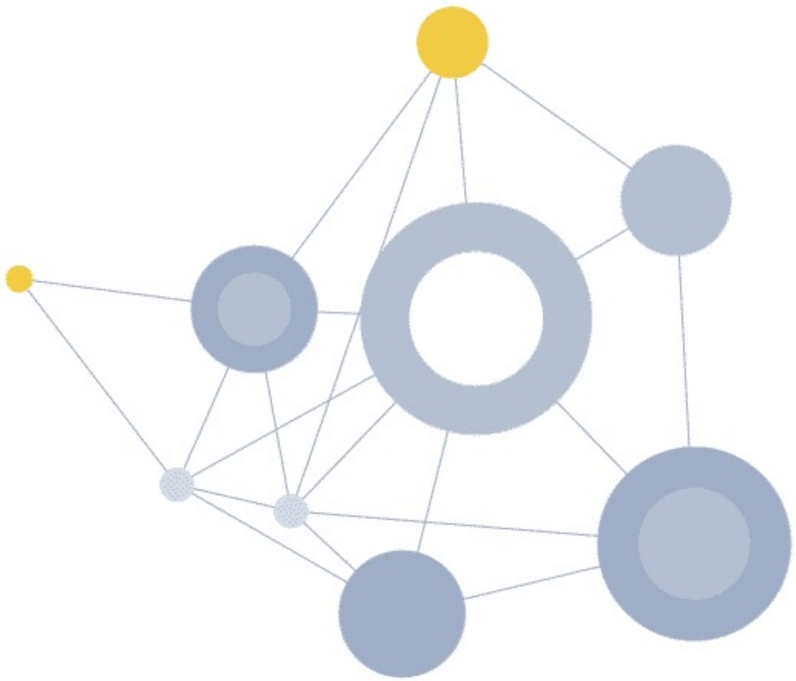
verifiable LEI (vLEI)
Ecosystem Governance Framework

Preparing for ToIP Public Review



ToIP All Member Meeting

December 8, 2021

GLEIF

Agenda

1. Introduction to LEIs and vLEIs
2. Examples of opportunities for the vLEI
3. The vLEI Ecosystem Governance Framework
4. GLEIF's role in the vLEI Ecosystem
5. vLEI workflows
6. vLEI infrastructure technology (KERI and ACDC)
7. vLEI sandbox demo
8. Next steps

Introduction to LEIs and vLEIs

Who is Global Legal Entity Identifier Foundation?

- GLEIF is a not-for-profit Swiss foundation, founded by the Financial Stability Board (FSB).
- GLEIF is overseen by 65 regulators and 19 observers in the Regulatory Oversight Committee (ROC) from more than 50 countries.
- GLEIF Board has 15 independent directors.

Partners for LEI issuing (LOUs)

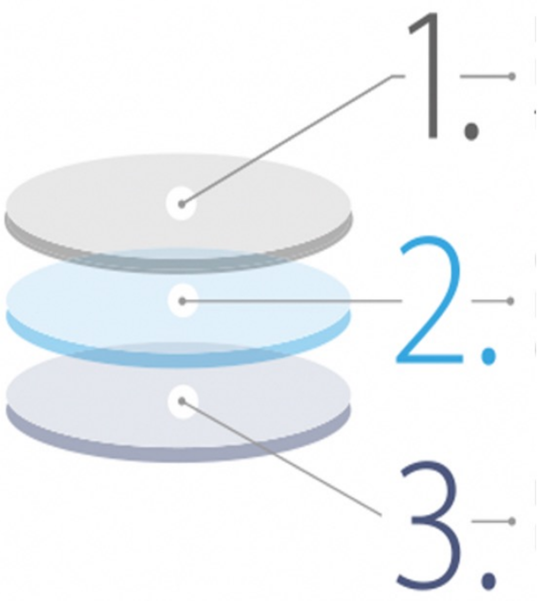
39
and growing

Issued LEIs to date

> 1,983,000

Introducing the Global LEI System

In 2011, the G-20 leaders supported "the creation of a global legal entity identifier (LEI) which uniquely identifies parties to financial transactions."



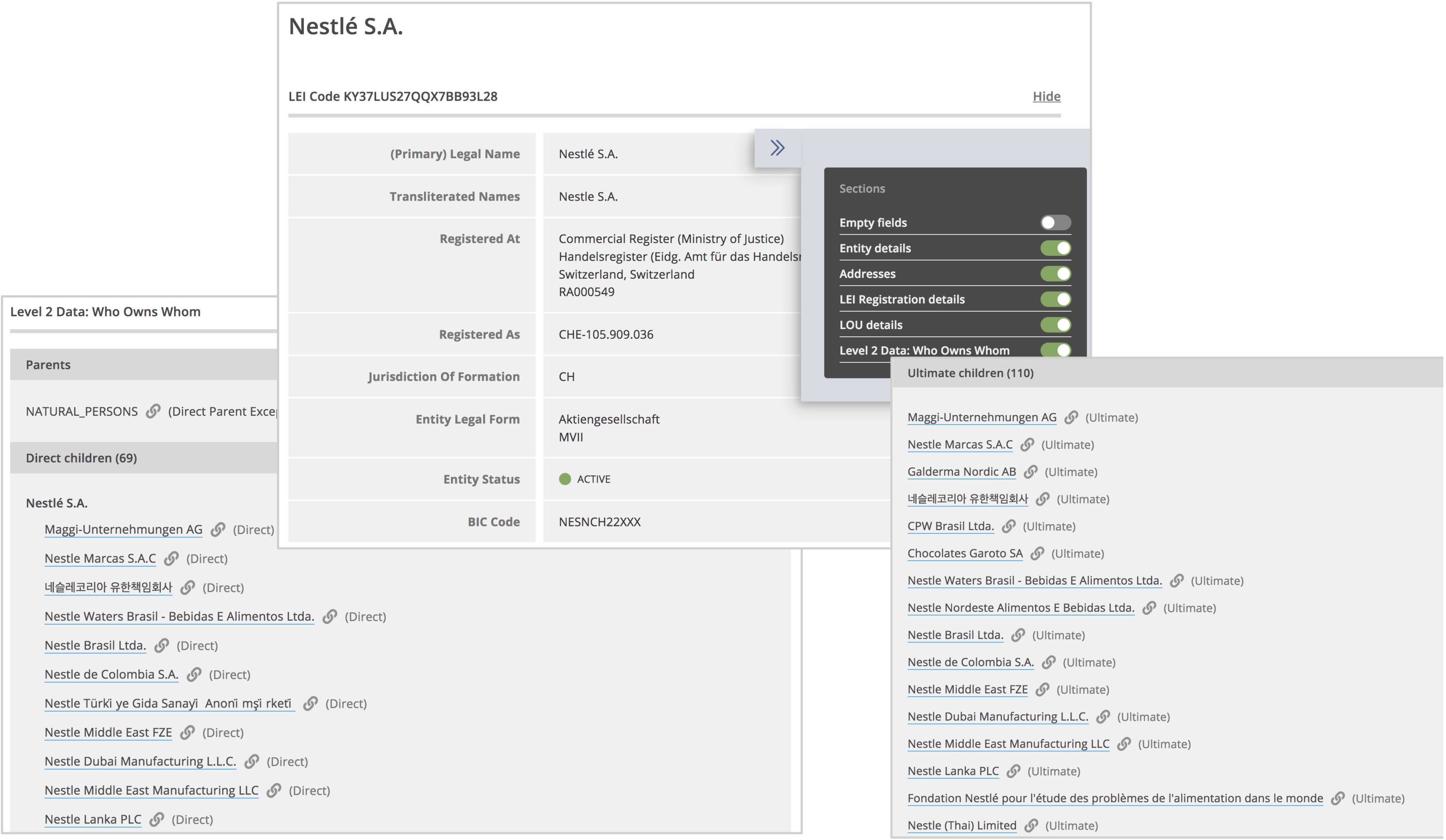
Regulatory Oversight Committee (ROC):
Represents public financial market authorities from around the world

Global Legal Entity Identifier Foundation (GLEIF):
Ensures the operational integrity of the Global LEI system

Local Operating Units (LOUs):
Issue LEIs to legal entities

The LEI

- The LEI is a life-long code **owned** by the respective legal entity.
- It points to the associated reference data.
- The LEI is an ISO standard ISO 17442



Nestlé S.A.

LEI Code KY37LUS27QQX7BB93L28 Hide

(Primary) Legal Name	Nestlé S.A.
Transliterated Names	Nestle S.A.
Registered At	Commercial Register (Ministry of Justice) Handelsregister (Eidg. Amt für das Handelsr Switzerland, Switzerland RA000549
Registered As	CHE-105.909.036
Jurisdiction Of Formation	CH
Entity Legal Form	Aktiengesellschaft MVII
Entity Status	● ACTIVE
BIC Code	NESNCH22XXX

Sections

- Empty fields ☐
- Entity details ☑
- Addresses ☑
- LEI Registration details ☑
- LOU details ☑
- Level 2 Data: Who Owns Whom ☑

Level 2 Data: Who Owns Whom

Parents

NATURAL_PERSONS (Direct Parent Exce

Direct children (69)

Nestlé S.A.

