



Decadal Survey Tier 2 implementation: “What's expected of us at the next decision point?”

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Decadal Survey Plans & Status



ESD Mission Prioritization



☞ We are working to develop a Program, not just fly individual missions, and are flying 1-2 missions every year well into the next decade

☞ Complete the foundational missions as planned and as fast as possible

2010: Aquarius & Glory (\$700M)

2011: NPP (\$800M)

2012: LDCM (\$950M)

2013: GPM (\$1,000M)

Venture Class calls – 2009, 2011, 2013, ...

☞ Complete the Decadal Survey Tier 1 missions as quickly as possible, followed by Tier 2, and ultimately Tier 3

2014: SMAP (\$700M)

2015: ICESat-2 (\$750M)

201X: DESDynI (\$1,000M+)

201Y: CLARREO (\$900M)



Decadal Survey Missions



- ☞ We are doing Tier 1 missions first
 - ☐ *SMAP and ICESat II were identified as the first two missions because of technology and mission concept maturity*
 - ◆ SMAP is in Phase A, ICESat II is in Pre-Phase A
 - ☐ *CLARREO and DESDynI will be the next two following ICESat II and SMAP*
 - ◆ CLARREO and DESDynI are in Pre-Phase A

- ☞ We are funding the Tier 2 missions at a lower, but still significant level.
 - ☐ *All five Tier 2 missions currently are funded at an equal level, as we prepare to assess their mission readiness.*
 - ☐ *All in early Pre-Phase A*

- ☞ We are utilizing Earth Science Technology Office (ESTO) calls to advance the Tier 2 and 3 missions' technology readiness

- ☞ Available funding for FY10 and beyond will strongly influence decisions on Tier 2 phase up and prioritization.

NRC Recommended Mid-Term Missions (Tier 2)



Mission	Mission Description	Orbit	Instruments
HyspIRI	Land surface composition for agriculture and mineral characterization; vegetation types for ecosystem health	LEO, SSO	Hyperspectral spectrometer TIR multispectral scanner
ASCENDS	Day/night, all-latitude, all-season CO ₂ column integrals for climate emissions	LEO, SSO	Multifrequency laser
SWOT	Ocean, lake, and river water levels for ocean and inland water dynamics	LEO	Ka-band wide swath radar C-band radar
GEO-CAPE	Atmospheric gas columns for air quality forecasts; ocean color for coastal ecosystem health and climate emissions	GEO	High and low spatial resolution hyperspectral imagers
ACE	Aerosol and cloud profiles for climate and water cycle; ocean color for open ocean biogeochemistry	LEO, SSO	Backscatter lidar Multiangle polarimeter Doppler radar



Tier 2 Mission Development Objectives



- Advance the science maturity and overall mission development
 - ❑ *Build on the results of the 2008 science workshops*
 - ❑ *Define/refine scientific requirements*
 - ❑ *Develop mission/instrument requirements*
 - ❑ *Conceptualize mission/instruments*
 - ❑ *Mature mission-enabling technologies, assess, and downselect*
 - ❑ *Support cross and common mission activities*
 - ❑ *Develop partnering opportunities and conduct joint studies*

- Conduct the studies in an integrated fashion, led by the Program Scientist and Program Executive and coordinating across multiple levels within the Earth Science Community

Where do we expect to be by October 1, 2009?



➤ For each of the Tier 2 missions:

□ ***Quantitative assessment of the readiness to proceed to Formulation (Phase A)***

- ◆ Draft level 1 science requirements, baseline mission concept, draft formulation authorization document, partnership evaluations, technology readiness level assessments

□ ***Mission maturation plan for FY10 and beyond, through launch and ops***

- ◆ Life Cycle Cost, independent cost and schedule estimates



Tier 2 Study Execution



- ☞ Tier 2 studies are directed by the ESD and supported by the Earth Systematic Missions (ESM) Program Office at GSFC
- ☞ All mission development have a study management team, led from HQ ESD by the HQ Program Scientist and Program Executive, and including representatives from ESTO, data systems, applied sciences, and the ESM program office

Mission		Program Scientist		Program Executive	Data Systems	Applied Science	Resources	ESTO Technology	ESM PO
		Primary	Backup						
Tier 2	SWOT	Lindstrom	Entin	Neeck	Maiden	Haynes	Black	Smith	Bolton
	HyspIRI	Turner	LaBrecque			Haynes			
	ASCENDS	Jucks	Wickland			Turner			
	GEO-CAPE	Al-Saadi	Bontempi			Friedl			
	ACE	Maring	Bontempi			Friedl			



DS Tier 2 Funding & Status



- Assigned budget
 - Tier 2 missions (total): \$2.3M in FY08, \$10.7M in FY09, \$11M in FY10 (TBC)
- FY08, FY09 and preliminary FY10 funding allocations and Center distribution based on input from mission Program Scientists
- Funding levels for FY11 and beyond will be determined as part of the budget process, informed by the progress and outcome of these many studies

