ASTROPHYSICS
DECADAL SURVEY 2020

Management Plan For
Large Mission Concept Studies – Rev D

February 26, 2018
http://science.nasa.gov/astrophysics/2020-decadal-survey-planning/

This is a living document and will evolve over time
<table>
<thead>
<tr>
<th>Date</th>
<th>Change</th>
<th>Pages</th>
<th>Rev</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/28/15</td>
<td>Initial Release</td>
<td></td>
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<tr>
<td>03/15/16</td>
<td>Replaced “STDT Chair” with “STDT Community Chairs”</td>
<td>P20, 22</td>
<td>A</td>
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<tr>
<td>03/15/16</td>
<td>Removed references to “co-chair” from “Center Study Scientist”</td>
<td>P20, 23</td>
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<tr>
<td>03/15/16</td>
<td>Expanded list of points-of-contact for STDT questions</td>
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<td>3/15/16</td>
<td>Added Program Chief Scientists to the DSMT</td>
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<td>3/15/16</td>
<td>Replaced “Voting Members” with “Members”, and “Non Voting Members” with “Ex Officio Non Voting Members”</td>
<td>P17, 20, 23, 25</td>
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<tr>
<td>3/15/16</td>
<td>Updated the M1 milestone to be Friday 4/29, consistent throughout document</td>
<td>p42</td>
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<tr>
<td>3/15/16</td>
<td>Replaced co-chair language with “discipline lead” within the STDT</td>
<td>P22</td>
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<tr>
<td>6/15/16</td>
<td>Updated contents to reflect current order</td>
<td>2</td>
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<tr>
<td>6/15/16</td>
<td>Definition of term “Study Team”: Updated to graphically reflect same depiction of study team that is provided on page 24</td>
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<tr>
<td>6/15/16</td>
<td>Inserted new slide showing study team leadership</td>
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<td>6/15/16</td>
<td>Guiding Principles (2/4): Added ‘Lifecycle’ to cost estimating principles</td>
<td>12</td>
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<td>6/15/16</td>
<td>Removed the chart titled ‘APD Predicted Budget Profile’</td>
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<td>6/15/16</td>
<td>Guiding Principles (¾): Added ‘technologies’ to first sub bullet</td>
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<td>6/15/16</td>
<td>Relocated CML chart from Success criteria section to Guiding Principles section. Renumbered to 4/4. First statement and 2nd bullet: Added clarification language on use and tailoring.</td>
<td>14</td>
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<td>6/15/16</td>
<td>Updated Study Success Criteria to reflect more detail for M7</td>
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<td>Guidelines for International Agency Engagement: This chart relocated from the back of the package to here</td>
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<td>Study Drivers Important to Study Deliverables: Removed ‘and resource requirements’ from 2nd bullet</td>
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<td>6/15/16</td>
<td>Study Deliverables: Removed study deliverables M2 &amp; M3, and changed M5 to O3. Updated description of M4, M6, &amp; M7</td>
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<td>6/15/16</td>
<td>Pause and Learn Meetings: Added chart to list the newly added Pause and Learn meetings</td>
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<td>6/15/16</td>
<td>Changed title of slide to ‘Expected Reporting from the Teams’</td>
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<td>Roles and Responsibilities: A Team and Customer View: Added line to show study direction from the DSMT and added a line to show engagement of the science community</td>
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<td>6/15/16</td>
<td>Relocated Integrated Review Team chart to after the Program Chief Scientist, Now chart 34. Added the Integrated Review Team and members</td>
<td>34</td>
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<tr>
<td>6/15/16</td>
<td>Study Team Detail: Under Ex-Officio Non-voting members, added ‘Program’ to the APD Scientist line</td>
<td>24</td>
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<tr>
<td>6/15/16</td>
<td>Roles and Responsibilities Overview (1 of 2): Updated to provide clarification to roles and responsibilities for the STDT Community Chairs, Ex-Officio non-voting members, Program Manger, Program Chief Technologist, Program Chief Engineer. Removed Study Program Level Program Executive (APD)</td>
<td>25</td>
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<td>Roles and Responsibilities Overview (2 of 2): Updated to provide clarification on Funding Authority, Management Direction and When STDT members have questions</td>
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<td>Center Study Scientist (CSS): 2\textsuperscript{nd} bullet – Added ‘to the engineering team’ for clarification. Added 5\textsuperscript{th} bullet to clarify to whom the CSS is accountable to. Added 6\textsuperscript{th} bullet “Does not act autonomously from the STDT chairs”</td>
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<td>6/15/16</td>
<td>Center Study Manger (CSM): 3\textsuperscript{rd} bullet, 2\textsuperscript{nd} sub-bullet – Removed ‘The DSMT (programmatic, cost, schedule)’. 7\textsuperscript{th} bullet – removed ‘Provides periodic updates to Program Office and APD’. Removed 9\textsuperscript{th} bullet – ‘Responsible for Study Office’. Added last bullet – ‘Does not act autonomously from the STDT chairs’. Updated with minor edits</td>
<td>29</td>
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<td>6/15/16</td>
<td>ApD Program Scientist: Removed ‘DOES’ and ‘DOES NOT’ to match format of previous R&amp;R charts. Added first bullet – ‘Serves as a single point of contact for the STDT’. Added 6\textsuperscript{th} bullet – ‘Prepares and reports on STDT progress to DSMT regularly including a formal monthly progress reporting’. Modified 7\textsuperscript{th} bullet – ‘Does not direct the Study Team on how or what science case to include/exclude’. Added last bullet - ‘Does not act autonomously from the STDT chairs’.</td>
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<td>ApD Program Executive: Removed ‘DOES’ and ‘DOES NOT’ to match format of previous R&amp;R charts. Added first bullet – ‘Serves as a member of the DSMT’. Added 2\textsuperscript{nd} bullet – ‘Carries a programmatic responsibility for respective APD program area in relation to STDTs (e.g., PCOS: X-ray Surveyor, COR: LUVOIR and Far-IR, Exoplanet: HabEx) scientific classification’</td>
<td>31</td>
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<td>6/15/16</td>
<td>Program Office (PO) Manager: Added ‘Manager’ to title. Removed ‘DOES’ and ‘DOES NOT’ to match format of previous R&amp;R charts. Added first bullet – ‘Advises DSMT on study execution and associated programmatic issues’. Added 2\textsuperscript{nd} bullet – ‘Supports study execution as necessary by implementing ApD direction’. 3\textsuperscript{rd} bullet – removed ‘representatives of’ and added ‘directed by’. 7\textsuperscript{th} bullet – Added ‘At the direction of the DSMT, may provide’, removed ‘to APD’. 7\textsuperscript{th} bullet, removed 1\textsuperscript{st} sub-bullet – ‘CML completeness at transition points/gates’. 8\textsuperscript{th} bullet – Removed ‘APD’ added ‘DSMT’, removed ‘conducting’ added ‘facilitating’. 9\textsuperscript{th} bullet – Reworded to read ‘Coordinates with other Program Offices’. Added last bullet - ‘Does not act autonomously from the STDT chairs’</td>
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<td>6/15/16</td>
<td>Program Chief Scientist: Removed 4\textsuperscript{th} bullet ‘May serve as member with the approval of APD DD. Added last bullet - ‘Does not act autonomously from the STDT chairs’</td>
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<td>6/15</td>
<td>Removed Exoplanet Standards definition Team Chart</td>
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<td>6/15/16</td>
<td>DSMT Governance: Updated to reflect current approach. Removed ‘Key Elements’ from title. Removed 3rd bullet under Objectives. Insight and Oversight Tools, Mechanisms Section: Removed 2nd, 3rd, 4th, 5th bullets from. Added bullet – ‘APD PS will provide monthly report on STDT’s progress to the ApD DD’. Removed ‘TBC’ 7th bullet. Added 8th bullet - ‘Awareness of each STDT key events’. Removed ‘Governance Guidance provided on these timescales by these Governance Bodies’ and all associated sub-bullets. Now page 40 in rev B</td>
<td>37</td>
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<tr>
<td>6/15/16</td>
<td>Title Changed to ‘Overall Study Coordinators’. Modified 1st bullet to read ‘Provide overarching coordination of the policies and practices of the individual study teams and the communications between the DSMT, PS’s and the study teams’. Changed 2nd bullet to read ‘Represents ApD Director/Deputy Director’. Modified 3rd bullet to read ‘Objectives: 1. ApD coordination with the study Program Scientists through the DSMT; 2. Stay informed about Study Teams’ progress towards milestones established in this Management Plan; 3. Assist and represent the ApD Management as needed’. Specific tasks Section: Removed 1st sub-bullet. Modified 2nd sub bullet to read: ‘Receive and review the monthly, reports from the APD PS’s and summarize for the ApD Management’.</td>
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<td>ApD Staff Involvement: Removed ‘Governance of Decadal Studies’ from title and replaced with ApD Staff Involvement. Removed Center Program Office column, Changed Study Center column title to ‘Center Study Office Location’, combined Mission Concept Coordinator and Overall Study Coordination Columns.</td>
<td>39</td>
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<td>6/15/16</td>
<td>Implementation of Decadal Studies: Removed Program Office Column, Changed Center Program Office column title to ‘Center Study Location’</td>
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<td>6/15/16</td>
<td>Program Office Involvement: Removed ‘Implementation of Decadal Studies from Title and replaced with Program Office Involvement. Updated with correct names.</td>
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<td>6/15/16</td>
<td>Deleted e-mail contact chart</td>
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<td>6/15/16</td>
<td>Removed Governance Structure Lines of Authority, Communication chart</td>
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## Change Log

