MITRE

Blueprint for the Future of Grants Management

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Executive Summary

In fiscal year 2021, Federal agencies granted over 1.3 trillion dollars to state and local governments, universities, tribal nations, and other community-based organizations. The administrative burden and lack of transparency that permeate the grants ecosystem undermine achieving the intended outcomes of Federal grants and cooperative agreements.

Industry proposed to Federal government grants management leaders that the use of distributed ledger technology (DLT), commonly referred to as "blockchain," could be used to manage grants information as "digital assets." Unsure why this technology was necessary to solve their business challenges, the Federal government grants management leaders turned to MITRE, the independent, not-for-profit, operator of the U.S. Treasury Department's Federally Funded Research and Development Center (FFRDC), to identify how to best address grants management business challenges and evaluate the potential use of DLT.

A rigorous, iterative approach was used throughout this initiative, starting with a Research Study to verify with stakeholder communities the problems to be addressed, identify potential solutions, and identify how technology could enable a future state. Building on the results of the study, MITRE formed a public-private consortium of Federal and non-Federal end-user organizations, industry solution providers, and multi-organization communities of interest that collaboratively:

- Developed a Functional and Technical Definition of the future state, agnostic to specific technologies and useful to end-user communities and service/solution providers to plan, acquire, and implement the grants management future state.
- Designed, developed, integrated, tested, and evaluated the results of a Proof-of-Concept Technology Solution to demonstrate technical feasibility and identify additional technical considerations for an operational future state solution.
- Executed Solution Adoption Analyses to explore and address stakeholder concerns associated with implementing and sustaining the grants management future state.

The key outcomes from these collaborative efforts are:

- Confirmation of the potential benefits to each stakeholder community of a modified grants management business process where grants management entities post and retrieve grants information via a Distributed Grants Ledger without using the DLT for transfer of stored value (i.e., virtual- or crypto-currency).
- The Functional and Technical Definition of the future state vetted with representative end-user communities, service/solution providers, and multi-organization communities of interest.
- Demonstrated ability to implement the future state Functional and Technical Definition using a mixture of commercial and government providers, multiple technology products, and decentralized parallel development/deployment activities without requiring significant changes in existing technology products' user interface or internal data architecture.

- Confirmation that, although there are challenges, there are no significant barriers to successful implementation and adoption of the grants management future state and identification of important near-term and longer-term actions to enable successful implementation and use of the future state.

The next steps should be to use the body of knowledge presented in this Blueprint to:

- Initiate an operational pilot with an initial cohort of Federal and non-Federal government and private sector organizations supported by the Office of Management and Budget (OMB) and the Health and Human Services (HHS) Grants Quality Service Management Organization (Grants QSMO).
- Address solution adoption challenges related to legislation, policy, guidance, and standards through actions that include:
    - Congress updating Federal grants management legislation and OMB updating the Uniform Guidance regulations to:
        - Shift language from "reporting" to "making information available."
        - Eliminate references to current technologies and systems to enable the continuous evolution of solutions.
        - Emphasize the contractual relationship between grantmaking and grant recipient entities while also allowing for other authorized entities to receive grants management information and streamline payment request processing.
    - OMB and HHS updating grants management data standards to incorporate learnings from the Demonstration Project.
    - OMB establishing a policy for Federal grantmaking agencies to incorporate progress towards the grants management future state into their investment requests to acquire a new or modernize an existing grants management solution (GMS).
    - National Institute of Standards and Technology (NIST) developing grants management–specific information privacy and protection guidance.
    - National Archives and Records Administration (NARA) updating Federal records management guidance for information stored on a DLT.

MITRE and the government, university, community-based organization, and industry consortium partners have successfully demonstrated how to address the longstanding challenges of transparency and administrative burden in grants management. The Blueprint provides the business operating model, technology architecture and design, and action plan needed to achieve the future state. It will be imperative for Congress, OMB, and the Grants QSMO to leverage the work accomplished to date and actively lead and support grants management ecosystem stakeholders in this effort.

Acknowledgments

MITRE thanks the following Federal and non-Federal government and private sector organizations that contributed their knowledge, expertise, and efforts to the activities described in this document:

- American Council for Technology-Industry Advisory Council (ACT-IAC)
- AmpliFund
- Coral Blockchain
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- Health and Human Services (HHS) Administration for Children and Families (ACF)
- Health and Human Services (HHS) Program Support Center (PSC)
- Illinois Coalition Against Domestic Violence (ICADV)
- Indicio
- National Academy of Public Administration (NAPA)
- National Head Start Association (NHSA)
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- University of Washington
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1 Introduction

1.1 Background

MITRE is a not-for-profit organization chartered in the public interest to address issues of national importance. Through public-private partnerships and the federally funded research and development centers (FFRDCs) we operate, MITRE works across government to tackle challenges to the safety, stability, and well-being of our nation.

As an operator of FFRDCs, MITRE collaborates openly and closely with government agencies and private sector organizations, while also remaining independent and objective in our analyses, research, and interactions with the private sector on behalf of the government. When addressing government-wide challenges, we leverage our whole-of-government perspective and established relationships with many Federal and non-Federal entities to find the optimal solution that addresses each stakeholder's needs and risks, and do not presume the Federal government is the only or best entity to implement the optimal solution.

FFRDCs do not sell products or solutions. MITRE-funded research products and prototypes are made available to Federal government agencies at no cost to inform agency solution acquisition activities or be further developed by government or industry into production-ready ("minimum viable product") solutions.

MITRE's role in designing, conducting, and integrating the activities described in this Blueprint is that of an independent third party with expertise in grants management, financial management, distributed ledger technology (DLT), and system-of-systems engineering. MITRE leveraged the results of prior assistance to the Federal government establishing cross-government business capabilities and data elements for grants management and financial management.

MITRE and our private sector partners contributed human and technology resources to execute the activities described in this document, without financial support or compensation from the Federal government. Likewise, our Federal government partners contributed human resources without reimbursement to execute activities described in this document. All the parties conducted their work on a part-time basis, constrained by their organization's capacity and primary business or mission demands.

A rigorous, iterative, data-driven approach was used throughout the initiative to verify the grants management problems to be addressed from the perspective of each stakeholder community, identify potential mitigation actions and solutions, and evaluate how technology could enable an improved future state of grants management.

The activities executed and the associated timeframes to execute the activities described in this document are presented in Figure 1 below:

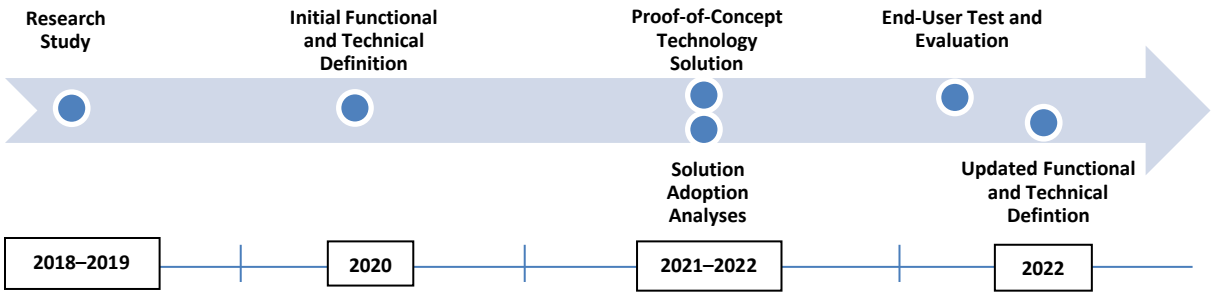

Figure 1. Timeline of Activities to Date

1.2 Blueprint Content

The Blueprint provides a summary of the activities and artifacts completed to date, our lessons learned to date, and the key activities needed for successful implementation and sustainment of the grants management future state.

The activities covered in the Blueprint include:

- The initial Research Study, which:
  - Validated the current state grants management problems to be solved.
  - Explored stakeholder community perceptions of the benefits, action items, challenges, and barriers to the proposed grants management future state.
  - Explored the use of traditional data management technologies vs. distributed ledger technologies.
- The Functional and Technical Definition that developed the business processes, business data and flows, and solution architecture for the grants management future state.
- The Proof-of-Concept Technology Solution which resulted in a cloud-based, distributed, End-to-End (E2E) functional solution evaluated by representatives from end-user communities.
- The Solution Adoption Analyses, which further explored and identified actions to address challenges and barriers to the implementation and sustainment of the grants management future state.

