SURREY
SATELLITE TECHNOLOGY US

Changing the economics of space

Reduced Risk for a Lesser Cost Approach

Small Satellite Reliability Technical Interchange Meeting

February 14, 2017

Introduction

- Reducing mission risk while maintaining reliability… at a low cost
  - Surrey approach
    - Employing COTS parts where possible
    - Fully utilize spacecraft resources
      - Power
      - Mass
      - Data storage/Telemetry

COTS

- What do I mean by COTS?
  - Standard part, standard design, on the shelf, i.e. bought off a data sheet and not specifically designed for your program
  - Commercial COTS, plastic parts etc.
  - (Military COTS is not a world wide concept although available in the US)
- Why try to use COTS components?
  - In simple terms … to drive down the price and schedule of satellite missions
    - Cost
    - Schedule
    - Availability
    - Innovation
- How to use COTS components?

An Approach To Using COTS in Small Satellites

- Apply common space industry standards and approaches
  - Screening at the part level
  - Parts-level analyses
- Provides assurance from the component level upwards

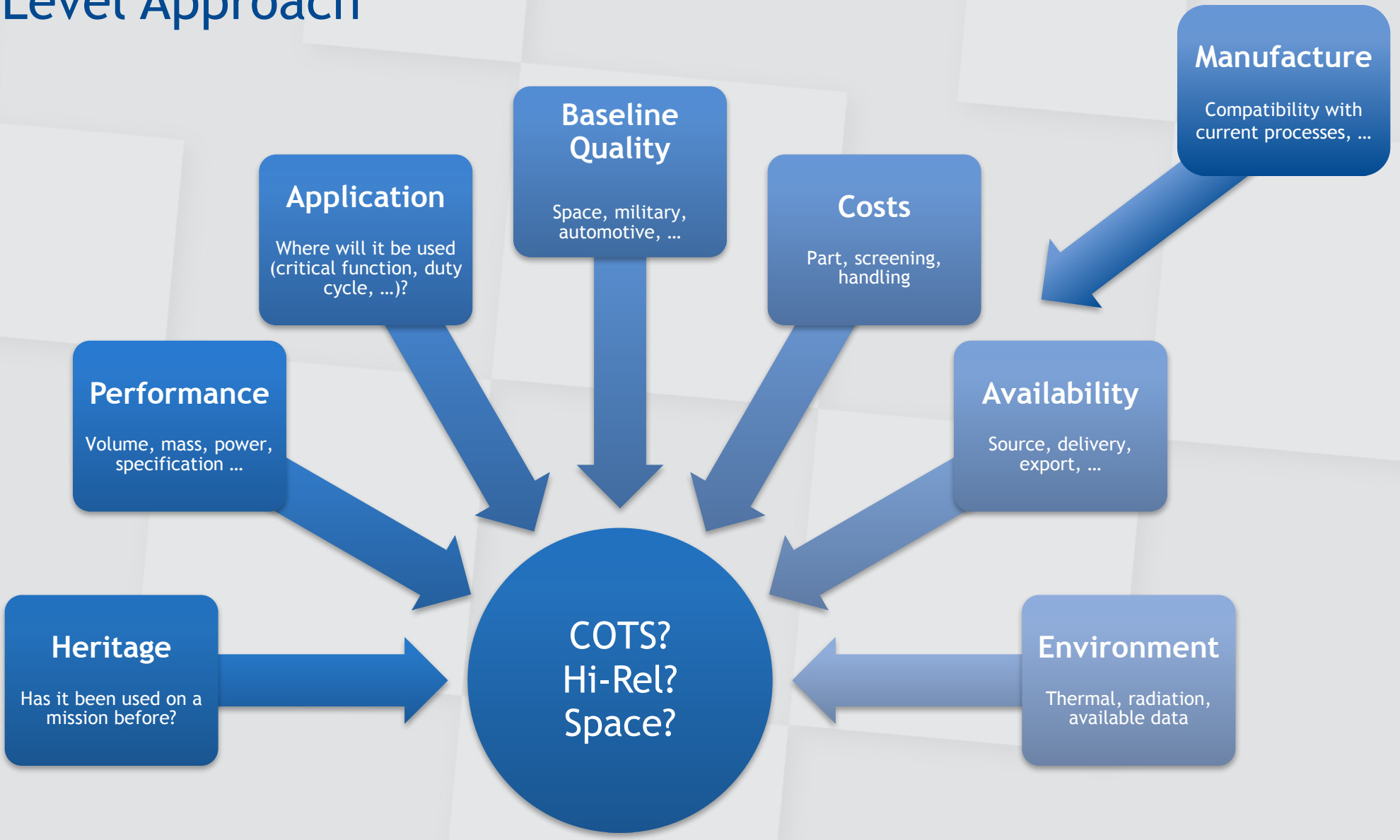
- A ‘bottom-up’ approach, often driven by multiple contractual layers
  - Will impact cost and schedule

