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| RESEARCH ARTICLE

Digital Finance Architecture for the Public Sector: Redesigning U.S. Tax and Fund Distribution Systems with FAST™ and DFRA™

Rahul Bhatia
Senior IEEE Member, Independent Researcher, United Kingdom
Corresponding Author: Rahul Bhatia, **E-mail**: : rahul.bhatia20@ieee.org

| ABSTRACT

Public sector finance in the United States is at a critical juncture. The tax collection and fund distribution processes that underpin federal, state, and local governance were designed for an earlier era, and today's complex, high-speed digital economy exposes their limitations. With trillions of dollars flowing annually through these systems, inefficiencies and fraud are no longer minor inconveniences—they are systemic risks that erode public trust and weaken national resilience. In 2022, the U.S. Government Accountability Office reported $247 billion in improper payments across federal programs, while pandemic relief initiatives such as the Paycheck Protection Program (PPP) saw unprecedented fraud losses exceeding $100 billion. These failures highlight the urgent need for an architectural redesign. This paper argues that tax and fund distribution must now be treated as critical national infrastructure. Beyond modernizing legacy systems, the U.S. requires a digital-first, fraud-resistant, and future-ready financial architecture. Frameworks such as the Finance Architecture Strategy Technology (FAST™) and Digital Finance Reference Architecture (DFRA™) offer structured approaches to embed compliance, transparency, and scalability into the core of financial operations. By leveraging cloud-native enterprise platforms like SAP S/4HANA Public Cloud, integrating AI and robotic process automation (RPA), and preparing for post-quantum cryptography (PQC), the U.S. can build an ecosystem where every dollar collected is traceable, every disbursement transparent, and fraud minimized by design. The contribution of this paper is twofold: first, to diagnose the structural weaknesses of U.S. tax and fund distribution; and second, to propose a framework-led, architecture-first redesign aligned with national priorities of resilience, accountability, and citizen trust.

| KEYWORDS

Digital Finance Architecture, Public Sector Financial Systems, U.S. Tax and Fund Distribution, Fraud Prevention in Public Finance, Finance as Critical Infrastructure, Cloud ERP (SAP S/4HANA Public Cloud), Finance Architecture Strategy Technology (FAST™) Framework, Digital Finance Reference Architecture (DFRA™), Government Accountability and Transparency, National Financial Resilience, Public Sector Modernization

| ARTICLE INFORMATION

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1. Introduction

Public finance underpins the stability and prosperity of any nation. In the United States, federal, state, and local governments collectively manage budgets exceeding $7 trillion annually [1]. These funds sustain critical services such as healthcare, defense, infrastructure, education, and social welfare. Yet the systems responsible for collecting taxes and distributing funds are increasingly incapable of meeting modern demands.

The U.S. relies on a patchwork of legacy enterprise resource planning (ERP) systems, siloed databases, and manual processes. The Internal Revenue Service (IRS) still operates core functions on code dating back to the 1960s [4]. State and local agencies manage their budgets with disparate systems, limiting real-time oversight of federal transfers. This fragmentation results in inefficiency, lack of transparency, and vulnerability to fraud.

