



***Cassini* Free Market Resource Allocation**

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Project Scientist (*for the Prime Mission*)
NASA/ESA Cassini/Huygens Mission
Jet Propulsion Laboratory, California Institute of Technology

NASA PI-Team Masters Forum 2
The NASA Academy of Program/Project and Engineering Leadership
April 27-29, 2010, Annapolis, Maryland



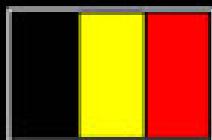
Cassini Free Market Resource Allocation

How the Cassini Payload Reserves were Managed

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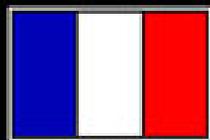
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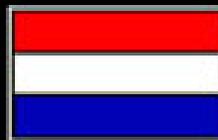
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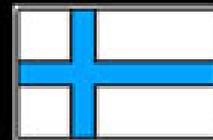


SPAIN

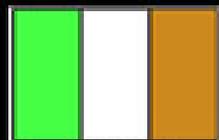


INTERNATIONAL
PARTICIPATION IN

CASSINI
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HUYGENS TITAN
PROBE



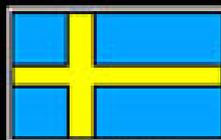
FINLAND



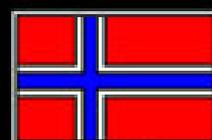
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The Payload Challenge

Deliver all 18 instruments:

- On time
- Within cost
- At allocated mass (or less)
- At allocated power (or less)
- With allocated data rate
- Within agreed upon configuration

Also Desire

- Optimum use of payload resources
- Use the best expertise in any reallocation of payload reserves
- Minimize management overhead (consistent with above)



Cassini/Huygens Payload Situation

- 18 instruments, most using cutting-edge technologies
- Needed “expert” advice for using reserves
- In a half dozen cases all of the world’s “experts” were associated with payload instruments
- Needed a process for using their expertise and avoiding conflict of interest
- The answer for this and other problems was to set up a “free market trading” system

Prelude to Opening the Market for Trading

- Payload
 - Negotiate delivery contracts with PI's for each of the 18 instruments
 - Hold “expert” reviews to verify that the deliveries should be possible
- Distribute all payload margin (about 15%) to the PI's
 - \$ by FY
 - Mass (in kg)
 - Power (in Watts)
 - Data rate to spacecraft bus (in kbs)
- Provide a method for the PI's to trade resources
 - Define the method well !
 - Establish rules !
 - **Open the market!** (All offers and trades reported electronically.)
 - Project Manager, Project Scientist, and the Payload Manager had veto authority

The Contract

- Instruments that are delivered on time and within their resource envelopes will fly.

Comparison of "Traditional" vs. Market Approaches

- Margin vesting
- Who changes an instrument's resource profile?
- Visibility of resource usage
- Margin optimization
- Who will fly?
- Trading complexity
- Overhead
- Team building
- Lessons learned

Margin Vesting

Payload Manager

- **Margin or reserve is vested in the Payload Manager (“payload reserve account”)**

Resources Exchange

- **Each PI is vested with the reserve for his instrument**
- Gives the PI control over his/her fate

Who Changes Resource Profiles?

Payload Manager

- **Payload Manager**
- Manager does not have detailed knowledge of the situation and necessary expertise
- Every margin allocation by the Payload Manager is a win-lose transaction. The PI who is granted additional reserve wins and everyone else loses due to there now being less reserve.
- “Early bird gets the worm.” Those who declare an early bankruptcy have the advantage. Those who struggle to get by with what they have are at a disadvantage. If they later need help, the reserves may be full allocated.
- “NASA Board said my instrument more important!” Take what I need from someone else.

Resources Exchange

- **Instrument PI's via the commodities exchange**
- Decision made by PI's and teams. They are best qualified to evaluate complexity, risk, and need for their instrument and investigation.

Visibility of Resource Usage

Payload Manager

- **Payload Manager is often expected to maintain a predefined reserve profile.**
- Payload Manager under pressure to increase his reserve if it is too low for the present stage of development. Often the only option is to cancel an instrument.
- Pl's are wise to hide anything not used in order to prevent seizure . This behavior undermines an accurate assessment of the reserve available.

Resources Exchange

- **No advantage to secrecy**
- **No required reserve levels**
- **Knowledge of reserve is continuously available**
- Openness has advantages. (e.g., an accurate knowledge of instrument development status)
- Others can make helpful suggestions (e.g., trades).
- Gifts can be given by a rich instrument in order to avoid a specific adverse impact later.
- Promotes shared developments such as data reduction software through the recognition of common problems

Margin Optimization

Payload Manager

- **Depends upon the skill (some say luck) of the manager.**
- Needs advice from external experts
- PI's try to hide anything not used in case they need it later.

Resources Exchange

- **System tends to drive outcome in direction of optimum usage.**
- Strong motivation to trade excess mass and power. These commodities will have no value at launch.
- Strong motivation to loan unneeded current year \$\$ (e.g., earn interest)

Who will Fly?

Payload Manager

- **Management decides**
- When management feels that it must raise more reserve it removes instruments. Big lose-lose for everyone as the science advisory group is usually called upon to recommend which instrument goes.

Resources Exchange

- **Flight guaranteed if instrument delivered on schedule and within budget (i.e., the PI meets his contract)**
- This is a big morale booster because many teams know well in advance that they will fly.

Trading Complexity

Payload Manager

- **Single transactions**
- Payload Manager moves resources to and from his “payload reserve account”
- Transactions are against current holding in the “payload reserve account”

Resources Exchange

- **3 or 4 party transactions possible**
- Parties do not need to trade with each other. In 3 or 4 party trades you can give to and receive from different parties.
- We had a "broker" and software to help arrange multiparty exchanges

Overhead

Payload Manager

- Payload manager must prepare for each decision
- Unhappy parties may appeal to Project Scientist or Project Manager
- All parties prepare for each level of management “shoot out”.

Resources Exchange

- Decisions are made at the lowest possible level
- Trades are final. No appeal after a trade has been made.
- PI's are not compelled to trade and will only trade if they believe that they will benefit from the transaction.

Team Building

Payload Manager

- **Interactions have winners and losers.**
- **People hate each other. ☹️**

Resources Exchange

- **Transactions are win-win.**
- **Everyone happy. 😊**
- Strong team building program requires win-win activities.

Lessons Learned

- Traded commodities and rules must be well defined. Uncertainty “kills” the system.
- Team building –through win-win interactions– paid off later when PI’s and their teams had to cooperate in using the spacecraft.
- Resource trading worked very well. All 18 instruments flew to Saturn.

[Additional reading: Wessen RR, and D. Porter, A management approach for allocating instrument development resources, *Space Policy* **31** (3): 191-201 Aug 1997]