SURREY SATELLITE TECHNOLOGY LTD *Changing the economics of space*

Using COTs components to Reduce Space Mission Costs: Facts, Myths, Advantages & Pitfalls

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CEOI Affordable Space Workshop
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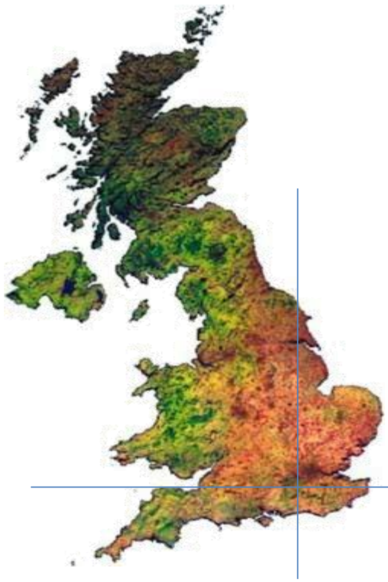
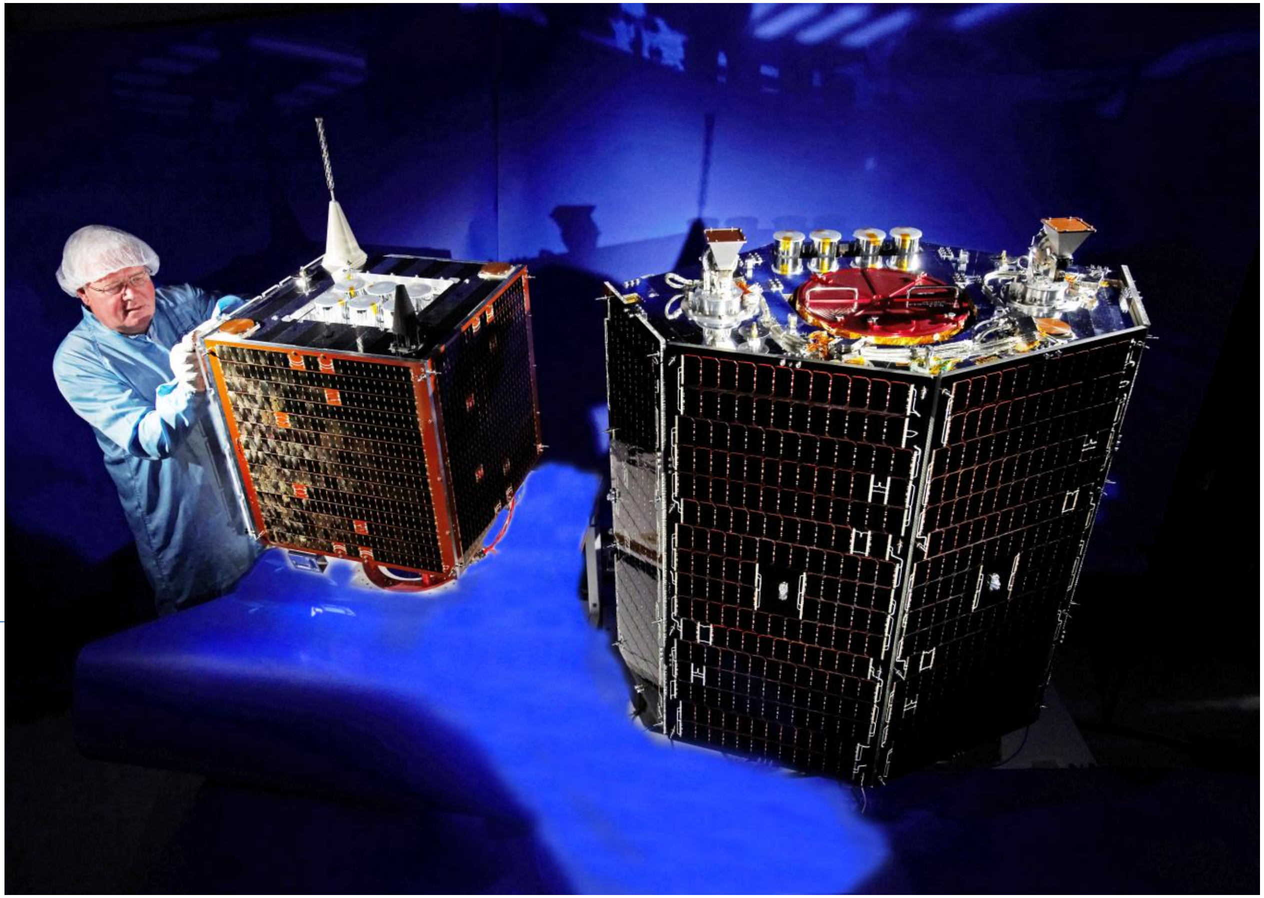
SSTL – 'Changing the Economics of Space'

