

The Space Engineering Education Program around South Africa's second Small Satellite

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Overview

- A short overview of the pathfinder satellite
- Satellite engineering education experience on SUNSAT
- Satellite Engineering Education
- The education planned as part of the pathfinder mission
- A unique tool - Satellite Development Toolkit
- Expected outputs
- Conclusion

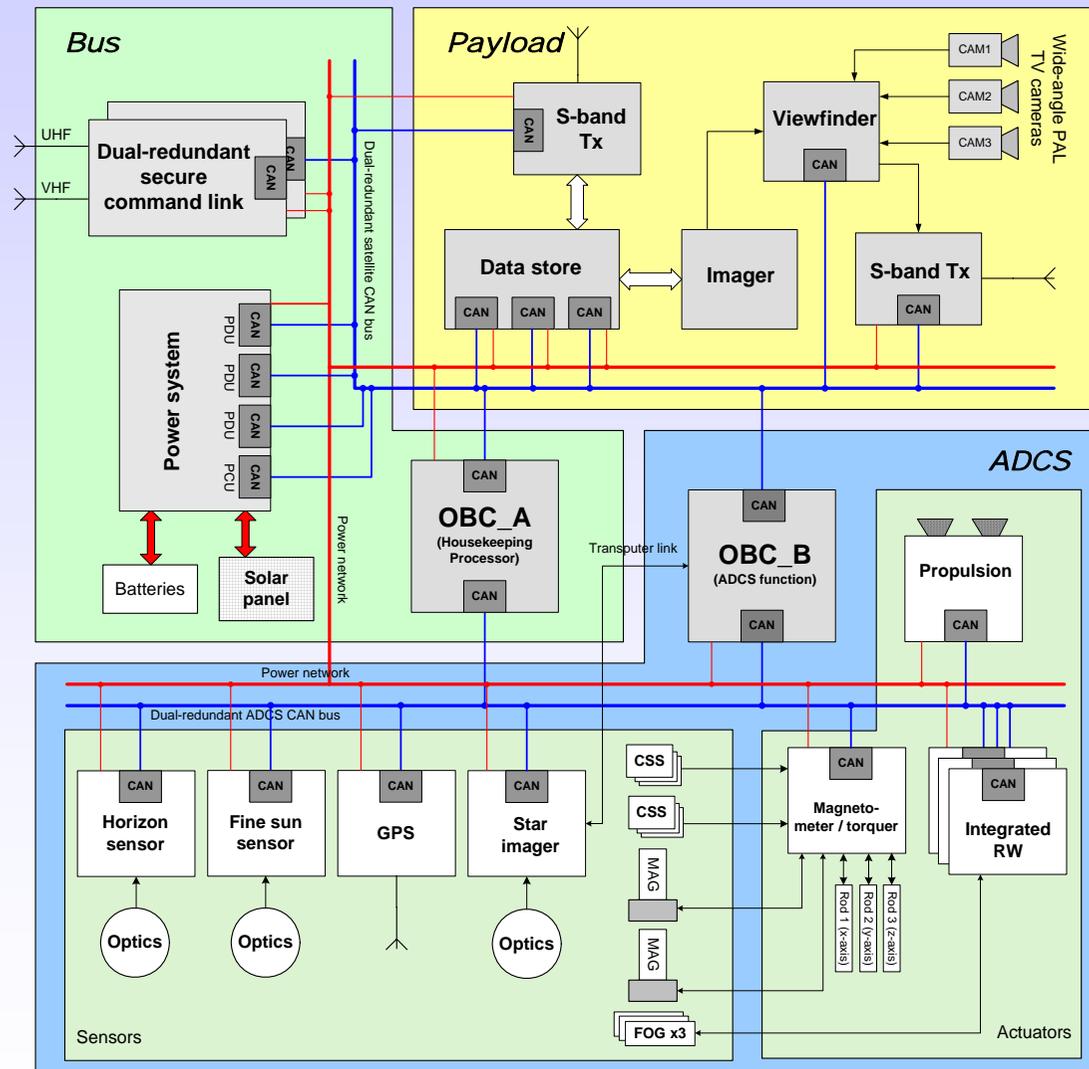
South African Second Satellite Program Announced

- 3 October 2005 on the eve of International Space week, by the minister of Science and Technology in South Africa
- Operational satellite supplied by SunSpace
- Space education program offered together by Stellenbosch University and SunSpace - four year program with 40 post-graduate space engineers

