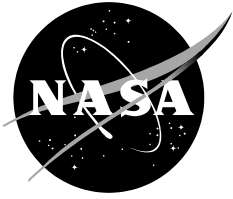


NASA/TM–20220018538



NASA's Digital Transformation Strategic Framework & Implementation Approach

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December 2022

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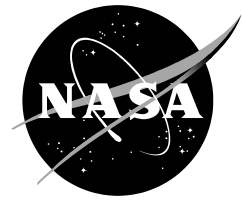
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Abstract

Since 1958, NASA has delivered its enduring bold purpose, characterized in the 2022 NASA Strategic Plan as a mission to discover, explore, innovate, and advance solutions to the problems of flight, within and outside the Earth's atmosphere, for the benefit of humankind. The NASA Strategic Plan also recognizes that this mission will be delivered differently as it looks to a future marked by radical global change, which is in part being driven by digital advances. For this reason, in late 2020 NASA established an Enterprise Digital Transformation (DT) agency-level strategic initiative to accelerate and coordinate leveraging digital advances to transform the way the Agency works, the experience of its workforce and the agility of its workplace. This paper documents NASA's DT strategic framework and associated implementation approach, with the DT strategic initiative serving to ignite, connect, integrate, and facilitate DT progress across a federated organizational operating model.

1. Background & Context

A hallmark of the early 21st century has been the exponential discovery, maturation, and adoption of digital advances to create radically new products and services that have transformed societies around the globe. The way people live their personal lives, the way businesses conduct professional work, and the way governments engage with each other and deliver services to citizens has permanently and profoundly changed through digital technologies – and in many cases, previously unimaginable needs, expectations, and aspirations have emerged because of what these technologies now make possible. This revolution in employing digital technologies to radically transform processes, products, and capabilities so dramatically that they are unrecognizable from their prior forms is now known as Digital Transformation (DT). The DT forecast is for increasing exponential change, as new digital technologies (such as cloud computing, mobile access, automation, robotics, data analytics, artificial intelligence, machine learning, Internet of Things (IoT), modeling and simulation, high performance computing, augmented / virtual reality, 3D printing, agile software development, crowdsourcing, social media and more) emerge and combine, creating a positive feedback cycle of accelerating invention, possibilities, disruption and ultimately, expectations.

NASA's historic and enduring purpose is aligned to four Strategic Goals in the newly released 2022 NASA Strategic Plan:

- *Discover*: missions of scientific discovery of the natural phenomena of the Earth, of other worlds, and of the cosmos as a whole
- *Explore*: missions of exploration in our solar system with humans and robotic probes which expand the frontiers of human experience
- *Innovate*: missions to innovate new technologies in space systems and sustainable aviation that allow American industry to catalyze economic growth and address national challenges; and
- *Advance*: missions to advance capabilities, including growing the aero-space talent pool, transforming national capabilities (including experimental infrastructure) stewarded by NASA for the next era of aerospace, and building the next generation of explorers.

Though NASA's mission is enduring, the digital revolution is fueling global forces that are driving NASA to need to fundamentally transform how it delivers this core value to the nation (and the world), necessitating the transformation of products, processes, and capabilities.

The NASA Associate Administrator established Enterprise DT (hereafter referred to as "DT") as a key agency-level strategic initiative in October 2020, under the leadership of a newly created Digital Transformation Officer to address this challenge. In fiscal year 2021 (FY21),

NASA established high level goals and objectives for the DT initiative (approved jointly by the Agency Program Management Council and Mission Support Council) and tested the efficacy of an enterprise coalition model for DT solutions that relied upon organizations partnering with DT leaders to develop shared enterprise DT solutions to common challenges. The experiment showed some organizational willingness to team as evidenced by the launch of five major DT coalition projects, but that overall NASA's DT progress would likely be too slow to keep pace with the external pace of change. In addition, NASA determined that the management processes that would be required to execute the coalition model (to form, sustain and manage multi-org coalitions) was cumbersome and difficult to implement, integrate, and communicate, and relied upon significant coordination with key organizations, in particular the Office of the Chief Information Officer (OCIO). Therefore, in order to drive the transformational progress needed to create a vibrant and capable NASA through harnessing digital advances, in FY22 the DT initiative shifted to a more directive and focused implementation model. The intent of this pivot was to accelerate identification, development and adoption of high-priority digital actions that deliver near-term benefits, while concurrently defining and aligning on the key digital plans and strategies to achieve longer-term NASA mission needs and agency priorities. To facilitate progress, the DT initiative, continuing under the leadership of the Digital Transformation Officer, was organizationally realigned with the OCIO to better coordinate and accelerate core foundational digital capabilities critical to enabling DT efforts. Key DT governance decisions were aligned to the NASA Information Technology Strategy Board (ITSB), which includes voting members from the Centers, Missions, and Mission Support Enterprise Offices to ensure vetting and adoption by NASA leadership.

2. Stakeholders

There are numerous stakeholders with vested interests in NASA's DT initiative, each with different expectations. Key stakeholders include NASA's organizations, NASA's employees, NASA's partners, and the general public. These groups and the DT initiative's engagement approach/forum for each community are outlined below.

The primary internal stakeholders and beneficiaries of the DT initiative at the strategic level are all of NASA's organizations, led by the Officials in Charge (OIC) spanning Mission Directorates, Centers (including the Jet Propulsion Laboratory) and functional Offices. Most of the OICs have initiated one or more transformation efforts in response to NASA's Strategic Goals, and associated modernization efforts that are required. These organizational modernization efforts are the key intersection between the OIC interests and the DT initiative, which seeks to accelerate, integrate, and enable their transformation results through full and coordinated adoption of DT solutions. Because DT is dependent on access to and acceleration of digital technologies to achieve its transformation goals, the Office of Chief Information Officer (OCIO) has been identified to host this agency strategic initiative. To establish organizational consensus and alignment on common DT needs, plans, and projects, the DT initiative facilitates a *DT Champions Network* made up of executive Senior Leader Champions for every OIC to represent their interests on establishing enterprise DT priorities and coordinating investments to develop shared DT solutions.

Primary internal stakeholders and beneficiaries for DT at the working level are all of NASA's employees, whether they work in Mission Directorates, Centers (including the Jet Propulsion Laboratory) or functional Offices. Employees aspire to have their unique contributions enable NASA to do great things, but often encounter real-world challenges in the execution of their work, such as: finding, getting access to and/or validating versions of the data they need; spending time in meetings to get/share information; figuring out how to integrate their inputs/outputs with others either internally or externally that they need to work with; having to

spend significant touch time on low-value work such as generating status reports or completing forms; or figuring out “free” ways to get their jobs done faster without compromising quality. Many employees are early DT adopters who have taken initiative to explore foundational digital technologies and spearhead local adoption efforts to attack their challenges. The DT initiative facilitates agency wide *DT Foundation Communities of Practice* to share learning from their DT pathfinders across the enterprise, get feedback on working level challenges, tap into their insights as they proactively monitor emerging digital technologies, team to prototype further DT use cases, and share their work as exemplars to inspire and educate others on the benefits of DT. The broader employee community is invited to follow and engage in the DT initiative.