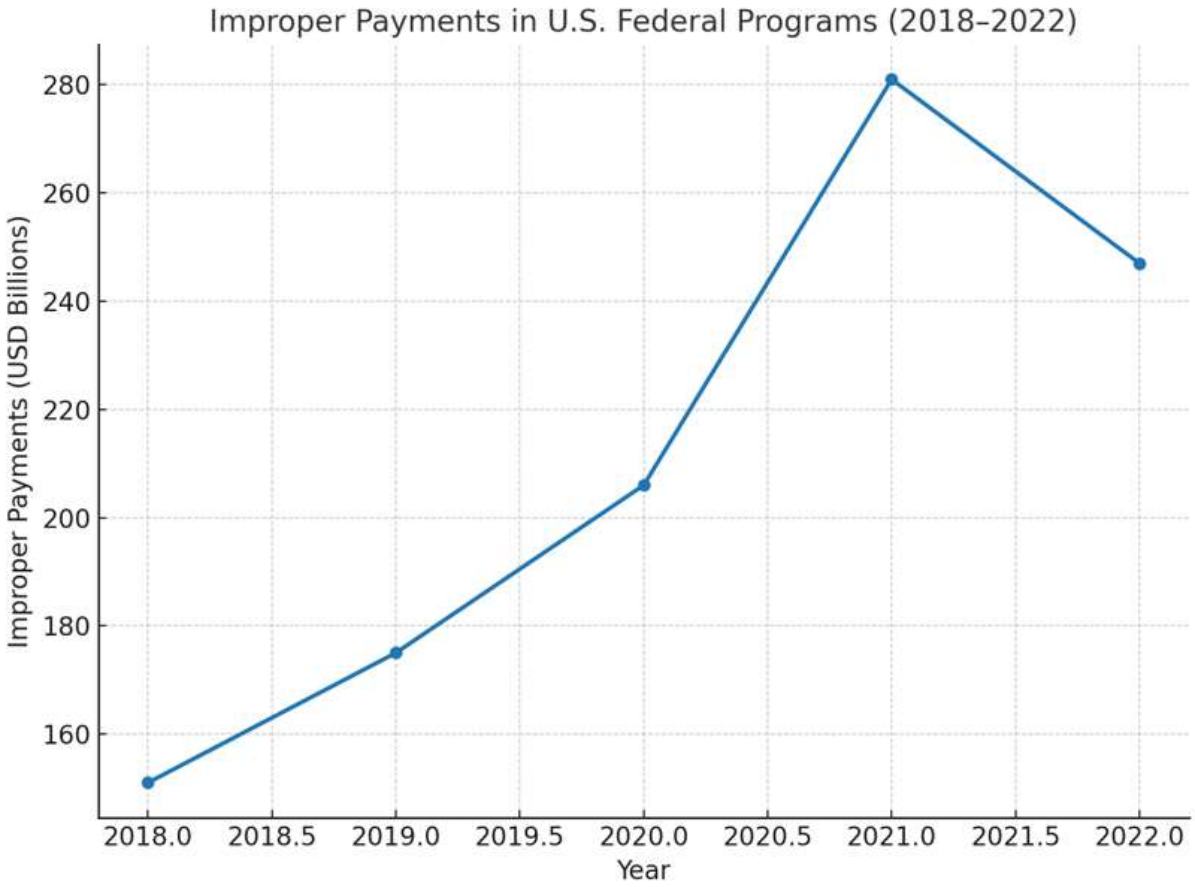
The scale of the problem is enormous. In 2022, the Government Accountability Office (GAO) estimated $247 billion in improper payments across federal programs [2]. Medicare and Medicaid alone lose tens of billions each year to fraud [6]. Pandemic-era relief programs revealed systemic weaknesses: the Paycheck Protection Program (PPP) and unemployment insurance disbursements were exploited at an unprecedented scale, with fraud estimates between $100–$200 billion [3].

These losses are not abstract—they represent taxpayer dollars failing to reach intended beneficiaries. More importantly, they undermine public trust at a time when trust in government institutions is already fragile.

This paper proposes that U.S. tax and fund distribution systems must be redesigned, not merely modernized. The guiding principle should be to treat financial systems as *critical infrastructure*—as essential to national resilience as energy grids or transportation networks [10]. By leveraging digital finance frameworks, cloud-native platforms, and intelligent automation, the U.S. can transform its financial architecture into one that is transparent, resilient, and fraud-resistant.

2. Current Challenges in U.S. Public Sector Tax and Fund Distribution

The U.S. public finance system operates at one of the largest scales in the world, handling trillions of dollars annually in tax revenue and government disbursements [1]. Despite its size and importance, the underlying financial infrastructure is riddled with inefficiencies, fragmentation, and vulnerabilities that compromise both fiscal performance and public trust. This section outlines the key challenges under five interrelated dimensions: legacy systems, fragmentation, fraud, manual processing, and lack of real-time visibility.



Source: Government Accountability Office. Improper Payments: Fiscal Year 2022 Estimates. GAO-23-106285. Washington, DC: GAO; 2023.

2.1 Legacy Systems and Technical Debt

The persistence of outdated IT infrastructure is among the most pressing challenges. The Internal Revenue Service (IRS), responsible for collecting approximately $4 trillion in federal revenue annually, continues to rely on the Individual Master File (IMF) and Business Master File (BMF), core systems developed in the 1960s using COBOL [4]. These platforms, while functional, present multiple problems:

- **Maintenance Burden:** Legacy systems require highly specialized skills that are increasingly scarce, driving up maintenance costs and creating dependencies on a shrinking pool of IT professionals.
- **Inflexibility:** Modifying or upgrading these systems is costly and risky, which slows the adoption of new processes or technologies.
- **Integration Barriers:** Legacy IRS systems are not easily interoperable with state and local platforms, limiting the potential for a holistic, national financial view.

