# Discovery Preproposal Conference

# Technical, Management, and Cost (TMC) Evaluation

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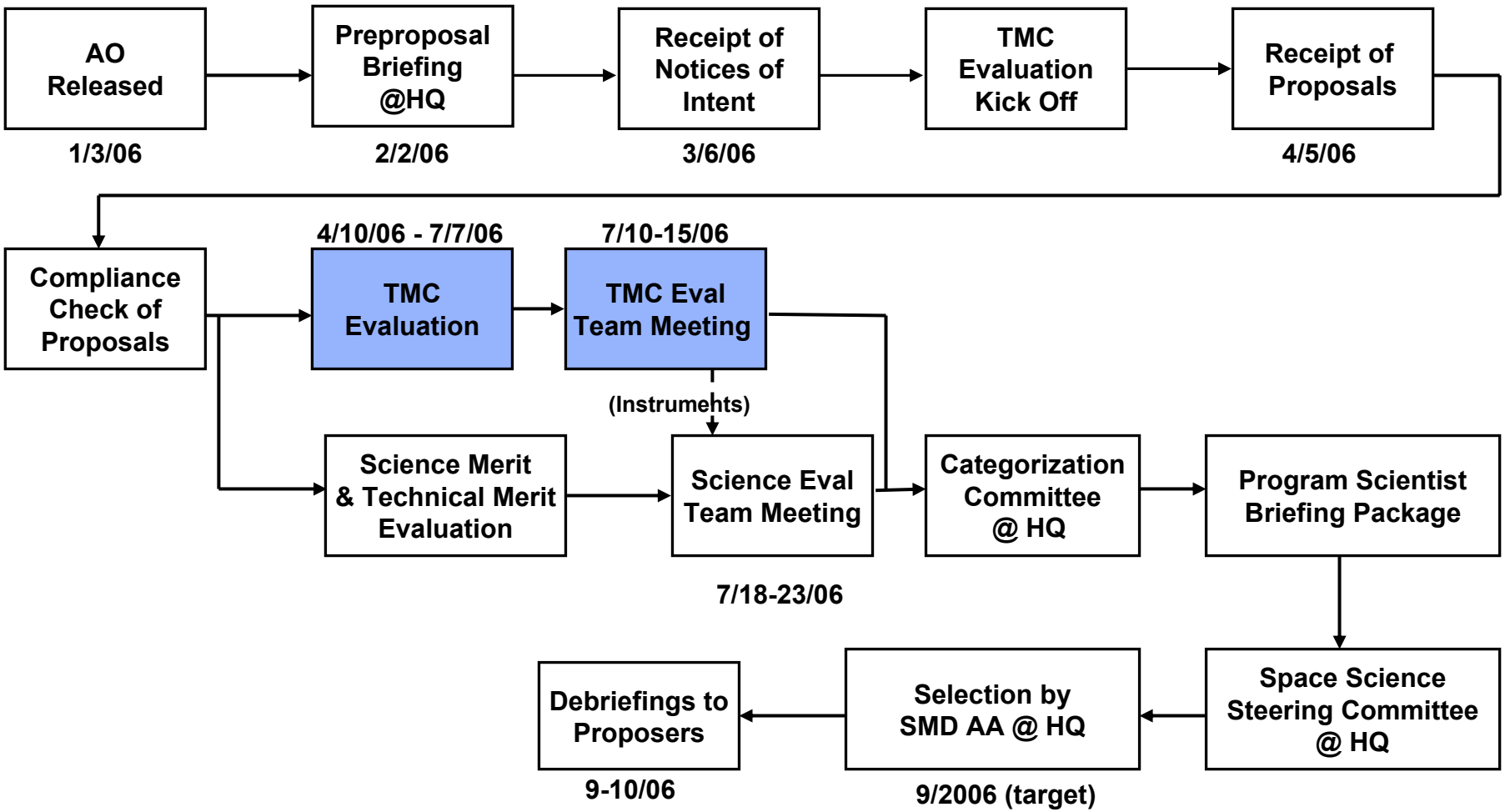
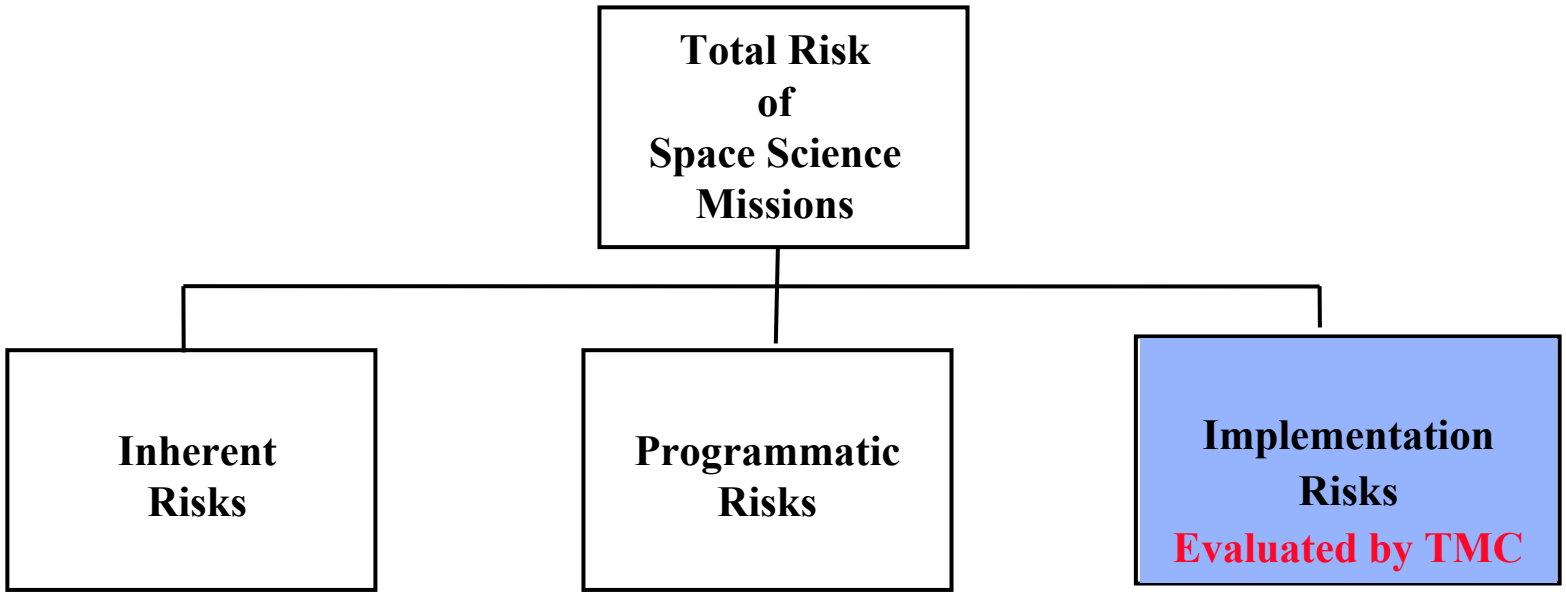
# Discovery Proposal Evaluation Process