Primary external stakeholders for Enterprise DT at the operational level are NASA’s partners across other government agencies, industry, and academia, who team and interface with NASA to achieve our missions. Their engagement mechanisms with NASA include contracts, grants, cooperative agreements, or other agreements. Partners are playing an increasingly important role in achieving NASA’s missions as well as synchronizing the way we work and ensuring that modernization efforts seamlessly integrate are key to our collective success. The DT initiative solicits perspectives from external partners through a variety of mechanisms to include sharing NASA DT efforts at external conferences, hosting bilateral collaboration meetings to seek feedback as well as share lessons learned and best practices, and sponsoring multilateral workshops and events to facilitate convergence and alignment of digital strategies and plans, particularly across the aerospace market sector.

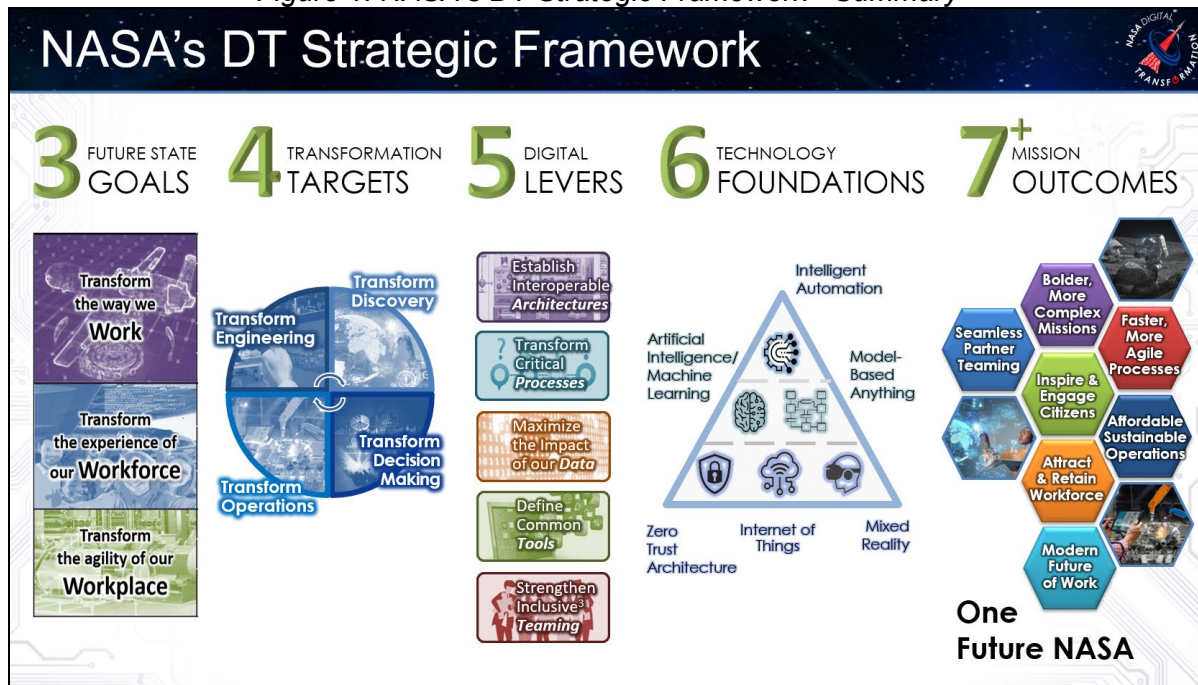
Finally, the general public, to include taxpayers and students alike, are also stakeholders for NASA’s DT initiative. As inspiring as our missions are, very often what is equally inspiring are the stories of how NASA accomplishes its missions. These stories can feature how we are providing opportunities for small businesses and start-ups with novel ideas to show how they are changing NASA’s missions and the way we work, or how our people are inventing or adapting the latest technology breakthroughs to achieve even bolder things, or how NASA’s missions make a tangible difference for life on Earth (including technology spin-offs and smart use of government investment), and can excite the next generation to join us and/or a STEM career in future discovery and exploration by sharing alluring excerpts of our people and the many ways they are inventing the future. The DT initiative facilitates NASA exemplars to share compelling stories of how DT is enabling our missions with public audiences of all ages, in order to both garner broad support for NASA and collect ideas for future DT opportunities.

3. DT Strategic Framework

NASA’s DT Strategic Framework (Figure 1) outlines the DT initiative’s approach for coordinating and aligning organizational efforts to digitally transform NASA. This framework has been codified in the 2022 NASA IT Strategic Plan as Goal 3, “Transform NASA with information and technology.” The framework defines:

- **WHY** we need to transform in **3 Future State Goals**
- **WHERE** we will align agency transformation efforts around **4 Transformation Targets**
- **HOW** we will use a best practice digital methodology to drive progress and coordinate efforts using **5 Digital Levers**
- **WHICH** digital technologies we want to pursue at scale next as **6 Technology Foundations**
- **WHAT** results we are seeking through these DT efforts in **7+ Mission Outcomes**

Figure 1: NASA's DT Strategic Framework - Summary



3.1. Three Future State Goals

NASA's vision for DT is to take full advantage of 21st Century digital enablers across our enterprise to accelerate and enable NASA's transformation to achieve NASA's Strategic Goals, which are being shaped by an expanding partnership landscape, evolving employee expectations, and increasing budget constraints. These drivers, representing *why* we must transform NASA, are reflected in the DT initiative's three Future State Goals, specifically:

- **Transform the way NASA Works:** Deliver increasingly complex missions leveraging increasingly complicated partnerships, on shorter timelines to achieve bolder outcomes that inspire the world
- **Transform the experience of NASA's Workforce:** Create a seamless, integrated, and inclusive employee experience that energizes our people by feeling connected to the NASA enterprise, continuously grow, and take pride in rapidly delivering high-value work
- **Transform the agility of NASA's Workplace:** Optimize a 21st Century cyber-physical work environment that powers flexible, adaptable, resilient, efficient, and effective employee / partner teaming

The DT initiative intentionally chose non-digital top line goals in order to keep a strategic focus on the intended transformation outcomes and not become enamored by or wedded to particular digital approaches or technologies. To aid in communicating what these Future State Goals look like if realized, DT initiative developed companion vignettes (Figure 2) to describe how these changes would be experienced through the lens of three employee personas (Sondra the scientist, Caryn the resource analyst, and George the laboratory technician).

These Future State Goals were approved by a joint Agency Program Management Council (APMC) and Mission Support Council (MSC) decision in November 2020.

Figure 2: NASA's DT Strategic Framework - 3 Future State Goals

WHY digitally transform NASA?

3 Future State Goals

NASA must transform...


