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Digital Identities — Mobile Driver's License (mDL)

Accelerating Development and Adoption of mDLs for Financial Institutions

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SECOND PUBLIC DRAFT

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FEEDBACK

You can improve this guide by contributing feedback. As a second public draft, this document intends to gain critical feedback from stakeholders across government and industry on the implementation of mDL to support Customer Identification Programs and high-assurance use cases more broadly. Comments are welcome on all aspects of this document and specifically encouraged on the following areas:

1. **Document structure.** The initial public draft of NIST Special Publication (SP) 1800-42 (published March 2026) has been reorganized into separate documents for conciseness and to enable faster access to content. The base document provides a cross-sector overview of verifiable digital credentials, including security, privacy, and usability considerations. This document focuses on specific challenges and mDL adoption methodologies within the financial sector, building on content in the base document where appropriate. Feedback on this updated structure is encouraged.
2. **Same-device implementation.** The demonstration documented in the initial public draft has been updated to include a same-device scenario. The project team seeks feedback on the

implemented architecture and controls when using mobile apps and browsers in a same-device scenario.

3. **Implementation and Adoption Challenges**. This document highlights challenges to the adoption of mDL technology learned through engagement with collaborators and stakeholders spanning technology providers, financial institutions, standards bodies and government agencies. However, additional insights on barriers to adoption can help focus the project and future phases of work and NIST's engagement with standards development organizations.
4. **Regulatory and Compliance Alignment**. This document offers insights into the ways in which mDL online presentation aligns with existing regulatory structures. Additional insights on other regulatory mappings, views on the degree to which alignment is achieved, and suggested clarifications are encouraged.
5. **Technology Transfer and Resources**. This document, as well as the project resource hub, are intended to aid in implementation of the technology in real world environments. The project team is highly interested in additional resources and tools which may further aid in both technical implementation and broader technology adoption.
6. **Threats and Threat Model**. The threat model proposed here is intended to act as a starting point for members of the ecosystem to identify and prepare for how attacks may shift in an mDL environment. Input on approach, specific threats, and mitigations will be highly valuable in maturing this view and providing greater visibility into future risks.

Comments on this publication may be submitted to: mdl-nccoe@nist.gov.

Comments can also be submitted on the deliverables published on the project resource hub.

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All comments are subject to release under the Freedom of Information Act.

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The documents in this series describe example implementations of cybersecurity practices that businesses and other organizations may voluntarily adopt. These documents do not describe regulations or mandatory practices, nor do they carry statutory authority.

ABSTRACT

Mobile Driver's Licenses, and Verifiable Digital Credentials more broadly, represent an emerging technology with the capability to enhance the methods used to prove identity both in-person and online. Many sectors stand to benefit from this emerging technology, including financial institutions (FIs) seeking to enhance the security, privacy, usability, and reliability of online identity services. This practice guide captures insights generated through engagement with a robust cohort of industry collaborators and the lessons learned by developing a functional online mDL demonstration to provide a practical roadmap to enable adoption and implementation of mDLs for online financial account management.

KEYWORDS

authentication; credentials; identity; mobile driver's license (mDL); verifiable digital credentials.

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1 Executive Summary

- Identity proofing is the process of establishing that a person is who they claim to be. Online identity proofing is a critical security capability that relies on verifying identity evidence to protect individuals from identity theft and organizations from unauthorized access and fraud.
- Common online identity proofing processes, such as uploading an image of a driver's license or knowledge-based verification, are not optimized for online transactions and do not sufficiently mitigate against current threats, especially those posed by generative Super Intelligence (SI) (e.g., deepfakes).
- Mobile driver's licenses (mDLs), and more broadly Verifiable Digital Credentials (VDCs), are an emerging technology that, when implemented using standards and best practices, can help mitigate current threats to identity proofing systems, while also offering potential benefits in user experience and privacy.
- High-assurance relying parties, such as Financial Institutions (FIs), represent high value targets for identity-related fraud and are considering the adoption of mDLs to support Know Your Customer (KYC) processes. To move forward, however, FIs need a better understanding of how this technology integrates with their current identity systems and business processes, as well as insights into how mDLs meet Customer Identification Program (CIP) compliance requirements and the identity proofing component of KYC.
- To help address these needs, the National Cybersecurity Center of Excellence (NCCoE) at the National Institute of Standards and Technology (NIST) created this practice guide as part of a portfolio of resources to help FIs implement mDL standards and best practices using commercially available technology. This project highlights the potential security, privacy, usability, reliability, and compliance benefits that can result from an FI mDL deployment.
- FIs can use the tools and resources in this guide to assess the feasibility of integrating mDLs with their current technology and business processes while aligning to compliance requirements.
- To develop these resources, the NCCoE collaborated with technology providers, government agencies, standards bodies from across the mDL ecosystem, and the financial sector to build a laboratory environment that demonstrates a standards-based mDL architecture that integrates with financial institution identity systems and banking back ends.
- This architecture uses existing standards and commercial off-the-shelf technologies to demonstrate 1) the presentation of mDLs for online transactions as identity proofing evidence when a potential customer applies to open a financial account, 2) the provisioning and issuance of a phishing-resistant authenticator to applicants whose financial account is approved, and 3) the presentation of mDLs by financial institution customers as an additional security signal (often referred to as a step-up) when authorizing high-risk transactions.
- This practice guide is complemented by the resources published on the mDL project resource hub, to include a video demonstration of mDL implementation built in the NCCoE lab environment.

1.1 Key Findings

Over the course of the project and through collaborator engagement, the project team identified several factors that will influence the strategic direction and adoption of VDC and mDL. These findings include:

1. **FIs should begin assessing VDC and mDL technology adoption**. mDLs are currently in the hands of millions of Americans and have the potential to improve online Customer Identification Programs. While standards and ecosystem practices continue to mature, the assessment of integrating mDL adoption in high-assurance and regulated industries is a multi-year effort. Institutions that begin market research, proofs of concept, and pilots now will be better positioned to onboard mDL verification and realize the technology's potential benefits. This has only become more relevant with the recent regulatory FAQ[2] which makes clear that mDL and other VDC ***are acceptable*** forms of documentary evidence for Customer Identification Programs. The portfolio of resources published under this project can assist FIs in initiating their mDL journey.
2. **VDCs and mDLs Can Improve Security, Privacy, Reliability, and Usability of Online CIP**. mDLs present an opportunity to improve upon current CIP practices by providing accurate, integrity-protected information delivered through phishing-resistant mechanisms, with selective disclosure, and support for more efficient customer onboarding. This project demonstrates how mDLs can advance the security, privacy, reliability, and usability of online identity proofing by integrating them into financial sector account opening and high-risk transaction authorizations.
3. **High-Assurance Relying Parties Want Additional Trust Signals.** Financial institution collaborators see the value in this technology. However, the adoption of this technology hinges on the ecosystem understanding the needs and concerns of high-assurance and regulated sectors. Notably, shifting FIs to a new trust model will require a more consistent issuance process across states and territories, standardized holder verification techniques, enhancements to credential protocols to support access requirements, and trust establishment in the wallet as a key component of transactions.
4. **Scaled adoption requires greater standards and protocol ecosystem convergence.** Standards Development Organizations (SDOs) have laid the essential technical foundation for the mDL ecosystem. However, as the market shifts from pilot to commercial deployment, the project identified several areas where standards maturity and protocol fragmentation can cause implementation complexity for verifiers. This is particularly urgent for presentation protocols, where fragmentation currently complicates implementations for verifiers and Relying Parties (RPs). The ecosystem must prioritize aligning core specifications with RP requirements and progress towards operational stability. The project has brought these implementation findings to the relevant standards organizations who continue to evolve the protocols to meet market needs.

[2] In September of 2026 FinCEN and their regulative partners released guidance clarifying that mDL can be accepted as part of KYC processes.

2 Introduction to the Guide

This publication provides guidelines for organizations seeking to implement mDLs for online remote identity proofing (often referred to as identity verification) and high-risk transaction authorization (often referred to as "step-up"). The content in this guide is the result of a collaborative project at the NCCoE that developed, demonstrated, and documented an example mDL use case for Financial Institutions (FIs) such as banks. The NCCoE and its collaborators have used commercially available technology in lab environments to build a functional, interoperable, standards-based mDL implementation ("build"). While this guide contains information useful to any organization seeking to accept the online presentation of mDLs, the focus of the recommendations, considerations and resources in this document is to support financial institutions in accepting mDLs for online identity proofing and meeting CIP requirements.

2.1 Scope

The scope of this guide specifically covers the use of mDL by FIs in online identity verification scenarios. It provides guidelines on how implementers can deploy mDLs to improve security, privacy, and usability, while supporting Customer Identification Program implementation and reducing potential fraud vectors introduced by more traditional identity management technologies. It provides guidelines on the online presentation of mDL in support of identity proofing and high-risk transaction verification. User authentication is addressed through the deployment of Passkeys (i.e., WebAuthN/FIDO2 credentials [1][2]).

Note that this build did not cover the issuance of mDLs to a digital wallet; however, considerations for these processes are addressed in the NIST SP 800-63A profile, developed because of trust and governance discussions that arose over the course of the project. It is also discussed at a high level in the threat model. The issuance of corresponding physical IDs or RealID requirements at state issuers is out of scope.

The mDL project is a multi-phase collaborative effort, and this document describes only the first phase, which focuses on an FI use case. The next use case will address the use of mDLs in a government or public sector use case. The scope of each guide is as follows:

- SP 1800-42 is the base document that covers information applicable generally across mDL deployments.
- SP 1800-42A specifically addresses how mDLs can be deployed to meet the requirements of Financial Institutions (FIs) and aligns with Customer Identification Program (CIP) requirements.
- SP 1800-42B focuses on mDL deployments with Federal and State government credential service providers and relying parties.

2.2 Audience

The audience for this guide is anyone looking to implement mDLs, as well as any person or organization that engages with or relies upon mDL, VDC, and identity proofing technologies. This includes but is not limited to:

- Financial institutions and other high-assurance relying parties
- State and federal agencies
- Technology vendors (e.g., wallets, verifiers, IDMS)
- Standards bodies and regulators
- Cybersecurity, privacy, risk, and compliance professionals
- General members of the public interested in digital identity

2.3 How to Use This Guide

The NCCoE mDL project offers three complementary channels for publishing knowledge, lessons learned, and guidelines relevant to the mDL ecosystem:

1. The mDL Blog Series – The blog series provides a high-level introduction to VDCs, mDLs, and the concepts, technologies, and standards that underpin the ecosystem.
2. The NIST mDL Resource Hub – The resource hub is how the project team iteratively releases deliverables under the mDL project to more quickly get stakeholder feedback and publish information that may not be well-suited for standard PDF documents or deliverables that need to be updated more frequently than Special Publications generally allow.
3. This mDL Practice guide – The 1800-42 practice guide series highlights and integrates information from the mDL blog series and the resource hub, and adds detailed information about the mDL reference architecture, mDL implementations, and key findings. It also offers in-depth details on the technologies leveraged, their specific integrations and configurations, and the use cases and scenarios demonstrated. The 1800-42 base document covers content that applies generally to mDL deployments, while the later volumes provide sector-specific information

This report uses callout boxes to highlight certain types of information, as depicted in Figure 1. Except for **Definition** boxes, which repeat the definitions of key terms or provide more formal definitions for them, callout boxes usually contain new material that is not covered elsewhere in the report. A **Caution** box provides a warning of a potential issue with doing or not doing something. A **Note** box gives additional general information on a topic. A **Tip** box offers advice that may be beneficial to the reader.

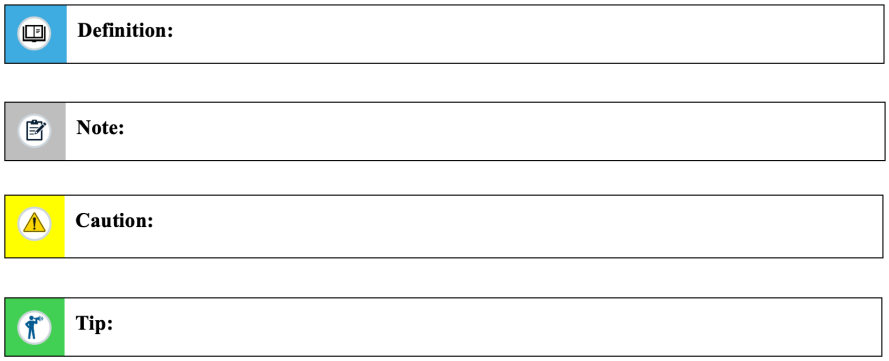


Figure 1. Callout Box

3 Project Overview

This project is motivated by the emergence of verifiable digital credentials as a practical technology, the need for secure, usable, and privacy-preserving identity solutions, recent progress in relevant standards that support the VDC ecosystem, and the emergence of new threats to identity-proofing systems. Verifiable Digital Credentials and specifically mDLs in the U.S. have the potential to improve security, privacy, regulatory compliance, and user experience for online identity proofing.

To achieve this, the project brings together government, industry, standards organizations, and financial institutions to create a reference architecture and demonstration build with a focus on real-world use cases. Specifically, this document is the result of the first use case—deploying mDLs at financial institutions to support identity proofing and Customer Identification Program (CIP) requirements [8].

> **Note:** This project specifically explores how financial institutions could accept mDLs to collect only necessary user attributes required by CIP. This effort does not address broader KYC requirements such as transaction monitoring, fraud and sanctions checks, enhanced customer due diligence or reporting requirements.

3.1 Financial Institutions Use Cases

Financial institutions, who have direct access to money and sensitive personal information, are subject to cyber threats. Attackers seeking to drain bank accounts, open fraudulent lines of credit, launder money or steal PII, may target financial institution identity-proofing systems. These threats directly impact bottom lines: The Financial Crimes Enforcement Network (FinCEN) linked $212 Billion [9] to identity-related suspicious activity in 2021, a figure that reached as much as $394 billion by 2023 [10]. Furthermore, inadequate digital identity systems cost institutions an estimated 3.1% of annual revenue [11].

The industry also operates under regulations, such as the CIP Rule, which requires institutions to maintain a "reasonable belief" in a customer's identity. This combination of high-risk and regulatory oversight makes the financial sector a "high-assurance" use case. Consequently, the NCCoE chose the financial sector for its initial mDL project for two reasons:

- **High-Impact:** FIs operate in a highly regulated environment, manage sensitive information, and face significant identity-related fraud risks with substantial economic impact.
- **Transferability:** Solving the most stringent requirements gives confidence the solution can transfer to other sectors with equal or lower assurance needs.

Ultimately, by addressing the rigorous demands of the financial sector, the NCCoE hopes to establish a blueprint for mDLs that can be scaled across all sectors of the economy.

3.2 Advancing Customer Identification through mDL

As highlighted in SP 1800-42, there are many challenges associated with identity proofing or, as it is referred to in financial processes, customer identification. The financial industry faces many of the same challenges that other high-assurance sectors – such as government and health care – face when

attempting to identify individuals in an online transaction. Namely, traditional identity verification processes are either insufficient considering the threat environment (e.g., large scale data breaches, generative SI) or rely on security features that do not translate well to digital environments. In practice financial institutions are left to build complex verification solutions that rely heavily on deterministic signals and heuristics. These signals are used as a means of confirming identity evidence, data, and user-initiated transactions are valid, authentic, and accurate. This environment has resulted in systems that are error-prone, create additional vectors for fraud, lack authoritativeness and accuracy, and often result in failures or abandonment.

mDLs can improve this paradigm by providing a high-assurance, privacy-preserving, streamlined user experience through a credential that is **cryptographically backed** and **issued by a trusted authority**. mDLs introduce characteristics that improve the security, privacy, usability, and reliability[3] of presenting identity information online:

- The content of the mDL is cryptographically signed by the government issuer, adding data accuracy and integrity and limiting the need to query third-party data sources for identity information.
- The content can be independently verified through public-key cryptography, increasing confidence and reliability of the data.
- The credential is bound to a user-controlled device, preventing theft or cloning.
- Digital wallets storing mDLs can implement measures—such as local authentication on the device—to protect against unauthorized access to credentials.
- If the device storing the mDL is lost or suspected of compromise, the credential can be revoked (and reissued) remotely.
- User information can be obtained directly from the mDL, reducing data-entry time, and limiting user error, and ensuring data conformity.
- mDLs support selective disclosure, allowing users to choose the driver's license information they wish to share with relying parties.
- mDLs enable relying parties to only request the information they need for a given purpose or transaction.
- Digital wallets storing mDLs allow for users to consent to the information shared, while also providing a record of what information a user has shared, with whom, and when.

mDLs are designed to convey trust digitally, offering benefits for online customer identification processes. mDLs shift identity proofing from document authentication and biometric matching alone, to cryptographically verifiable, issuer-signed credentials that reduce the threat of deepfakes, counterfeit, lost or stolen IDs, and synthetic identities.

For financial institutions, mDLs are another tool in the toolbox that can meet or exceed current identity proofing systems. In a recent white paper, the American Banking Association, Better Identity Coalition, and Financial Services Sector Coordinating Council call out mDLs as a key mitigation to SI-powered attacks against identity systems stating that "Government-issued verifiable credentials, such as mDLs, can play a crucial role in reducing the risk of deepfake attacks. If available, they can be used to cryptographically assert an identity" [12]. Additionally, The Secretary of Treasury also offered support

[3] Review for a detailed comparative analysis composed of security, privacy, and usability considerations.

for mDLs saying that "[t]hese types of verifiable credentials represent innovative means for financial institutions […] to conduct customer identification and verification while minimizing the amount of sensitive data collected," and that, "Treasury will issue guidance to financial institutions on how they can utilize verifiable digital credentials consistent with their existing customer identification programs" [13].

