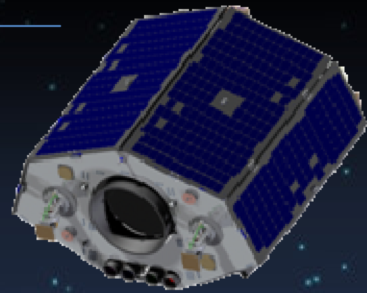
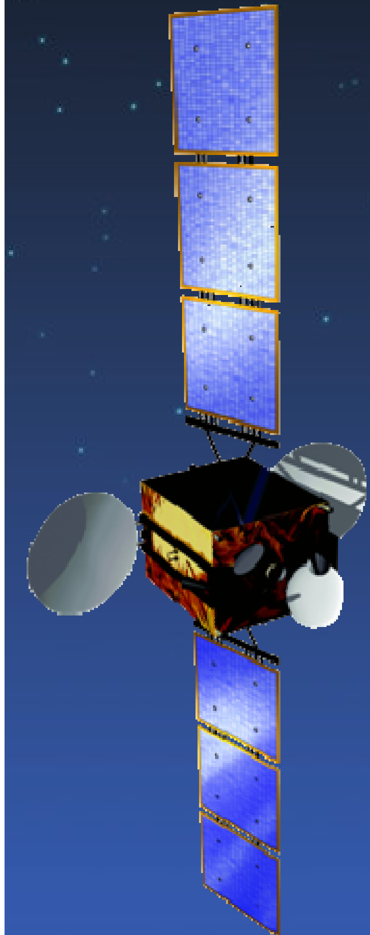
SURREY SATELLITE TECHNOLOGY LTD Changing the economics of space



Accommodating Instruments on Small Platforms



Philip Davies
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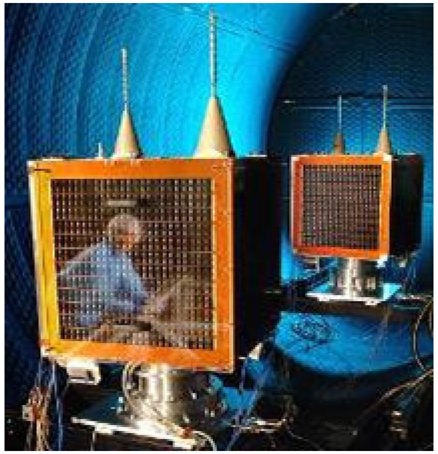
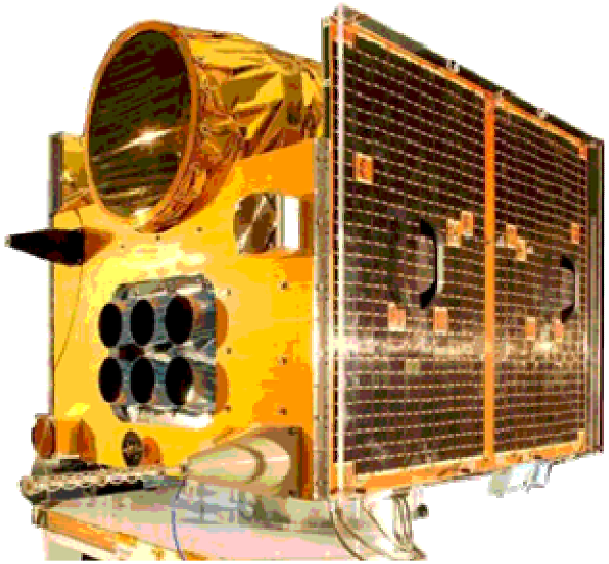
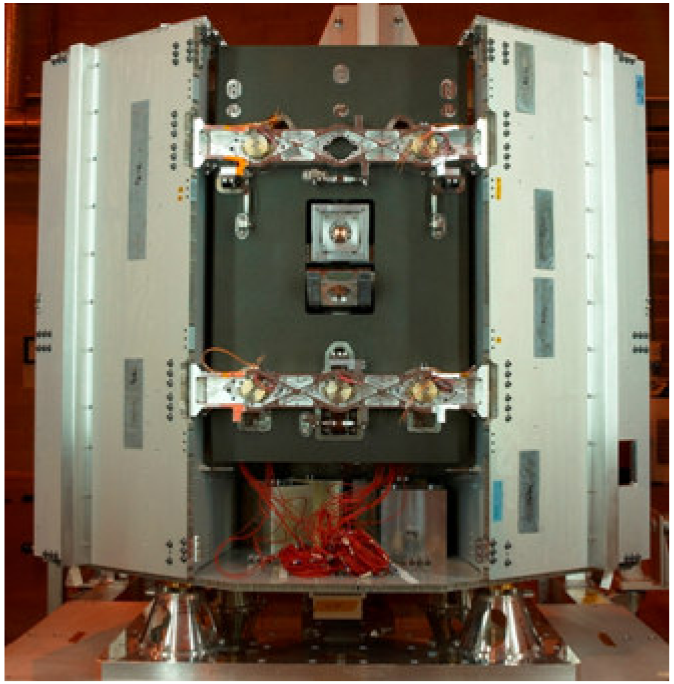
SSTL's Wide Range of Platforms