# Risks for Space Science Missions






Risks that are unavoidable to do the investigation:

- Launch environments
- Space environments
- Unknowns
- Etc.

Risks that are uncertainties due to matters beyond project control:

- Environmental Assessment approvals
- Budgetary uncertainties
- Political impacts
- Etc.

Risks that are associated with implementing the investigation:

- Adequacy of planning
- Adequacy of management
- Adequacy of development approach
- Adequacy of schedule
- Adequacy of funding
- Adequacy of Risk Management (planning for known & unknown)

# TMC Evaluation Objective

- **The TMC evaluation is to determine, for each Proposal, the level of risk of accomplishing the scientific objectives of the investigation, as proposed, on time and within cost.**
- **There are three possible Risk Levels: Low, Medium, and High**
  - **Low Risk:** There are no problems in the proposal that cannot be normally solved within the time and cost proposed. Problems are not of sufficient magnitude to doubt the Proposer's capability to accomplish the investigation.
  - **Medium Risk:** Problems have been identified, but are considered within the proposal team's capabilities to correct with good management and application of effective engineering resources. Mission design may be complex and resources tight.
  - **High Risk:** Problems are of sufficient magnitude such that failure is highly probable.

# TMC Principles for Evaluation

- **Basic Assumption**: Proposer is the expert on his/her proposal.
  - **TMC:** Task is to try to validate proposer's assertion of Low Risk.
  - **Proposer:** Task is to provide evidence that the project is Low Risk.
- **All Proposals will be reviewed to identical standards.**
  - Science Support Office established in 1996 by OSS to support Discovery and Explorer, now also supports New Frontiers, Mars Scout, and others.
  - The TMC process is used by SSO to support all SMD evaluations with a standard process.
  - All proposals receive same evaluation treatment in all areas.
- **TMC Panel is made up of evaluators that are experts in the areas of the proposals that they evaluate.**
- **TMC Panel develops findings for each proposal that is the consensus of the entire TMC panel.**
  - Findings: As expected (no finding), above expectations (strengths), below expectations (weaknesses).

# TMC Principles for Evaluation

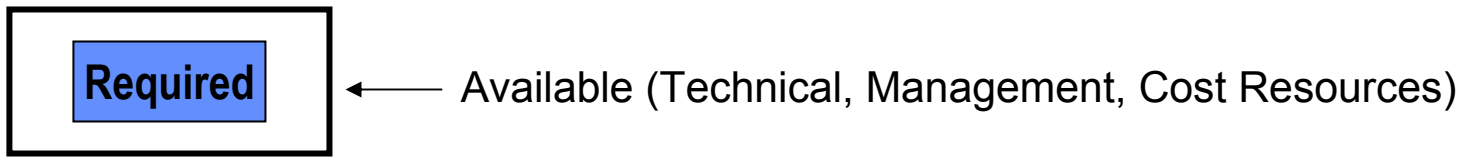
- **Step One Proposal Risk Assessment:**
  - The TMC Risk Assessment is based on a *preliminary concept* with appropriate benefit of the doubt given to the Proposer.
  - The Cost Analysis is done without Proposer feedback and is integrated into overall risk.
- **Mission of Opportunity (MO) investigations will be evaluated using subset of criteria used to evaluate full mission investigations**.

# TMC Envelope Concept

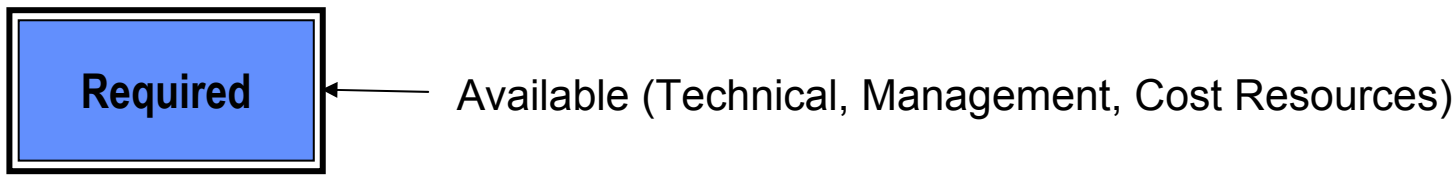


**Envelope:** All TMC Resources available to handle known and unknown development problems that occur. Includes schedule and funding reserves; reserves and margins on physical resources such as mass, power, and data; descope options; fallback plans; and personnel.

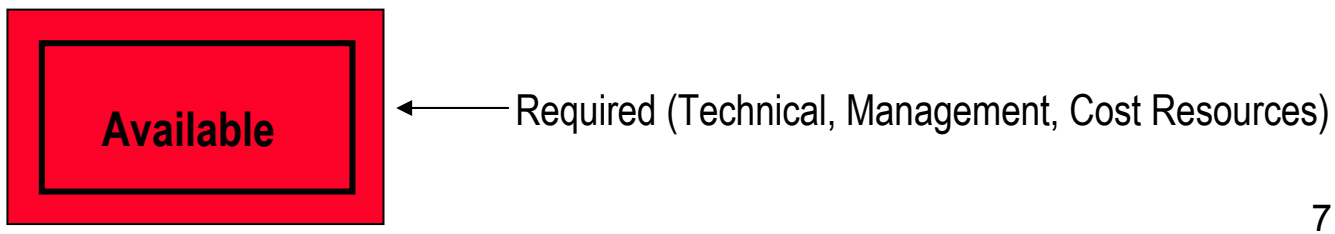
**Low Risk:** Required resources fit well within available resources