The GAO has consistently flagged IRS modernization as a high-risk area, citing repeated delays and budget overruns in attempts to replace IMF and BMF [2,4]. Technical debt in core finance systems therefore remains a structural weakness that constrains broader digital transformation.

2.2 Fragmentation Across Federal, State, and Local Levels

Another structural challenge lies in the fragmented nature of U.S. fiscal architecture. Federal funds typically flow from the Treasury to state governments, then down to local agencies and ultimately to service providers or beneficiaries [5]. At each stage, funds are often managed using different ERP systems, accounting practices, and reporting formats. This results in:

- **Siloed Data:** Information about fund allocations and expenditures is dispersed across systems that do not communicate with one another.
- **Delayed Reporting:** Consolidated reports can take months to produce, limiting policymakers' ability to make data-driven decisions.
- **Accountability Gaps:** Federal oversight is weakened because it lacks timely, standardized reporting from states and municipalities.

For example, during the rollout of pandemic relief funds, many states struggled to report on the actual flow of funds to local agencies and businesses due to incompatible financial systems [9]. This fragmentation significantly reduces transparency and slows corrective action when irregularities occur.

2.3 High Exposure to Fraud and Improper Payments

The sheer volume of funds managed by U.S. public finance systems makes them attractive targets for fraud. Improper payments, defined as payments made in error or obtained through fraudulent means, totaled $247 billion in fiscal year 2022 [2]. Medicare and Medicaid are particularly affected, losing tens of billions annually to fraudulent claims [6].

The COVID-19 pandemic further exposed vulnerabilities. The Paycheck Protection Program (PPP), designed to quickly deliver aid to small businesses, was exploited by criminal networks and fraudulent applicants. Investigations by the SBA Office of Inspector General estimate that over $100 billion was lost to fraud and abuse [3,21]. Similarly, state-administered unemployment insurance programs saw extensive fraud, with cases of identity theft, false claims, and organized crime exploiting weak verification processes.

These events reveal a fundamental weakness: fraud detection is often reactive and occurs *after* funds have already been disbursed. Without architecture-level controls, such as embedded anomaly detection and real-time verification, fraudsters can exploit systemic blind spots.

2.4 Manual Processes and Operational Inefficiencies

Despite the scale and complexity of U.S. financial operations, many agencies continue to rely heavily on manual workflows. Tasks such as reconciliations, claims validation, and financial reporting are often spreadsheet-driven [7]. This has several consequences:

- **Human Error:** Manual processing increases the likelihood of mistakes in financial records, misclassifications, and miscalculations.
- **Slow Response Times:** Manual workflows are time-intensive, delaying fund disbursement and reporting.
- **Misallocation of Resources:** Skilled financial staff spend significant time on repetitive tasks rather than strategic oversight and policy analysis.

The GAO has noted that this reliance on manual controls is particularly problematic in high-volume programs such as Medicaid, where the complexity of claims processing creates multiple points of vulnerability [6].

2.5 Lack of Real-Time Visibility and Transparency

Transparency is foundational to public trust in financial governance. However, the U.S. currently lacks the ability to provide policymakers and citizens with real-time, end-to-end visibility of how taxpayer dollars are collected, allocated, and spent [8]. Key issues include:

- **Delayed Oversight:** By the time consolidated reports are produced, the opportunity to intervene in cases of misallocation or fraud has often passed.
- **Reactive Governance:** Oversight bodies are forced into a reactive stance, identifying problems after they have already materialized.
- **Reduced Citizen Trust:** Without transparency, citizens remain skeptical about whether their tax dollars are used effectively.

For instance, during the disbursement of pandemic relief funds, oversight committees highlighted the difficulty of tracking how federal allocations flowed through states to local programs [9]. The lack of real-time dashboards or integrated reporting platforms meant that accountability was delayed and partial at best.