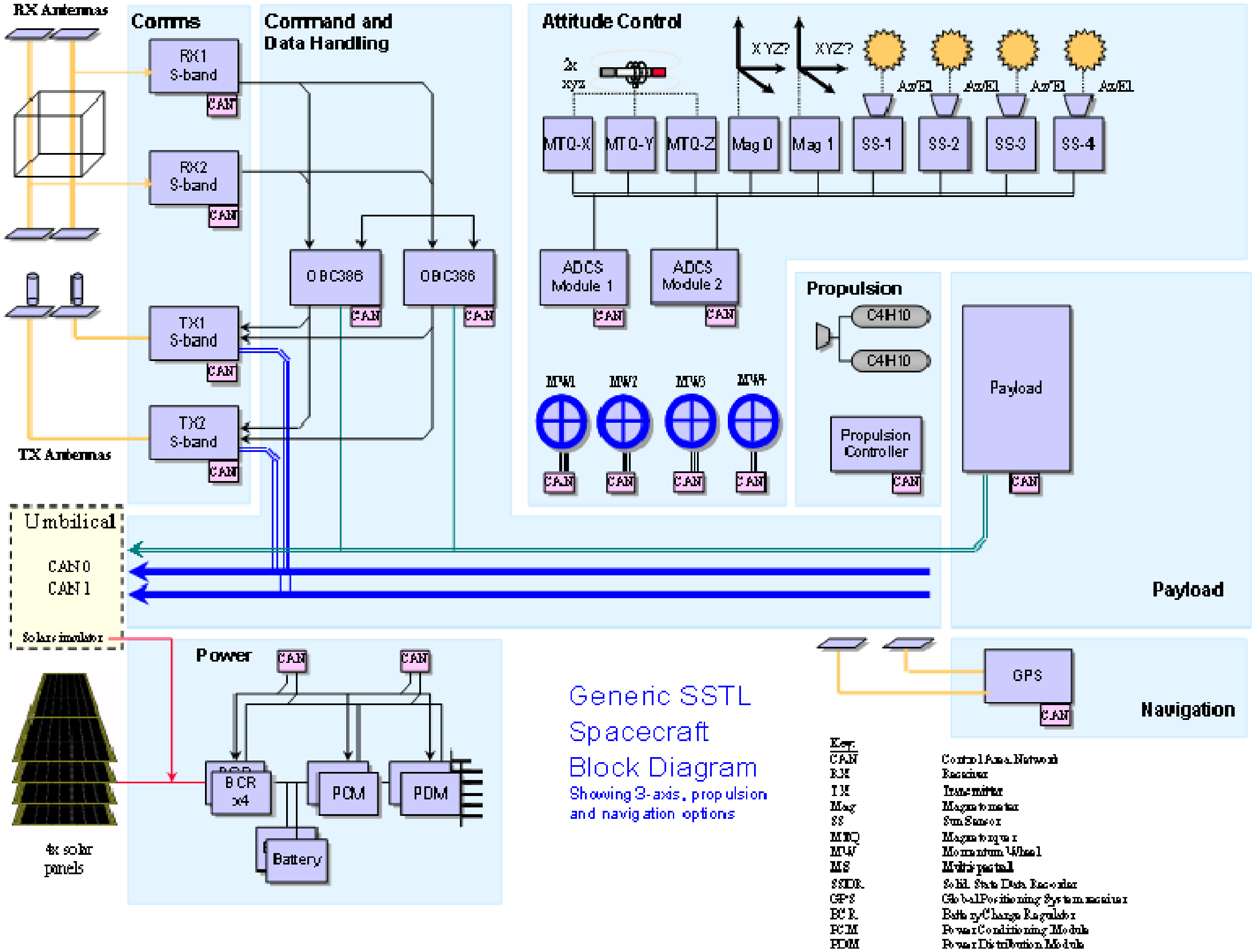
- **Platforms at a variety of price/performance points:**
  - SSTL 10, nanosatellite platform
  - SSTL 100, compact modular platform
  - SSTL 150, enhanced modular platform
  - SSTL 300, high-performance modular platform
  - SSTL 300+, future missions
  - Ability to rapidly design and qualify custom platforms