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<tbody>
<tr>
<td>6/15/16</td>
<td>Funding Guidelines: deleted all bullets, added ‘The funding profile for each team will be provided individually to each team by summer 2016’</td>
<td>42</td>
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<tr>
<td>6/15/16</td>
<td>Removed near term schedule chart</td>
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<td>6/15/16</td>
<td>Applicable Metrics (all charts): Added ‘and can be further tailored by the study teams based on their approach’ to asterisk at top of chart</td>
<td>48-52</td>
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<tr>
<td>6/15/16</td>
<td>Added chart titled ‘Working Version of Consensus’</td>
<td>53</td>
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<tr>
<td>6/15/16</td>
<td>Added chart titled ‘How are CML assessed at M3,M4, M6</td>
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<td>12/18/17</td>
<td>X-ray Surveyor - Center Study Manager name corrected</td>
<td>10, 40</td>
<td>C</td>
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<td>12/18/17</td>
<td>Schedule drivers chart deleted</td>
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<td>12/18/17</td>
<td>Study deliverables schedule updated</td>
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<tr>
<td>12/18/17</td>
<td>Added Final report review process and schedule</td>
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<td>C</td>
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<tr>
<td>12/18/17</td>
<td>Additional Pause and Learn dates added</td>
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<tr>
<td>12/18/17</td>
<td>Added Large Mission Concept Studies Report Team Description</td>
<td>34</td>
<td>C</td>
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<tr>
<td>12/18/17</td>
<td>Overall study coordinator name updated</td>
<td>36, 39</td>
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<tr>
<td>02/26/18</td>
<td>Replaced CATE with Independent Cost Assessment (ICA)</td>
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• Guiding Principles
• Study Success Criteria
• Study Deliverables
  – Interim Deliverables
  – Final deliverables
• Guidelines for International Engagement
• Governance Approach
  – Roles and Responsibilities
  – Lines of Authority, Communications
  – Oversight/Insight Mechanisms
• Study Phase Funding Process
Plan Objectives: Defining the Why, What, When, and How