**Medium Risk:** Required resources just barely inside available resources. Tight, but likely doable

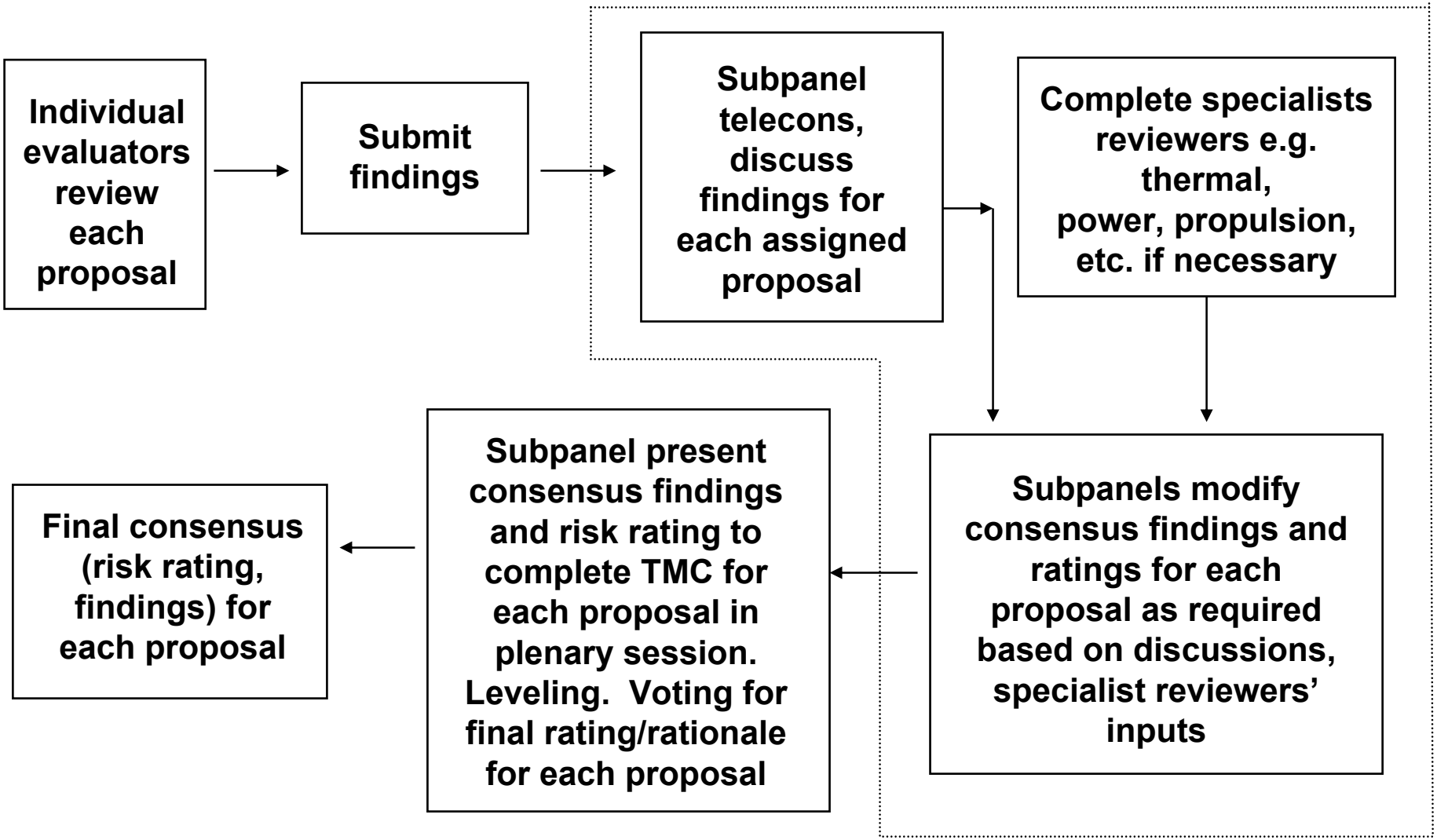



**High Risk:** Required resources DO NOT fit inside available resources. Expect project to fail



# TMC Evaluation Flow





# TMC Evaluation Factors and Sub-Factors for Discovery Mission Investigation Proposals

**Generally, the degree to which Proposals address the following factors directly relates to the grade of Low, Medium, or High Risk:**

- **Instrument**
  - Instrument Design, Accommodation, and Interface
  - Design Heritage
  - Environment Concerns
  - Technology Readiness
  - Instrument Systems Engineering
- **Mission Design and Operations (N/A for MO's)**
  - Mass Margins
  - Trajectory Analysis
  - Launch Services
  - Concept of Mission Operations
  - Ground Facilities – New/Existing
  - Telecom
- **Flight Systems**
  - Hardware/Software Design