This is achieved through:
Rapid-response small-satellites using advanced terrestrial technology





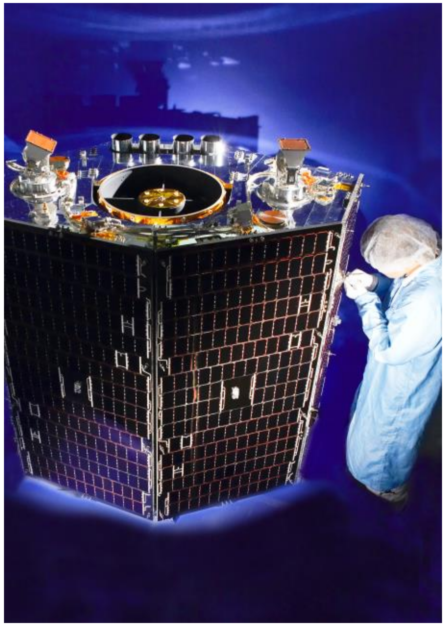
SSTL Today

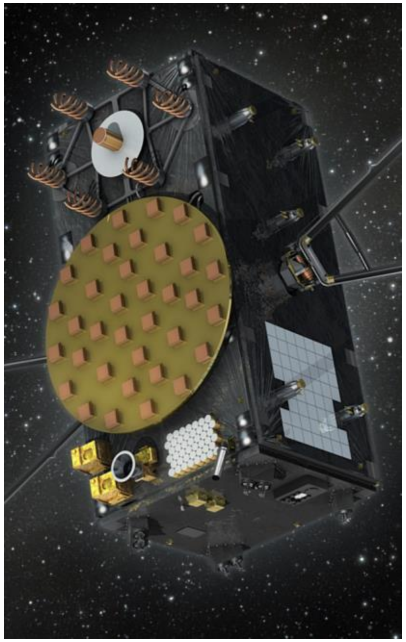
A fully commercial company, part of the Airbus Group

- 'Arms Length' Subsidiary

Current & Recent Projects

- Earth Observation (RapidEye fleet, NigeriaSat-2, DMC3 constellation, NovaSAR)
- Science – Platforms for FormoSat-7 Mission
- ESA Projects
  - Galileo FOC Payloads
  - Earthcare Multi Spectral Imager

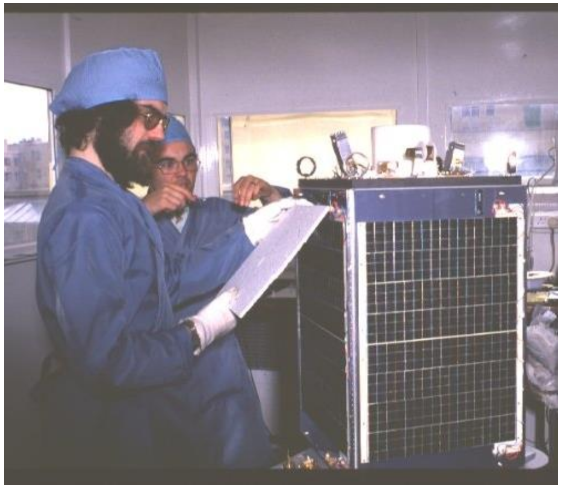




The History of SSTL & COTs

COTs components were adopted early in SSTL's history – their use became the 'norm' in early SSTL Satellites