2.6 The Systemic Impact

Taken together, these challenges represent more than operational shortcomings—they are systemic risks. Technical debt limits modernization, fragmentation obstructs oversight, fraud drains public resources, manual processes slow responsiveness, and lack of transparency erodes trust. The combined effect is a financial infrastructure that is **fragile, inefficient, and ill-suited to the needs of a digital-first economy**.

As subsequent sections of this paper argue, addressing these weaknesses requires an **architecture-led redesign** rather than piecemeal fixes. The frameworks of FAST™ and DFRA™ are designed to tackle these very challenges, embedding resilience, transparency, and fraud prevention into the core of U.S. financial operations.

3. Why Redesign is Essential

Addressing these challenges requires more than incremental modernization. A **full architectural redesign** is essential.

3.1 Transparency at Scale

Taxpayers and policymakers must be able to trace every dollar from collection to final expenditure. Real-time dashboards, powered by digital finance architectures, can make this possible.

3.2 Fraud Prevention by Design

The weaknesses exposed during the pandemic highlight the cost of reactive, fragmented fraud detection. Fraud prevention must be embedded into the architecture itself through anomaly detection, rules-based controls, and intelligent monitoring.

3.3 Efficiency Gains

Automation of reconciliations, claims processing, and reporting will reduce errors and free staff to focus on oversight.

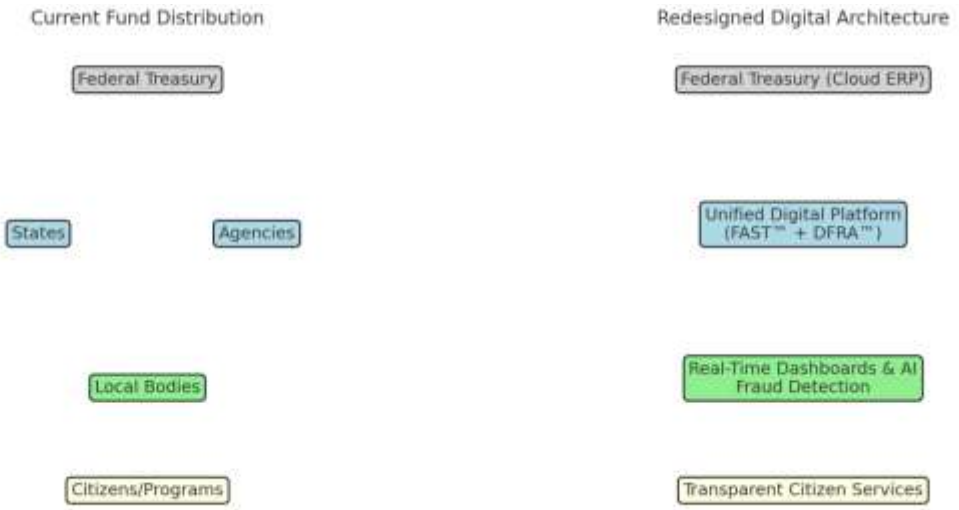
3.4 Agility in Crisis Response

Crises such as natural disasters and pandemics require rapid fund deployment. With legacy systems, this can take weeks; digital-first architectures can compress timelines to hours.

3.5 Finance as Infrastructure

The U.S. already classifies sectors such as energy, water, and transport as critical infrastructure. Financial systems are equally vital. They enable everything else. Positioning finance as infrastructure is essential for prioritization, funding, and protection [10].

Comparative lessons from countries like Estonia and Singapore demonstrate the feasibility of digital-first government finance. Estonia's e-Governance ecosystem provides real-time transparency, while Singapore's GovTech integrates finance and service delivery seamlessly. The U.S. must catch up.



4. Frameworks for Transformation: FAST™ and DFRA™

Technology alone cannot solve systemic problems. An architecture-led approach is required, anchored in structured frameworks.

4.1 The FAST™ Framework

The Finance, Architecture, Strategy, Technology (FAST™) framework is designed to embed compliance and fraud prevention into financial systems. Its key principles include:

- **Finance-first design:** Prioritizing control, compliance, and auditability.
- **Architecture-driven governance:** Embedding fraud detection and anomaly monitoring directly into system architecture.
- **Strategy alignment:** Linking financial flows to policy objectives in real time.
- **Technology enablement:** Leveraging AI, RPA, and blockchain for execution.

Applied to the PPP program, for example, FAST™ could have prevented fraud by enforcing eligibility verification, detecting anomalies in loan applications, and flagging suspicious fund flows before disbursement.