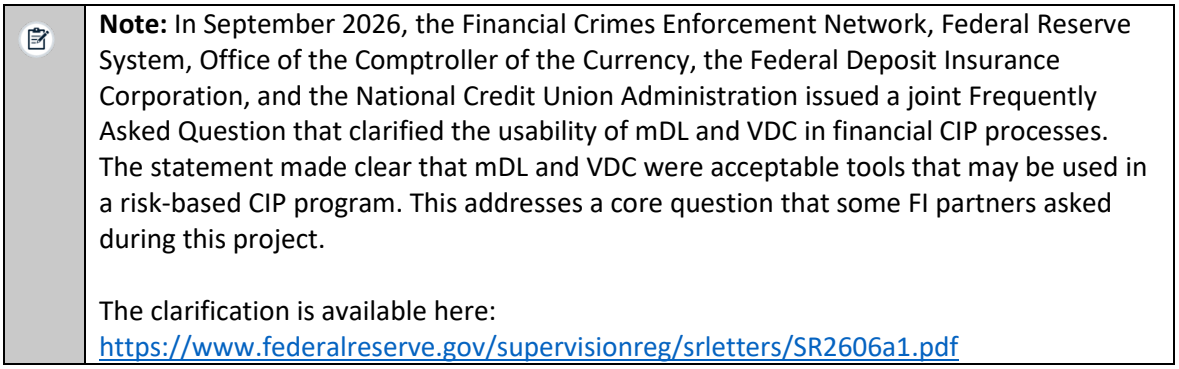
3.3 Financial Institution Adoption Challenges

As mDLs and VDCs gain traction, financial institutions stand to benefit significantly. Yet, the path to adoption is hindered by a persistent market maturity challenge: the classic "chicken-and-egg" dilemma.

Consumers are unlikely to adopt mDLs unless they are accepted in high-value, everyday use cases. Meanwhile, financial institutions are hesitant to invest in mDL integration without widespread consumer demand or adoption. This deadlock stalls the emergence of scalable, high-assurance digital identity solutions in the financial sector, despite their long-term value.

What limits current mDL adoption is not the technology itself, it is the maturity of the surrounding ecosystem. This ecosystem includes a complete set of mature standards, clear governance, and interoperable tools that make it easy to verify mDLs across diverse workflows, whether at the branch, online, or through mobile apps.

Constructing this ecosystem requires deep coordination between the financial services sector, government issuers, and technology providers. Just as the industry coalesced around common protocols to scale previous digital innovations, stakeholders must now align to reduce the integration burden and provide the necessary foundation for mDLs to operate as a scalable, high-assurance identity proofing solution.



4 A Collaborative Approach

Engagement with financial institution partners helped the team understand their concerns (discussed in Section 3), compliance regimes, privacy expectations, internal systems, and business processes that might impact integrating an mDL. Engagement with standards bodies informed the profiles and best practices in the implementation and enabled the NCCoE to serve as a feedback loop, providing implementation experience to advance the standards. State partners and the American Association of Motor Vehicle Administrators (AAMVA) provided crucial context from the issuer's perspective, including the wallet support decision-making process, trust frameworks, and accessibility/user experience concerns. Technology providers in the mDL ecosystem, such as digital wallets, verifiers, and identity management systems, provided subject matter expertise on the current state of mDL components and how to design an architecture that would meet the needs of financial institutions.

These discussions and working sessions produced the artifacts on the project resource hub, as well as this practice guide.

4.1 Project Collaborators

The NIST project team would like to acknowledge the CRADA consortium that helped the team realize the mDL project. The technology collaborators who participated in this project submitted their capabilities in response to a Federal Register notice. Respondents with relevant capabilities, products, or subject matter expertise were invited to sign a CRADA with NIST, allowing them to participate in a consortium to build this example solution. The team worked with:

Table 1. Project Collaborators

Organization(s) / Project Collaborator(s)	
1Password	MATTR Limited
American Association of Motor Vehicle Administrators (AAMVA)	Microsoft Corporation
California Department of Motor Vehicles	Navy Federal Credit Union
Capital One	Open Identity Foundation (OIDF)
Department of Homeland Security (DHS), Science and Technology Directorate	PNC Bank
Google	Raymond James

Organization(s) / Project Collaborator(s)	
Idemia	SpruceID
iLabs	Synchrony
JP Morgan Chase	US Bank
Maryland Department of Transportation	Wells Fargo
	Yubico

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5 Architecture and Build

This section defines the architecture and reference design developed in collaboration with the consortium. It highlights the approach to developing the architecture, including decisions and assumptions made, as well as the components, standards, and best practices used.

5.1 Defining an mDL User Journey at a Financial Institution

Before building an mDL architecture, the NCCoE project team needed to define how financial institutions should support online mDL presentation. Through discussion with the financial institution partners and consortium members, the team reached a consensus to demonstrate the following capabilities:

1. **Account Application** – Illustrate a journey from the perspective of an "applicant" who applies for a new bank account using an mDL as evidence to verify their identity in alignment with CIP requirements.
2. **Digital Enrollment** – After account approval, show a "customer" setting up online account access, using an mDL to confirm that the user accessing the account is the same user who applied for the account, and subsequently issuing the user a Passkey (or other phishing-resistant authenticator) for future authentication.
3. **High Risk Transaction Authorization** – Demonstrate a customer attempting to make a high-risk transaction who is put through mDL re-verification flow to confirm they are in possession and control of the mDL linked to their account and provide the financial institution with an additional security signal before authorizing the transaction.

This user journey set the goalpost for the final demonstration and informed the architectural decisions of this project. It's worth noting that these capabilities can and will vary in operational implementations based on the needs of the FI and the technologies available to them.



Tip: mDL should be part of a holistic risk management solution. Financial institutions should still leverage additional risk signals when executing the above defined transactions to provide as complete a picture as possible related to transaction fraud risks. Signals such as device posture, behavioral indicators, network information, and transaction velocity can augment the cryptographic features of mDL to provide an even more complete protection profile for financial interactions.

5.2 Architecture Decisions and Assumptions

This section describes key decisions and assumptions made in collaboration with the consortium members to support the build architecture. Readers should note that while the decision path resulted in this architecture, it is only one potential implementation. Organizations in other sectors or regulatory environments may confront different decision points that shape their final architecture.

5.2.1 Centralized IDMS and Verifier

In initial discussions with the technology, SDO, and financial institution partners, there was consensus that for the financial industry to adopt strong identity proofing and authentication encompassing mDL verification. Further, they needed a plug-and-play solution that can scale across all interactions between the financial institution and the customer, referred to as consumer touchpoints. To enable this capability, the team implemented a standards-based, centralized, scalable IDMS and verifier.

Centralized Verifier

It is conceivable that large financial service providers may choose to implement multiple verifiers (typically for resilience or to potentially deal with different presentation protocols). However, a single central verifier integrated with the IDMS offered a pattern that limited integration complexity while supporting scaled integration across enterprise-wide services.

Centralized Identity Management System (IDMS)

Although individual applications may provide limited identity services, the build team elected to leverage a dedicated enterprise Identity Management System (IDMS) to serve as the bank's central orchestration layer. In this architecture, the IDMS coordinates the entire account opening process initiated by the mDL holder, supporting a compliant and seamless workflow. This workflow includes managing critical regulatory steps such as capturing appropriate notice and consent, while aggregating mDL data with additional verification details (i.e., Taxpayer Identification Numbers) required to align with CIP mandates. This design empowers financial institutions to customize the orchestration logic, controlling exactly which attributes are validated in transit and which persist within the FI's backend systems to align with risk and business objectives.

By centralizing mDL verification and authentication within the IDMS, the bank requires only a single integration point, allowing all customer touchpoints to programmatically leverage this capability at scale. This architecture replicates an enterprise service model that maximizes value across the FI's entire portfolio, consistent with industry input from the collaborators.

Integrating the verifier into this orchestration layer also allows banks to extend their existing policies, governance frameworks, logging, and auditing mechanisms to mDL data. Attributes derived from the mDL are processed consistently with other identity data subject to the same consent, attribute release, risk evaluation, and audit requirements already enforced by the IDMS. This approach prevents the creation of parallel identity silos, minimizes integration complexity, supports asynchronous mDL presentation to account activation processes and ensures that mDL adoption fits naturally into a bank's broader Customer Identity and Access Management (CIAM) strategy.

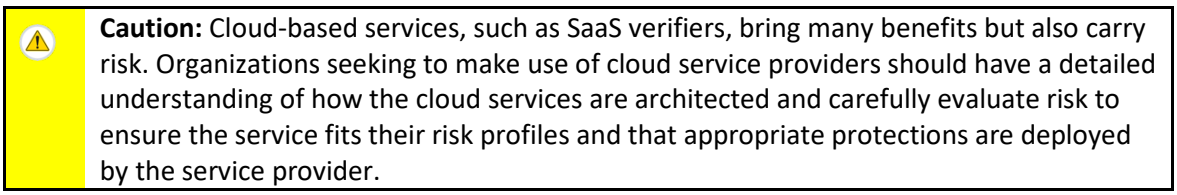
5.2.2 Use of Software as a Service (SaaS) products

As with most modern technology deployments, there are multiple patterns and architectures that can be used to achieve desired outcomes, depending on the implementing organization's risk appetite and preferences. Notably, organizations have many options available to them on where and how to deploy software. For this project, the project team prioritized SaaS products for several key components—notably the verifier and IDMS. A SaaS deployment was chosen for several reasons:

- Using SaaS allowed the project to rapidly integrate multiple disparate services with minimal resources. As NIST is not an operational entity and the outcome was not intended to be a long-term operational service, this approach allowed the project team to deliver maximum value with minimal cost and resources.
- SaaS also enabled the team to make use of expertise offered by SaaS partners to deploy and maintain their software. IDMS and verifiers are complex software that often require substantial experience to operate effectively and troubleshoot when issues arise. This is particularly true with respect to the MATTR verifier, which is implementing standards and protocols that evolved as the project progressed. Thus, SaaS gave the project team the greatest chance for success, given its development stage.

While SaaS offers substantial benefits, it also has drawbacks. SaaS products hosted in different environments do introduce new threats by allowing attackers additional pathways into the mDL verification process. For example, communications crossing boundaries between the Verifier, IDMS, and Core Banking Service could be intercepted, forged, or replayed and used to compromise aspects of the mDL trust model. While many of these can be mitigated through common, standards-based controls, the threat of exposure is increased, and some organizations may choose alternative architectural patterns.

As mDLs become operational, several viable deployment alternatives exist. The most notable includes the deployment of verifier, IDMS, and core banking systems in a common, Financial Services controlled infrastructure. The infrastructure could be on-premises, Infrastructure-as-a-Service (IaaS), private cloud, or similar. Direct control over the infrastructure provides FIs with greater confidence and visibility into the controls and protections applied to the mDL verification functions and the data involved in the process. Additionally, such an architecture can be deployed with fewer exposures as data does not need to be communicated over the internet to components residing in different trust domains, infrastructure, or networks. During the project this was indicated as the increasingly preferred deployment pattern among FIs with the resources to deploy, operate, maintain, and troubleshoot the respective software components.



5.2.3 User Experience (UX) Expectations

Financial institutions devote significant resources to user experience (UX) development to promote customer retention and satisfaction. Any “friction” introduced could result in outcomes such as potential customer abandonment during the account application process. Thus, the build sought to enable a seamless experience across the account application and identity proofing process. This meant providing a consistent experience and reducing confusion as the user interacted with and between the banking website and the IDMS. This also meant limiting the number of clicks, manual input fields and pop-ups to only those needed to guide the user through the process and provide necessary information such as user consent. Additionally, efforts were taken to implement consistent branding, color schemes, and optimizations where possible for mobile and desktop web browsers.

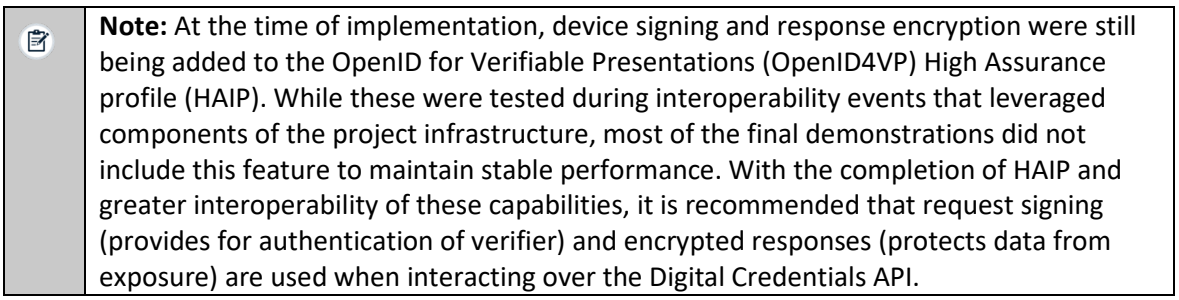
5.2.4 Use of Digital Credentials API and Avoiding Custom Uniform Resource Indicator (URI) Schemes

From the start of this project, the build team wanted to prioritize using the W3C Digital Credentials API (DC API). Before the existence of the DC API, application developers were left with the task of managing the wallet and credential selection mechanism between the device and the verifier. This often resulted in wallets on mobile devices being invoked by a custom Uniform Resource Identifier (URI) scheme—a mechanism that allows applications to register a unique URI prefix with the operating system. This pattern creates a problematic user experience where little information is presented to the user before the wallet is invoked. It can also result in credentials that are non-responsive to verifier requirements being invoked and are unable to support the wallet selection if credentials are present in multiple wallets. Further, once a wallet is selected, there is a context switch that makes it difficult for users to return to the original website if the user is accessing the website from the same device as the wallet.

The DC API offers UX improvements over custom URIs by showing the user which application is making the wallet request and displaying a consistent view of the queried credentials and attributes being requested from the credential. This enables users to make an informed decision and proceed with presenting their mDL with increased context.

The DC API further enhances VDC request and presentation by providing more robust security than custom URI. In the custom URI flows, the QRC for wallet invocation is presented by the verifier and not through the browser. By using the DC API and integrating with platform APIs, this technique allows the presentation method to make use of FIDO's Client to Authenticator Protocol [2]. This protocol enforces proximity by establishing a secure connection between the primary device (e.g., the laptop) and the device hosting the VDC. This feature ensures the device with the credential is near the device requesting the presentation, preventing phishing attacks. For example, an attack where a bad actor initiates a presentation on their own device and relays the QRC via a malicious website visited by the legitimate credential holder.

In summary, because of the security and user experience benefits of the DC API, it is expected that it will become a W3C recommendation and be widely adopted across the web browser ecosystem. Refer to the base volume for more discussion on this topic.



Note: At the time of implementation, device signing and response encryption were still being added to the OpenID for Verifiable Presentations (OpenID4VP) High Assurance profile (HAIP). While these were tested during interoperability events that leveraged components of the project infrastructure, most of the final demonstrations did not include this feature to maintain stable performance. With the completion of HAIP and greater interoperability of these capabilities, it is recommended that request signing (provides for authentication of verifier) and encrypted responses (protects data from exposure) are used when interacting over the Digital Credentials API.

5.2.5 Representative Core Banking Capabilities

Due to the complex and sensitive nature of banking systems, it was not feasible for any of the financial institution collaborators to provide a demonstration banking system that could integrate with the

architecture. Therefore, in the early stages of this project, the consortium reached a consensus that building a representative bank would better support the project's goals and timelines. The core technical team then surveyed several open-source projects that could provide "core-banking" capabilities as described in Section 5.1 and chose Fineract as the development banking platform.

5.2.6 Attribute Validation Capabilities

Not all attributes needed for alignment with CIP are available from the mDL data model. Additionally, financial institutions may want to compare user (e.g., phone number or email address) or device attributes against established fraud services to further increase confidence in transaction security. As a result, the project team identified early on that any architecture would need to illustrate the capability to validate additional attributes. This capability would acknowledge mDLs as a complement to current identity verification processes rather than a wholesale replacement. Time and scoping constraints prevented the integration of a commercial, SaaS-based attribute validation and fraud detection platform; therefore, the project team decided to develop a system that mimicked the electronic Consent Based Social Security Number Verification (eCBSV) Service created by the Social Security Administration (SSA). SSA developed eCBSV to facilitate "accepting and comparing fraud protection data provided electronically by a permitted entity." eCBSV's open specification and wide acceptance as a valuable service for FIs made it an ideal choice to emulate in the demonstration, which enabled the banking system to verify if an applicant's Social Security Number, name, and date of birth combination matches (test) Social Security records.

5.2.7 Use of mDL for Authentication

VDCs can feasibly be used for several purposes in potential customer-facing processes, including identity verification, authentication, account recovery, and high-risk transaction authorization. However, using mDLs for authentication requires the driver's license number (along with the state issuer) to be conveyed at each usage to support account linking. For this reason, the project team decided not to use mDLs for authentication.

> ⚠ **Caution:** Frequently conveying a reusable identifier for transactions, coupled with conditioning users to routinely present a credential that contains identity information, is undesirable. Technology specifically designed for authentication scenarios—such as passkeys (see Section 5.4.2.2)—should be chosen for day-to-day user authentication.

Due to the far less frequent nature of identity proofing (typically one-time per institution or for account recovery) and high-risk transactions (only when certain thresholds were met), these were deemed the most valuable scenarios for mDL as a credential type.

5.2.8 Local Versus Server-Side Holder Verification

As discussed in the use case, FIs must understand the third-party risk they are accepting from issuers and wallets and will seek to implement risk mitigations where appropriate. Some FIs may choose to implement a server-side biometric match during mDL presentment to address the lack of information available about the wallet's ability to authenticate the user locally. This match would compare the portrait image on the mDL with a selfie image collected from the user during mDL presentment. The NCCoE and its collaborators decided not to demonstrate this as part of the mDL project. While server-

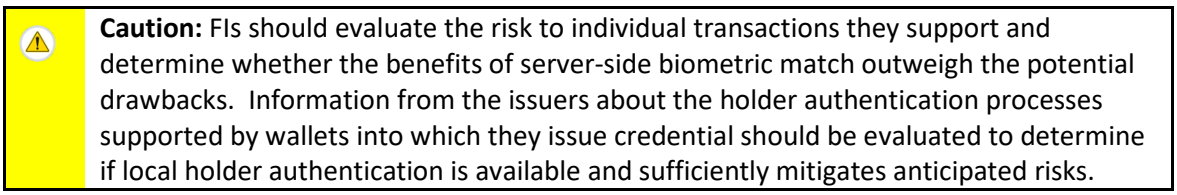
side biometric matching may give RPs additional confidence that the person presenting the mDL is the rightful mDL holder, it also introduces user friction which might result in orphaned accounts, creates privacy concerns through the collection of a biometric reference that must be managed by the RP, and is susceptible to biometric injection attacks at scale. Ultimately, the NCCoE team determined the risks of server-side biometric matching outweighed its marginal security benefit.