- *Cost Driven (Low Project Budgets!)*



Underpinning Academic Research in to effects of radiation on electronics was a vital factor in early mission success

- *University of Surrey Space Centre*

Today – SSTL routinely and successfully specify COTs parts in its satellites

- 43 satellites launched to date, all (even GIOVE-A) heavily featuring COTs parts

Examples of COTs Parts Used

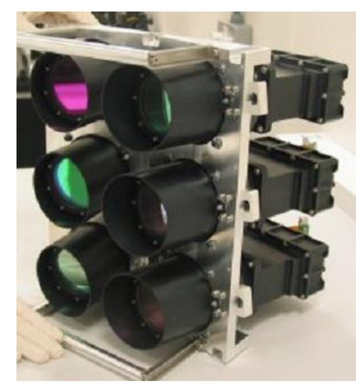
On Board Computer Central Processors

- 386 was the workhorse of all SSTL satellites for more than 10 years

- Power PC chip at the heart of early Data Recorders

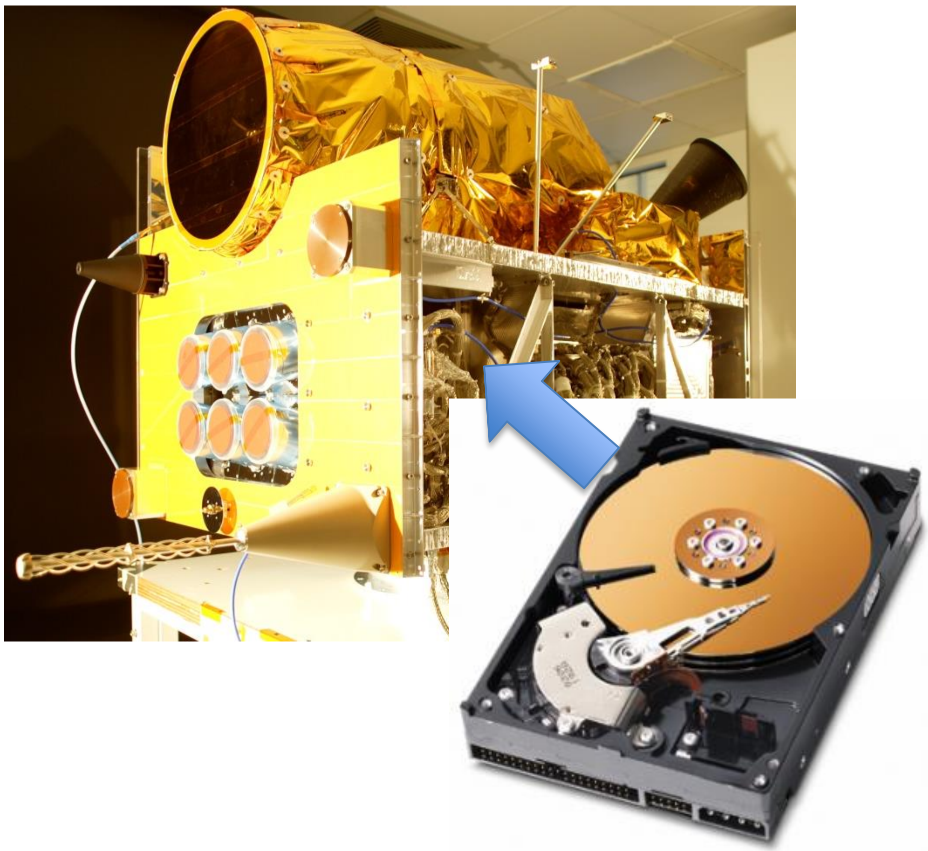
Commercial Optics

  – Used to make Effective Space Based Cameras

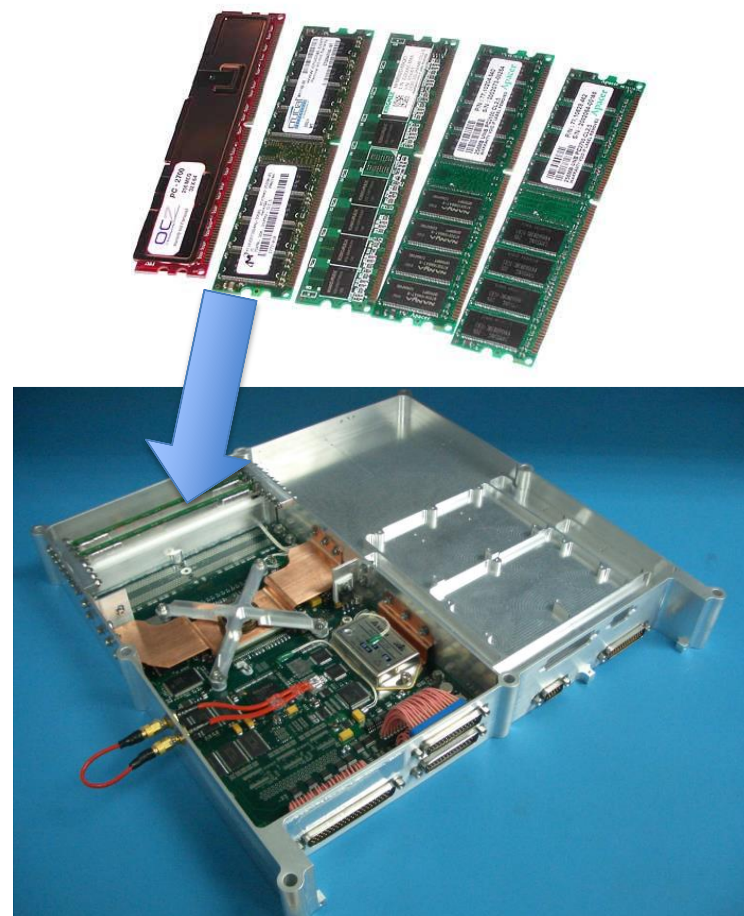


More Examples of COTs parts on SSTL Missions

Commercial Hard Drives, Flying and Operational on Beijing-1 Satellite (>7 years)



Commercial DDRAM, Employed in Early versions of High Speed Data Recorder Unit (HSDR)



Parts Selection in System Design Context

SSTL build each mission solution on an existing, demonstrated design (the 'Heritage Baseline' approach)

- This principle also applies to parts selection

Parts Selection is an integrated part of the design process – not an isolated one

- Performed primarily by design teams, not driven by QA
- Support and guidance by Parts Engineering and Environment Engineering teams/functions

Selection of parts is performed considering all mission parameters

- There is no 'one size fits all' approach
- Parts selection decisions are made taking individual mission specifics in to account (orbit, mission life, nature of mission etc.)

Component related specific risks are targeted and mitigated with appropriate selection & screening measures

Parts selected & approved for one mission may not be approved for another (again if the orbit, lifetime, mission nature is different)

Module/Unit Level Burn in

- Helps identify gross component defects and manufacturing induced issues (Applies to all components not just COTS!)