	FY08 (\$K)	FY09 (\$K)	FY10 (\$K)
304029.01.04 Decadal Mission Studies			
304029.01.04.04 – ACE		2,305	2,200
304029.01.04.04.01 - GSFC ACE	225		
304029.01.04.04.02 - LaRC ACE	50		
304029.01.04.04.03 - JPL ACE	80		
Total	355		
304029.01.04.05 – ASCENDS		2,000	2,200
304029.01.04.05.01 - GSFC ASCENDS	70		
304029.01.04.05.02 - LaRC ASCENDS	29		
304029.01.04.05.03 - JPL ASCENDS	126		
Total	225		
304029.01.04.06 – GEOCAPE		2,125	2,200
304029.01.04.06.01 - GSFC GEOCAPE	135		
304029.01.04.06.02 - LaRC GEOCAPE	25		
304029.01.04.06.03 - JPL GEOCAPE	65		
Total	225		
304029.01.04.07 – HypsIRI		2,200	2,200
304029.01.04.07.01 - GSFC HypsIRI	70		
304029.01.04.07.02 - LaRC HypsIRI			
304029.01.04.07.03 - JPL HypsIRI	380		
Total	450		
304029.01.04.08 – SWOT		2,063	2,200
304029.01.04.08.01 - GSFC SWOT	100		
304029.01.04.08.02 - LaRC SWOT			
304029.01.04.08.03 - JPL SWOT	425		
Total	525		

Note. FY10 allocations are preliminary and will be revised as study plans mature.



Decadal Survey Implementation



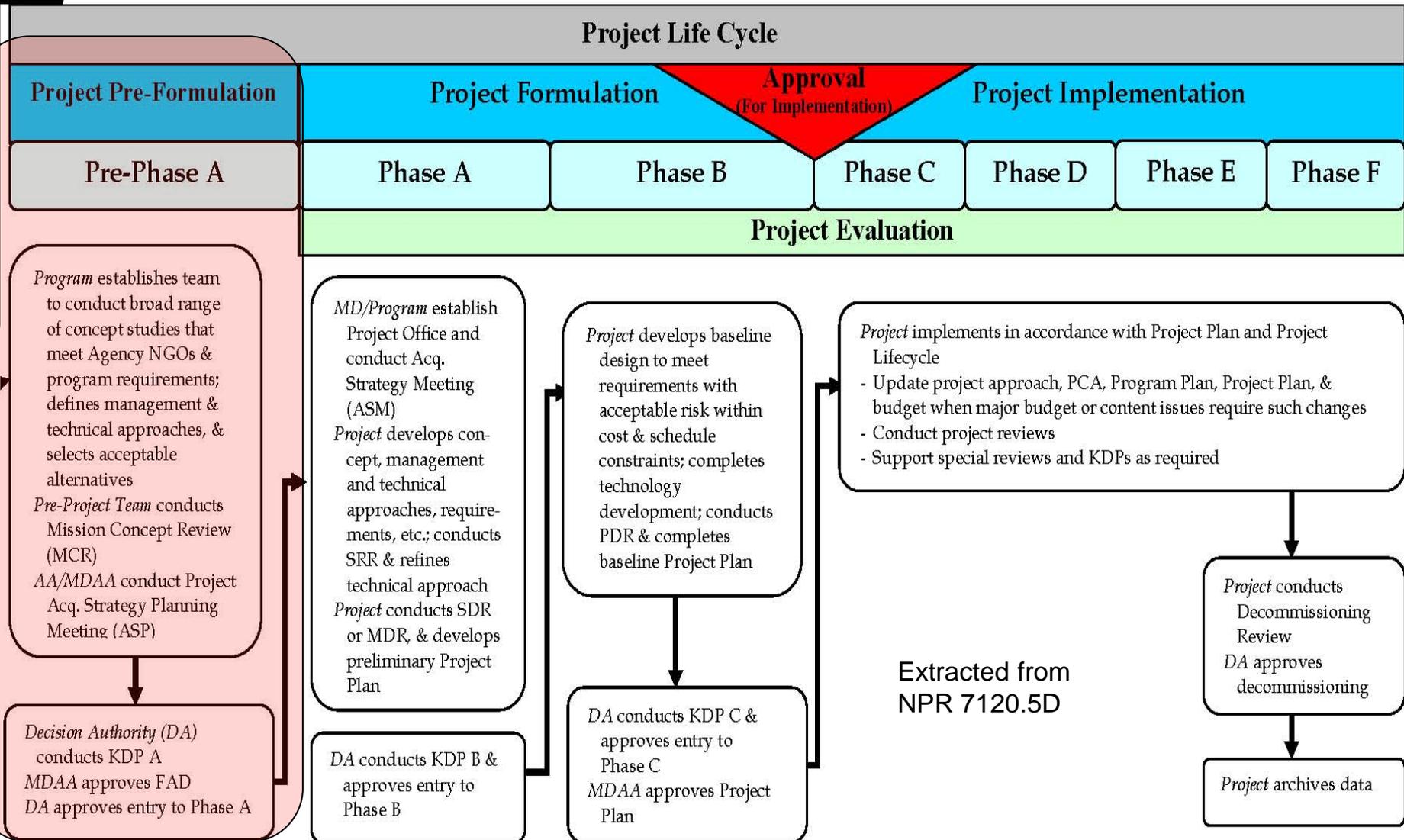
Mission Implementation



- ☞ NASA standard practices define the process for mission implementation
- ☞ The immediate focus on the best initiation of these missions
 - ☐ *Level 1 requirements & Formulation Authorization Document (FAD)*
 - ☐ *Mission classification*
 - ☐ *Launch Vehicle selection*
 - ☐ *Partnership identification and determination*
 - ☐ *Cost & Schedule assessment*

