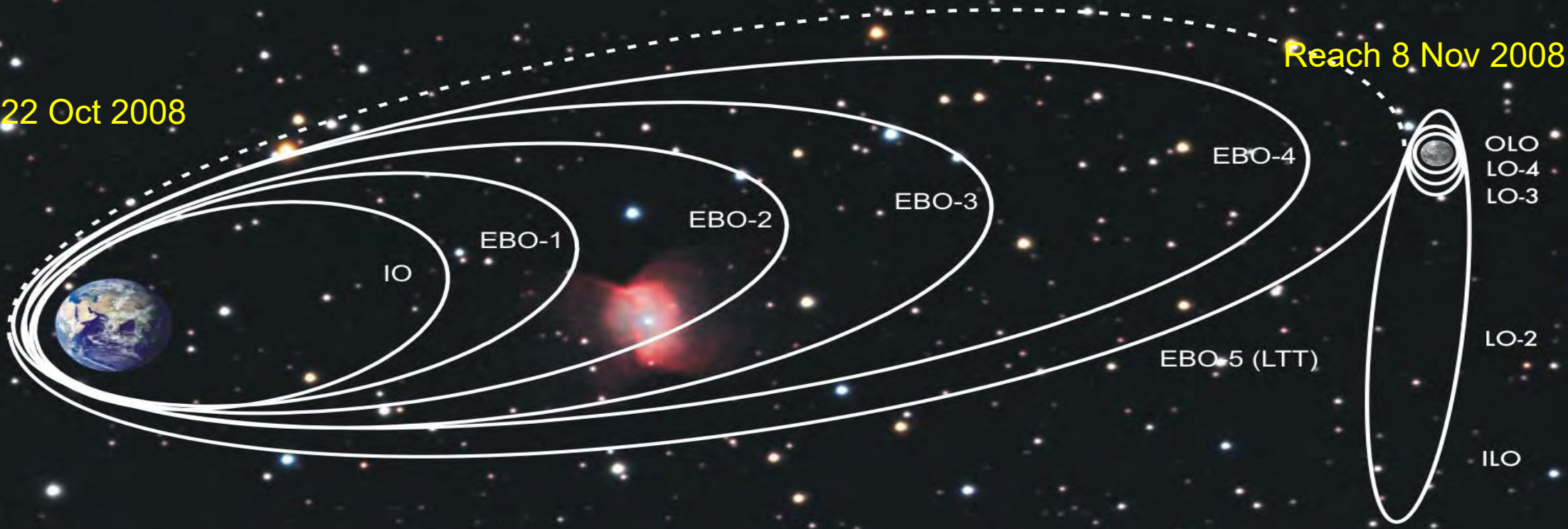
PAYLOADS



* 11 Instruments/16 sensors
* 22 units Besides BUS

Launch 22 Oct 2008

Reach 8 Nov 2008

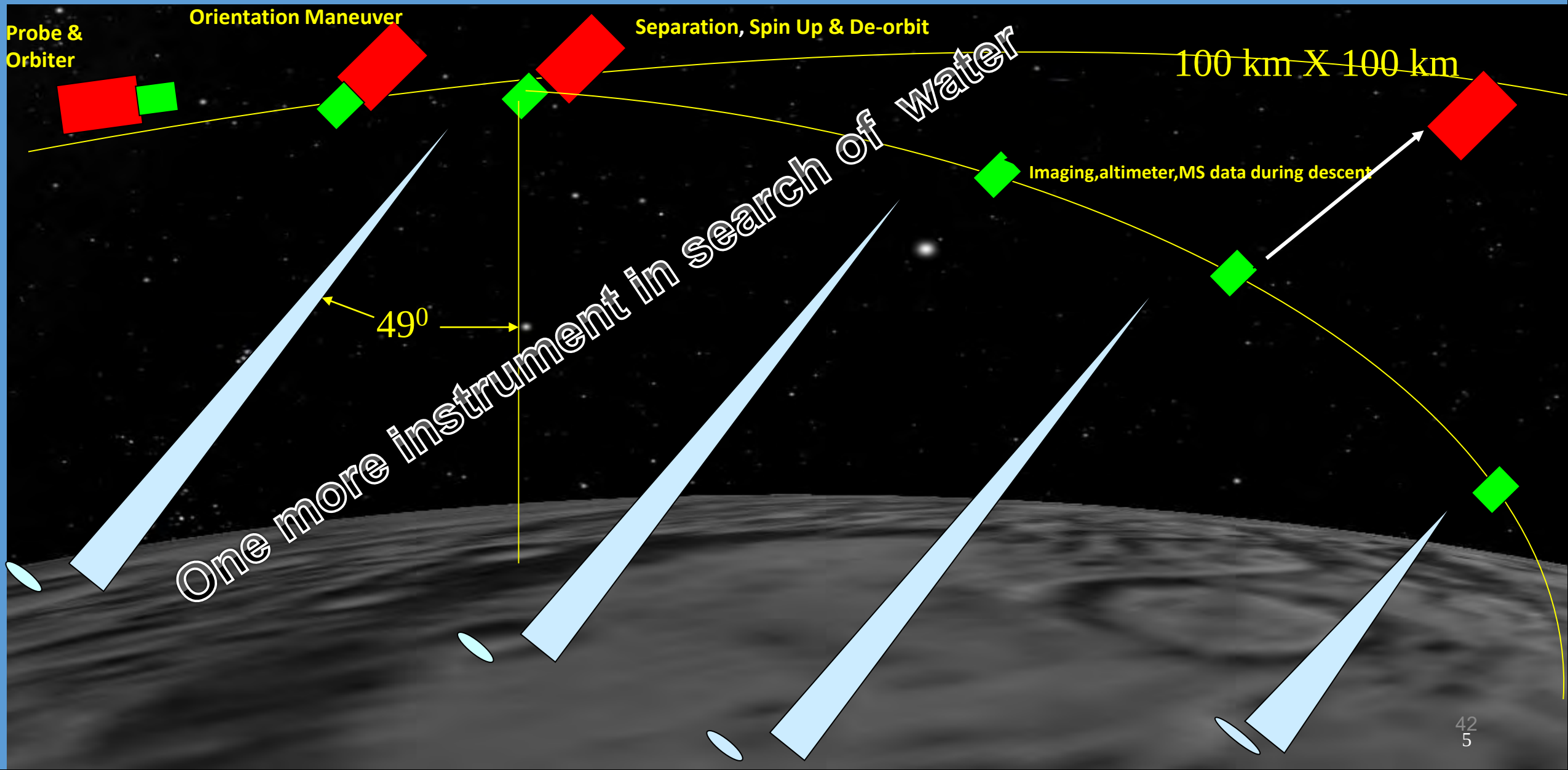


1040 s
960 s
570 s
180 s
130 s

IO: Intial (Earth) Orbit : 255 km x 22,860 km
EBO: Earth Bound Orbit
EBO-1 : apogee at 37,900 km
EBO-2 : apogee at 74,715 km
EBO-3 : apogee at 164,600 km
EBO-4 : apogee at 267,000 km
EBO-5 (LTT-Lunar Transfer Trajectory): apogee at 380,000 km

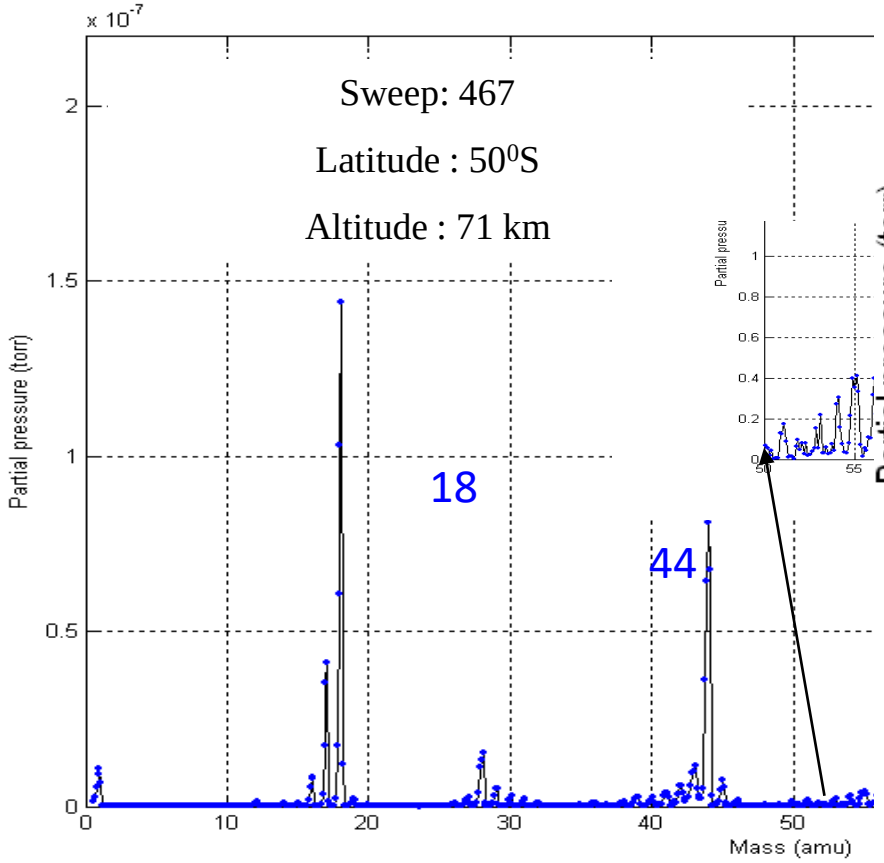
ILO (Initial Lunar Orbit) : 504 km x 7502 km
LO : Lunar Orbit
LO-2 : 200 km x 7502 km
LO-3 : 182 km x 255 km
LO-4 : 182 km x 100 km
OLO (Operational Lunar Orbit) : 100 km x 100 km