Factors to be Considered

Proof of on orbit device performance:

- Manufacturers not likely to recommend (and certainly not guarantee) space use of their COTs parts (enthusiasm varies from manufacturer to manufacturer)
- Diverse applications/orbits/mission scenarios need to be considered
- Difficult therefore for new entrants to establish sufficient heritage (unless in demonstration/'high risk' missions)
- Responsibility firmly with prime/integrator

Accommodating Characteristics of COTs components

- System & Mission Design – e.g. to accommodate and mitigate against upsets (SEEs)

Understanding the Parts – making informed and Intelligent decisions

- Need to take responsibility for use of parts (manufacturers will not – see 1st point)
- Needs access to experts (often in academia) to assess likely risks of using new devices, assessing their similarity to others, analysing their likely susceptibility to radiation

Sharing Information, data gathered & Lessons Learned

- Need access to historical data
- May be considered as proprietary for some organisations, some commercial organisations may not be keen to share

COTS Parts – What they Give You (Good & Bad)

Allows a Different, more Iterative approach to Hardware Development & Project Scheduling:

- COTs parts are cheap – you can afford to order lots of them and break/'blow up' a lot of them on the way to the final design solution
- Many Development models therefore possible – focus on the actual hardware performance rather than analysis/simulation (less pressure to 'get it right first time')

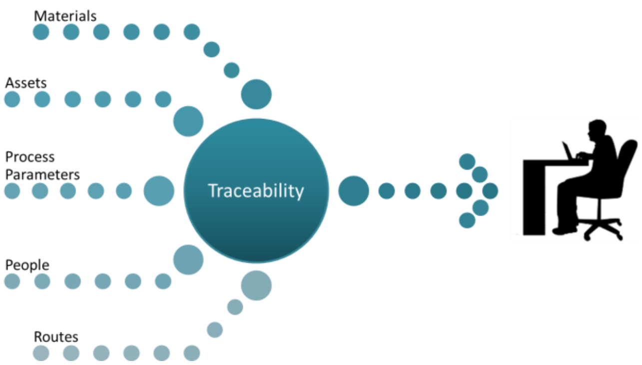
BUT issues such as traceability and part level screening need to be accounted for

- Traceability is not as good/robust as that for Hi Rel/Space Grade parts
- COTs parts are supplied with zero/minimal screening ; some screening will need to be performed post delivery (to identify dud parts as a minimum)

COTS Components – ‘Hot Topics’

Traceability

- Can you guarantee you fly the same part that you ‘qualified’ every time

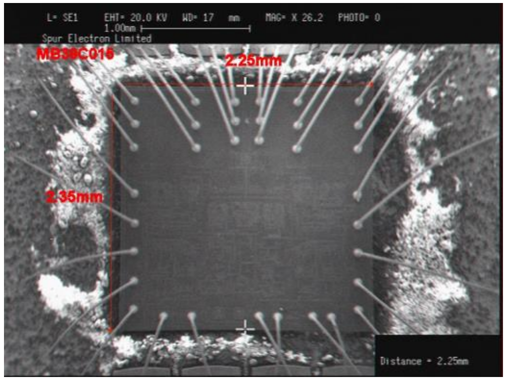


Level of inherent Risk Perceived

- View on whether COTs parts are more or less risky than their HiRel equivalents (in mission context)

Quality & Product Assurance Approach (needs a whole day on it’s own!)

- Parts Approval
- Part Level Screening
- General Selection, Testing & Quality Assurance measures

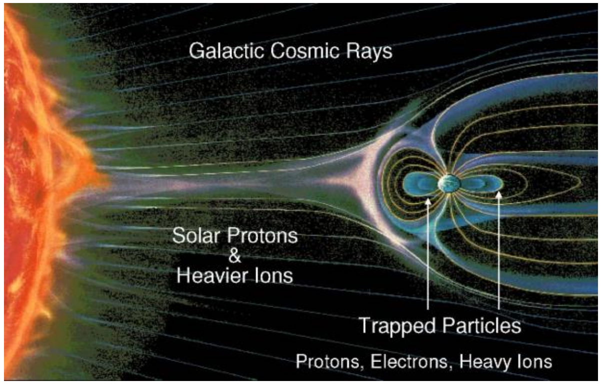


Accommodating COTS parts – Radiation Effects

Two main flavours of Radiation Effects

- **Total Dose**
  - Can be mitigated by shielding (spot or 'system level')
  - SSTL satellites achieve 7rs life or more with 3mm of Al shielding at module level