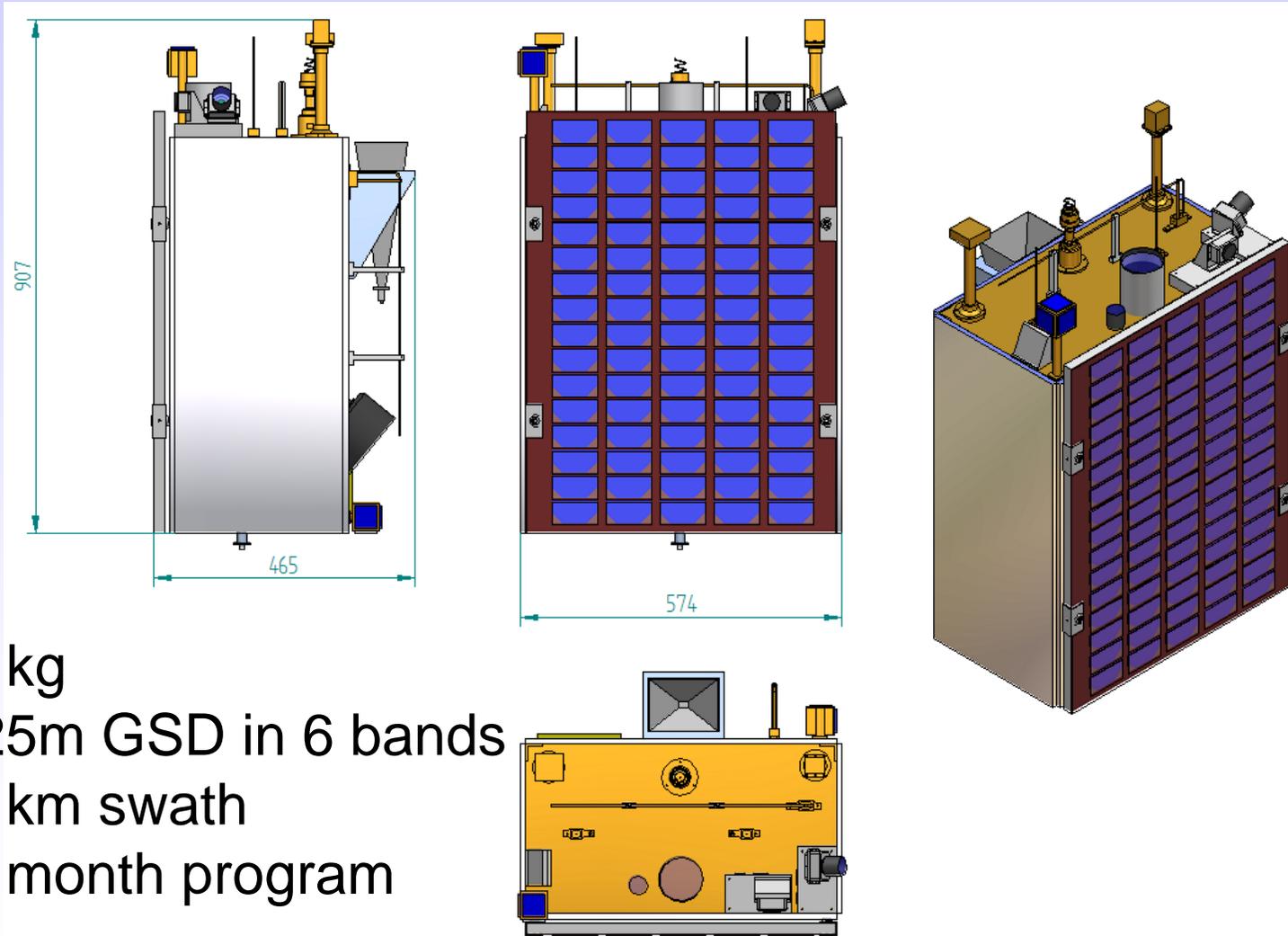
Overview of the pathfinder Satellite

Objectives

- Capacity building
- Useful applications
- Inform space policy process
- Satellite is of type MMSat



MMSat Satellite Layout



70 kg
6.25m GSD in 6 bands
45 km swath
12 month program

MMSat payload specification

Assumption: orbit height = 500km

Payload	Imager	Optics: athermalised, refractive optics design (400mm focal length)		
	MS data	Detector 1:	CCD (3 spectral bands; 7200 pixels each)	
			Swath = 45km	
			Best GSD: 6.25m	
			Sampling: 12bit	
		Detector 2:	CCD (3 spectral bands; 7200 pixels each)	
			Swath = 45km	
			Best GSD: 6.25m	
			Sampling: 12bit	
	Viewfinder	Viewfinder capability with real-time joystick control and single snapshot activation		
		On-board selection between 3 viewfinder cameras		
		FOV = 6° (PAL camera 1)		
		FOV = 120° (PAL camera 2)		
	Mass memory	Non-volatile memory		
		Multispectral capacity:	10 scenes of 45km x 45km (FMC = 4:1)	
			contiguous strip of 450km (FMC = 1:1)	
	Downlink	S-band transmitter (5W) for PAL video data transmission (1MHz BW)		
Omni-directional S-band antenna (sat. boresight pointed away from GS in viewfinder mode)				
S-band transmitter (5W) for image data transmission (60Mbit/s)				