- Maggi-Unternehmungen AG (Direct)
- Nestle Marcas S.A.C (Direct)
- 네슬레코리아 유한책임회사 (Direct)
- Nestle Waters Brasil - Bebidas E Alimentos Ltda. (Direct)
- Nestle Brasil Ltda. (Direct)
- Nestle de Colombia S.A. (Direct)
- Nestle Türki ye Gida Sanayi Anoni mşi rketi (Direct)
- Nestle Middle East FZE (Direct)
- Nestle Dubai Manufacturing L.L.C. (Direct)
- Nestle Middle East Manufacturing LLC (Direct)
- Nestle Lanka PLC (Direct)

Ultimate children (110)

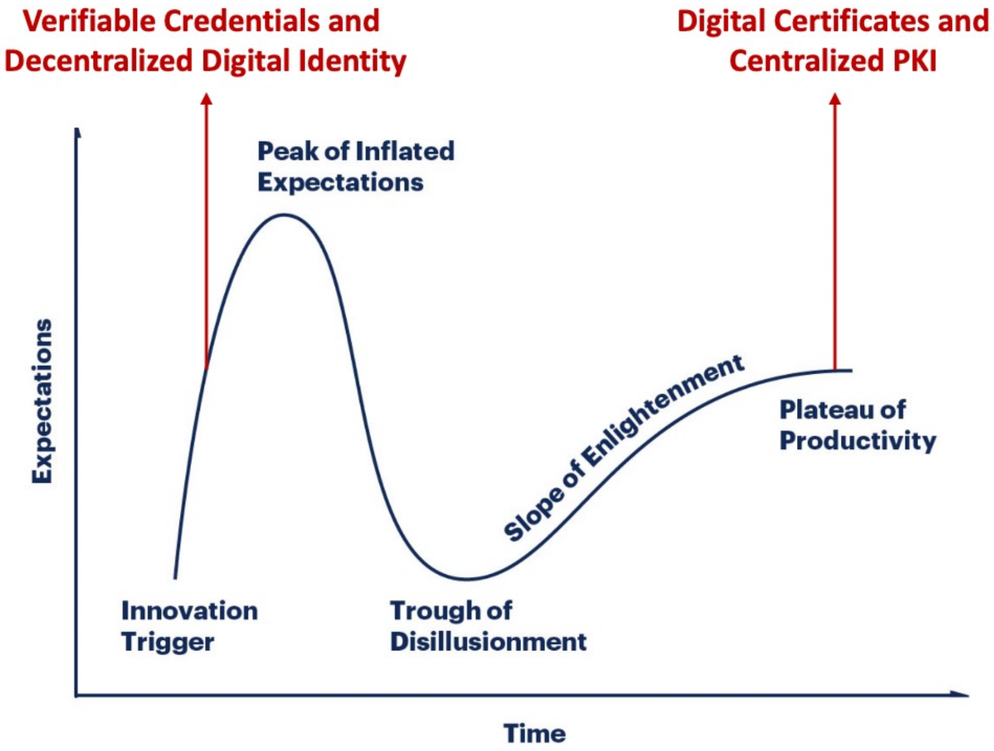
- Maggi-Unternehmungen AG (Ultimate)
- Nestle Marcas S.A.C (Ultimate)
- Galderma Nordic AB (Ultimate)
- 네슬레코리아 유한책임회사 (Ultimate)
- CPW Brasil Ltda. (Ultimate)
- Chocolates Garoto SA (Ultimate)
- Nestle Waters Brasil - Bebidas E Alimentos Ltda. (Ultimate)
- Nestle Nordeste Alimentos E Bebidas Ltda. (Ultimate)
- Nestle Brasil Ltda. (Ultimate)
- Nestle de Colombia S.A. (Ultimate)
- Nestle Middle East FZE (Ultimate)
- Nestle Dubai Manufacturing L.L.C. (Ultimate)
- Nestle Middle East Manufacturing LLC (Ultimate)
- Nestle Lanka PLC (Ultimate)
- Fondation Nestlé pour l'étude des problèmes de l'alimentation dans le monde (Ultimate)
- Nestle (Thai) Limited (Ultimate)

LEI Digital Strategy

Digital Certificates as well as Self-Sovereign-Identity Networks

- The LEI has a critical role to play in today's digital world through its ability to provide organizations with unique, permanent identification globally. This especially is important in the context of **identifying legal entities involved in digital transactions.**

- LEI delivers value to both the more mature product - Digital Certificates - and the more recent innovation of **Verifiable Credentials**


Verifiable Credentials and Decentralized Digital Identity
Digital Certificates and Centralized PKI
Peak of Inflated Expectations
Expectations
Slope of Enlightenment
Plateau of Productivity
Innovation Trigger
Trough of Disillusionment
Time

LEIs in a digital world

Making LEIs verifiable

- When presenting an LEI, it is not clear if
  - The LEI is valid
  - the presenter is the LEI owner or an affiliate
  - the presenter has the right to use it
- As a result
  - the recipient of the LEI must still check and verify,
  - background checks are often done manually at a high cost

Use case for the vLEI:

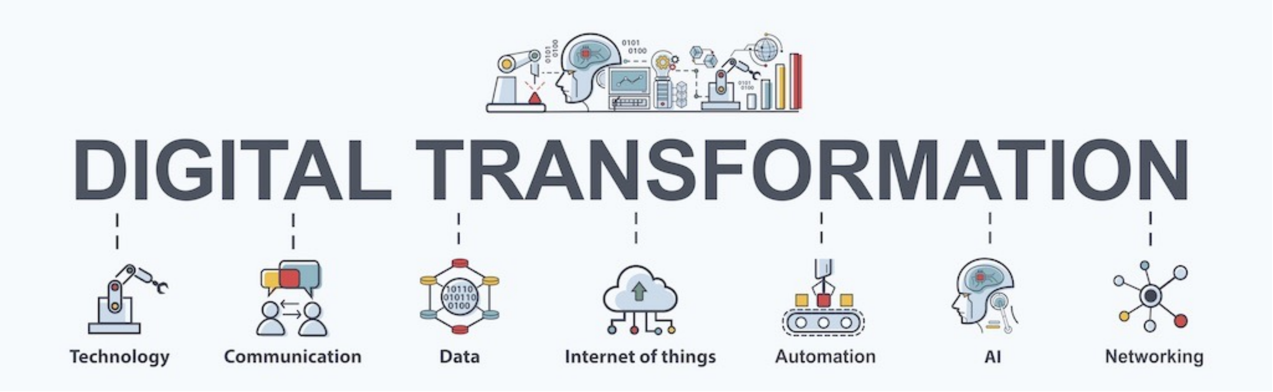
- Decentralized identification and verification for organizations as well as the persons who represent their organizations either in official or functional roles

Solving the common problem of lack of trust and the costs involved for creating trust

The model – fostering LEI adoption
Digital Transformation of entire industries

- Digital transformation, e.g., Platform Economy, Artificial Intelligence, Distributed and federated Networks etc., is changing the way we interact with each other
- Digital Identity and Strong Authentication become vital for distributed systems spanning many actors
- vLEIs are going to address many business needs in all industries