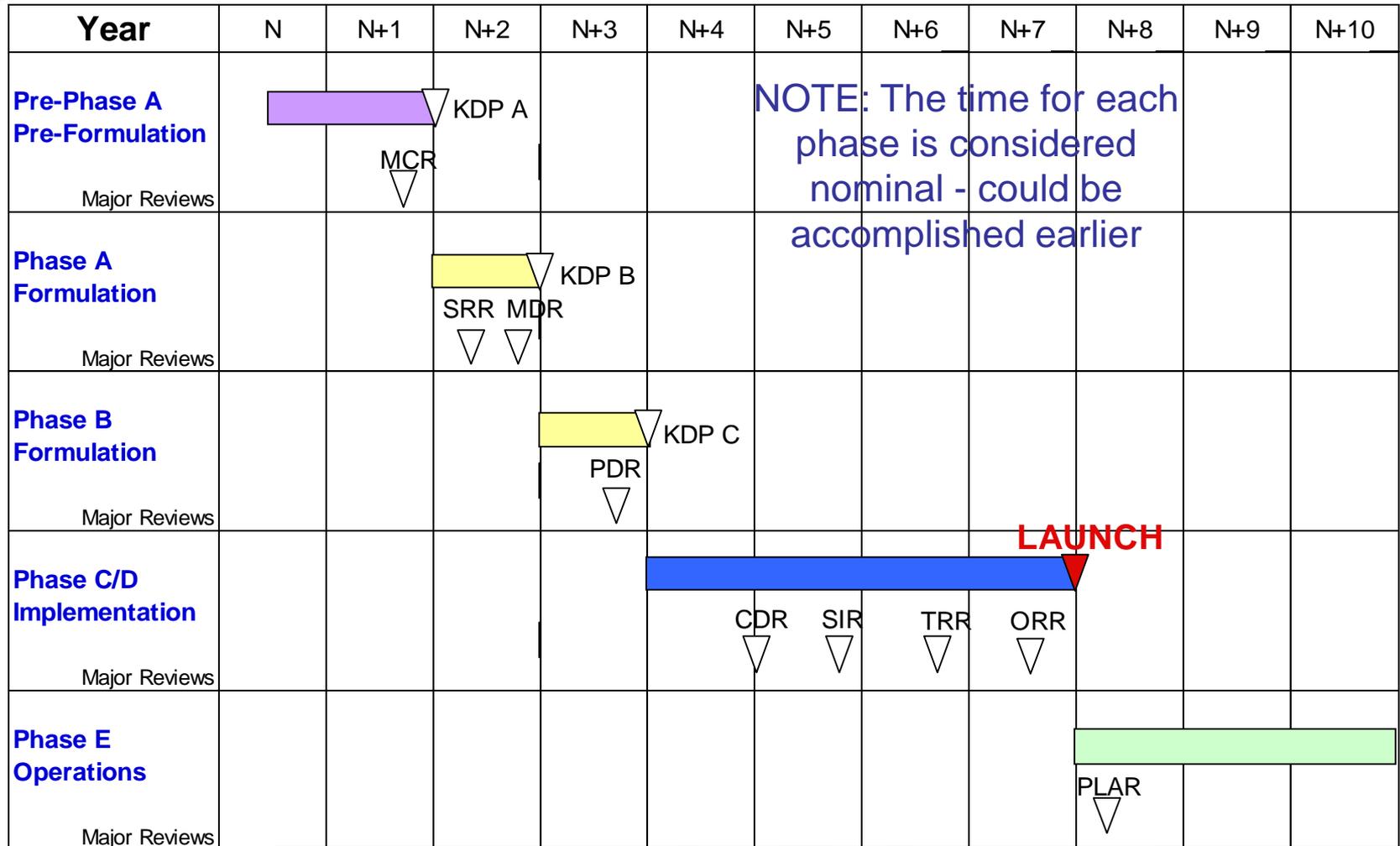


Flight Project Life Cycle





Notional Mission Timeline

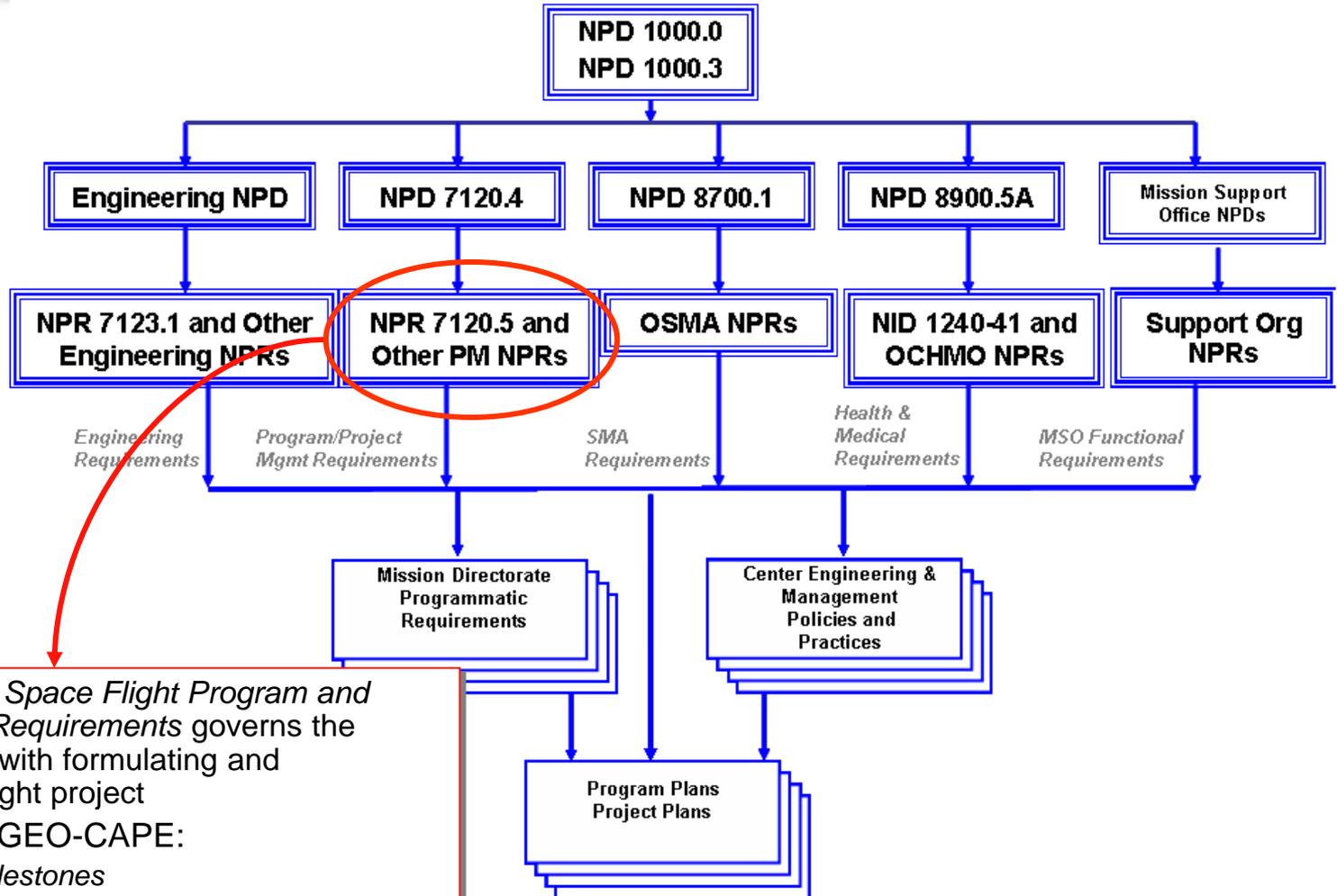


NOTE: The time for each phase is considered nominal - could be accomplished earlier

LAUNCH



NASA Hierarchy of Directives