Expanding Partnership Landscape



the way we WORK

Sondra's digital assistant alerts her to a newly published partner data set related to her science research. She kicks off a bot to transfer & clean the data and integrate it into her model. Using analytics to rapidly cross-check the results, she discovers a potential breakthrough


Evolving Employee Expectations



the experience of our WORKFORCE

Caryn is excited to have joined a 1-day collaboration jam session where she connected with new teammates from across NASA to quickly learn and apply AI/ML tools on an elusive space suit challenge. She loved helping the mission and can't wait to share her new ideas with her financial peers.

Increasing Budget Constraints



the agility of our WORKPLACE

George pauses digital manufacturing of an urgent job after a critical IoT sensor alert. He imports the data history into the lab digital twin model and rapidly forecasts the job can safely continue, avoiding delays.

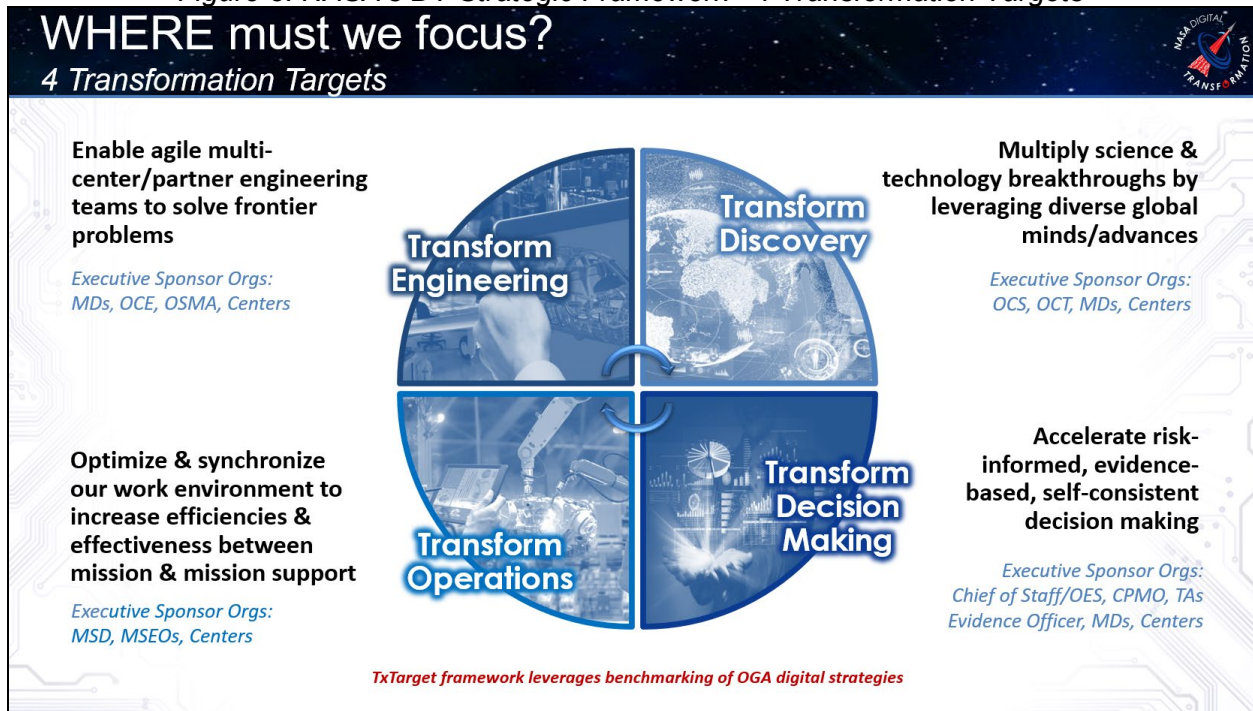
3.2. Four Transformation Targets

The scope of NASA's DT ambitions as outlined in the 3 Future State Goals is vast, which required discussion and decisions on *where* NASA must align and focus transformation efforts for action planning. The DT initiative conducted listening tours with OICs, benchmarked external agency digital strategies and worked with the DT Champions Network to distill four Transformation Targets (TxTargets), shown in Figure 3, as the primary focus areas for NASA's DT efforts in order to achieve mission outcome. The goals of the four TxTargets are:

- **Tx Engineering:** Enable agile multi-center/partner engineering teams to solve frontier problems
- **Tx Discovery:** Multiply science & technology breakthroughs by leveraging diverse global minds/advances
- **Tx Decision Making:** Accelerate risk-informed, evidence-based, self-consistent decision making
- **Tx Operations:** Optimize & synchronize the NASA work environment to increase efficiencies & effectiveness across mission and mission support

These Transformation Targets were approved by the NASA IT Strategy Board in August 2022.

Figure 3: NASA's DT Strategic Framework - 4 Transformation Targets



3.2.1. Transform Engineering

DT's Engineering TxTarget seeks to enable agile multi-center and multi-partner engineering teams to solve frontier problems. The frontier problems require engineering development, delivery and operation of systems that span ground experiments to operational flight missions. The proposed attributes of the future state of a transformed engineering capability at NASA include, but are not limited to, the following:

- Multi-fidelity solutions that span concept-design-develop-build-test-evaluate-operate life-cycle
- Inclusive, integrated multi-center/partner teams
- Shared interoperable product life cycle work environment that enables agile processes & diverse mission-driven approaches
- Integrated interdisciplinary processes to affordably develop/evaluate options & close complex designs
- Authoritative, discoverable design/analysis/test artifacts with integrated confidence measures

Executive sponsor organizations who collaborate to perform engineering across NASA include: Mission Directorates, Centers (who house performing engineering organizations), the Office of Chief Engineer, and the Office of Safety and Mission Assurance.

3.2.2. Transform Discovery

DT's Discovery TxTarget seeks to multiply science and technology breakthroughs by leveraging diverse global minds and advances. The discovery efforts at NASA span science, foundational research, and early-stage technology invention/development. The proposed attributes of the future state of a transformed discovery capability at NASA include, but are not limited to, the following:

- Inter-disciplinary and cross-disciplinary domains
- Incentivize diverse internal/external collaboration
- Speed data/model/software internal/external release to enable sharing & learning
- Promote data/models/software search & reuse
- Leverage wealth of existing large, complex internal/external data sets
- Enable integration & mining of relevant data/models/software
- Develop data literacy, fusion, protection skills
- Reward interdisciplinary discoveries & culture

Executive sponsor organizations who collaborate to perform scientific, research and technology discovery across NASA include: Mission Directorates, Centers (who house performing science and research organizations), the Office of Chief Scientist, and the Office of Chief Technologist.

3.2.3. Transform Decision Making

DT's Decision Making TxTarget seeks to accelerate risk-based informed, evidence-based, self-consistent (across time, organizations) decision making. Though decision making is required across every corner of NASA, the initial scope for the DT efforts is focused on execution decision making spanning all levels from project management to program management to executive council-level decisions. The proposed attributes of the future state of a transformed decision-making capability at NASA include, but are not limited to, the following:

- Dynamic "live" configuration-managed (project) plans
- Real-time, role-based access to authoritative, drillable performance data, with confidence measures
- Analytics to rapidly identify & forecast risks
- Reviews focused on discussion of issues using live information
- Fully informed decision making with governance at right levels
- Workflows to rapidly solicit feedback & streamline decision approvals
- Find & mine historical decisions, rationale & lessons learned

Executive sponsor organizations who perform program and project management decision making across NASA include: the Chief Program Management Officer, the Office of the Executive Secretariat (runs Agency program management councils), Mission Directorates, Centers (who host project managers and some program managers), and the Technical Authority organizations.