*

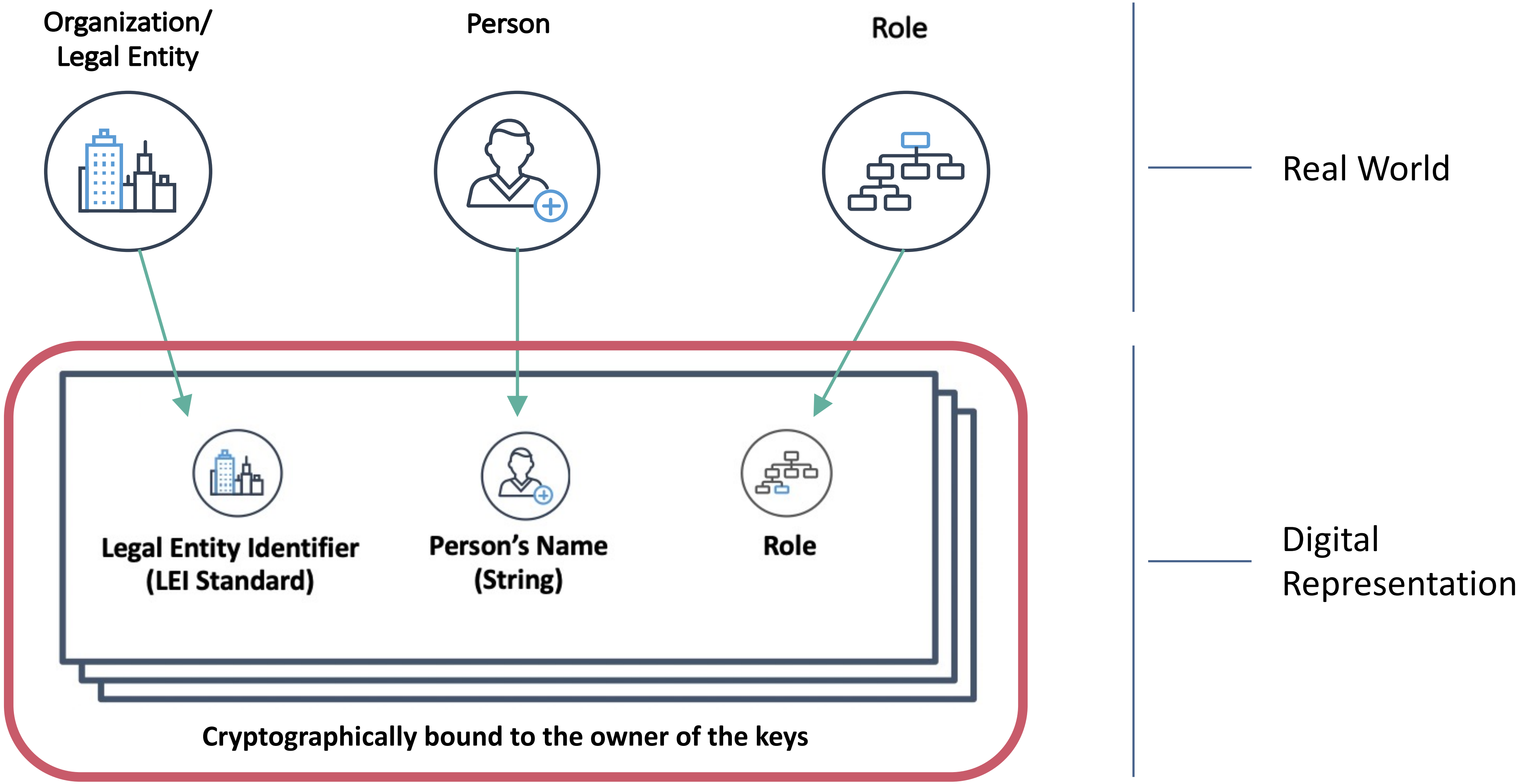


Each vLEI requires an underlying LEI !

* Source: https://sdlt.asia/blockchain-platforms/

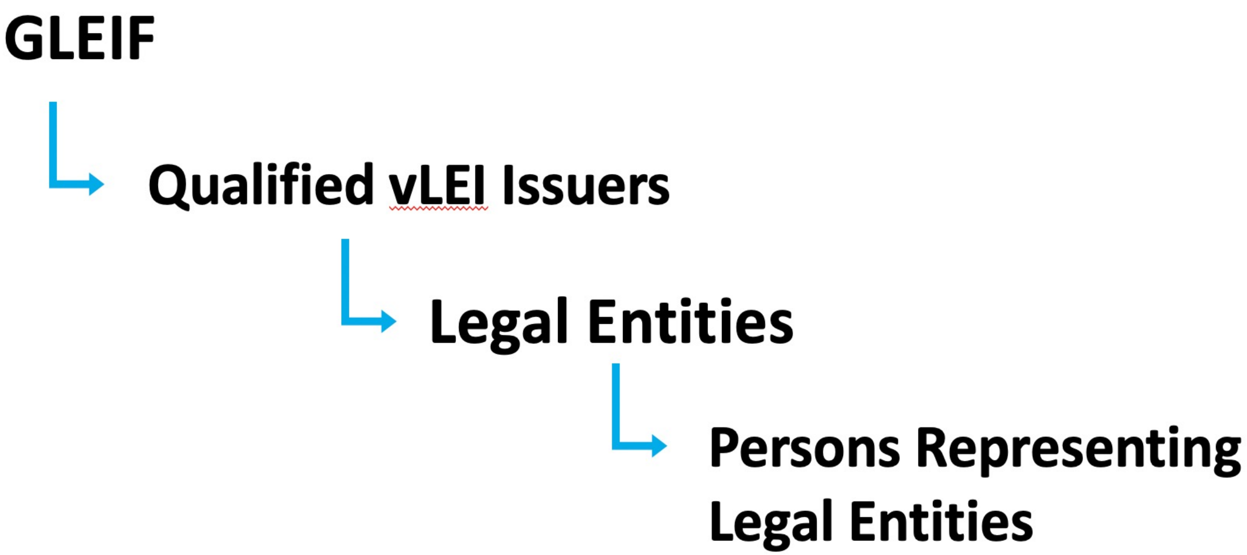
Embedding the LEI in digital tools

Representing Organizations, Persons and Roles


Organization/ Legal Entity
Person
Role
Real World
Legal Entity Identifier (LEI Standard)
Person's Name (String)
Role
Digital Representation
Cryptographically bound to the owner of the keys

The LEI as a Verifiable Credential – the vLEI Trust Chain

- GLEIF is the Root of Trust
  - Root AID (Autonomic Identifier) to establish the Root of Trust
  - Delegated AIDs to issue Credentials
- GLEIF will establish a trusted network of Qualified vLEI Issuers (QVIs)
- QVIs are qualified to issue Entity and Role Credentials:
  - to Legal Entities
  - to Persons who represent Legal Entities either in official or functional roles



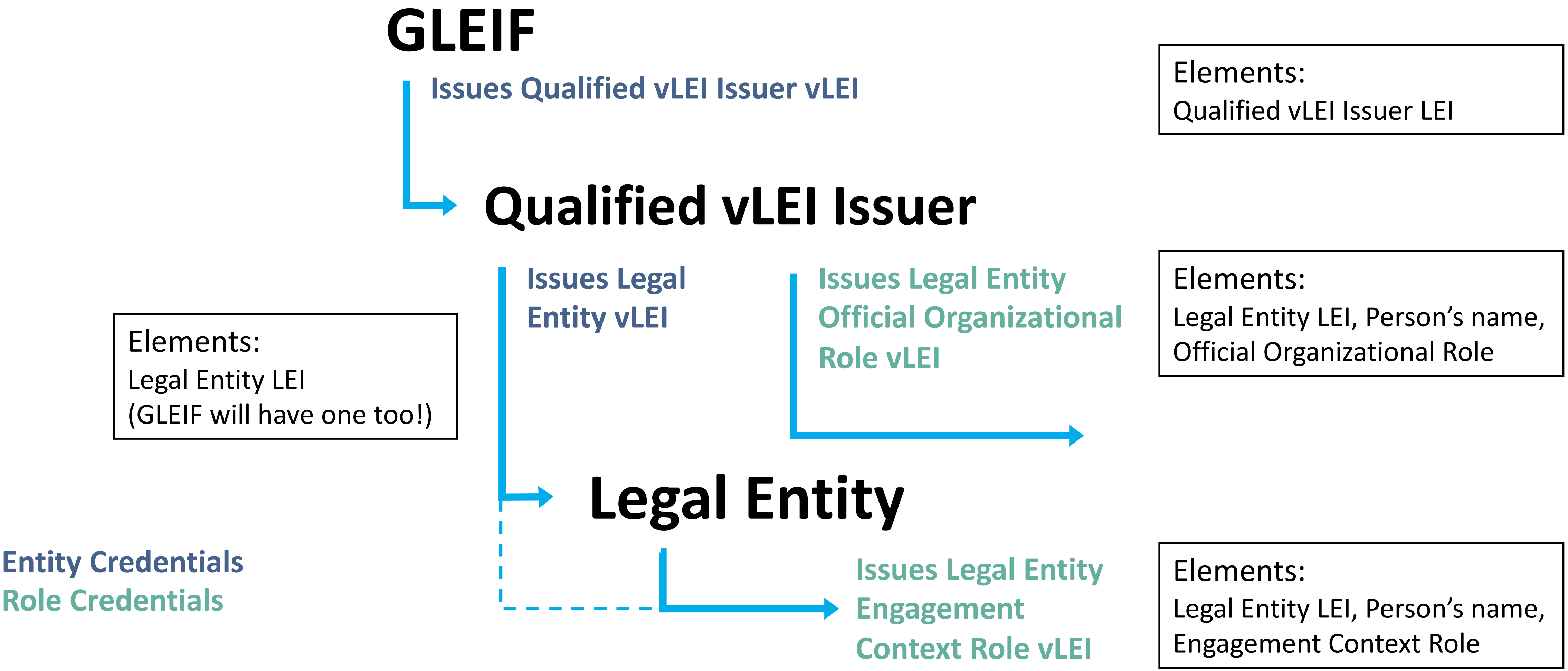
GLEIF

Qualified vLEI Issuers

Legal Entities

Persons Representing Legal Entities

The vLEI Ecosystem Chain of Trust and vLEI Credentials



GLEIF

Issues Qualified vLEI Issuer vLEI

Elements:
Qualified vLEI Issuer LEI

Qualified vLEI Issuer

Issues Legal Entity vLEI

Issues Legal Entity Official Organizational Role vLEI

Elements:
Legal Entity LEI, Person's name, Official Organizational Role

Elements:
Legal Entity LEI
(GLEIF will have one too!)