☞ NPR 7120.5D - NASA Space Flight Program and Project Management Requirements governs the processes associated with formulating and implementing a new flight project

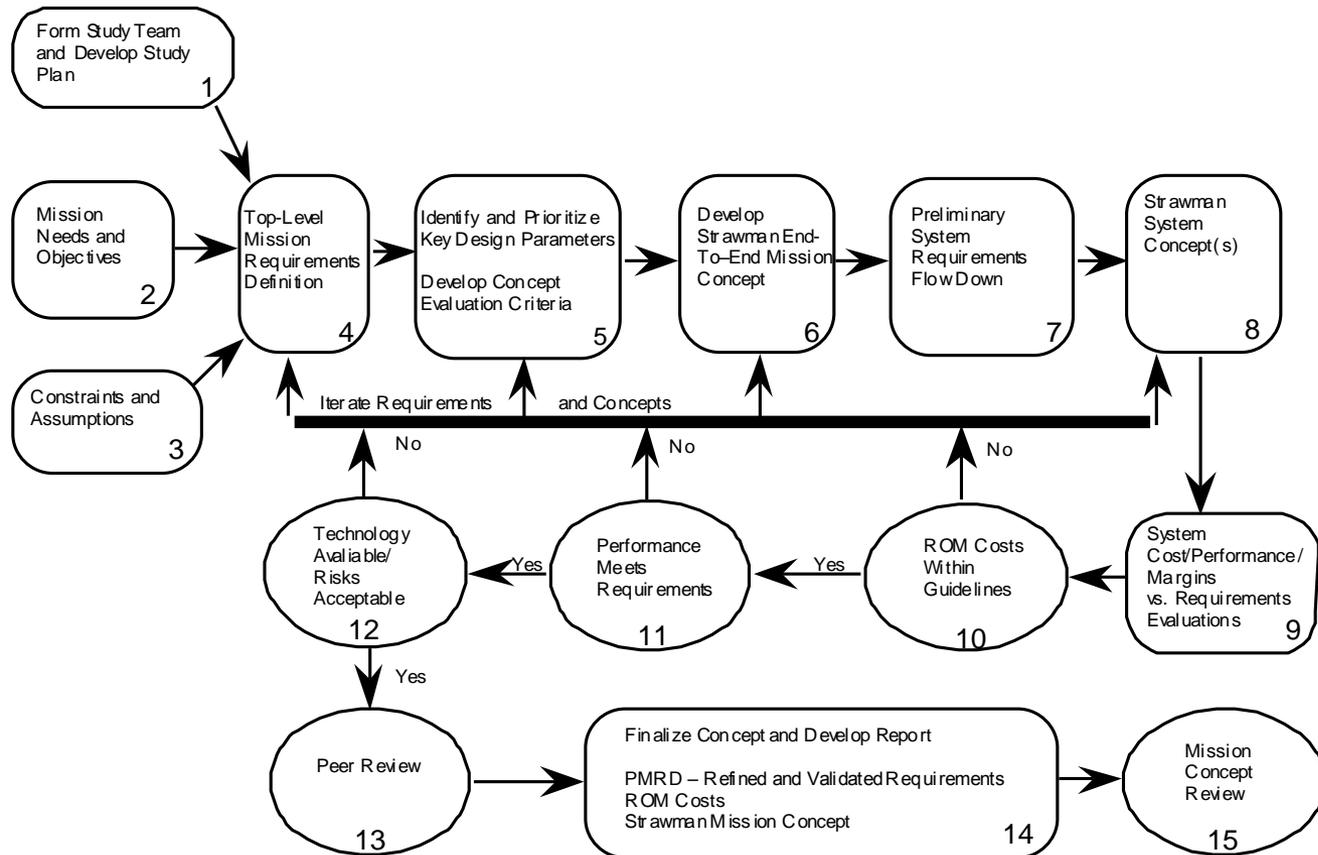
☞ Important details for GEO-CAPE:

- ☐ Defines the Major Milestones
- ☐ Identifies all requirements for each phase of the Project
- ☐ Identifies all gate products for each phase
- ☐ Defines roles and responsibilities
- ☐ Identifies all major reviews

Road to MCR and KDP-A: The Mission Study Process



- Conduct studies and analyses to derive the Level 1 requirements (Science, engineering, cost and schedule)
- Complete an analysis of alternatives resulting in a conceptual design, and conduct Mission Concept Review
- Prepare for approval all documents required in NPR 7120.5D (NASA Space Flight Program and Project Management Requirements)



Mission Requirements for Pre-Phase A



Scope of Major Pre-Phase A Activities:

Headquarters

- ☞ Approve a Formulation Authorization Document
- ☞ Develop DRAFT Level 1 Requirements
- ☞ Conduct Acquisition Strategy Planning Meeting
- ☞ Conduct initial cost & schedule assessment

Technical Activities:

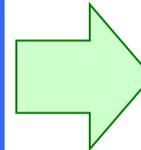
- ☞ Develop and document preliminary mission concepts
- ☞ Conduct internal Reviews
- ☞ Conduct Mission Concept Review Project Planning, Costing and Scheduling
- ☞ Develop and document a DRAFT Integrated Baseline, including:
 - ☐ *High level WBS*
 - ☐ *Assessment of Technology Readiness Levels*
 - ☐ *Assessment of Infrastructure and Workforce needs*
 - ☐ *Identification of potential partnerships*
 - ☐ *Identification of conceptual acquisition strategies for proposed major procurements*

KDP Readiness

- ☞ Obtain KDP A Readiness products
- ☞ Approval through the governing PMC

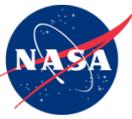
Areas the Science Community must work:

- ☞ Development of DRAFT Level 1 Science Requirements
- ☞ Support development of preliminary mission concepts
- ☞ Support the assessment of Technical Readiness Levels
- ☞ Identify potential partnerships



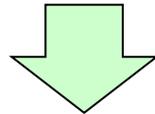


Key Pre-Phase A Questions



☞ What science **MUST** this mission achieve?

- ❑ *What specific measurements?*
- ❑ *To what accuracy?*
- ❑ *What are the required data products?*



☞ What mission parameters can achieve the science?

- ❑ *What orbit (inclination/altitude)?*
- ❑ *Which instruments?*
- ❑ *What is the baseline mission duration?*

☞ How can NASA achieve these measurements?

- ❑ *Are there other missions required/desired to achieve the science?*
- ❑ *Who can NASA partner with to achieve this mission?*