1. **WHY:** Establish specific and measurable requirements so that
   a) The Study Teams can
      1. Establish concept status at starting point
      2. Understand the success criteria for each milestone
      3. Produce the appropriate products for the Decadal Survey Committee
   b) APD / Program Offices can
      1. Assess and negotiate the resource requirements
      2. Monitor the study progress against specific metrics
      3. Guide the Study Teams in the depth & breadth of the study

d) Set community expectations

3. **WHEN:** Define due dates for study deliverables that
   a) Are consistent with programmatic needs
   b) Provide the necessary time for the Study Teams to achieve the objectives
   c) Are enabled by the near-term schedule

4. **HOW:**
   a. Establish the governance guidelines and approach so that
      1. Lines of authority, roles, responsibilities, and customer relationships, are clearly defined
      2. Lines of communications are clear
   b. Agree on the study funding approach that
      1. Is consistent with the current budget set aside for these activities
      2. Allocates resources according to the individual study plans
   c. Plan the execution of the study and determine resources for each milestone

2. **WHAT:** Define final & interim deliverables that
   a) Are clear, reasonable and valuable to stakeholders and Study Teams
   b) Provide quantitative measure of progress
   c) Meet the programmatic needs of APD
Definition of term: “Study Team”

Study Team
- Union of STDT and Study Office
- STDT and Study Office work together as one team for success of Study
- Each has distinct and complementary roles within the Study Team

Observers
- Welcome and not part of Study Team per se
- Attendance is optional or on-call
## Study Team Leadership

<table>
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<tr>
<th>Far IR Surveyor</th>
<th>Community STDT Chairs</th>
<th>Center Study Team</th>
<th>Study Lead Center</th>
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<tr>
<td></td>
<td>Asantha Cooray</td>
<td>David Leisawitz Ruth Carter</td>
<td>GSFC</td>
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<td>Margaret Meixner</td>
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<td>Habitable Exoplanet Imaging</td>
<td>Scott Gaudi</td>
<td>Bertrand Mennesson Keith Warfield</td>
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<td>Large UV/Optical/IR Surveyor</td>
<td>Debra Fischer</td>
<td>Aki Roberge Julie Crooke</td>
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<td>X-ray Surveyor</td>
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<td>Jessica Gaskin Karen Gelmis</td>
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<td>Alexey Vikhlinin</td>
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Guiding Principles (1/4)

• **APD Decadal Success Criteria:**
  – APD defines "full success" as delivery to the Decadal Survey Committee of compelling and executable concepts for all four large missions so that science can be adequately prioritized by the Decadal Committee.
  – Executable is defined as *feasible* with respect to technical, cost, and risk resources outlined in the Study Report

• **Study Teams are not in competition with one another**
  – Study Teams are making the best case – within fuzziness of boundary conditions – for science and mission concepts that enable science
  – Study Teams (especially leadership) are encouraged to create a collaborative environment that allows for each team to promote their concept and to acknowledge (and not undermine) the other concepts
  – Study Teams are encouraged to share or combine technical areas or observing strategies

• **This is not an Announcement of Opportunity**
  – Do not expect AO-like, crisp rules and guidelines
  – A goal of the Study Team should be to define a reference mission that accomplishes a certain level of scientific discovery
Guiding Principles (2/4)

- **Cost Estimating Principles**
  - Perform costing as necessary to drive design trades that inform science capabilities, priorities
  - Perform engineering as necessary for parametric costing, not solely for the purpose of more accurate costing
  - Explore a range of architectures to understand the relative relationship of cost, risk and science for the concepts
  - Present implementation strategies as “reference missions” – credible hardware configurations that can achieve the science goals and are sufficiently defined for a reasonable cost evaluation
  - Recognize that any actual mission is likely to vary from the study concept

- **There isn’t a cost cap on mission costs**
  - Study Teams should address the “mission cost vs. science capability”
  - Consider the sweet spot factoring in science, technology, cost, and risk
  - Parametric results for key scientific performance are highly desirable
  - Teams may consider other budget profiles to explore additional opportunities

- **Study teams should engage industry in such a manner that it preserves mission study participants’ ability to respond to potential future solicitations related to mission development work**
Guiding Principles (3/4)

• Technology Development Principles
  – The Technology Readiness Levels (TRL) of enabling technologies at the time of Decadal submittal will be one factor important to the Decadal Survey Committee and independent cost/risk assessment

  – Of equal or greater importance will be the credibility of the technology roadmap that shows
    o How TRL5 will be achieved by KDP-B (SMD Handbook¹)
    o How TRL6 will be achieved by PDR (NASA policy²)
    o Description of technology funding and timeline required to achieve TRL5

  – Reference to TRL Definitions used for the Large Decadal Mission Studies: http://nepis3.gsfc.nasa.gov/npg_img/N_PR_7123_001B_/N_PR_7123_001B_.pdf

¹ Defined in NPR 7123.1B, NASA Systems Engineering Processes and Requirements
² According to NPR 7120.5e
Concept Maturity Level (CML) can be used by the teams to guide their mission concept development.

**What is Concept Maturity Level (CML):**

- CML is a classification scheme for characterizing the various levels of a concept’s maturity. The key strength of CML is the ability to evolve mission concepts guided by an incremental set of assessment needs. This process gauges a study conduction through measurable and deliverable milestones which helps to evaluate and manage the products during a given timeline.

- Defined in the detailed table in backup charts. The study teams are encouraged to further tailor the CML 4 requirements to best fit their final design reference mission (DRM) and available resources.

