Implementation Issues

An Approach to Enhance Participation, Innovation, and Develop an inclusive Culture

- Proposing a “Tool Library” for Science Investigations that the means (technical, instrumentational, and managerial) to enhance access to space by removing the implementation obstacles
    - Key Element is implementing a system that enables science via standardized instruments and interfaces
    - The focus is put back on science rather than on the ability to document, manage and execute to process requirements
    - Provides the resources that may not be available to many potential PIs.
- A central clearing house for hosted payload information with concierge services that provide expert advice as enablers would broaden access and awareness.

Implementing Payloads

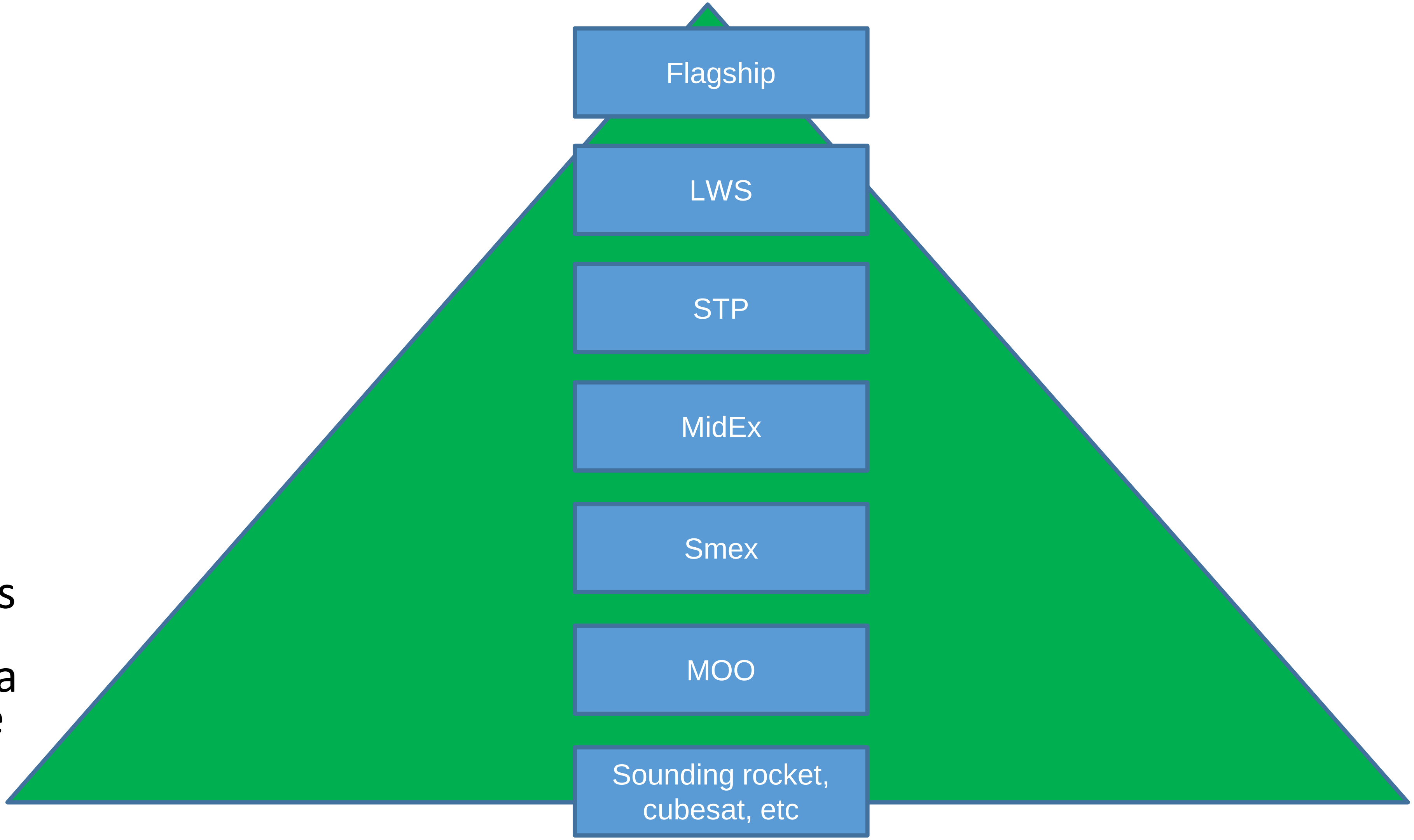
- Overarching goal is to do new, innovative science
- How do we achieve this while
  - Producing opportunities for the broadest scientific community
  - Enhancing diversity
  - Promoting equal access to opportunities
  - Creating and maintaining the pool of scientists, engineers and technologists that ‘do space’
- There are many obstacles including the current proposal structure and the implicit acceptance of a system with compounded inequalities.
- NASA Heliophysics is the ideal home for a new ‘hosted’ payload paradigm
  - NSF could be an extremely important and valuable partner in that effort.
- **This is meant to be a positive message promoting a shared and enriching future for us all**