Should be resolved ~ 12 months prior to KDP A

Should be resolved ~ 6 months prior to KDP A

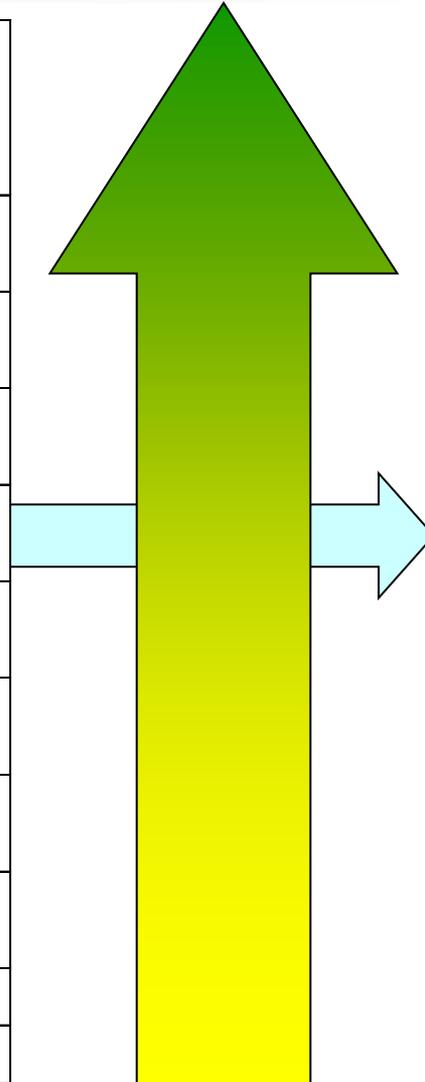
Year	N	N+1	N+2	N+3	N+4	N+5	N+6	N+7	N+8	N+9	N+10
Notional Mission Schedule		KDP A		KDP B	KDP C	LAUNCH					
		MCR	SRR	MDR	PDR		CDR	SIR	TRR	ORR	PLAR
Major Reviews		▽	▽	▽	▽	▽	▽	▽	▽	▽	



Technology Readiness Level



Technology Readiness Level - (TRL)	Definition
9	Final product validated through successful mission operations (ground, airborne or space).
8	Final product in mission configuration qualified through test and evaluation
7	High-fidelity functionality and scaled form/fit demonstrated in its operational environment
6	Mid-fidelity functionality and scaled form/fit demonstrated in a relevant environment
5	Mid-fidelity functionality demonstrated in a relevant environment
5	Mid-fidelity functionality demonstrated in a relevant environment
4	Low-fidelity functionality demonstrated in laboratory
3	Analytical and/or experimental proof-of-concept demonstrated
2	Application and/or operating concept formulated
1	Basic principles observed and reported.



TRL levels defined in NPR 7123.1A

High Maturity

TRL 6 is the desired minimum level for integration of new technology

Low Maturity



NPR 8705.4 Payload Risk Classification Rationale



Mission Classification



- ☞ Classification drives numerous elements of the mission implementation approach and is a significant driver in defining the cost and schedule of the mission
- ☞ Determines the governing Program Management Council (PMC) and through that the approach for authorization and modification to all baseline control documents
 - ☐ *Class A: Agency PMC*
 - ☐ *Class B & C: Directorate PMC*
- ☞ Centers also impose different criteria on mission development depending on the classification
- ☞ Classification is proposed during pre-Phase A, with assignment made no later than KDP-B



Mission Classification Criteria



	Class A	Class B	Class C	Class D
Priority (Criticality to Agency Strategic Plan) and Acceptable Risk Level	High priority, very low (minimized) risk	High priority, low risk	Medium priority, medium risk	Low priority, high risk
National Significance	Very high	High	Medium	Low-to-medium
Complexity	Very high to high	High to medium	Medium to low	Medium to low
Mission Lifetime (Primary Baseline Mission)	Long >5yrs	Medium 2-5 yrs	Short	Short (<2 yrs)
Cost	High	High to Medium	Medium to low	Low
Launch Constraints	Critical	Medium	Few	Few to None
In-flight Maintenance	N/A	Not feasible or difficult	May be feasible	May be feasible and planned
Alternative Research Opportunities or Re-flight Opportunities	No alternative or re-flight opportunities	Few or no alternative or re-flight opportunities	Some or few alternative or re-flight opportunities	Significant alternative or re-flight opportunities
Achievement of Mission Success Criteria	All practical measures are taken to achieve minimum risk to mission success. The highest assurance standards are used.	Stringent assurance standards with only minor compromises in application to maintain a low risk to mission success.	Medium risk of not achieving mission success may be acceptable. Reduced assurance standards are permitted.	Medium or significant risk of not achieving mission success is permitted. Minimal assurance standards are permitted.

Reference: NPR 8705.4, Appendix A *Classification Considerations for NASA Class A-D Payloads*



GEO-CAPE Team Actions



- ☞ Develop an assessment of how the mission fits within these parameters
- ☞ Define mitigations or tailoring to classification, consistent with Center requirements
 - ☐ *Class C+ or Class B-*



Cost & Schedule Assessment

Mission Requirements for Completing Pre-Phase A



To pass KDP-A and moved into Phase A the mission team must complete the following:

Headquarters Functions

- ☞ Approve a Formulation Authorization Document
- ☞ Develop DRAFT Level 1 Requirements
- ☞ Conduct Acquisition Strategy Planning Meeting
- ☞ **Conduct initial cost & schedule assessment**

Technical Activities:

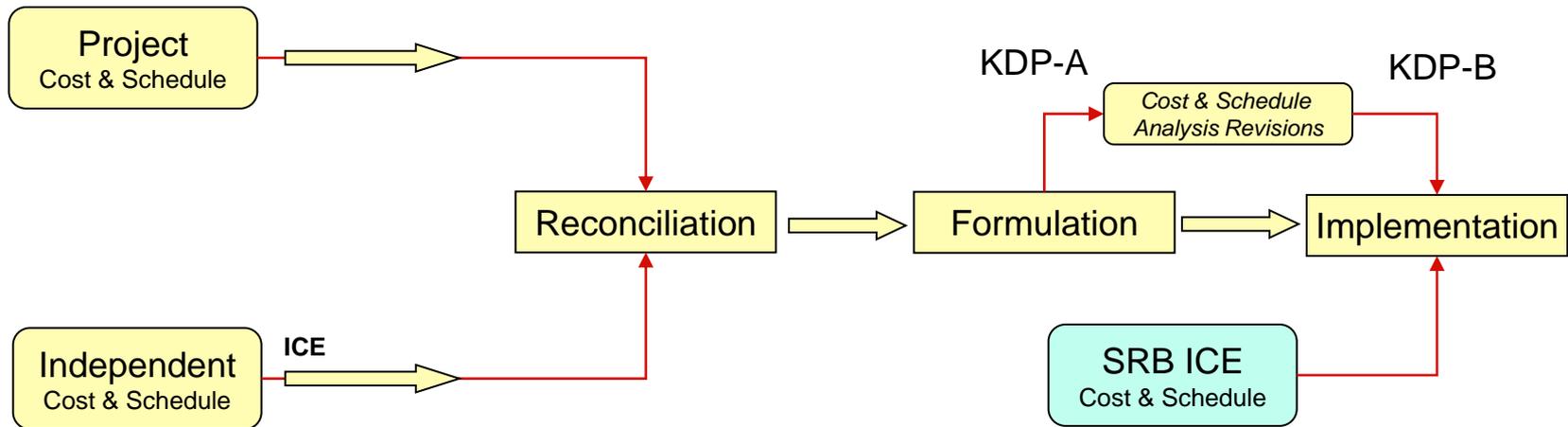
- ☞ Develop and document preliminary mission concepts
- ☞ Conduct internal Reviews
- ☞ Conduct Mission Concept Review Project Planning, Costing and Scheduling
- ☞ Develop and document a DRAFT Integrated Baseline, including:
 - ☐ *High level WBS*
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 - ☐ *Assessment of Infrastructure and Workforce needs*
 - ☐ *Identification of potential partnerships*
 - ☐ *Identification of conceptual acquisition strategies for proposed major procurements*



Cost & Schedule Analysis Approach



- Each mission team will develop a project level Life Cycle Cost, based on the implementing Center principles, monitored and approved by NASA HQ
- The ESD, working through the Earth Systematic Mission (ESM) program office, will conduct a parametric ICE to augment the project-generated assessment and to improve the overall Decadal Survey program planning



- The required SRB ICE and ISA will be done as part of the standard major mission milestone gate reviews (KDP-B, -C, ...)

 - ICE conducted to determine the 70% confidence level for LCC & LRD

- Additional requirements are likely from the Agency for an integrated ICE/ISA



GEO-CAPE Team Actions



- ☞ Develop the bottoms up estimate
 - ☐ *Combination of grass roots and parametrics allowed*
 - ☐ *Look to Center principles for specific guidance*



Requirements Definition



Requirements Definition



- ☞ Phase A defined by Formulation Authorization Document (FAD)
 - ☐ *Signed at /by KDP-A*

- ☞ Phase B/C/D/E defined by Level 1 Requirements, which will include
 - ☐ *Life Cycle Cost (LCC) and Development (B/C/D) cost allocations*
 - ☐ *Performance requirements*
 - ☐ *Hardware (Phase B/C/D) and Data delivery (Phase E) requirements **and** schedule*
 - ☐ *Management implementation approach*
 - ◆ Hardware responsibilities, data system
 - ◆ Partnerships
 - ◆ Mission Classification
 - ☐ *Baseline and minimum mission*
 - ☐ *Mission Success Criteria*

- ☞ Not needed to be signed until Mission Confirmation (KDP-C), but clarity is needed much sooner to correctly define the mission scope



GEO-CAPE Team Actions



- ☞ Support FAD development during pre-Phase A
- ☞ Develop draft Level 1 working with PS, PE and ESMPO



MCR and KDP-A Lessons Learned



MCR Lessons Learned



- ☞ **Concept Definition**
 - ☐ *Must have sufficient fidelity to support trades, risk identification, and a credible cost estimate*
 - ☐ *Sufficient margins per NASA and implementing Center standards must be incorporated*
 - ☐ *Robustness*
- ☞ **Technology Readiness and Risk Assessment**
 - ☐ *Technology is at an appropriate maturity level (TRL 6). Risks should be identified and risk mitigation plans in place. Project should have a risk management system in place (the software and a primary manager)*
- ☞ **Level 1 Requirements Definition**
 - ☐ *Supported by documented trade studies, an SDT report, simulations, modeling, and analysis*
 - ☐ *Science requirements formally decomposed and traceable to mission element requirements (Level 2 & 3). Documentation for traceability exists and has been peer reviewed*
- ☞ **Credible cost and schedule estimates supported by at least one independent estimate or assessment**
 - ☐ *Estimates should be coordinated with the PE and the ESM-PO at least two months before the MCR itself. Surprises at the MCR itself will delay KDP-A.*
 - ☐ *Both cost and schedule must have reserves specified by Agency and implementing Center policies*
 - ☐ *Launch Vehicle availability and cost must address availability via NLS contracts*
- ☞ **Credible descope options need to be identified**
 - ☐ *Options for cost containment exist and have been quantified*
- ☞ **Partnering & Contributions**
 - ☐ *Need to be identified with the notional content of MOU's (gives/gets) identified*
- ☞ **Review Team, TOR, and IPAO**
 - ☐ *7120.5 D does not require a formal SRB for MCR. However, the review chair, agenda, and TOR should be coordinated with the implementing Center's Systems Review Office. The review team members should have independence from the Project, and at least half should be from an independent Center. Team members should be suitable for appointment to the official SRB in Phase A.*