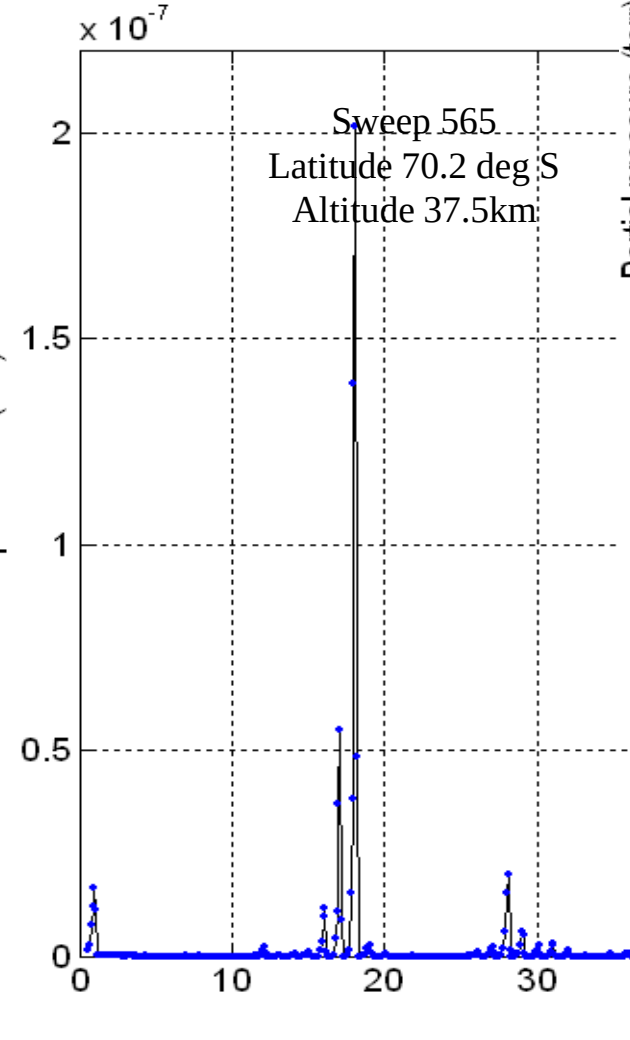
Impact Probe Mission Profile

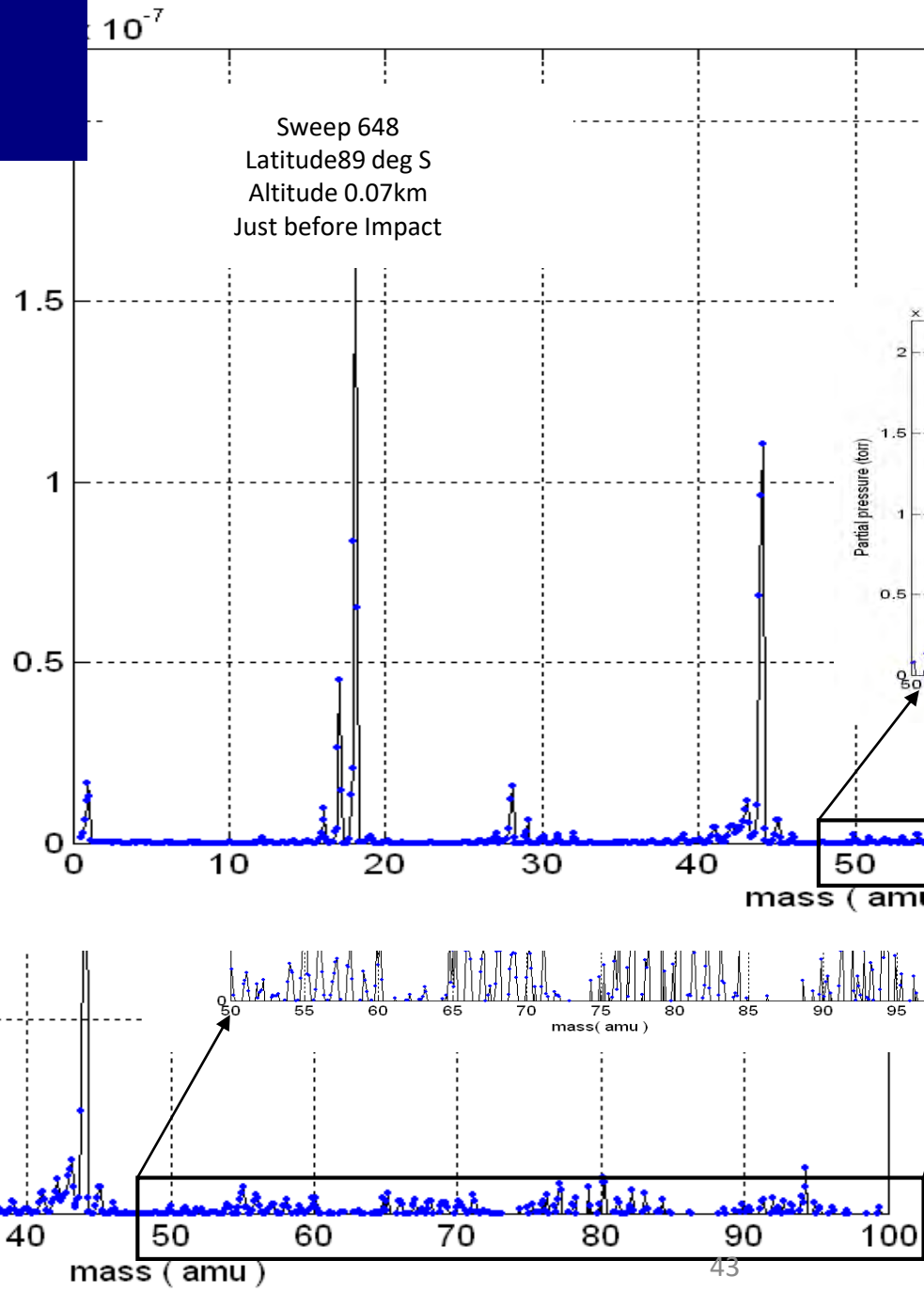


Results from Mass-Spec

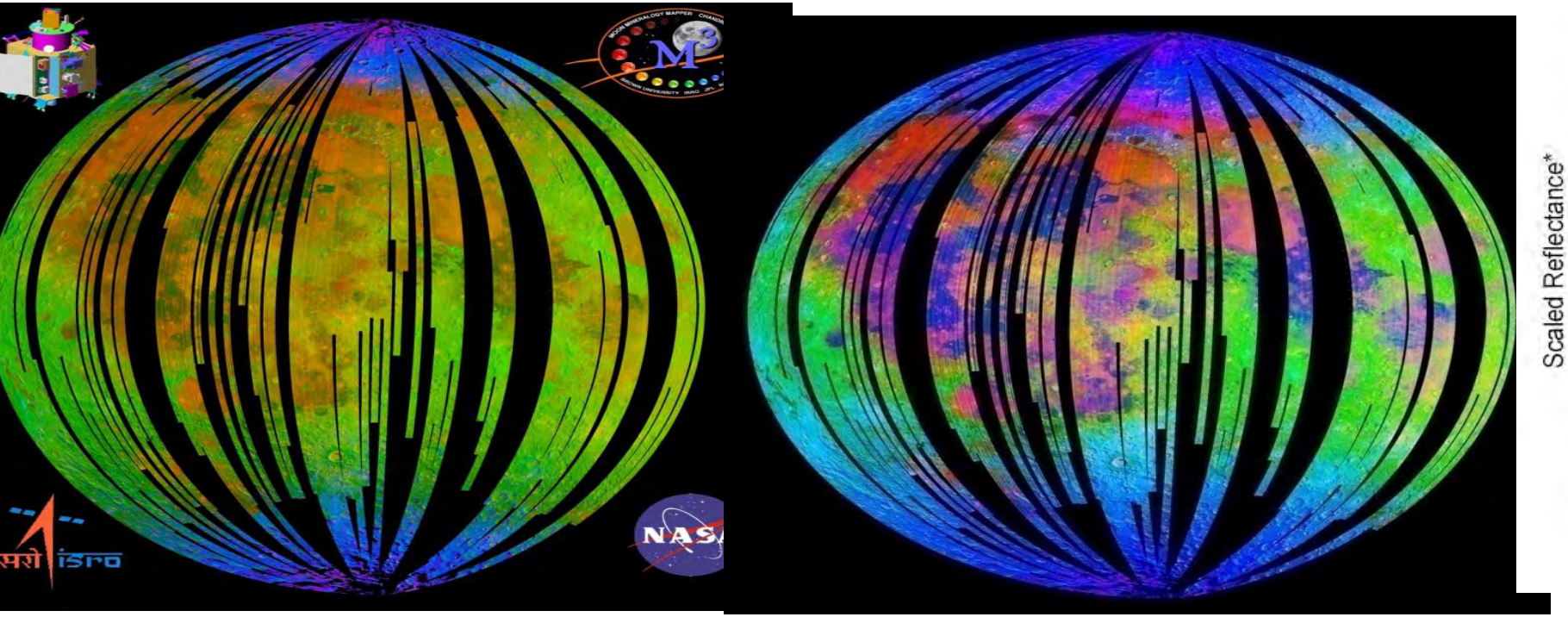
"ChACE" on Chandrayaan-1

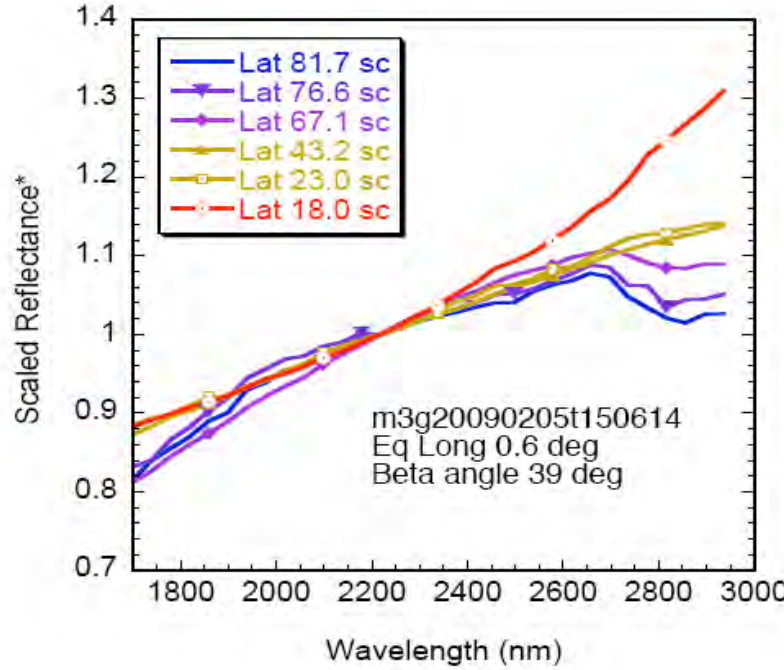






Water on Moon



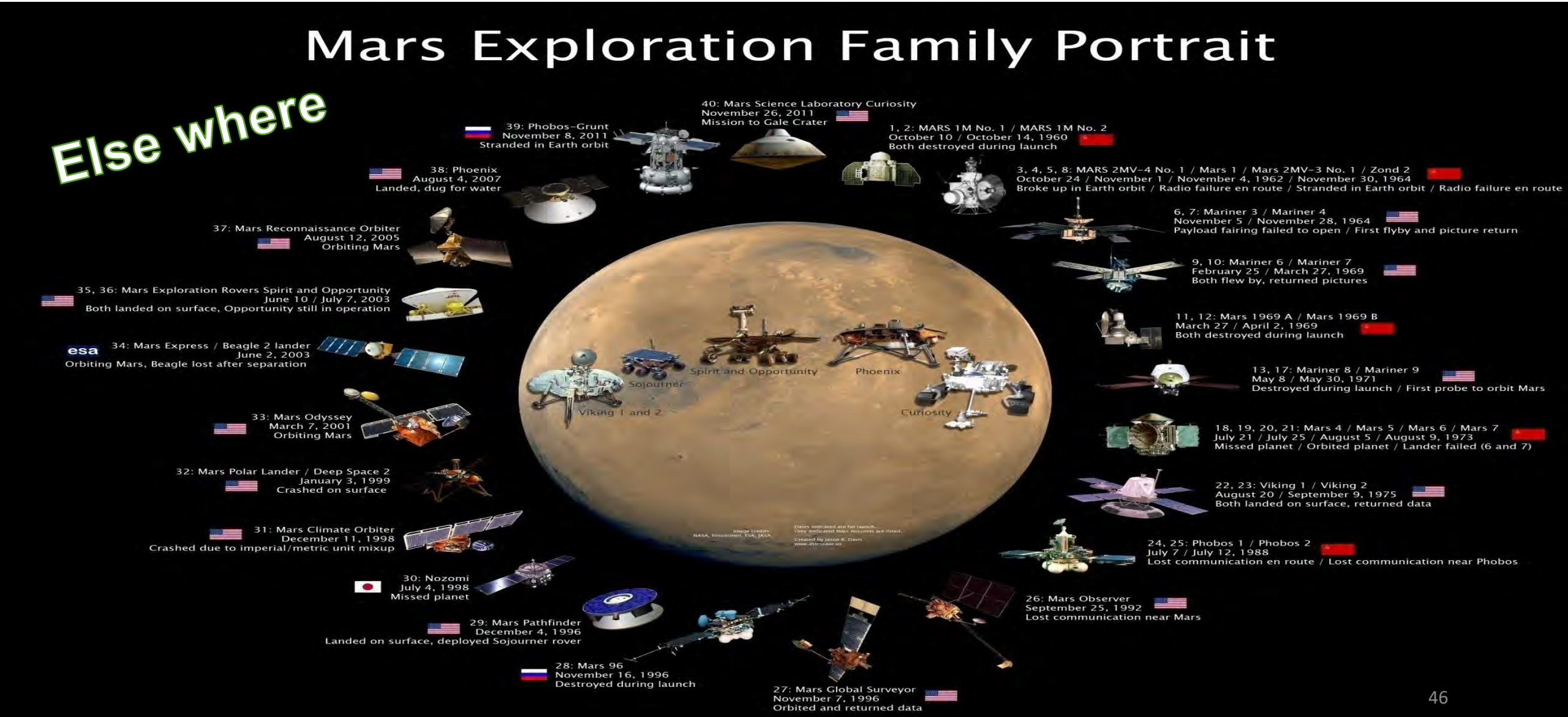


27 & 28 Yrs into ISRO

2009: Discovery of Water on the surface of the Moon

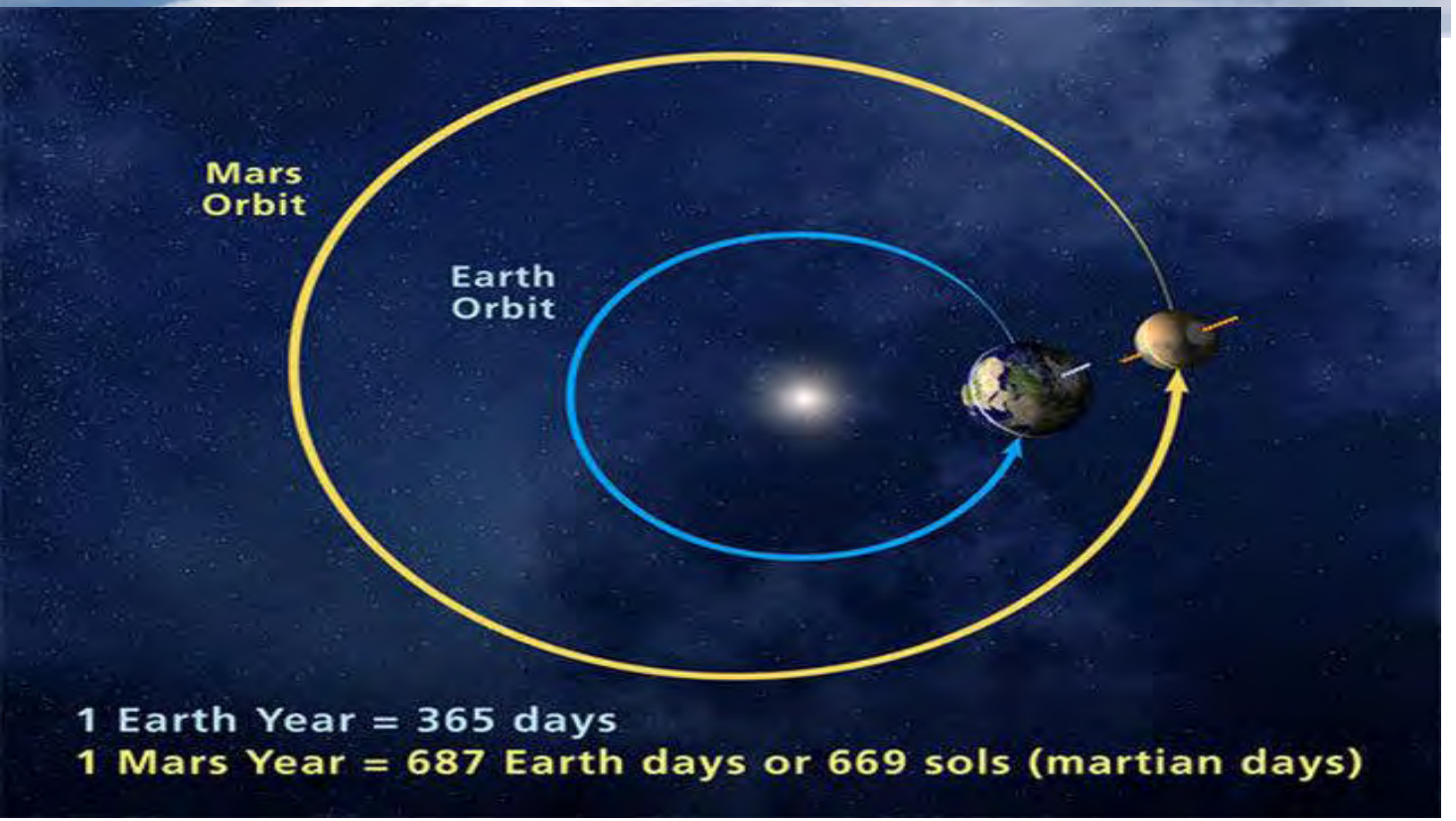
2010: Chandrayaan-2 Orbiter system H/W were ready

