

Process to Create and Maintain NASA's Aero-Space Technology Area Roadmap (A-STAR)

Purpose: This document outlines the process that the Office of the Chief Technologist (OCT) will use to create and maintain a NASA integrated technology roadmap.

Definition: The Aero-Space Technology Area Roadmap (A-STAR) is defined as a set of approximately 15 *technology area roadmaps*, accompanied by an overarching *integrated technology roadmap*. Together, these A-STAR products provide recommendations regarding the identity and prioritization of the primary and alternative technology pathways needed to meet NASA Strategic Goals, Outcomes and Objectives, as well as National needs. Prioritization across NASA's technology investment portfolio will balance technology development risks against the advantages of alternate technology pathways. The final A-STAR deliverables will provide high-level coordinated guidelines and time-phased goals for all major NASA technology investment activities. A-STAR is a product of the NASA Office of the Chief Technologist and is fully revised every four years (consistent with NASA Strategic Plan updates) via a formal peer review process. To support NASA's programmatic budget and planning cycle, OCT will perform yearly A-STAR progress assessments that include minor roadmap adjustments and realignments as warranted. The approximately fifteen technology areas will logically decompose NASA's strategic technology investments. Decomposition of the technology areas will take into account: 1) NASA strategic goals, outcomes and objectives; 2) reference missions, architectures and timelines supplied by the Mission Directorates; 3) technology focus areas provided by the NASA Centers and other Agency offices; and 4) past NASA technology roadmapping efforts¹. For each technology area, the primary A-STAR product is a recommended technology roadmap that is balanced, achievable and prioritized. The A-STAR products will take into consideration life-cost, operational demands and regulatory constraints with respect to individual technology pathways. The intent is to use a team of technology experts (including external representatives) to develop each technology area roadmap. NASA staff will develop the integrated technology roadmap and perform the prioritization of the pathways across the technology areas.

Scope: A-STAR will span NASA's significant technology development efforts and thus, have relevance to all NASA Mission Directorates, as well as the OCT technology programs. The A-STAR scope will not cover all NASA capability areas, or all work within the NASA Mission Directorates. The approximately 15 chosen A-STAR technology areas will focus only upon capability areas where significant technology investments are anticipated to provide substantial benefits to future NASA Missions or National needs. Mission Directorate activities and NASA capability areas without significant technology investments will fall outside the A-STAR purview. Past NASA technology roadmapping efforts, as well as inputs from the Mission Directorates and the NASA Centers will provide the starting point for each technology area roadmap. A-STAR products may identify or prioritize alternate technology pathways that are either adjustments or additions to the Mission Directorate (MD) and NASA Center supplied inputs. In such cases, the NASA Technology Executive Council (NTEC) governance process will be used to resolve discrepancies.

¹ NASA has performed several previous similar exercises, an example can be found at: <http://history.nasa.gov/DPT/DPT.htm>.

Deliverables: A-STAR is a set of roadmap documents that provides recommendations covering NASA's current and planned technology investments over a 20-year horizon, with greater detail provided over the first 10 years. In addition to the actual Technology Area Roadmap, each TA document will include the following: Technology Area description and scope; ground rules and assumptions used to develop the roadmap (e.g., reference to a NASA Strategic Goal, Design Reference Mission, or NRC Science Decadal missions); current TA status; benefits and applications of the technologies; consideration of leveraging and partnerships with other Government Agencies, industry and international entities; major remaining technical challenges/gaps; technology evaluation/ prioritization criteria; phased cost estimates at logical increments along the technology pathways; consideration of life-cycle costs, operational demands and regulatory restriction; and relationships with other TA roadmaps. The A-STAR integrated roadmap document will provide: a summary of the elements covered within the technology area (TA) roadmap documents; an integrated and complete mapping and prioritization of all TA roadmaps to NASA's Strategic Goals, Outcomes and Objectives; a description of the level to which NASA's technology investments contribute to larger National needs; an identification of all dependencies, gaps and overlaps between the TA pathways; a top level assessment of schedule, cost, operations and regulatory challenges; and an ordered list of the most challenging technology milestones.

Timeframe: Delivery of the initial draft version of A-STAR will occur by Oct 1st, 2010. A final release of the first version of A-STAR will occur by Oct 1st, 2011. Subsequent final releases of yearly A-STAR progress assessments will occur by October 1st. The initial draft (completed by 10/1/2010) will undergo an internal review. The purpose of this initial draft version is to enable a check against the FY12 budget submit plans and to provide an opportunity to influence or benchmark FY11 technology solicitation selections. The initial full release version (10/1/11 delivery) will undergo external review, and is intended to inform the Agency's FY14 budget process. Subsequent yearly progress assessments delivered on 10/2012, 10/2013 and 10/2014 will not be peer reviewed and will only contain roadmap updates as a consequence of progress in the technology programs or the emergence of game changing technologies that alter our plans. The 10/2015 roadmap and prioritization will serve as the next externally-reviewed update.