Defining terms

- Hosted payload program
  - An ad hoc program of limited scope that supplies the means to execute particular scientific investigations via an existing launch program.
  - That launch program may be a commercial pursuit wherein the commercial entity has provided a limited amount of space with prescribed accommodations for a specified price via a contract arrangement
- I do not include the procurement of s/c busses and associated services from a spacecraft provider even though having a commercial provider provide the s/c bus, launch services, mission operations, data delivery, etc as one package wherein science payloads are 'hosted' by them, even though that may present a significant cost savings by placing the programmatic focus on the host and the payload rather than the process-oriented NASA system.
  - Note that this obviates the arguments concerning class D, tailored class D, etc.
  - Using standard buses will drive down costs.
  - This is like renting a car or truck - the rental company assumes maintenance processes, delivers a working vehicle with know performance specs and liability is shared. When you rent a car, your home institution does not require documents describing how the car was built, etc before allowing you to rent it.

Target of this presentation

- There is a progression of missions in complexity and cost.
- Do we have a path for people and ideas to 'mature' throughout the process?
- Many opportunities at the lower funding levels and a greater acceptance of risk.



Program Design: If you were designing a hosted payload program, what aspects should be focused on and what are the major obstacles (with solution ideas if possible)?

The major focus of a hosted payload program should be ‘enabling opportunities for all’

A hosted payload program that had as ***a component called a “tool library”*** could be valuable

A review of current LEO mission concepts would demonstrate that there are just a few in situ instrument types and just a few remote sensing instrument types.

- There are many science topics – most benefit from multiplicity rather than a unique instrument.
- Instrument builders are fading away from lack of opportunity to keep skills fresh

The tool library would ensure that the ability to propose great science is more widely available.

The 'Tool Library' as a rapid response enabler

- The notion is that for certain classes of missions and certain kinds of science, the instruments themselves should NOT be the enabler
  - Much of our focus now is on getting multipoint observations
  - If we had a suite of canonical, proven sensor designs that were ready for manufacturing and calibration and delivery to a flight opportunity this would
    - Move the focus to science making PI-ship more accessible
    - Provide instrument builders with a path for proposing development of instrument designs that are not yet tied to flight and transferring skills to the next generation.
- The Tool Library provides the impetus for developing the next generation of instrumentation.
  - Not intended to freeze designs and prevent progress
  - A concomitant commitment to developing instruments and refreshing the designs would be needed.
  - Provides many flights of the same instrument for different purposes.
- Note that hosted payloads offer far larger SWAP allocations than a cubesat
  - Building the exquisite compact, low geometric factor/ low etendue/ low power aperture product instrument is no longer the only path to success.
- Standardization removes barriers to entry and reduces the accommodation issues we generally have to address.

A Precedent of Sorts Exists: GDC STDT

- The GDC STDT report focuses on the measurement requirements.
- Instruments, if available as well-documented, ‘build to print’ versions that could be manufactured readily could be used to implement GDC
- GDC STDT refers to a multi-element constellation
  - Can we build many copies of the same instrument with our current system?
  - We don’t have enough trained people to build 12 sets (or more) of any one instrument in a timely fashion.
  - Currently, we focus on processes that are all hand-work intensive and the skills are concentrated in just a few people.
- GDC may well establish (part of) the tool library by solving its problems of instrumenting its multi-point observatory.

Program Design: If you were designing a hosted payload program, what aspects should be focussed on and what are the major obstacles (with solution ideas if possible)?

We don’t (usually) see the major obstacles because we come from a few successful institutions that are represented because we are successful.

- There are R1:115; R2:104; R:109; M1: 742
- How many are represented here?
- Many are small
- Some have special focuses (e.g. HBCU, tribal, etc)
- https://nces.ed.gov/programs/digest/d18/tables/dt18_317.40.asp

A hosted payload program enables opportunity - to a limited degree.
If our goal is to develop the next generation of PIs from the broadest possible community we have to recognize that hosted payloads require:

- Community connections to develop science goals
- Infrastructure (engineering, review, etc)
- Management resources
- Fabrication and testing
- Quality assurance/documentation
- Integration, testing, calibration, etc.

Which of these elements produces PIs?
Engineering education is not the same things as producing PIs or doing science.