- **Single Events**
  - can be mitigated by error correction coding, majority voting, protection circuitry
  - Risk of Permanent Latch – up needs to be understood (irrecoverable)



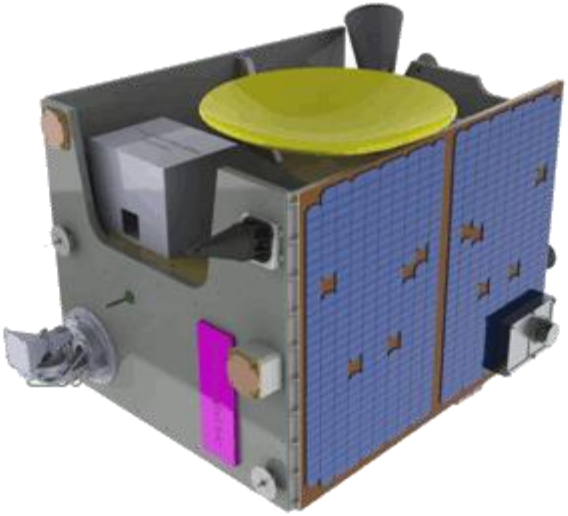
Testing may be required to demonstrate suitability/robustness

The Importance of Heritage

Commercial Customers (and insurance underwriters) tend to like ‘old stuff that works’

They do not like unproven/unflown technology

Technical performance must be tradable with demonstrated on-orbit reliability/robustness



Therefore we need to be innovative in getting new technologies in to orbit

- Dedicated On orbit demonstrators
  - Cannot assure performance of unflown technologies and components until they are actually operating in orbit
- ‘Fly new with old’
  - Use every mission as on opportunity to fly a new piece of technology (or part) in a non mission critical application

The Proof of the Pudding…

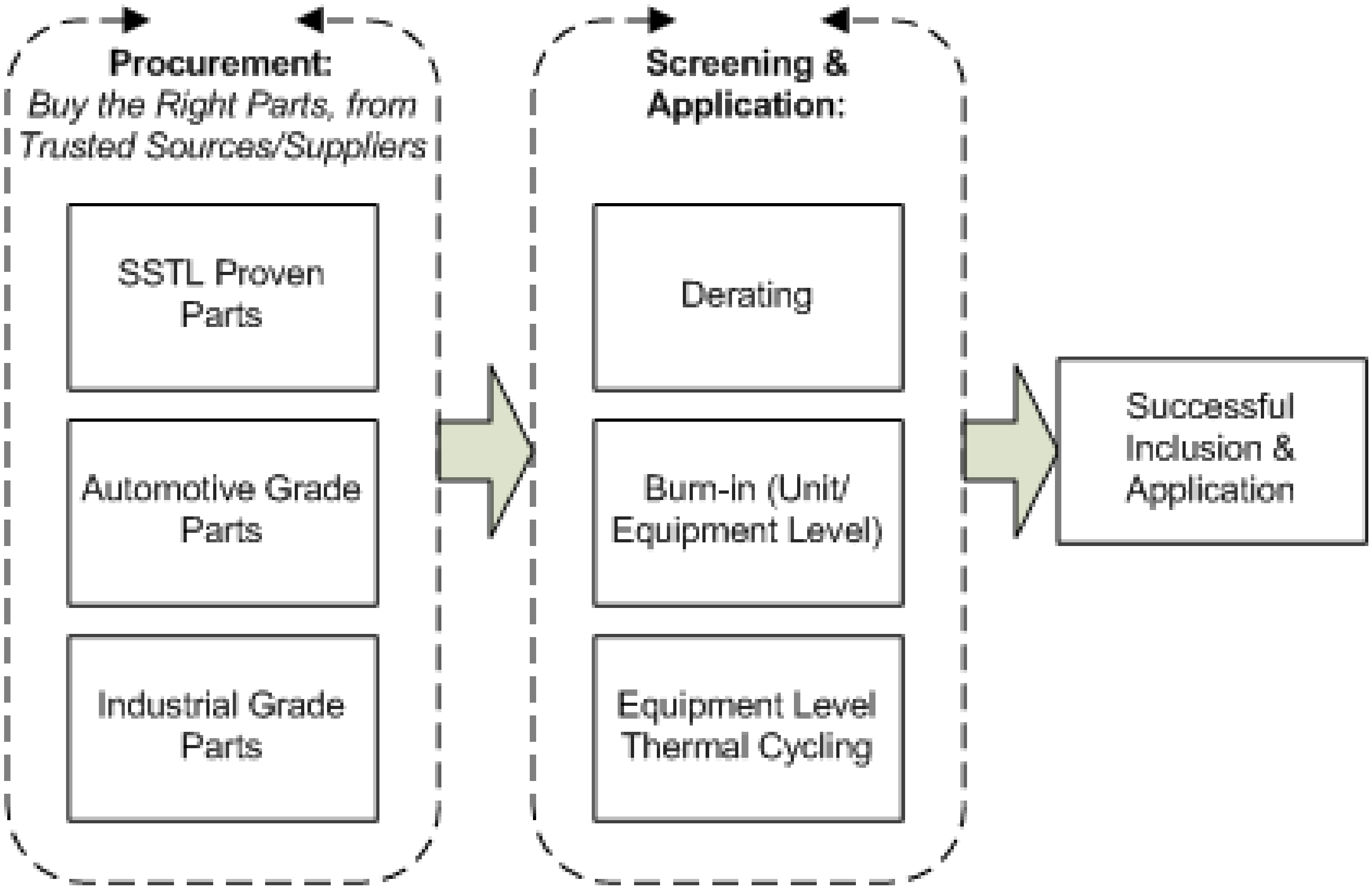
SSTL have used COTS components on all 43 satellites to date – so it is possible!