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* Space Mission Concept Development using Concept Maturity Levels, Randii Wessen, Chester S. Borden, John K. Ziemer, Robert C. Moeller, Joan Ervin, and Jared Lang, AIAA SPACE 2013 Conference and Exposition. September

The final study deliverable shall include:

- *Science case for the mission*
- *Mission and observatory performance requirements that deliver these science capabilities*
- *Design reference mission, including straw-man payload trade studies conducted to arrive at the final mission concept*
- *Technology assessment:*
  - *Current status, at the time of submittal of the final report*
  - *Roadmap for maturation to both TRL-5 by the start of Phase-A and TRL-6 by the mission PDR*
  - *Phased resources needed to achieve the required technology maturity levels by the start of Phase A and by mission PDR*
- *Cost assessment, major technical, and risk burn-down plans as a function of science capability.*
- *Top-level schedule for major phases of development including a notional launch date (assuming entering phase-A as a post-WFIRST budget wedge opens) and top schedule risks.*
Guidelines for International Agency Engagement

- NASA welcomes international participation in the upcoming Decadal Studies as well as in the implementation of the mission(s) prioritized by the Decadal.
- NASA (APD DD) invites representatives from international agencies to engage in the decadal study teams
- Study teams are encouraged to engage with their international counterparts to inform them of this opportunity
- To be a member of the Study Team, the international member needs to be formally endorsed by their respective government agency
  - International partners will be subject to the International Traffic in Arms Regulations (ITAR)
- Interested international individuals are free to attend all open meetings of the study teams, as an observer, in accordance with export regulations
- NASA does not provide funding for any international participants; instead, this funding comes through the home institution
What, When:

Deliverables and Schedule
Study Deliverables

M1 Comments on Study Requirements and Deliverables
   – Accept the study requirements/deliverables and submit plan--- or
   – Provide rationale for modifying requirements/deliverables

O1 Optional: Initial Technology Gap Assessment
   – To impact PCOS/COR/ExEP 2016 technology cycle

O2 Optional: Update Technology Gap Assessments

M4 Interim Report
   – Provide science case and mission concept (use CML 3 as a guide)
   – Deliver initial technology roadmaps; estimate technology development cost/schedule
   – CML 4 tailored approach (optional)

O3 Update Technology Gap Assessments

M6 Draft Final Report at Concept Maturity Level 4 Audit / Freeze Point Design
   – Provide science case and mission concept (use CML4 as a guide)
   – Support independent cost estimation/validation process
   – Submit to HQ for Independent Cost Assessment (ICA)

M6’ ICA report returned by HQ to STDTs for incorporation into M7

M7 Final Report / incorporate ICA report + final changes
   – As described in study success criteria chart 15

M8 HQ Submits final report to Decadal

*Note: Schedule relaxed from original by ~4 months due to decadal committee schedule delay
Delivery Schedule for Final Report

M6 + MEL provided to HQ and STDTs

ICA performed by Aerospace

~ 01/2019

ICAs’ sent by HQ to STDTs

HQ receives M6’ (ICAs) and sends to STDT

~ 05/2019

Completed ICAs

STDTs works on M7

HQ Review of M7

~ 06/2019

Delivery of M7

~ 7/2019

Final Report M8 / Submit to Decadal

1 month to finalize report / clarify w/ STDT and generate submittal letters

* ICA - Independent Cost Assessment
Pause and Learn Meetings

• Periodic Pause and Learn activities will be held for all teams to participate
  – Teams will provide status updates and opportunities for information exchange across the teams
  – Participants will be the Study Team Leadership (Chairs, Center Study Manager, and Center Study Scientist), the DSMT and the APD Division Director.
  – Schedule:
    o October 2016
    o April 2017
    o October 2017
    o June 2018
    o December 2018
    o June 2019
Reporting from the Teams

• STDT Community Chairs will present at each Winter meeting of the American Astronomical Society (2017, 2018, 2019)
  – Either special session or at PAG meeting
• STDT Community Chairs should assume periodic presentations to National Committee Meetings at the request of Committee Chairs (e.g. APS, CAA, AAAC). An estimate of ~4 per year can be used for planning purposes
• STDT Community Chairs will present to the Decadal Survey Committee and be prepared for follow-up questions (as needed) during 2019. The schedule for 2019 will be further clarified when the Decadal Survey Committee is chartered in early 2018
• Study Team Leadership to meet semi-annually to cross-coordinate studies with APD, through Pause & Learn sessions
• Interim and Final reports include a briefing to APD before public release
• Study Deliverables listed on page 19 are briefed to APD Decadal Studies Management Team (defined on page 36) with the Integrated Review Team (defined on page 34) present to provide technical and programmatic analysis
• HQ Program Scientists (PS’s) will be included in routine Study team meetings, therefore regular formal reporting is not required.
  – The PS’s will provide a status report to the APD DD on a monthly basis.
How:

Roles and Responsibilities

Lines of Communication

Governance Approach
Roles and Responsibilities: A Team and Customer View

**Roles and Responsibilities:**

- **STDT** (Study Team)
  - Study Products
  - Design Trade and Analysis Direction
  - Engagement

- **Study Office**
  - Design Products

- **Decadal Studies Management Team** (APD DD)
  - Study Direction
  - Integrated Review Team

- **Observers**

**Legend:**
- Arrow points to Customer
- External Science Community
Members
- Appointed from community by ApD DD
- Appointed from Centers and PO by ApD DD

Ex-Officio Non-voting Members
- Appointed by ApD DD virtue of office
- Not participate in deliberations

Observers
- Welcome and not part of Study Team per se

Examples
- Members of community and NASA Centers
- Center Study Scientists

- ApD Program Scientists
- Program Office Chief Scientists
- Representatives of International Partners

- Mission Concept Coordinator (ApD)
- Program Office Manager
- Program Office Chief Technologist
- Program Office Chief Engineer
Roles and Responsibilities Overview
(1 of 2, detail pages follow)

STDT

• **STDT Community Chairs**
  – Members of the non-NASA science community
  – Lead the STDT
  – Provide design trade and analysis direction, in consultation with the STDT, to the Study Office
  – Ultimate responsibility for interim and final products
  – Responsible for progress briefings to ApD, national committees
  – ApD DD and Community Chairs may appoint discipline leads as needed (co-chairs will have an area of responsibility within the overall study)