For each completed activity, the Blueprint describes the purpose, available artifact(s), approach used to execute the activity, and outcomes from executing the activity. For each artifact referenced, the Blueprint describes how to obtain the artifact and the artifact's content and intended use during the grants management future state implementation and sustainment.

The lessons learned section in the Blueprint provides a summary of the challenges encountered in executing the activities completed to date and recommendations for other organizations executing a similar initiative.

The key implementation and sustainment activities section in the Blueprint provides a summary of the actions needed to operationalize the grants management future state.

1.3 Blueprint Use

The primary use of the Blueprint is to provide the grants management stakeholder communities the information needed to implement and sustain the grants management future state. The grants management stakeholder communities include:

- End-user communities.
  - Grantmaking entities.
    - Federal government agencies.
    - State and local government agencies.
    - Grant recipient entities that issue subawards.
  - Grant recipient entities.
  - Independent auditors.
  - Federal and state inspectors general.
  - Public interest groups.
- Grants Management Service (GMS) providers.
  - Federal and state shared service providers.
  - Commercial service providers.
- Payment Request Processing Service (PRPS) providers.
  - Federal service providers.
  - State service providers.
- Grants Information Reporting and Analytics (GIRA) service providers.
  - Federal and state shared service providers.
  - Commercial service providers.
  - Other service providers (e.g., associations).
- DLT service providers.
- Legislation, regulation, policy, and standards-setting bodies.
  - Congress.
  - Office of Management and Budget (OMB).
  - Grants Management Standards Setting Agency (GSSA).
  - Grants Management Quality Service Management Office (Grants QSMO).
  - U.S. Department of the Treasury.

- National Institute of Science and Technology (NIST).
- National Archives and Records Administration (NARA).
- State and local government agencies.

By leveraging the results of this initiative and the information provided in this Blueprint, the grants management stakeholder communities listed above can make substantial progress on resolving their long-standing grants management challenges.

A secondary use of the Blueprint is to provide a knowledge resource for other organizations who are exploring the challenges, barriers, and implementation considerations of using "digital assets" and DLT to address business needs not easily satisfied by traditional data management technologies.

A tertiary use of the Blueprint is to provide a repeatable methodology for use by other organizations who want to address government-wide challenges through collaborative efforts between the government and private sector.

2 Research Study

2.1 Purpose

In October 2018, MITRE was approached by a group of Federal government agencies, including the Departments of Education, Health and Human Services, and Housing and Urban Development; the National Science Foundation; Office of Management and Budget; and Treasury Bureau of Fiscal Service, seeking FFRDC input on the potential to improve grants management by using blockchain technology.

In response, MITRE funded a Research Study to validate the current state grants management problems to be solved and explore the hypothesis that improvements in grants management for both Federal agencies and grant recipients could be enabled by implementing a blockchain-based solution ("a Distributed Grants Ledger"). The MITRE Research Study sought to identify:

- Impacts to grants management functions/activities related to grant payment processing, spending information sharing, and performance information sharing.
- Impacts to financial management functions/activities performing grant payment processes and reporting payment disbursement information.
- Business, organizational, programmatic, economic, technical, and operational impacts on Federal agency and grant recipient entities overseeing, managing, or using the Distributed Grants Ledger.

2.2 Outcomes

Outcomes of this activity were:

- Confirmation of the administrative burden and lack of timely, accurate, and complete data that exists in the current state operating model, which is based on point-to-point

information exchange (see Figure 2. Grants Management Current State Business Operating Model).

- Increased awareness and understanding by stakeholder communities of the use of blockchain technology for sharing information as "digital assets" (see Figure 2. Grants Management Current State Business Operating Model).
- Confirmation of the potential benefits to each stakeholder community of a modified grants management business process where grants management entities post and retrieve grants information via a Distributed Grants Ledger (see Figure 3. Grants Management Future State Business Operating Model) without using the DLT for transfer of stored value (i.e., virtual- or crypto-currency).
- Identification of the unique capabilities of blockchain technology to support the future state business operating model compared to traditional database technologies.
- Identification of important impacts and concerns related to topics other than technology that would require additional research and analysis to ensure successful and widespread solution adoption of the proposed future state business operating model.
- Unexpectedly strong support from multiple stakeholder communities for pursuing a demonstration project, which would include a proof-of-concept technology solution and further analysis of the solution adoption challenges.