Three-axis ADCS

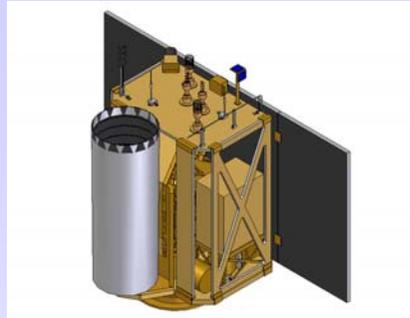
Forward Motion Compensation

Real-time view finder

24 Gigabyte to 240 Gigabyte on-board storage

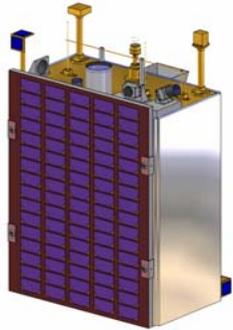
SunSpace Product Roadmap – Family of Technology

Performance



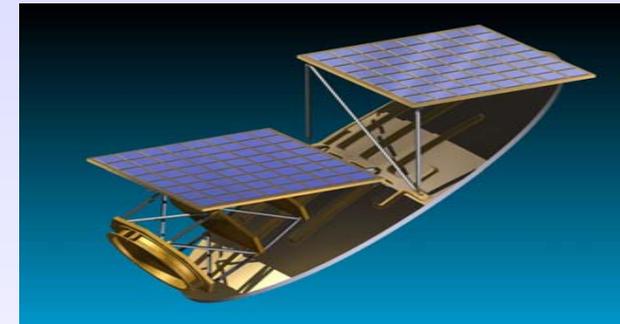
SunSpace 360 (ZASat 3)

- very high resolution
- SAR and Visual



MSMISat (ZASat 2)

- 2m5 GSD Panchromatic
- 5m GSD Multispectral
- 15m GSD Hyper spectral

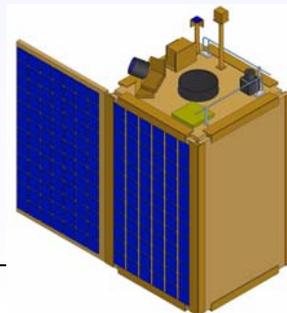


MMSat (ZASat 1)

- 6m5 GSD Multispectral
- 6m5 GSD Viewfinder

MxSat 40

- 4m GSD Viewfinder



Mass

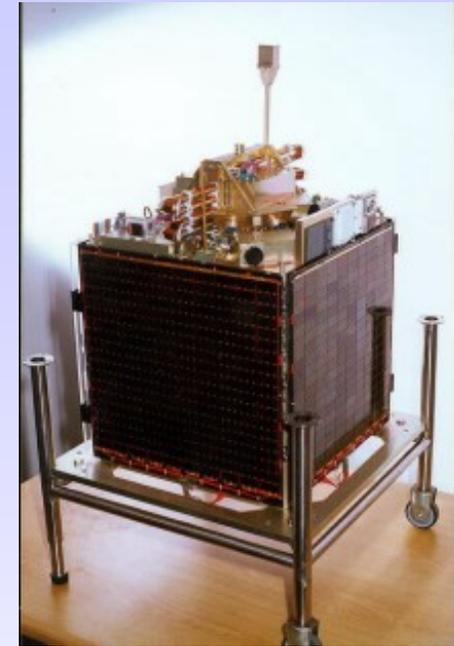


Space Engineering Education

- Satellite engineering education on SUNSAT
- Updated Satellite Engineering Education Overview
- The education planned as part of the pathfinder mission
- A unique tool - Satellite Development Toolkit

Satellite Engineering Education on SUNSAT

- SUNSAT Objectives
 - Graduate training program
 - Demonstrate new capability
 - Stimulate science and maths at school level
- Program Outputs
 - Completely independent satellite technology base
 - Master of Engineering studies (2 years) (70 graduates and still ongoing)
 - SUNSTEP schools program (130,000 school children and still growing)
 - Post graduate diploma in Engineering and Master of Engineering Science (155 students and program completing end 2005)



Space Science Inspires Teachers, Learners and Students!