3.2.4. Transform Operations

DT's Operations TxTarget seeks to optimize and synchronize our work environment to increase efficiencies and effectiveness between mission & mission support. Operations spans people, processes, and plant (physical & digital), across mission and mission support organizations. The proposed attributes of the future state of a transformed operations capability at NASA include, but are not limited to, the following:

- Dynamic recruitment, development, (re)deployment & optimization of unique individual talents
- Cohesive, coordinated cross-enterprise business practices/services optimized for end-user experience, including internal users & external partners
- Modern, interoperable, secure, vendor agnostic processes & systems to enable geographically distributed teams

- Reliable, adaptable, agile & secure cyber-physical infrastructure with seamless integration of cross-cutting & mission-specific/hosted capabilities
- Authoritative, discoverable operations hindsight, insight, foresight data to enable informed operations & plans

Executive sponsor organizations who collaborate to integrate operations across NASA include: the Mission Support Directorate, Mission Support Enterprise Offices, and Centers (who manage mission-funded operations).

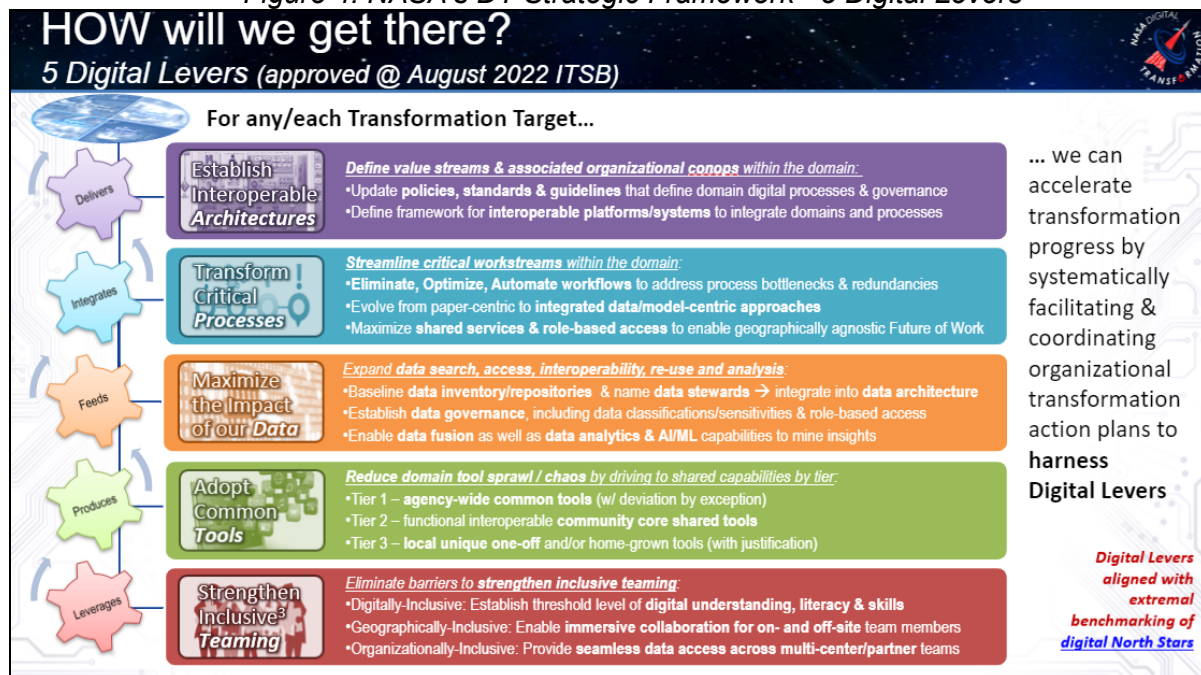
3.3. Five Digital Levers

In order to accelerate and synchronize organizational progress in achieving the desired attributes across the four TxTargets, the DT initiative developed five Digital Levers as a consistent, best-practice digital methodology for *how* to guide organizational digital efforts, ensuring attention on key elements to maximize mission outcomes from NASA's digital efforts. This methodology was developed by benchmarking external digital best practices, working with the DT Champions to identify organizational gaps/interests, and leveraging NASA early adopters to incorporate their lessons learned. These five Digital Levers represent NASA's digital north stars as guiding principles for digital investments across NASA organizations:

- **Establish Interoperable Architectures**, to provide the right work environment to enable us to work with who we need to work with in order to deliver our products (our value streams)
- **Transform Critical Processes**, to streamline and modernize the workstreams to produce that value
- **Maximize the Impact of Data**, to ensure the data required by and produced by those workstreams is findable, accessible, interoperable, and re-usable (aligned with NASA's Data Strategy)
- **Adopt Common Tools**, to reduce tool sprawl and facilitate working in new ways using shared capabilities
- **Strengthen Inclusive³ Teaming**, to eliminate barriers that inhibit teams from leveraging the full talents across our extended internal/external workforce

These Digital Levers were approved by the NASA IT Strategy Board in August 2022.

Figure 4: NASA's DT Strategic Framework - 5 Digital Levers



3.3.1. Establish Interoperable Architectures

The first essential element of a digital action plan for any given effort is to establish interoperable architecture(s) as the digital work environment for the team. This “business architecture” task first requires us to understand what needs to be produced (value stream outcomes) and who needs to work together (organizational concept of operations, or “conops”) in order to produce it. The conops not only includes an understanding of who will need to be involved (including internal and external organizations) but the overarching policies, standards and guidelines that govern the work. The conops will be enabled by a zero-trust architecture that provides NASA’s employees and partners with timely, appropriate platform, data and resource access by consistently requiring IT user identity and device authentication. The digital action plan will need to include:

- Update policies, standards & guidelines that define domain digital processes & governance
- Define framework for secure, interoperable platforms/systems to integrate domains and processes

3.3.2. Transform Critical Processes

The next essential element of a digital action plan is to be proactive and intentional to transform critical processes that will be conducted by the team using the interoperable architectures. This activity will require evaluating current ways of working to trim non-value added legacy steps and identify the core activities needed to produce products (eliminate waste/variability, aligned with lean six sigma), reinvent modern ways of working consistent with a digitally enabled world (tapping tenets of business process engineering and design thinking), and digitalizing the resulting steps and worker experience through integration of data and models (leveraging human-centered design). An overarching consideration in process transformation must be enabling NASA’s vision for our Future of Work. Key steps include:

- Eliminate, Optimize, & Automate workflows to address process bottlenecks & redundancies