Instead, the NCCoE chose to demonstrate online presentation flows using local device authentication to unlock the mDL. This was done for several reasons: 1) local authentication preserves the privacy of users and enables a more efficient workflow, and 2) the signed, device-bound credential, local authentication, and CTAP-enforced proximity mitigate the majority of attacks that threaten FIs at scale today (e.g., fake documents, social engineering, and presentation attacks). This provides a streamlined, privacy-preserving workflow that is notably more secure than current CIP processes. It does not, however, eliminate all threats.

The NCCoE recognizes there are inconsistencies in how wallets perform holder authentication—some make use of device unlock, others use a biometric specific to the credential. Each of these permutations provides different security characteristics. Notably, wallets that make use of device unlock are susceptible to a close associate presenting an mDL for which they are not the rightful holder. However, to achieve this, they would need to have physical access to the device and either:

1. Be enrolled on the device (for example having a spouse's face enrolled to unlock a phone), or
2. Have knowledge of an unlock secret (for example sharing the PIN with a child to unlock a phone) from presenting an mDL that does not represent them.

In either case, this type of compromise is limited to a single device and user credential and is not subject to the same level of scalability of most threats to identity proofing that banks face today. As the mDL ecosystem evolves, standards, best practices and wallet capabilities for device holder authentication are expected to improve. Additionally, the availability of information on holder authentication practices to the FIs and other RPs will improve as well.



5.2.9 Cross-Device and Same Device Presentation

mDLs are presented by holders in two scenarios – cross-device and same device. In a cross-device scenario, mDL holders present their credential from a mobile device through an interaction with a website on a separate desktop or laptop computer. In same device scenarios, all interactions occur on the mobile device. This demonstration implements both the cross-device and same-device scenarios. Previous versions of this document did not address same-device workflows

5.3 Build Components

This section highlights the architecture components deployed in the NCCoE lab environment. For a more general overview of components in the mDL ecosystem, please consider the "Digital Identities: Getting to Know the Verifiable Digital Credential Ecosystem" blog post. Implementers are encouraged to visit the project's resource hub, which describes configuration details of each component.



Tip: Video demonstrations of the NCCoE build are available at the project's online resource hub. Readers may benefit from taking a few minutes to see this architecture in action before reading through the components, flows, and how it was built.

Table 2 enumerates the products used to build the NCCoE Architecture. This includes a mix of products from the team's CRADA collaborators and components developed by the NCCoE using open-source software. Column 4 highlights the function of each component, demonstrating capabilities listed in Section 5.1.

698 **Table 2. Architecture Technology Contributions**

Component	Collaborator(s)	Product	Function
Mobile Driver's License Issuer	Maryland Department of Transportation California Department of Motor Vehicles	State mDL test credentials	Test mDL credentials were issued to state-approved wallets and presented to the MATTR verifier to test and demonstrate the NCCoE Architecture
Wallet Applications	Google MATTR SpruceID	Google Wallet MATTR Kakapo Wallet California Deparment of Motor Vehicles (DMV) Wallet	• mDL Storage and Protection • mDL holder authentication • mDL holder consent • Presentation of the mDL to the verifier
Trust Service	AAMVA	Digital Trust Service (DTS)	Provide the Verifier with access to the valid public keys that correspond to the test mDL credentials
Identity Management System	Microsoft	Microsoft Azure Active Directory Business to Consumer (B2C)	• Passkey enrollment and authentication • Directory services storing credentials, profile data, and the banking system's application registration • Create account application and digital enrollment identity validation workflows • Create and protect encryption keys used for signing and validating tokens

Component	Collaborator(s)	Product	Function
Verifier	MATTR	MATTR VII[4]	• Initiating verification via QRCs (cross-device flows) or deep links (same-device flows) • Requesting a verifiable presentation from a credential stored in a digital wallet • Verifying the cryptographic signature of received verifiable presentations • Verifying the cryptographic signature of the received verifiable credential and accepting the issuer
Bank-end Banking Services	NCCoE Developed	Laravel Open-Source Software	A system that enables a scoped set of banking functions, provides an API to facilitate front-end interactions, and provides a client to the core banking services
Core Banking Services	NCCoE Developed	Apache Fineract Open-Source Software	System(s) that facilitate financial services such as opening new accounts and processing transactions (e.g., deposits, withdrawals, and transfers).
Verifier Mediation Service	NCCoE Developed	Azure Functions	A proprietary API that facilitates mDL verifier attribute retrieval on behalf of the IDMS. This service was custom developed using Azure's serverless functions and leveraged the verifier's documented management API.
Social Security Number (SSN) Validation Service	NCCoE Developed	Laravel Open-Source Software	A system that emulates the functionality of the Electronic Consent Based SSN Verification (eCBSV) Service designed to validate social security numbers.
"NCCoE Bank" Mobile Application	NCCoE Developed	Developed for Android 15	A native banking mobile application that facilitates an identity re-verification scenario.

[4] At the time of this demonstration, the MATTR VII tenant was consistent with OpenID4VP 1.0.

> **Caution:** The NCCoE used open-source products to build the example NCCoE Bank, its back-end services, SSN validation service, and native mobile banking application. Since this technology was used for demonstration purposes only and FIs will already have their banking services implemented, the NCCoE does not intend to release configuration files or code for these architectural elements. The configuration used for the IDMS and verifier to support the deployment of mDLs and passkeys is available on the project resource hub.

5.3.1 Reference Architecture

Figure 2 is a graphical representation of the representative architecture we have implemented as part of the NCCoE Lab demonstration. This architecture is based on criteria that resulted from discussions with the industry collaborators and illustrates the general interactions between key components found in Table 2, while also highlighting some of the important protocols that were implemented as part of the architecture.

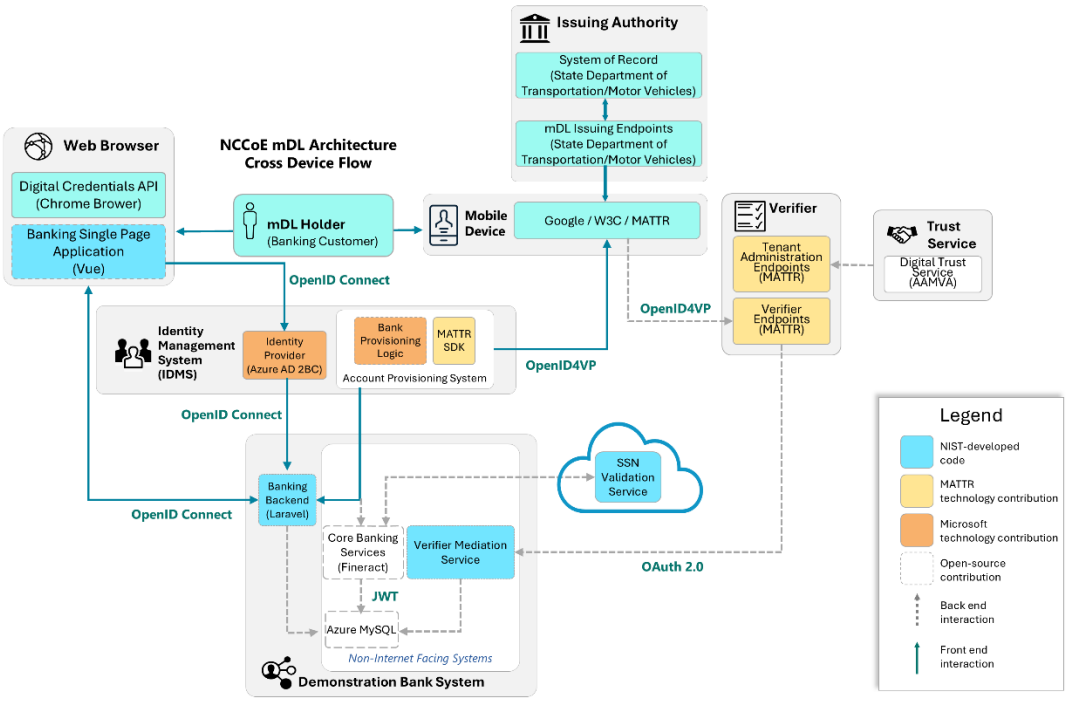


Figure 2. Reference Architecture Cross-Device Flow

As mentioned in Section 5.2.9 this figure illustrates the cross-device flow the project team implemented. The cross-device flow occurs when the user needs to present their mDL to a website or service that is not being accessed from the same device where the mDL is stored. The most common example is a user presenting an mDL stored in a wallet on their mobile phone to a website or service they have navigated to in the browser on their desktop or laptop.

> **Definition:** Cross-device flow, as defined by OpenID4VP, is "*when an End-User presents a Credential to a Verifier interacting with the End-User on a different device than the device on which the Wallet resides."* A same-device flow occurs when an *"End-User presents a Credential to a Verifier interacting with the End-User on the same device that the device the Wallet resides on".* The architecture above refers to cross-device scenarios in which the user accesses an online service. Cross-device flows could occur in person, such as a user walking up to a terminal and scanning a QRC code or tapping a Near Field Communications reader.

The cross-device flow makes the following assumptions:

1. A banking customer navigates to a banking service and engages in an action that requires them to present their mDL. For the NCCoE project, customers will be required to present their mDL for identity proofing when opening a new financial account and for step-up verification when a user conducts a high-risk transaction.
2. The customer has an mDL provisioned to the digital wallet on their mobile device and chooses to present it to the banking web site, which they are accessing from a browser on a separate device.

The figure below illustrates the same-device flow implemented in the demonstration. The same-device flow occurs when the user needs to present their mDL to a website or application that is being accessed from the same device where the mDL is stored. A same-device flow can be initiated by the user from a mobile web browser that supports the Digital Credential API or a native application installed on the mobile device. In both cases, they invoke the mobile device's platform credential management capabilities. While the platform's credential management capability can be accessed directly from native applications, this demonstration integrated a software development kit supplied by the verifier technology provider to manage the interactions to the platform credential management functions as well as the interactions with the verifier components.

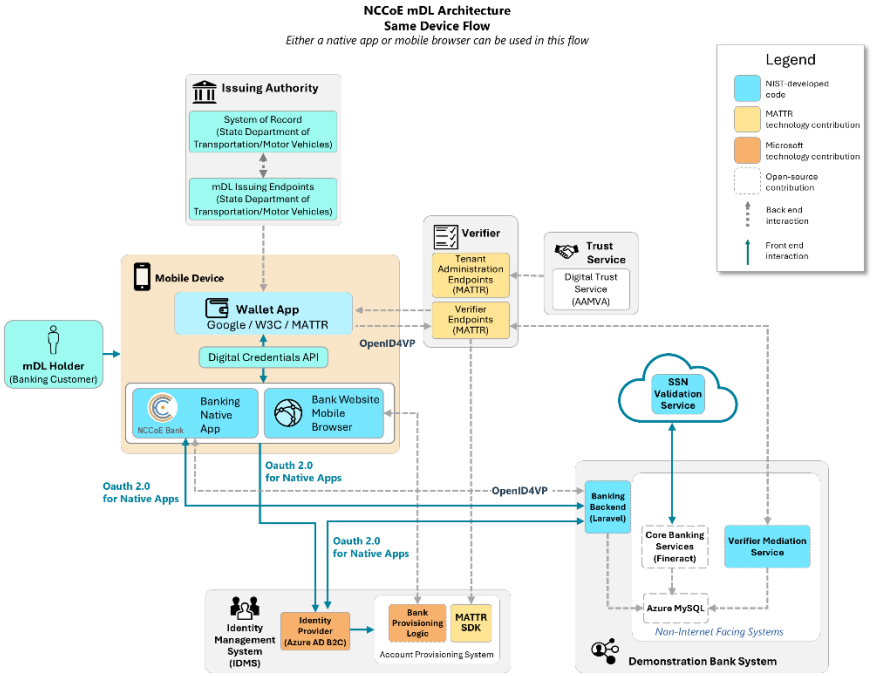


Figure 3. Same-Device Architecture

The same-device flow makes the following assumptions:

1. The customer has an mDL provisioned to the digital wallet on their mobile device and chooses to present it to the banking system, which they are accessing from a web browser or native mobile application.

2. (mobile browser-initiated scenario – identity proofing) A banking customer navigates to a banking service and engages in an action that requires them to present their mDL. For the NCCoE project, customers will be required to present their mDL for identity proofing when opening a new financial account and for step-up verification when a user conducts a high-risk transaction.

(native mobile app scenario – transaction authorization) A banking customer has completed account opening identity verification and bound a phishing-resistant authenticator to his provisioned online account.

5.4 Architecture Capabilities

This section details how the reference architecture in Figure 2 enables the capabilities we discussed in Section 5.1. The flows detailed in this section incorporate same and cross-device flows.

5.4.1 Account Application Flow

> **Note:** This flow applies to cross-device and same-device when initiated from a mobile browser that supports the Digital Credential API.

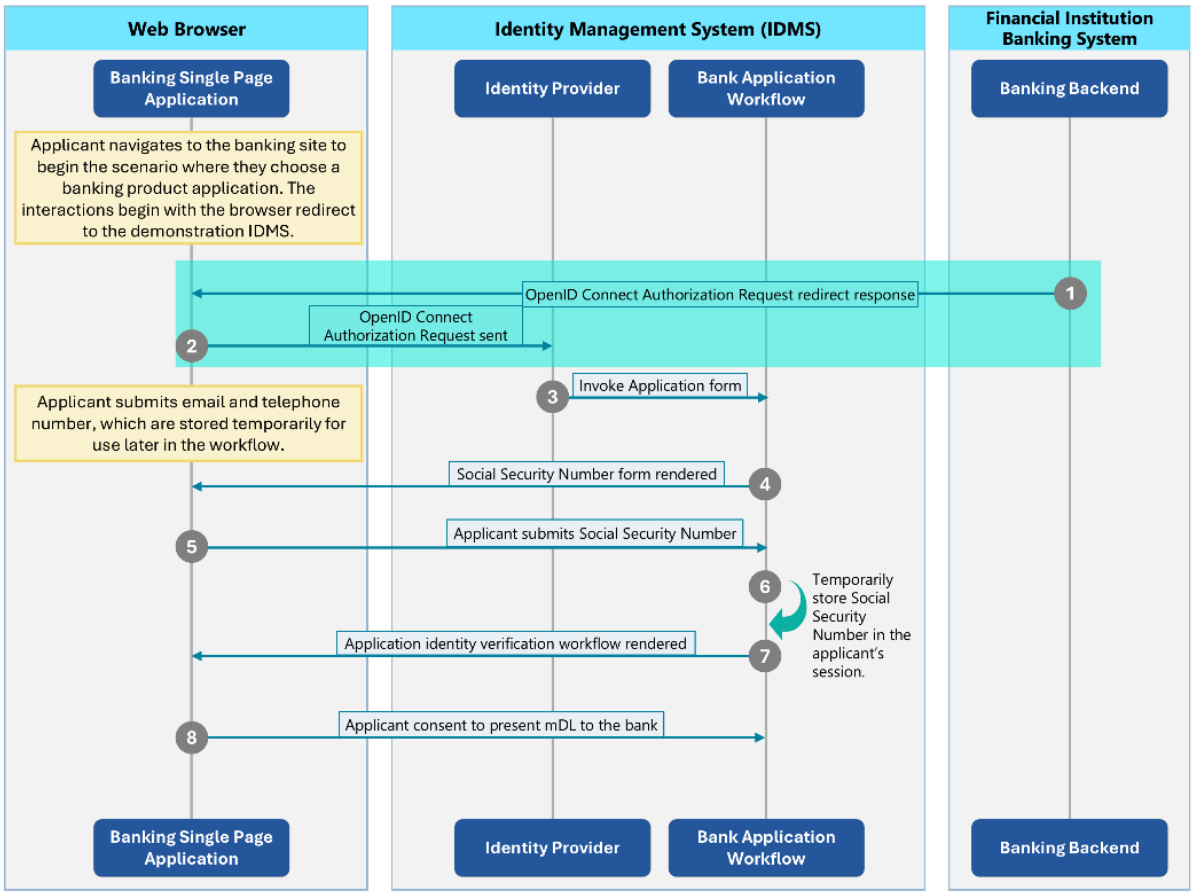
The account application flow is the beginning of the user journey where the goal is to use an mDL to identity proof an "applicant" applying to open a financial account. A video demonstration of this flow can be seen at the project's resource hub. In this flow, the applicant navigates to the NCCoE Bank web page, selects the type of account they wish to apply for, and is then entered into the identity proofing process. This process includes three steps:

1. **Email address and phone number verification.** To ensure the bank can contact the applicant, they must link an email address and phone number to their account. This linking is accomplished by sending separate six-digit codes via email and SMS to verify the applicant is in possession of and controls the email and phone number provided to the bank. These codes are then entered by the applicant into the bank's web form and verified by the bank.
2. **SSN or Tax ID Number (TIN) validation.** CIP compliance requires that financial institutions collect and validate the applicant's SSN or TIN. For the NCCoE build, the project team opted to demonstrate the SSN and built out an example SSN validation service as discussed in Section 5.2.6. The applicant enters their SSN in the web form, and the banking back-end validates that the applicant's name, date of birth, and SSN match a valid record. In production, this would often be a third-party service; however, for the purposes of this build, the SSN validation service resides on the bank of NCCoE infrastructure.
3. **Presentment of the mDL and collection of the remaining CIP attributes.** The applicants may use their mDLs to prove their identity. When selected, they are presented with a QRC they scan with their device camera to invoke their wallet. To access their mDL, the applicants are asked to complete verification on device (biometric or PIN, based on what the wallet supports). Upon successful authentication, the applicants consent to presenting their information and the wallet responds to the initial request with the applicant's information from the mDL needed to meet CIP requirements. The verifier cryptographically verifies the data and passes it to the IDMS.

Upon completing the above three steps, the applicant confirms their information is accurate and submits their account application.