- SUNSTEP programme
 - Run by Stb Univ since '96
 - Active in 7 provinces
 - Reached > 130,000 learners (end 2005)
 - Electronics focus
- Becoming part of technology curriculum



Satellite Engineering Education

SUNSAT Lessons Learned

- Students who do Master and/or Phd of Engineering have conflict of interest between project milestones and academic milestones
- A significant amount of satellite engineering has to do with topics not of interest to university research, but it is relevant for being better prepared for industry
- Without a fully funded program, a significant amount of academic research capacity goes into sourcing funding

Satellite Engineering Education – an Overview

	Subsystem	Functional	Mission
Hands-on Satellite Engineering Training			
Specialised Satellite Engineering Training			
Training with Full Satellite Mission			
Courses in Satellite Applications			

Education Planned for pathfinder Mission

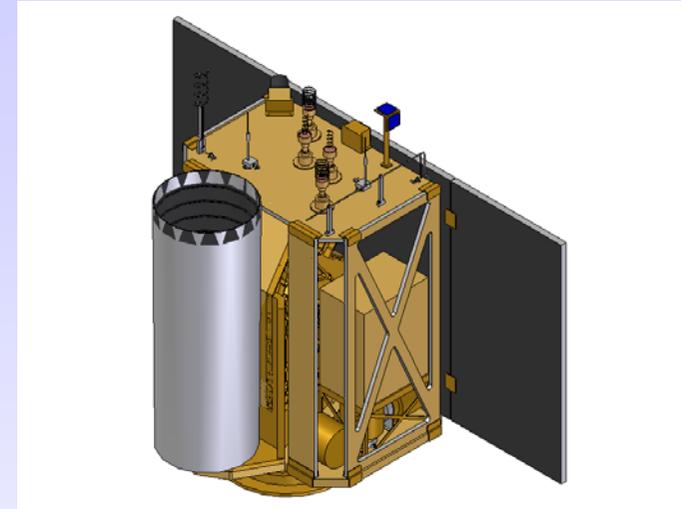
- Inspiring school children to choose science and mathematics
- Post graduate engineering training in electronic and mechanical engineering
- * Industry internship training giving hands on satellite engineering experience
- * Space science and satellite technology research programs

Implementing Education for pathfinder Mission

- Schools program
 - Expand SUNSTEP program: more provinces and link some of the experiments directly to space
- Post graduate satellite engineering
 - * A steady state team of 18 students p..a (16 M.Eng and 2 Phd) plus a post-doc position is fully funded
 - * Student output not on critical path and only used if of sufficient quality
- * Industry experience
 - Internship program with Satellite Development Toolkit for 5 to 8 people per annum
- * Space science and satellite technology research programs
 - Payload opportunities on the satellite, 2kg at start