Legal Entity

Issues Legal Entity Engagement Context Role vLEI

Elements:
Legal Entity LEI, Person's name, Engagement Context Role

Entity Credentials

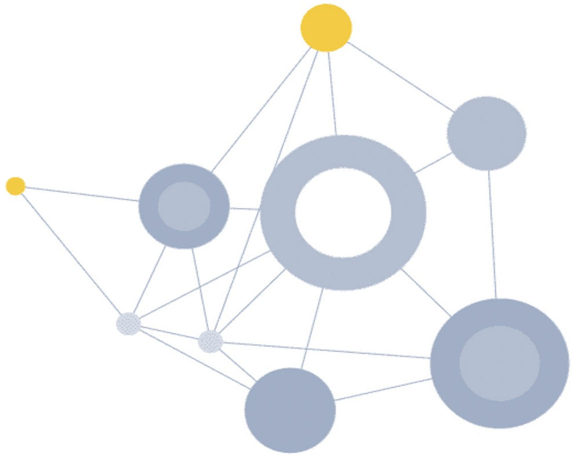
Role Credentials

Broader application of the vLEI Role Credential

vLEI Role Credentials issued by Legal Entities to Persons whose **Official Organizational Roles** that can be verified both by the Legal Entity as well as against one or more public sources.

- Examples:
  - Legal Entity – CEO
  - Legal Entity – Board Chair

ISO 5009 standard awaiting publication, GLEIF will be managing the code list



vLEI Role Credential issued by Legal Entities to Persons **in the context of the engagement** of those Persons with the Legal Entities which can be verified by the Legal Entity.

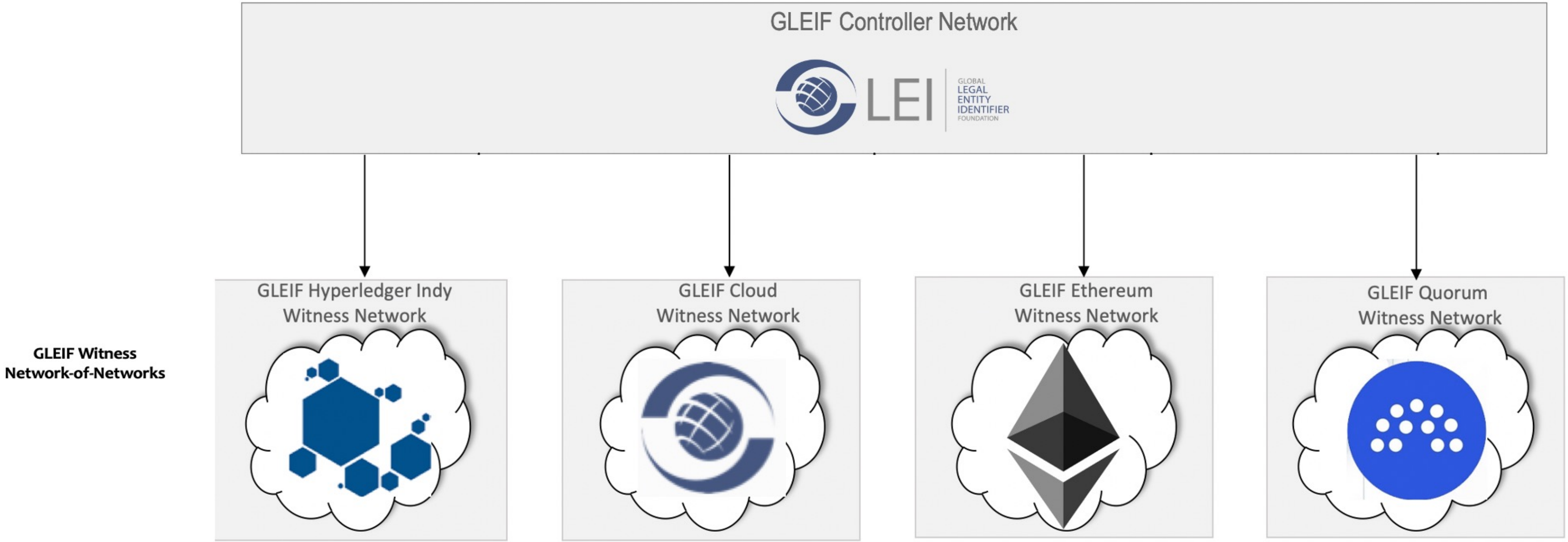
- Examples:
  - Legal Entity – Employees in Functional Roles
  - Legal Entity – Authorized Suppliers
  - Financial Institutions - Clients

Examples of opportunities for the vLEI

Network-of-networks

True interoperability and portability

- Development of the capabilities needed for issuance, verification and revocation of vLEIs do not need to operate on blockchain or distributed ledger technology.
- This would allow GLEIF to **connect to any blockchain or distributed ledger technology SSI network or cloud infrastructure** without the need for custom implementation, cost and overhead of operation.


GLEIF Controller Network
LEI
GLOBAL LEGAL ENTITY IDENTIFIER FOUNDATION
GLEIF Witness Network-of-Networks
GLEIF Hyperledger Indy Witness Network
GLEIF Cloud Witness Network
GLEIF Ethereum Witness Network
GLEIF Quorum Witness Network

Expanding the use of LEIs using vLEIs

First core use cases for the vLEI

- Finance
  - Trade Finance
  - Transaction banking – Payments infrastructure
- Supply Chain/Digital Trade
  - Materials/Product tracking
    - Raw materials-manufacturing-distribution-finished goods traceability
    - Materials/manufacturing sustainability traceability
    - Pharmaceuticals e-Leaflet verification
- Telecom
  - ‘Approved’ SMS campaigns
- Client on-boarding, monitoring, compliance
  - KYC/AML/CFT by financial institutions

Expand the use of the LEI to become the broad public good envisioned and endorsed by the G-20

Realize the vision statement of GLEIF:
A Legal Entity should have one global identity and this should include a digital identity

Examples of opportunities

- **Aviation**
  - Pilot’s licenses
  - Customs/Aviation/Cargo
  - COVID testing and vaccine credentials for air travelers
- **Telecom**
  - Smishing (SMS phishing)
  - eBot calls
- **Pharmaceuticals**
  - Supply-chain
  - Clinical trials
  - eConsent clinical trial participants
- **Education credentials**
  - Transcripts, degree certificates
- **Healthcare exchanges**
  - Hospitals, doctors’ practices, insurance companies, patients
- **National initiatives**
  - Digital identities for companies (3 jurisdictions)
- **Regulation**
  - Technology software certification to regulators

The vLEI Ecosystem Governance Framework

GLEIF will provide the governance for the vLEI Ecosystem

- The GLEIF vLEI Ecosystem Governance Framework, under development for the past year, is one of the most comprehensive frameworks developed using the ToIP Governance Metamodel.

- The Framework is designed from the ground up to complement GLEIF’s existing LEI governance—one grows from the other.

vLEI Ecosystem Governance Framework

Primary Document

1. Introduction
2. Terminology
3. Localization
4. Governing Authority
5. Administering Authority
6. Purpose
7. Scope
8. Objectives
9. Principles
10. General Requirements
11. Revisions
12. Extensions
13. Schedule of Controlled Documents

Controlled Documents

1. Glossary
2. Risk Assessment
3. Trust Assurance & Certification
4. Governance Requirements
5. Business Requirements
6. Technical Requirements

   Part 1: KERI & Key Management

   Part 2: Identifiers & Credentials
7. Information Trust Requirements
8. Inclusion, Equitability, and Accessibility Requirements
9. Legal Agreements
10. vLEI Identifier and Credential Frameworks

A closer look at documents for the vLEI Issuer Qualification Program and Identifier and Credential Frameworks

vLEI Issuer Qualification Program

1. vLEI Issuer Qualification Agreement

Appendices

1. Non-Disclosure Agreement
2. Program Manual
3. Program Checklist
4. Contact Details
5. vLEI Services Catalog (Service Level Agreement to be added)
6. Terms of Use Qualified vLEI Issuer TrustMark
7. Qualified vLEI Issuer Legal Entity Required Contract Terms

Identifier and Credential Frameworks

1. GLEIF Identifier Governance Framework

vLEI Credential Governance Frameworks

1. Qualified vLEI Issuer vLEI
2. Legal Entity vLEI
3. Legal Entity Official Organization Role vLEI
4. Legal Entity Engagement Context vLEI