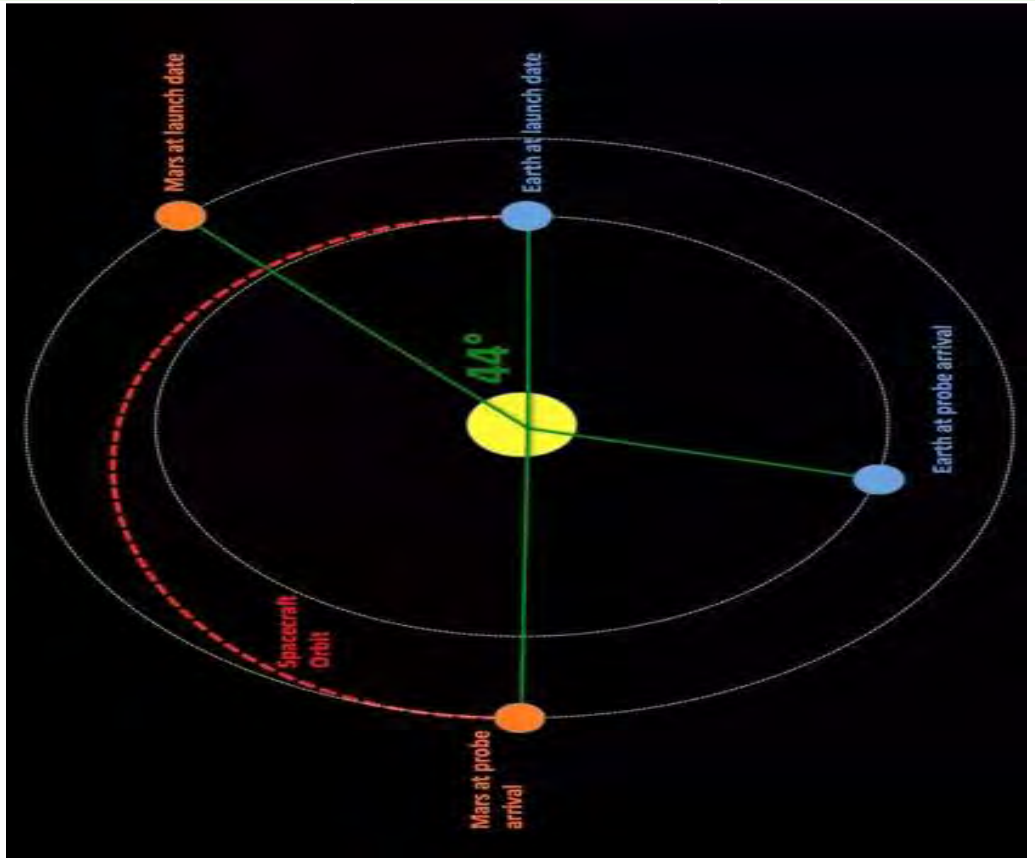
Typical Schedule for a MARS Satellite Project:
4 to 7 years



In 2011
Russia's Request to Change Chandrayaan-2 Configuration

Departure from Earth orbits	Transfer Days	Mars Orbit insertion
26-11-2013	299	21-09-2014
10-01-2016	275	11-10-2016
17-05-2018	239	11-01-2019





Earth to Mars – Minimum energy transfer opportunity : once in 26 months

Launch Oppotunities

Departure from Earth bound orbits	Transfer Days	Mars Orbit insertion	
26-11-2013	299	21-09-2014	
10-01-2016	275	11-10-2016	
17-05-2018	239	11-01-2019	

Destination MARS is ISRO's next big thing

THE INDIAN EXPRESS
MAY 12, 1999 - FRONT PAGE

PALLAVA BAGLA
NEW DELHI, MAY 11

TODAY may have been the anniversary of Pokharan II but what caused more excitement in the scientific community was chairman K Kasturirangan's announcement that ISRO's Polar Satellite Launch Vehicle can "undertake a mission to the moon." And a core team of scientists is being put together to work out the details.

In his Technology Day lecture here this evening on "The Indian Space Odyssey," Kasturirangan said that India could easily launch a small satellite of about 275 kg in a "fly-by mission" to the moon or even place a 140-kg satellite in an orbit around the moon. The mission: to study the moon's core. A manned mission, however, is still far away.

Destination Moon, he said, could symbolise the next big challenge for ISRO which has satellite technology well under its belt.

Working out the mission's objectives and payload could take time and if all goes well, it could be a reality by 2013-14

The launch vehicle "will not be the pro... said. The cost will be estimated, he said, once the scientific details have been worked out and the government will be approached for funds, Kasturirangan said. According to ISRO's plan, the Indian way to go to the moon could be by injecting a satellite that has a lot of onboard fuel into a ...en using onboard rockets to nudge the satellite closer to the moon. Later, there could also be a moon landing.

30 years into ISRO : one more crazy idea

Team Meeting : Change Moon to Mars

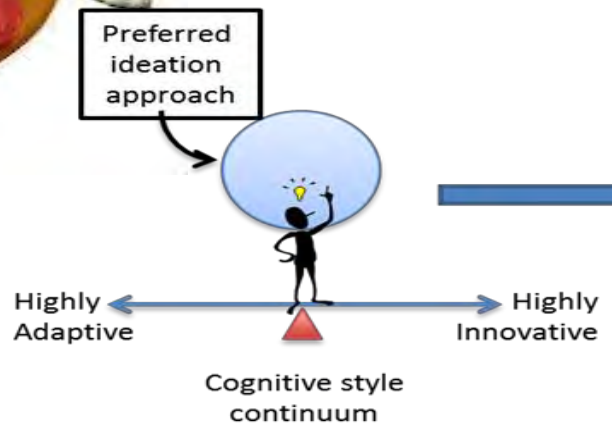
Mars Missions : More Challenges

Mission Type	Success rate	Total Attempts	Success	Partial Success	Launch Failure	Failed enroute	Failed to orbit/land
Flyby	45%	**11**	**5**		**4**	**2**	
Orbiter	50%	**22**	**9**	**2**	**5**	**3**	**3**
Lander	30%	**10**	**3**			**3**	**4**
Rover	57%	**7**	**4**	**1**			**2**
Sample Return	0%	**1**				**1**	
Total	42%	**51**	**21**	**3**	**9**	**9**	**9**

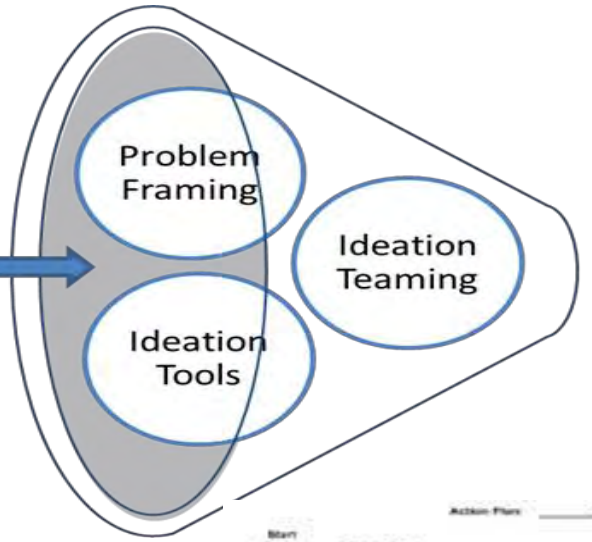
Majority of failures are primarily due to ***Launch related*** *issues followed by* ***propulsion system problems, software errors*** *both in ground and on –board, Human errors,* ***insufficient hardware testing and the conceived mission concepts***

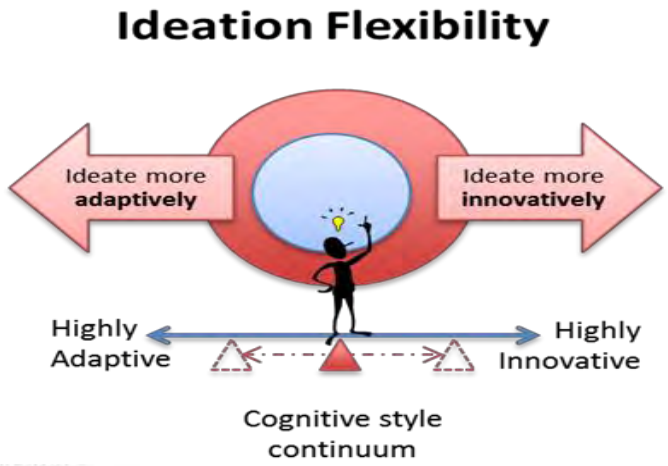
Crazy Idea(s) & Systematic Implementation(s)

