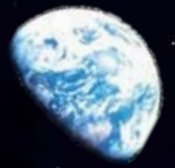
SURREY SATELLITE TECHNOLOGY LTD

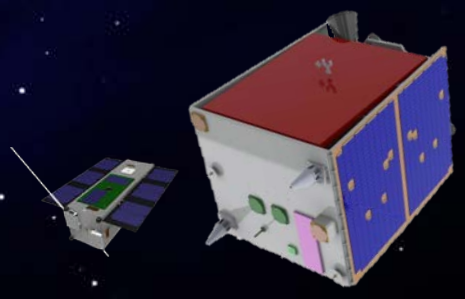
Changing the economics of space



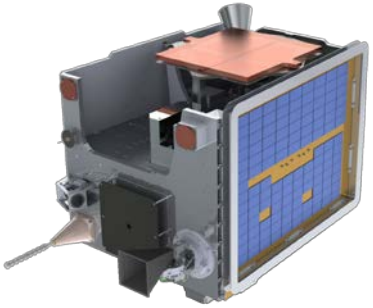
TechDemoSat-1

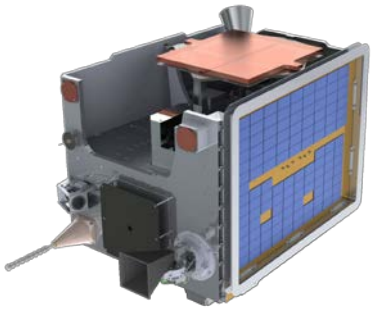
Presentation to the Appleton Space Conference 2014