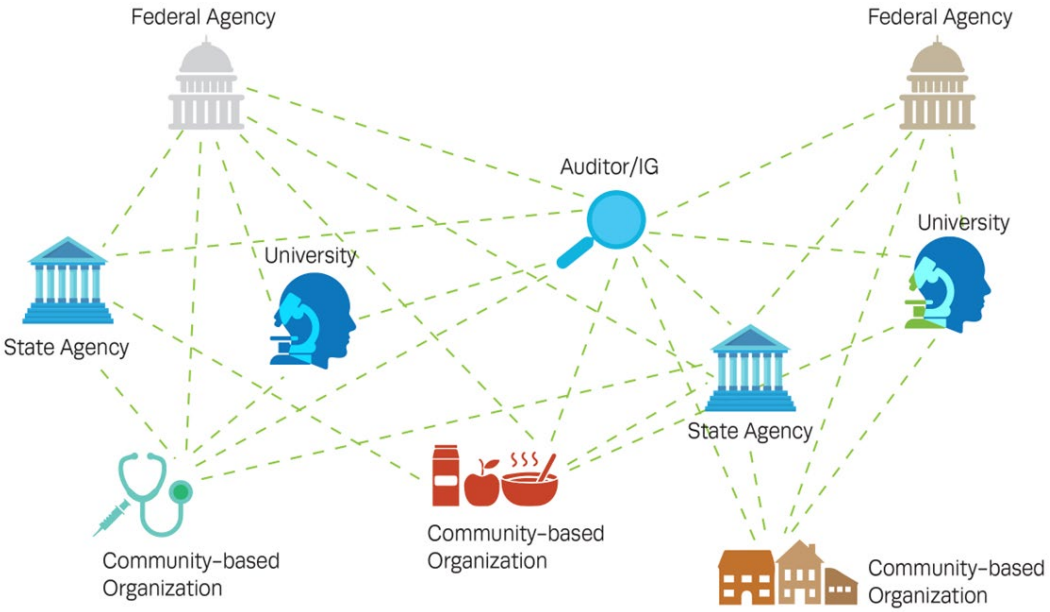

Figure 2. Grants Management Current State Business Operating Model

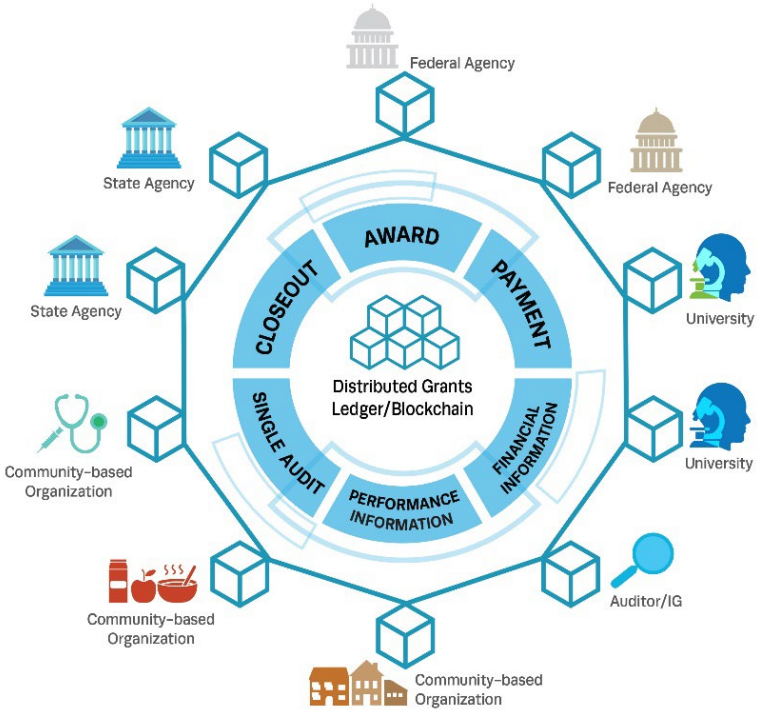

Figure 3. Grants Management Future State Business Operating Model

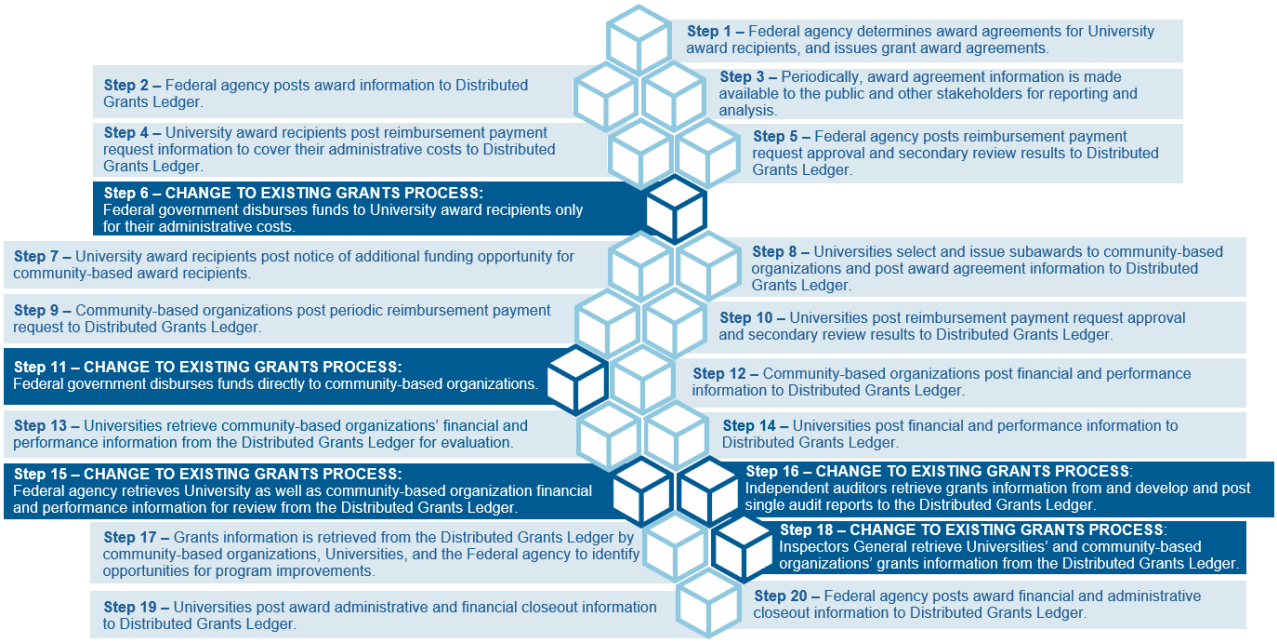

Figure 4. Grants Management Future State Leveraging DLT/Blockchain

2.3 Approach

To get a full picture of grants management challenges and whether utilizing a blockchain-based solution would improve grants management, MITRE engaged and interviewed experts from all sectors and aspects of the grants and financial management communities. We interviewed and consulted with Federal agencies, the Inspector General community, and first-, second-, and third-tier grant recipients which included state government agencies, public and private universities, community-based service organizations, and a tribal nation. Interviewees ranged from subject matter experts (SMEs) in grants management and payment processing, to those with expertise in blockchain solution design and implementation.

MITRE followed a disciplined analytical process to formulate study conclusions and recommendations. We launched the study in October of 2018 by:

- Establishing an Executive Advisory Group and Working Group with participants from the Departments of Education, Health and Human Services, and Housing and Urban Development; the National Science Foundation; Office of Management and Budget; and Treasury Bureau of Fiscal Service.
- Documenting study Objectives, Assumptions, and Constraints (OACs) and validating them with the Executive Advisory Group and the Working Group.
- Documenting a hypothetical new business operating model using business use cases (user stories) that were based on the Federal grants management and financial management business function/activity lists and blockchain capabilities.

From November 2018 through January 2019, MITRE conducted interviews and documented findings. This included:

- Developing interview pre-read materials and interview guide using the OACs, business use cases, impact categories and questions, and grant recipient award/funding profile information.
- Interviewing more than 25 Federal agency grants and financial management subject matter experts, numerous members of the Inspector General community, and three Federal agencies implementing blockchain solutions.
- Interviewing more than 30 grants and financial management professionals from 10 first-, second-, and third-tier grant recipient entities, including four universities, three community-based service organizations, agencies in two states, and a tribal nation.
- Documenting findings based on interviewee impact inputs.

In January and February 2019, MITRE analyzed the findings and developed conclusions. This included:

- Analyzing the business, organizational, programmatic, economic, technical, and operational impacts of the hypothetical new business operating model that uses a blockchain-based Distributed Grants Ledger and supporting Grants Documentation Repositories.
- Identifying potential mitigation actions to address impact challenges and barriers.
- Developing evidence-based conclusions and recommendations derived from the analysis of the findings.

MITRE completed the study in March of 2019. This involved:

- Reviewing study findings, analysis, conclusions, and recommendations with Executive Advisory and Working Group members and incorporating feedback.
- Issuing a final report with recommendations on next steps.

2.4 Artifacts

- **"Assessing the Potential to Improve Grants Management Using Blockchain Technology," May 2019** (*https://www.mitre.org/publications/technical-papers/assessing-the-potential-to-improve-grants-management-using-blockchain*) [1]
  - Provides: Summary of the research, including the hypothesis, approach, findings, conclusions, and recommendations.
  - Use: Gain a high-level understanding of the grants management ecosystem, stakeholder communities' business needs, and concerns related to the proposed future state of grants management.
- **"MITRE Grants Management-Blockchain Study Final Report (Federal Government Version)," March 2019** [2]
  - Provides: Details of the research, including the hypothesis; initial set of future state business use cases (user stories); initial set of OACs; approach; organizations interviewed; findings and conclusions by organization; overall analysis of traditional

vs. blockchain technologies for managing information; and recommendations for next steps.

- Use: For Federal agencies to gain an understanding of their specific agency and grant recipient communities' business needs and concerns related to the proposed future state of grants management.

3 Functional and Technical Definition

3.1 Purpose

The Functional and Technical Definition is the foundational set of documents that describe the business processes, business data and flows, and solution architecture used to develop the Proof-of-Concept Technology Solution. After the Proof-of-Concept Technology Solution was successfully built and tested, the Functional and Technical Definition documents were updated based on the results.

These documents are agnostic to specific technologies and are useful to end-user communities and service/solution providers to plan, acquire, and implement the future state business operating model that was validated by the Research Study.

3.2 Outcomes

Outcomes of this activity were:

- Functional and Technical Definition of the future state vetted with representative end-user communities, service/solution providers, and multi-organization communities of interest.
- Additional business process, information flows, and business rules information to guide development of the Proof-of-Concept Technology Solution.
- Additional impacts and concerns related to topics other than technology that would require additional research and analysis to ensure successful and widespread solution adoption of the proposed future state business operating model.
- Sufficient information for consortium partners to determine their desired role and level of effort/resources to contribute to the Proof-of-Concept Technology Solution.

3.3 Approach

As with the Research Study, MITRE engaged stakeholders from the grants end-user community, including Federal agencies, grant recipients, Inspectors General, and independent auditors. MITRE also engaged the private sector, including grant management solution providers, technology providers, and professional associations. MITRE established partnering arrangements through discussions with Federal agencies and executed non-disclosure agreements with private sector organizations, enabling the entities to collaborate as a public/private consortium. The consortium partners provided input to and feedback on the Functional and Technical Definition artifacts.

From March through September 2020, MITRE followed a rigorous process to develop an initial set of functional and technical artifacts that guided development of the solution. This included:

- Reviewing the findings, conclusions, and recommendations of the Research Study.
- Based on results from the Research Study and subsequent planning activities:
  - Revising and expanding the OACs.
  - Revising and expanding the future state business use cases.
  - Developing a proposed solution architecture.
  - Identifying the subset of Federal government published Grants Management Federal Integrated Business Framework (FIBF) Business Data Elements and any additional data elements needed to support the future state business use cases.
  - Developing business information flows based on the future state business use cases, solution architecture, and business data elements.
  - Researching current state grants management business ules and developing future state business rules based on the future state business use cases and business data elements.
  - Conducting iterative reviews of OACs, business use cases, information flows, business data elements, business rules, and solution architecture with the representative end-user communities, service/solution providers, and multi-organization communities of interest.