4.2 The DFRA™ Framework

The Digital Finance Reference Architecture (DFRA™) provides a modular, cloud-native blueprint for finance transformation. Its principles include:

- **Modularity:** Allowing agencies to migrate in phases, reducing risk.
- **Cloud-native architecture:** Leveraging platforms such as SAP S/4HANA Public Cloud for scalability and resilience [11].
- **Embedded compliance:** Ensuring regulatory requirements are integrated into workflows.
- **AI-driven analytics:** Providing predictive insights for revenue forecasting and fund allocation.

Together, FAST™ and DFRA™ offer a comprehensive approach: FAST™ secures compliance and fraud prevention, while DFRA™ ensures scalability, modernization, and future-readiness.

5. Technology Enablers

A redesigned architecture will leverage several key technologies:

The redesign of U.S. public sector tax and fund distribution architecture cannot be realized without the strategic adoption of enabling technologies. These tools, when deployed within structured frameworks such as FAST™ and DFRA™, form the backbone

of a digital-first financial infrastructure. The following subsections discuss key technologies that can enable transformation, with specific reference to their application in U.S. public finance.

5.1 Cloud Enterprise Resource Planning (ERP)

At the center of digital finance transformation lies **cloud-native ERP platforms**. Systems such as **SAP S/4HANA Public Cloud** are already being used by governments worldwide to achieve standardized, scalable, and continuously updated finance operations [11].

For the U.S., cloud ERP provides several advantages:

- **Standardization across jurisdictions:** Federal and state agencies can operate on consistent financial structures while retaining flexibility for local policies.
- **Continuous innovation:** Cloud ERP allows seamless adoption of updates, ensuring compliance with evolving accounting and tax standards.
- **Cost efficiency:** By reducing reliance on custom legacy systems, agencies lower long-term maintenance costs.

Cloud ERP thus becomes the **foundation layer** in DFRA™, providing the technical infrastructure upon which compliance, fraud prevention, and analytics are built.

5.2 Artificial Intelligence (AI) and Machine Learning (ML)

AI and ML are pivotal in transitioning from **reactive to proactive fraud detection**. Instead of waiting for audits, ML algorithms can analyze vast streams of financial data in real time to detect anomalies.

Practical applications in the U.S. context include:

- **Medicare billing analysis:** ML models can identify outlier claims that deviate from normal patterns, flagging potential fraud [12].
- **Unemployment benefits oversight:** AI can verify identity data across multiple datasets, reducing fraudulent claims.
- **Tax fraud detection:** Machine learning can compare income reporting across multiple channels, reducing underreporting.

When embedded into FAST™, AI models are not an "add-on" but an **integrated control mechanism** in the architecture, continuously scanning transactions and providing real-time alerts.

5.3 Robotic Process Automation (RPA)

While AI targets complex pattern recognition, **RPA addresses operational inefficiencies** in repetitive tasks. In public finance, this includes:

- Automating **fund reconciliations** between federal and state accounts.
- Processing **routine tax filings** without manual intervention.
- Generating **compliance reports** for OMB or GAO requirements [13].

RPA's significance lies in **freeing human resources**. Skilled finance staff can focus on oversight and strategic policy alignment rather than routine transaction processing. In DFRA™, RPA is placed within the **process optimization layer**, ensuring consistent, error-free workflows.

5.4 Blockchain and Distributed Ledgers

One of the most promising technologies for **public accountability** is blockchain. By providing an immutable ledger of transactions, blockchain ensures that once a fund allocation is recorded, it cannot be altered without traceability [14].

Potential U.S. applications include:

- **Disaster relief tracking:** FEMA disbursements could be monitored transparently, ensuring funds reach intended recipients.

- **Grant management:** Federal grants to universities, NGOs, and local governments could be tracked across their lifecycle.
- **Public dashboards:** Citizens could view blockchain-based records of fund allocation, strengthening trust in government spending.

Blockchain aligns with the **transparency pillar of FAST™**, embedding public accountability at the architectural level.

5.5 Post-Quantum Cryptography (PQC)

While current encryption methods such as RSA and ECC safeguard financial data, the emergence of **quantum computing** threatens to render them obsolete. PQC algorithms, currently being standardized by NIST, are critical to securing sensitive tax and citizen data against future threats [15].