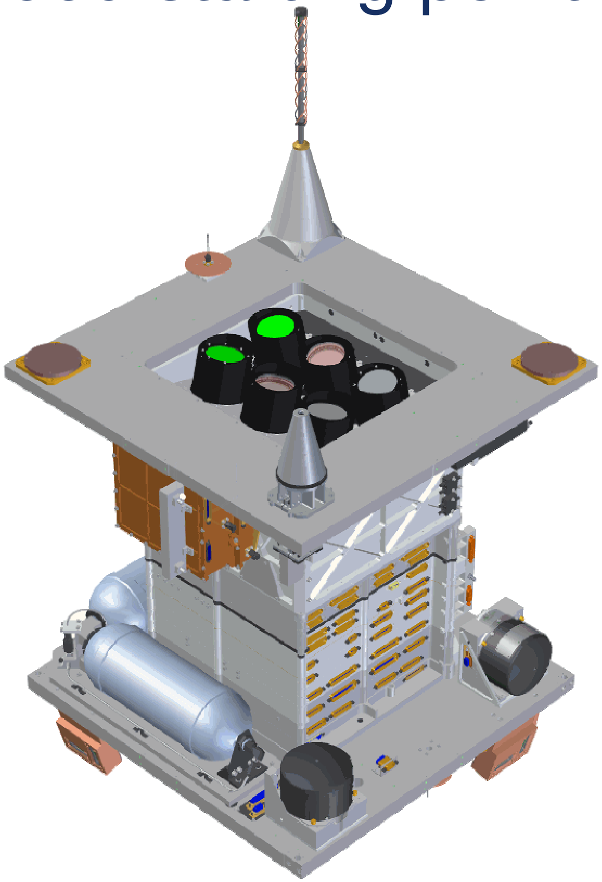


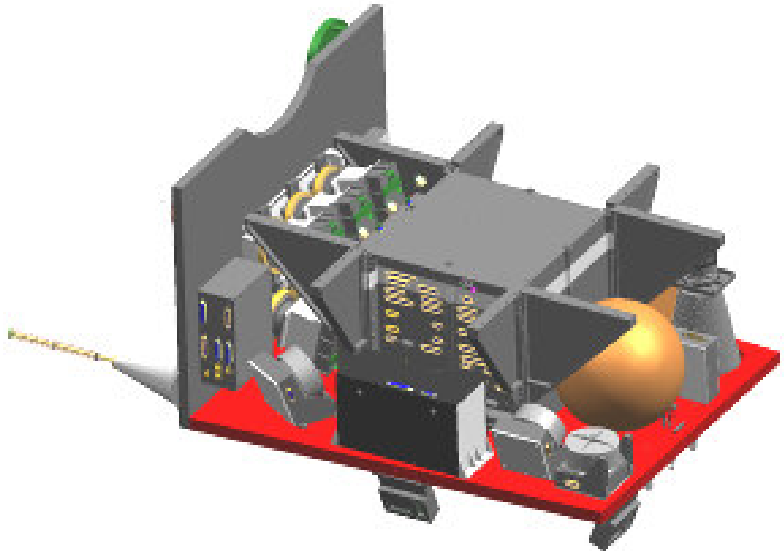
Generic Electrical Architecture

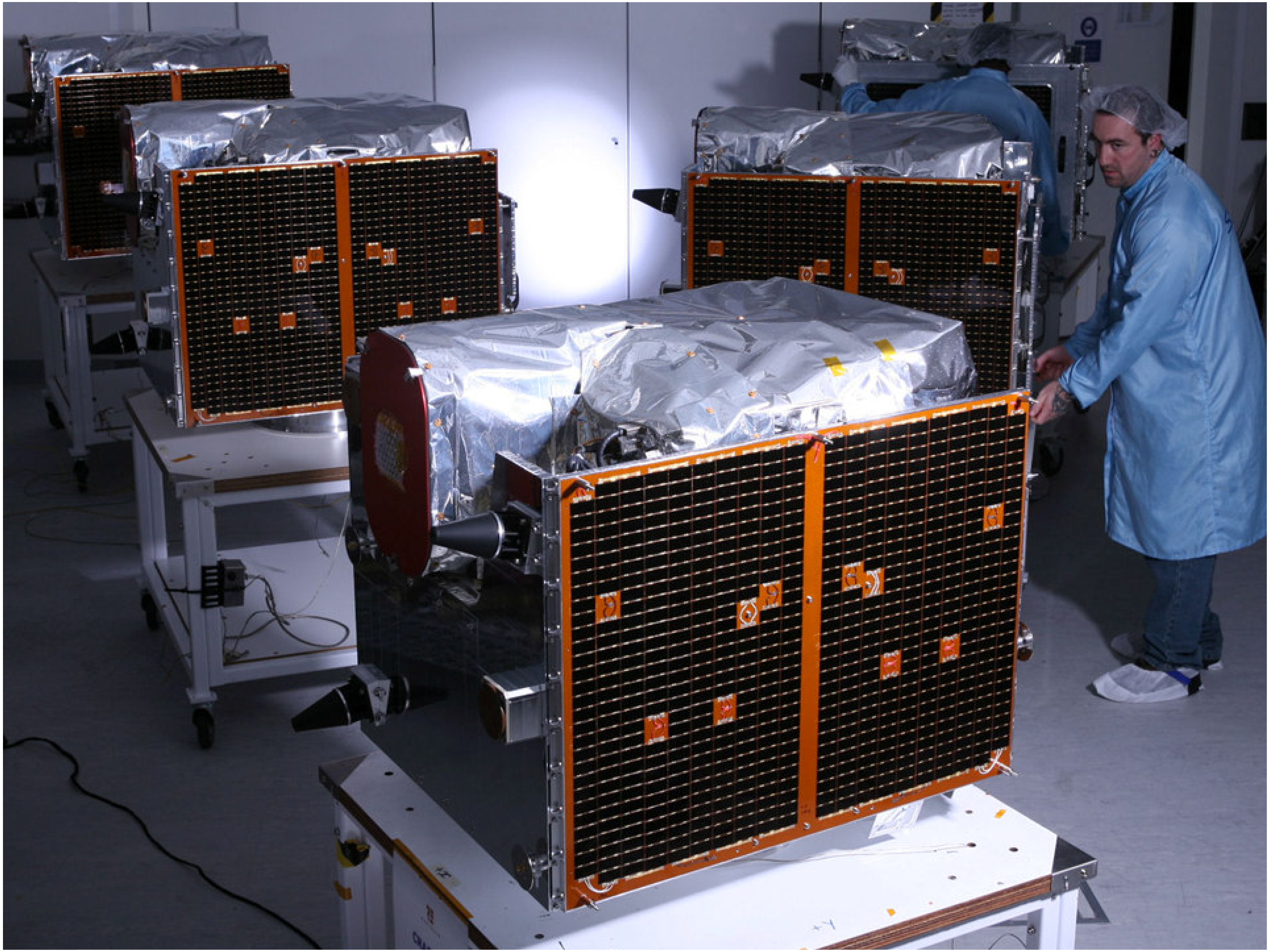


SSTL – 100 / 150

- “Entry level” operational missions
- Good starting point for constellations

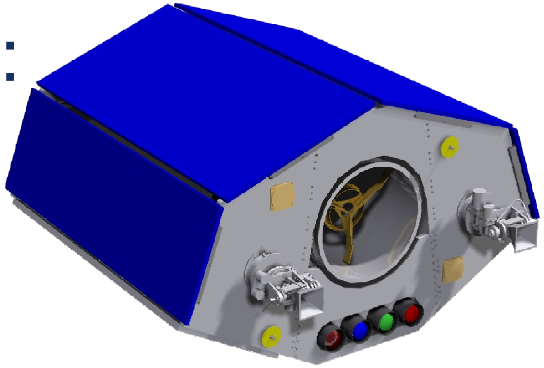