A unique tool - Satellite Development Toolkit

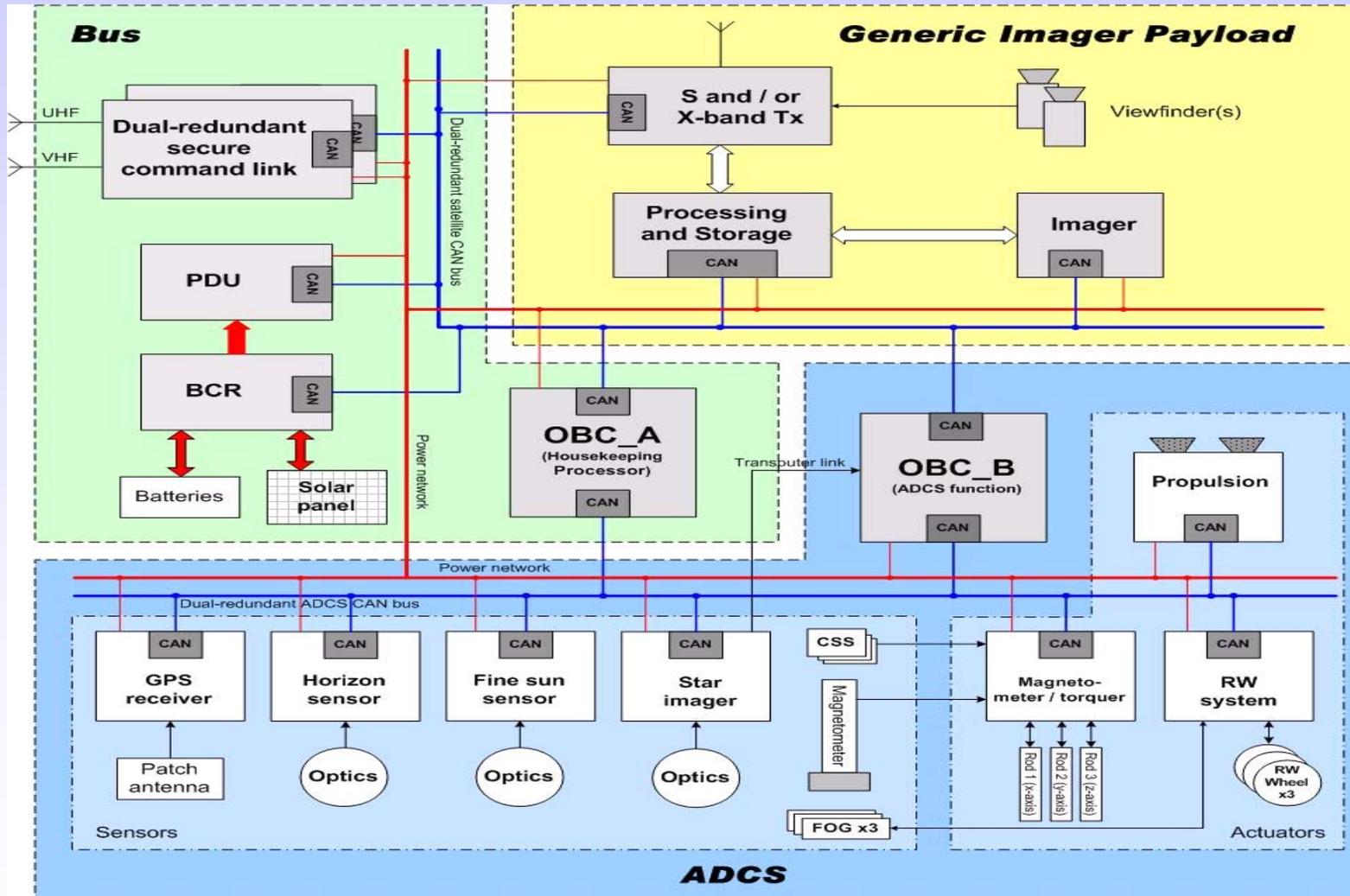
- Objective:
Fast track system level satellite engineering know-how transfer
- Approach:
Top-down approach to gain maximum understanding of why functionality is required and how it interconnects before doing detail design
- Available tool:
Satellite Development Toolkit



Satellite Development Toolkit – Used for Three Essential Knowledge Bases

- 1. Hands-on Satellite Engineering Training**
 - Hands-on system level building of complete satellite in own country with satellite engineering laboratory infrastructure established
- 2. Training with a Full Satellite Mission**
 - Intertwined with a specific satellite mission
 - Includes AIT Laboratory Establishment and Training, In-orbit Commissioning and Training and In-orbit Operational Training.
- 3. Specialised Satellite Engineering Training**
 - Detail design of components and sub-systems
 - Based around a specifically planned mission