The vLEI Ecosystem Governance Framework Highlights

- Covers all 4 layers of ToIP stack
- Establishes GLEIF as vLEI Root of Trust using KERI Autonomic Identifiers (AIDs)
- Includes Credential Governance Frameworks for 4 ACDC vLEI Credentials
- First EGF to include Technical Requirements for
  - Key management, including high security key pre-rotation
  - Integrated multi-sig digital signature protocols for all vLEI Credentials
  - Identity Verification of Legal Entities and Persons representing them includes
    - NIST 800-63A LOA2 Identity Assurance
    - Out-of-band Introduction (OOBI) Identity Authentication
  - High security credential chaining using ToIP ACDC specifications

Risk Assessment and Trust Assurance Framework

- Comprehensive Risk Assessment by Ecosystem Roles and Layers
  - GLEIF as the Root of Trust
  - Qualified vLEI Issuers
  - Verifiers
  - Ecosystem Utilities
- Corresponding Trust Assurance Framework

		SCALE OF SEVERITY				
		NEGLIGIBLE (1)	MINOR (2)	MODERATE (3)	MAJOR (4)	CRITICAL (5)
SCALE OF LIKELIHOOD	HIGHLY UNLIKELY (1)	LOW	LOW	LOW	LOW - MEDIUM	LOW - MEDIUM
	UNLIKELY (1)	LOW	LOW - MEDIUM	LOW - MEDIUM	MEDIUM	MEDIUM
	POSSIBLE (3)	LOW	LOW - MEDIUM	MEDIUM	MEDIUM	MEDIUM-HIGH
	LIKELY (4)	LOW - MEDIUM	MEDIUM	MEDIUM	MEDIUM-HIGH	HIGH
	HIGHLY LIKELY (5)	LOW - MEDIUM	MEDIUM	MEDIUM-HIGH	HIGH	HIGH

GLEIF’s role in the vLEI Ecosystem

GLEIF also will provide vLEI services focused on a Qualification Program for a trusted network of partners - Qualified vLEI Issuers

- vLEI Issuer Qualification and Annual vLEI Issuer Qualification
  - vLEI Issuers must seek initial Qualification by GLEIF and maintain Qualified vLEI Issuer’s compliance with its expected requirements within its vLEI operations

- Termination of vLEI Issuer Qualification
  - if the Qualified vLEI Issuer does not meet ongoing requirements of Qualification, allows its LEI to lapse or wants to cease vLEI Issuer operations

- Provide Relationship Management for Qualified vLEI Issuers
  - Dedicated Relationship Managers as well as a portal for communications between GLEIF and Qualified vLEI Issuers

vLEI workflows

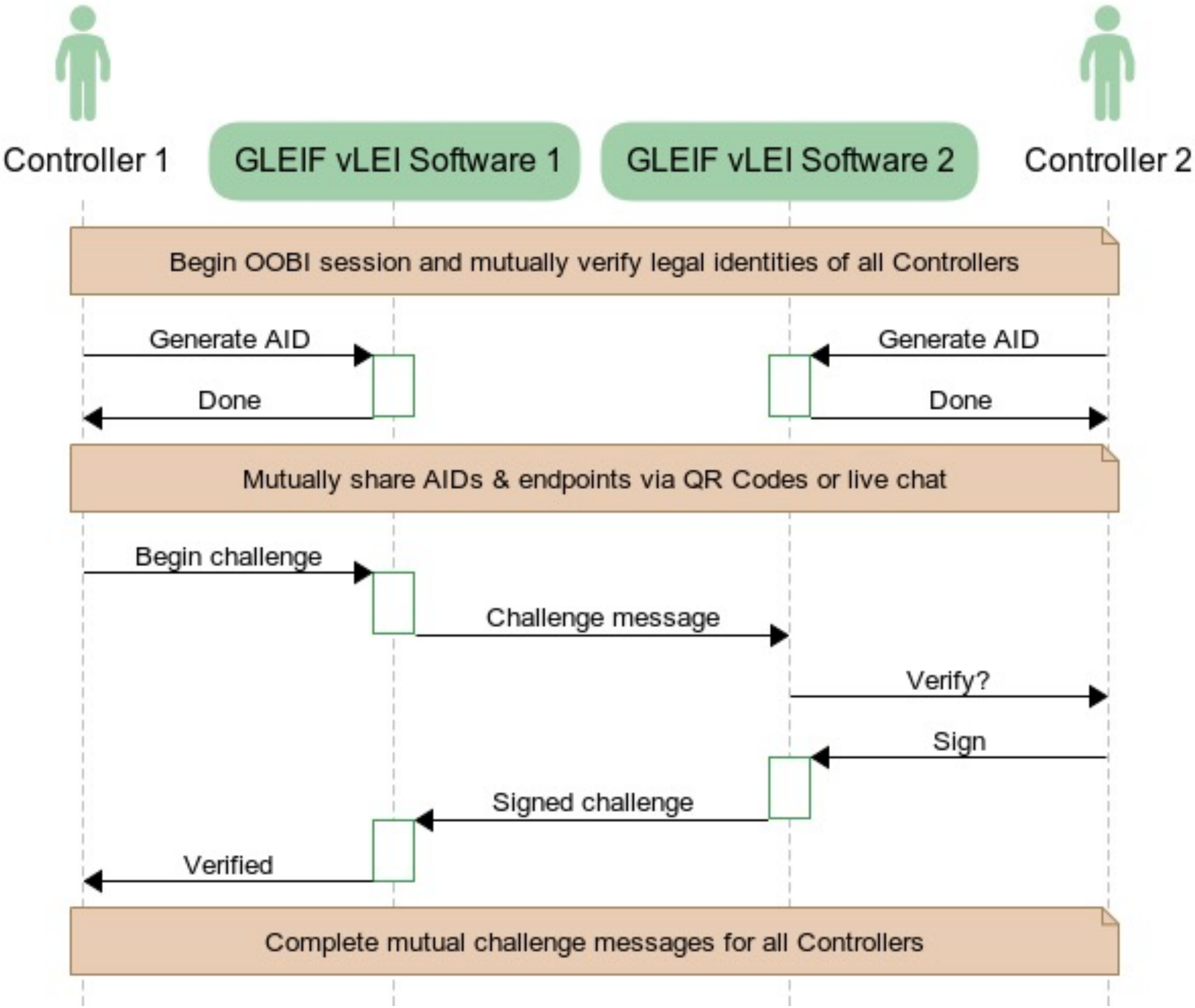
Business Logic Workflows vLEI Identifiers

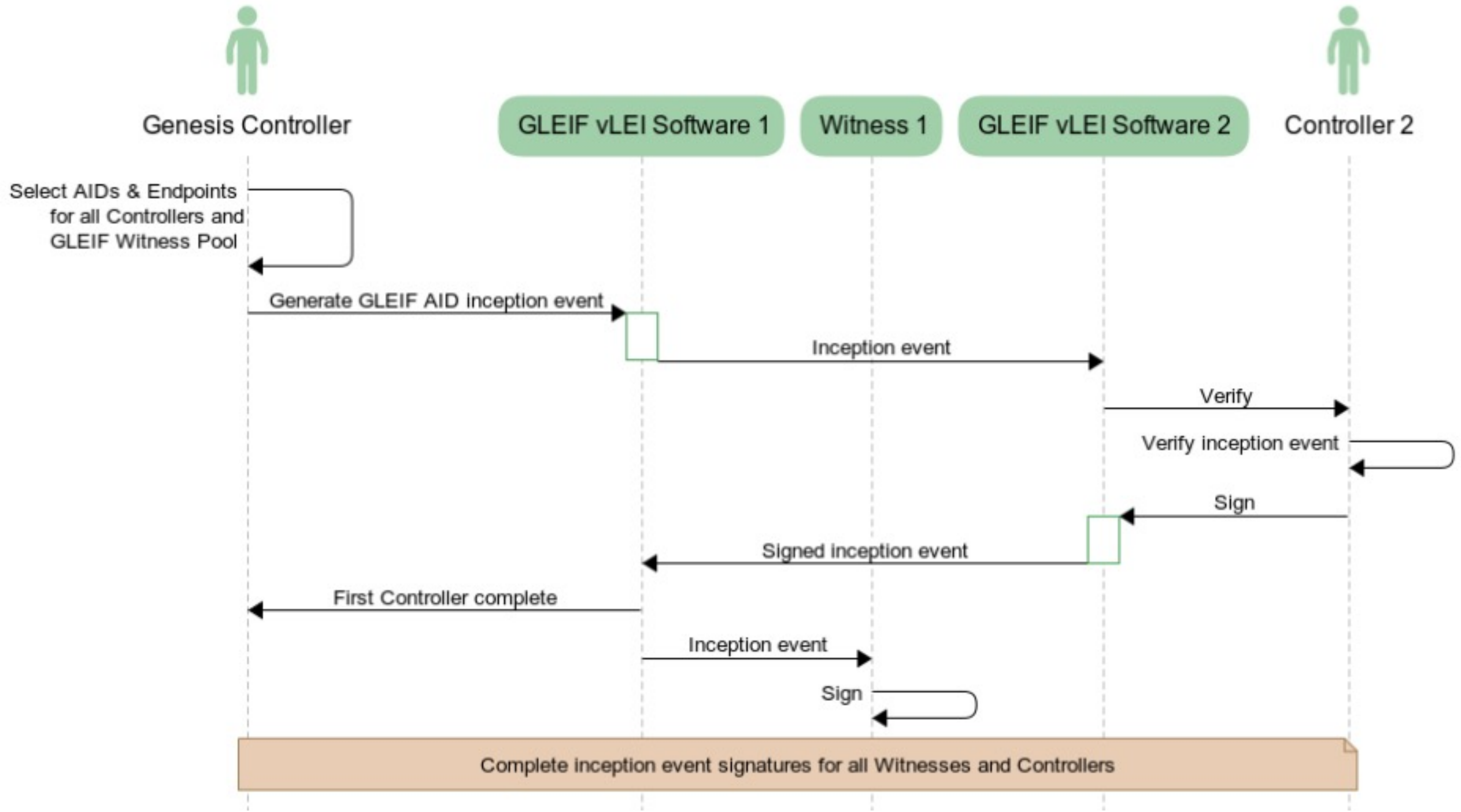
- GLEIF Autonomic Identifier (AID) Genesis
  - **Creation of GLEIF Root AID**
  - Creation of the GLEIF Delegated AIDs
  - Rotation Event to delegate the GLEIF Delegated AIDs
  - Creation of QVI Delegated AIDs
  - Interaction Event to delegate QVI Delegated AIDs
  - Rotation Event to delegate QVI Delegated AIDs
- GLEIF Root AID Publication
- Abandonment