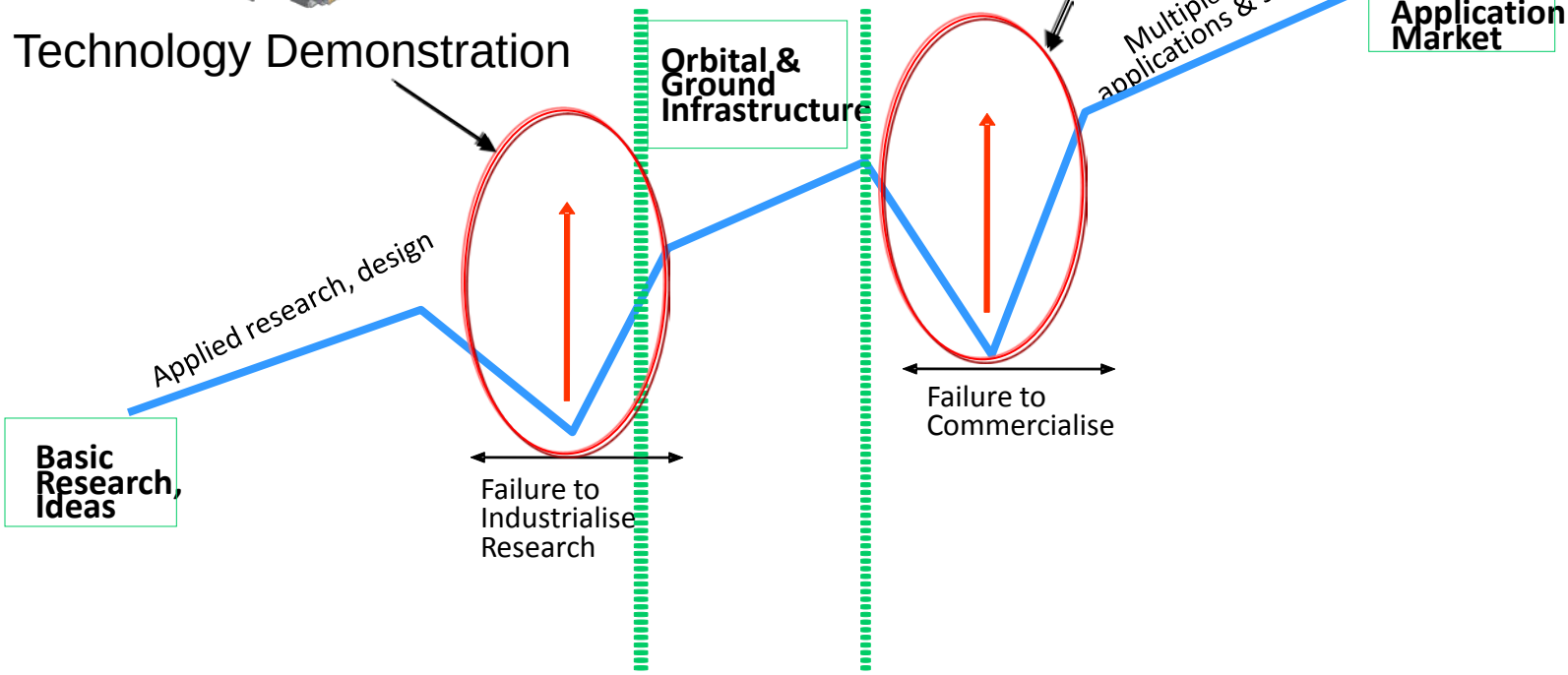
Andy Bradford and
Doug Liddle
SSTL



Rationale for TDS-1



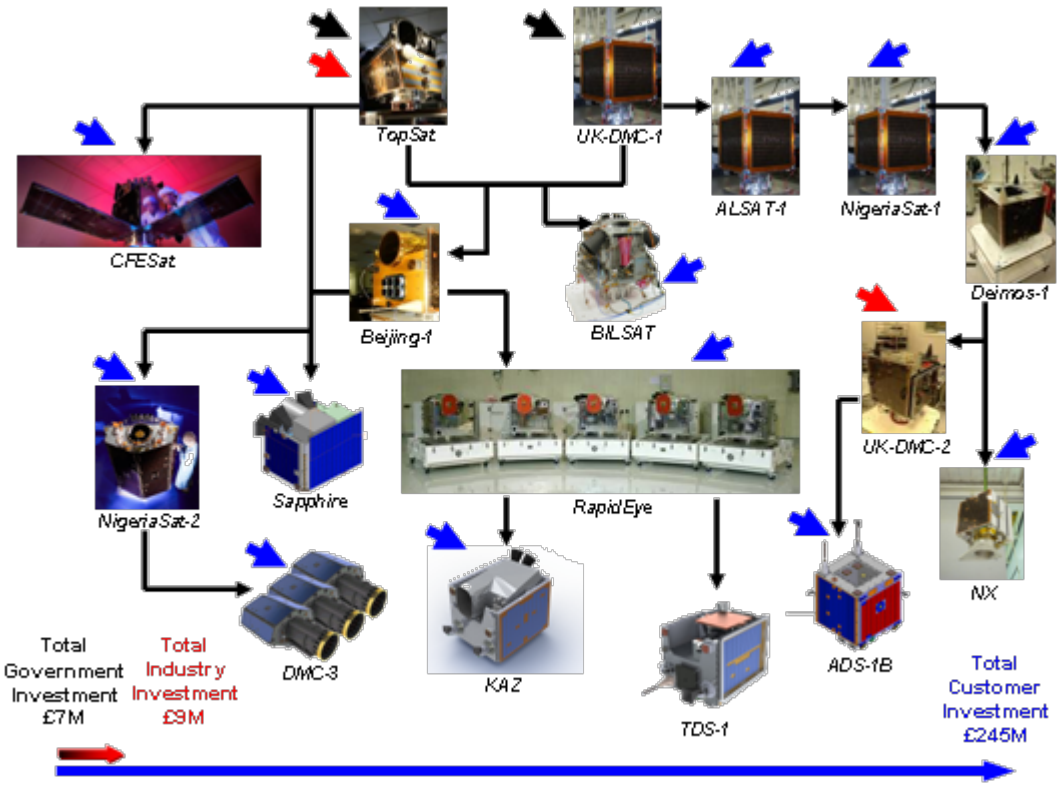




The challenge – twin valleys of death

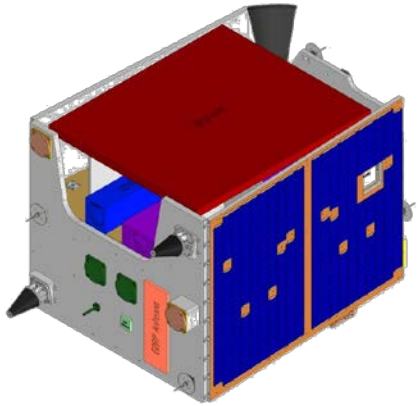
Why do it? Example: Return on the Mosaic Investment