Satellite Development Toolkit – Complete Satellite Technology

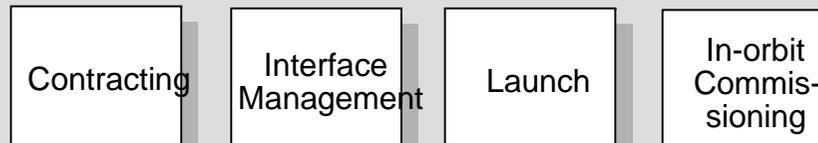


Know-How Development on all Mission Elements

Flight Model Satellite System - in-orbit operational use

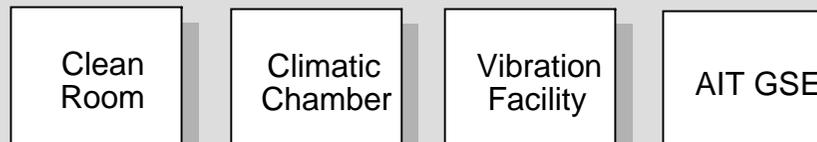


Launch Campaign



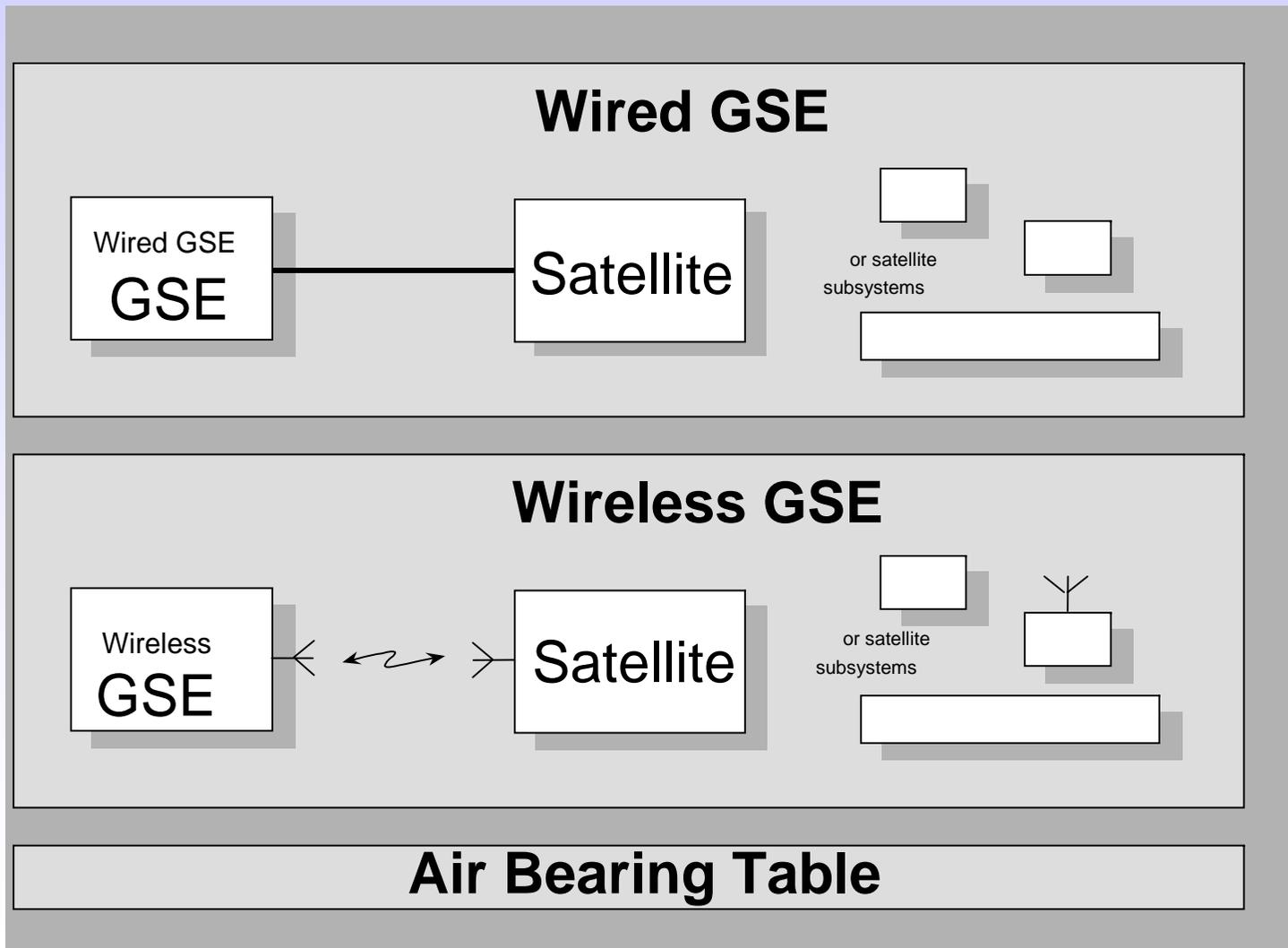