> **Note:** This project specifically chose to allow the applicant to apply for a financial account before digitally enrolling them and provisioning an authenticator. This choice was made based on explicit feedback from the financial institution partners: that the applicant's goal is to be approved for, and open, the financial account, and that any additional steps in that process could be detrimental to that goal.

774 To demonstrate how the architecture supports the account application flow, Figure 4, Figure 5, and
775 Figure 6, below detail the sequential interaction of the components.



776 **Figure 4. User Initiates Application Process**

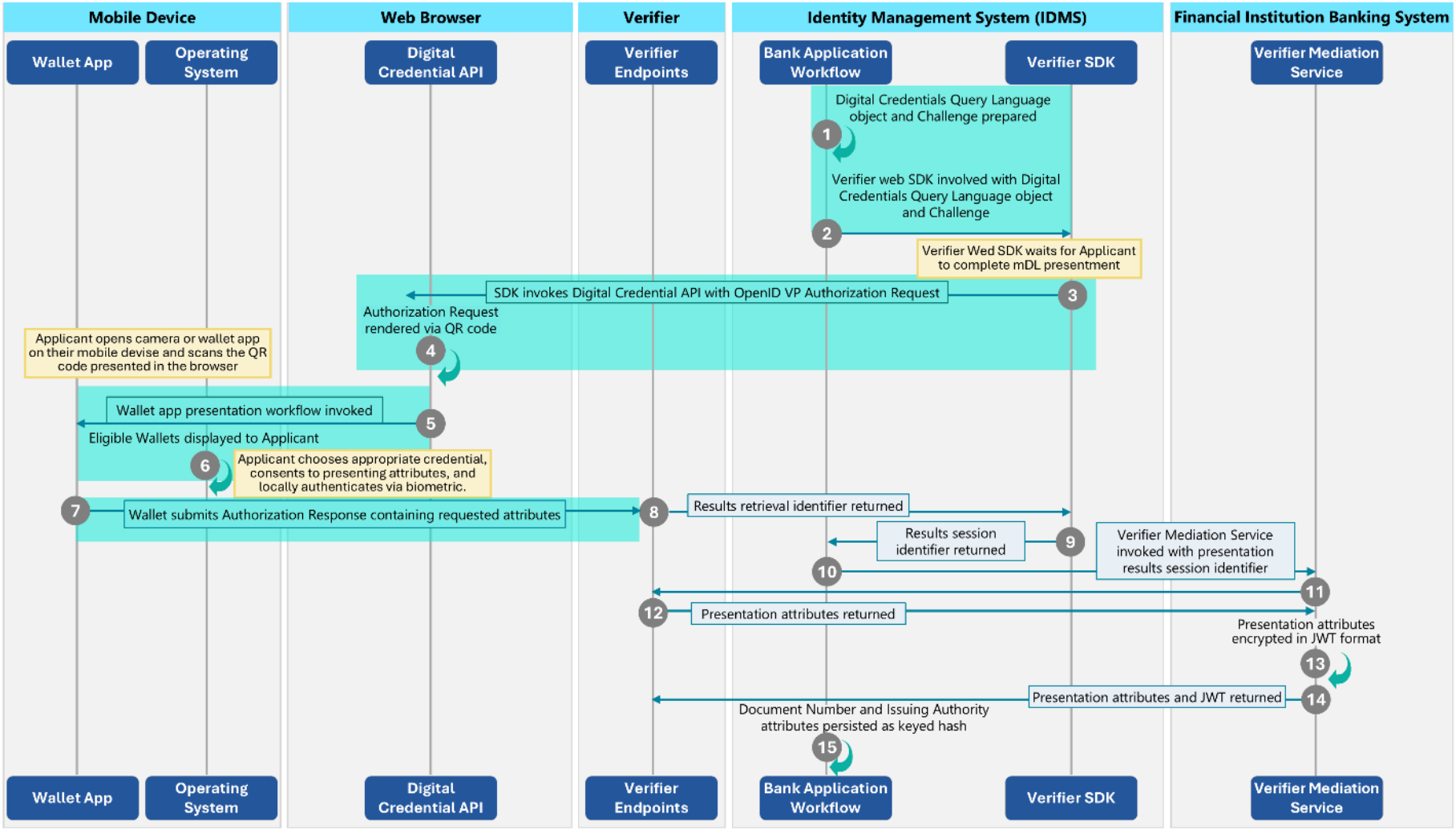
Steps 1-3	The applicant initiates the flow at the banking website by selecting the account they wish to create. The banking website logic then triggers the identity verification process with a browser redirect to the IDMS via an OpenID Connect authorization request,[5] which includes the Account Application user journey identifier to indicate which workflow Azure AD B2C will use.[6]
Steps 4-6	The IDMS recognizes the Account Application user journey identifier in the authorization request and proceeds to collect the applicant's email address, phone number, and SSN/TIN.
Steps 7-8	Upon successful validation of the email address and phone number, the IDMS requests the applicant's consent to collect mDL attributes.

[5] The demonstration uses the authorization code flow with Proof Key for Code Exchange (PKCE). The details of these interactions are not shown in Figure 4, Figure 5, or Figure 6. Review Azure AD B2C documentation for detailed implementation details.

[6] The demonstration IDMS extends the standard OAuth 2.0 flows by adding a policy parameter which specifies the user flow to run. Review Azure AD B2C documentation for detailed implementation details.

At this stage the IDMS invokes the verifier SDK with the Digital Credential Query Language (DCQL) that allows a verifier to request a verifiable presentation from a wallet that matches a query. When used in an OpenID4VP transaction, a DCQL query enables the wallet to display to applicants the attributes being requested and credentials on their device that meet the parameters of the request. The SDK also requires a challenge (i.e., nonce) to be generated by the relying party. The challenge ensures the security and integrity of the credential verification process by preventing replay attacks and verifying the authenticity of each request and response [14]. Finally, the SDK is instructed to simultaneously support same-device and cross-device flows (as described in (Section 5.2.9). In the cross-device flow, the applicant's wallet is invoked via a QRC device engagement. To complete the transaction, the applicants scan the QRC presented in their browser as part of the DC API. In the same-device flow, the mobile web browser invokes the wallet using platform credential management APIs.

788



789 **Figure 5. mDL Verification Using the DC API**

Steps 1-6	The DCQL query (see Figure 13) requests attributes that support the bank's CIP. The SDK then creates an OpenID4VP authorization request which is relayed to the applicant's wallet via the Digital Credential API operating out of the applicant's browser.
Steps 7-14	After the applicant completes the Digital Credential API cross-device workflow, the mDL attributes are transmitted to the verifier, and a session identifier is returned to the IDMS through the verifier SDK. The IDMS creates an association, which is accessible later in the flow through temporary storage, of the session verifier identifier and the active application. The IDMS then submits the verifier session identifier to the bank verifier mediation service API where it retrieves the mDL attributes which are subsequently encrypted in a JSON Web Token.
Step 15	The attributes, including the encrypted JWT, are returned from the bank's verifier mediation service to the IDMS where the mDL Document Number and Issuing Authority attributes are hashed and persisted as an identifier for the applicant. This identifier is stored in the applicant's directory object which is created as the final step of the IDMS user journey.

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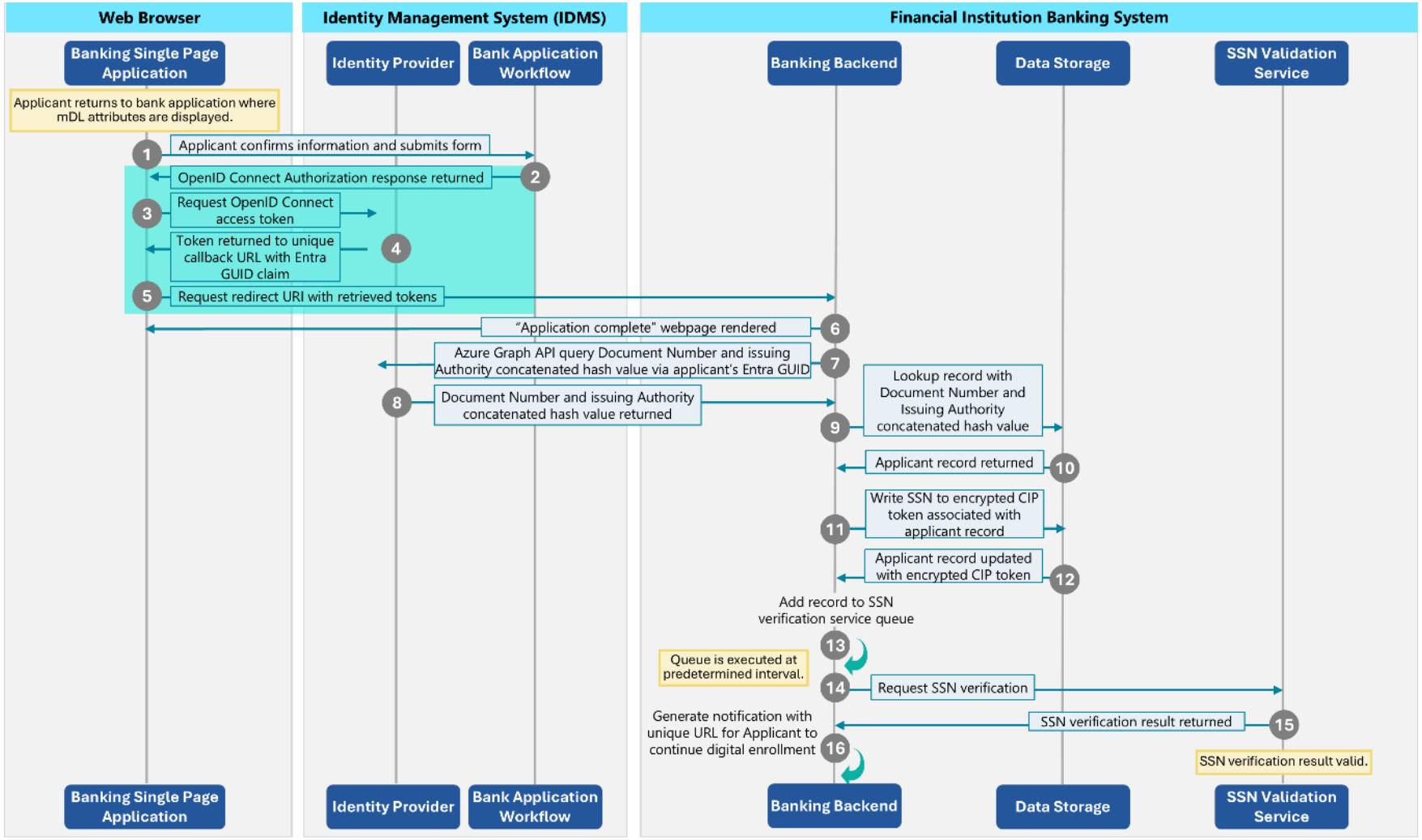


Figure 6. Collection of Additional User Identity Information and Application Completion

Step 1	The Account Application flow concludes with the IDMS displaying the returned attributes from the verifier mediation service to the applicant. The applicant confirms the attributes are accurate and submits the web form.
Steps 2-6	The IDMS processes the form and redirects the applicant's browser back to the banking website via an OpenID Connect Authorization response. The banking backend then uses the returned authorization code to retrieve an access token from the IDMS. The returned token signals to the bank that the application has been completed, and the flow should proceed.[7]
Steps 7-12	Next, the banking system uses the IDMS' internal identifier returned in the token to retrieve the applicant's SSN via a backchannel API call to the IDMS. The SSN is added to the existing encrypted JSON Web Token (JWT) associated with the applicant's profile in the banking system's data storage.
Steps 13-15	The banking system checks the applicant's SSN against the validation service to ensure that the name and date of birth attributes correlate to the mDL. Upon successful validation, the banking system considers the applicant a customer and creates the requested account product.
Step 16	The bank notifies the new customer the account has been approved and that they should initiate the digital enrollment flow via a one-time-use URL. This is presented via email for this demonstration.

5.4.2 Digital Enrollment Flow

The digital enrollment flow is the second step in the user journey. The goal of digital enrollment is to allow approved applicants, who are now a "customer", to set up online access and management of their financial account. This includes provisioning the customer with an authenticator for subsequent login to the account.

5.4.2.1 Synchronous and Asynchronous Digital Enrollment Flows

Once the applicant has completed the application process, the financial institution must approve or reject the application. This process will differ based on the type of financial account requested, the information provided during identity proofing, and internal financial institution checks (e.g., fraud, Office of Foreign Assets Control (OFAC), credit checks). For some applications, the financial institution might offer instant account approval, while others might have a waiting period as the bank executes its internal decision-making processes. The team refers to these user experiences as the synchronous (instant approval) and the asynchronous (user must wait for account approval) flows. The type of flow that occurs affects how the approved applicant progresses to phase two of the user journey, the digital enrollment flow.

In the synchronous flow, the applicant is instantly approved and immediately offered the option to digitally enroll. Because the customer remains in the same browser session used to apply for the account, the bank has high confidence that the applicant who applied for the account is the same

[7] In all demonstration capabilities, a unique OpenID Connect callback URL is used to differentiate between user journeys. In the future, an Authentication Context Class Reference (ACR) claim will be included in the access token to align more closely with a standards-based method to inform the relying party which authentication methods were satisfied.

person as the customer who is digitally enrolling. This allows for a streamlined user experience with no additional steps needed for the applicant to begin digital enrollment.

In the asynchronous flow, however, the initial browser sessions are closed. This might occur because the applicant is told that the financial institution will reach out to them once a decision has been made on their application (i.e., "you'll receive an email in the next 24 to 48 hours") or could occur if the applicant is instantly approved but opts to end the browser session and digitally enroll later. In either case, when the applicant, now a customer, initiates digital enrollment in a new browser session, the financial institution must verify that the person entering the digital enrollment flow is the same person who applied for and was approved for the financial account. The demonstration accomplished this by having the customer re-present their mDL to facilitate the account linking.



Note: Account Linking - When using an mDL to link the customer to an account, the financial institution needs only to collect those attributes from the mDL necessary to uniquely resolve individuals to their account. In the demonstration, the team used a hash value of the driver's license number + the state issuer. Since driver's license numbers should be unique within each state's system of record, this combination of attributes was enough to constitute a unique identifier. This account linking is expected to be infrequent and not a solution for recurring authentication as discussed in Section 5.2.7. It may also be used to support account recovery in the event of a lost authenticator.

The figure below details the asynchronous flow for digital enrollment, where the mDL is used for account linking, after the user initiates the flow through a link sent to them via email.

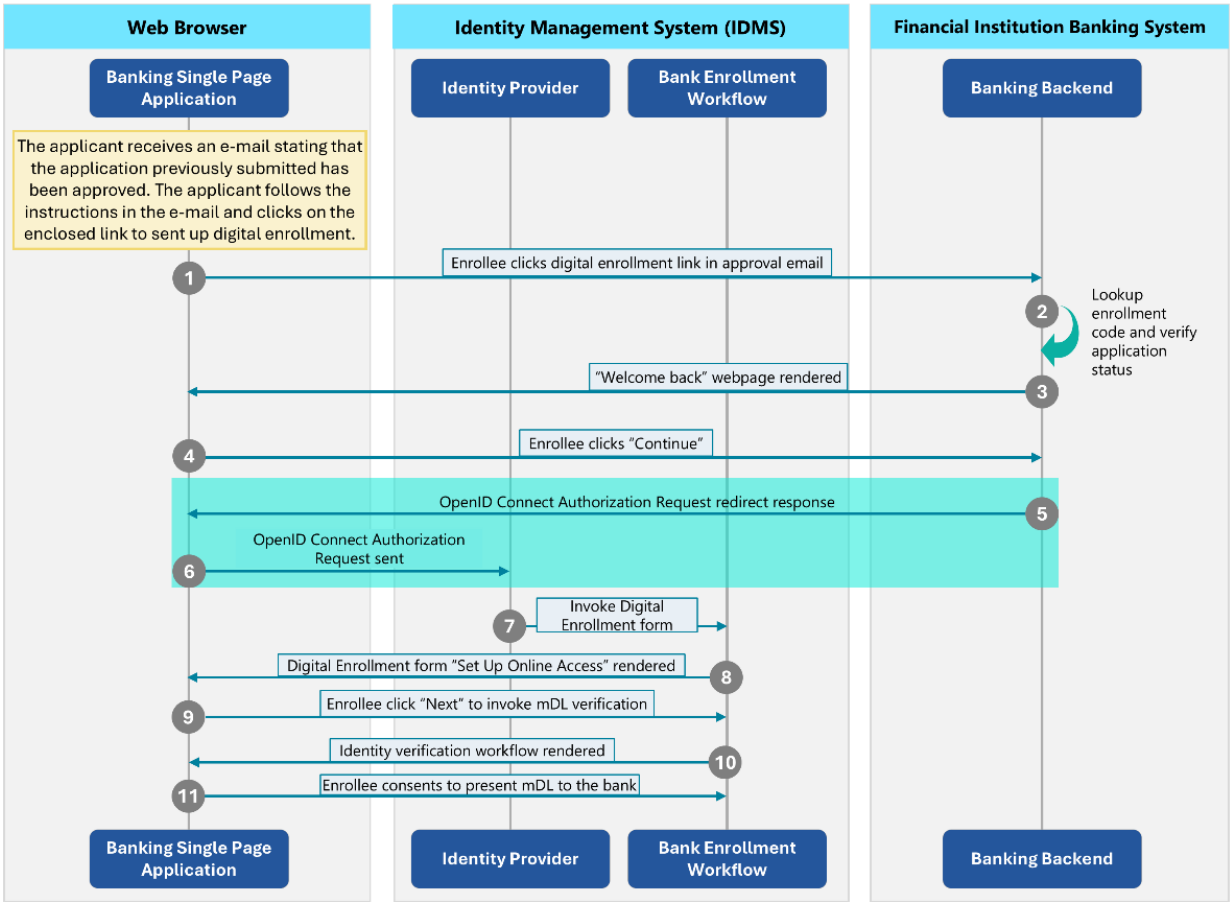


Figure 7. Initiating the Digital Enrollment Process from the Banking System

Step 1	The customers receive an email stating their application has been approved. The customers are directed to click on the enclosed link to set up online access to their account.
Steps 2-11	The banking system ensures the enrollment code in the link is valid, then redirects the customer to the IDMS via an OpenID Connect Authorization Request where they are prompted for consent for mDL re-verification. *Note: when this step is completed, users will present their mDL, the flow is the same as what is illustrated in Figure 4. In this flow, enrollees present only their mDL driver's license number and issuing authority attributes as described in the Account Linking note above, supported by the DCQL query in Figure 13.*