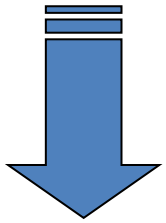
- Government investment - £7m
- Industry investment - £9m
- These £16m investments in the TopSat, UK-DMC-1, and UK-DMC-2 satellites have led to mission contracts worth £245m
- A 15-fold return on investment
- The TDS-1 programme represented a similar growth opportunity

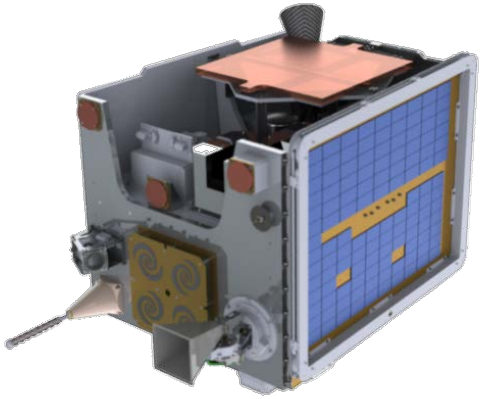


TechDemoSat-1

- Summary:
  - Funded by TSB/SEEDA in UK to provide a national platform for technology demonstration and rapid flight qualification of equipment and services
  - 8 distinct payloads + SSTL next gen avionics.
  - Payload history
    - Started with 7 payloads
    - Lost 3
    - SAR → Altimeter and merged with GNSS Reflectometry P/L
    - Added 5 new payloads
- Key Requirements:
  - Must be rapid schedule – to short circuit need for ground qualification
  - Must be flexible on payload accommodation –
  - Payloads must have clear exploitation route
  - Mission must be low cost – platform + s/c AIV (£3.5m), launch and operations







Who's involved ?

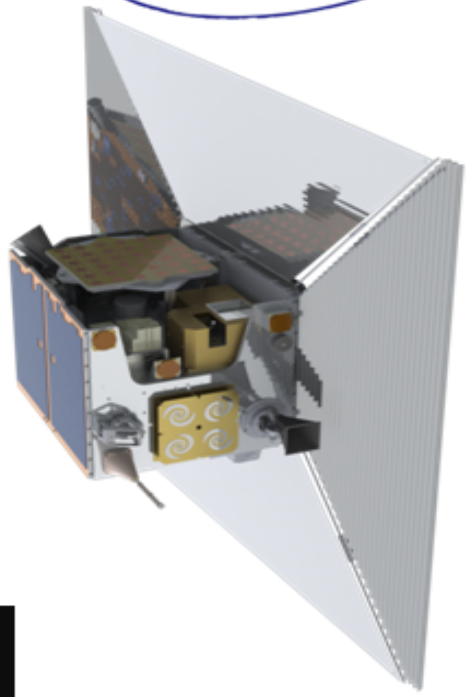
TechDemoSat-1

ISIC

SCISYS

Technology Strategy Board
Driving Innovation

SEEDA South East England Development Agency
Working for England's World Class Region



Cranfield University

SSBV

Langton Star Centre

SURREY SPACE CENTRE

UCL
MULLARD SPACE SCIENCE LABORATORY

RAL Space

University of Oxford

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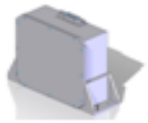
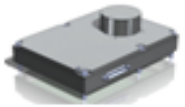
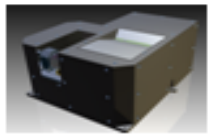
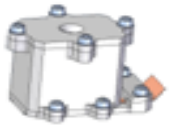
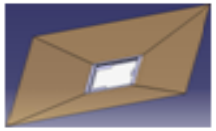
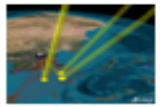
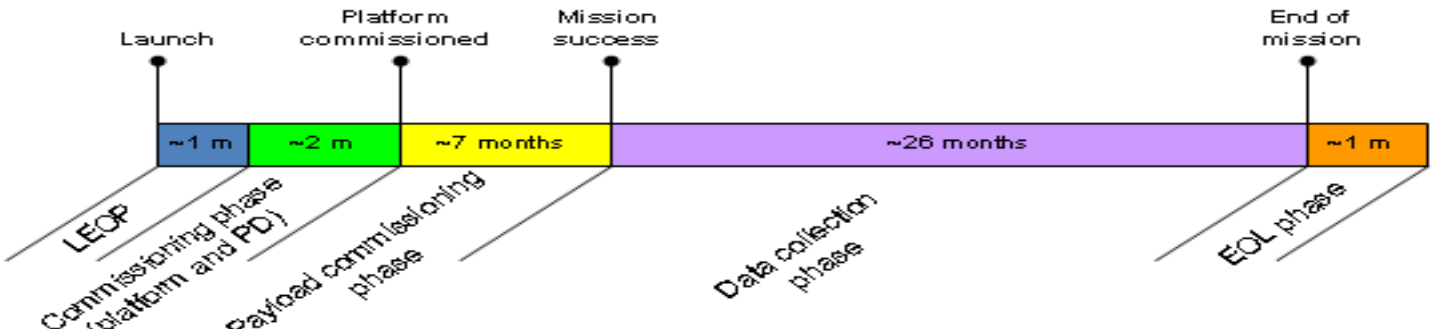
The External Payloads