Participation Diversity: How do we ensure the program is accessible to a broad community? How do we minimize barrier to entry? What role could students play? Could there be centers of excellence/mentoring institutions?

- There are implicit barriers to entry that prevent broader participation in NASA-sponsored flight programs
- These may not be recognized yet (because of the implicit assumptions of the community) they may prevent many organizations from participating.
- Most of us come from an R1 perspective and see little problem with the current scheme. This privileged perspective reduces the chances for inclusion and diversity
  - Universities that serve under-represented segments (e.g. HBCU, tribal, formerly women's colleges, small masters granting universities, etc) lack the infrastructure at all steps in the proposal process to support a competitive NASA proposal.
  - Consider the SMA and cost documentation elements alone can amount to very large investments and rely on technical skills at the home institution
  - Cost accounting offices at non-research institutions often lack the procedures to set up and manage subcontracts or even support travel accounting.
- To reduce the barriers to entry by under-represented segments of society and inspire the next generation, we need to recognize which barriers can be ameliorated.

Hosted payload opportunities: What are some of the issues and steps to be taken from awareness of an opportunity to final agreement to host a payload?

- To fly a hosted payload – you first have to have a payload.
- The first step is to establish a long-lived, robustly funded program that is targeted for these opportunities.
- If we have the typical NASA AO cycle, can we produce and deliver a payload in a timely fashion that enables (and guarantees) integration with no impact to the host?
- Generally there are issues with interfaces and environments.
- Payloads on many commercial rides – as hosted payloads – are required to demonstrate ‘non-interference’ and ‘do no harm’
- This requirement can be complex requiring a fault tree analysis and reliability analysis.
- Interfaces require understanding of launch loads, EMI environments, thermal contraints, mission profiles that may be proprietary.
- NASA-levied requirements on the payload host may be seen as onerous – ‘not worth the trouble’ – to the host.
  - If the accommodation requirements are well known and not subject to drift this enhances the likelihood of a successful accommodation.

Hosted payload opportunities: What are some of the issues and steps to be taken from awareness of an opportunity to final agreement to host a payload?

- One challenge that potential investigators may face is that there is no central source of information about potential hosts for hosted payloads.
- Some people are in environments in which there is a constant discussion of the business of space (to greater of lesser degrees).
- A clearinghouse for this type of information should be established with an active effort to promote this among industry suppliers.
  - A NASA role would assist in this if it was seen by industry as betokening a commitment to pursue broad engagement with minimal bureaucratic entanglements
  - If there were ‘experts’ associated with this to act as concierges to help potential investigators and assess the quality of the offerings, this would also enable broader participation.

Host platform concerns: What are the most common requirements, concerns, and interface characteristics of hosted platforms?

- Most commonly the goal of the hosted platform is to maximize commercial return which means minimizing costs and maximizing income.
- Risk of any kind is eschewed.
- Schedules don’t slip to accommodate hosted payloads
- Many hosted payload opportunities are not optimized for science payloads especially in terms of ground-handling including purge lines, bagging, special item handling (e.g. remove before flight items), etc. and if the launch slips there is the concern of maintenance of the hosted payload.

Host platform concerns: What are the most common requirements, concerns, and interface characteristics of hosted platforms?

- Hosted payloads do offer another potentially game changing interface/environment.
- As an example consider Blue Origin’s New Shepherd product.
  - In one option, ‘lockers’ are provided for experiments inside the New Shepherd capsule.
  - These lockers provide a STP (standard temperature and pressure) environment
  - A lab setup (that can survive launch loads) can be flown.
  - If a ‘view to space’ is provided, then TRL 5 can be achieved
    - Technology Readiness Level 5: Component and/or breadboard validation in a relevant environment
    - This lowers the bar for proving new measurement concepts PARTICULARLY in the region critical for understanding the I/T/Meso and E-region.
    - Lab-grade payload is recovered and can be tweaked
      - No complex thermal and mechanical design, etc
  - The key idea here is to remove the barrier to proving a new sensor methodology

TRL 9

- Actual system “flight proven” through successful mission operations

TRL 8

- Actual system completed and “flight qualified” through test and demonstration (ground or space)

TRL 7

- System prototype demonstration in a space environment

TRL 6

- System/subsystem model or prototype demonstration in a relevant environment (ground or space)

TRL 5

- Component and/or breadboard validation in relevant environment

TRL 4

- Component and/or breadboard validation in laboratory environment

TRL 3

- Analytical and experimental critical function and/or characteristic proof-of-concept

TRL 2

- Technology concept and/or application formulated

TRL 1

- Basic principles observed and reported