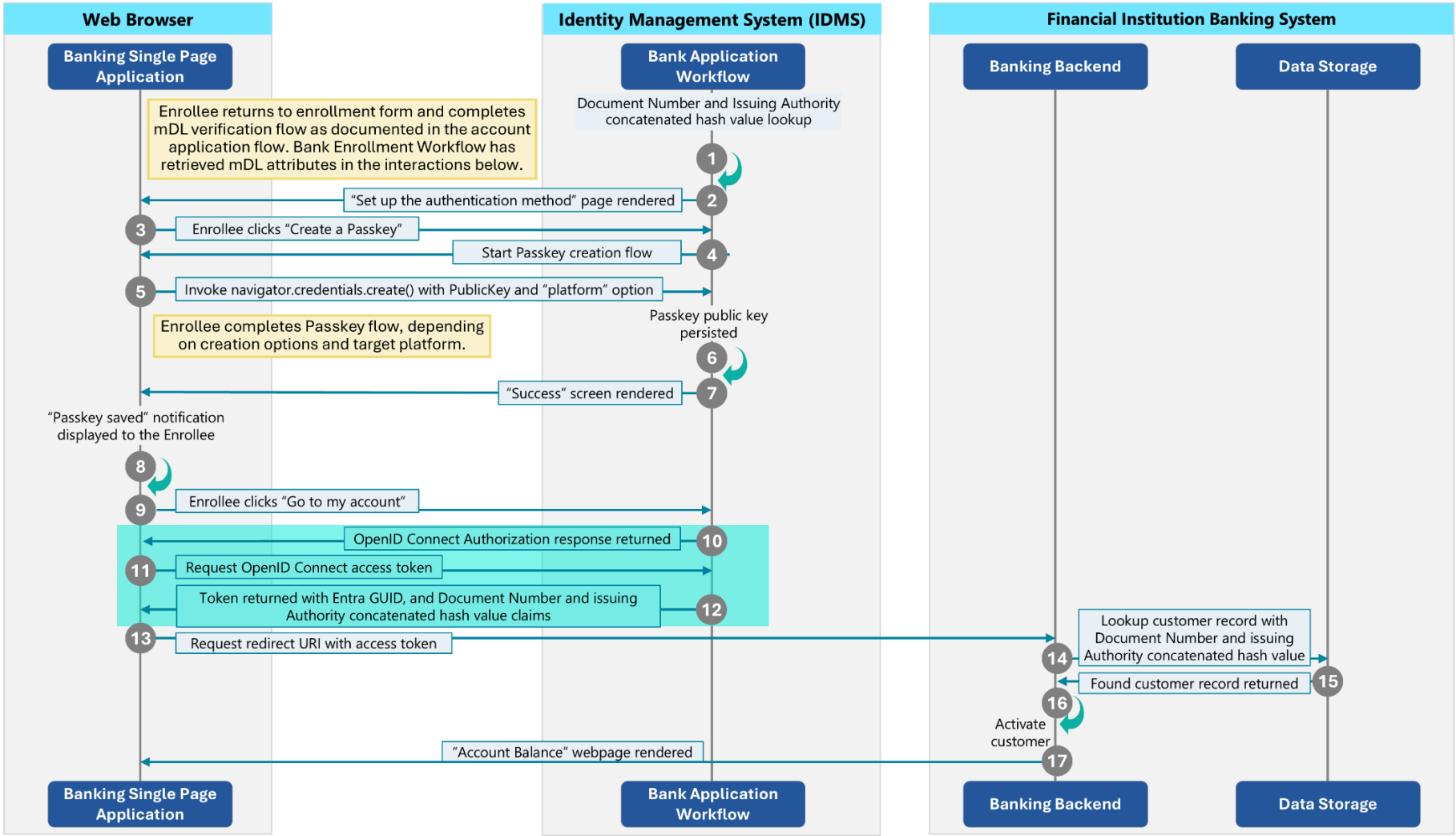
5.4.2.2 Provisioning the Customer a Passkey

While mDLs are highly useful during identity proofing, for day-to-day access to the financial account, it makes sense to provision the customer with a pseudonymous authenticator that does not require or pose the risk of revealing identity attributes. For this project, the consortium chose to provision Passkeys on the customer's device, enabling phishing-resistant authentication with the convenience of not typing a username or password or managing a security key.



Tip: For all high-assurance use cases, NIST recommends the use of phishing-resistant authenticators. Phishing resistance is important because phishing attacks remain a common and effective way to gain unauthorized access to accounts and systems. Phishing attacks attempt to lure a user (usually through an email) into interacting with a counterfeit web page or application and trick the user into revealing information (typically passwords or one-time codes) that can be used to masquerade as that user to the real web page or application. This project provisioned a phishing-resistant passkey to the customer's device for authentication. For more information on phishing-resistance authentication, please read the blog post on the topic.

831



832 **Figure 8. Passkey Registration and Linkage to the Application**

833 At this stage, the IDMS invokes mDL verification as documented in Figure 5 except for the attributes that
834 are requested from the customer. In this flow, only the document number and issuing authority mDL
835 attributes are requested through the DCQL query.

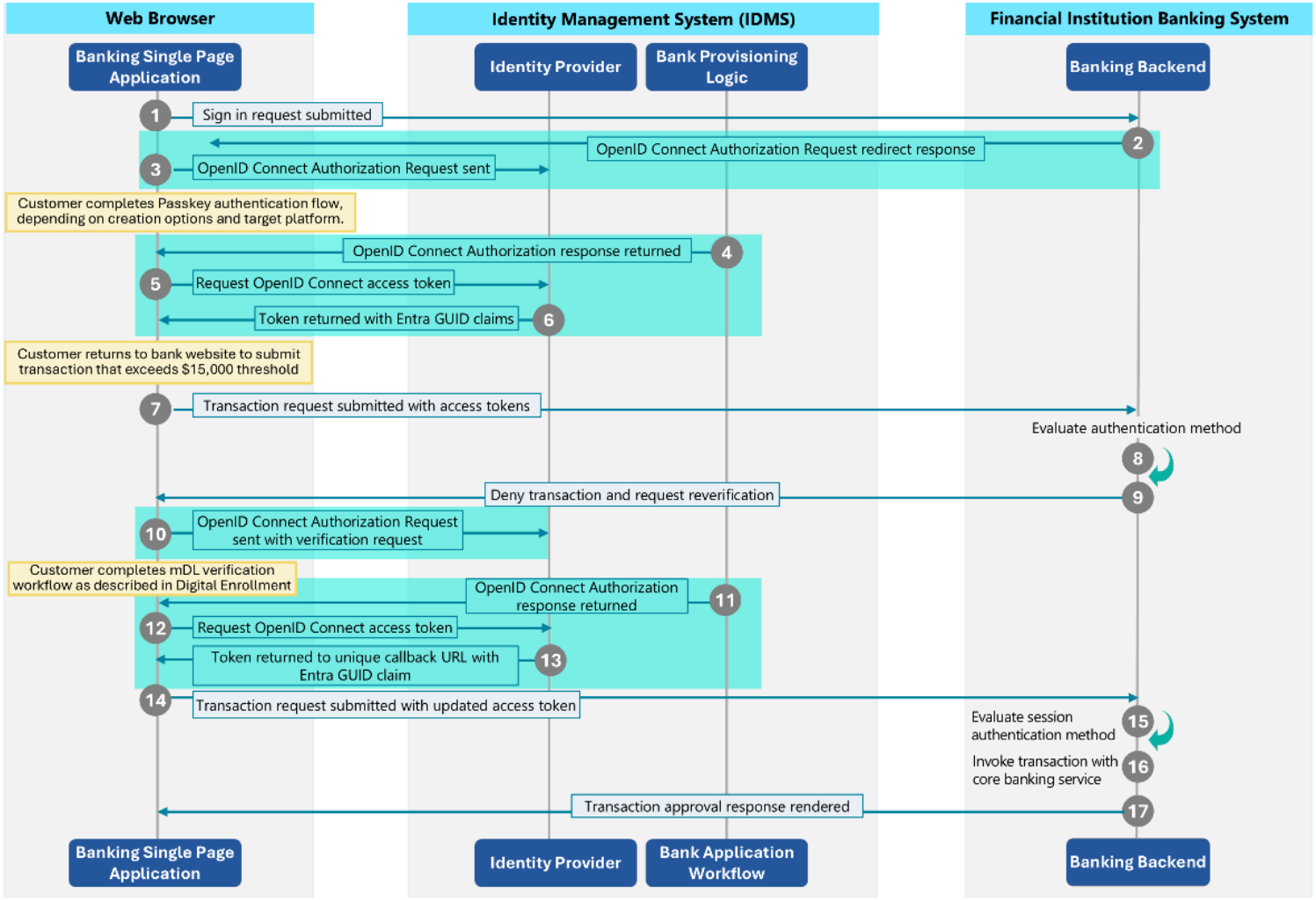
Steps 1-8	Once the IDMS validates the customer's mDL identifier,[8] passkey registration begins. The customer's browser generates a cryptographic keypair, with the public portion transmitted and persisted in the customer's account profile at the IDMS per the WebAuthn API.[9] The customer will then be asked to authenticate on their device using a previously established biometric or PIN to complete the Passkey enrollment.
Steps 9-17	The IDMS prompts customers to access their online account and redirects the customer's browser back to the banking website via an OpenID Connect Authorization response. The banking backend then uses the returned authorization code to retrieve an access token from the IDMS. The returned token signals to the bank that customers have completed passkey enrollment and should be given access to their account, which is rendered in their browser.

Note: While the team did not demonstrate account recovery as part of this project, financial institutions may consider using mDLs as a security signal and convenient element of the account recovery process, when a customer is unable to successfully authenticate.

836 ### 5.4.3 High Risk Transaction Authorization

837 This flow is not part of the initial user journey but rather occurs when a customer attempts a transaction
838 that is deemed high risk by the financial institution's policy and triggers a step-up re-verification of the
839 mDL. The financial institution may offer mDL re-verification as one of several options for authorizing a
840 high-risk transaction but may also specifically ask for an mDL when the bank knows the customer
841 presented an mDL during the identity proofing process. mDL re-verification is one of many signals a
842 financial organization might use to decide whether to authorize a specific transaction. Each FI should
843 consider how to integrate mDL re-verification with additional signals when authorizing high risk
844 transactions. Figure 9 below details the interactions between systems when a high-risk transaction is
845 triggered in a cross-device scenario.

[8] Hashed value of document number and issuing authority concatenation.
[9] Passkeys in this demonstration's context are configured to prefer native platform biometrics or a PIN to verify the user, however, implementations may differ across ecosystems.



846 **Figure 9. Re-Verification for High-Risk Transaction Authorizations**

Steps 1-6	The customer authenticates to the bank system via the IDMS using the passkey registered in Figure 8. The returned token contains an Authentication Context Class Reference value that denotes passkey authentication.
Steps 7-10	The customer submits a transaction request exceeding the bank risk threshold, which triggers a redirect to the IDMS via an OpenID Connect Authorization Request with a parameter that requests mDL verification. The customer completes the mDL presentation as described in Figure 8.
Steps 11-13	The customer's browser is redirected back to the banking website via an OpenID Connect Authorization response. The banking backend then uses the returned authorization code to retrieve an updated access token from the IDMS.
Steps 14-17	The updated access token is used with a new transaction request to the banking system, which is subsequently approved, granting the customer the ability to complete the high-risk transaction.

Similarly, the NCCoE Bank native application supports high risk transactions via mDL reverification in an app-to-app[10] same-device scenario using Android Credential Manager platform APIs. Credential Manager facilitates credential exchange across multiple authentication methods including verifiable digital credentials. This differs from the cross-device scenario above where credential presentation is mediated by the browser via the Digital Credential API. In both scenarios, the same OpenID for Verifiable Presentation authorization request is used to access the user's mDL from their wallet. Figure 10 and Figure 11below depict the interactions when accessing Credential Manager in an app-to-app same device high-risk transaction.

[10] App-to-app in this context refers to the communication between native mobile applications.