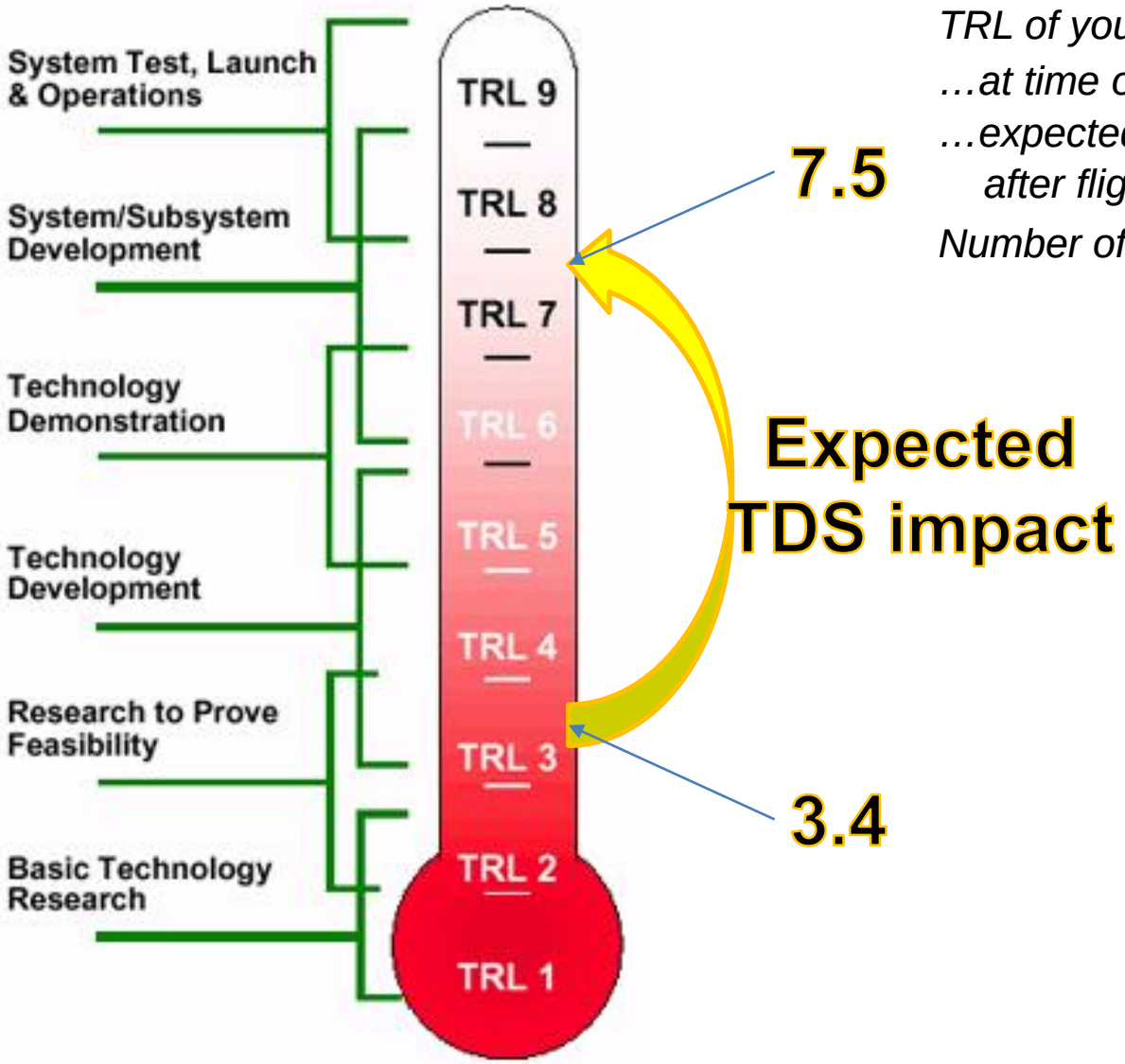
Payload	Supplier	Description	Illustration
MuREM	University of Surrey (Surrey Space Centre)	The Micro (μ) Radiation Environment Monitor (MuREM) is a miniature radiation environment and effects monitoring payload.	
ChaPS	Mullard Space Science Laboratory (MSSL)	The Charged Particle Spectrometer (ChaPS) is designed to measure electron and ion populations in the orbit of the host spacecraft.	
LUCID	Langton Star Centre	The Langton Ultimate Cosmic ray Intensity Detector (LUCID) allows characterisation of the energy, type, intensity and directionality of high energy particles.	
CMS	University of Oxford / RAL	The Compact Modular Sounder (CMS) is a set of compatible optical, detector, cooling and electronic sub-systems which can be used to implement miniature infrared remote sensing spectrometers or radiometers.	
HMRM	Rutherford Appleton Laboratory	The Highly Miniaturised Radiation Monitor (HMRM) is a an ultra-compact, low power radiation monitor developed for re-use on future ESA missions.	
CubeSAT ACS	Satellite Services Ltd	The CubeSAT ACS payload is a complete 3-axes attitude determination and control subsystem for Cubesats.	
DOS	Cranfield University	The De-Orbit Sail (DOS) is intended to demonstrate a novel means for de-orbiting a satellite at the end of its mission lifetime through deploying a sail to increase aerodynamic drag.	
Sea State Payload	Surrey Satellite Technology Limited (SSTL)	Passively monitors ocean roughness via detecting reflected GPS signals and provides orbit determination via dual-band GPS (SGR-RESI).	