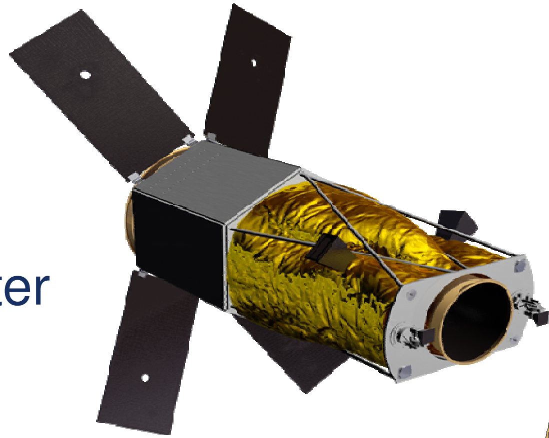


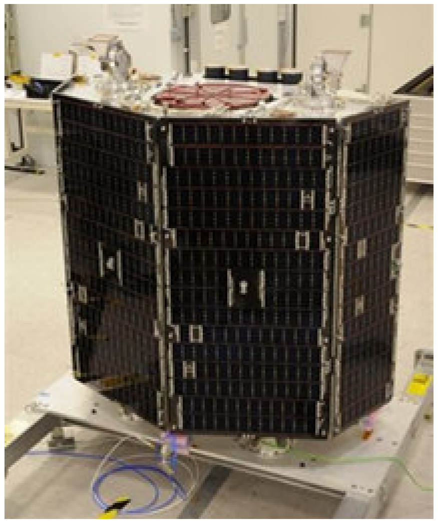


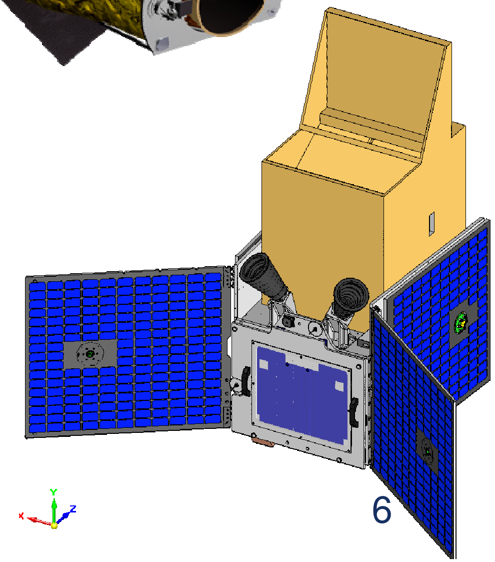
SSTL – 300 / 300+

- Higher performance & throughput:
  - NigeriaSat-2
    - 2.5m Pan, 5m 4 band MS
  - Earth Mapper
    - 60cm Pan, 2.4m 3 band MS
  - GMES Sentinel-5P
    - UV, ViS, NIR, SWIR Spectrometer