- Evolve from paper-centric to integrated data/model-centric approaches
- Maximize shared services & role-based access to enable geographically agnostic Future of Work

3.3.3. Maximize the impact of Data

The third essential element of a digital action plan is to maximize the impact of our data, by ensuring that the data required and produced by the newly transformed processes is findable, accessible, interoperable, and reusable. This step requires a data culture where people “default to share” versus hoarding or controlling data, which will speed people being able to access the data they need and enable better insights from new abilities to combine and integrate datasets. This culture will be enabled by secure, interoperable architectures for environments that provide NASA’s employees and partners with timely and appropriate data access. The key steps of this activity are derived from NASA’s Data Strategy, and include:

- Baseline data inventory/repositories & name data stewards to integrate into data architecture
- Establish data governance, including data classifications/sensitivities & role-based access
- Enable data fusion as well as data analytics & AI/ML capabilities to mine insights

3.3.4. Adopt Common Tools

The fourth essential element of a digital action plan is to adopt common tools. The intent of this lever is not to rigidly dictate or mandate single tool standards, but instead to promote a business-based evaluation of similar tools within domains and identify opportunities to reduce tool sprawl, not only to reduce costs but also to promote consistent ways of working that promote collaboration and agility and enable automation where appropriate. The proposed tier structure for evaluating tools is:

- *Tier 1:* Agency-wide common tools (w/ deviation by exception)
- *Tier 2:* Functional interoperable community core shared tools
- *Tier 3:* Local unique one-off and/or home-grown tools (with justification)

3.3.5. Strengthen Inclusive³ Teaming

The final essential element of a digital action plan is to proactively think about the workforce and full spectrum of talents that NASA would like to tap to execute the work. This requires planning for how digital solutions will address the range of digital proficiency (from “digital natives” to “digital dinosaurs”, and those in between), the geographic locations of team members (to enable our vision for a hybrid on/off site Future of Work), and their organizational identities (which are often limited in current systems by internal “org code” or external access restrictions). Key attributes and activities to plan for strengthening inclusion are:

- *Digitally-Inclusive:* Establish threshold level of digital understanding, literacy & skills
- *Geographically-Inclusive:* Enable immersive collaboration for on- and off-site team members
- *Organizationally-Inclusive:* Provide seamless data access across multi-center/partner teams

3.4. Six Technology Foundations

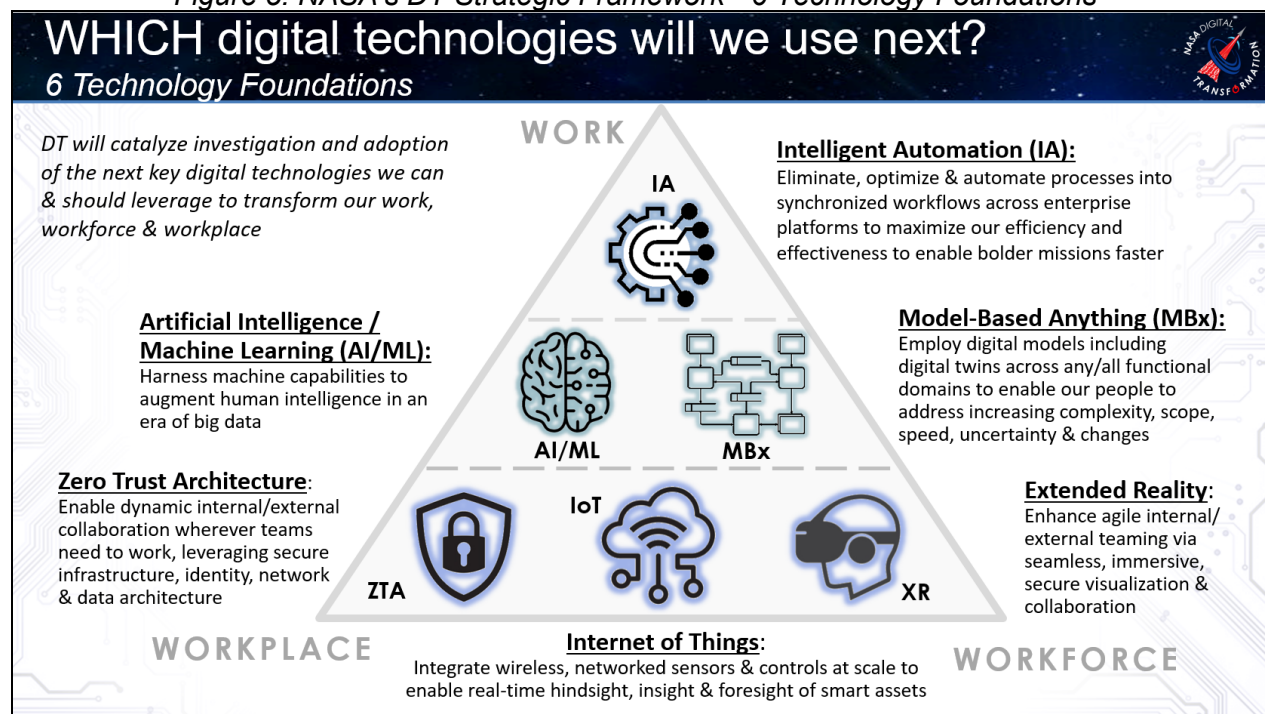
As organizations develop digital action plans using the Digital Levers methodology, they will be leveraging a variety of different digital technologies suited to the nature of their work. From its inception, the DT initiative has curated a short list of digital technologies, initially called

Thrusts and now called Foundations, which represent the next technologies that are most promising for NASA to leverage to drive our mission outcomes. In some cases, these Foundations are not yet mature, and DT will promote prototype tests to assess and mature their feasibility for our use-cases; in others the technologies are relatively mature, and DT will mobilize early adopters through a Community of Practice to attack barriers to scale adoption. In addition, for each Foundation, DT will conduct annual horizon scanning to identify external progress or use-cases that NASA may wish to assess, and DT will produce a maturity roadmap to help organizations scale adoption and maximize benefits. DT's current six Technology Foundations (Figure 5) are:

- **Intelligent Automation (IA):** Eliminate, optimize & automate processes into synchronized workflows across enterprise platforms to maximize our efficiency and effectiveness to enable bolder missions faster
- **Artificial Intelligence / Machine Learning (AI/ML):** Harness machine capabilities to augment human intelligence in an era of big data
- **Model-Based Anything (MBx):** Employ digital models including digital twins across any/all functional domains to enable our people to address increasing complexity, scope, speed, uncertainty & changes
- **Zero Trust Architecture (ZTA):** Enable dynamic internal/external collaboration wherever teams need to work, leveraging secure infrastructure, identity, network & data architecture
- **Internet of Things (IoT):** Integrate wireless, networked sensors & controls at scale to enable real-time hindsight, insight & foresight of smart assets
- **Extended Reality (XR):** Enhance agile internal/ external teaming via seamless, immersive, secure visualization & collaboration

These Foundations are envisioned to evolve over time and are retired and/or selected at the discretion of the Digital Transformation Officer as adoption at scale is achieved and/or new technology advances emerge.