The Functional and Technical Definition artifacts were referenced routinely and updated incrementally as solution design and development progressed. After completion of the Proof-of-Concept Technology Solution and Solution Adoption Analyses, MITRE updated the Functional and Technical Definition artifacts to incorporate results of both activities.

3.4 Artifacts

- **"Grants Management Future State Objectives, Assumptions, and Constraints (OACs)," December 2022** [3]
  - Provides: Overall results to be achieved (objectives), working assumptions (dependencies), and constraints for the future state, organized into six categories:
    - Business.
    - Technical Design.
    - Operational Design.
    - Programmatic.
    - Economic.
    - Organizational.
  - Use: To evaluate proposed alternatives or modifications to the future state grants management business operating model or solution architecture.

- **"Grants Management Future State Solution Architecture," December 2022** [4]
  - Provides: Visual representation of the grants management ecosystem, solution components and boundaries, information repositories, and user interactions.
  - Use: As a high-level reference for end-user stakeholders to understand how the future state solution will work and for solution developers as an architectural guideline.
- **"Grants Management Future State Business Use Cases and Information Flows," December 2022** [5]
  - Provides: Textual and visual representations of the detailed business events that are executed during grants management processes, annotated with the information captured, generated, and shared by the solutions identified in the solution architecture.
  - Use: To evaluate proposed alternatives or modifications to the future state grants management business operating model or solution architecture.
- **"Grants Management Future State Business Data Elements and Business Rules," December 2022** [6]
  - Provides: Detailed descriptions, attributes, and groupings of information captured, generated, and shared in the future state, and the business rules that govern its execution, all conforming to the FIBF Grants Management Business Data Standards *(Grants Management Federal Business Standards and Capabilities)*.
  - Use: To modify and extend the Proof-of-Concept Technology Solution implementation.

4 Proof-of-Concept Technology Solution

4.1 Purpose

MITRE and the consortium teams designed, developed, integrated, tested, and evaluated the results of a Proof-of-Concept Technology Solution to demonstrate technical feasibility and identify additional business and technical considerations for an operational future state solution.

4.2 Outcomes

Outcomes of this activity were:

- Successful demonstration of future state E2E business processes and secure information exchanges.
- Demonstrated ability to implement the future state Functional and Technical Definition using a mixture of commercial and government providers, multiple technology products, and decentralized parallel development/deployment activities without requiring significant changes in existing technology products' user interface or internal data architecture (see Figure 4. Grants Management Future State Leveraging DLT/Blockchain).

- Identification of additional grants management business data elements ("data standards") that provide grantmaking entities, IGs, and independent auditors with improved visibility into award costs and performance
- Identification of design decisions needed to enable providers to build a marketplace offering and production operation–ready solutions.
- Test and evaluation results substantiated end-user community benefits when compared to the current state, as shown in Table 1. Benefits of the Future State Solution.
- Identification of additional capabilities that should be considered for an operational pilot. These are summarized in Table 2. Enhanced Capability Requests, and are further documented in the Test and Evaluation (T&E) Results files.
- Identification of technical items to be considered if Open Source Corda is chosen for the operational pilot (and may also be relevant if another DLT platform is chosen).

Table 1. Benefits of the Future State Solution

Stakeholder Group	Benefits of Future State Solution

Federal Agencies	• Access to award and subaward financial information in a consistent, machine-readable format addresses the challenges that some agencies face to align data across systems such as GrantSolutions, Health and Human Services Payment Management System (PMS), and internal agency systems ("done correctly, it would be a huge improvement").
	• Access to award and subaward information on disbursed funds by cost category enables comparison of actual costs against planned (budgeted) costs.
	• Access to subaward information enables a better view for social equity purposes.
	• Access to subaward entity and disbursement information by cost category.
	  ○ Eliminates the need for data calls to states and other passthrough entities.
	  ○ More efficient and comprehensive gathering of information currently captured in the Federal Subaward Reporting System (FSRS), as required by the Federal Funding Accountability and Transparency Act.
	• Access to single audit reports in a standardized, machine-readable format enables more efficient audit finding resolution, which is currently a very manual process; providing data to analytical tools that code, parse, and distribute findings releases personnel to perform value-added activities.
	• Having "one source of truth" that is accessible to staff at different grade levels and seniority:
	  ○ Improves pre-award risk assessment.
	  ○ Saves time and provides opportunities for more effective oversight.
	  ○ Reduces discrepancies between and resources required to maintain multiple agency IT solutions.
	  ○ Reduces time and effort to prepare and send grants information to USAspending.gov and increases accuracy of reported information.

Stakeholder Group	Benefits of Future State Solution
Award Recipients and Subrecipients	• Ability to receive award information in machine-readable format to automatically populate detailed data in recipient GMS is a significant time saver and reduces the likelihood of errors from data entry. • Information requested through data calls does not require manual effort. • Automating business rule checks streamlines reviews of subaward payment requests. • Where multiple passthrough entity agencies are involved in processing payment requests, subrecipient receives funds more quickly with fewer "hops" between agencies and without having to "re-disburse" Federal funds. • Elimination of data entry to FSRS is a significant reduction of burden and results in more accurate information. • Maximizing pre-population of information that is already in the hands of Federal agencies is a significant improvement; today the data is in different places, resulting in data duplication and problems with accuracy. • Receiving documentation for Single Audit and automated generation of the Schedule of Expenditures of Federal Awards (SEFA) from the ledger results in a significant savings in time. • Having a single source of information provides greater accuracy for first-tier and passthrough collection of subaward information. • However, standardizing performance and financial information requirements across Federal and state grantmaking agencies is needed to fully reduce reporting burden.
Inspectors General	• Access to award and subaward financial, cost, and performance information from a single source results in significant time savings and improved data accuracy where duplication of information is eliminated. • Access to subaward cost information results in significant time savings.
Independent Auditors	• Direct access to applicable entity award and subaward information saves time on retrieval and verification and yields more accurate results without relying on selected samples or notification of awards by recipient. • Eliminating the requirement to enter duplicate data into the Federal Audit Clearinghouse Data Collection Form saves time and increases accuracy.

Table 2. Enhanced Capability Requests

Stakeholder Group	Enhanced Capability Request
Federal Agencies	• Incorporate pre-award capabilities as part of the full grants management lifecycle. • Incorporate certificates of banking information to enable single validation. • Improve traceability to past-due debts of grant award recipients by integration with the Treasury Offset Program. • Connect accounts receivable and the return/repayment of funds from award recipients.
Award Recipients and Subrecipients	• Implement traceability from payment request through Federal Reserve Bank funds distribution instructions to award recipient bank deposit.
Inspectors General	• Enhance search capabilities. • Provide performance, financial, and budget data in addition to documentation (e.g., performance report PDFs). • Provide additional cost information (e.g., vendor data for purchases). • Provide additional indirect cost information.

Stakeholder Group	Enhanced Capability Request
Independent Auditors	• Provide award-specific audit findings for individual grant awards in addition to reporting at recipient entity level.

4.3 Approach

MITRE used the results of the Research Study and the Functional and Technical Definition to identify what was known and unknown about the future state technology solution and its adoption by grants management stakeholders. Based on this information and the selection criteria presented in Table 3 below, MITRE determined that a proof-of-concept was the appropriate next step because a prototype would not provide sufficient information to address grants management stakeholder adoption concerns, and stakeholders were not yet able to support a pilot.