The Operations Plan

- 3 year Mission
- SSTL donated use of Ground stations to support TDS free of charge for Mission duration
- TDS-1 was the first Satellite commissioned from Harwell
  - Mission Operations Centre (MOC) is located at Harwell –operation of Payloads & MPS
  - Spacecraft Operations Centre (SOC) will be at SSTL, Guildford
- Payloads Operated in an 8 day cycle – 2 days are for SSTL PD
- MPS funded by UKSA and written and developed by SciSys with SSTL



Results from Catapult Survey



TRL of your payload…

…at time of proposal?

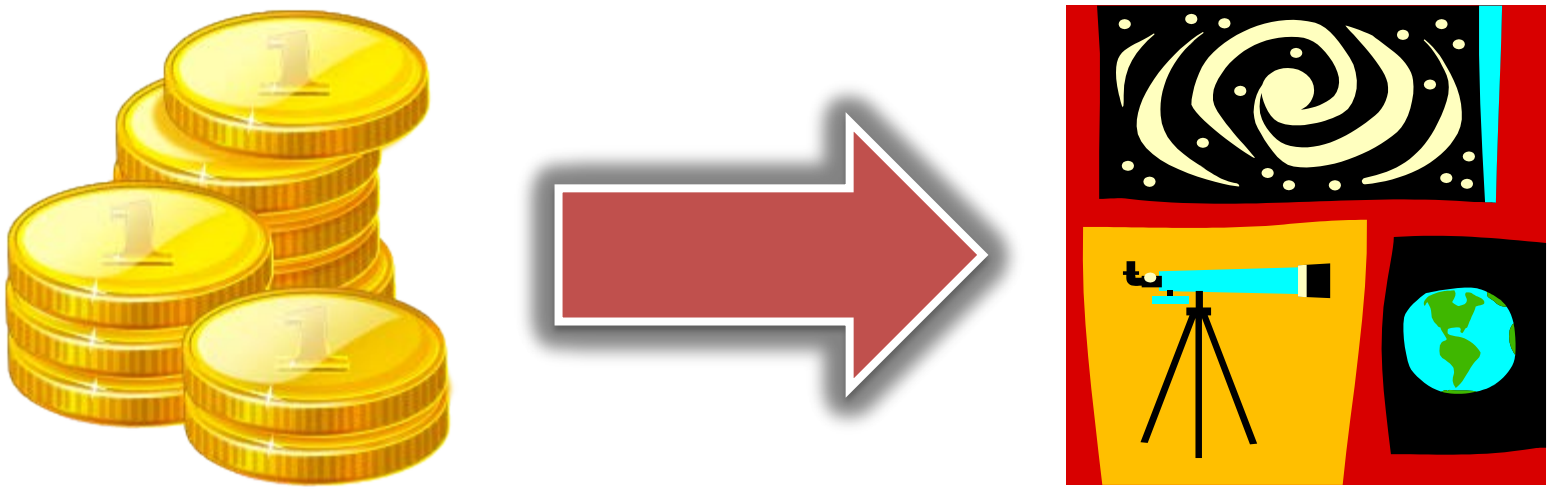
…expected to reach after flight?