Another Approach To Using COTS in Small Satellites

- Consider what you want the mission to achieve
  - Technology demonstration, operational, lifetime, environment, etc.
- Consider what the mission price and schedule constraints are
  - Absolute deadline for launch (e.g. frequency filing), limited funding, etc.
- Consider your risk profile

- A ‘big picture’, top-down approach
  - Asking the right questions can allow you to achieve mission objectives and value for money

System Level Approach

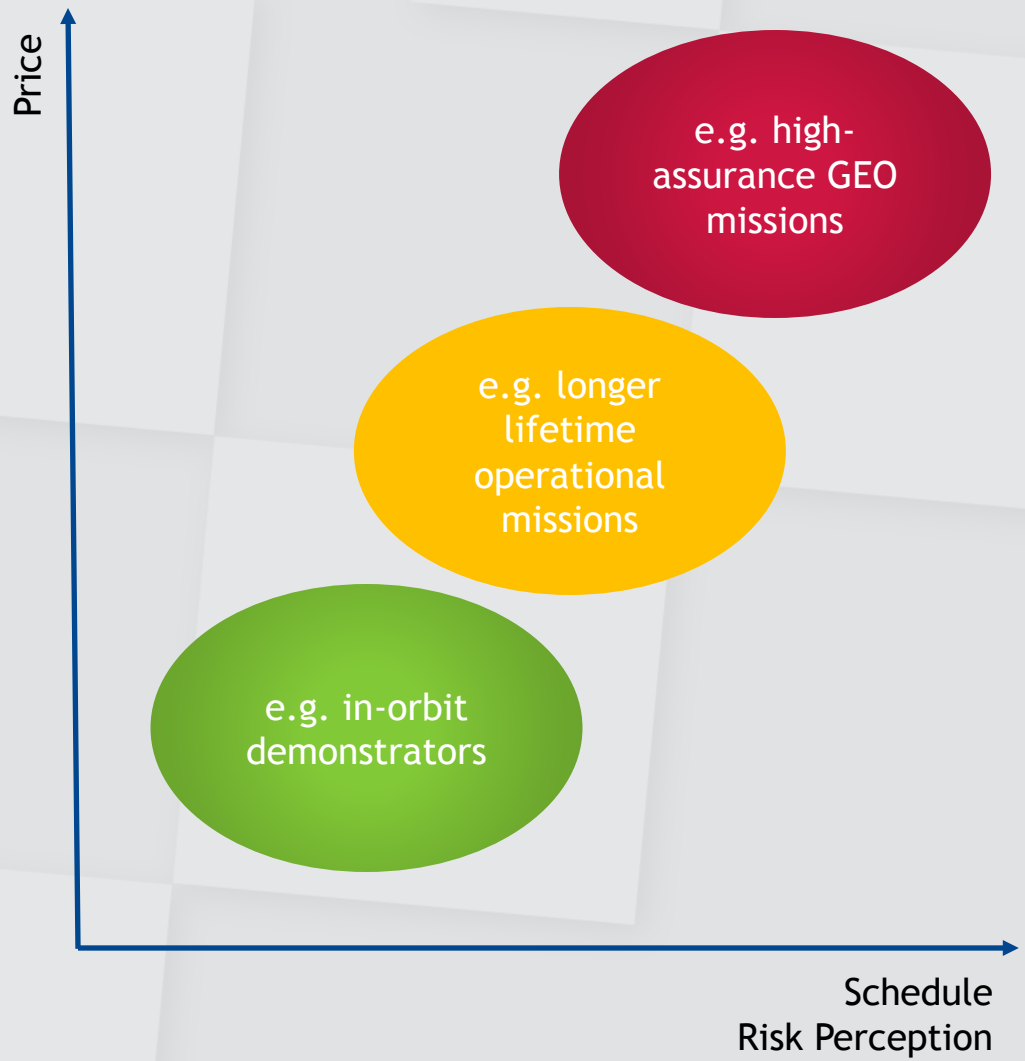


System Level Approach

- Parts selection is an integrated part of the design process
- Mission life and mission environment
- Margins
- Redundancy philosophy
- Radiation exists! so factor it into the system and board design
  - Consider the use of spot shielding by using high density metals (e.g. copper, brass or tantalum)
  - Consider replacing the part altogether with a rad-hard version if shielding is insufficient
  - If a part is sensitive to single event effects (SEE) then consider mitigation measures
    - Error-detection and correction (EDAC)
    - Triple mode redundancy (TMR)
    - Power system design
- Additional screening and radiation testing of certain critical components (if needed)

System Level Approach: Adaptability

- Allows adaptation of the solution during the mission design to reach a balance between
  - Mission requirements
  - Risk profile
  - Schedule
  - Price



An Example Mission

- Mission in a Medium Earth Orbit (MEO) for a traditional space customer
  - What's your first instinct on parts approach? Can you use COTS or not?
- Bringing Into Use (BIU) mission
- Required operational lifetime of 2 years
- Technology demonstration of new payload elements
- Hard deadline for frequency filing, you have just over two years until launch
  - Now what approach are you thinking?