AIT Laboratory -

Assembly, Integration & Testing of Flight Model Satellite

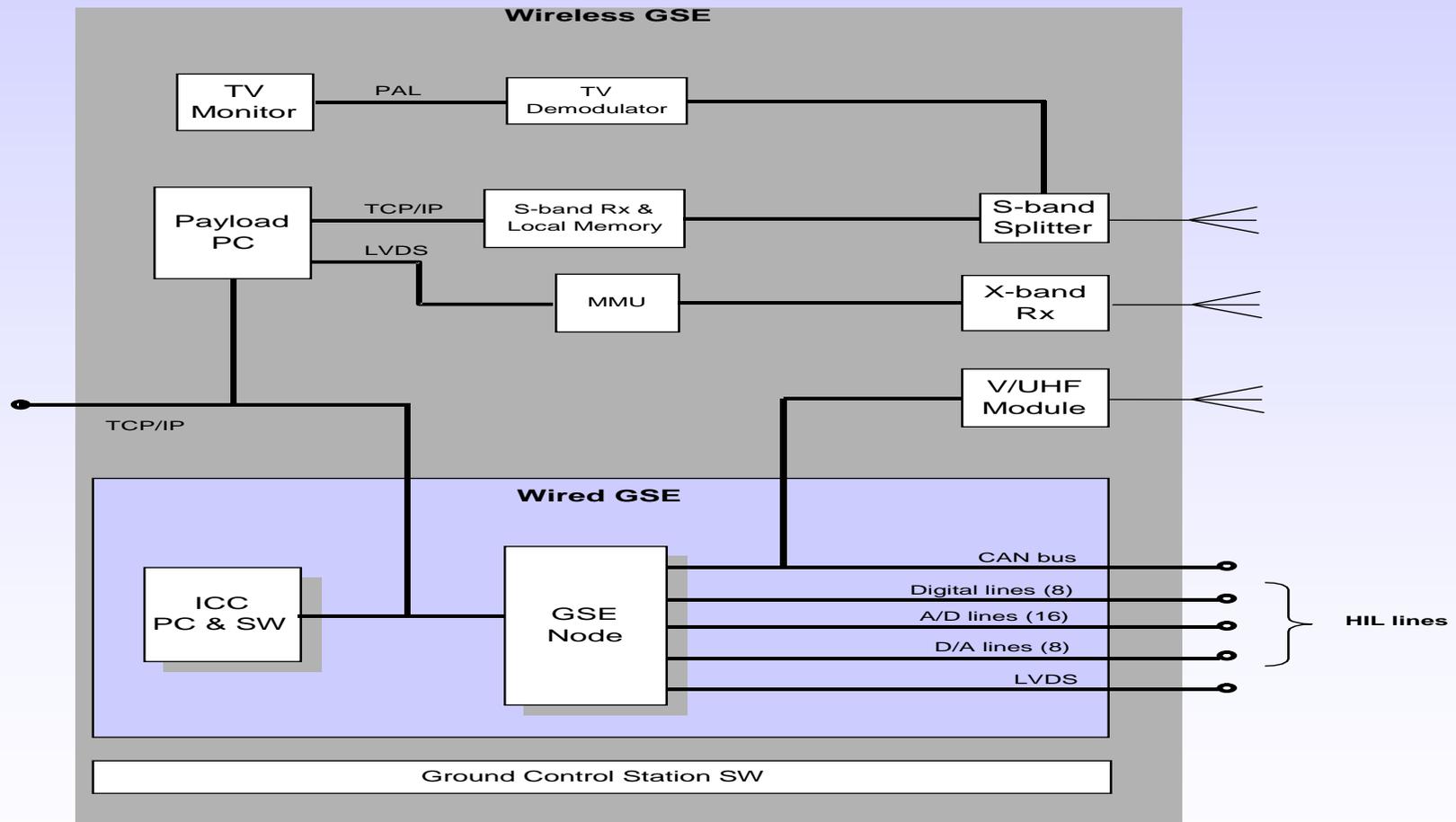


Satellite Development Toolkit

- Hardware and Software

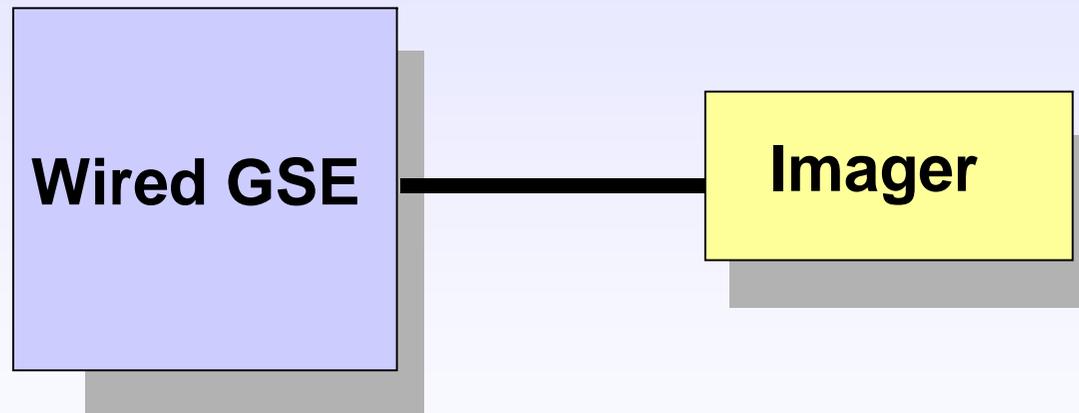


Satellite Development Toolkit – Ground Support Equipment State of the Art Know-How Transfer