• **STDT Members**
  – Appointed by ApD DD
  – Include members of community and of NASA Centers
  – **Center Study Scientist (CSS)**
    o Interfaces to Study Office and Center engineering teams

• **STDT Ex-Officio non-voting members**
  – **ApD Program Scientist (APD PS)**
    o Supports and liaises “up-and-out” with emphasis on science objectives to ApD, NASA stakeholders and Reports to DSMT on study progress
    o Represents ApD at the Study Team meetings
  – **Program Office Chief Scientist (PCS)**
    o Represents PM in insight/oversight of the study progress

STUDY OFFICE

• **Center Study Manager (of Study Office)**
  – Supports STDT. The STDT is the customer of the Study Office
  – Leads the engineering team
  – Responsible for developing an implementable DRM meeting the science objectives

OBSERVERS

• **Program Office (PO) Manager**
  – Supports ApD technical insight/oversight of the Study Teams
  – Provides input/advice on study team management; implements HQ actions as directed
  – More detail page 32

• **Program Office Chief Technologist**
  – Represents Agency technology plans and progress to STDT and Study Office
  – Performs STDT technology oversight
  – Represents study technology needs to Agency
  – Integrates technology requirements into the SAT process

• **Program Office Chief Engineer**
  – Performs STDT engineering oversight
  – Available as PO engineering resource to Study Teams
  – Represents study cost estimates to ApD
  – Assess CML fidelity and readiness for Integrated Review Team
• **Technical direction**
  – To Study Office comes from STDT Community Chair

• **Trade decisions**
  – Options assessed and recommended by Study Office
  – Choice made by STDT Community Chair

• **Funding authority**
  – Provided to Study Offices by the NASA HQ Astrophysics Division (ApD)

• **Management direction**
  – Provided by the Decadal Survey Management Team (DSMT)
  – Implemented by Program Offices upon direction from ApD.

• **When STDT members have questions:**
  – First point of contact will be the STDT Community Chairs
  – Next POC will be the Center Study Scientist and the Center Study Manager
  – After that, questions should go to ApD Program Scientist who will bring the question to the DSMT for guidance and consistency of direction.
  – *Note:* Programmatic questions (cost, schedule, governance per this Management Plan) should be directed to the DSMT via the Program Scientist.
STDT Community Chairs

- Leads the STDT in defining the science case
- Members of science community
- Ensures that the science case is a community driven process
- Are the community advocates for this reference mission
- May appoint discipline leads from within the STDT as needed
- May utilize the Program Analysis Group (PAG) infrastructure to obtain community input and provide status to the community
  - Science Analysis Groups (SAGs)
  - Science Interest Groups (SIGs)
Center Study Scientist (CSS)

• Appointed member of STDT
• Represents STDT to the engineering team in its day to day activities
  – Engineering and science tradeoffs, etc.
• Provides guidance to the STDT regarding NASA processes
• Provides guidance to the STDT regarding the practicality of implementing science objectives
• Accountable to:
  • The STDT chair (technical direction)
  • Center Study Manager
• Does not act autonomously from the STDT chairs
Center Study Manager (CSM)

- Leads the Study Office (engineering team)
- Supports the STDT; the STDT is the customer of the Study Office.
- Accountable to the STDT chair (technical direction)
- Responsible for developing an implementable Design Reference Mission (DRM) meeting the science objectives
- Obtains the necessary technical & administrative resources from the NASA Center
- Obtains Center approval/reviews of the deliverable milestones prior to delivery
- Responsible for cost estimates and inputs to independent cost estimates
- Through Study Office staff, is responsible for Study Team logistics: websites, document postings, mailing lists, processing affiliate travel, contracts, export compliance guidelines, budget, schedule, etc.
- Does not act autonomously from the STDT chairs
ApD Program Scientist

Represent ApD science interests at the STDT meetings

• Serves as a single point of contact for the STDT
• Serves as a resource to the STDT in providing clarification of STDT charter
• Provide “big picture guidance” to the STDT
• Serves as conduit of information exchange between STDT, APD, DSMT and science community
• Serves as appointed ex-officio non-voting members of STDT
• Prepares and reports on STDT progress to DSMT regularly, including a formal monthly progress reporting
• Does not direct the Study Team on how or what science case to include/exclude
• Does not act autonomously from the DSMT in managing the study teams or the conduct of the studies.
ApD Program Executive

- Serves as a member of the DSMT
- Carries a programmatic responsibility for respective ApD program area in relation to STDTs (e.g., PCOS: X-ray Surveyor, COR: LUVOIR and Far-IR, Exoplanet: HabEx) scientific classification
- Represents ApD programmatic interests at the Study Team meetings
- Supports the Study Teams in developing international partnerships, as needed
- Serves as Observer/Resource to Study Team
- Does not direct the engineering team on how or what architectures to develop
Program Office (PO) Manager

- Advises DSMT on study execution and associated programmatic issues
- Supports study execution as necessary by implementing ApD direction
- Provides programmatic (cost, approach) guidance to Study Teams as directed by ApD
- Facilitates synergy between all mission studies
- Provides progress/status of Strategic Astrophysics Technology (SAT) driven technologies to the Study Teams
- Supports the Study Teams in developing industrial partnerships
- At the direction of the DSMT, may provide independent assessment of all study deliverables
  - Thoroughness of the technology roadmap
  - Thoroughness of the systems engineering and trades
  - Study resource requirements
- Supports DSMT in facilitating independent cost estimates of mission concepts
- Coordinates with other program offices
- Does not direct the engineering team on how or what architectures to develop
- Does not act autonomously from the DSMT in managing the study teams or the conduct of the studies.
The Program Office Chief Scientist represents the Program Offices at the Study Team meetings

