Rideshare Mission Assurance on Multi-Payload Missions

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Introduction

• Given the decreasing cost and increasing capabilities of small (<250Kg) spacecraft, the traditional One Satellite, One Launch mission is no longer a guarantee
  – There are an increasing number of missions that are including rideshare partners, including launches in the NSS realm

• An established method of assessing mission risks across programs with differing levels of risk tolerance is becoming essential

• Rideshare Mission Assurance allows multiple programs with vastly different risk tolerances to share a single launch
  – Especially useful when the organization responsible for certifying the entire mission does not have a Mission Assurance role for all of the spacecraft on the mission

NSS: National Security Space
Rideshare Mission Assurance/Do-No-Harm

Where did it come from?

• The AFSPC-4 mission included an SMC primary payload (GSSAP) and an AFRL provided APL (ANGELS)

• This created a clash of cultures between a traditionally risk averse primary payload and a much more risk tolerant APL
  – *This forced the development of a hybrid mission assurance system that would allow all mission partners to accept mission risks independently*

• Rideshare Mission Assurance/Do-No-Harm (RMA/DNH) is a process by which risk acceptance can be downwardly delegated to the lowest possible authority for a given rideshare partner
  – *Allows mission partners to accept all self induced/programmatic risks without having to evaluate any circumstances beyond their direct control*
Rideshare Mission Assurance/Do-No-Harm

What Is It?

- A process that focuses on insuring that no payload on a rideshare mission will negatively affect the on-orbit functionality of any other payload.
- The Aerospace risk identification and capture process is unchanged
  - *Guides which of the identified risks require further effort/mitigation*

*RMA/DNH does NOT take into account the on-orbit functionality of the payload being assessed*
Rideshare Mission Assurance/Do-No-Harm

Cradle to Grave process

Design
- Design Loads
- Electrical inhibits

Build
- Implementation of design criteria and military standards

Test
- Qualification regimen
- Appropriate margin

Launch Integration
- De-confliction of joint operations

Launch
- Deployment sequence

Operations/End of Life
- Safing
- Disposal
- Deorbit
Mission Unique Risks

• RMA/DNH allows Mission Managers to break all payload related mission risks into two categories
  – *Payload Mission Success*
  – *Safety of Flight*

• Payload Mission success risks are accepted by each individual payload’s Risk Acceptance Authority
  – *These risks only affect the functionality of an individual payload*
  – *Risks that are generally considered “mission assurance”*

• Safety of Flight risks are accepted by the mission team as a whole
  – *Only risks that pose a threat to the mission from the start of launch processing until SV separation*
  – *Risks that are generally considered “space safety”*
Mission Unique Risks

Overlapping and separating risks

- Some risks are clearly “safety of flight risks”
  - Underqualified bus structure
  - Weak inhibit strategy, etc.
- Some risks are clearly “performance” risks
  - Solar Array not power-positive
- Some risks overlap
  - Unable to control a SV in active GEO orbit
- Good engineering can help separate risks
  - Separating risk-tolerant SV into GEO disposal orbit
  - Once SV checkout is complete, SV moves to GEO orbit
Rideshare Mission Assurance/Do-No-Harm Example

- SMC-provided launch
- Multiple SV’s from different providers
  - Some SV’s have hosted payloads
- SMC/CC is Risk Acceptance Authority for the mission

Launch Vehicle procured by SMC

Secondary Payload – Government Rideshare Partner (provided by NASA)

Hosted Payload – Government Experiment (provided by Naval Research Lab)

Secondary Payload – Commercial Rideshare Partner (provided by commercial agency)

DoD Primary Payload (provided by Air Force)

SMC: Space and Missile Systems Center
SMC/CC: Space and Missile Systems Center Commander
SV: Space Vehicle
NASA: National Aeronautics and Space Administration
Rideshare Mission Assurance/Do-No-Harm Certification

- DoD Primary provided by Air Force
  SV Certification: Air Force Sponsoring Agency
  DNH Mission Assurance: SMC

- Commercial Rideshare Satellite
  SV Certification: Commercial Company
  DNH Mission Assurance: SMC

- Gov’t Rideshare Satellite provided by NASA
  SV Certification: NASA Sponsoring Agency
  DNH Mission Assurance: SMC

- Hosted Payload provided by Navy
  Hosted PL Certification: Navy via hosting agency
  DNH Mission Assurance: SMC

- Launch Vehicle
  LV Certification: SMC
  Full Mission Assurance

DoD: Department of Defense
SV: Space Vehicle
SMC: Space and Missile Systems Center
NASA: National Aeronautics and Space Administration
PL: Payload
Rideshare Mission Assurance/Do-No-Harm

Summary

• Each agency provides its own Mission Assurance and certification letter for their own spacecraft
  – *Verification artifacts are provided with the certification letter to provide inputs to the DNH analysis*
• SMC with Aerospace support provides the Do No Harm mission assurance assessment for the payload stack
• SMC/CC will provide certification for the mission as a whole
Rideshare Mission Assurance/Do-No-Harm

Expanded System Example: STP-2

• The STP-2 Mission
  – 2 Co-prime Missions
    • DSX – Provided by AFRL
    • Formosat-7/COSMIC-2 – Provided by NSPO (Taiwan) with US Air Force instruments
  – 6 Auxiliary Payloads
    • NASA
    • Surrey Satellite Technologies US
    • Georgia Tech
    • Michigan Tech
    • US Air Force Academy
    • Naval Postgraduate School
  – 24U of Cubesats

Photo courtesy of SpaceX
DNH Relevant Testing

• Random Vibration
  – Generally tested to proto-qual (MPE +3dB)

• Acoustic
  – Also tested to proto-qual
  – Can be waived if SV does not have acoustically driven components

• Shock
  – Measured against industry standard 50in/sec line

• Outgassing & Contamination
  – Primary concern is to protect optics

• EMI/EMC
  – Focused on ground operations in co-processing facilities

• Inhibits
  – Three required for all critical functions
Lessons Learned

- RMA / DNH process must be agreed to early in the program
  - *I&T methods must be detailed to the program office to ensure that sound designs are not compromised by inadequate processes*
  - *All post test changes to the SV (Component Remove & Replace, new/differing payloads etc) must be vetted by the Rideshare Mission Assurance authority PRIOR to implementation*

- Adequate “do no harm” test levels not always clear cut
  - *For STP-2, the Falcon Heavy has not yet launched, so environments are uncertain*
  - *Many secondary / rideshare spacecraft are designed and sometimes built before a launch vehicle is identified*
    - Assumptions must be made about launch loads / environments
    - Conservative assumptions drive cost; relaxed environments drive risk
Conclusion

• Rideshare Mission Assurance/Do-No-Harm allows mission partners to accept all internal risks at the program level while elevating only the safety risks to the mission level

• The RMA process as developed by Aerospace is currently being implemented and refined on both STP-2 and an upcoming Air Force Space Command mission
Questions?

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