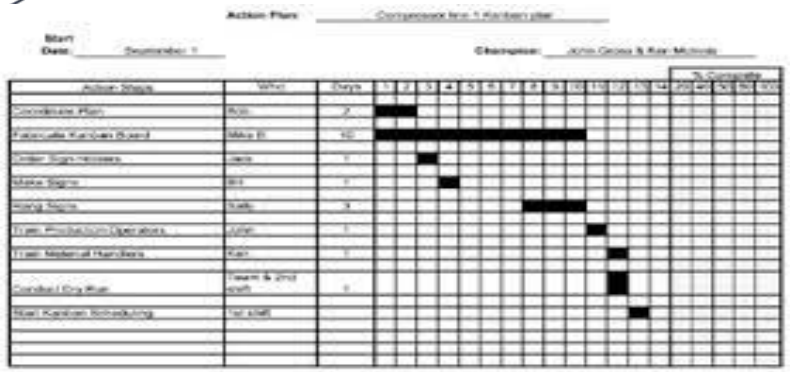
Crazy



Systematic Implementation : Innovation Vs Adaptive

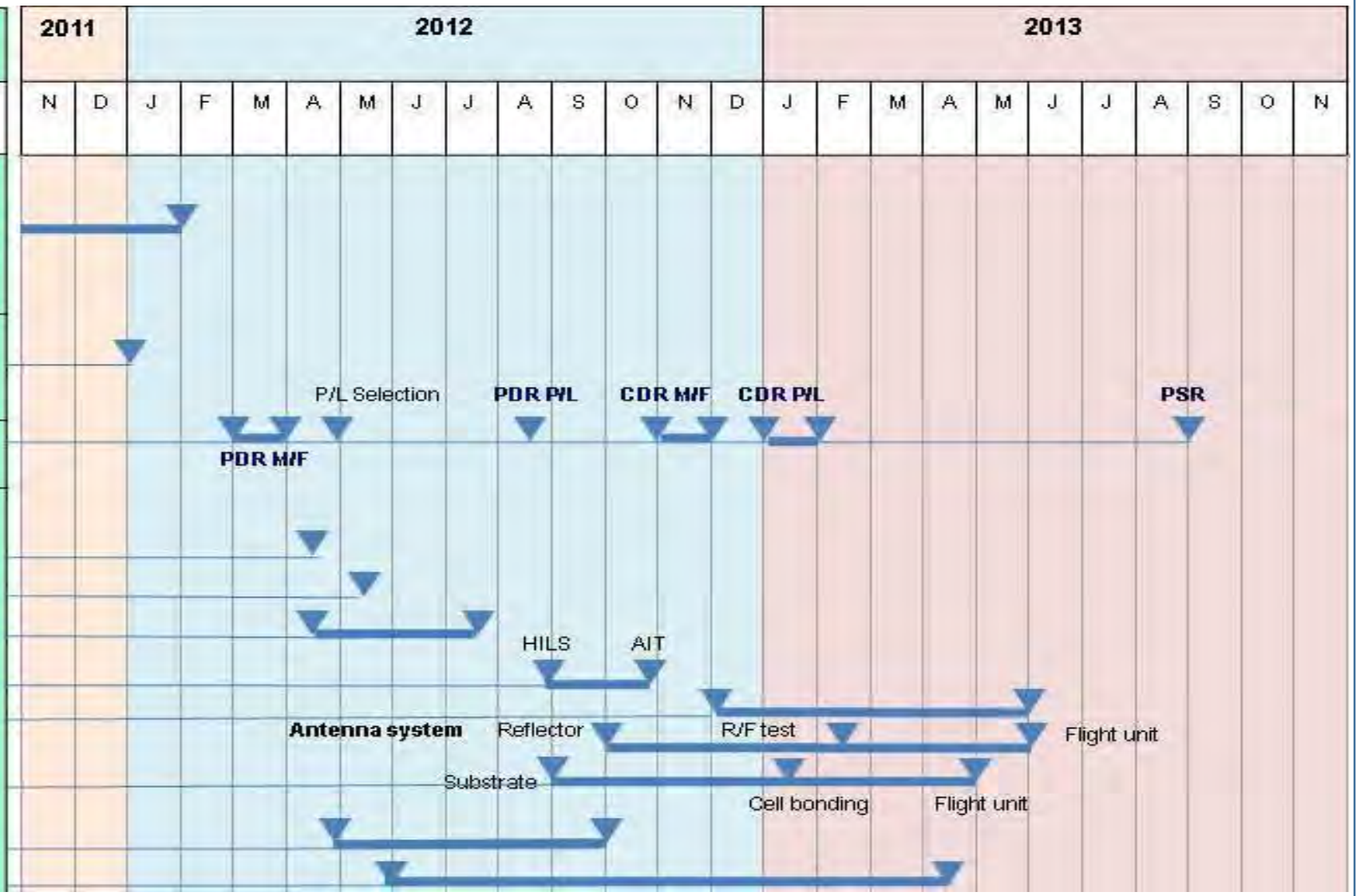




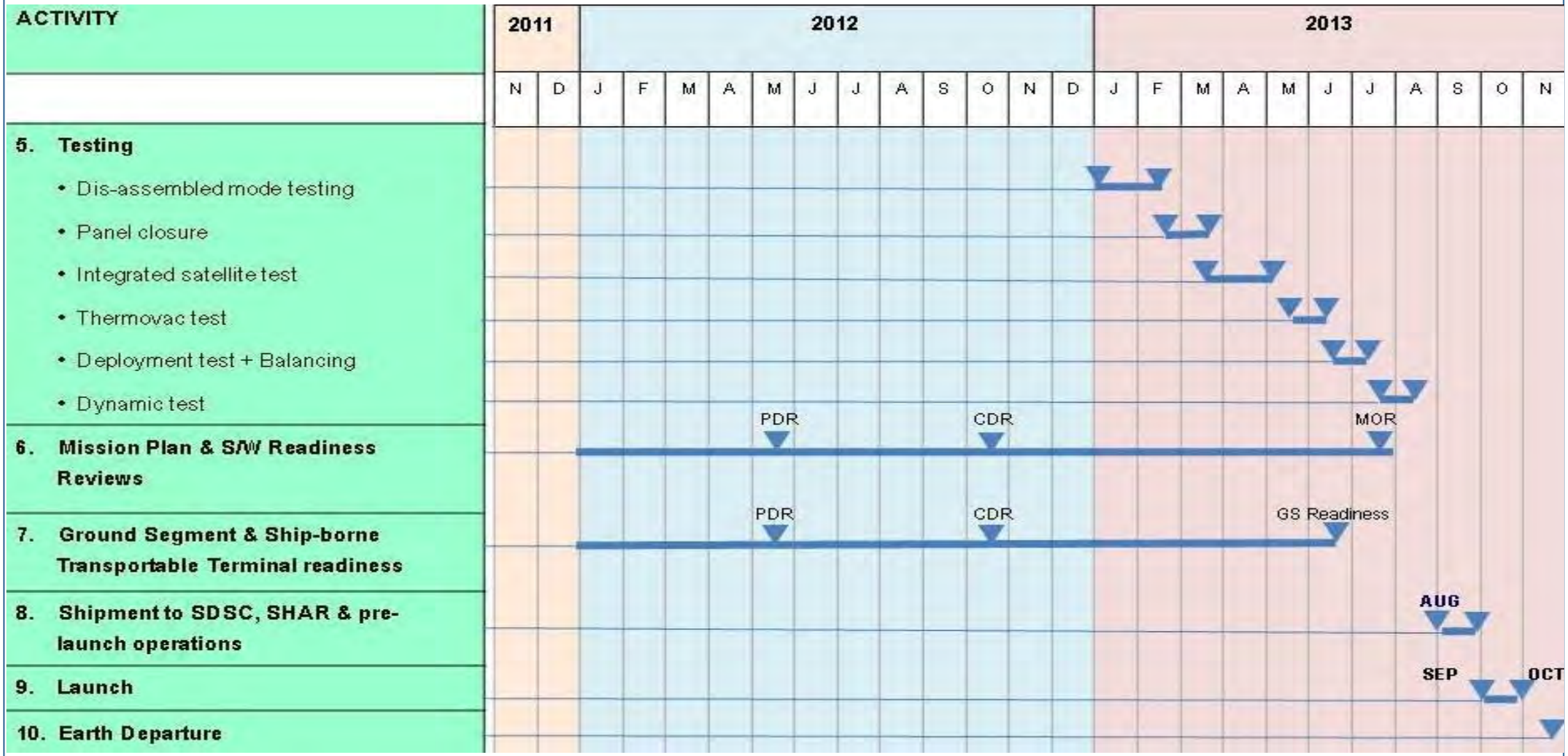


Mars Orbiter Mission Schedule

ACTIVITY
1. **Pre-Project Activities** Mission Design, Mars orbiter baseline satellite configuration, short listing of scientific instruments, Mars orbiter mainframe cylinder and bottom deck fabrication drawing etc
2. **Project Approval** Placement of order for Procurement of long lead items TWTA's, 2 ship borne TT etc
3. **Major Reviews**
4. **Readiness of mainframe systems** • Availability of Structure • Power systems readiness • Propulsion elements integration • Readiness of AOCS • RF systems • Solar panel (substrate & flight unit) • Flight harness fabrication • Payloads



Mars Orbiter Mission — Schedule



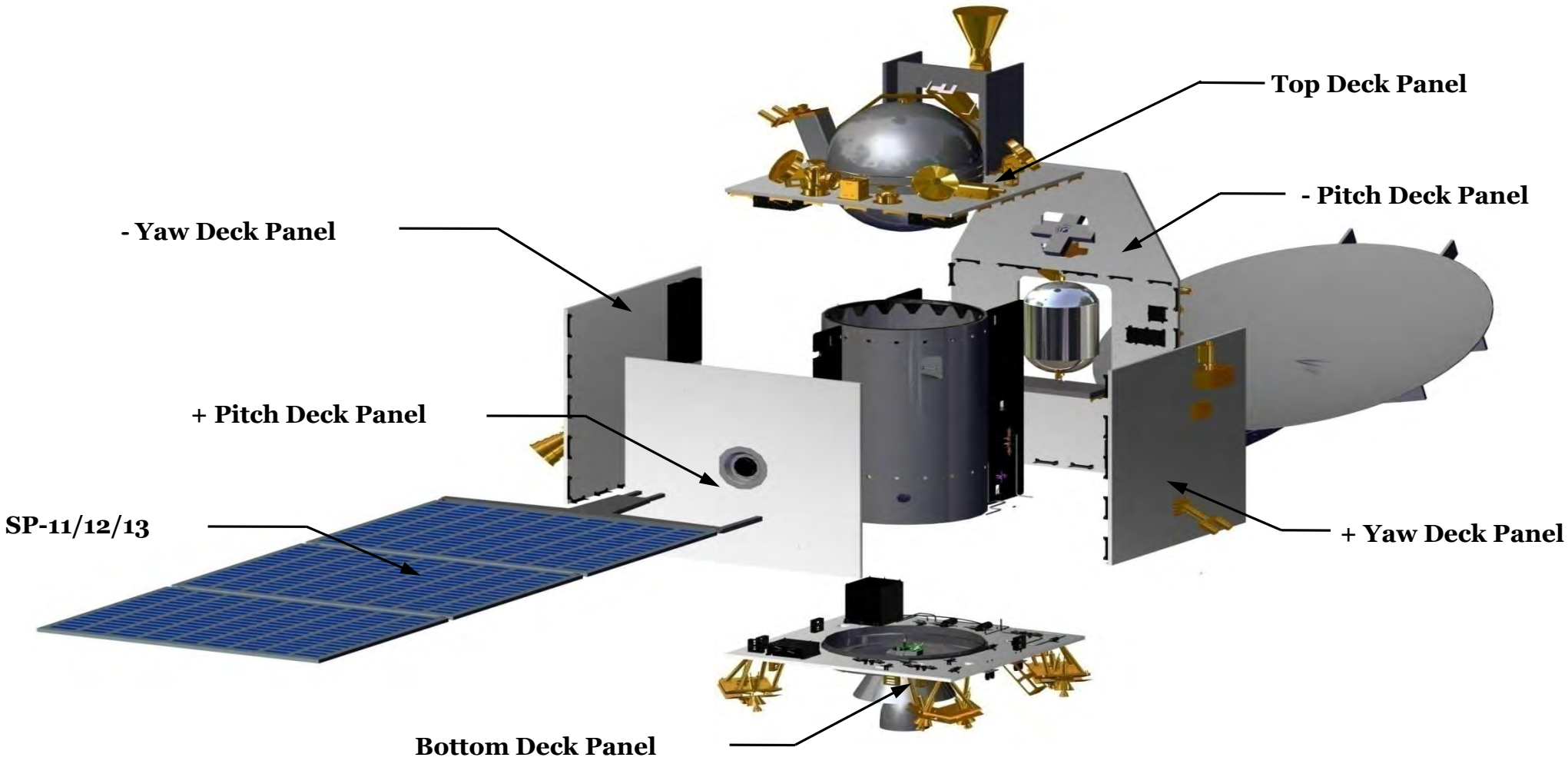
Mars Orbiter Mission

Payloads

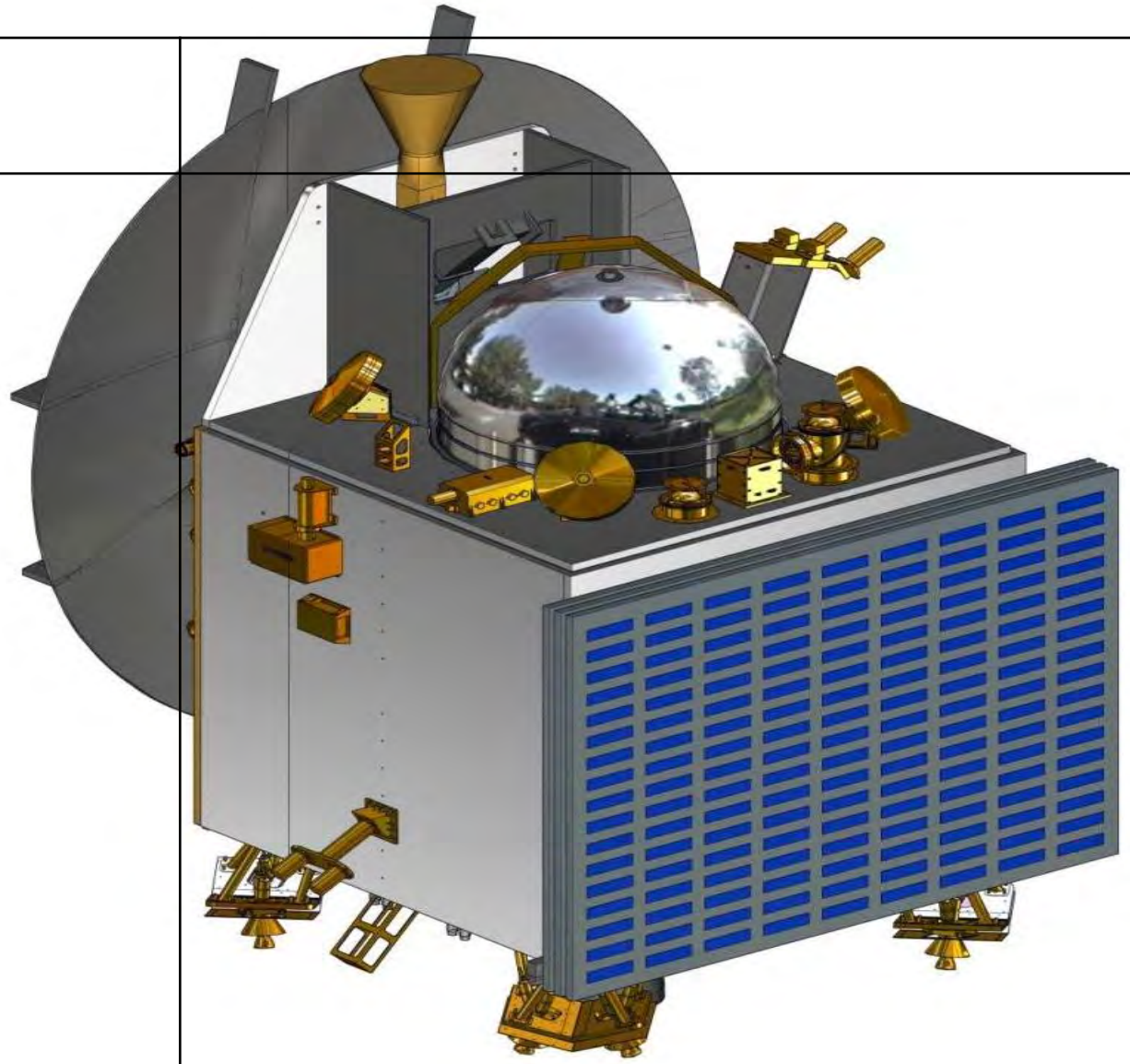
Science Theme	Payload	Primary Objective	Centre	Mass
Atmospheric studies	RO (Radio Occultation)	• Study of Martian Ionosphere	PRL, VSSC	2.0
	LAP (Lyman Alpha Photometer)	• Escape processes of Mars upper atmosphere through D/H	LEOS	1.5
	PRISM (Probe for Infrared Spectroscopy of MARS)	• Detect presence of H_2O,CO_2,O_2	ISAC	3.0
	MSM (Methane Sensor for MARS)	• Detect presence of CH_4	SAC	3.0
Plasma and particle environment studies	MARIS (MARS Radiation)	• Characterise energy particle spectrum Electron, proton	ISAC	0.88
	PACE(Plasma and Spectrometer)	• Plasma studies	PRL	2.9
	MENCA (Martian Exospheric Composition Explorer)	• Study the neutral composition of the Martian upper atmosphere	VSSC	4.0
Surface Imaging Studies	MCC (MARS color Camera)	• Optical imaging	SAC	1.5
	TIRIS (TIR imaging spectrometer)	• Map surface composition and mineralogy,	SAC	4.5