  - Design Heritage
  - Spacecraft Systems Design
  - Design Margins (Excluding mass)
  - Qualification and Verification
  - Assembly, Test, and Launch Operations
  - Mission Assurance
  - Development of New Technology
- **Management and Schedule**
  - Roles and Responsibilities
  - Team Experience and Key Individuals' Qualifications
  - Project Management and Systems Engineering
  - Organizational Structure and Work Breakdown Schedule (WBS)
  - International Participation
  - Risk Management, Including Descope Plan and Decision Milestones
  - Project-Level Schedule
  - Proposed Subcontracting Plans and SDB Participation.
- **Cost**
  - Basis of Estimate (BOE)
  - Cost Realism and Completeness
  - Cost Reserves by Phase
  - Comparison with TMC Estimates (Including
  - Parametric Models/Analogies)

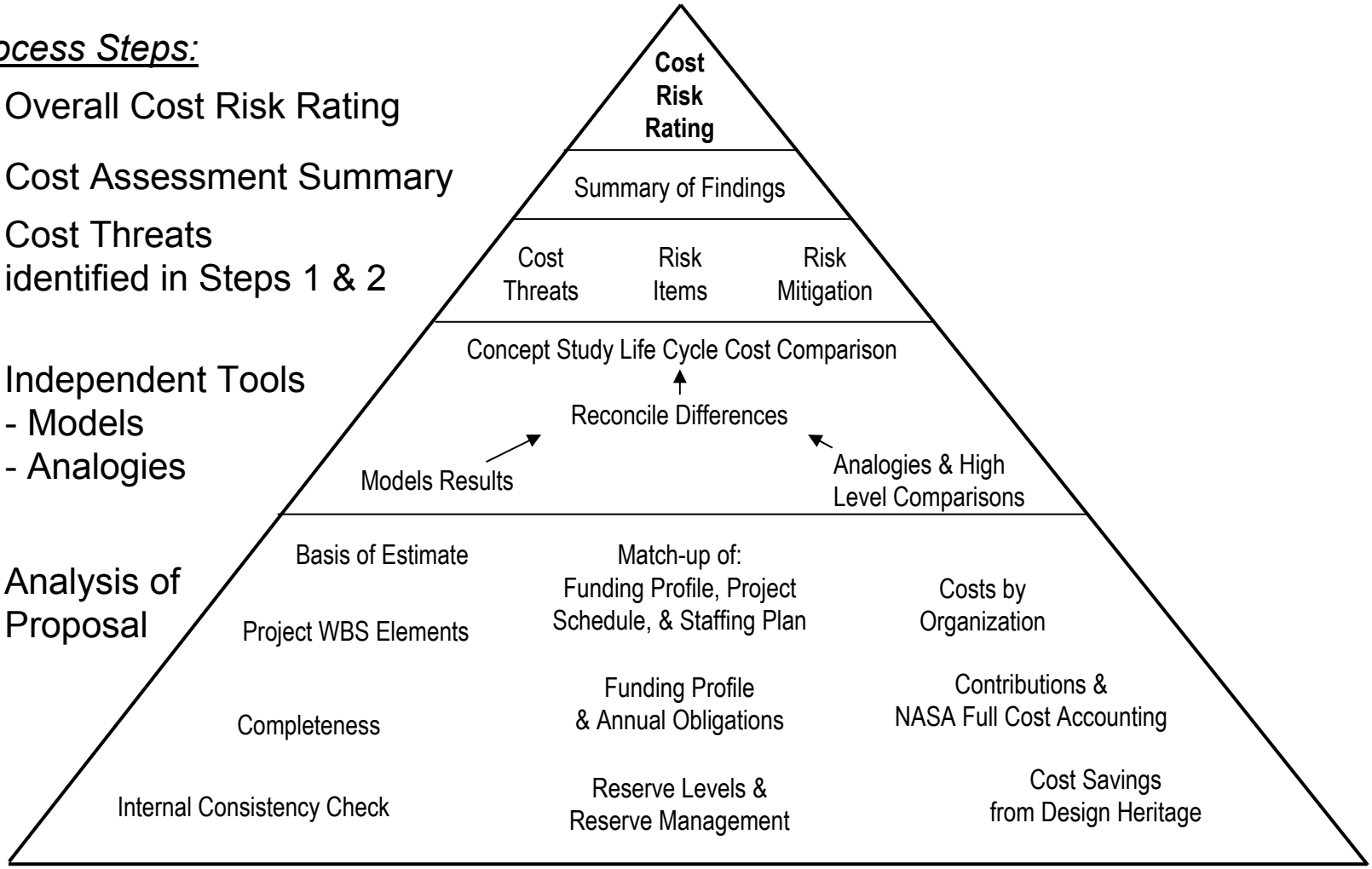
# TMC Independent Cost Assessment Pyramid