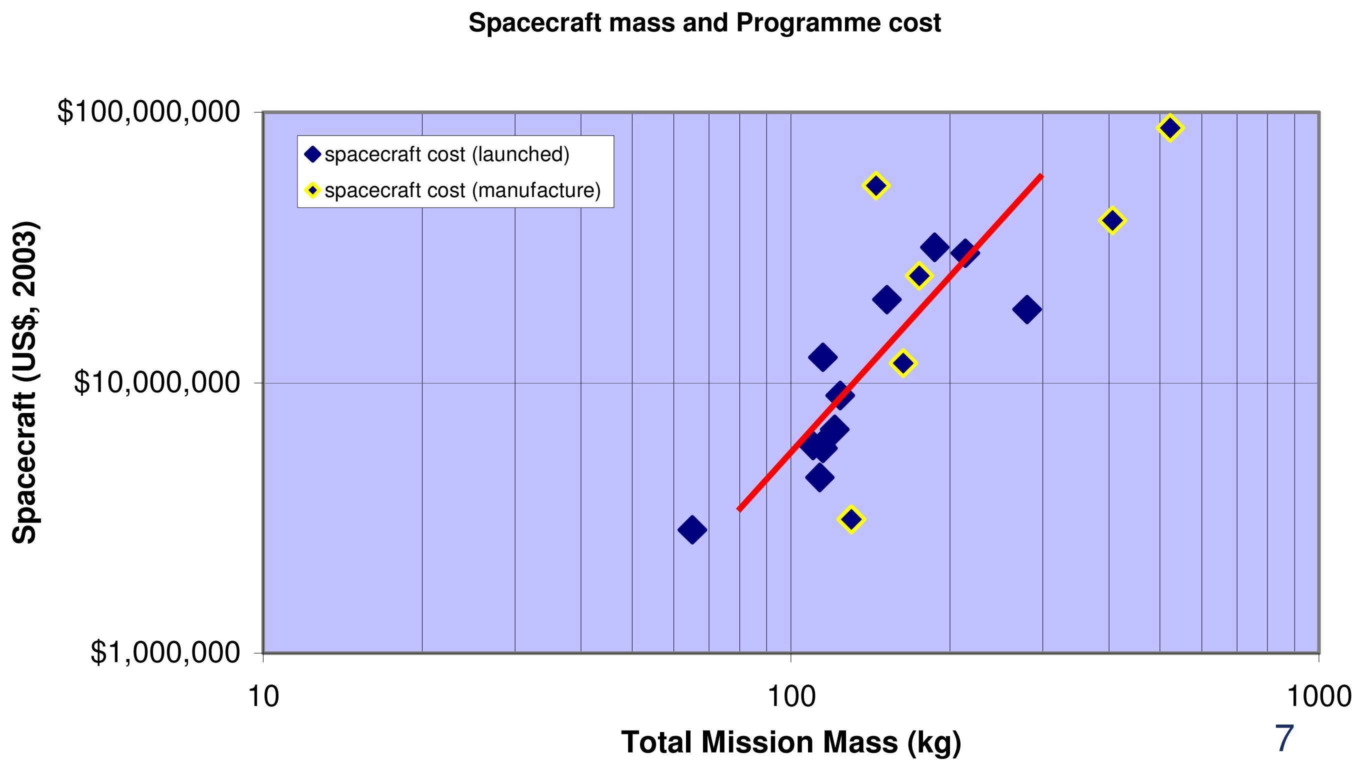




Smallsat performance

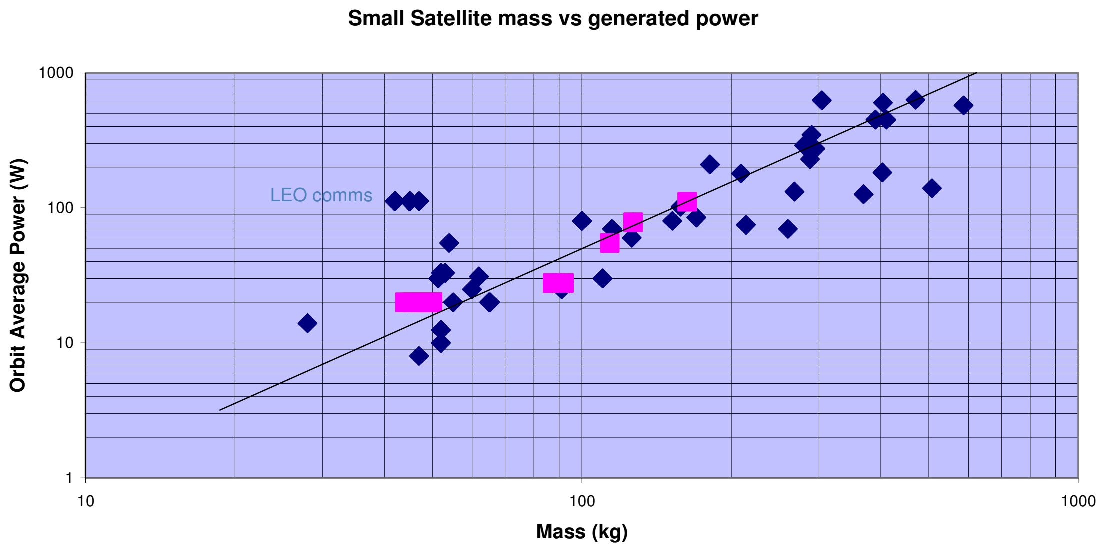
- Performance is mature, and keeping