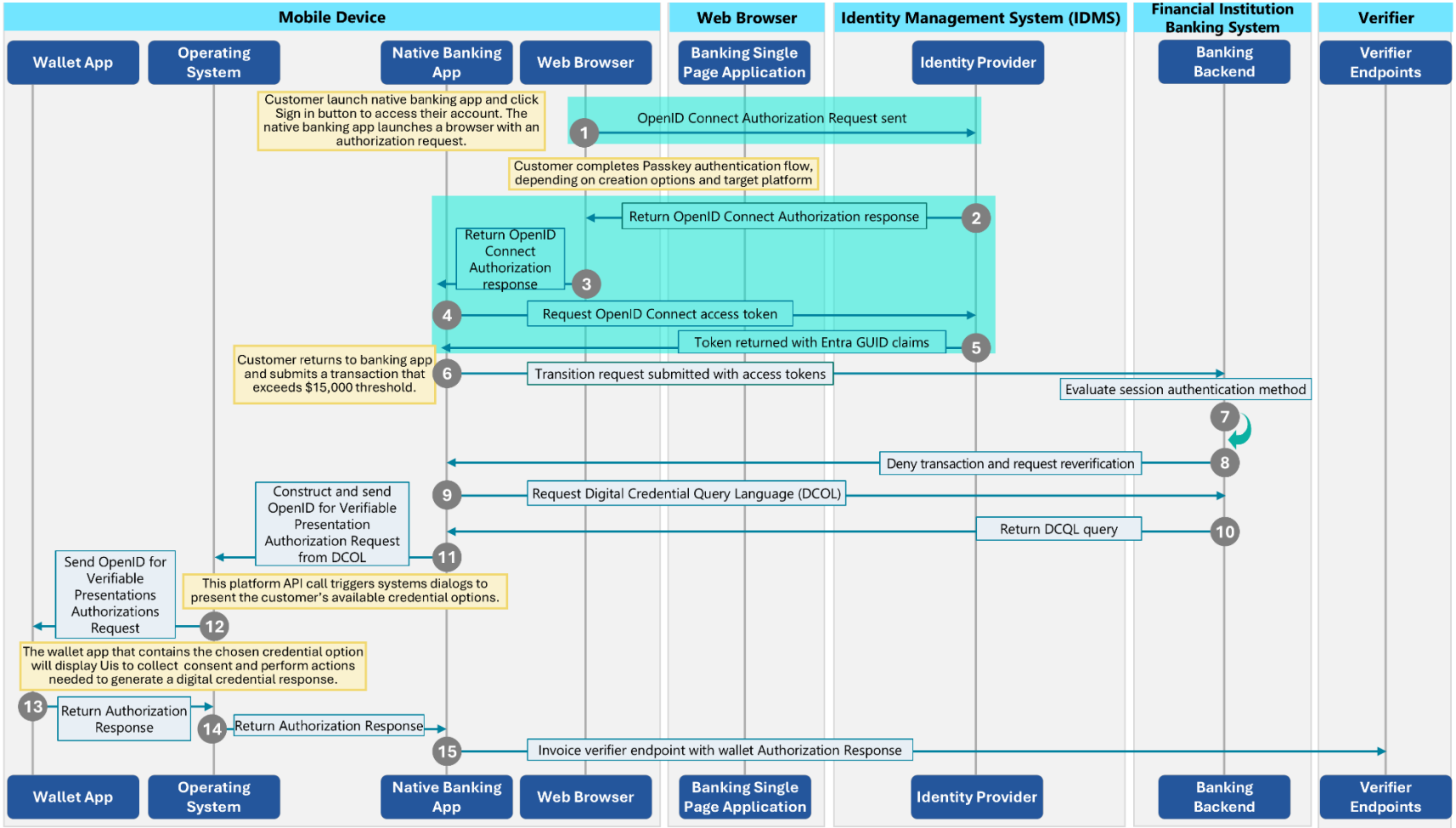


Figure 10. App-to-App Same Device High Risk Transaction Part 1

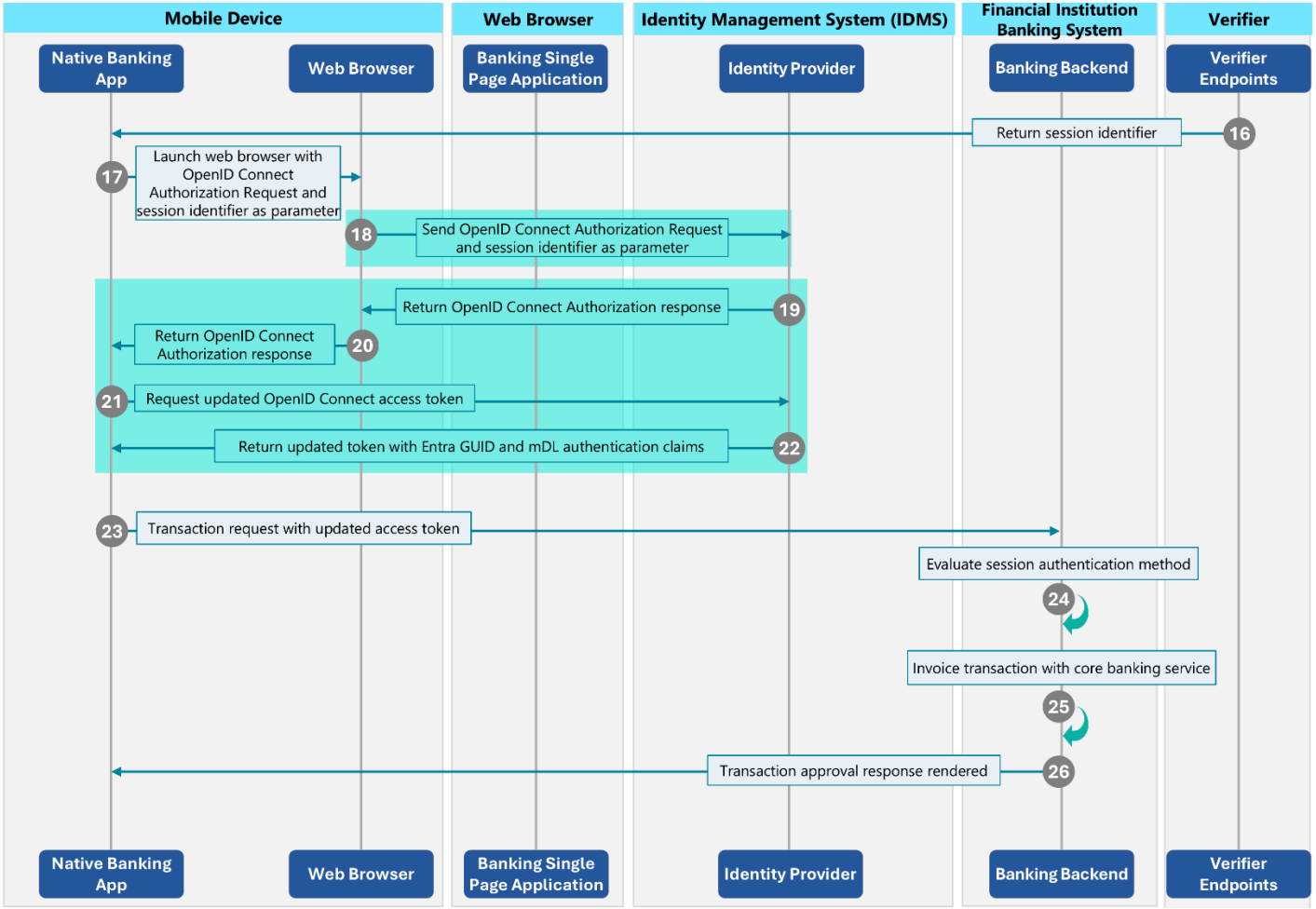


Figure 11. App-to-App Same Device High Risk Transaction Part 2

5.5 Storage of Attributes and Meeting CIP Requirements

Prior to the build phase, the project team agreed to a specific criterion in which the representative financial institution demonstrated storage of digital documents and associated data elements in a discrete repository in alignment with CIP retention requirements [15] (five years after the account has closed). The demonstration maintains the required attributes in an encrypted format associated with the bank system's customer profile record in the bank system's internal database. A web-based administrative interface enables auditors (or other personnel) to decrypt and view the token associated with the banking customer. However, since the project timeline is much shorter than five years and only representative, it does not demonstrate production-level controls that an actual financial institution might implement (e.g., encryption key management, database access controls, etc.). A mapping of the minimum CIP retention requirements [16] to the representative demonstration can be found in the table below. Specific implementation details can be found on the project's resource hub.

CIP Retention Requirement	Demonstration Capability
All identifying information about a customer (e.g., name, date of birth, address, and TIN).	The demonstration stores the following attributes from the customer's mDL in an encrypted token: First Name, Last Name, Birthdate, Issue Date, Expiry Date, Issuing Country, (State) Issuing Authority, Document (License) Number, Address, City, State, Zip Code The customer's Social Security Number is also stored as a token attribute.
A description of the document the bank relied upon to identify the customer.	The encrypted token defines a *Verification Type* attribute. The demonstration uses a value *mdl* to indicate a *mobile security object* document type as defined by ISO 18013-5. This is associated with a timestamp indicating the customer's verification date.
A description of the non-documentary methods and results of any measures the bank took to verify the identity of the customer.	Non-documentary methods were not in the scope of the demonstration.
A description of the bank's resolution of any substantive discrepancy discovered when verifying the identifying information obtained.	Discrepancy scenarios were not in the scope of the demonstration.

5.5.1 RealID Compliance and Additional Assurance Attributes

Core to CIP is the requirement a financial institution has *reasonable belief that it knows each customer's identity.* Thus, in addition to the collection and storage of mDL data elements described in Figure 13, the demonstration requests the *DHS_compliance* element from the customer's credential. This attribute asserts compliance with the REAL ID Act (RealID), a federal law that sets national security standards for state-issued driver's licenses. Specifically, it describes the process used to vet identity and enroll a resident into the state DMV's system of record. These processes give additional assurance to the FI that

the presented mDL is based on consistent physical license issuance requirements. The demonstration rejects account applications from mDL credentials do not assert full compliance with RealID.

As assurance information contained in the credential expands, FIs may wish to create more comprehensive records for investigative or decision purposes. Claims such as those discussed in Building Assurance in the mDL Ecosystem and those being developed in the Open ID Foundation Electronic Know Your Customer Working Group should be integrated into FI records to help further analysis and remediation of potentially fraudulent activity.



Note: This demonstration did not store the cryptographic evidence of the user's mDL presentation in the representative Financial Institution database. Financial Institutions should capture and store an identifier generated by the verifier during mDL presentation to maintain the necessary integrity for potential investigations or have contractual coverage to ensure verifier maintenance and FI access to this information. This transaction identifier can be used as a proof point for future forensic activities**.**

6 Privacy Considerations

Mobile driver's licenses can help reduce privacy risks that arise during identity verification and account enrollment. However, as with any new technology, it may also introduce new or different risks for users compared to existing or previous practices. Understanding and balancing these benefits and risks is critical to deploying a system that supports an organization's privacy objectives. This section gives a primer on the importance of privacy protections when using mDL for online services, the relationship between privacy and cybersecurity risk, and how NIST approaches privacy risk assessment.

6.1 Privacy in the mDL Architecture

Managing privacy risk is essential to protecting individuals and organizations. Emerging identity verification technology should seek to improve on the current state of privacy and provide users with greater protections. Mobile Driver's Licenses (mDL) and other Verifiable Digital Credentials provide opportunities to improve not only security, but also privacy. Through the selective disclosure of attributes, improved user control of credentials, the reduction of calls to third party services to validate user data, and the potential for future use of zero-knowledge proofs, mDLs can pave the way for a more privacy-preserving ecosystem.

For Financial Institutions (FIs), safeguarding customer privacy is important for several reasons:

- **Compliance**: FIs must comply with federal laws and regulations, such as:
    - Gramm-Leach-Bliley Act (GLBA);
    - Consumer Financial Protection Bureau (CFPB)'s guidelines and requirements for privacy, and;
    - Federal Deposit Insurance Corporation (FDIC)'s Customer Identification Program (CIP), Customer Due Diligence (CDD) regulations, and safety and soundness standards.

Individual states may have additional regulations that may apply; for example, California has four additional laws: California Financial Information Privacy Act (CFIPA), California Consumer Privacy Act (CCPA), California Privacy Rights Act (CPRA), and California Right to Financial Privacy Act (CRFPA).

In general, these laws and regulations require FIs to implement systems and processes to protect customer privacy and their financial records. For example, by prohibiting the disclosure of such records without the customer's consent, except under specific circumstances such as complying with law enforcement investigations.

- **Consumer Trust and Confidence**: Protecting privacy fosters trust and confidence among customers. When customers know their sensitive financial information is secure and that organizations take additional measures to protect privacy, they are more likely to remain loyal and continue using the FI's services. Privacy failures can lead to problems for individuals, such as identity theft, embarrassment, or distress—as well as problems for organizations, such as reputational damage, financial loss, and customer attrition. Privacy can become a key differentiator and provide a competitive edge to FIs that demonstrate robust privacy protections, attracting and retaining customers who place a premium on their privacy.

- **Due Care**: FIs handle vast amounts of personal and financial data and have an ethical obligation to protect the confidentiality and integrity of this data. Unauthorized access can result in identity theft, fraudulent transactions, and significant financial losses. Strong security practices, including encryption, access controls, and incident response protocols, help mitigate these security risks, as well as some privacy risks, and protect both the FI and its customers from harm.
- **Transparency:** As digital banking expands, customers expect transparency and control over how their information is used, making privacy protection a fundamental part of business. It empowers customers to decide, under certain circumstances, what data to share. Further, it improves transparency to provide customers with visibility into how their data is processed, with whom it is shared, and for what purposes.

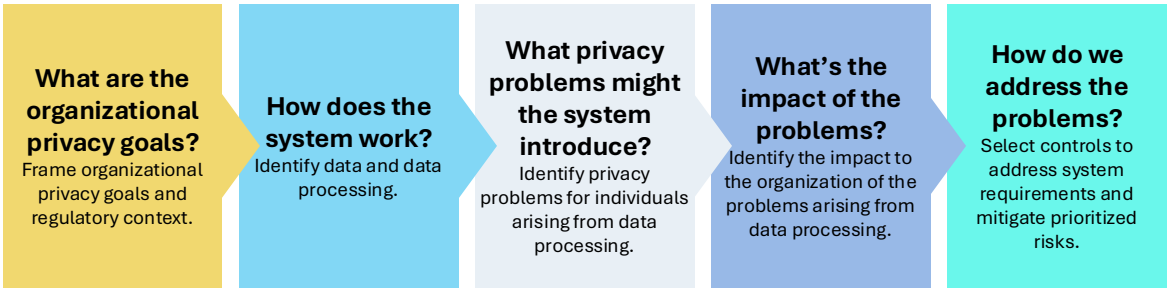
mDLs present privacy benefits for both in-person and online identity verification flows that are not possible with traditional physical IDs. The following table illustrates a few of the benefits mDL may introduce. See the project resource hub for a more thorough comparative analysis of mDL and other CIP models.

Table 3. mDL Privacy Benefits

Privacy Benefits	Description
User Control and Selective Disclosure	Only data *required* for opening the account is shared, minimizing the data collected and stored—a level of granular data control which is unique to the mobile Driver's License.
Notice and Transparency	Customers are provided with easy-to-understand customer interfaces to enable informed decision-making about sharing their personal information.
Data Integrity and Accuracy	Customer data is presented, stored, and transmitted in a way that incorporates strong security. Enabling confidentiality, integrity, and availability of data facilitates controls that double as privacy protections for customer data, such as access control, encryption, and retention/deletion.
Local Biometric Verification	Customers can make use of local biometric capabilities, removing the need for centralized biometric comparison at the FI and limiting the amount of biometric data regularly transmitted to support account onboarding.

Another benefit of mDL is its ability to enable future-looking, privacy-preserving technologies; for example, mDL can support zero-knowledge proofs and other cryptographic techniques for uses such as age verification. As with many technologies, the ability to realize the privacy benefits of mDLs greatly depends on the design and technical implementation decisions of each FI. When implementing mDL technology, FIs should initiate a privacy risk assessment to identify, assess, prioritize, and manage privacy risks tailored to their specific organization, implementation architecture, and business processes. NIST's Privacy Risk Assessment Methodology (PRAM) provides an approach that FIs can apply to manage risk consistently across the organization and technology implementations.

The PRAM helps organizations tackle five major questions:



950 **Figure 12. Five Privacy Questions**

951 Taking on the role of an FI, the NCCoE applied the PRAM to assess the privacy risk of using an mDL to
952 establish a financial account through online remote identity proofing. The NCCoE developed
953 representative responses of how an FI may complete this assessment. Table 4 below offers a sampling of
954 the content in an mDL PRAM. A more robust assessment can be found on the project resource hub.

955 To demonstrate how an FI can apply the PRAM, the NCCoE created an example data flow diagram to
956 enumerate each data action. The NCCoE identified a variety of problems individuals may encounter
957 arising from mDL, along with a set of controls that are valuable for managing these privacy risks when
958 implementing mDL.

959 **Table 4. mDL Problems and Controls**

Potential Problems for Individuals	Controls
Loss of Trust Customers could lose trust if their data is processed beyond what they predict. **Surveillance** With mDL for account enrollment, there is a chance for surveillance if the verifier or the issuer creates a pattern of the users' behaviors and actions online with the mDL. **Dignity Loss** If customers' activities are known in a way they could not predict, they could experience emotional distress. For instance, if the verifier tracks customer activities across transactions,	**Device retrieval:** This verification model allows the verifier to independently verify the integrity and accuracy of the user's attributes without contacting the issuer at transaction time. Device retrieval supports data quality, while also preventing the issuer from getting a notification each time an individual uses their mDL (which could more easily lead to surveillance of an individual across their financial transactions). Server retrieval is not supported. **Cryptographic protection:** Leveraging mDL for account enrollment and step-up verification introduces new parties (e.g., the verifier) into the data processing ecosystem. This inherently introduces risk as data is transferred between partners. As in all scenarios that involve the processing of different data in a process flow, it is crucial to protect customer data at rest and in-transit using cryptographic techniques. For mDL, this includes signing requests and responses between the verifier and wallet to increase confidence in participating entities and encrypting responses. It also includes encryption of attributes when at rest in different FI backend systems as well as connected vendors.

Potential Problems for Individuals	Controls
it could create a narrative the customer never wanted to be known or a false narrative that could be misused. **Loss of Autonomy** Customers may feel like they have lost control over the processing of their data (e.g., if it is shared with third parties whom they did not expect to have access to it, if it is retained beyond a predictable timeframe, or if it is used for processing to which the customer never consented).	**Supplier assessments and reviews:** The introduction of mDL adds new parties to the account enrollment process (e.g., verifiers). Each additional party increases risk; thus, it is important to ensure that organizational risk management processes account for the broader supply chain. Supply chain participants should be evaluated to confirm they implement controls sufficient to meet the FI's privacy and compliance objectives. For example, if a third-party software is processing customer data, the FI should assess whether the software only processes the data for the agreed-upon purposes and deletes the data at the end of the retention period, whether the data is securely stored, and whether the data is shared downstream with additional third parties. **Notice and consent:** With the addition of an mDL, it may be harder for customers to predict how their data is processed—and predictability is an important part of maintaining trust in an FI. Further, FIs have regulatory requirements for notice and consent before collecting personal information. Providing real-time notice for individuals is important to ensure predictability of how their data is processed, and it provides an opportunity to highlight that the only attributes collected from the mDL are those required for compliance. Consent empowers customers by giving them choice over which processing activities they do and do not agree to, such as whether they want to proceed with mDL or choose an alternative path to account enrollment. **Data retention:** FIs must retain certain customer data for five years after a customer closes their account. However, not all parties in the ecosystem will need to comply with this same retention schedule. It is ideal for a third party to delete customer data promptly, and in accordance with its own retention obligations, to reduce the risks of holding that personal data.

The above problems for individuals, if realized, can translate to impacts on a financial institution, for example:

- **Reputational Damage**: Customers are becoming increasingly aware of and interested in how their data is handled, and some companies are even positioning privacy as a competitive advantage. If an FI uses customer data outside of the agreed-upon purposes, or a third party working with the FI surveils a customer across their transactions, this could become known to customers and impact the FI's reputation. Reputational damage can, in turn, have tangible downstream effects on the institution, such as costs associated with noncompliance with privacy regulations or direct business costs resulting from customers ending their relationship with an FI.

- **Direct Business Costs**: There are many reasons customers may not trust an FI with handling their data; for instance, a customer may have requested the deletion of their data, only to receive a personalized mailer indicating that their data wasn't deleted after all. They may have received notification of a breach at an institution. They may have read an article about ineffective access management processes that expose their data beyond what they expected. In any of these situations and more, a customer may choose to take their business to a competitor with different data handling policies. This can hurt the company's revenue and ability to attract new customers.
- **Noncompliance Costs**: FIs operate under strict regulatory environments, where problems for individuals may also be indicative of noncompliance with a financial regulation. For example, FIs must obtain consent from individuals before collecting certain data. If they fail to demonstrate compliance with the swath of privacy regulations, they may face regulatory scrutiny and financial or other consequences.

Given the impact privacy problems can have on individuals and ultimately on financial institutions, it is crucial to complete a thorough privacy assessment. This enables an FI to identify, within a given environment, the problems that could arise for individuals, assess the likelihood and impact of those problems, and implement controls for risk management. With a thoughtful approach such as this, the privacy benefits of mDL can be realized while minimizing the risk to individuals and organizations. The above is a brief sampling of problems and controls. A more detailed PRAM can be accessed on the project resource hub.

7 Barriers to Scaled Adoption and Recommendations

7.1 Trust Models and Trust Establishment

In project discussions with the financial sector, FIs have expressed a need for greater clarity on the processes for enrolling, issuing, and presenting mDLs. Specifically, FIs must have a clear understanding of the assurances they are getting and the potential risk they are accepting when implementing mDLs.

Traditionally, FIs own and control their identity verification systems, which allows for agility when responding to threats and mitigating risks associated with identity verification. While the mDL ecosystem offers potential benefits to FIs across security, fraud reduction, privacy, and usability, adoption of this technology requires trust in third parties, such as the mDL issuer and the wallet that stores the mDL.

To accept this third-party risk, FIs are seeking assurances to assuage their concerns around the processes used to enroll, issue, and present mDLs. The table below summarizes these concerns. For a more detailed discussion on this topic, please review the resource hub.

Table 5. Assurance in the mDL Ecosystem

Issue	Discussion	Approaches
Issue #1: Enrollment into the System of Record (SOR) at the DMV	FIs are concerned about the lack of visibility into the process used to identity-proof and enroll a user into the SOR at the DMVs when issuing the user with their initial, physical credentials on which the mDL will be based.	This is addressed by the inclusion of the AAMVA-mandated "Real ID" compliance field in the mDL. This provides issuer signed indicators of how the initial issuance was achieved.
Issue #2: Issuance of the mDL or Digital Credential to the Holder's Digital Wallet	FIs are concerned about the limited visibility they have into issuance processes for mDL and other forms of verifiable digital credentials. As mDLs become more valuable, the issuance processes are increasingly likely to be targeted by attackers.	The project proposed addressing this in two ways: 1. By providing a profile of NIST SP 800-63A for the issuance of mDLs. This can be referenced as a baseline for consistent issuance processes; and 2. Encoding security characteristics of issuance process into the credential itself. Using attribute sets such as those in the OpenID for Identity Assurance, this security "metadata" can be signed by the issuer and stored in the mobile

Issue	Discussion	Approaches
		security object of the mDL. 3. The Identity Assurance eKYC working group under OIDF is working on standardizing a common set of claims that represent the identity proofing and vetting process used when an identity credential or assertion was issued. The claims can be signed by issuers and passed to relying parties for evaluation.
Issue #3: Holder Binding during mDL Presentment	FIs are concerned that processes used to authenticate the holder of an mDL vary in implementation and security assurances across wallet and mobile operating systems. Absent clear signals or more consistent implementations, FIs are likely to adopt a server-side biometric match whenever an mDL is used, which presents significant privacy concerns.	This could be addressed by adding data to the presentation protocols that defines a set of holder authentication methods supported by the wallet that can be requested by verifiers. This would provide RPs with insight into the degree to which the mDL holder is bound to the credential during presentation. ISO working group 10 is currently undertaking efforts to define these authentication values to be included in ISO 18013-7.