*"The Pyramid"*

*Process Steps:*

5. Overall Cost Risk Rating
4. Cost Assessment Summary
3. Cost Threats identified in Steps 1 & 2
2. Independent Tools
   - Models
   - Analogies
1. Analysis of Proposal



# TMC Evaluation for Discovery MO, SEO, TDO and SC

Mission of Opportunity (MO)

- NASA will evaluate only the portions of the investigation that are funded by NASA . Spacecraft and launch vehicle capabilities will be considered in the evaluation only as appropriate to support the success of the proposed investigation.

SEO, TDO, and SC

- Innovative Science Enhancement Opportunity, Technology Demonstration Opportunity, and Student Collaboration proposals will be considered strengths.
- Evaluated for overall merit, cost and schedule risk.
- **Important** to show clearly separable from the primary objectives and risk.

# Typical TMC Evaluation Questions to be Answered



- Will overall investigation approach allow successful implementation as proposed?
- If not, are there sufficient resources (time & $) to correct identified problems?
- Does proposed design/development allow the investigation to have a reasonable probability of accomplishing its objectives and include all needed tools?
- Are requirements within existing capabilities or are advances required?
- Does the proposal accommodate sufficient resiliency in appropriate resources (e.g., money, mass, power) to accommodate development uncertainties?
- Is there a Risk Management approach adequate to identify problems with sufficient warning to allow for mitigation without impacting the investigation's objectives?
- Does the proposer understand the known risks and are there adequate fallback plans to mitigate them, including risk of using new developments, to assure that investigation can be completed as proposed?

# Typical TMC Evaluation Questions to be Answered (cont'd)



- Is the schedule doable?
- Does it reflect an understanding of work to be done and time it takes to do it?
- Is there a reasonable probability of delivering the investigation on time to meet Discovery Project Schedules?
- Does it include schedule margin?
- Will proposed management approach (e.g., institutions and personnel, as known, organization, roles and responsibilities, experience, commitment, performance measurement tools, decision process, etc) allow successful completion of investigation? Is the PI in charge?
- Does the investigation, as proposed, have a reasonable chance of being accomplished within proposed cost?
- Are proposed costs within appropriate caps and profiles and does cost estimate cover all costs including full-cost accounting for NASA Centers?
- Are costs phased reasonably?
- Is there evidence in the proposal to give confidence in the proposed cost?
- Does the proposer recognize all potential risks/threats for additional costs or cost growth (e.g., late deliveries of components)?