Figure 5: NASA's DT Strategic Framework - 6 Technology Foundations

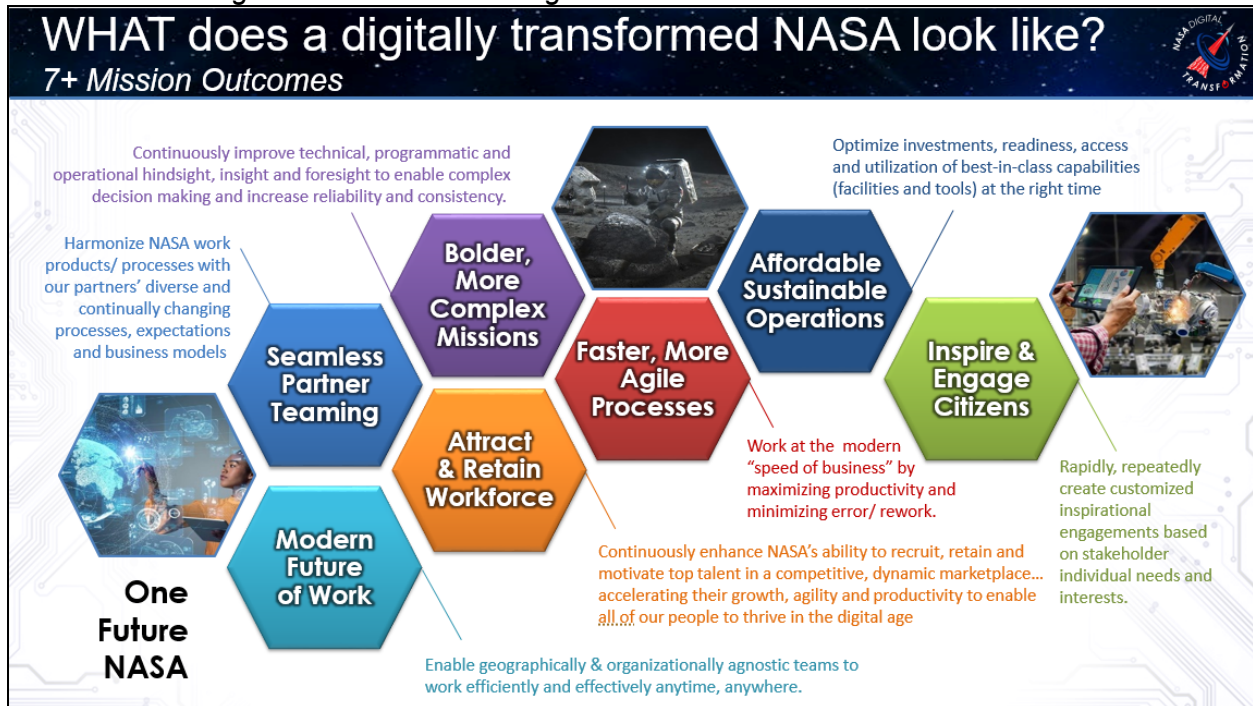


3.5. Seven (+) Mission Outcomes

At a high level, DT envisions a digitally transformed NASA where speed, agility, insights, innovation, resilience, and efficiency are the norms. This translates into addressing challenges facing our missions as an ability to achieve, shown in Figure 6:

- **Bolder, More Complex Missions**, by continuously improving technical, programmatic and operational hindsight, insight and foresight to enable complex decision making, and increase reliability and consistency
- **Seamless Partner Teaming**, by harmonizing NASA work products/ processes with our partners' diverse and continually changing processes, expectations, and business models
- **Faster, More Agile Processes**, by working at a modern “speed of business” by maximizing productivity and minimizing error/ rework
- **Affordable, Sustainable Operations**, by optimizing investments, readiness, access, and utilization of best-in-class capabilities (facilities and tools) at the right time
- **Attract & Retain Workforce**, by continuously enhancing NASA’s ability to recruit, retain and motivate top talent in a competitive, dynamic marketplace... accelerating their growth, agility, and productivity to enable all of our people to thrive in the digital age
- **Inspire & Engage Citizens**, by rapidly, repeatedly creating customized inspirational engagements based on stakeholder individual needs and interests
- **Modern Future of Work**, by enabling geographically & organizationally agnostic teams to work efficiently and effectively anytime, anywhere

Figure 6: NASA DT Strategic Framework – 7+ Mission Outcomes



4. Implementation Approach

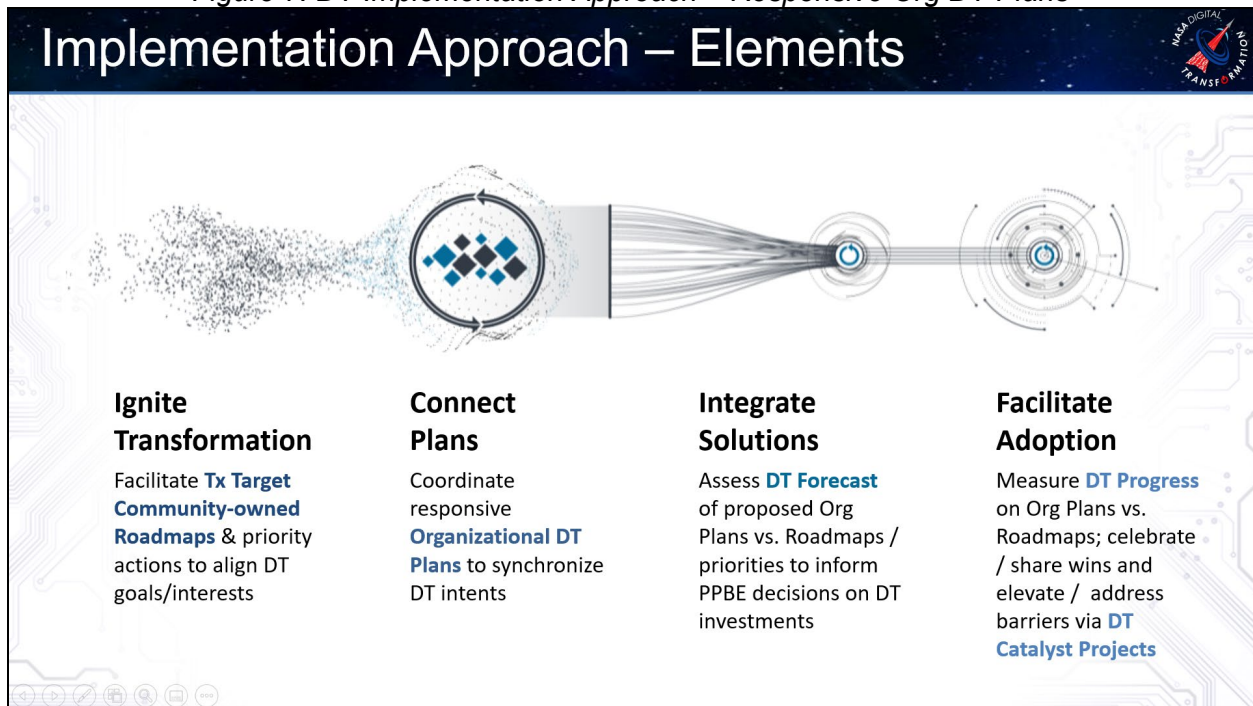
Achieving the vision for the Transformation Targets requires the organizations within those communities to align their transformation goals and approaches and coordinate (and in many cases integrate) their DT efforts, in order to produce the desired mission outcomes. NASA has a federated operating model with subordinate organizations across the agency retaining decision authority and budget for their respective efforts. After looking at a spectrum of directive to incremental approaches, the IT Strategy Board selected a “responsive” approach to implement the DT Strategic Framework.