pace with modern space and terrestrial technology

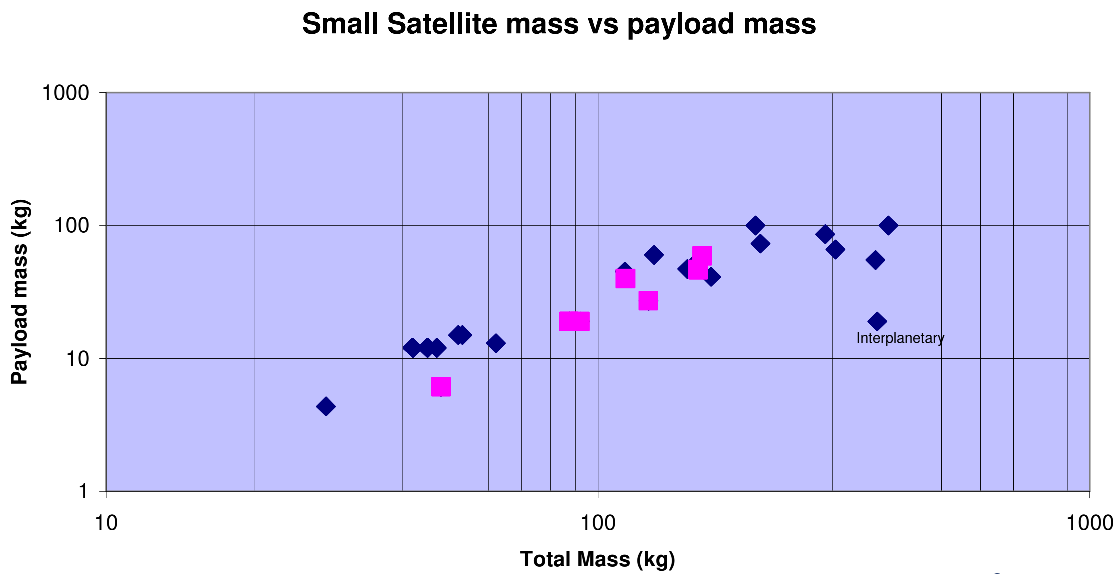
- Strong relationship between mass and cost