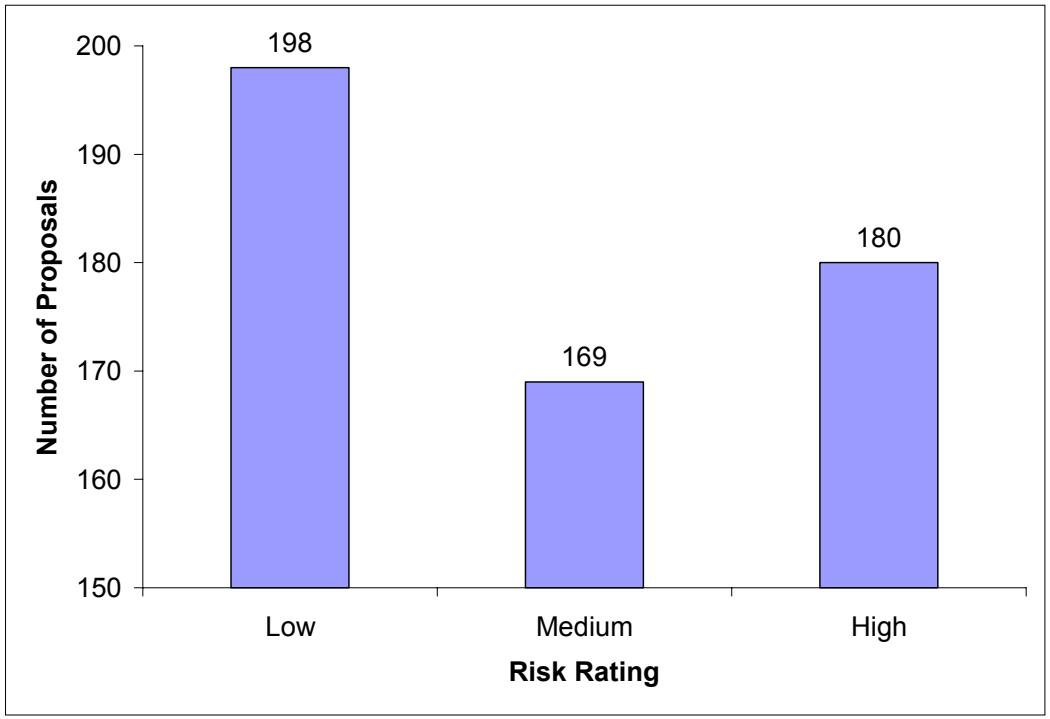
# Some Characteristics
## Applicable to a Low Risk Rating

- All risks for the project have been/are being identified and managed by the team, with plans to reduce or retire the risk before launch.
- No risk exists for which there is neither a workaround planned, nor a very sound plan to develop and qualify the risk item for flight.
- The proposed project team and each of its critical participants are competent, qualified, and committed to execute the project.
- The project will be self managed to a successful conclusion while providing reasonable visibility to NASA for oversight.
- The team has thoroughly analyzed all project requirements, and the resulting resources proposed are adequate to cover the projected needs, including an additional percentage for growth during the design and development, and then a margin on top of that for unforeseen difficulties.
- Reserve time exists in the schedule to find and fix problems if things do not go according to plan.
- Any contributed assets for the project are backed by letters of commitment.
- The team understands the seriousness of failing to meet technical, schedule, or cost commitments for the project in today's environment.

# Lessons Learned Summary from TMC Reviews



- Study based on ten years of NASA directed TMC evaluation of PI-Led Science Mission proposals.
- No full missions rated as High Risk by TMC have been selected for implementation.