The responsive approach, depicted in Figure 7, requires organizations to either develop or adapt an organizational DT plan that aligns with the Transformation Targets and Digital Levers laid out in the DT Strategic Framework. To seed development of these plans, the DT initiative will facilitate each Tx Target community of organizations to create their TxTarget Roadmap that defines their desired 5-year future state and the digital activities (using the Digital Levers methodology) that the community needs to execute now, next, and later to realize those goals. Organizations will take these roadmaps as input to identify where their organization can/should lead various required activities and will reflect them in an Organizational DT Plan. The Organizational DT Plans have two parts: a narrative document that provides context on the organization motivation and local goals for transformation and the organization’s rationale for the particular transformation activities they are pursuing, accompanied by a structured DT Alignment Matrix providing data on the particular DT activities that are proposed or planned by TxTarget and Digital Lever. Organizations with existing narrative transformation or strategic plans are free to adapt them to reflect the DT Strategic Framework, organizations that have not yet developed a narrative plan may use the DT initiative provided template. The DT initiative will then integrate the organizational plans to identify gaps/duplication and forecast progress of proposed efforts across the community against their roadmap to inform organizational investment decisions in DT efforts. Finally, once the plans are implemented in year of execution, the DT initiative will measure integrated progress of organization efforts against their community roadmaps to celebrate and share exemplars and seed DT Catalyst Projects to elevate and address cross-cutting barriers.

The benefits of this responsive implementation approach, given NASA’s operating model, are:

- Facilitates comprehensive progress by aligning transformation needs to inform organization DT/strategic plans
- Preserves maximum flexibility and minimum work for organizations by building on organization DT/strategic plans where they exist
- Drives consistency by using “alignment matrix” or template to illuminate DT alignment/content in organization plans
- Promotes leveraging across organizations by making organization needs, plans, and solutions visible & accessible for cross-org re-use

Figure 7: DT Implementation Approach – Responsive Org DT Plans



4.1. TxTarget Roadmaps

To “digitally transform NASA,” it is essential that organizations are aligned on what we are aiming to transform, the outcomes we are seeking from those efforts, and the steps we need to take to get there. This work is a necessary first step before organizations go off and initiate various digital efforts, so that we are aligned to make sure we are working on the right things and we know how those efforts need to integrate to achieve overall outcomes. To facilitate this understanding, the DT initiative will facilitate each TxTarget community in creating a community-owned TxTarget Roadmap that defines their desired 5-year future state and the digital activities (using the Digital Levers methodology) that the community needs to execute now, next, and later to realize those goals. DT will also facilitate the community to identify the near-term priorities to help focus investments. The roadmaps and priorities are provided to organizations as an input to guide their DT investment plans.

4.2. Organizational DT Plans – Narrative Template

The first part of the Organizational DT Plan is a narrative document that describes motivation, goals and plans to transform the organization. If organizations do not have narrative transformation, strategic or DT plan that already provides this context, the DT initiative has developed the outline in Figure 8 as a suggested format. The outline proposes organizations use the TxTargets and Digital Levers as the organizing principle for their DT plans, and the template provides prompts for the kind of high-level narrative context to include in each section. While the template contains considerable detail in the prompts, the intent is for the document to provide a high-level framing (<5 pages) of the organization’s transformation vision, goals and intended outcomes (with particular focus on their role in the four Transformation Targets), along with their planned approach to leveraging the DT Digital Levers to accelerate their progress.

Figure 8: Narrative Organizational DT Plan - Optional Table of Contents / Template

1. Background & Context	<ul style="list-style-type: none"> • Provide any relevant historical background on the organization • Describe the primary work in your organization's portfolio today • Describe key challenges facing the organization today • Describe the external drivers influencing and/or driving change in your organizations work • Identify any key assumptions, policies or constraints that serve as guardrails for the organization's change efforts
2. Customers, Stakeholders & Partners	<ul style="list-style-type: none"> • Describe where the organization gets its strategic direction • Describe key relationships with other NASA organizations (customers, stakeholders, partners) • Describe key relationships with other federal agencies, industry, academia and/or other organizations • Describe the mechanisms used to coordinate with internal & external parties who have a vested interest in the transformation of the organization
3. Transformation Vision & Goals	<ul style="list-style-type: none"> • Outline the overarching vision and goals for your organizational transformation efforts, focusing on the organization's intended future value proposition within NASA and/or to the aerospace sector • Describe the primary work in your organization's portfolio in the future; include any major new and/or divested work areas
<i><use the TxTargets as Strategic Framework in sections 4/5/6/7 as relevant></i>	
4. Transform Engineering	<ul style="list-style-type: none"> • Describe current state of the TxTarget within the organization • Describe the desired 5-year future state of the TxTarget within the organization • Describe past efforts that the organization plans to leverage • Describe any sequencing or dependencies between planned activities below (can be links to roadmaps)
<i><repeat outline shown under 4.1 for all Digital Lever sub-sections></i>	
4.1 Establish Interoperable Architectures	
a) Activity 1 <i><repeat for each Activity></i>	<ul style="list-style-type: none"> • Title, Lead, Description & Status (wrt funding) • Motivation/Problem being solved • Desired/Expected Results • Key Partners & Stakeholders • Assumptions and/or Constraints • Action Plans or Roadmaps (can be links) • Anticipated Challenges, Barriers, Risks • Needed Enterprise Support/Solutions
4.2 Transform Critical Processes	
4.3 Maximize Impact of Data	
4.4 Adopt Common Tools	
4.5 Strengthen Inclusive ³ Teaming	
5. Transform Discovery	
6. Transform Decision Making	
7. Transform Operations	
8. Additional Transformation Strategic Thrusts	<ul style="list-style-type: none"> • Adapt this section to describe any transformation thrusts for the organization that do not map to the DT TxTargets
9. Risks & Opportunities	<ul style="list-style-type: none"> • Describe any significant potential disruptions to your organization's future (e.g., technological, political, environmental, etc.) • Describe any anticipated inflection points as key opportunities to drive change
10. Outcomes	Describe the integrated outcomes and results of the transformation efforts outlined (perhaps a subset or adaptation of the 7+ Mission Outcomes)