KDP-A Lessons Learned



- ☞ KDP-A is approval *for Phase-A only*
- ☞ Agenda is defined in SMD management instructions
 - ☐ *SMAP sample on following page*
- ☞ Launch vehicle must comply with commercial Space Act Provisions. Must start with a standard NASA Launch Services vehicle as the primary option. This cost must be in the baseline cost estimate
- ☞ Payload Risk Classification: rationale and implementation approach for the mission risk classification should be identified



SMAP KDP-A Agenda



Time	Topic	Presenter
1:00 PM	Purpose & Introductions	Eric lanson (PE)
1:10 PM	SMAP Introduction	Kent Kellogg (PM)
1:35 PM	Science Transition Team Report	Dr. Dara Entekhabi (PS)
1:50 PM	SRB Assessment & SMAP Project Response	Mark Goans (RC) Kent Kellogg (PM)
2:20 PM	Earth Systematic Missions Program Office Readiness Assessment	Mary DiJoseph(Prog M)
2:30	JPL Readiness Assessment	Eugene Tattini (Center M)
2:35	ESD Readiness Assessment	Dr. Michael Freilich (ESD M)
2:40	Discussion	
3:00	Adjourn	



BACKUP



NPR 7123 requirements for MCR

Mission Concept Review

Entrance Criteria

1. Mission goals and objectives.
2. Analysis of alternative concepts to show at least one is feasible.
3. Concept of operations.
4. Preliminary mission descope options.
5. Preliminary risk assessment, including technologies and associated risk management/mitigation strategies and options.
6. Conceptual test and evaluation strategy.
7. Preliminary technical plans to achieve next phase.
8. Defined MOEs and MOPs.
9. Conceptual life-cycle support strategies (logistics, manufacturing, and operation).

Success Criteria

1. Mission objectives are clearly defined and stated and are unambiguous and internally consistent.
2. The preliminary set of requirements satisfactorily provides a system that will meet the mission objectives.
3. The mission is feasible. A solution has been identified that is technically feasible. A rough cost estimate is within an acceptable cost range.
4. The concept evaluation criteria to be used in candidate systems evaluation have been identified and prioritized.
5. The need for the mission has been clearly identified.
6. The cost and schedule estimates are credible.
7. An updated technical search was done to identify existing assets or products that could satisfy the mission or parts of the mission.
8. Technical planning is sufficient to proceed to the next phase.
9. Risk and mitigation strategies have been identified and are acceptable based on technical risk assessments.



MCR and KDP-A



☞ To be ready to proceed to Phase A, the following must exist:

- ❑ *FAD is ready for signature*
- ❑ *Appropriate trades for Phase A have been identified, planned and budgeted*
- ❑ *Required Phase A funding has been identified and is available*
- ❑ *Draft Level 1 Requirements exist. Lower level requirements are understood and documented. Analysis deriving lower level requirements from the Level 1's exists and has been documented.*
- ❑ *Project has done an excellent job on the technical definition, grassroots cost estimate, and Phase A/D schedule*
- ❑ *Risks are identified and appropriate mitigation plans in place*
- ❑ *Project needs to iterate technical content and cost estimates with the ESD and ESM-PO during Phase A to develop a baseline for MDR.*



Major Formulation (Phase A/B) Events



Review	Description
Mission Concept Review (MCR)	The MCR will affirm the mission need and examine the proposed mission's objectives and the concept for meeting those objectives. Technologies will be assessed and identified. It is an internal review (SRB may not have been formed) that usually occurs at the cognizant organization for system development. ROM budget and schedules will be presented.
System Requirements Review (SRR)	The SRR examines the functional and performance requirements defined for the system and the preliminary program or project plan and ensures that the requirements and the selected concept will satisfy the mission.
Mission Definition Review (MDR)	The MDR examines the proposed mission/system architecture and the flow down to all functional elements of the system. Technology planning with off-ramps will be described. The preliminary description of the management approach and initial budget and schedule will be presented. Risk assessment and management will be presented as well as initial de-scope plan.
Preliminary Design Review (PDR)	The PDR demonstrates that the preliminary design meets all system requirements with acceptable risk and within the cost and schedule constraints and establishes the basis for proceeding with detailed design. It will show that the correct design option has been selected, interfaces have been identified, and verification methods have been described. Full baseline cost and schedules as well as all risk assessment, management systems and metrics will be presented.