Affordable, Low-Risk Approach to Launching Research Spacecraft as Tertiary Payloads

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INTRODUCTION

• Successfully Launched the first set of CubeSats as tertiary payloads on the Rockot launch of 30 June 2003 (Nanosatellite Launch System 1 and 2):
  - **NLS-1:**
    CanX-1 (UTAS/SFL, Canada), DTUsat (DTU, Denmark), AAU Cubesat (Aalborg U., Denmark), PPOD Launcher (Calpoly, USA)
  - **NLS-2:**
    QuakeSat (Stanford U./QuakeFinder, USA), PPOD (Calpoly, USA)

• Demonstrated that it can be done
• Developed a direct and effective approach to arranging launches
• We will do it again (NLS-3+) !!!
CURRENT DEMANDS

Affordable Access to Space

• Expectations:
  - Minimal *overall* cost
    • From launch inception to launch campaign
  - Fast turn-around
    • From launch inception to launch campaign
  - Higher associated risks
    • Minimum project down-time: increasing individual flexibility while reducing group risks
    • Typical of low-cost programs
CURRENT DEMANDS

⇒ Affordable Access to Space

• Past Availability:
  – Specialized Launch Programs
    • Long lead-time
    • Uncertainty in scheduling
  – Piggybacks
    • Pre-established and/or limited interface options
    • Compliance to pre-established interface may introduce additional costs
MANAGING LAUNCH RISKS

Minimizing Overall Risks

- Risks Prior to Spacecraft Delivery:
  - Know-how, Relationship with Launch Provider
  - Coordination Risks with Multiple Participants
  - External Risks associated with Regulatory Compliance
MANAGING LAUNCH RISKS

⇒ Minimizing Overall Risks

• Risks during Launch Campaign:
  - Unexpected S/C Issues
    • As tertiary payloads, S/C-related issues could mean no launch
  - Unexpected LV Interface Issues
    • Proper ICDs
MANAGING LAUNCH COSTS

Minimizing Overall Costs

- Expenses Prior to S/C Delivery:
  - Interface Coordination
  - Other Support Costs
MANAGING LAUNCH COSTS

Minimizing Overall Costs

- Expenses during Launch Campaign: Careful consideration of expenses incurred at the launch site:
  - Personnel Travel and Living Expenses
  - Specialized Requirements
UTIAS/SFL APPROACH

• Coordination:
  Small number of participants per payload
  - NLS-1:
    • Three: UTIAS/SFL (CanX-1), Danish Technical University (DTUSat) and Aalborg University (AAU Cubesat)
  - NLS-2
    • One: QuakeFinder (QuakeSat)
  - Ease of coordination
  - Lower risks for participants
UTIAS/SFL APPROACH

• Coordination:
  Two independent launch contacts
  
  - NLS-1:
    • Contract between UTIAS/SFL and Launch Provider
    • MOU between UTIAS/SFL and DSRI/DTU/AAU
  
  - NLS-2:
    • Contract between UTIAS/SFL and Launch Provider
    • MOU between UTIAS/SFL and QuakeFinder
  
  - Isolates and contains risks
UTIAS/SFL APPROACH

Eurockot
Launch Provider

UTIAS Space Flight Laboratory
Launch Arranger and Integrator

Danish Space Research Institute

QuakeFinder
Participant

CalPoly
Sep System Provider

DTU
Participant

Aalborg U.
Participant

Launch Contracts
Cost Recovery MOUs
Collaboration MOU
UTIAS/SFL APPROACH

• Coordination:
  – De-Centralized Export Licensing
    • Each participants are responsible for arranging their export permits
    • UTIAS/SFL coordinates Canadian re-export permits and Russian import duties
  – Make It Real!
    • Finalize contract w/ launch providers before recovering costs - US$40k/flight kg
    • No waiting game: get everything going fast and keep it going until launch!
UTIAS/SFL APPROACH

• Rapid execution and launch coordination
  - Talks begin with Launch Provider in September 2002
  - Launch Contracts signed January 2003
  - Spacecraft delivered to UTIAS/SFL May 2003
  - Spacecraft launched June 30, 2003
LESSONS LEARNED

• Test satellite mockups with P-POD before launch.

• Review deployables and test reports for all satellites.

• Ensure large power and link margins for CubeSats.

• Don’t launch too many CubeSats at a time -- chaos in the weeks following launch.

• Launch multiple CubeSats in different directions if possible.

• Put CubeSats in their own distinct orbit.

• Coordinate ground station and orbit tracking activities
LESSONS LEARNED

• Understand the complete launch cost structure
  - Identify ways that benefits both the launch participants AS WELL AS the launch provider
  - What is best done by individual participants vs. what is best done by a central coordinating party?

• Is the “Cubesat standard” optimal?
  - Maximum mass utilization for a given cost
FUTURE PLANS

• NLS-3
  - Talks with Launch Providers have already begun
  - Late 2004 or early 2005 target launch date
  - Participants from Canada, Denmark, and Japan
  - Improved satellite dispenser system
  - Improved pre-launch coordination between NORAD, primary and auxiliary ground stations

• NLS-n, where $n=4,5,... \infty$
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