Business Logic Workflows vLEI Credentials and Key Rotation

- Issuance of a Qualified vLEI Issuer vLEI Credential by GLEIF
- Issuance of a Legal Entity vLEI Credential by a Qualified vLEI Issuer (QVI)
- Issuance of a Legal Entity Official Organizational Role (OOR) vLEI Credential by a QVI
- Issuance of a Legal Entity Engagement Context Role (ECR) vLEI Credential by a QVI
- Revocation of a QVI vLEI Credential by GLEIF (voluntary revocation)
- Revocation of a QVI vLEI Credential by GLEIF (involuntary revocation)
- Revocation of a Legal Entity vLEI Credential
- Revocation of the Legal Entity vLEI Credential (involuntary revocation)
- Revocation of a Legal Entity Official Organizational Role (OOR) vLEI Credential
- Revocation of a Legal Entity Official Organizational Role (ECR) vLEI Credential
- Automatic Key Rotation
- Triggered Manual Key Rotation

Creation of GLEIF Root AID in two parts


Controller 1
GLEIF vLEI Software 1
GLEIF vLEI Software 2
Controller 2
Begin OOBI session and mutually verify legal identities of all Controllers
Generate AID
Done
Generate AID
Done
Mutually share AIDs & endpoints via QR Codes or live chat
Begin challenge
Challenge message
Verify?
Sign
Signed challenge
Verified
Complete mutual challenge messages for all Controllers


Genesis Controller
GLEIF vLEI Software 1
Witness 1
GLEIF vLEI Software 2
Controller 2
Select AIDs & Endpoints for all Controllers and GLEIF Witness Pool
Generate GLEIF AID inception event
Inception event
Verify
Verify inception event
Sign
Signed inception event
First Controller complete
Inception event
Sign
Complete inception event signatures for all Witnesses and Controllers

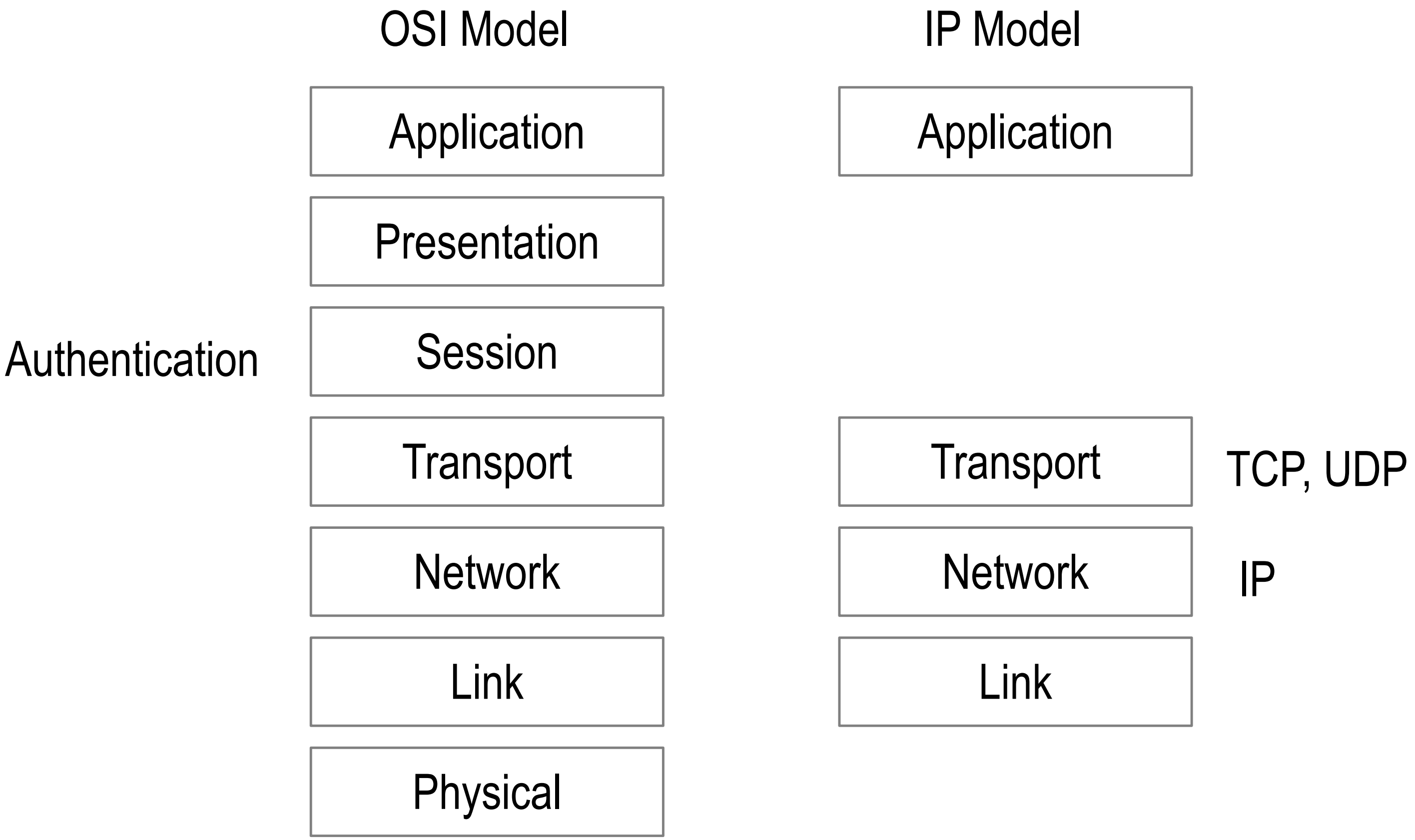
vLEI infrastructure technology (KERI and ACDC)

What makes KERI different the best choice for developing the vLEI infrastructure?