Mars Orbiter Mission

Exploded View

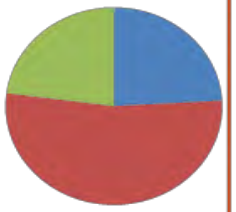
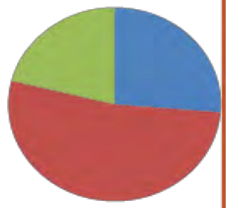


MOM Spacecraft Systems-hardware Identification

New Systems		Heritage (without modifications)
•MGA •ΔDOR Transmitter • Five Payloads		•IRAP •S-band Receiver ▫TMTC ▫NIN10 ▫TTC Transmitter ▫MDH ▫Structure ▫EED ▫Solar Panels ▫**<u>with modifications</u>** ▫Core Power ▫Battery ▫AOCE ▫LGA,HGA,Feed ▫Thermal ▫Mechanisms ▫Propulsion ▫Sensors •TWTA, High Power Circulator, Filter,Diplexer

Flight Sofware:

On Board Software Elements

Attitude Orbit Control Electronics(AOCE)		Tele - command Processor(TCP)		Solid State Recorder (SSR)		Baseband Data Handling (BDH)	
	SRS √ SDD √ IBT √ CWT √ DBV √		SRS √ SDD √ IBT √ CWT √ DBV √		SRS √ SDD √ IBT √ CWT √ DBV √		SRS √ SDD √ IBT √ CWT √ DBV √
Language : Ada µ Processor MA31750 **Code volume: 63,706 LOC**		Language: Ada µ Processor MA31750 **Code Volume: 13,335 LOC**		Language:Assembly µ Processor : 8086 **Code Volume: 13.6kbytes**		Language:Assembly µ Processor : 8086 **Code Volume: 9.7 kbytes**	

***SRS**: Software Requirement Specification*
***SDD**: Software Design Document*
***IBT**: Integrated Bench Test*
***CWT**: Code Walk Through*
***DBV**: Database Verification*
***LOC**: Lines of Code*

new modified old

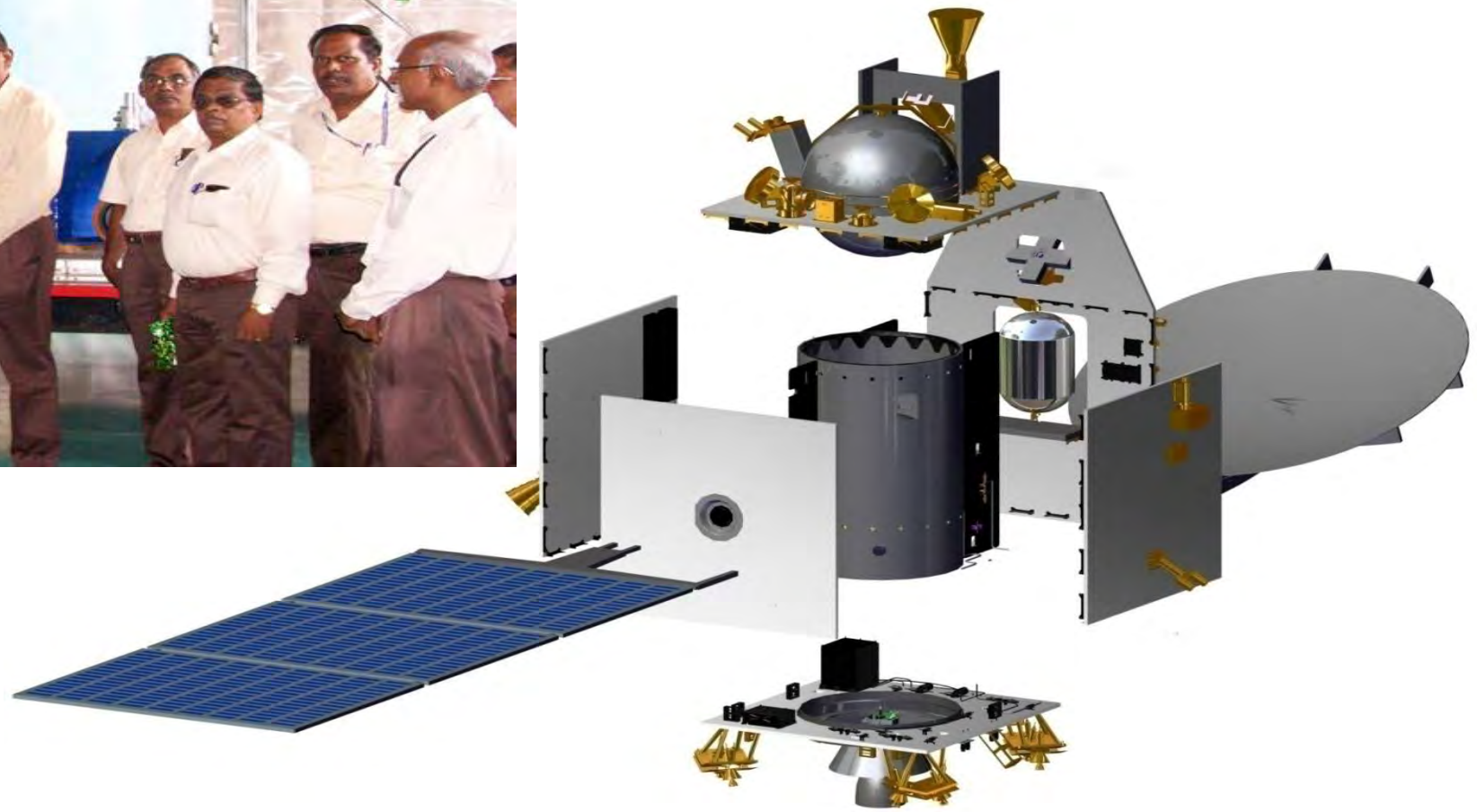
The autonomy have been extensively tested in a ground simulator and uplinked to the S/C ****

Project Approval & Parallel Teams

- Trade of studies& Configuration
- Satellite
  - Repeat
  - Autonomy
  - Mission Specific
- Launch Vehicle
- Payloads
- Launch Service
- Ground System
- Tests & Simulations
- Budget & Schedule
- Procurements
- Mission Plan & Ops
- Science Team
- Out Reach

First Step to Realise MOM Spacecraft

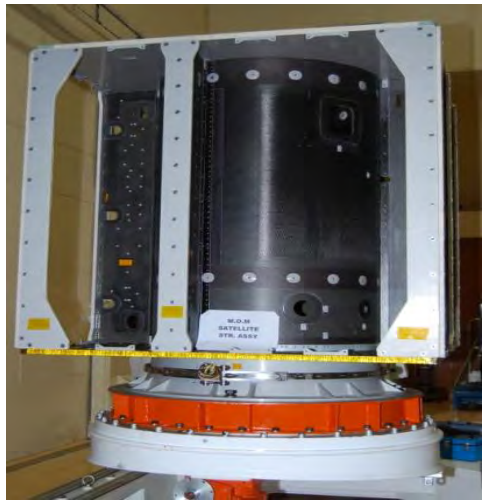
21 Sep 2012 (T-13.5 months)



Mars Orbiter Mission – Making of Mars

Contd..

Commencement of Satellite Integration, 25th Sep 2012



Structure Delivery & Start of Integration activity Clean Room

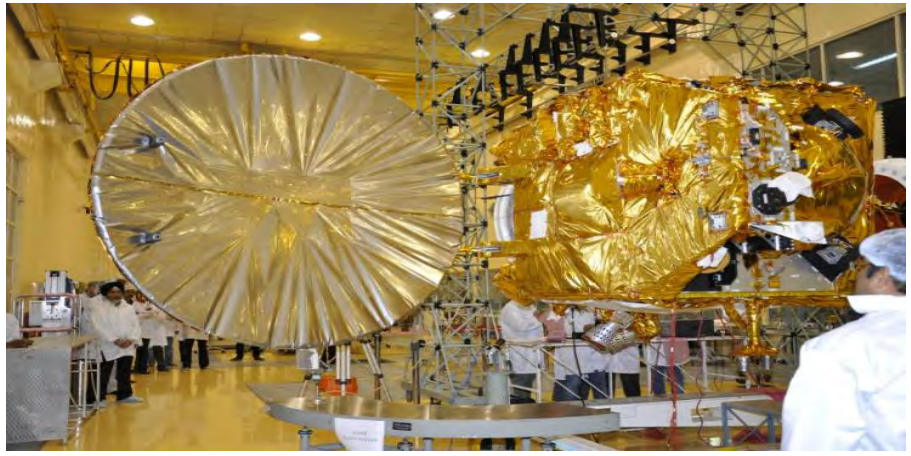
Subsystem Integration activities in Clean Room