Table 3. Comparison of Prototype, Proof-of-Concept, and Pilot Solutions

	Overview	Technical Characteristics	Functional Characteristics	Selection Criteria
Prototype	• Partially developed solution • Intended to test specific subset of technology or functionality • Not ready for production use	• Technically incomplete • Likely developed and run in an isolated test bed or lab (i.e., not integrated or tested with any production-equivalent infrastructure components) • Does not typically address security, performance/ capacity, interfacing solutions, and technology operations	• Functionally incomplete • Not integrated and tested with any agency business policies/procedures or interfacing business processes • Does not address organizational success factors (e.g., training, communications, performance measurement, etc.)	• Technology: Unproven for intended business domain • Adoption: Focus on technology exploration but not business process, programmatic, and workforce concerns • Funding: Minimal
Proof-of-Concept	• Partially developed solution • Intended to test ability of solution (or subset of solution) to address specific outcome/ objective • Not ready for production use	• Technically incomplete • Likely integrated and tested with 1–2 production-equivalent infrastructure components in a test environment • May partially address security, performance/capacity, interfacing solutions, and technology operations	• Functionally partially complete • Integrated and tested with a subset of agency business policies/procedures or interfacing business processes • May partially address organizational success factors (e.g., training, communications, performance measurement, etc.)	• Technology: Unproven for intended business domain • Adoption: Focus on technology exploration as well as business process, programmatic, and workforce concerns • Funding: Limited

	Overview	Technical Characteristics	Functional Characteristics	Selection Criteria
Pilot	• Fully developed solution • Ready for production environment and use in "live" business operations with a subset of users or customers or locations	• Technically complete • Integrated and tested with production infrastructure components • Addresses security, performance/capacity, interfacing solutions, and technology operations	• Functionally complete • Integrated and tested with agency business policies/procedures and interfacing business processes • Addresses organizational success factors (e.g., training, communications, performance measurement, etc.)	• Technology: Proven for intended business domain • Adoption: Approaches to address business process, programmatic, and workforce concerns have been defined but not fully implemented • Funding: Sufficient for initial implementation and sustainment but not widespread implementation

To create the Proof-of-Concept Technology Solution, MITRE and the consortium teams used the Functional and Technical Definition to develop a solution design, developed and integrated software components of the future state solution, and worked with representatives of the end-user communities to plan and execute end-user tests and evaluations of the future state solution.

4.3.1 Solution Design

From October 2020 through March 2021, MITRE and the consortium teams developed the high-level technical design and prepared to begin software development. This included:

- Assembling two teams, each consisting of a GMS provider, a distributed ledger technology provider, a Federal agency, and a grant award recipient. Each team took responsibility for one of two business use cases.
- Reviewing Functional and Technical Definition artifacts.
- Assessing alternatives and selecting an open source distributed ledger technology platform.
- Developing and documenting high-level physical and software designs for the distributed ledger technology platform.
- Developing and documenting high-level designs for the front-end GMS software and user interfaces.

The solution architecture for the Proof-of-Concept Technology Solution is illustrated in Figure 5 below.

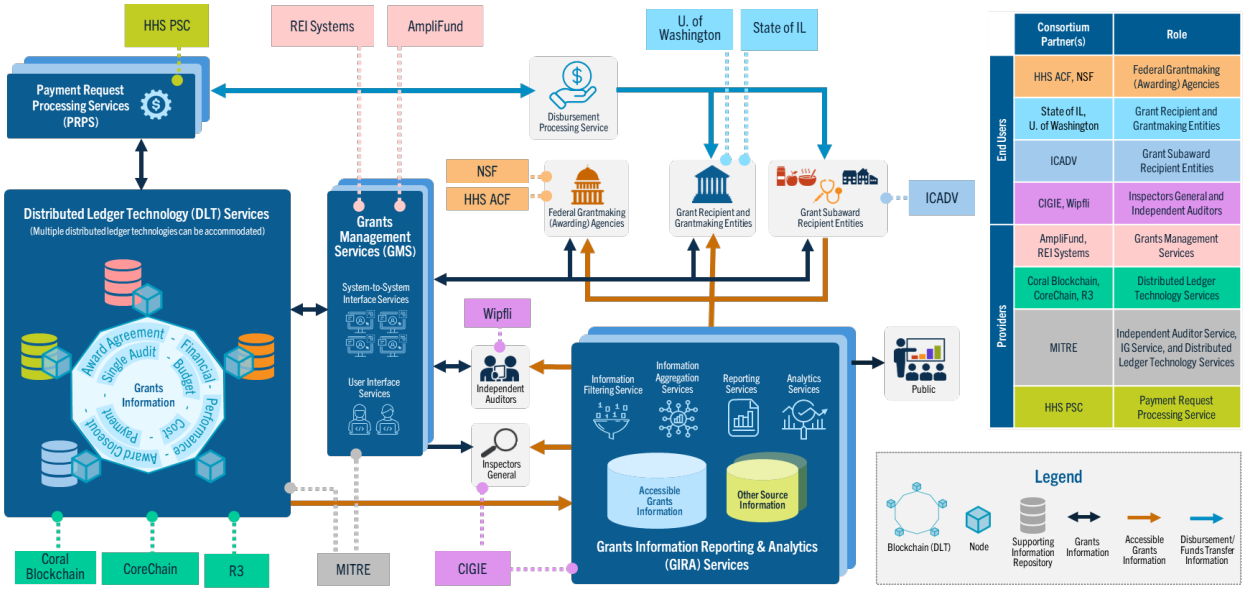

Figure 5. Proof-of-Concept Technology Solution Architecture

4.3.2 Solution Development

From April 2021 through April 2022, MITRE and the consortium teams developed the detailed design for the software components of the Proof-of-Concept Technology Solution. This included:

- Mapping GMS data to the Grants Management FIBF Business Data Elements.
- Developing shared code ("end points") for exchanging information and executing business rules via the Distributed Grants Ledger.
- Developing extensions to the commercial GMS user interfaces and back-end software to connect to the Distributed Grants Ledger end points and supporting Grants Documentation Repositories.
- Developing user interfaces and back-end software for the Inspector General and Independent Auditor Services.

4.3.3 Solution Integration

From May 2022 through October 2022, MITRE and the consortium teams performed integration testing to identify and resolve software issues prior to End-User T&E. This included:

- Developing test cases for each business use case transaction between the front-end GMSs and the back-end distributed ledger end points.
- Executing test cases and resolving software issues as they were identified.
- Performing regression testing when common software changes were made.
- Conducting E2E testing for each business use case.

- Conducting hybrid testing to verify that each GMS could successfully execute transactions with other GMSs.
- During this time, the team also prepared for End-User T&E. This included:
  - Developing an End-User T&E Framework documenting:
    - Current state conditions and challenges for each end-user group (i.e., Federal agency, first-tier award recipient, etc.).
    - Future state conditions to be demonstrated during End-User T&E sessions.
    - Criteria for capturing end-user feedback to address future state improvements in efficiency, data accuracy, and data completeness.
  - Obtaining end-user feedback to refine and validate current state conditions for each end-user group.

Table 4 below illustrates the approach used for the T&E framework.

Table 4. End-User T&E Framework

Current State (baseline) challenges and Future State for each Business Use Case stage			End-User Evaluation Feedback		
Activity	**Condition**		**Efficiency (# of Access Points/Steps)**	**Data Accuracy (Likelihood of Erroneous Data)**	**Data Completeness (Likelihood of Incomplete Data)**
GRM.030.010 Award Issuance <or> GRM.040.010 Award Modification (First-Tier Award)	**Baseline**	* Describes current state challenges for the end user during each part of the lifecycle	1. Will it save the user time? 2. Require fewer steps? 3. Transmit information between parties more efficiently?	Is data less likely to contain errors: 1. due to manual data entry between systems? 2. due to information stored in multiple systems that may get out of synch?	Is more information available: 1. to make informed decisions? 2. to manage risk? 3. for analysis (using external tools)?
	Future State	* Describes the future state during each part of the lifecycle, as demonstrated in the Proof of Concept * If greyed out, the capability will be part of the Future State, but not demonstrated in the Proof of Concept			

4.3.4 End-User Test and Evaluation

In November 2022, MITRE and the consortium teams conducted End-User T&E. Each team executed the steps of their business use case for end-user stakeholders, who provided feedback that was captured in the T&E Framework for each business use case activity.

4.4 Artifacts

- **"Grants Management Future State Distributed Ledger Technology (DLT) Analysis," December 2022** [7]
  - Provides: DLT Participation Model, DLT Platform Comparison.
  - Use: Identify DLT characteristics required for the future state solution and provide parameters for selection of the DLT platform.
- **"Grants Management Future State Design Specifications," December 2022** [8]
  - Provides: Business Process Model, Data Model, Software End Point Reference Guide.
  - Use: Reference for detailed business process specification, distributed ledger state and object model specifications, and description of software endpoints and usage for the business use cases used in the Proof-of-Concept Technology Solution.