In addition to these items, most FIs expressed a desire to have greater confidence in a wallet's underlying security and ability to meet existing and emerging features (such as those identified above). A more robust trust ecosystem that includes wallet certification against well-defined requirements has emerged as a critical step toward adoption, particularly as the overall mDL and VDC ecosystem begins to solidify. In the U.S., the Fast Identity Online (FIDO) Alliance recently announced a working group focused on developing wallet certification criteria to address this gap area. Additionally, organizations like the OIDF have developed testing tools to determine conformance with their presentation protocols and issuance protocols. Taken together, these efforts provide a foundation for the expansion of trust across the ecosystem.

7.2 Standards Maturity Levels

A notable element of this project was that the technical ecosystem for online presentation of mDLs was still taking shape as the work progressed. Key standards and protocols, including OpenID4VP, High Assurance Interoperability Profile (HAIP), Digital Credentials API, and ISO/IEC 18013-7 underwent substantive changes during the project, resulting in near constant updates, testing, and troubleshooting of the architecture and technology. This was inevitable given the evolving mDL ecosystem. However, for large, customer-facing organizations such as FIs with a heavy focus on the scaled, reliable systems to meet their business needs, stability and trust in the underlying standards is critical. While this evolution created implementation challenges, it also provided an important opportunity. Rather than waiting for the standards ecosystem to mature, the NCCoE brought together technology providers, credential issuers, relying parties, and other stakeholders to identify the capabilities needed for mDLs to operate securely and reliably at scale.

Since the build was completed, OpenID4VP and HAIP have been approved as final, and an updated version of 18013-7 based on these is expected this year.

At the time of writing, there remain some broader standards items that need resolution. The first is completion of the W3C DC API. While several initial implementations are already shipping in browsers such as Chrome and Safari, the specification is still a draft and has some critical issues that need to be addressed before it is ready for scaled implementations.

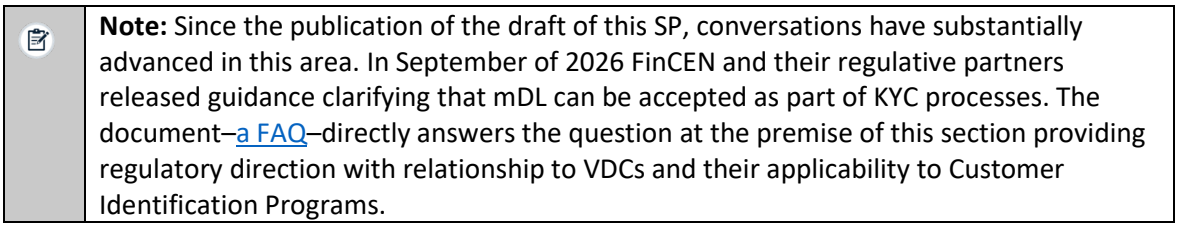
The second substantial issue is the bifurcation of the presentation protocols. At the time of writing, there are two different presentation protocols in use by the major platform providers: OpenID4VP and 18013-7 Annex C. Each protocol has benefits and drawbacks, and the existence of two protocols may not severely impede adoption. It does, however, complicate verifier implementations requiring the dynamic handling of both protocols to fully support mDL users across all wallets. Verifiers trying to manage these divergent protocols at scale, while limiting user impact, need time to design, test, and evaluate these protocols. Fortunately, there is a new Digital Credentials Harmonized Presentation Working Group that is tackling this challenge.

By implementing emerging specifications against real-world, high-assurance relying-party requirements, the project identified interoperability, security, privacy, and usability issues before standards and approaches were widely deployed. The team brought these findings directly to several standards bodies, including the Open ID Foundation, the FIDO alliance, W3C, and ISO/IEC WG10 on critical aspects of the standards and protocols needed to promote scaled adoption of mDLs and VDCs writ large. In particular, the NCCoE project team provided feedback to these standard bodies on the functional, security, privacy and usability requirements of high assurance RPs such as financial institutions, who have historically had challenges in consistently engaging SDOs. This feedback loop is a key aspect of this project, and such engagement will continue as additional phases of work progress.

7.3 Regulatory Alignment

Perhaps one of the most common refrains the NIST project team heard during the discussions with FI collaborators was, “but will the regulators allow us to use this?” Regulation and compliance are core to the risk management and decision-making processes for FIs, who face potentially costly impacts of non-compliance, which makes early adoption complicated.

While it is not within NIST's capacity to make authoritative determinations of whether mDL is compliant with CIP requirements, the project team has attempted to minimize this barrier to adoption through two resources: 1) a regulatory mapping that compares the capabilities demonstrated through the project to the requirements defined in Title 31 Code of Federal Regulations 1020.220 (commonly referred to as a Customer Identification Program for banks), and 2) the CIP/KYC documentary considerations appendix provides a simple reference for risk management professionals that compares existing CIP documentary methods to the built demonstration. The tables compare documentary methods along three axes: security, privacy, and usability.



Appendix A References

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Appendix B List of Available Online Resources

This appendix provides a comprehensive list of resources related to this project that are available on the project resource hub.

Resource Name	Location
CIP Use Case Criteria	https://pages.nist.gov/nccoe-mdl-project-static-website/use-case-1/criteria.html
Sample Bank mDL Information Page	https://pages.nist.gov/nccoe-mdl-project-static-website/use-case-1/nccoe-bank-faq.html
Wire Frames	https://pages.nist.gov/nccoe-mdl-project-static-website/use-case-1/wireframes.html
Financial Use Case Reference Architecture and Demonstration Videos	https://pages.nist.gov/nccoe-mdl-project-static-website/use-case-1/architecture/kyc-cip-onboarding.html
Interaction Diagrams	https://pages.nist.gov/nccoe-mdl-project-static-website/use-case-1/architecture/interaction-diagrams.html
Building Assurance in the mDL Ecosystem	https://pages.nist.gov/nccoe-mdl-project-static-website/use-case-1/building-mdl-assurance/index.html
NIST SP 800-63A Profile for mDL Issuance	https://pages.nist.gov/nccoe-mdl-project-static-website/use-case-1/building-mdl-assurance/nist_800-63a.html
Privacy Risk Assessment Methodology	https://pages.nist.gov/nccoe-mdl-project-static-website/use-case-1/pram.html
Usability Assessment	https://pages.nist.gov/nccoe-mdl-project-static-website/use-case-1/usability-results.html
CIP Regulatory Mapping	https://pages.nist.gov/nccoe-mdl-project-static-website/use-case-1/cip-mapping.html
Privacy and Security Comparative Analysis	https://pages.nist.gov/nccoe-mdl-project-static-website/use-case-1/pram.html
Configuration Guide	https://pages.nist.gov/nccoe-mdl-project-static-website/use-case-1/vol-c.html

Appendix C Regulatory Mapping

To help FIs understand how mDLs might meet compliance requirements, the core project team, along with project collaborators, federal agencies, and NIST subject matter experts, have developed a mapping in the table below between the technical implementation capabilities and Title 31 Code of Federal Regulations 1020.220 commonly referred to as a Customer Identification Program for banks.



Note: This mapping is an effort to illustrate the alignment of mDL and the process implemented as part of the NCCoE build with the requirements defined in the CIP. It does not guarantee regulatory acceptance or compliance.

1119 **Table 6. CIP Requirement to Capability Mapping**

CIP Requirement	Demonstrated Capability or Process	Capability Relationship to CIP Requirement	Relationship Explanation
31 CFR 1020.220(a)(2) ***Identity verification procedures.*** The CIP must include risk-based procedures for verifying the identity of each customer to the extent reasonable and practicable. The procedures must enable the bank to form a reasonable belief that it knows the true identity of each customer. These procedures must be based on the bank's assessment of the relevant risks, including those presented by the various types of accounts maintained by the bank, the various methods of opening accounts provided by the bank, the various types of identifying information available, and the bank's size, location, and customer base. At a minimum, these procedures must contain the elements described in this paragraph (a)(2).	Customer Identification with mDL Verification and TIN Validation	Aligned to CIP general requirement.	This requirement defines the general expectation that financial services organizations apply a risk-based approach to determine the "true identity" of each customer. mDL verification provides means to mitigate risk associated with identity theft or fraudulent account opening by **leveraging cryptographic security features embedded** within the digital credential. Coupled with holder verification to the mobile device through biometrics and other local authentication factors, this provides financial institutions with an increased degree of confidence over existing methods that **1) the evidence is real and not forged**, and **2) in the possession of the individual who is represented by the credential**. Note: see the base document threat model for discussion of local v. server-side verification of holders.
31 CFR 1020.220(a)(2)(i)(A)(1) – 31 CFR (a)(2)(i)(A)(3)(iii) (A) ***In general.*** The CIP must contain procedures for opening an account that specify the identifying information that will be obtained from each customer. Except as permitted by paragraphs (a)(2)(i)(B) and (C) of this section, the bank must obtain, at a	Verifiable mDL Attributes.	Aligned to CIP Requirements for identity and address attributes.	The following attributes are mandatory and encoded and signed into all mDL presentations. - Family Name - Given Name - Date of Birth - Address Each of these elements is mandatory in the AAMVA Implementation Guidelines and necessary to meet CIP requirements. The presence of these attributes within the

CIP Requirement	Demonstrated Capability or Process	Capability Relationship to CIP Requirement	Relationship Explanation
minimum, the following information from the customer prior to opening an account: (*1*) Name; (*2*) Date of birth, for an individual; (*3*) Address, which shall be: (*i*) For an individual, a residential or business street address; (*ii*) For an individual who does not have a residential or business street address, an Army Post Office (APO) or Fleet Post Office (FPO) box number, or the residential or business street address of next of kin or of another contact individual; or (*iii*) For a person other than an individual (such as a corporation, partnership, or trust), a principal place of business, local office, or other physical location; and			Mobile Security Object (MSO) ensures their integrity and accuracy. Additionally, these attributes are compared against access policy requirements in the financial services IDMS—meaning if the credential did not contain the necessary data an enrollment attempt would not be successful. APO/FPO may be available on an mDL in addition to a physical address depending on the state policy, though this was not tested or observed during the project. At this time, mDLs are for individuals only and would not support clause (ii) which allows for next of kin/contact individuals, or clause (iii) which refers to corporations.
31 CFR 1020.220(a)(2)(i)(A)(*4*)(*i*) (*4*) Identification number, which shall be: (*i*) For a U.S. person, a taxpayer identification number;	Tax Identification Number (e.g., Social Security Number) Applicant Identifier Request and validation	Aligned to requirements for an identification, specifically a Tax Identification Number for U.S. persons	A TIN[11] attribute is not included in U.S. state issued mDLs. The demonstration collects TIN (social security number) as part of

CIP Requirement	Demonstrated Capability or Process	Capability Relationship to CIP Requirement	Relationship Explanation
			the account opening web workflow and validates this information against a mock third-party data source.[11]
31 CFR 1020.220(a)(2)(i)(A)(4)(B) and (C) (B) ***Exception for persons applying for a taxpayer identification number…*** (C) ***Credit card accounts…***	Not Addressed	Not Addressed	These two clauses are related to customers without a TIN and allowances for credit card accounts to be opened with third party data. The build is not intended to address risk-based decisions on those who do not have TINs or processes for extending credit. As such, they are out of scope for the build, and in NIST's view do not impact the ability for an mDL-based process to support compliance with CIP requirements.
31 CFR 1020.220 (a)(2)(ii) ***Customer verification.*** The CIP must contain procedures for verifying the identity of the customer, using information obtained in accordance with paragraph (a)(2)(i) of this section, within a reasonable time after the account is opened. The procedures must describe when the bank will use documents, non-documentary methods, or a combination of both methods as described in this paragraph (a)(2)(ii).	mDL Verification with TIN Validation	Aligned to requirements in both documentary (mDL) and non-documentary (TIN) verification processes	The mDL process as defined in this demonstration uses **both documentary and non-documentary processes** to verify the identity of an individual applying for an account. The mDL itself conforms to documentary verification processes, proving identity based on the existence of a verifiable digital credential (mDL) signed by the issuing state, while the non-documentary process validates the existence of a TIN. These are discussed in more detail below.

[11] Note that an exemption in June 2025 was granted from the requirement to collect a TIN from a customer before opening an account so long as a TIN could be validated for the user based on third - party sources. This means the mDL workflow could be implemented without an additional data request to the user so long as the attributes provided off the mDL are able to resolve to a TIN in third party data sources used by the bank.

CIP Requirement	Demonstrated Capability or Process	Capability Relationship to CIP Requirement	Relationship Explanation
31 CFR 1020.220 (a)(2)(ii)(A)(1) and (2) (A) ***Verification through documents.*** For a bank relying on documents, the CIP must contain procedures that set forth the documents that the bank will use. These documents may include: (*1*) For an individual, unexpired government-issued identification evidencing nationality or residence and bearing a photograph or similar safeguard, such as a driver's license or passport; and (*2*) For a person other than an individual (such as a corporation, partnership, or trust), documents showing the existence of the entity, such as certified articles of incorporation, a government-issued business license, a partnership agreement, or trust instrument.	mDL Verification including verifiable attributes and holder authentication	Aligned to documentary verification processes.	An mDL is a digital document issued to an individual by **a state government authority** (e.g., DMV) through an identity proofing process. It contains attributes and data elements which have been signed using public key cryptography ensuring the integrity and accuracy of the data. They are also signed by a unique device key preventing them from being shared to other devices and are protected during online presentation through local authentication mechanisms (often biometrics). In addition to the user's personal attributes an mDL also contains signed attributes such as the **License Expiration date** and **the holder's portrait,** and **physical address** as mandated by this requirement. While nationality is not indicated on a driver's license (mDL or otherwise), DLs and mDL do serve as proof of residence. This is further supported by the inclusion of a RealID compliance flag which has elevated expectations for residency status. The portrait can be used to 1) augment local authentication by enabling a bank biometric verification at the time of account opening and 2) physical verification in branches. This project only focused on identification of individuals and, therefore, does not cover example (2) at this time. It is NIST's view that this does not impact the ability of an mDL to be used as part of a compliant CIP process.

CIP Requirement	Demonstrated Capability or Process	Capability Relationship to CIP Requirement	Relationship Explanation
31 CFR 1020.220 (a)(3)(i)(A) – (D) (3) ***Recordkeeping.*** The CIP must include procedures for making and maintaining a record of all information obtained under the procedures implementing paragraph (a) of this section. (i) ***Required records.*** At a minimum, the record must include: (A) All identifying information about a customer obtained under paragraph (a)(2)(i) of this section; (B) A description of any document that was relied on under paragraph (a)(2)(ii)(A) of this section noting the type of document, any identification number contained in the document, the place of issuance and, if any, the date of issuance and expiration date; (C) A description of the methods and the results of any measures undertaken to verify the identity of the customer under paragraph (a)(2)(ii)(B) or (C) of this section; and	CIP record establishment with representative financial institution	Representative of record keeping requirements	The NIST Bank of NCCoE is not a real financial institution. The demonstration records are established to represent a real-world architecture and process but are not as robust as real-world record systems. Attributes collected during the customer identity verification process in this demonstration were stored in an encrypted structured token within a database accessible to the banking system. The following information is captured in these tokens for all mDL related test transactions: • (A) Verified user attributes (see above for details) • (B) Document Identification Number (i.e., license number) • (B) Identification Expiration Date • (B) Issuing Entity (i.e., issuing state) • (B) Issuance Date • (C) A value of “mDL” stored in the token indicating the CIP method used. Other methods were not included as values since they were not tested, though FIs should

CIP Requirement	Demonstrated Capability or Process	Capability Relationship to CIP Requirement	Relationship Explanation
(D) A description of the resolution of any substantive discrepancy discovered when verifying the identifying information obtained.			expand and include values for all their supported CIP methods. • (D) Existence of a token was provided as an indication of successful identity verification – Financial Institutions should expand on the token or an associated supplementary record to include more detailed information related to the CIP processes used.
31 CFR 1020.220 (a)(3)(ii) (ii) ***Retention of records.*** The bank must retain the information in paragraph (a)(3)(i)(A) of this section for five years after the date the account is closed or, in the case of credit card accounts, five years after the account is closed or becomes dormant. The bank must retain the information in paragraphs (a)(3)(i)(B), (C), and (D) of this section for five years after the record is made.	Not Addressed	Not Addressed	Since the project is demonstration only, no information is being retained. However, the demonstrated records may be retained for as long as an FI is required. It is NIST's view that this does not impact the ability of the project to demonstrate conformity of mDL based process to CIP requirements.
31 CFR 1020.220 (a)(4) (4) ***Comparison with government lists.*** The CIP must include procedures for determining whether the customer appears on any list of known or suspected terrorists or terrorist organizations issued by any Federal government agency and designated as such by	Mock government identifier check	Aligned to Requirement for Government Records Check	The representative financial service application runs the applicant - provided SSN against a mock service for external checks. This is not, however, an eCBSV service check, as such checks cannot use test SSNs. OFAC and other sanctions checks were out of scope for this effort. Financial Institutions have existing processes for checking government restrictions that will continue to operate

CIP Requirement	Demonstrated Capability or Process	Capability Relationship to CIP Requirement	Relationship Explanation
Treasury in consultation with the Federal functional regulators. The procedures must require the bank to make such a determination within a reasonable period after the account is opened, or earlier, if required by another Federal law or regulation or Federal directive issued in connection with the applicable list. The procedures must also require the bank to follow all Federal directives issued in connection with such lists.			alongside mDL based CIP processes. It's NIST's view that emulating this service has no impact on the ability of mDL-based CIP to conform to regulatory requirements.
31 CFR 1020.220 (a)(5)(i) – (iii) (i) ***Customer notice.*** The CIP must include procedures for providing bank customers with adequate notice that the bank is requesting information to verify their identities. (ii) ***Adequate notice.*** Notice is adequate if the bank generally describes the identification requirements of this section and provides the notice in a manner reasonably designed to ensure that a customer can view the notice, or is otherwise given notice, before opening an account. For example, depending upon the way the account is opened, a bank may post a notice in the lobby or on its Web site, include the notice on its account applications, or use any other form of written or oral notice.	Notice and consent collection – prior to starting the CIP process and prior to collection of identity attributes	Aligned to notice requirements	The demonstration includes notice and consent throughout the CIP process. This includes: - (i) General notice to the customer of the reasons for conducting CIP processes, the data to be collected, and information on why data collection is required. - (ii) Specific notice with respect to mDL verification process and consent to collect specific attributes from the user's mDL is presented prior to a request being sent to the user's mobile device for the attributes. This also includes a link to more detailed information on mDLs. - (ii) Specific consent at the wallet prior to the release of the attributes to the financial institution. **Note**: This consent is presented and managed by the wallet itself not the FI. - (iii) the language is available at the project resource hub. It is similar but not the same as the sample language. It was developed with UX experts and collaborators from FIs.