Number of answers: ***8***

NASA TRL scale

Commercial exploitation

- Withdrawal of some payload providers led to a more academic focus for TDS-1
- Superb for technology demonstration, created a very different exploitation story….

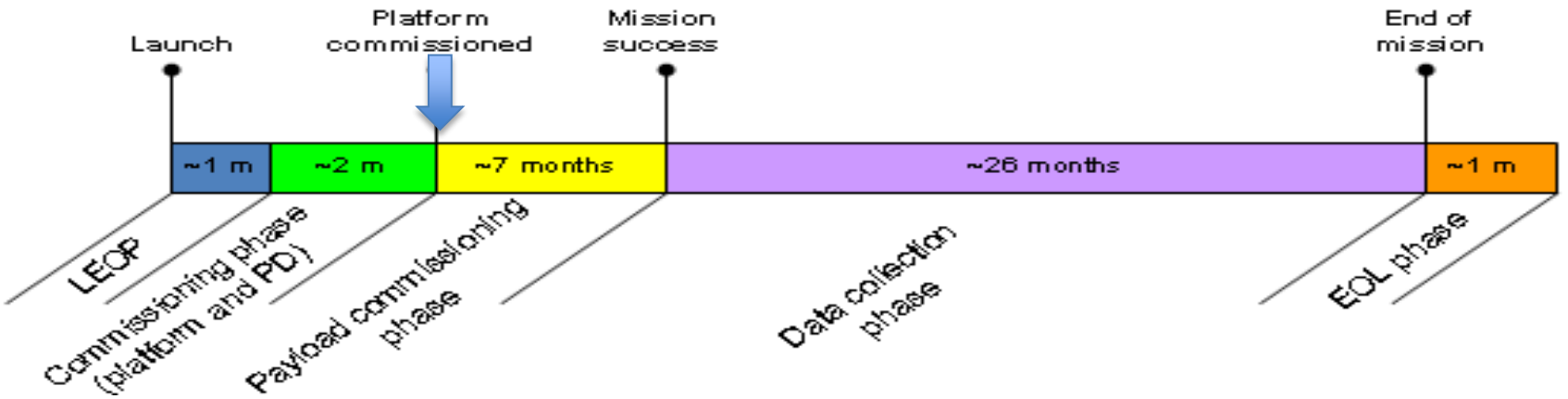


Launch

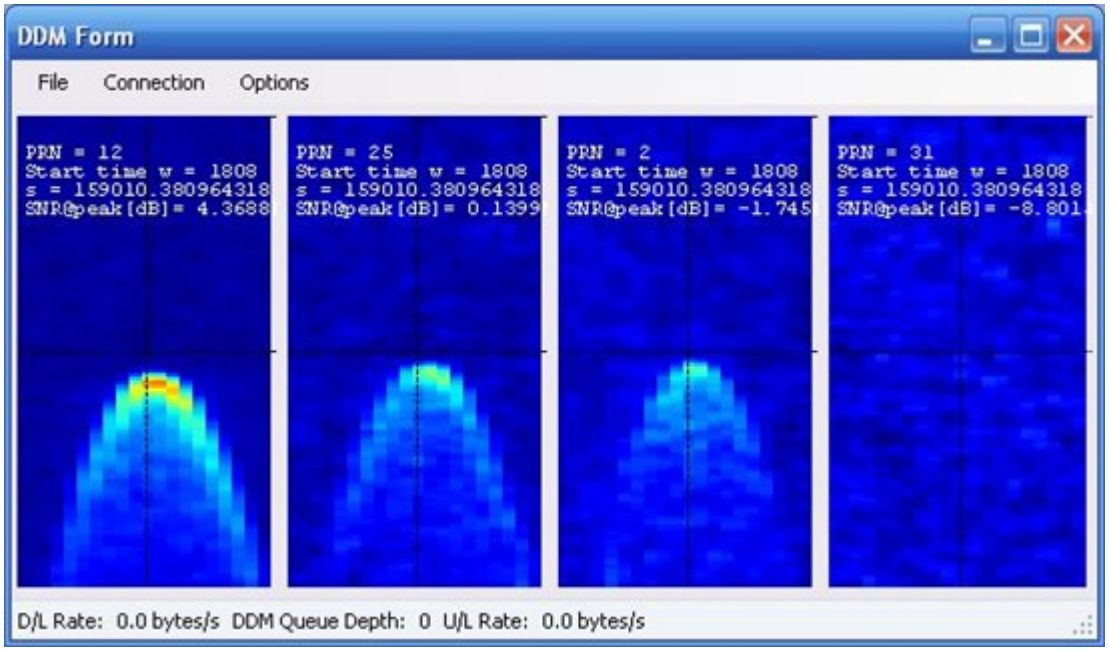
- Securing a Launch for TDS-1 was a difficult process!
- Initial Baseline: to be launched ‘free’ on PSLV
- Second Baseline: Auxiliary Passenger on VEGA qualification flight
- Third Baseline: Auxiliary Passenger Soyuz from Baikonur
  - This one worked out in the end!
  - Unfortunately delays with the primary passenger and politics resulted in multiple delays to launch date
- TDS-1 was launched >12 months later than hoped, on 8th July 2014

LEOP and Commissioning from Catapult (Harwell)