- **"Grants Management Future State Infrastructure Specifications," December 2022** [9]
  - Provides: Physical Architecture, Network Map.
  - Use: As a reference for infrastructure and GMS providers.
- **"Grants Management Future State Software Artifacts," December 2022** [10]
  - Provides: Common ("back-end") Software, Node Deployment Process, Front-end Setup Processes, Test Data.
  - Use: As a set of baseline solution components to be built out for an operational pilot.
- **"Integration Test and E2E Test Plan," December 2022** [11]
  - Provides: Sequence of test cases for integration of software components.
  - Use: As a baseline for initial and regression testing of operational pilot functionality.
- **"End-User Test and Evaluation (T&E) Framework," December 2022** [12]
  - Provides: Consistent approach for evaluating feedback for each business use case activity from the perspective of the stakeholder group.
  - Use: Capture and evaluate end-user feedback based on stakeholder group business needs.
- **"End-User Test and Evaluation Results: Federal Agencies," December 2022** [13]
  - Provides: End-user feedback captured in T&E sessions.
  - Use: Reference information.
- **"End-User Test and Evaluation Results: Award Recipients and Subrecipients," December 2022** [14]
  - Provides: End-user feedback captured in T&E sessions.
  - Use: Reference information.
- **"End-User Test and Evaluation Results: Inspectors General," December 2022** [15]
  - Provides: End-user feedback captured in T&E sessions.
  - Use: Reference information.
- **"End-User Test and Evaluation Results: Independent Auditors," December 2022** [16]
  - Provides: End-user feedback captured in T&E sessions.
  - Use: Reference information.

5 Solution Adoption Analyses

5.1 Purpose

Even with the best technology solutions, major change initiatives cannot be successful without addressing stakeholder concerns associated with solution implementation and use. Detailed analyses of the concerns identified by grants management ecosystem stakeholders were conducted to document how they will be addressed in the future state business operating model by the solution architecture and/or through actions to be executed during implementation and sustainment of the grants management future state.

5.2 Outcomes

Outcomes of this activity were:

- Confirmation that, although there are challenges, there are no significant barriers to successful implementation and adoption of the grants management future state.
- Identification of stakeholder community concerns related to implementation and use of the future state and how they will be addressed, vetted with representative end-user communities and service/solution providers, as well as multi-organization communities of interest.
- Identification of important near-term and longer-term actions to enable successful implementation and use of the future state business operating model and solution architecture.

5.3 Approach

MITRE executed an iterative approach to the Solution Adoption Analyses activity. For each challenge area, we conducted research, determined findings, documented how the future state will address challenges, and proposed actions to address remaining future state challenge areas. The analyses and resulting documentation were reviewed with stakeholders and updated based on stakeholder feedback. Finally, MITRE integrated the findings and recommendations across challenge areas.

5.3.1 Planning

In April 2021, MITRE prepared to conduct Solution Adoption Analyses for the five challenge areas. This included:

- Analyzing the detailed results of the Research Study and feedback gathered during stakeholder reviews of the initial Functional and Technical Definition.
- Organizing the potential impacts, recommended mitigation actions, and future state concerns by grants management ecosystem stakeholder community and the categories of:
    - Governance.
    - Economics and funding.

- Legislation, regulation, and policy/guidance.
- Organizational and workforce change.
- Data integrity, access, and use.

5.3.2 Governance and Economics/Funding Analysis

From May through August 2021, MITRE conducted analysis on the governance and economic/funding challenges. This included:

- Researching various public-private governance models, including their strengths, dependencies, and challenges.
- Identifying characteristics for the grants management future state governance structure that could address stakeholder governance concerns.
- Researching industry marketplace economic models and governance structure funding models.
- Identifying the marketplace economic model and governance structure funding approach that could potentially sustain the proposed future state of grants management.
- Reviewing the combined results of the governance, economic, and funding analyses with consortium partners to gather and integrate their feedback.

5.3.3 Legislation, Regulation, Policy, and Guidance Analysis

From July through September 2021, MITRE conducted analysis on the challenges related to legislation, regulations, policy, and guidance. This included:

- Reviewing legislation, regulations, policy, and guidance relevant to Federal grants management.
- Identifying where the future state grants management business operating model and/or solution architecture enabled compliance with and achievement of objectives in the legislation/regulation/policy/guidance.
- Identifying how new and where changes to existing legislation/regulation/policy/guidance could enable a successful implementation and adoption of the grants management future state.
- Reviewing the results of the legislation, regulation, policy, and guidance analysis with consortium partners to gather and integrate their feedback.

5.3.4 Organizational and Workforce Change Analysis

From August through October 2021, MITRE conducted analysis on organizational and workforce challenges. This included:

- Researching leading practices in organizational and workforce change, and issues associated with the use of DLT.

- Identifying organizational and workforce changes necessary for the successful adoption and use of the future state business operating model and solution architecture, including stakeholder communication and engagement as well as stakeholder competency/skill development.
- Reviewing the results of the organizational and workforce change analysis with consortium partners to gather and integrate their feedback.

5.3.5 Data Integrity, Access, and Use Analysis

From September 2021 through January 2022, MITRE conducted analysis on Data Integrity, Access, and Use challenges. This included:

- Researching public-private data protection and sharing leading practices and issues associated with the use of DLT.
- Identifying policies/guidance and technology design and operation capabilities that would be needed to ensure appropriate grants management data integrity, access, and use.
- Reviewing the results of the data integrity, access, and use analysis with consortium partners to gather and integrate their feedback.

5.4 Artifacts

- **"Grants Management Future State Solution Adoption Analyses," December 2022** [17]
  - Provides: Categories of grants management ecosystem stakeholder communities; descriptions of value that the future state will provide each stakeholder community; detailed and summarized descriptions of stakeholder communities' concerns and how concerns will be addressed in the future state business operating model and/or by the solution architecture; detailed and summarized actions needed for successful implementation and use of the grants management future state.
  - Use: To develop implementation and action plans and stakeholder communication and engagement strategies; to evaluate proposed alternatives or modifications to the future state grants management Functional and Technical Definition.

6 Lessons Learned

MITRE and the consortium members were successful because we continuously engaged stakeholders throughout the execution of the initiative and employed a rigorous, data-driven, iterative approach to understanding business needs, challenges, and barriers and evaluating technical alternatives before starting to develop technology solutions.

The following lessons learned were identified:

- Because all the consortium partners were executing their respective activities using contributed, part-time resources, the initiative activities took longer than originally

expected, and it was critical to have an agile schedule, regular check-ins with each partner, and frequent progress/issue discussions facilitated among the partners.

- Because this initiative was exploring a future state that would require a significant shift in the public-private business operating model and an innovative use of emerging technologies, it was prudent to use an iterative funding approach with go/no-go gates tied to results of key activities and incremental feedback from stakeholder communities on whether to continue to move forward.
- Because this initiative involved Federal, non-Federal, public, and private organizations with differing objectives, risks to be managed, and areas of knowledge and expertise, it was crucial to have a trusted neutral organization with the appropriate organizational, functional, and technical expertise to perform the role of coordinator and integrator. This enabled the consortium partners to engage with each other more readily and collaboratively and with confidence that any issues would be resolved timely and equitably.
- Because the future state solution architecture included multiple services based on different technologies and developed by multiple teams, the integrator organization had to be prepared to oversee and validate each team's technical progress and, when needed, step in to develop the end-to-end integrated technical design and key components that connect the services or were needed across the service development teams.

7 Key Implementation and Sustainment Activities

7.1 Moving Toward the Future State

Based on the results obtained from evaluating the Proof-of-Concept Technology Solution and executing the Solution Adoption Analyses, MITRE and the consortium members recommend the next step of initiating one or more operational pilots (reference Table 3. Comparison of Prototype, Proof-of-Concept, and Pilot Solutions).

One or more operational pilots are recommended because:

- Technical criteria for a pilot have been met, and solution adoption criteria have been identified.
- The scope of the grants management stakeholder community is immense and extends across Federal, State, and Local governments, universities, and numerous community-based organizations; widespread implementation of a major change in business process and technology such as this takes time.
- The funding needed for widespread implementation will not be available to all stakeholders at the same time; stakeholders will need time to plan, budget, and implement over an achievable timeframe in concert with other stakeholder priorities and initiatives.

Operational pilots will accomplish the following:

- Provide the initial successful implementation needed by the Federal government to embrace and promote the Grants Management Future State Solution to State and Local governments and to the private sector.
- Allow time needed by OMB to update regulations and policy that foster widespread implementation.
- Establish the initial governance structure that can be refined and expanded for subsequent implementations.
- Provide an initial set of business use cases needed by standards setting bodies to develop DLT-specific guidance addressing privacy, records management, and security.
- Develop and evaluate approaches to improving end-user data analytics skills and competencies based on an initial set of end users.

The success factors for operational pilot participants, key activities to prepare for the operational pilot(s) and subsequent implementations, and key activities to address solution adoption challenges are presented in the following sections.