4.3. Organizational DT Plans - DT Alignment Matrix

In addition to the narrative portion of the organizational DT plans, organizations will complete a "DT Alignment Matrix" which provides a high-level itemized description of the

organization’s planned DT activities and their alignment to the agency DT Strategic Framework. The DT initiative partnered with the Strategy & Architecture Office (SAO) in the Office of the Chief Information Officer (OCIO) to include the DT Alignment Matrix fields in the SAO Technology Roadmap, which is designed to integrate IT technology needs across NASA to inform design of the Enterprise Architecture and drive OCIO strategic investments. By combining the DT Alignment Matrix into the SAO Technology Roadmap, organizations will not have to respond to multiple data calls, and the DT plans will seamlessly integrate considerations and needs of organizational DT activities into SAO-led NASA IT planning and investment process. The team augmented and refined the initial format of the SAO Technology Roadmap using lessons learned from a pilot effort with the MSD Technology Roadmaps, and then a modest number of additional fields to capture alignment with the DT Strategic Framework. The resulting format was evaluated and endorsed by a subset of the DT Champions.

The combined DT Alignment Matrix & SAO Technology Roadmap allows for each organization to identify their ongoing, planned or needed change, innovation, or transformation activities (funded or unfunded). This data call is currently implemented in an Excel workbook, with plans to migrate to a more user-friendly platform in the near future. The specific data elements requested for each planned DT activity are shown in Figure 9. While the number of fields requested may seem large at first blush, the pilot groups validated that completion of the information is quick as only a handful of the fields are free form response with the remainder being pull down selections or check boxes.

Figure 9: DT Alignment Matrix & SAO Technology Roadmap Fields

# Fields	Data Captured	Org Applicability
4	Organization & POC information	All
8	Existing, Planned, and/or Proposed Initiative/Project Specific Information	All
7	DT Alignment Matrix	All
3	NASA IT Strategy & Business Capability Model Alignment	All
7	Priority, Schedule & Funding	All
4	Dependencies, Partners, & Stakeholders	All
1	Notes/Comments/Questions	All
21	OCIO Transformation Service Portfolio Key Fields	OCIO Community Only

4.4. DT Forecast

Once organizations have submitted their DT plans (narrative document + DT Alignment Matrix), the DT initiative will conduct an integrated assessment of the plans against the TxTarget Roadmaps. This will provide a view of duplicative efforts by members of the community, which may be ripe for coordination or consolidation, as well as gaps, which may spark discussions within the community on whether reprioritization is appropriate. The assessment will also highlight organizational efforts that do not appear on the roadmap, which may be opportunities for alignment or indicate refinements are needed to the roadmaps. Taken together, this integrated assessment will enable NASA to forecast progress against the TxTarget Roadmaps, based on the organizational plans submitted. The conclusions from this integrated DT Forecast will be presented to agency senior leadership in order to inform final organizational investments as part of annual budget planning. In addition, the DT initiative intends to provide a searchable interface (accessible via DT’s internal SharePoint site, the DT Nexus) for organizations to be able to mine each other’s plans, within and across TxTarget communities. This integrated view of DT efforts will help organizations focus their transformation

activities by refining priorities, facilitating partnering and/or collaboration opportunities, providing knowledge and lessons learned of new capabilities and technologies in order to facilitate adoption and scalability faster.

4.5. DT Progress

Once organizational plans are implemented in year of execution, the DT initiative will monitor and extract progress of organizational efforts through existing reporting forums, such as the Baseline Performance Reviews (BPR) or Program Management Councils. The DT initiative will initially measure integrated progress of organizational efforts in the digital pipeline against Transformation Target community roadmaps and submit an integrated metric *“Project Progress in DT Pipeline (Ratio of DT efforts in Prototype: Pilot : Production)”* that will be shared via the OCIO’s Mission Support Program Management Council report. Green/Yellow/Red performance thresholds of this metric will correspond to the % of organizational activities being on plan against the roadmaps. As organizations increase coordination of their DT efforts and assess the progress of their integrated DT portfolios, the DT initiative intends to facilitate development of crisper metrics directly aligned with the 7+ Mission Outcomes to better measure and prioritize progress toward our ultimate transformation goals. Throughout NASA’s DT journey, the DT initiative will celebrate and share exemplars from organizational DT activities via forums such as DT’s Transformation Tuesdays seminar series in order to share best practices and lessons learned as well as promote leveraging.

4.6. DT Catalyst Projects

The DT initiative will mine both the TxTarget Roadmaps as well as organizational progress in execution to synthesize cross-cutting barriers and challenges that are inhibiting DT progress across NASA. The DT initiative has a modest investment budget to seed DT Catalyst Projects to elevate and address these cross-cutting barriers. Since the DT initiative is not an organization and does not and will not own any operational capabilities, these projects have finite start/end dates and finite scope with exit criteria and are intended to assist owning organizations in barrier resolution and/or adoption of key DT efforts needed by multiple organizations across NASA. These projects are always led and executed by a performing organization across NASA, and the DT initiative conducts a “project plan review” to document requirements, approach, and deliverables before releasing funds to the performing organization. The performing organization is responsible for ensuring delivery of the work using their own management forums, and DT only requests formal mid-year and end-of-year reviews on the activities, which serve as go/no-go decision gates for the efforts. Since many of the barriers and challenges that these DT Catalyst Projects address are high-risk, it is expected that some of these efforts will be cancelled when planned resolutions are determined to not be productive; the DT initiative will reallocate any end-of-year cancellation funds toward 3–6 month prototype projects aligned with investigation of Technology Foundations. Interested organizations can learn about and track progress of DT Catalyst Projects on the DT Nexus.

5. Conclusion

The DT Strategic Framework and associated implementation approach are designed to answer yes to the question, “are we digitally transforming NASA?” To achieve this, NASA must first be clear on why we need to transform (3 Future State Goals), where we need to begin (4 Transformation Targets), how we can best use digital advances to get us there (5 Digital Levers), which new digital technologies we need to adopt (6 Technology Foundations) and what results we are after (7+ Mission Outcomes). Then, because NASA has a federated operating

model with budget and decision authority for execution of our efforts (including digital efforts) allocated out to OICs, the DT initiative will facilitate alignment on what we need to achieve over the next five years (TxTarget Roadmaps) and facilitate planning on who is going to execute the various activities and when they expect to deliver (Organizational DT Plans). The DT initiative will assess planned activities against what is needed to predict progress we will make to inform annual investment decisions (DT Forecast) then infer organizational progress on DT efforts through regular performance management forums and score progress against the roadmaps (DT Progress Metric) and will invest in focused and finite activities to address cross-cutting barriers and challenges inhibiting DT progress across NASA (DT Catalyst Projects). Taken together, this DT Strategic Framework and implementation approach will accelerate NASA's ability to digitally transform NASA by creating alignment on what DT activities are needed, reducing duplication, and maximizing leveraging of DT efforts, and attacking barriers hindering DT progress and results.