- Supports the program manager in the insight/oversight activities
- Supports the ApD scientists in communication with the community
- Facilitates interaction between STDT and PAGs, as needed
- Does not direct (impose upon) the STDT on how or what science case to include/exclude
- Does not act autonomously from the DSMT in managing the study teams or the conduct of the studies.
A single team will review the M4 deliverable of all Study Teams

The purposes are to assess:

A. Completeness with respect to the M4 deliverable scope
B. Whether the STDTs are on the right track for delivering the final report

The charter of the LRT is documented here (https://science.nasa.gov/astrophysics/2020-decadal-survey-planning)

The LRT will provide a short written report for each study, and provide an individual out-brief to each STDT and a common out-brief to all STDT leadership at a future Pause-and-Learn

Makeup of the LRT (10-11 people) will be:
- Internal Subject Matter Experts, drawn from the Program Engineering Offices of PCOS/COR at GSFC and of ExEP at JPL;
- External Subject Matter Experts, drawn from those in the community not directly involved in the studies or the program offices
- The Aerospace Corporation
Roles and Responsibilities: A Team and Customer View

Legend:
- Arrow points To Customer

STDT (Study Team)
- Design Products
- Study Direction
- Integrated Review Team
- Study Products
- Study Direction
- Analysis

External Science Community
- Engagement

Center Study Office
- Design Trade and Analysis Direction

APD DD (Decadal Studies Management Team)

Observers
Decadal Studies Management Team (DSMT) Structure

Provided by standing leadership team reporting to ApD Deputy Division Director (14 members)

- **Participating Principles:**
  - Chair: Andrea Razzaghi
  - Overall Study Coordination: S.Habib (PE), R. Sambruna (PS)
  - ApD Program Executives: S. Habib (PCOS and COR), J. Gagosian (Exoplanet)
  - ApD Program Scientists: D. Evans (X-Ray Surveyor), K. Sheth (Far-IR), M. Perez (LUVOIR), M. Still (HabEx)
  - Program Office Managers: Mansoor Ahmed, G. Blackwood

**Function:**

- Provides agile, consistent, transparent guidance to the Study Teams; avenue of dissemination of this guidance (e.g. by PS, PO or DSMT) will be determined by the DSMT chair or delegate, as appropriate
- Recipient of STDT formal deliverables
- **For each study milestone deliverable, specific delivery instructions will be provided.** At a minimum, all study milestone deliverables will be sent to the ApD Deputy Director, designated as the ApD Overall Study Lead, Andrea Razzaghi, andrea.i.razzaghi@nasa.gov.
DSMT Governance

• **Objectives:**
  – Ensure the studies will produce the required deliverables on time
  – Ensure studies are adhering to the guidelines
  – Resolve questions in a consistent, transparent way
  – Provide synergy within the concepts to the extent practicable
    o Promote communications and coordination between studies

• **Insight & Oversight Tools, Mechanisms:**
  – Attendance at telecons and STDT meetings (as needed)
  – The ApD PS will provide monthly report on STDTs progress to ApD DD
  – Quarterly tag up telecon of all 4 study leadership with ApD Decadal Studies Management Team
  – Awareness of each STDT key events
  – Review of study milestone deliverables
Overall Study Coordinators

• Provide: overarching coordination of the policies and practices of the individual study teams and the communications between the DSMT, PS’s and the study teams.
• Represents ApD Director/Deputy Director
• Objectives: 1. ApD coordination with the study Program Scientists through the DSMT; 2. Stay informed about Study Teams’ progress towards milestones established in this Management Plan; 3. Assist and represent the ApD Management as needed
• Specific tasks:
  - Receive and review the monthly reports from the PS’s and summarize for ApD Management
  - Remain cognizant of the science content of the STDTs and synergies across STDTs and summarize for ApD Management
  - Facilitate interactions between the STDTs, advisory committees, and with ApD Management
  - Assist the ApD Director with reporting to advisory committees and the community (slides preparation, written reports, etc.)
  - Document entire process & write Lessons-Learned and Best Practices report
## ApD Staff Involvement

Overall Study Lead is the ApD Deputy Director, Andrea Razzaghi

<table>
<thead>
<tr>
<th>Study</th>
<th>Center Study Office Location</th>
<th>Program Scientists</th>
<th>Program Executives</th>
<th>Overall Study Coordination</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-Ray Surveyor</td>
<td>MSFC</td>
<td>Dan Evans</td>
<td></td>
<td>Shahid Habib</td>
</tr>
<tr>
<td>Large UV Optical and IR Surveyor</td>
<td>GSFC</td>
<td>Mario Perez</td>
<td>Shahid Habib</td>
<td>Shahid Habib</td>
</tr>
<tr>
<td>FAR IR Surveyor</td>
<td>GSFC</td>
<td>Kartik Sheth</td>
<td>Rita Sambruna</td>
<td></td>
</tr>
<tr>
<td>Habitable ExoPlanet Imaging Mission</td>
<td>JPL</td>
<td>Martin Still</td>
<td>John Gagosian</td>
<td></td>
</tr>
</tbody>
</table>
# Implementation of Decadal Studies

**NASA Center participation**

<table>
<thead>
<tr>
<th>Study</th>
<th>Center Study Office Location</th>
<th>Center Study Scientist</th>
<th>Study Office Manager</th>
<th>Center Line Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-Ray Surveyor</td>
<td>MSFC</td>
<td>Jessica Gaskin</td>
<td>Karen Gelmis</td>
<td>Martin Weisskopf</td>
</tr>
<tr>
<td>Large UV Optical and IR Surveyor</td>
<td>GSFC</td>
<td>Aki Roberge</td>
<td>Julie Crooke</td>
<td>Mark Clampin</td>
</tr>
<tr>
<td>FAR IR Surveyor</td>
<td>GSFC</td>
<td>Dave Leisawitz</td>
<td>Ruth Carter</td>
<td>Mark Clampin</td>
</tr>
<tr>
<td>Habitable ExoPlanet Imaging Mission</td>
<td>JPL</td>
<td>Bertrand Mennesson</td>
<td>Keith Warfield</td>
<td>Jeff Booth</td>
</tr>
</tbody>
</table>
## Program Office Involvement