Random On-orbit component failures have occurred, however

- No premature mission or significant loss of mission performance due to component failure
- On the ground we see a similar numbers of failures at manufacturing level with Hi-Rel parts and COTS, yet use % wise less Hi-Rel than COTS.

SSTL satellites are insured at the same general market rate as all other commercial satellite types

Summary of Success Factors



Key Process Points – using COTS

Must have a Parts Selection Policy

- Criteria for selection approval & any screening/testing measure required to confirm selection
- Required for consistency of approach
- Can be very short! (i.e. not process paperwork for the sake of it!)

Understand the actual operational environment

- ‘It’s flown in Space Before’ – does not denote ‘unilateral’ qualification
- Questions must be asked, e.g.
  - Orbit
  - Application /criticality
  - Level of Shielding assumed
  - Solar Cycle Timing

Mitigate the Risks

- E.g. you will need you will need to overcome premature failures (can be achieved simply with ‘burn-in’)

Summary

COTs parts are inherently reliable in a world dominated by consumer electronics

- Tight Process Control & Very High Volume Production results in high inherent quality

The risks of using COTS parts in space must be understood and acknowledged - designs and development plans must take this into account

- A ‘One size fits all’ approach is not possible

Using Commercial components in a space application is as much about <u>how</u> the parts are used as the individual parts themselves.

SSTL have shown that Insurable, Commercial Satellites can be successfully built from COTs parts

- No Difference in Mission Level Performance to equivalent ‘traditional’ missions

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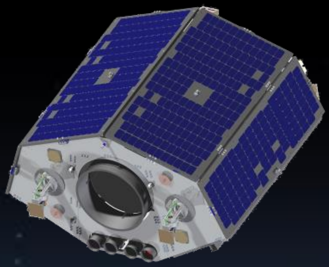
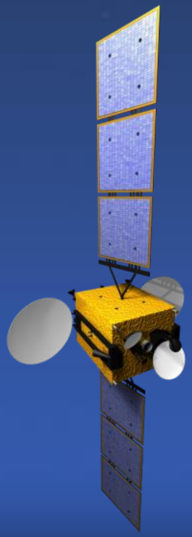


Thank You



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