In the context of U.S. public finance:

- **IRS and Treasury systems** that handle trillions in tax receipts must adopt PQC to avoid future vulnerabilities.
- **Healthcare data (Medicare/Medicaid)** linked to financial claims must remain secure under quantum scenarios.
- **State treasury systems** integrated into DFRA™ must be PQC-ready to ensure national financial resilience.

By integrating PQC readiness, DFRA™ ensures **future-proof security**, positioning financial systems as robust national infrastructure.

5.6 Data Integration and Real-Time Dashboards

Finally, a digital-first architecture requires **real-time, consolidated data visibility**. This is a major gap in current U.S. systems, where policymakers receive delayed and fragmented reports [8].

- **Unified dashboards:** Consolidate tax inflows and fund outflows across jurisdictions.
- **Predictive analytics:** Enable Treasury and OMB to forecast revenue and expenditure scenarios dynamically.
- **Citizen-facing portals:** Provide transparency into how taxpayer dollars are spent.

Within DFRA™, dashboards serve as the **presentation layer**, translating complex data flows into actionable intelligence for policymakers and transparency for citizens.

5.7 Integrated Impact

These enablers are not stand-alone technologies. Their real power emerges when **combined within a framework-driven architecture**. FAST™ ensures governance, fraud prevention, and compliance, while DFRA™ provides modular scalability and cloud-native infrastructure.

- **Cloud ERP** → provides standardization.
- **AI/ML** → detects anomalies proactively.
- **RPA** → eliminates inefficiencies.
- **Blockchain** → guarantees transparency.
- **PQC** → secures the future.
- **Dashboards** → deliver real-time accountability.

Together, they transform public finance into a system that is **transparent, resilient, and trustworthy**—a system where every dollar is traceable and every decision is data-driven.

6. Risks and Considerations

Any transformation of this magnitude carries risks:

- **Cybersecurity:** The 2021 SolarWinds breach demonstrated the vulnerability of federal systems [16].

- **Regulatory complexity:** Harmonizing GASB standards, IRS regulations, and OMB A-123 requirements will be challenging [17].
- **Change management:** Retraining government employees and restructuring processes requires cultural adaptation [18].
- **Digital divide:** Systems must be inclusive, ensuring that rural and underserved populations benefit equally [19].

These risks underscore the need for robust governance, phased rollouts, and sustained political commitment.

7. Policy & National Interest Alignment

A redesign of U.S. tax and fund distribution architecture is not simply a technological modernization effort; it is directly tied to policy priorities, national security, and economic resilience. For this reason, aligning digital finance transformation with the U.S. national interest is critical. This section examines how a finance architecture-led approach responds to four strategic imperatives: fraud reduction, transparency and accountability, resilience as critical infrastructure, and economic competitiveness.

7.1 Fraud Reduction as a National Priority

Fraud and improper payments represent a persistent challenge for U.S. governance. The GAO reported $247 billion in improper payments in fiscal year 2022 alone [2]. Programs such as Medicare, Medicaid, and unemployment insurance are repeatedly highlighted as high-risk for fraud and abuse [6].

The COVID-19 pandemic exposed the scale of vulnerability: the Paycheck Protection Program (PPP) and unemployment insurance benefits suffered fraud losses estimated between $100–200 billion [3,21]. Organized crime groups exploited weak verification systems and fragmented reporting structures, siphoning taxpayer dollars intended for struggling businesses and citizens.

Preventing fraud is not only a fiscal necessity but a matter of public trust. A digital finance architecture, guided by FAST™, directly addresses this by embedding fraud prevention into the system design itself. AI-driven anomaly detection, rule-based eligibility checks, and real-time monitoring mean that funds can be verified before disbursement, closing loopholes that fraudsters have historically exploited. This aligns with GAO recommendations for proactive, architecture-level controls [2].

7.2 Transparency and Accountability

Transparency in government finance is both a democratic imperative and a policy mandate. Federal guidelines such as OMB Circular A-123 emphasize management's responsibility for internal controls and risk management [17]. Similarly, the Governmental Accounting Standards Board (GASB) requires consistent financial reporting for state and local governments.

Yet, despite these frameworks, transparency is often delayed and incomplete due to the fragmentation of systems and reliance on manual reporting. Citizens and oversight bodies may wait months for consolidated reports, by which point funds may have already been misallocated or lost.