<table>
<thead>
<tr>
<th>Program Office</th>
<th>Program Office Center</th>
<th>Program Manager / Deputy</th>
<th>Program Chief Scientist / Deputy</th>
<th>Program Chief Engineer</th>
<th>Program Chief Technologist</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCOS</td>
<td>GSFC</td>
<td>Mansoor Ahmed</td>
<td>Ann Hornschemeier / Peter Bertone</td>
<td>Gabe Karpati</td>
<td>Harley Thronson</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bruce T. Pham</td>
</tr>
<tr>
<td>COR</td>
<td>GSFC</td>
<td>Gary Blackwood / Kendra Short</td>
<td>Karl Stapelfeldt / TBD</td>
<td>Kendra Short (acting for K. Warfield)</td>
<td>Nick Siegler</td>
</tr>
<tr>
<td>ExEP</td>
<td>JPL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Funding Guidelines

- The funding profile for each team will be provided individually to each team by summer 2016
Backup
Acronyms

- APD  Astrophysics Division
- CML  Concept Maturity Level
- COR  Cosmic Origins
- CSM  Center Study Manager
- CSS  Center Study Scientist
- DD   Division Director
- DDD  Deputy Division Director
- DRM  Design Reference Mission
- DS   Decadal Survey
- ExEP Exoplanet Exploration Program
- KDP  Key Decision Point
- LCC  Lifecycle Costs
- LL&BP Lessons Learned and Best Practices
- MCC  Mission Concept Coordinator
- MEL  Master Equipment List
- PAG  Program Analysis Group
- PCS  Program Chief Scientist
- PCOS Physics of the Cosmos
- PDR  Preliminary Design Review
- PO   Program Office
- RFI  Request for Information
- RFP  Request for Proposal
- SAG  Science Analysis Group
- SAT  Strategic Astrophysics Technology
- SIG  Science Interest Group
- SMD  Science Mission Directorate
- STDT Science and Technology Definition Team
- TBC  To Be Confirmed
- TRL  Technology Readiness Level
## Document Change Log

<table>
<thead>
<tr>
<th>Cover Date</th>
<th>Change</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/28/2015</td>
<td>Initial Release</td>
<td></td>
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Backup: “Decadal CML”

Decadal CML = Tailored CML4
*All columns tailored for Decadal, and can be further tailored by the study teams based on their approach*

<table>
<thead>
<tr>
<th>Attribute</th>
<th>CML 2*</th>
<th>CML 3*</th>
<th>CML 4*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific Objectives and System Requirements</td>
<td>Objectives described to levels that allow comparison with previous investigations and NASA science community documents</td>
<td>Objective linked to investigation and measurements</td>
<td>Working top-level scientific requirements drafted, linkages to scientific objectives identified and described</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scientific return as a function of cost, risk, and programmatics quantified</td>
<td>Design reference scientific investigation defined with viable reduction options identified</td>
</tr>
<tr>
<td>Science Data System</td>
<td>Identify science data drivers</td>
<td>Science data rates and volume included in trade space analysis</td>
<td>Design reference science data system sized to support data system flowdown requirements</td>
</tr>
<tr>
<td>Mission Development</td>
<td>Key mission concept parameters and performance requirements quantified</td>
<td>Alternative set of mission architectures evaluated against science objectives, cost &amp; risk Quantitatively bounded hazards of space environment</td>
<td>Design reference mission defined, including driving requirements, initial high-level scenarios, timelines and operational modes; mass, delta-V, and power estimates; telecom, and data processing approach defined to mission flowdown requirements</td>
</tr>
<tr>
<td>Spacecraft System Design</td>
<td>Key flight elements, design parameters &amp; performance requirements listed</td>
<td>Unique features that distinguish one flight system architecture from another evaluated Perform sensitivity studies to bound performance within trade space performed</td>
<td>Spacecraft system architecture for design reference mission defined with mechanical configuration drawings and block diagrams to support spacecraft flowdown requirements</td>
</tr>
</tbody>
</table>
### Applicable Metrics (2 of 5)

*All columns tailored for Decadal, and can be further tailored by the study teams based on their approach*

<table>
<thead>
<tr>
<th>Attribute</th>
<th>CML 2*</th>
<th>CML 3*</th>
<th>CML 4*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instrument System Design</td>
<td>One sentence description of potential measurement technique(s)</td>
<td>Key instrument performance requirements, measurement techniques and instruments selected against science / mission objectives, cost &amp; risk</td>
<td>Instrument system architecture for design reference mission defined with mechanical configuration drawings and block diagrams to support instrument flowdown requirements and performance simulations</td>
</tr>
<tr>
<td></td>
<td>Perform high-level comparison to similar measurement technique(s)</td>
<td>Sensitivity studies to bound performance within trade space performed</td>
<td>Instrument performance requirements traced to scientific requirements</td>
</tr>
<tr>
<td>Ground System / Mission</td>
<td>Mission ops approaches defined</td>
<td>Mission ops drivers and sensitivities assessed</td>
<td>Mission Operations System / Ground Data System architecture for design reference mission to support the ops scenarios described</td>
</tr>
<tr>
<td>Operations System Design</td>
<td></td>
<td>Major flight / ground trades identified</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>New ground system capabilities identified</td>
<td></td>
</tr>
<tr>
<td>Technical Risk Assessment &amp;</td>
<td>Identify risks</td>
<td>Compare risks across the various architectures</td>
<td>Risk drivers listed</td>
</tr>
<tr>
<td>Management</td>
<td>Identify areas of major concerns</td>
<td>Identify mitigation strategies for key risks</td>
<td>5x5 matrix provided with relevant risk drivers (include selected mitigation / development options)</td>
</tr>
<tr>
<td>Technology</td>
<td>Identify enabling technologies and / or significant engineering developments required to get to TRL 6 by PDR</td>
<td>Compare technologies and major developments required for design options across the trade space</td>
<td>Technology options described</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Baseline options selected and justified (technology roadmap)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rationale for TRL(s) explained</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Risk mitigations (including fallback options, if any) for all new technologies identified</td>
</tr>
</tbody>
</table>
### Applicable Metrics (3 of 5)