Top Level Process Outline

OCT will follow the roadmapping and prioritization process once every four years to create an A-STAR baseline.

Roadmapping and Prioritization Process:

- A. **Establish a List of Technology Areas:** The Technology Areas (TAs), sometimes referred to as technology capabilities or thrust areas, establish the taxonomy, or breakdown, for NASA's technology roadmapping process. The approximately 15 TAs will be directly derived from NASA's Strategic Goals, Outcomes and Objectives, as well as National needs (e.g. Commercial Space), and include balanced inputs from all Mission Directorates, all NASA Field Centers, and other Agency Offices (e.g. OCE, OSMA). OCT will draft a list of TAs that captures the breadth of the Agency's current and expected significant technology investments, and is responsive to all of the Agency's Strategic Goals. The A-STAR TAs will focus only upon those NASA capability areas where significant technology developments are expected to provide substantial benefits to

future NASA Missions or National needs. OCT will provide the resulting draft TA list to the Mission Directorates (through the NTEC) as well as the NASA Centers (through the CTC) for feedback prior to finalizing the TAs.

- B. Establish Technology Area and Integration Teams:** Each Technology Area will have a distinct *Technology Area team* with the responsibility to develop individual TA roadmaps and prioritizations. In addition to the approximately 15 TA teams, the *A-STAR strategic integration team* (consisting of NASA civil servants) will be formed with the responsibility of rolling-up and prioritizing the TAs roadmaps into the integrated top-level A-STAR roadmap. The intent is to establish the TA teams by including, as appropriate, Government members from both NASA and other Agencies, and non-Government members from both academia and industry. It is recognized that the appropriate balance on the TA teams will vary from team to team, with possible options including, wholly Government teams, wholly non-Government teams, and mixed Government and non-Government teams². To populate and lead the TA teams, OCT will seek suggestions from the Mission Directorates, the NASA Centers, and other Agency Offices.
- C. Establish Common Approach for all Technology Area Roadmaps:** OCT will specify the overall guidelines, instructions, formats, deliverable requirements and expectations to facilitate the development of a consistent and complete set of TA products. It is recognized that complete commonality across all TAs may be impractical or undesirable. TA specific guidelines will accommodate such needed differences.
- D. Provide a Starting Point for the Technology Area Roadmaps:**
As a first action, the TA teams will collect all inputs to form a starting point. These inputs will include: NASA strategic goals, outcomes and objectives; NASA's relevant past technology roadmaps; Mission Directorate strategic plans, reference architectures / missions, technology roadmaps, and the rationale for these plans along with any consequences due to changes; focused technology ideas from the NASA Centers along with the rationale for their inputs; and cost, risk, operational and regulatory implications for given technology pathways provided by other Agency Offices such as OCE, OSMA and MSD.
- E. Develop Draft Technology Area Roadmaps:** The development of the A-STAR products will take the TA and review teams considerable time. The full A-STAR development process will occur in two stages. The initial (draft) stage, will involve the TA teams developing draft deliverable roadmaps for preliminary review. During the draft roadmapping process, additional technology inputs will be gathered from other Government Agencies, industry and academia by reviewing relevant material from these organizations and through workshops for each TA.
- F. Roadmap Reviews:** In order to ensure both product quality and stakeholder acceptance, OCT will organize a thorough peer review of the A-STAR technology roadmaps. The review process will have separate internal and external review teams. OCT (NASA civil servants) and the NTEC will serve as the internal review team. OCT will coordinate with external entities such as the National Academy of Engineering to form the external review panel. The external review panel will review and assess the A-STAR products through a transparent and balanced process. The A-STAR TA and strategic integration

² Any TA team that it comprised of both civil servant and non-governmental participants will be analyzed for compliance with the Federal Advisory Committee Act.

teams will address the recommendations and findings from the review teams prior to finalizing the roadmaps. The final results and the disposition of the review findings will be presented to NTEC for approval.

G. Technology Area Roadmap Prioritization, Integration and Finalization: To complete NASA’s A-STAR, the TA teams will perform a second stage, post-review, update to their roadmaps. In parallel, the A-STAR strategic integration team will collect the draft TA roadmaps and form an Agency level integrated strategic roadmap. The A-STAR strategic integration team will also perform a prioritization between technology pathways from across the different TAs. The process is finalized by presenting the products to the NTEC for final approval and subsequent publication.

Yearly A-STAR Progress Assessment Process: On a yearly basis the A-STAR strategic integration team will assess the progress made relative to the A-STAR roadmap. These yearly efforts will provide strategic assessments of the performance of NASA’s technology investments relative to an established baseline. The yearly assessments will also inform any roadmap adjustments needed to account for technology development progress, changes in Mission Directorate architectures and timelines, or the emergence of a game-changing technology.

Figure 1: Flowchart of the A-STAR process