- Security first, always!
- Portability
- Result
  - Interoperable security and universal adoptability

Security – Trust Layer for the Internet

The Internet Protocol (IP) is bro-ken because it has no trust layer

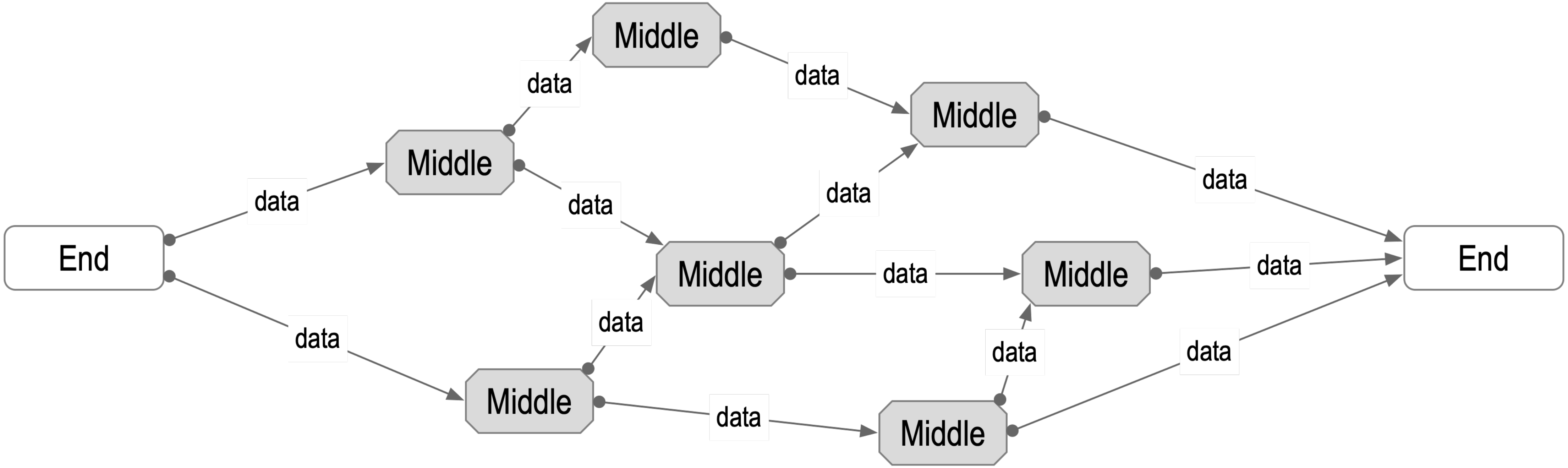


	OSI Model	IP Model	
	Application	Application	
	Presentation		
Authentication	Session		
	Transport	Transport	TCP, UDP
	Network	Network	IP
	Link	Link	
	Physical		

Instead … We use bolt-on identity system security overlays (DNS-CA)

Security – End-to-End Verifiability

End-to-End Verifiability



If the edges are secure, then the security of the middle doesn't matter.

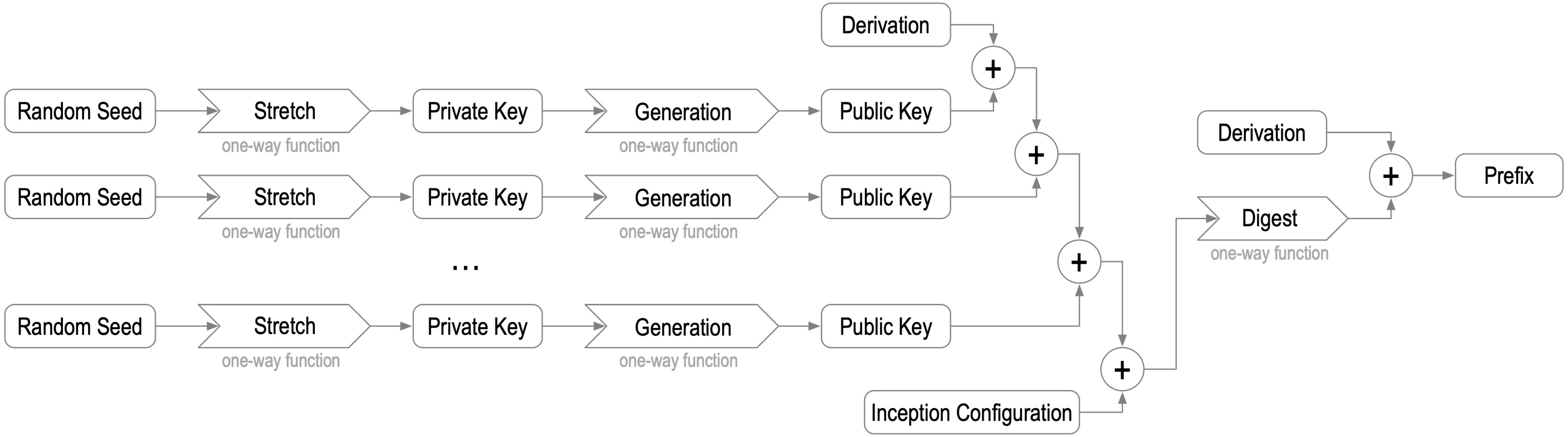
Ambient Verifiability: any-data, any-where, any-time by any-body

Zero-Trust Computing

Security and Portability - Root-of-Trust

- Administrative Root-of-Trust:
  - Insecure, Not-Portable, Fully Centralized
- Cooperative (shared algorithmic) Root-of-Trust:
  - Secure, Not-Portable, Shared Governance
- Cryptographic Root-of-Trust:
  - Secure, Portable, Fully Decentralized

Cryptographic Root-of-Trust:
Self-Certifying Identifier and Key Event Log



Prefix

Derivation	Inception Digest

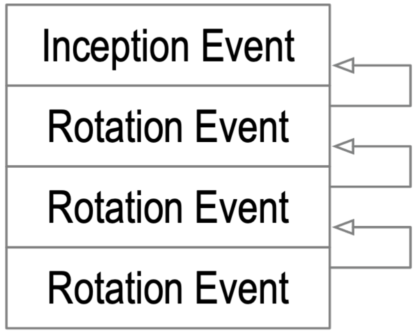
Inception Statement

Inception Data

Derivation	Public Keys	Configuration	Signatures

Key Event Log

Establishment Subsequence

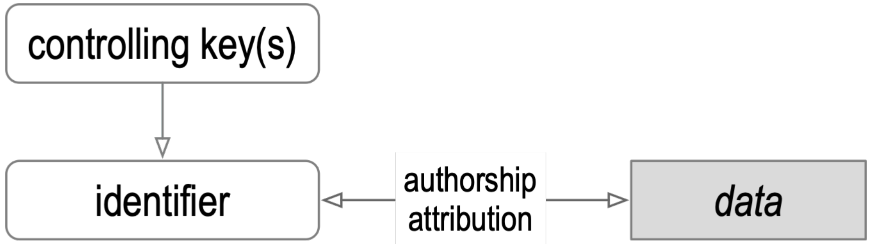


EXq5YqaL6L48pf0fu7IUhL0JRaU2_RxFP0AL43wYn148

did:un:EXq5YqaL6L48pf0fu7IUhL0JRaU2_RxFP0AL43wYn148/path/to/resource?name=secure#really

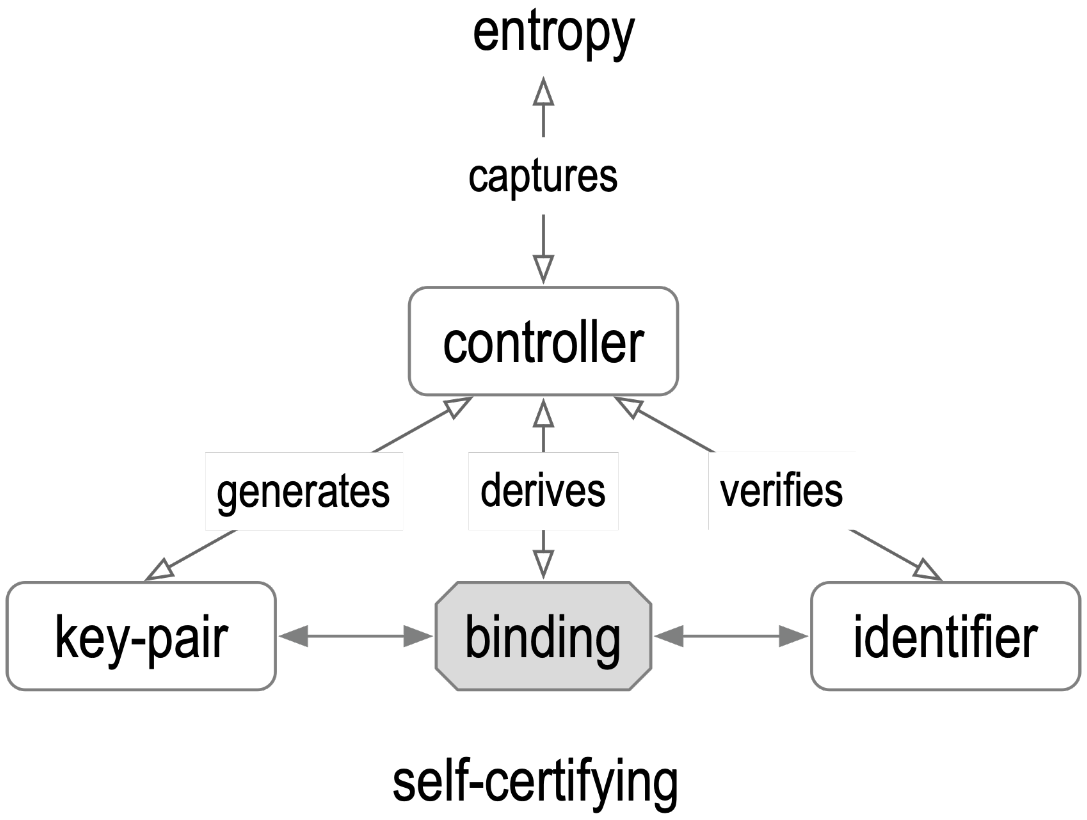
Security - Secure Attribution

- Secure attribution of any communication to its source
- Establish authorship of data, documents, credentials
- = authentic data provenance
- Secure attribution via *non-repudiable* digital signatures
- via (public, private) key pairs (PKI)
- Duplicity evident appraisal of key state
- Key state proofs are verifiable data structures
- Dumb crypto is adoptable crypto (minimally sufficient means)