*All columns tailored for Decadal, and can be further tailored by the study teams based on their approach*

<table>
<thead>
<tr>
<th>Attribute</th>
<th>CML 2*</th>
<th>CML 3*</th>
<th>CML 4*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inheritance</td>
<td>Identify source of assumed inheritance</td>
<td>Early evaluation of inheritance options, benefits, and risks across trade space</td>
<td>Discuss all significant heritage assets used by the design reference mission</td>
</tr>
<tr>
<td>Master Equipment Lists</td>
<td>N/A</td>
<td>Mass of major elements quantified based on subsystem estimates</td>
<td>MEL documented for design reference mission to assembly level (e.g., antenna, propellant tank, star tracker, etc.)</td>
</tr>
<tr>
<td>Technical Margins</td>
<td>Identify high risk areas that need significant margin</td>
<td>Use institutional margins where applicable</td>
<td>Critical performance margins estimated, resource margin estimated for design reference mission (AIAA S-120 margin policies followed )</td>
</tr>
<tr>
<td></td>
<td>Assess uncertainty</td>
<td>Analyze best and worst case scenarios</td>
<td></td>
</tr>
<tr>
<td>System Engineering</td>
<td>Initial generation of trade space options</td>
<td>Capture the relative merits of performance, cost and technical risk over a broad range of architectures</td>
<td>Selective, high-leverage science, spacecraft, and ground system trades completed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subsystem dependencies identified</td>
<td></td>
</tr>
<tr>
<td>Launch Services</td>
<td>Launch approach and performance identified</td>
<td>Perform trades for candidate launch vehicles demonstrating compatibility with performance and fairing size</td>
<td>Preliminary launch vehicle(s) selection documented (NASA Launch Services used)</td>
</tr>
</tbody>
</table>

*Applicable Metrics (3 of 5)*

*All columns tailored for Decadal, and can be further tailored by the study teams based on their approach*
### Applicable Metrics (4 of 5)

*All columns tailored for Decadal, and can be further tailored by the study teams based on their approach*

<table>
<thead>
<tr>
<th>Attribute</th>
<th>CML 2*</th>
<th>CML 3*</th>
<th>CML 4*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verification &amp; Validation</td>
<td>N/A</td>
<td>Identify any major or unique V&amp;V activities</td>
<td>Approach for verifying new and enabling functions of the design reference mission defined to support an acceptable risk assessment by independent reviewers System testbeds and prototype models identified where applicable</td>
</tr>
<tr>
<td>Acquisition &amp; Surveillance</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Project Organization, Implementation Mode &amp; Partnering</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Schedules</td>
<td>Potential launch opportunities identified Use Schedule &amp; Cost Rules-of-Thumb to estimate lifecycle duration</td>
<td>Assess variations and risks to science, development schedule and impacts to mission duration</td>
<td>Top-level schedule (one page) developed for design reference mission to support (coarse) independent cost estimates</td>
</tr>
</tbody>
</table>

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## Applicable Metrics (5 of 5)

*All columns tailored for Decadal, and can be further tailored by the study teams based on their approach*

<table>
<thead>
<tr>
<th>Attribute</th>
<th>CML 2*</th>
<th>CML 3*</th>
<th>CML 4*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Breakdown Structure</td>
<td>N/A</td>
<td>NASA Standard WBS &amp; Dictionary (down to level 2 and level 3 for spacecraft and payload) used</td>
<td>N/A</td>
</tr>
<tr>
<td>Cost Estimation and Cost Risk</td>
<td>Cost estimate range provided based on analogous missions Cost uncertainty quantified</td>
<td>Cost sensitivities explored across trade space as a function of major drivers Initial estimate down to level 2 and level 3 for spacecraft and payload Cost uncertainty quantified System cost risks identified</td>
<td>Cost estimate and basis of estimate provided for design reference mission Cost uncertainty quantified Cost risks identified at subsystem level, with emphasis on enabling technologies</td>
</tr>
<tr>
<td>NEPA Compliance</td>
<td>Identify any nuclear material or public safety issues</td>
<td>Explore options (e.g., non-nuclear options for nuclear power missions)</td>
<td>N/A</td>
</tr>
<tr>
<td>Export Compliance</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Working version of Consensus (yes, NASA has a policy)

• In general, consensus decisions can produce stronger and more durable decisions than those by votes or decree.
• However, convergence time can be a factor in consensus decisions – they take too long or do not converge.
• Instead, we suggest (but do not require) a Constrained Consensus method: defined as preferring and striving for consensus in the reasonable time available, else, the leaders make a decision, dissent (if any) is captured and the groups moves on with full support of the decision.
• Will follow 7120.5E, Ch 3.4, “Process for Handling Dissenting Opinion”
  o Three options: (1) Agree, (2) Disagree but fully support the decision, (3) Disagree and raise a dissenting opinion
• Treat (1) and (2) as consensus for STDT
• Dissents (3) will be documented and delivered to senior NASA management (APD DD) per 7120.5E
How are CML Assessed at M3,4,6

• The program chief engineer, as a member of the program office, may provide, if requested by the study teams, the CML assessment and presents that first to the Integrated Review Team for concurrence, and then to the DSMT for acceptance.

• The CML assessment is essentially a compliance assessment, based on professional experience, of each row of the CML table.

• We expect a set of conversations between the chief engineer and the study team to inform the assessment. Update MP to add these words.