Spacecraft Integration activities in Clean Room

Loading into Thermovac Chamber

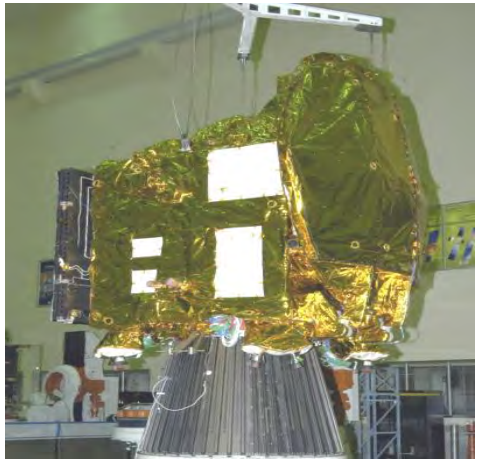
Mars Orbiter Mission – Making of Mars

Solar Panel Deployment Testing



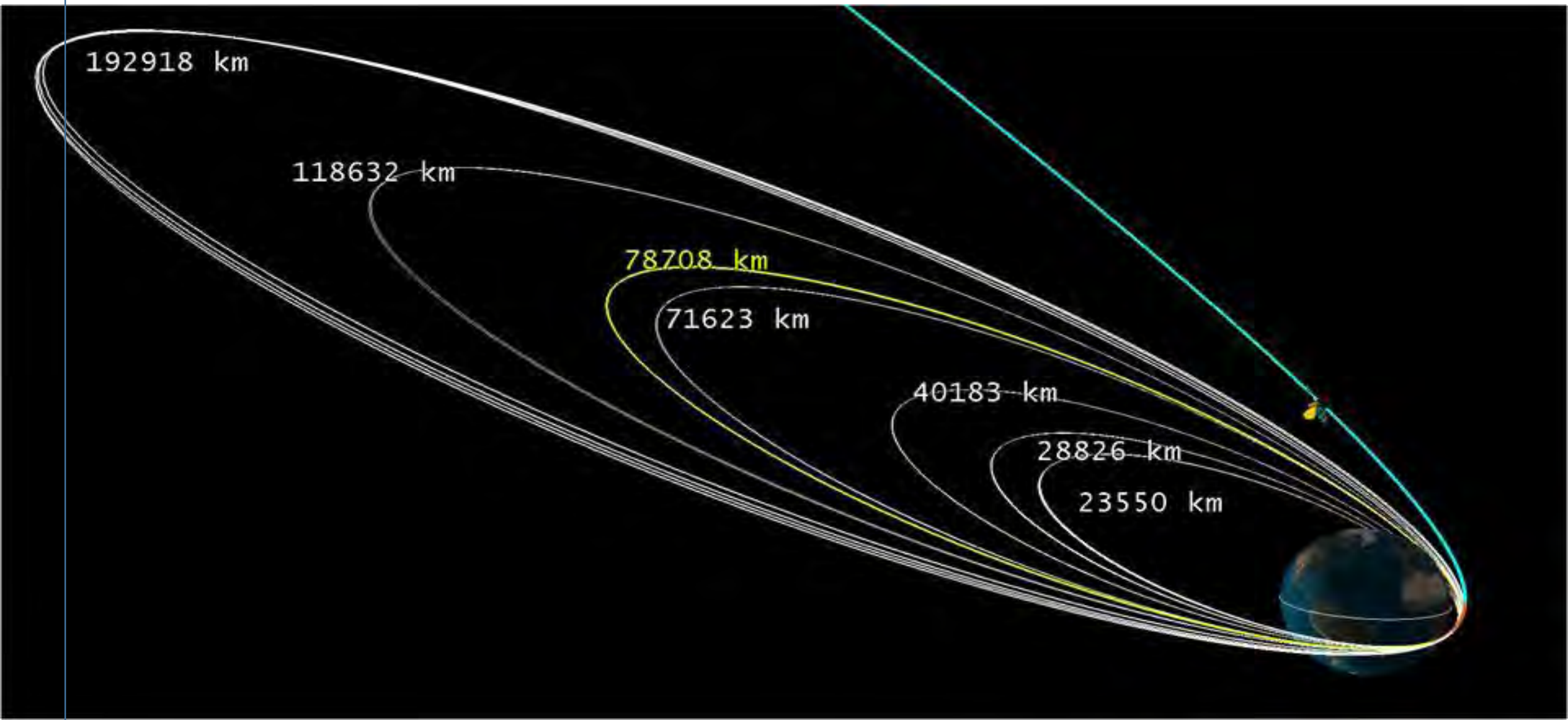
HGA-Antenna Deployment Test

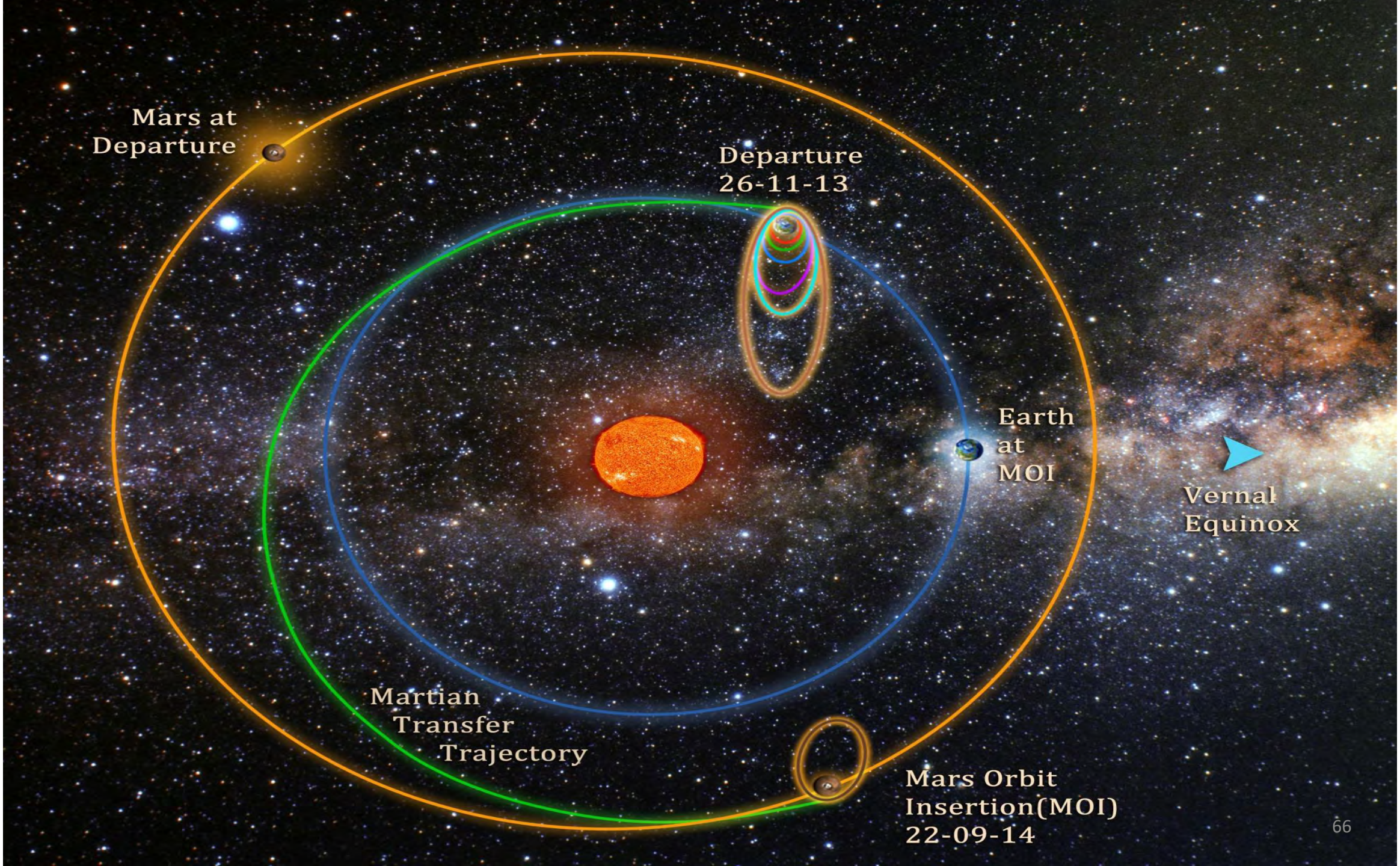
EMI/EMC Test

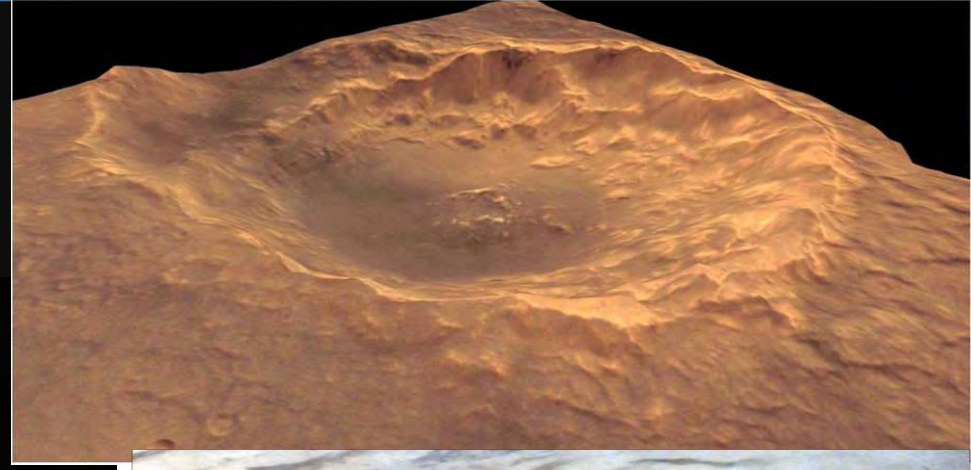


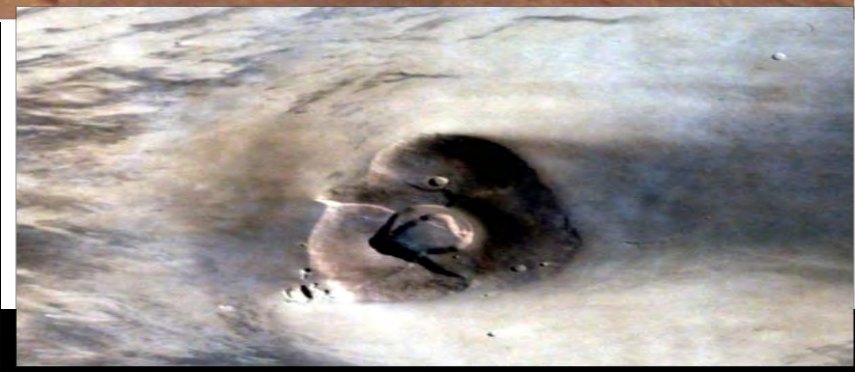
Vibration Test

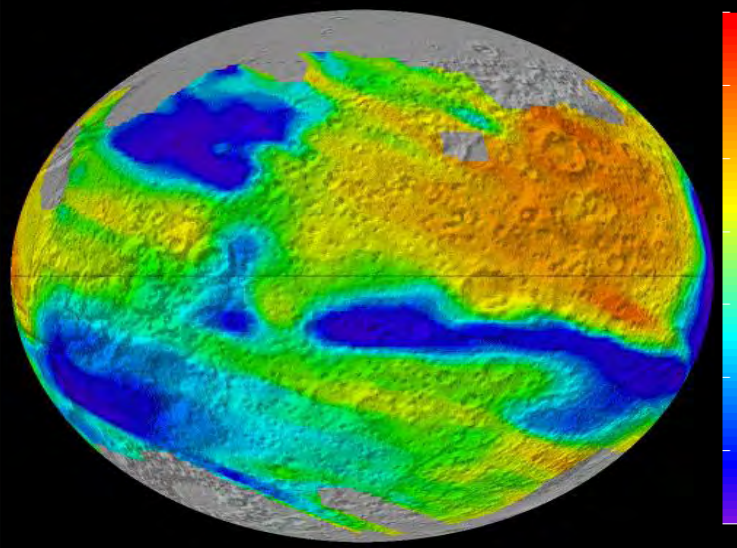
MOM Earth Phase Maneuver Strategy Realization & Evaluation

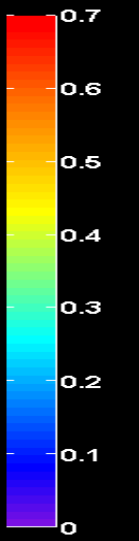



Mars at
Departure
Departure
26-11-13
Earth
at
MOI
Vernal
Equinox
Martian
Transfer
Trajectory
Mars Orbit
Insertion(MOI)
22-09-14









Mars Orbiter Mission (MOM)

Mars Atlas

Space Applications Centre

Out come of Mangalyaan

Promoting Space Technology

for

Governance and Development

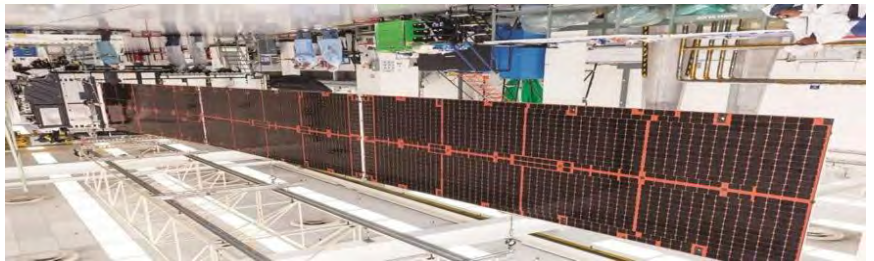
Demand/National Requirement

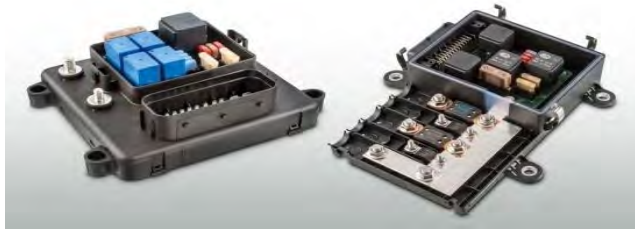
ANTICIPATED PROGRAM PROFILE 2017-2021					
Programme	2017	2018	2019	2020	2021
Communication	GSAT-9 GSAT-19 GSAT-11 GSAT-7A GSAT-17	INSAT-4AR Ka-Multi Ku-48 S band 12m Ku-24 GSAT-22	Com-sat-1 Ka/Ka-1 Ku-24 Ka/Ka-2 GSAT-11R GSAT-23 GSAT-24	Ku-48 GSAT-6A Ext ComSat-2 IDRSS-1	IDRSS-2 Ext ComSar-3 Ka/Ka-3 GSAT-7R
Navigation	IRNSS-1H IRNSS-1I	IRNSS-1K IRNSS-1J	IRNSS-S1	IRNSS-S2	IRNSS-S3
Earth Observation	CARTO-2D CARTO-2D(R) MICROSAT CARTO-2E	HYSIS EMISAT INSAT-3DS GISAT-1 CARTO-3 OCEAN-3 RISAT-1A	GISAT-2 CARTO-3A RISAT-2A SPADEX RES-3S RISAT-1B RES-3MX	Adv. GISAT CARTO-3B OCEAN-3A RES-3SA OCEAN-3B RES-3AMx NISAR	RES-3SB RES-3BMx
Space Science	CHAND-2		ADITYA-L1	XPOSAT	
TOTAL	12	15	16	13	7