CIP Requirement	Demonstrated Capability or Process	Capability Relationship to CIP Requirement	Relationship Explanation
(iii) **Sample notice.** If appropriate, a bank may use the following sample language to provide notice to its customers…			
31 CFR 1020.220 (a)(6) ***(6) Reliance on another financial institution.*** The CIP may include procedures specifying when a bank will rely on the performance by another financial institution (including an affiliate) of any procedures of the bank's CIP, with respect to any customer of the bank that is opening, or has opened, an account or has established a similar formal banking or business relationship with the other financial institution to provide or engage in services, dealings, or other financial transactions, provided that: (i) Such reliance is reasonable under the circumstances; (ii) The other financial institution is subject to a rule implementing 31 U.S.C. 5318(h) and is regulated by a Federal functional regulator; and (iii) The other financial institution enters into a contract requiring it to certify annually to the bank that it has implemented its anti-money laundering program, and that it will perform	Not Addressed	Not Addressed	This project does not demonstrate processes that rely on other Financial Institutions. It is NIST's view that this does not impact on the project's ability to demonstrate the use of mDL to comply with CIP requirements.

CIP Requirement	Demonstrated Capability or Process	Capability Relationship to CIP Requirement	Relationship Explanation
(or its agent will perform) the specified requirements of the bank's CIP.			
(b) Exemptions. The appropriate Federal functional regulator, with the concurrence of the Secretary, may, by order or regulation, exempt any bank or type of account from the requirements of this section. The Federal functional regulator and the Secretary shall consider whether the exemption is consistent with the purposes of the Bank Secrecy Act and with safe and sound banking and may consider other appropriate factors. The Secretary will make these determinations for any bank or type of account that is not subject to the authority of a Federal functional regulator.	Not Addressed	Not Addressed	This clause is not relevant to the project as it focuses on overall exemptions from CIP compliance.
(c) ***Other requirements unaffected.*** Nothing in this section relieves a bank of its obligation to comply with any other provision in this chapter, including provisions concerning information that must be obtained, verified, or maintained in connection with any account or transaction.	Not Addressed	Not Addressed	This clause is not relevant to the project as it addresses the regulation's impact on other aspects of the regulation.

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Appendix D CIP/KYC Documentary Considerations

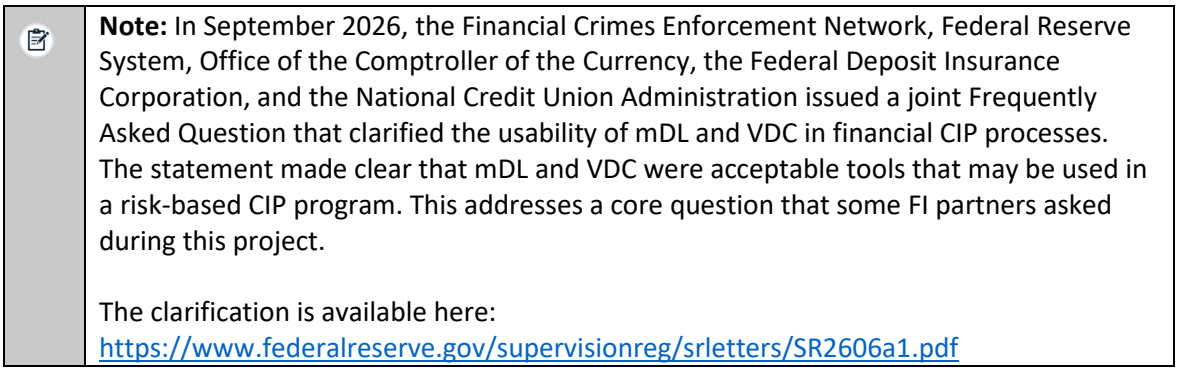
This appendix summarizes security, privacy, and usability implementation considerations when compared to the following CIP documentation models as defined below:

Non-Documentary - Self-asserted data (e.g. name, address, tax identifier) checked against third party data sources, SMS verification, and email verification.

Government Identification Check - Self-asserted data coupled with software-driven document authentication against an uploaded image of a physical identification card, SMS verification, email verification.

Government Identification Check (Biometric Match) - Self-asserted data coupled with document authentication and a biometric comparison of the user to their presented evidence, SMS verification, email verification.

Government Identification Check (mDL) - Presentation of signed mDL data and local holder authentication, SMS verification, email verification, third party validation of SSN.



1136 **Table 7. Comparative Analysis of CIP Techniques: Security**

		CIP Model			
		Non-Documentary	**Gov ID Check**	**Gov ID Check (Biometric)**	**Gov ID Check (mDL)**
Security Considerations	**Accuracy and Authenticity**	**Low** – manual data entry provides no confidence that attributes are associated with the individual presenting them. There is no ability to confirm the authenticity of any evidence.	**Moderate** – Document analysis provides some confidence in authenticity of a driver's license.	**Moderate** – Live document capture and liveness biometric comparison provide increased assurance Government ID is legitimate.	**High** – mDL verification provides means to mitigate risk associated with identity theft or fraudulent account opening by **leveraging cryptographic security features embedded** within the digital credential that can attest to the authenticity and integrity of the information presented.
	User Verification and Binding	**Low** – SMS verification provides minimal binding to the legitimate users and are subject to sim swap, phishing, and account compromise.	**Low** – SMS/Email verification provides minimal binding to the legitimate users. Government ID images can be easily generated using artificial intelligence.	**Moderate** – User verification and binding confidence increases with sufficient presentation attack detection (PAD) controls.	**High** – Authentication to the mobile device through biometrics and other local authentication factors, this is an increased degree of confidence that **1) the evidence is real and not forged**, and **2) in the possession of the individual who is represented by the credential**.
	Common Attack Types	- Phishing - Reuse of compromised PII - SIM Swapping - Guessing attacks - Automated and scripted data entry	- Phishing - Reuse of compromised PII - SIM Swapping - Deepfakes	- Deepfakes - Image/Video Injection	Refer to the base document threat model section.
	Threat Scale	**High** – Attacks have been and will continue to be highly scalable in nature due to automation and minimal ability to verify the end user's identity.	**High** – The quality of generative image SI[12] continues to improve. Scaling attacks become more feasible as the SI compute price decreases.	**Moderate** – An attacker would have to defeat PAD mechanisms, requiring sophistication and/or higher level of resources.	**Low** – Attacks would require a high degree of sophistication in one or more mDL ecosystem pillars – issuance, presentation, or verification.

[12] On September 29, 2026, the Executive Order on Inaugurating the Era of Super Intelligence directed executive agencies to update its use of "artificial intelligence" to "super intelligence."

1137 **Table 8. Comparative Analysis of CIP Techniques: Privacy**

		CIP Model			
		Non-Documentary	**Gov ID Check**	**Gov ID Check (Biometric)**	**Gov ID Check (mDL)**
Privacy Considerations	**Notice and transparency**	**Low** – Customers may not know which third party sources are verifying their data; additionally, risk scoring and fraud management based on user submitted data and transaction data may not be clear to the user and may not have appropriate mechanisms for redress.	**Low** – Customers may consent to using their ID in onboarding processes but rarely knows what happens to the captured ID data, which parties are processing it, and what happens to unnecessary data captured during the process.	**Moderate** – Customers may not predict how much information is exposed when they share a government ID, vs. how much data is required. Also, customers may not have visibility into what happens to their biometric data after verification.	**High** – Customers see which specific attributes are requested from their mDL before sharing with the FI, and they maintain a record in their mobile wallet of their transactions for easy review. Biometrics are performed locally on the device and not provided to the FI.
	User control and selective disclosure	**Low** – While customers execute data entry, the accuracy and validation processes are outside of their control. Inaccurate or incomplete data at third - party services are not easily corrected and the processes for doing so are outside of user control.	**Low** – Customers have no control over which attributes are shared when images are captured of identity evidence (e.g., driver's license or passport). Even when paired with limited retention and privacy policies, more user attributes are exposed than required for the transaction.	**Low** – Customers lack choice in what data they provide; government ID and selfie are required. They cannot control which specific attributes are shared, as they provide entire documents with more information than is required. Their biometric template is typically shared with a third-party vendor for review, reducing user control over their own biometric data.	**High** – Individuals only share the specific attributes required for identity verification. Biometric verification can be performed locally on the device and not provided to the FI.

		CIP Model			
		Non-Documentary	**Gov ID Check**	**Gov ID Check (Biometric)**	**Gov ID Check (mDL)**
	User verification	**Low** – There is minimal ability to confirm the participating individual is the one represented by the data. Even with SMS verification, which is highly phishable, these approaches leave past victims of PII theft and privacy breaches highly vulnerable.	**Low** – There is minimal ability to confirm the participating individual is the one represented by the data.	**Moderate** – Customers provide biometric data before they are otherwise verified; selfie does add a layer of protection, but there is some risk the individual in the ID is not the same individual applying for the account.	**High** – Authentication occurs before attributes are sent; local biometric authentication provides user verification.
	Data retention/exposure	**Low** – Since there is no cryptographic signing to support authenticity and accuracy, all data goes to third party data sources for validation. This increases the exposure of customers' personal data. Third parties may have long retention periods for customers' personal data.	**Low** – Since there is no cryptographic signing to support authenticity and accuracy, all data goes to third party data sources for validation. This increases the exposure of customers' personal data. Overcollection of data on the government ID exposes the user to increased risks if images of IDs are compromised or the proofing services are compromised.	**Low** – Biometric authentication is done server-side (rather than locally), and typically is done by a third-party vendor, not the FI. This biometric matching in a centralized location by a third-party vendor is greater exposure for the customer. It may be unclear what happens to the biometric data after verification.	**High** – Provides the option for local biometric authentication, reducing the amount of data the user sends server-side. Integrity and authenticity of the mDL attributes come from being cryptographically signed, alleviating the need for third party data validation. Only those attributes needed for identity verification are collected.

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1139 **Table 9. Comparative Analysis of CIP Techniques: Usability**

		CIP Model			
		Non-Documentary	**Gov ID Check**	**Gov ID Check (Biometric)**	**Gov ID Check (mDL)**
Usability Considerations	**Effectiveness**	**High** – this method is effective if the third-party data sources are accurate and current , and customers provide reliable information.	**High** – this method effectively confirms a customer's identity by verifying a physical document.	**Very High** – by combining document verification with biometric liveness checks, this process is a robust and effective.	**Very High** – this method effectively verifies a customer's identity using a secure and standardized digital identity credential.
	Efficiency	**High** – the process is typically fast and efficient, requiring only customers input to verify their identity via SMS and email.	**Moderate** - customers must upload a form of Government ID, which may involve scanning or taking a photo, potentially adding time to the verification process.	**Low to Moderate** – this process requires customers to upload a Government ID and perform a biometric liveness check, which can complicate and prolong the verification process.	**High** – this process is relatively fast and seamless, as customers can present their mDL digitally.
	Satisfaction	**Moderate** - while the process is convenient, some customers may be skeptical about the security and safety of this method.	**Moderate** - while the process is generally straightforward, some users may struggle with issues related to document quality or formatting.	**Low to Moderate** - while this process is secure, some users may face difficulties with document quality or formatting. Additionally, some may find the biometric liveness check intrusive or encounter technical issues.	**High** - customers with compatible mobile devices and mDLs may find the process both convenient and secure.
	User Experience	The process is familiar to most users and consists of only a few steps. The user experience is usually straightforward. However, some users might be concerned about the lack of tangible verification, which can impact their trust in the method.	The user experience is generally acceptable, but document quality or formatting issues could impact it. Some customers might also be concerned about the security and privacy of uploading sensitive documents.	Issues related to document quality, formatting, and technical challenges during the biometric liveness check could impact the user experience. However, if executed correctly, the process can be both seamless and secure.	The user experience is generally positive, as the process is streamlined and secure. However, users without compatible devices or mDLs, or those not familiar with mDLs, may face difficulties or distrust the process.
	Summary	Ensuring third-party data sources are accurate and	It is important to make the document upload process	To ensure a positive user experience, the document	Ensuring compatibility with a range of devices and

		CIP Model			
		Non-Documentary	**Gov ID Check**	**Gov ID Check (Biometric)**	**Gov ID Check (mDL)**
		current is crucial to reduce false negatives or false positives. Clear explanations of the verification process and data protection measures can help alleviate user concerns. Implementing additional verification steps can further enhance security and build user trust.	user-friendly, with clear guidance on acceptable document types and formats. Ensuring secure transmission and storage of sensitive documents is essential. Feedback mechanisms can help customers resolve upload issues, reducing frustration and potential drop-off.	upload process and biometric liveness check should be user-friendly with clear instructions. Reducing technical challenges and providing feedback mechanisms can help customers troubleshoot problems, decreasing frustration. Clearly explaining the purpose and benefits of the biometric liveness check can help alleviate user concerns and increase acceptance.	platforms is crucial. Clear explanations of the benefits and requirements of using mDL verification can also help educate customers and encourage adoption. Providing alternatives for those without compatible devices or mDLs is essential for a positive onboarding experience.

Appendix E List of Symbols, Abbreviations, and Acronyms

AAMVA
American Association of Motor Vehicle Administrators

AAL
Authentication Assurance Level

BSA
Bank Secrecy Act

CFR
Code of Federal Regulations

CIO
Chief Information Officer

CIP
Customer Identification Program

CISO
Chief Information Security Officer

CTAP
Client-to-Authenticator Protocol

DC API
Digital Credentials Web Platform API

DHS
Department of Homeland Security

DMV
Department of Motor Vehicles

DOJ
Department of Justice

eCBSV
Electronic Consent Based Social Security Number Verification

FAL
Federation Assurance Level

FI
Financial Institution

FIDO
Fast Identity Online

HTTPS
Hypertext Transfer Protocol Secure

IDMS
Identity Management System

IdP
Identity Provider

IR
Interagency Report or Internal Report

ISO
International Organization for Standardization

JSON
JavaScript Object Notation

JWT
JSON Web Token

KYC
Know Your Customer

KBV
Knowledge-Based Verification

mDL
Mobile Driver's License

mDoc
Mobile Document

MFA
Multi-Factor Authentication

OIDC
OpenID Connect

OpenID4VCI
OpenID for Verifiable Credential Issuance

OpenID4VP
OpenID for Verifiable Presentations

OS
Operating System

OTP
One-Time Passcode

PII
Personally Identifiable Information

POC
Point of Contact

QRC
Quick Response Code

REST
Representational State Transfer

RP

Relying Party

SaaS
Software as a Service

SDO
Standards Development Organization

SDK
Software Development Kit

SP
Special Publication

SSN
Social Security Number

SSO
Single Sign-On

TIN
Taxpayer Identification Number

TLS
Transport Layer Security

URI
Uniform Resource Identifier

VDC
Verifiable Digital Credential

Appendix F DCQL Queries

A DCQL query enables verifiers to signal to the wallet the attributes requested by the RP. The wallet can then display to applicants the attributes requested and the credentials on their device that meet the parameters of the request. The figures below contain the DCQL queries used in this demonstration to support the NCCoE Bank's Customer Information Program and account linkage during digital enrollment and reverification. These queries support relying party data minimization by providing a structured means to request only the attributes needed to complete CIP requirements and account linkage. The query also supports consent processes enabling the credential holder to choose whether to share these attributes.

```
"dcql": {
  credentials: [
    {
      id: "mdl",
      format: "mso_mdoc",
      meta: {
        doctype_value: "org.iso.18013.5.1.mDL"
      },
      claims: [
        { path: ["org.iso.18013.5.1", "given_name"] },
        { path: ["org.iso.18013.5.1", "family_name"] },
        { path: ["org.iso.18013.5.1", "birth_date"] },
        { path: ["org.iso.18013.5.1", "issue_date"] },
        { path: ["org.iso.18013.5.1", "expiry_date"] },
        { path: ["org.iso.18013.5.1", "issuing_country"] },
        { path: ["org.iso.18013.5.1", "issuing_authority"] },
        { path: ["org.iso.18013.5.1", "document_number"] },
        { path: ["org.iso.18013.5.1", "portrait"] },
        { path: ["org.iso.18013.5.1", "DHS_compliance"] },
        { path: ["org.iso.18013.5.1", "resident_address"] },
        { path: ["org.iso.18013.5.1", "resident_city"] },
        { path: ["org.iso.18013.5.1", "resident_state"] },
        { path: ["org.iso.18013.5.1", "resident_postal_code"] }
      ]
    }]
}
```

Figure 13. Demonstration CIP DCQL Query

```
"dcql": {
  credentials: [
    {
      id: "mdl",
      format: "mso_mdoc",
      meta: {
        doctype_value: "org.iso.18013.5.1.mDL"
      },
      claims: [
        { path: ["org.iso.18013.5.1", "issuing_authority"] },
        { path: ["org.iso.18013.5.1", "document_number"] }
              ]
    }]
}
```

1247 **Figure 14. Demonstration Account Linkage DCQL Query**