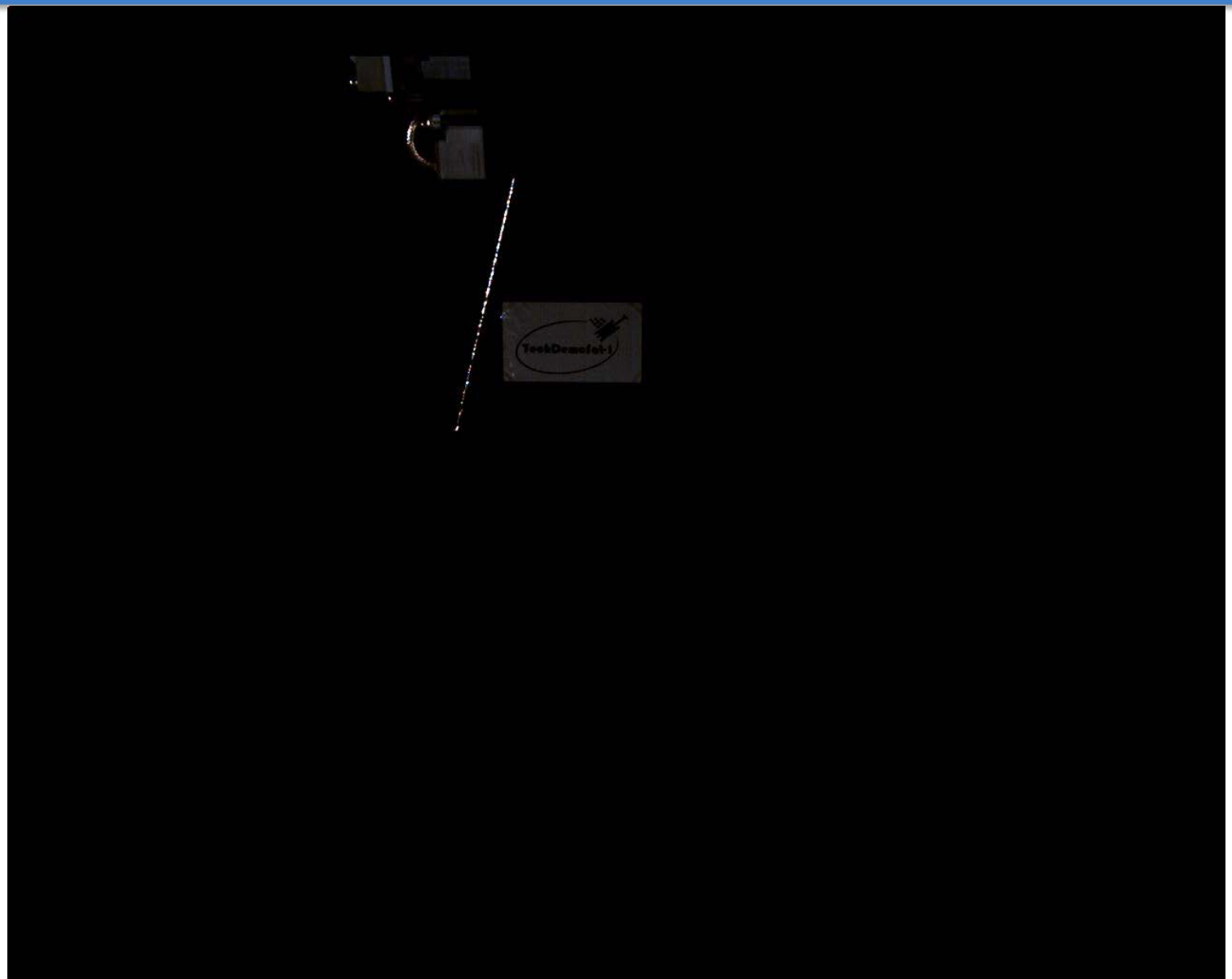
LEOP and Commissioning



- Platform commissioned and satellite handed over to Catapult on 22nd October
- 8 Day Operations Cycle now up and running.



8th July 2014



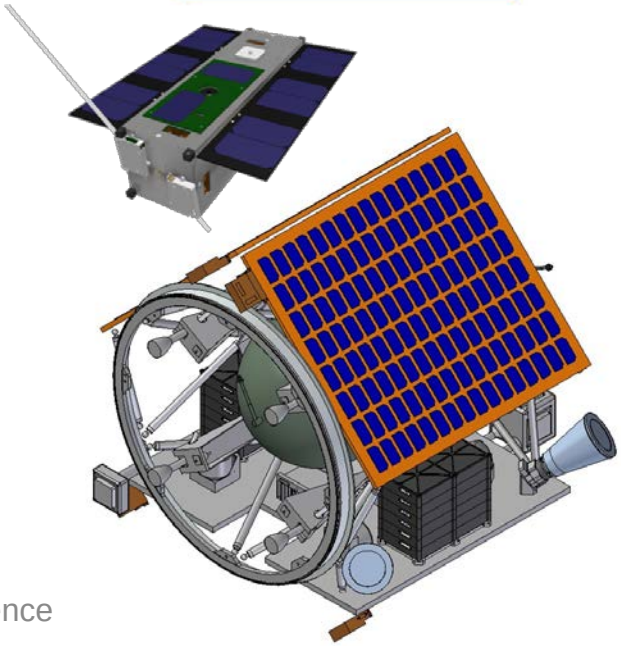
Future UK IOD Programmes?

- If it can be achieved at an Acceptable Price Point, and at the ‘right time’, In Orbit Demonstration is a Uniquely Valuable Facility

- Should be an ongoing activity to get most value
  - Platform availability should have a regular cadence to allow developers to plan
  - Would decouple platform schedules from payload schedules
    - Mitigates risk of payloads going past ‘sell by date

- Should look at all sizes of satellite bus including hosting on other missions

- Should address a range of orbits – up to lunar



Future Rationale and Benefits

- Hosting payloads is only one benefit of an IOD mission!
- We need to also address applications and services to maximise downstream benefits
- Possible vision:
  - Thematic missions with anchor customers (government or commercial) to address future markets
  - Mission transfers to commercial operator ownership after demonstration phase
  - Payload space allocated to technology demonstrations and outreach
- This vision of IOD could become a self-sustaining reality...

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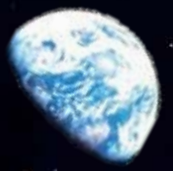

Thank you!

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