2013: 4 2014:5 2015 : 7 2016 : 13 2017: 11 2018:10

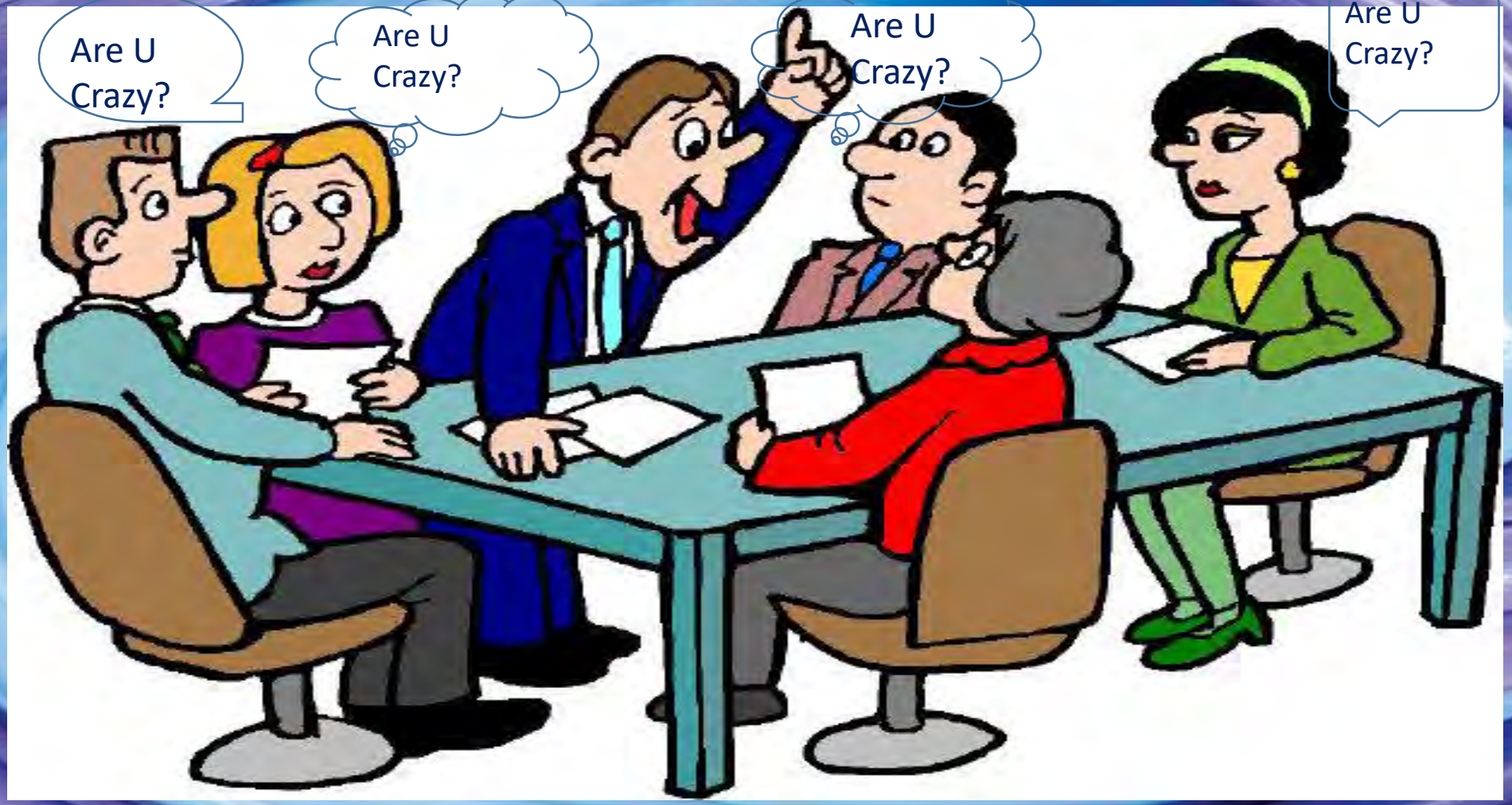
SUBSYSTEM REQUIREMENTS 2017-2021

Deliverables	2017		2018		2019		2020		2021	
	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2
Power Electronics	53	55	64	60	90	78	82	74	80	72
DC-DC Converter	65	61	85	65	120	84	97	95	138	120
Battery	14	14	15	19	24	20	24	18	22	18
Solar panel	32	38	46	36	55	45	60	44	52	40
Sensors	113	130	174	120	260	140	150	127	210	180
AOCE	6	4	8	6	9	7	8	8	6	2
BMU/OBC	10	8	14	6	18	6	14	12	18	14
BDH &SSR	25	31	46	40	28	28	27	24	40	26
TMTC	8	7	10	11	18	6	12	12	8	4
TTC Transponder	32	24	40	28	60	28	44	40	48	32
Antennae	8	6	10	6	14	8	10	12	24	16
SPS & SPS Ant.	12	16	18	14	28	20	28	16	30	18
Data Tx	18	10	14	18	24	24	26	18	30	26

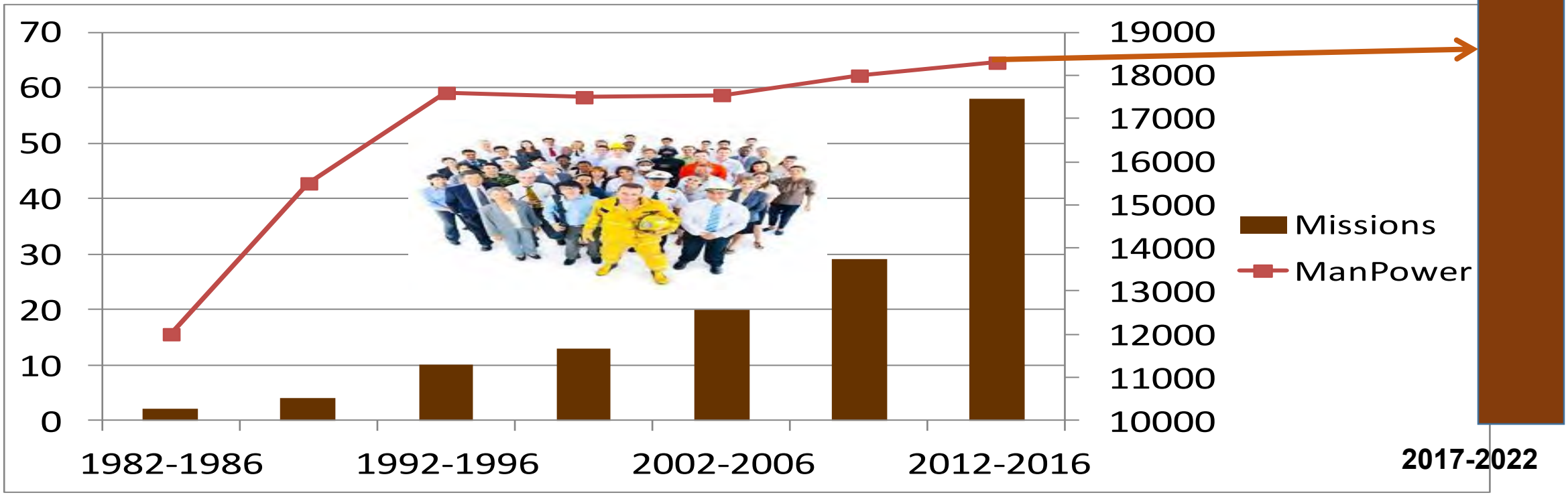




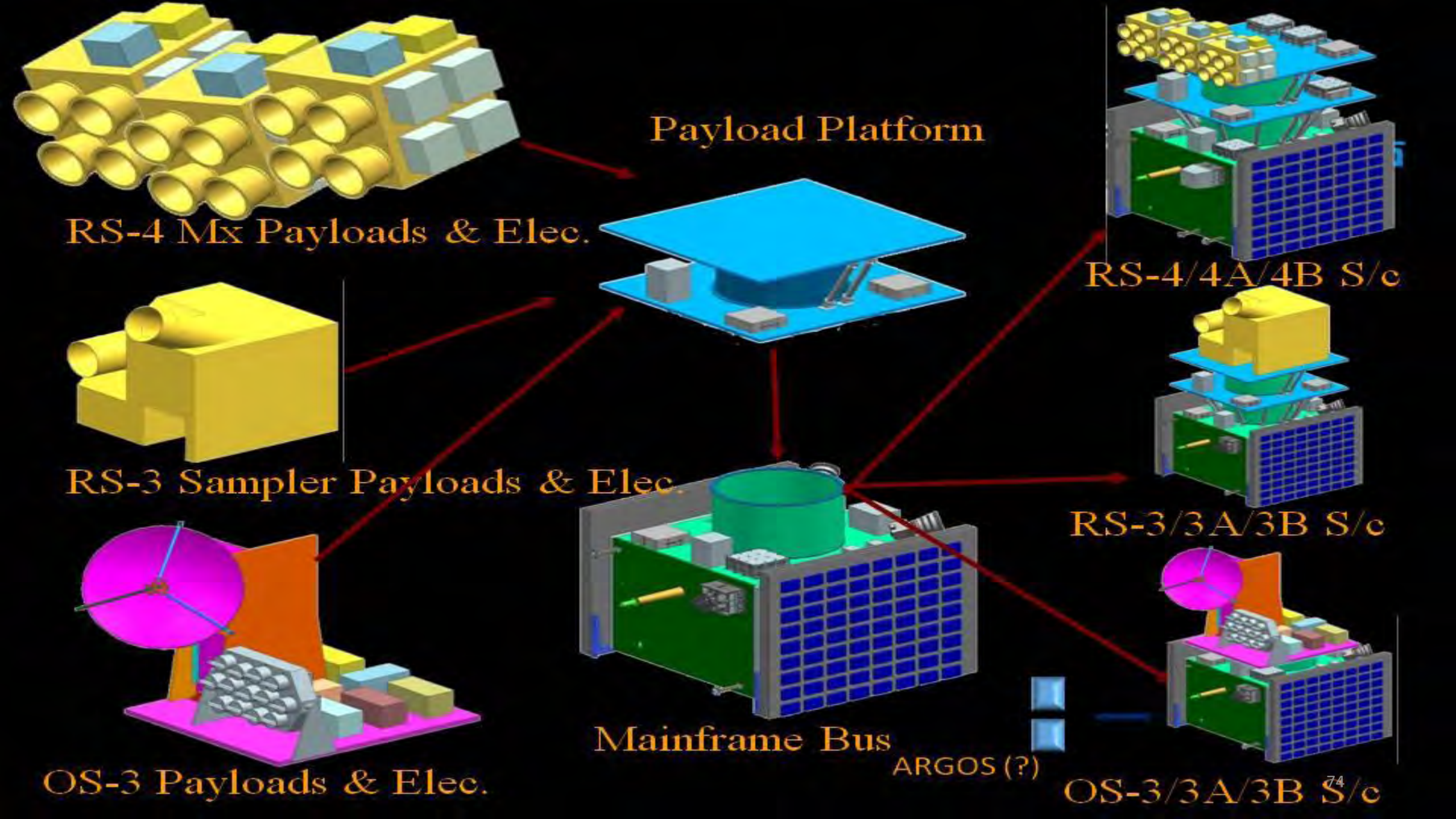
Team Meeting : making to producing satellite



ISRO: Past , Present & Future..



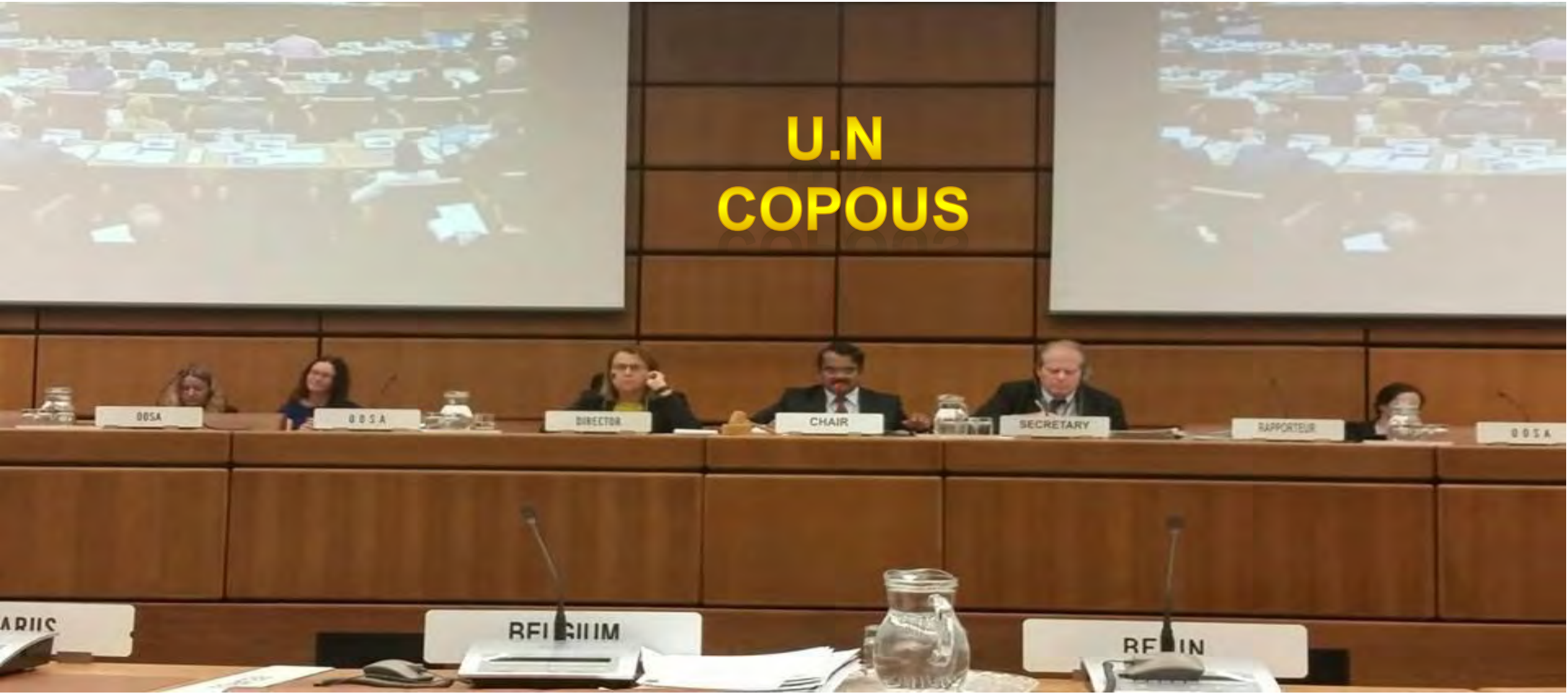
Pre-MOM	Post MOM : Proposed
Project Specific systems - Max	Standardised Systems - Max
Inhouse Systems - more	Vendors Systems - more
Project Based Procurement - more	Programmetic Procurement - more
Made to order - Project Specific Systems	Off the self systems
Project Specific ILDs, Panels, Harness	Standard ILDs, Panels, Harness
Made to order - Project Specific Bus sys	Off the self Bus systems
Made to order - S/C	Off the self S/C
Meetings - more	Meetings - Min
Individual data basese : Project & Phase	Common data base : Bus & Phases
Project Driving R&D	Production Driving Projects & Technology Driving R&D