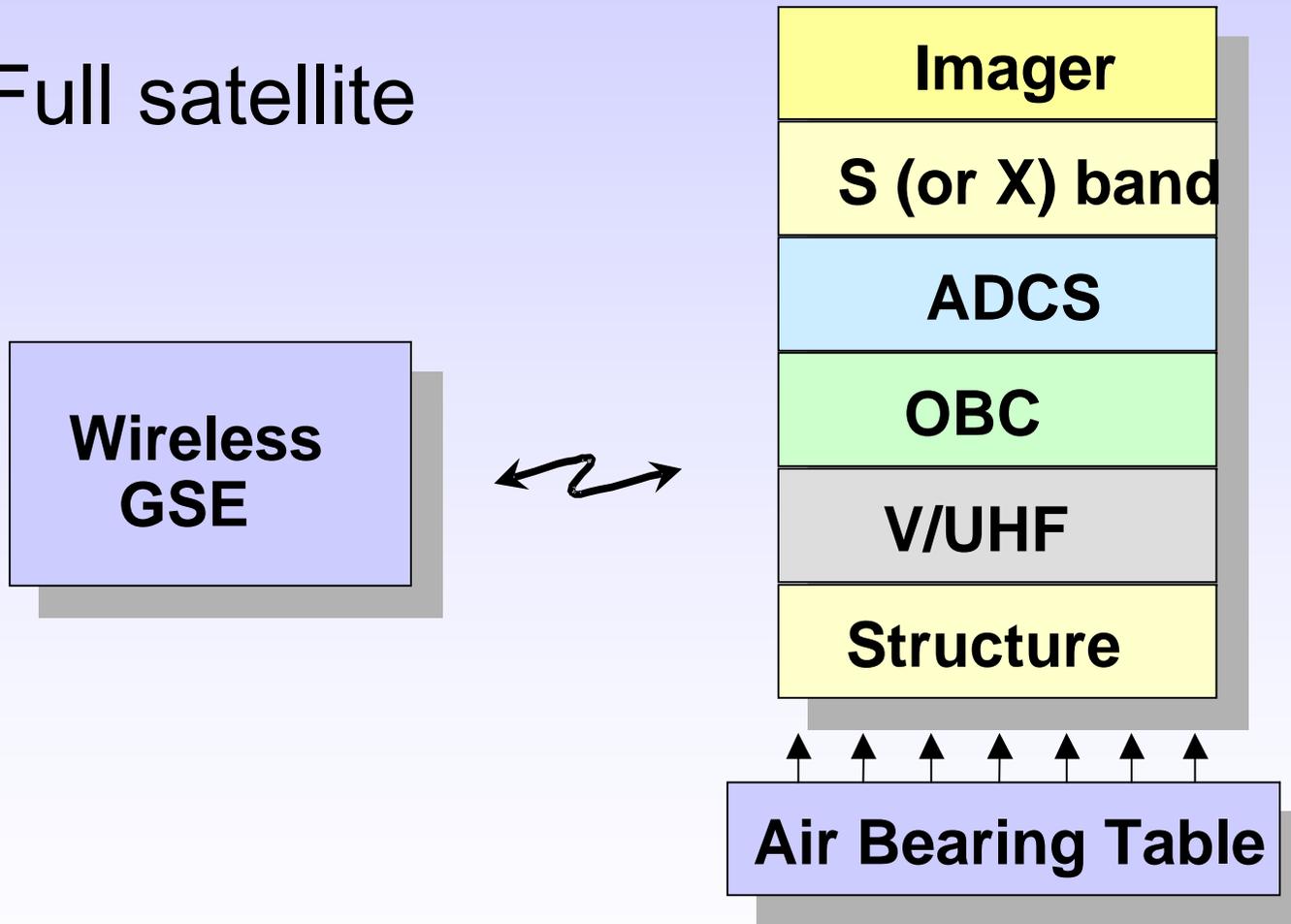
Satellite Development Toolkit – Stepwise Build Up

- First Step – Payload control



Satellite Development Toolkit – Stepwise Build Up

- Full satellite



Expected Outputs from South Africa Space Engineering Education Program

Type of Education	Year 1	y2	y3	y4
M.Eng students	8	8		
Can expand up to intake of 12 per annum		8	8	
			8	
Phd Students	1	1	1	
Can expand up to 6 per annum		1	1	
			1	
Satellite development toolkit	Establish			
Industry internship	5			
Can expand up to 8 per annum		5	5	
			5	
Total Manpower in Program per Annum	14	23	24	Ditto

Expected Outputs

- Team of engineers who can build own satellite with components and sub-systems supplied – join industry
- School children enthusiastic about engineering and technology and making the important decisions FOR science and mathematics
 - knowledge economy careers
- Ongoing training vehicle to bring new engineers up to speed with satellite engineering
 - growing industry

Conclusion

- Space engineering education program value = program value of complete satellite
- New-generation technology satellite gives high resolution (6m GSD) in 70kg package
- Satellite Engineering Education program: post graduate engineering, research, schools program and industry internships
- Invitation to join the program or start a dedicated space education project