Performance

- Orbit average power generated is typically less than 1W for each spacecraft kg.
  - Inertial pointing missions or those with tracking panels can perform better





- Typical payload mass fractions are ~30%, 50% demonstrated

Payload / Instrument Accommodation

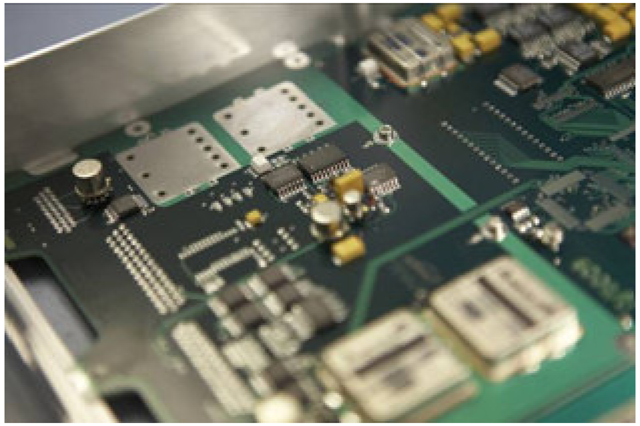
- Think about:
  - Key areas
    - Mechanical
    - Power
    - Thermal
    - Data
    - Attitude & Orbit Determination/Control
    - Orbit Constraints
    - Other (lifetime, special requirements)
    - Ground systems & CONOPS

Mechanical Interface

- Chosen Platform will have ability to carry a range of different masses & dimensions
  - Mass and mass properties (MoI etc) important
  - Think about a 3D model
- Even if mass ‘fits’ then there are other impacts into system such as agility which depend on mass and mass properties
- Does payload need mechanical isolation from platform sources of mechanical noise
- Launch vibration – must be analysed at spacecraft level

Power/Electrical Specification

- Key drivers are peak power and average power
- Duty cycle - some instruments can be switched on/off – even when off is there a power requirement (standby mode)
  - “day in the life” scenario



- Other considerations:
  - Noise
  - In-rush currents
  - Switching interface definition
  - Voltages and tolerances (5V reg., 28V unreg.)
  - Physical power connector definitions
- High powers (>200W) typically imply sun-tracking panels – adds complexity to power system, ADCS, FDIR

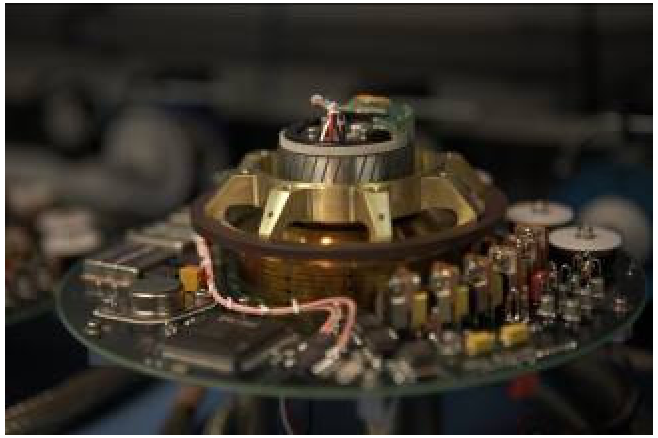
Thermal

- Constraints e.g. upper and lower limits of allowable temperatures
  - Is this a platform function or is it best performed within the instrument
- Thermal Stability (short term variation)
  - Is this a platform function or is it best performed within the instrument
- Possible major impacts into power (if heaters or active coolers required)
- Possible mechanical impacts (does platform need radiators)