7.2 Identify Pilot Participants and Support Organizations

OMB and the Grants Management Quality Service Management Organization (QSMO) will need to play a leadership role in:

- Identifying and supporting the Federal agencies intending to execute an operational pilot.
- Establishing the initial governance structure needed to manage the operational pilot(s).
- Assisting pilot participants in obtaining project funding (e.g., from the Technology Modernization Fund).

To execute a successful operational pilot, the Federal agency, grant recipient, and service provider entities should have the characteristics and resources described in Table 4. Pilot Participant Characteristics and Resource Needs.

In addition to the Federal agency, grant recipient, and service provider entities characteristics and resources described above, pilot participants will need assistance from:

- MITRE to transfer Grants Management Demonstration Project knowledge to pilot participants and the initial governance structure.
- An entity reporting to the initial governance structure with the appropriate grants management, technology, and program management expertise to orchestrate, evaluate, and assist in pilot participant activities.

Table 5. Pilot Participant Characteristics and Resource Needs

Entity	Characteristics	Required Resources
Federal Agency	• Mission-driven need to improve grants management. • Willingness to modify existing grants management business processes where needed to conform to future state business operating model. • Has existing GMS Provider willing to connect GMS to DLT Service or willing to procure a new GMS Software-as-a-Service (SaaS) that will connect to DLT Service SaaS. • Has existing PRPS Provider willing to connect payment processing solution to DLT Service or willing to establish an agreement with a new PRPS Provider that connects payment processing solution to DLT Service.	• Grants management subject matter experts (SMEs) (government). • If existing GMS to be used: ◦ GMS SMEs. ◦ Technology resources and environments for development, test, and production operations (preferably cloud-based).
Grant Recipients and Subrecipients	• Willingness to modify grants management business processes where needed to conform to future state business operating model. • Has existing GMS Provider willing to connect GMS to DLT Service or willing to procure new GMS SaaS that will connect to DLT Service SaaS.	• Grants management SMEs. • If existing GMS to be used: ◦ GMS SMEs. ◦ Technology resources and environments for development, test, and production operations (preferably cloud-based).
GMS Service Provider(s)	• Willingness to map existing GMS data structure to Grants Management (GRM) Business Data Elements and, if necessary, add business data elements to GMS data structure. • Willingness to develop skills/knowledge to integrate GMS to DLT Service or subcontract to DLT Service Provider.	• GMS functional and technical SMEs. • Technology environments for development, test, and production operations (preferably cloud-based).
PRPS Provider	• Willingness to map existing PRPS payment data structure to GRM Business Data Elements and, if necessary, add business data elements to PRPS payment data structure. • Willingness to develop skills/knowledge to integrate with DLT Service to PRPS or subcontract to DLT Service Provider.	• PRPS functional and technical SMEs. • Technology environments for development, test, and production operations (preferably cloud-based).
DLT Service Provider(s)	• Willingness to leverage Grants Management Demonstration Project solution architecture and design. • Willingness to develop skills/knowledge to connect DLT Service to GMS and PRPS.	• DLT technical SMEs. • Technology environments for development, test, and production operations (preferably cloud-based).
GIRA Service Provider(s)	• May be the same entity as the GMS Provider or a separate entity. • Willingness to map existing GIRA grants management data structure to GRM Business Data Elements and, if necessary, add business data elements to GIRA grants management data structure or willingness to develop new GIRA Service based on GRM Business Data Elements. • Willingness to develop skills/knowledge to connect GIRA to DLT Service or subcontract to DLT Service Provider.	• GIRA functional and technical SMEs. • Technology environments for development, test, and production operations (preferably cloud-based).

7.3 Conduct Operational Pilot(s)

7.3.1 Review and Update Demonstration Project Artifacts

Before initiating technology service/solution acquisition activities for the operational pilot, key Demonstration Project artifacts must be reviewed by and may need to be tailored to the pilot participants. The review and tailoring of the artifacts should be conducted in a manner that proactively and continuously engages stakeholders and ensures continued conformance to the Grants Management FIBF business standards. The Demonstration Project artifacts to be reviewed and, if needed, tailored are listed below:

- Functional and Technical Definition.
  - OACs.
  - Business Use Cases.
  - Information Flows.
  - Business Rules.
  - Solution Architecture.
- Proof-of-Concept Technology Solution.
  - DLT Analysis.
  - Design Specifications.
  - Infrastructure Specifications.
  - Integration Test and E2E Test Plan.
  - End-User Test and Evaluation Framework.
- Solution Adoption Analyses.
  - Solution Adoption Analyses.

When reviewing and tailoring the OACs, solution architecture, and infrastructure specifications, attention should be given to technology security, capacity, performance, and operations needs specific to the pilot participants. Once these artifacts have been reviewed and tailored, they should then be used to inform operational pilot investment, project management, acquisition, and organizational change activities.

7.3.2 Execute Operational Pilot(s)

As the operational pilot progresses, successes, lessons learned, and recommendations for subsequent implementations should be documented and disseminated by the governance structure to grants management stakeholder communities. In addition, an evaluation of the governance structure should be conducted to identify any needed changes.

The strategy for identifying participants for subsequent implementations of the grants management future state should take into consideration the following factors:

- Which grantmaking entities and grant recipients have mission-driven needs to improve grants management.
- Whether the Federal government can provide grant program incentives for grantmaking entities and grant recipients to adopt the grants management future state.
- Whether the Federal government intends to issue directives to grantmaking entities and grant recipients to adopt the grants management future state.
- Progress made by service providers to adapt their offerings to conform to the grants management future state.

As each subsequent implementation participant cohort is identified, the key Demonstration Project artifacts identified above should be reviewed by and tailored to those participants to inform investment, project management, acquisition, and organizational change activities.

7.4 Address Solution Adoption Challenges

To ensure successful implementation and sustainment of the grants management future state, grants management stakeholder concerns related to the following topic areas must be addressed:

- Governance, economics, and funding.
- Legislation, regulations, policy, and guidance.
- Organizational and workforce change.
- Data integrity, access, and use.

The Solution Adoption Analyses identified the actions needed to address grants management stakeholder concerns in the above topic areas and recommended entity to execute each action:

- Governance structure.
- Legislation, regulation, policy, and standards setting bodies.
- Service providers.
- End-user communities.

The detailed list of actions identified in the Solution Adoption Analyses have been summarized into higher-level activities and grouped by stakeholder community to be used as input to the planning for the operational pilot(s) and subsequent implementations. Many of the activities will be initially executed during the operational pilot(s), then revisited during subsequent implementations and refined/expanded based on the results of the operational pilot(s).

The following tables identify the stakeholder community, a description of the needed activities, the Solution Adoption Analyses actions from which the activity was derived, and any dependencies between activities.

Table 6. Key Activities: Governance Structure

Governance Structure							
Activity ID	Activity Dependencies	Activity Description	Solution Adoption Studies				
			Governance Model	Economic and Funding Model	Legislation, Regulation, and Policy/ Guidance	Organization and Workforce Change	Data Integrity, Access, and Use
GS.01		Develop charter and establish legal structure for governance members.	G.1.1.1; G.1.3.1	E.1.1.1			
GS.02	GS.01	Determine cost and obtain funding for governance structure operations.		E.1.2.1; E.1.2.2; E.1.2.5; E.1.2.6; E.1.2.7			
GS.03	GS.02	Hire staff and contractor to enable governance operations.	G.1.2.1; G.1.2.2				
GS.04	GS.03	Develop policies and procedures for governance operations and ecosystem oversight and monitoring.	G.1.2.3; G.1.2.4				
GS.05	GS.03	Develop policies and procedures for managing the solution architecture and design.	G.2.3.2; G.2.3.3				
GS.06	GS.03	Develop and execute communication plans tailored for each stakeholder group.		E.2.1.1		O.1.1.1	
GS.07	GS.03	Determine if technologies from previous implementation(s) are sufficient to operationalize Grants Future State.	G.5.1.2				
GS.08	GS.03	Determine how to deconflict and/or integrate Federal and state and local government legislation, regulation, policy, guidance, and standards.	G.4.2.1				