Payload Platform
RS-4 Mx Payloads & Elec.
RS-4/4A/4B S/c
RS-3 Sampler Payloads & Elec.
RS-3/3A/3B S/c
Mainframe Bus
ARGOS (?)
OS-3 Payloads & Elec.
OS-3/3A/3B S/c

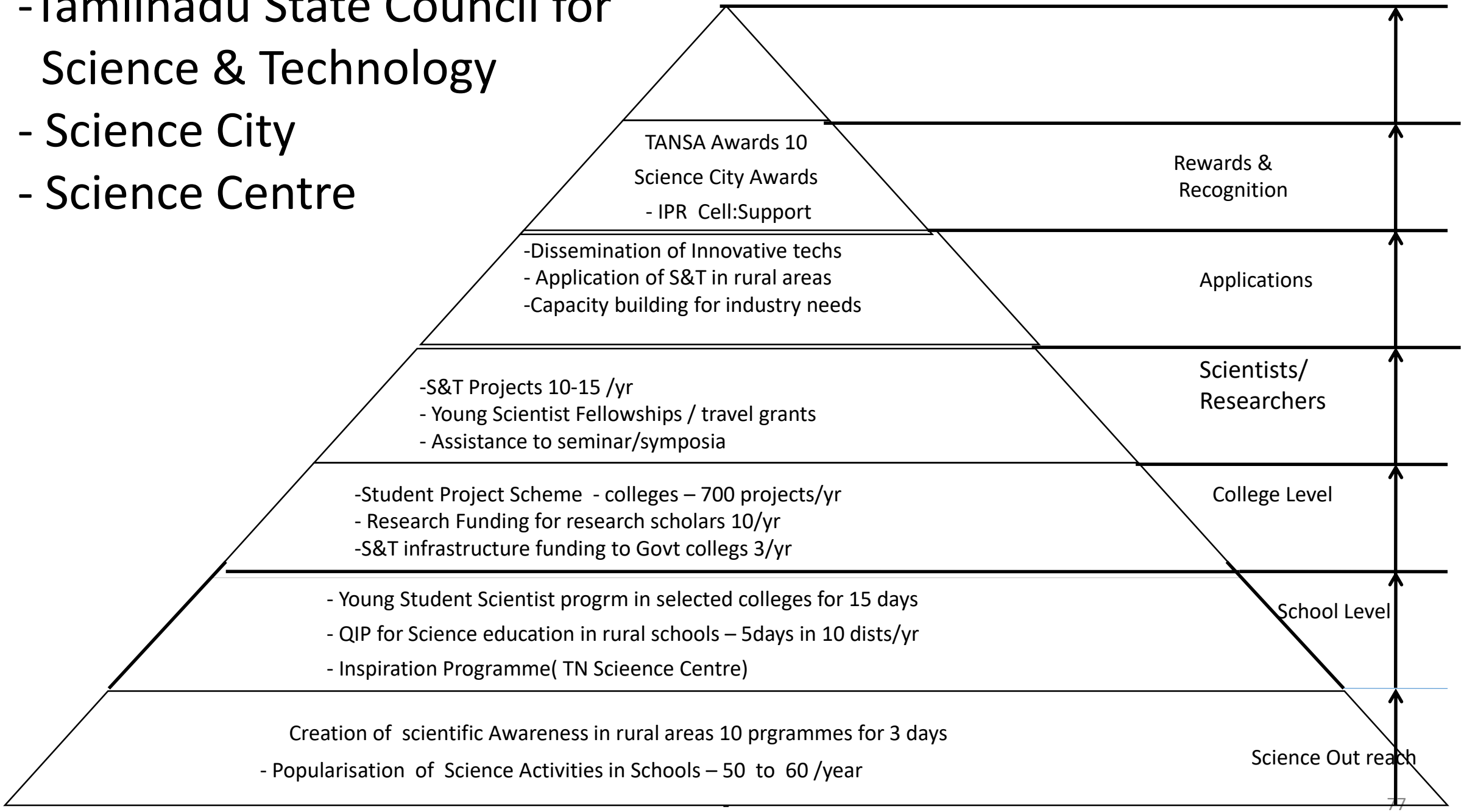
A special initiative on Spacecraft Assembly Integration and Test support from Industry

Three contracts with private industry to make Satellites end to end

Initiative at UN Office for Outer Space Affairs



-Tamilnadu State Council for Science & Technology
- Science City
- Science Centre



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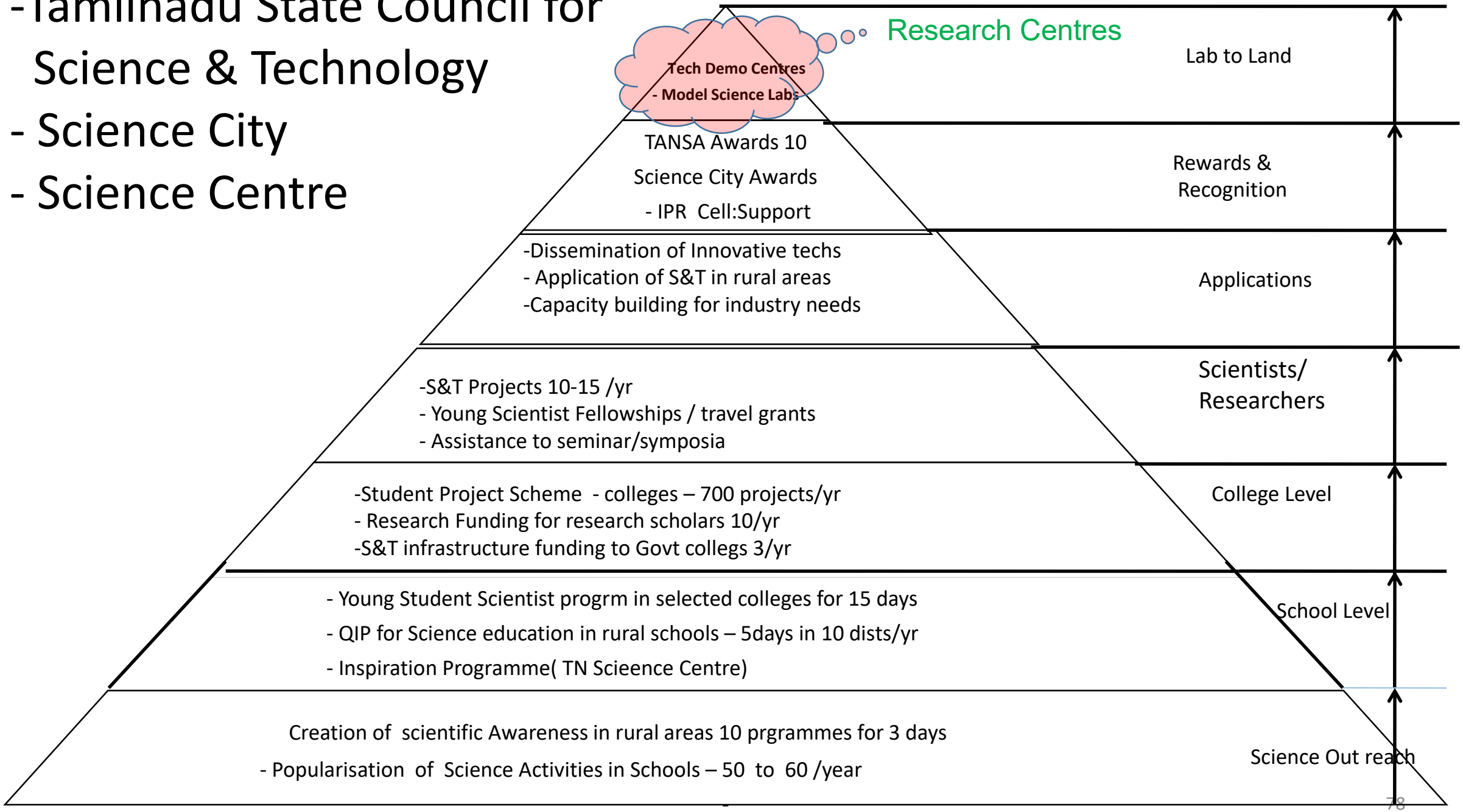


Prepardness & Plan to utilize Research centres….

- An opportunity for a professor to be

→ Professional/Enterpreneur/Innovator/Researcher

- To take Tamilnadu in the fore-front in the areas of
  - Eng Education
  - Innovation
  - Technology
  - Industry

Be a part of Well Being of the Country

- What is **Wellbeing**? A state in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully and is able to make a contribution to her or his community”

Indian Space Programme : Evolution

Born in 60's with a vision of national development and benefit to common man through Space

Gradual Increase in Space Assets : Starting experimental in 60-70s

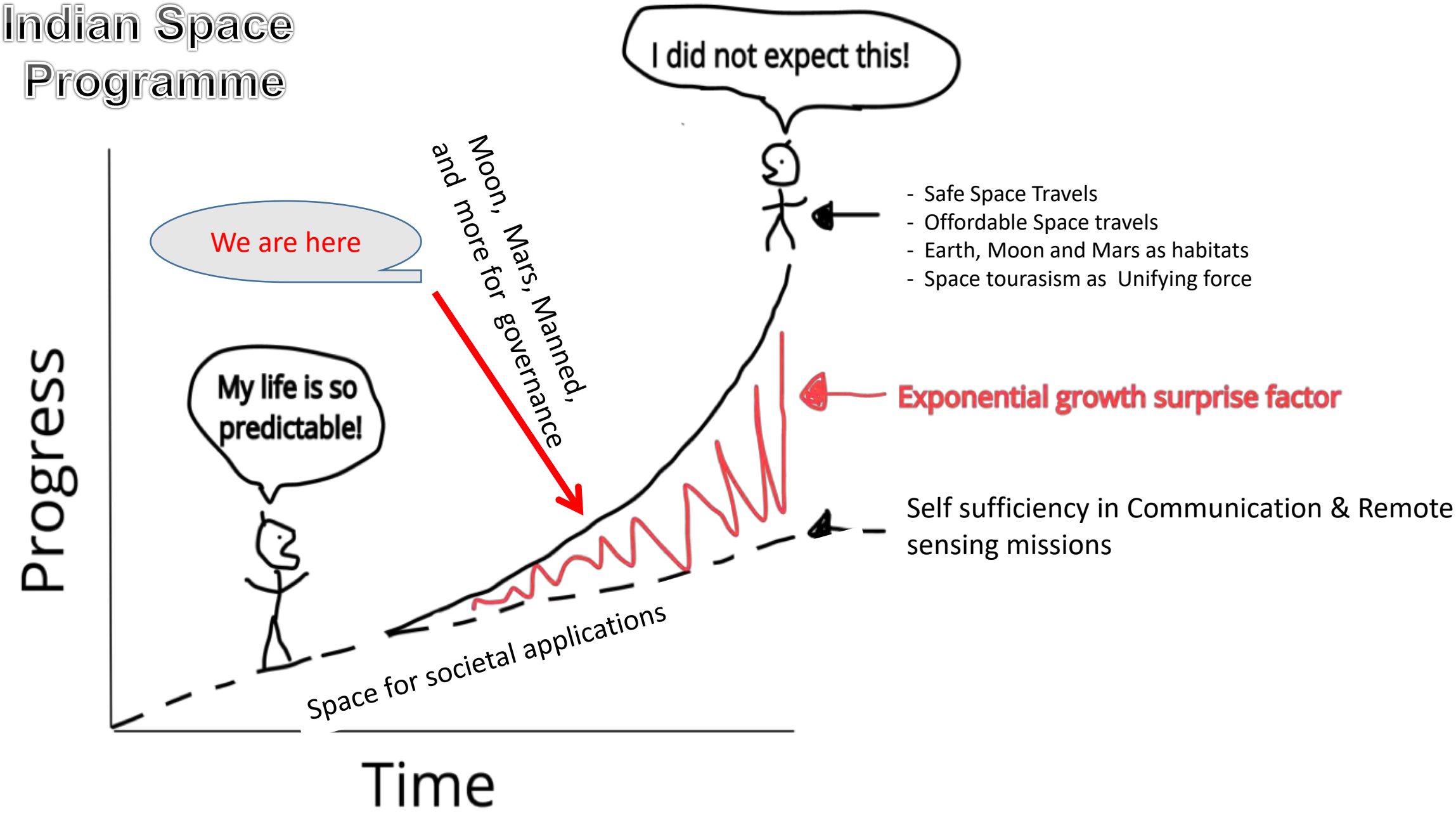
- **80's** : 4 Satellites : experimental to Operational
- **90's:** 40 Transponders in C, Ext C bands & sensors in space with the support of 4 Operational satellites in Communication & 4 Remote sensing
- **2000's**: Nearly 50 Satellites operational with approx 300+ Transponders& multiple sensors in space

First time in the Indian History of Space Programme

- Successful launch of **Chandrayaan-1** in with its major scientific findings in 2009
- Successful **Insertion of MOM** in Martian Orbit in 2014 in its maiden attempt
- **Bulk Satellite launches in One-Go** through versatile launch vehicles in 2017

Moving Ahead with Satellite Manufacturing & Advanced Research & Development Activities to meet **NATIONAL DEMANDS** in a **BIG WAY**

Indian Space Programme



I did not expect this!

-Vice Chairman State council for S&T
-Chairman, BOG, NDRF
-Director ISRO Satellite Centre
-Chairman Committee of the whole
at UNOOSA

My life is so predictable!

Exponential growth surprise factor

High school teacher

Progress

Student

Time


Happy New Year 2018
ISRO SATELLITE CENTRE
BANGALORE


THANKS