Data

- Physical data interfaces (House-Keeping, Payload Data) inc. mechanical connectors and pin-out definitions
- Protocols inc. command and telemetry layout
- Data rates – peak & average
- Storage requirements (how much data should platform store and/or buffer)
- Processing requirements (does any payload processing occur on the platform)
- Downlink requirements – volume, rate, latency, band: drives Tx equipment, G/S usage

Attitude & Orbit (AODCS)



- Attitude
  - Control
    - Pointing accuracy
    - Pointing modes
    - Pointing stability
    - Agility
  - Determination
    - Accuracy of determination of pointing direction (typically instrument bore-sight angle or geolocation)
    - Frequency of attitude determination (agility)
- Orbit
  - Control
    - How much orbit maintenance (formation flying, constellation, repeating ground track, LTAN maintenance)
    - Deorbit requirement
  - Determination
    - Precise (GPS, GPS 2 frequency, retro-reflectors/DORIS)

Choice of Orbit

- Probably LEO
- Sunsynch, Polar, Equatorial, Inclined
  - Major impacts onto power generation, thermal
- Impact of altitude
  - Low e.g. <500km, need ability to raise altitude, attitude disturbances, environment (AO)
  - Mid ~500-700km, most missions
  - High >700km, problem of de-orbit gets bigger, possible radiation issues
- ESA will always assume worst case date for launch

Other considerations

- Special requirements e.g. EMC/EMI/Magnetic Cleanliness
  - What are the EMC/EMI requirements on the platform?
  - Any magnetic cleanliness requirements?
  - Any limitations on spacecraft propellant choice and other materials
- Lifetime
  - Drives redundancy & operations costs

Operations & Ground Systems

- What is the operational concept?
  - Mission planning
  - Downlink scenarios
  - Mission specific data processing
  - Archiving
  - Data dissemination
- Drives ground segment architecture
- Requirements on flight operations segment
  - Data volumes
  - Networks
  - Latency

Typical SSTL Platform Specifications

	SSTL-100	SSTL-150	SSTL-300	SSTL-300+
Lifetime (Years)	5	7+	7+	7+
Delivery (Years)	1.5	2	2	2.5
Payload Mass (kg)	40	70	70	150+
Payload Power (W)	30	50	70-100	150+
CPU	386 25MHz	386 25MHz	Sparc V7 11 Mips	Sparc V7 11 Mips
Memory (Gbytes)	4	16	24	32+
Comms (Mbps)	80	80	210	210-320
Pointing (degree)	1	0.1	0.1	0.1
Geolocation (m,99.7%)	-	100	100	30
Vibration isolation	-	yes	yes	yes
Delta-v (m/s)	20	30	20	55

Conclusions

- Vital to involve spacecraft prime contractor early in process
  - System engineer
  - Subsystem engineers if difficult problems are identified

- SSTL can provide support for EE8 Missions and other equivalent programmes

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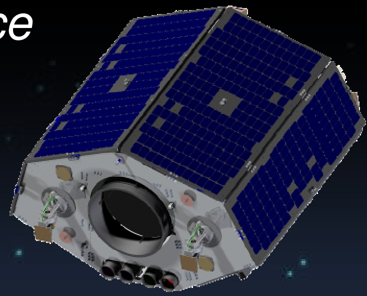
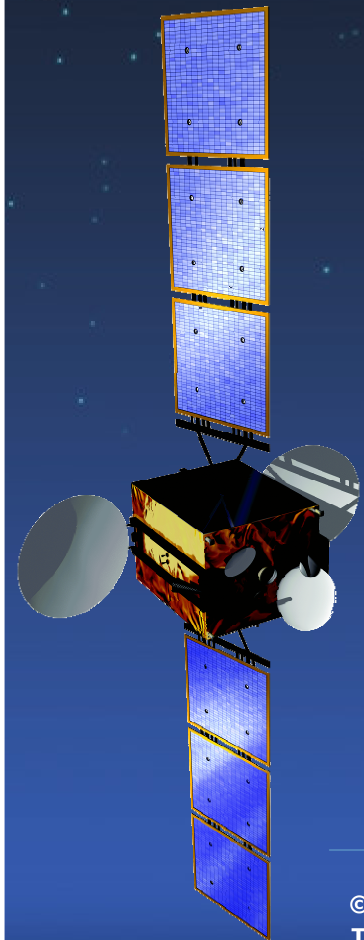


Thank you



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