Governance Structure							
Activity ID	Activity Dependencies	Activity Description	Solution Adoption Studies				
			Governance Model	Economic and Funding Model	Legislation, Regulation, and Policy/ Guidance	Organization and Workforce Change	Data Integrity, Access, and Use
GS.09	GS.08	Determine review/approval process and cadence for implementing changes in legislation, regulation, policy, guidance, and standards.	G.4.1.1				
GS.10	GS.03	Determine how compliance with regulations and standards will be monitored.	G.2.4.1				D.2.1.1; D.3.1.2
GS.11	GS.03	Develop service provider entry criteria and evaluation process.	G.2.3.1				
GS.12	GS.11	Engage with Grants QSMO to assess Federal agency readiness to adopt Grants Future State Solution.		E.2.1.3			
GS.13	GS.12	Perform service provider Grants Future State Solution demand and readiness assessment.	G.2.1.1	E.2.1.2; E.2.3.1			
GS.14	GS.12	Establish service provider agreements.	G.2.5.1				D.1.1.1; D.2.3.2
GS.15	GS.05	Manage solution architecture and design, including assessment and implementation of proposed changes.	G.2.4.2; G.2.4.3; G.5.1.1; G.5.1.3; G.5.1.4; G.5.1.5; G.5.3.1				D.2.3.1
GS.16	GS.05	Respond to issues arising through the monitoring of the technical and operational health of the Grants Future State Ecosystem.	G.5.2.1				

Governance Structure							
Activity ID	Activity Dependencies	Activity Description	Solution Adoption Studies				
			Governance Model	Economic and Funding Model	Legislation, Regulation, and Policy/ Guidance	Organization and Workforce Change	Data Integrity, Access, and Use
GS.17	GS.03	Conduct small business outreach activities and, if feasible, provide guidance or assistance to enable participation as Service Providers in the marketplace.	G.2.2.1				
GS.18	GS.03	Conduct under-served/disadvantaged community outreach activities and, if feasible, provide guidance or assistance to support participation as grant recipients in the Grants Future State ecosystem.	G.3.1.1				

Table 7. Key Activities: Standard Setting Bodies

Standard Setting Bodies							
Activity ID	Activity Dependencies	Activity Description	Solution Adoption Studies				
			Governance Model	Economic and Funding Model	Legislation, Regulation, and Policy/ Guidance	Organization and Workforce Change	Data Integrity, Access, and Use
SSB.01		Establish policy for Federal grantmaking agencies to incorporate the Grants Future State Solution into investment requests to acquire a new GMS or modernize an existing GMS.		E.2.1.4	L.3.1.2	O.3.1.1	
SSB.02		Establish policy to transition from agency and program-specific form-/report-based submission of grants information to retrieval of grants information from an OMB-approved information sharing service.			L.3.1.3		
SSB.03		Update Code of Federal Regulations (CFR) and OMB Memorandum to enable achievement of the desired outcomes of the Grants Future State Ecosystem.		E.2.1.5; E.2.1.6; E.2.2.1	L.2.1.1; L.2.1.2; L.2.2.1; L.2.3.1; L.2.4.1; L.2.5.1; L.2.6.1; L.3.1.1; L.3.1.4	O.3.1.2; O.3.1.3	
SSB.04		Update GRM business standards based on learnings from previous implementation(s), including identification of general and program-specific business rules for award lifecycle activities.				O.4.1.1; O.4.2.1	D.1.2.1; D.3.1.1
SSB.05		Perform data sensitivity analysis of grants information passed to the DLT to identify data protection requirements.					D.2.2.1

Standard Setting Bodies							
Activity ID	Activity Dependencies	Activity Description	Solution Adoption Studies				
			Governance Model	Economic and Funding Model	Legislation, Regulation, and Policy/ Guidance	Organization and Workforce Change	Data Integrity, Access, and Use
SSB.06	SSB.05	Define Federal information security/protection and records retention policies and guidance when grants information is stored in a DLT Service (ledger and Grants Supporting Information Repositories [GSIRs]) that may or may not be managed by a Federal agency.					D.1.3.1; D.2.2.2; D.2.2.3; D.2.2.4
SSB.07	SSB.05	Determine grants information that will be made available to the public.					D.3.2.1
SSB.08		Establish policies and procedures that require users to attest/certify integrity of information entered in their GMS and stored on the ledger.					D.1.1.2
SSB.09		Establish policies, procedures, and requirements for foreign and tribal nation grant recipient participation.					D.2.1.2

Table 8. Key Activities: Service Providers

Service Providers							
Activity ID	Activity Dependencies	Activity Description	Solution Adoption Studies				
			Governance Model	Economic and Funding Model	Legislation, Regulation, and Policy/ Guidance	Organization and Workforce Change	Data Integrity, Access, and Use
SP.01	GS.02; GS.13	Incorporate sufficient funding for operating reserves into service fees.		E.2.2.2			

Table 9. Key Activities: End User Communities

End User Communities							
Activity ID	Activity Dependencies	Activity Description	Solution Adoption Studies				
			Governance Model	Economic and Funding Model	Legislation, Regulation, and Policy/ Guidance	Organization and Workforce Change	Data Integrity, Access, and Use
All End User Communities							
EUC.01	GS.06	Create workforce training plans for Federal awarding agency personnel, independent auditors, and Inspectors General to develop skills and competencies in analytics.				O.2.1.1	
Federal Government Grantmaking Agencies							
EUC.02	SSB.05	Develop program- and/or award-specific guidance for grant recipient and subrecipient entities on appropriate handling of sensitive and classified grants information.					D.2.2.5
EUC.03	GS.02	Obligate sufficient funding to support ongoing governance operations.		E.1.2.3; E.1.2.4			

Appendix A List of Artifacts

[1] The MITRE Corporation, "Assessing the Potential to Improve Grants Management Using Blockchain Technology," May 2019. [Online]. Available: https://www.mitre.org/news-insights/publication/assessing-potential-improve-grants-management-using-blockchain-technology.

[2] The MITRE Corporation, "MITRE Grants Management-Blockchain Study Final Report (Federal Government Version)," 2019.

[3] The MITRE Corporation, "Grants Management Future State Objectives, Assumptions, and Constraints (OACs)," 2022.

[4] The MITRE Corporation, "Grants Management Future State Solution Architecture," 2022.

[5] The MITRE Corporation, "Grants Management Future State Business Use Cases and Information Flows," 2022.

[6] The MITRE Corporation, "Grants Management Future State Business Data Elements and Business Rules," 2022.

[7] The MITRE Corporation, "Grants Management Future State Distributed Ledger Technology (DLT) Analysis," 2022.

[8] The MITRE Corporation, "Grants Management Future State Design Specifications," 2022.

[9] The MITRE Corporation, "Grants Management Future State Infrastructure Specifications," 2022.

[10] The MITRE Corporation, "Grants Management Future State Software Artifacts," 2022.

[11] The MITRE Corporation, "Integration Test and E2E Test Plan," n.d.

[12] The MITRE Corporation, "End-User Test and Evaluation (T&E) Framework," n.d.

[13] The MITRE Corporation, "End-User Test and Evaluation Results: Federal Agencies," n.d.

[14] The MITRE Corporation, "End-User Test and Evaluation Results: Award Recipients and Subrecipients," n.d.

[15] The MITRE Corporation, "End-User Test & Evaluation Results: Inspectors General," n.d.

[16] The MITRE Corporation, "End-User Test and Evaluation Results: Independent Auditors," n.d.

[17] The MITRE Corporation, "Grants Management Future State Solution Adoption Analyses," 2022.

Appendix B Abbreviations and Acronyms

Term	Definition
ACF	Administration for Children and Families
ACT-IAC	American Council for Technology-Industry Advisory Council
CIGIE	Council of Inspectors General on Integrity and Efficiency
DLT	Distributed Ledger Technology
E2E	End-to-End
FFRDC	Federally Funded Research and Development Center
FIBF	Federal Integrated Business Framework
FSRS	Federal Subaward Reporting System
GIRA	Grants Information Reporting and Analytics
GMS	Grant Management Service
GRM	Grants Management
GSIR	Grants Supporting Information Repository
HHS	Health and Human Services
ICADV	Illinois Coalition Against Domestic Violence
NAPA	National Academy of Public Administration
NHSA	National Head Start Association
NSF	National Science Foundation
OAC	Objectives, Assumptions, and Constraints
OMB	Office of Management and Budget
PRPS	Payment Request Processing Service
PSC	Program Support Center
QSMO	Quality Service Management Organization
SaaS	Software-as-a-Service
SME	Subject Matter Expert
T&E	Test and Evaluation