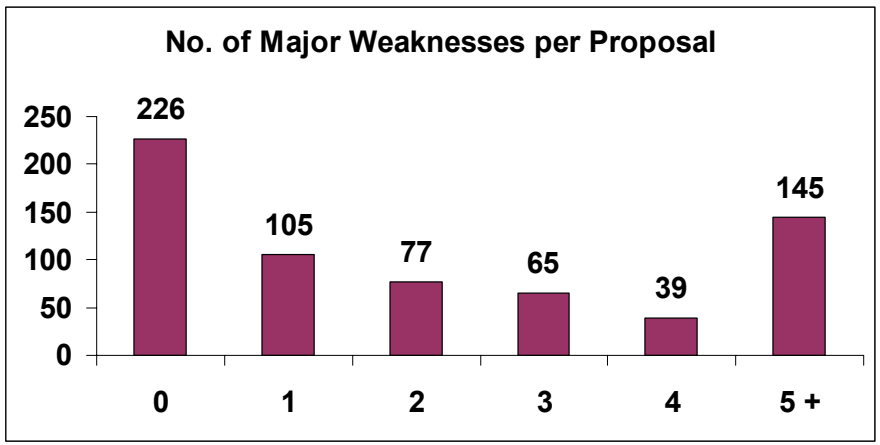



Summary of Risk Ratings for Step 1 Proposals

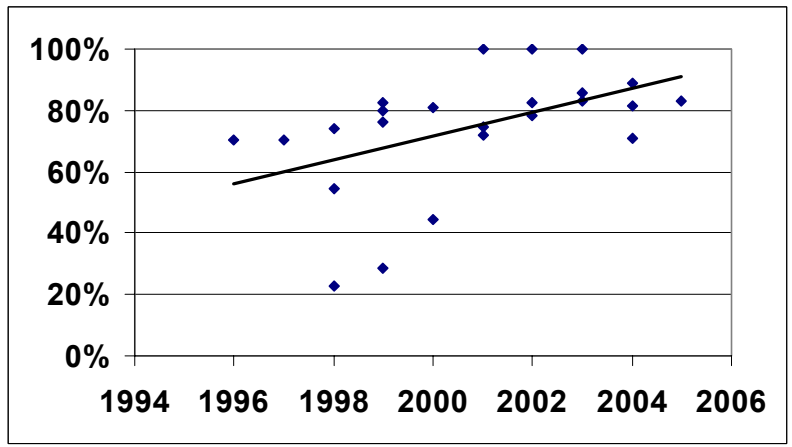
# Lessons Learned Summary from TMC Reviews (cont'd)



- Only 34% of proposals reviewed were judged to have no major weaknesses
- Number and severity of major weaknesses directly affect the overall implementation risk rating.
- Trend in percentage of proposals with one or more major weaknesses is increasing




History of Major Weaknesses per Proposal Evaluated




Percentage of Proposals with one or more Major Weakness

# Lessons Learned Summary from TMC Reviews (cont'd)



**Common Causes of Major Weaknesses:**

- Technical Design Margins (Mass, Power, etc.)
  - Insufficient data provided from which to independently verify the margins.
  - No margin provided or conflicting data provided.
  - Margin provided deemed too low based on the maturity of the design.
- Cost
  - Concerns relating to cost reserve (Below AO requirement, too low based on liens/threats, phasing inconsistent with anticipated needs).
  - Unable to validate proposed cost
- Instrument Implementation
  - Heritage claims not substantiated/development risks not adequately addressed.
  - Inadequate/inconsistent description and detail.
  - Inconsistencies between instrument requirements and bus capabilities.
- Complex Operations
  - More common in payloads containing multiple instrument that required tight scheduling/sequential operations.
  - Inadequately addressing the challenges inherent in lander operations.

# Lessons Learned Summary from TMC Reviews (cont'd)



**Common Causes of Major Weaknesses (cont'd):**

- Systems Engineering
  - Incomplete flow-down of science requirements to payload/flight system accommodations.
  - Incomplete description of how the systems engineering function will be executed.
  - Inadequate resources allocated to accomplish this function.
- Management Plans
  - Confusing/conflicting organizational roles and responsibilities.
  - Lack of demonstrated organizational/individual expertise for specified role.
  - Insufficient time commitments for key personnel.
- Schedules
  - Insufficient detail from which to perform an independent assessment.
  - Inadequate/no schedule reserve identified.
  - Overly ambitious schedules that are not consistent with recent experiences.

# Draft Discovery Downselect Schedule/Evaluation Flow