A digital-first architecture provides real-time dashboards that consolidate tax inflows and fund outflows across jurisdictions [8]. By embedding transparency into the architecture itself, policymakers, auditors, and citizens gain timely insights into financial flows. This not only fulfills policy mandates but also strengthens the democratic contract between government and taxpayers.

7.3 Finance as Critical Infrastructure

The U.S. Department of Homeland Security (DHS) defines critical infrastructure as systems so vital that their incapacitation would have a debilitating impact on national security, the economy, and public health [10]. Currently, sectors such as energy, water, and transportation are classified as critical infrastructure. However, public finance systems—through which trillions of dollars are collected, allocated, and distributed—are equally vital.

Classifying finance as critical infrastructure has two implications:

1. Prioritization of funding and cybersecurity resources for modernization.
2. Integration into national resilience planning, ensuring continuity even in the face of cyberattacks, natural disasters, or geopolitical threats.

The 2021 SolarWinds breach, which compromised multiple federal agencies, underscored the vulnerability of public systems [16]. If attackers were to target financial flows, the impact could be catastrophic. Embedding DFRA™ ensures cloud-native resilience, zero-trust security, and PQC readiness [15], aligning financial architecture with national infrastructure protection goals.

7.4 Economic Competitiveness and Agility

Efficient financial systems are not only about compliance—they directly affect economic performance. Delays in fund disbursement slow down infrastructure projects, healthcare delivery, and emergency relief. Conversely, streamlined systems accelerate policy implementation and economic impact.

For example, delays in disbursing CARES Act funds to local governments hampered pandemic response efforts in several states [9]. A digital-first architecture would have enabled near real-time allocation, ensuring timely relief. Similarly, infrastructure funding from the Bipartisan Infrastructure Law depends on efficient fund distribution mechanisms.

By adopting cloud-native finance systems with AI-enabled analytics, the U.S. can allocate resources more dynamically, responding to shifting economic conditions with agility. This enhances economic competitiveness, ensuring that public investments yield maximum benefit.

7.5 Global Leadership in Digital Governance

International benchmarks such as the OECD's Digital Government Index highlight how peer nations like Estonia and Singapore have achieved real-time financial transparency and citizen engagement [22]. The U.S., despite its technological leadership, lags behind in modernizing its public finance infrastructure.

By adopting frameworks like FAST™ and DFRA™, the U.S. not only addresses domestic challenges but also positions itself as a global leader in digital governance. This contributes to soft power and reinforces the U.S. as a model of transparent, accountable, and digitally resilient governance.

7.6 Integrated Policy Alignment

Taken together, these elements demonstrate clear policy and national interest alignment:

- Fraud reduction supports GAO and White House priorities [2,3].
- Transparency aligns with OMB A-123 and GASB mandates [17].
- Resilience addresses DHS's critical infrastructure framework [10].
- Economic competitiveness supports Treasury and OMB goals for efficient fiscal management [9].
- Global leadership reinforces U.S. standing in the international digital governance landscape [22].

This alignment underscores the central argument: a digital finance architecture is not a luxury but a national imperative. By treating finance as critical infrastructure and redesigning it with frameworks such as FAST™ and DFRA™, the U.S. can strengthen fiscal resilience, reinforce public trust, and secure its position in the digital age.

8. Conclusion & Recommendations

The U.S. cannot continue to rely on outdated financial systems to manage trillions in taxpayer dollars. The risks are too great, and the inefficiencies too costly. The failures exposed during the pandemic underscore the urgency of action.

Recommendations:

1. **Federal pilot programs:** Deploy SAP S/4HANA Public Cloud for fund distribution in selected states.
2. **AI-driven fraud detection:** Implement AI analytics in Medicare, Medicaid, and unemployment benefit programs.
3. **National blueprint:** Develop a U.S. Digital Finance Architecture, anchored in FAST™ and DFRA™, as a regulatory standard.
4. **Critical infrastructure classification:** Formally classify financial systems as national infrastructure, ensuring long-term funding and cybersecurity protection.

By adopting an architecture-led redesign, the U.S. can ensure every tax dollar is accounted for, every fund disbursement is transparent, and public trust in government finance is restored.

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ORCID iD https://orcid.org/0009-0007-8701-3320
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