An Example Mission: GIOVE-A

- System Level Approach
  - Heritage based (COTS) avionics
  - Applied additional shielding
  - Introduced select changes in avionics design
  - Redundancy in system design

- Outcome
  - Delivered in 28 months for €28M (~$31M)
  - Launched 28 December 2005 with signals generated 12 January 2006
  - Full mission success

Mission Level Approach - Shared Resources

- There is increasing interest in utilizing available resources on space assets, allowing a cheaper alternative and solution
- Accommodate a wide range of payload operational requirements, while ensuring optimal spacecraft resources and data access
  - Leverage proven and demonstrated technical, programmatic, and financial capabilities to provide the end-to-end elements required for successful hosted payload missions
  - Flight-proven, spacecraft buses based on modular designs that are tailored to suit mission-specific payload and launch requirements.
    - Fully utilizing available capacity: Mass; Power; and Data
  - Flexible mechanical configurations accommodate internally and externally-mounted payload modules, supporting a wide range of missions for Earth and space sciences, remote sensing, technology demonstration, space situational awareness, communications, and navigation.

History of Hosted Payload Missions

- Surrey has a long history with hosted payload missions stretching back to 1981

Surrey has hosted **over 60** hosted payload missions on 32 of 43 satellites launched

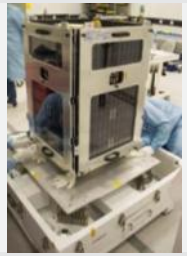
- While there is no “one-size-fits-all” when it comes to providing hosted payload solutions, Surrey combines:
  - A rigorous technical approach and end-to-end solution
  - Inherently adaptable, modular designs
  - A flexible mindset
  - Desire to fully understand each stakeholder’s motivations as well as key organizational and mission drivers

Heritage and Modular Design

- Extensive flight heritage in multiple configurations

DMC-4

TOPSat



LANL CFESat

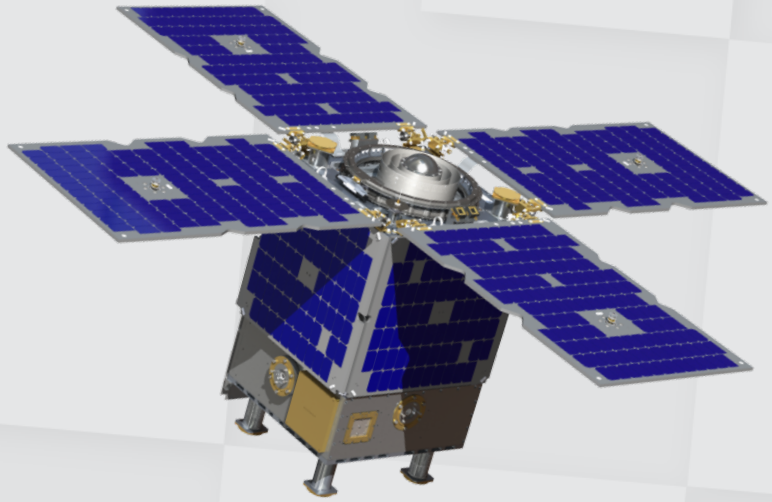
RapidEye Constellation

- Incremental controlled changes for platform development
- Starting from the core architecture, platforms are adaptable to many payloads needs
  - Deployable arrays
  - Fine pointing
  - Rapid tasking
  - Data interface options (CAN, RS422, 1553, Spacewire)

Example Hosted Payload Mission

- Orbital Test Bed (OTB)
  - SST-US owned and operated
  - Primary mission:

    Fly a suite of Surrey payloads to demonstrate new platform and payload technologies
  - Mission was initially designed for the SSTL-150 platform but interest from additional hosted payload providers led to the platform being grown to the SSTL-150 ESPA platform
  - Platform growth allowed for additional mass and power capability that could be offered to a variety of hosted payloads
  - Scheduled to launch on SpaceX Falcon Heavy, as part of the USAF Space Test Program



Conclusion

- Reducing mission risk while maintaining reliability… at a low cost
  - System Level - COTS
    - Not a blanket approach to use COTS or to use high-reliability components
      - COTS technology is one element that can provide significant reductions in costs and schedule
      - However many grades of components can be used on space missions
        - » Pure terrestrial COTS components
        - » Military standard components
        - » Traditional high-reliability space qualified components
      - Select parts to meet the individual demands of the mission and of the requirements
  - Mission Level – Hosted Payloads
    - No “one-size-fits-all” when it comes to providing hosted payload solutions
      - Compatible mission pairing
      - Available resources: Power; Mass; Data/Telemetry
      - Flexibility in Spacecraft Design
        - » Flight-proven, spacecraft buses based on modular designs that are tailored to suit mission-specific payload and launch requirements

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Thank You

Surrey Satellite Technology US LLC

345 Inverness Drive South, Suite 100

Englewood, CO 80112

(303) 790-0653