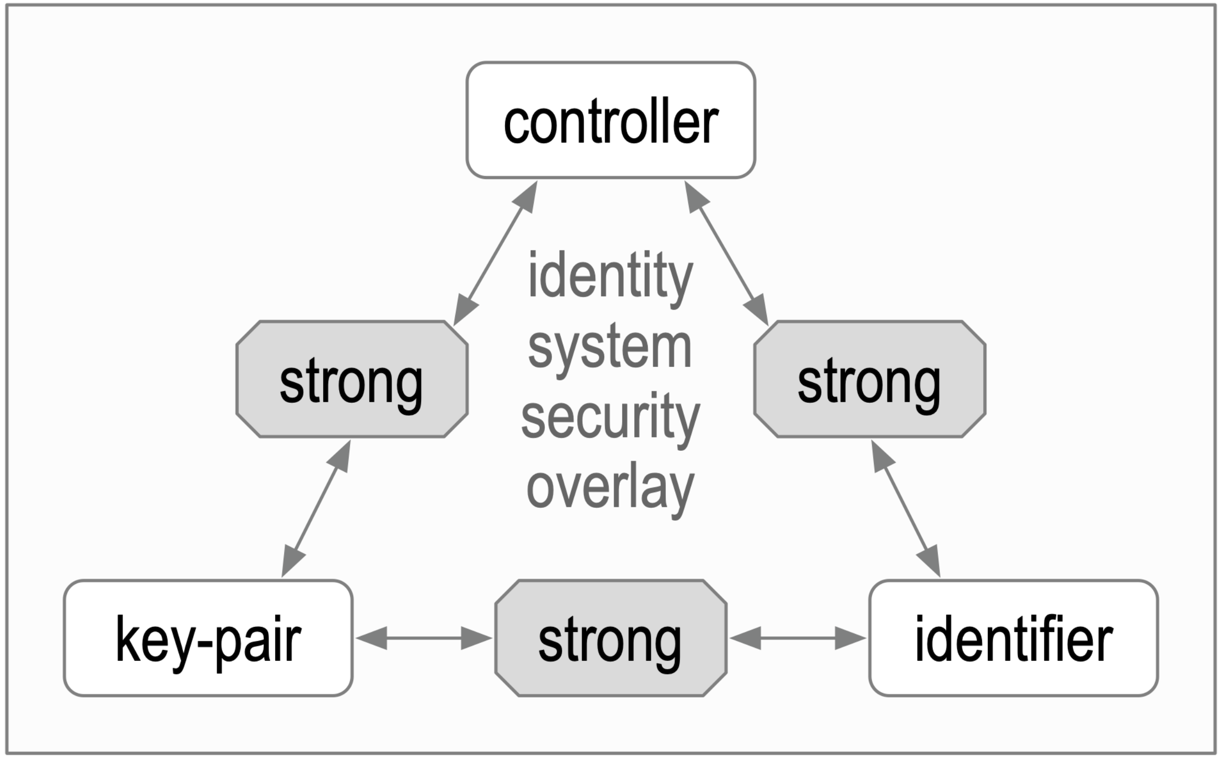


Share duplicity evident verifiable public key state.
Protect private keys (secrets).

Self-Certifying Identifier (SCID): Issuance and Binding



self-certifying

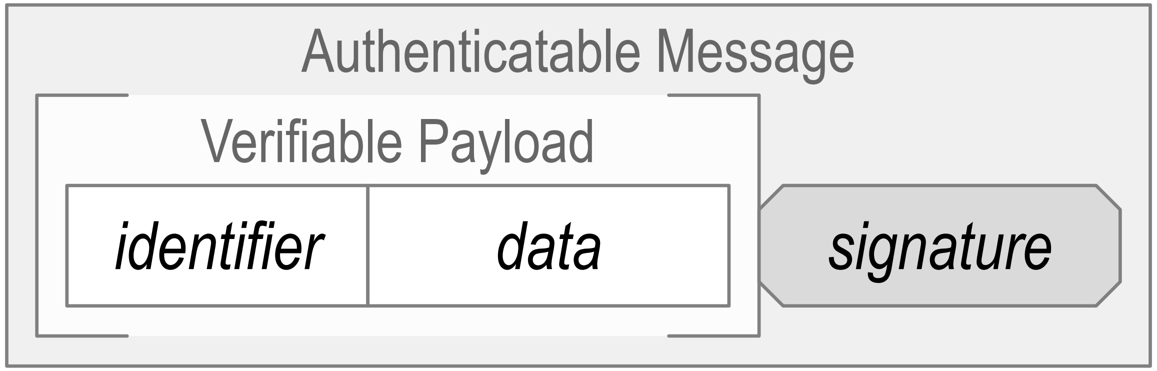


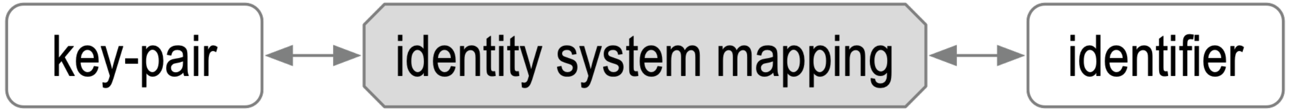
Self-Certifying Identifier Issuance

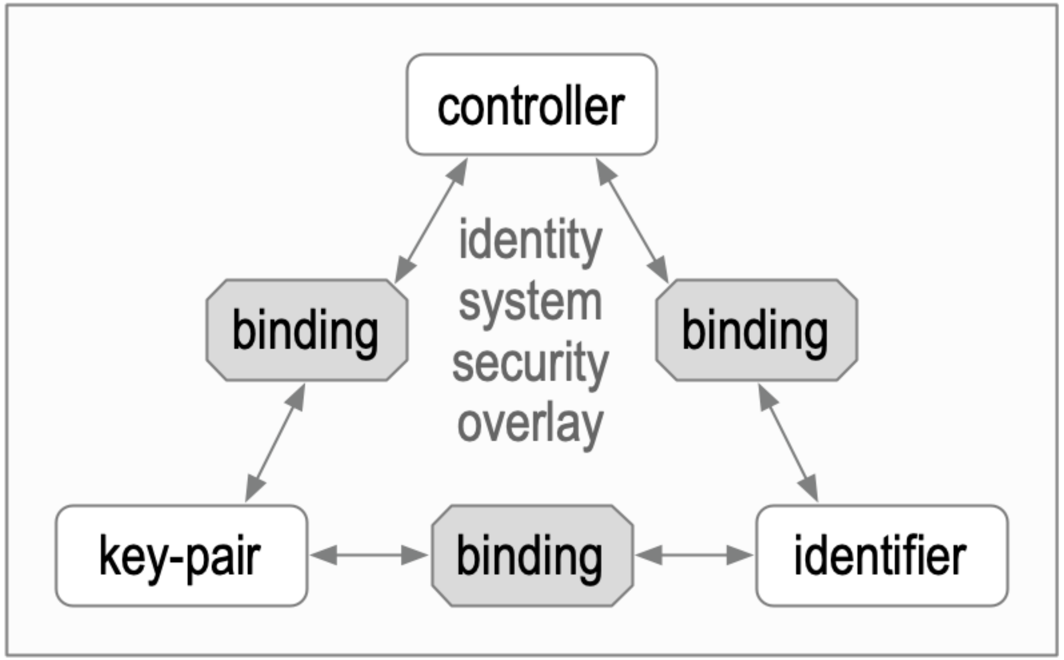
Cryptographic root-of-trust

Identity System Security Overlay

Establish authenticity of Internet Protocol packet’s message payload.



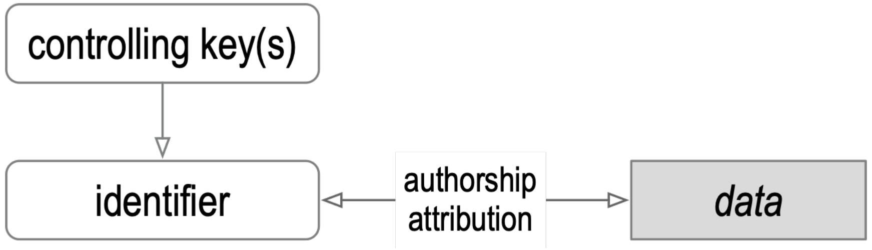




Identifier Issuance

The overlay’s security is contingent on the mapping’s security.

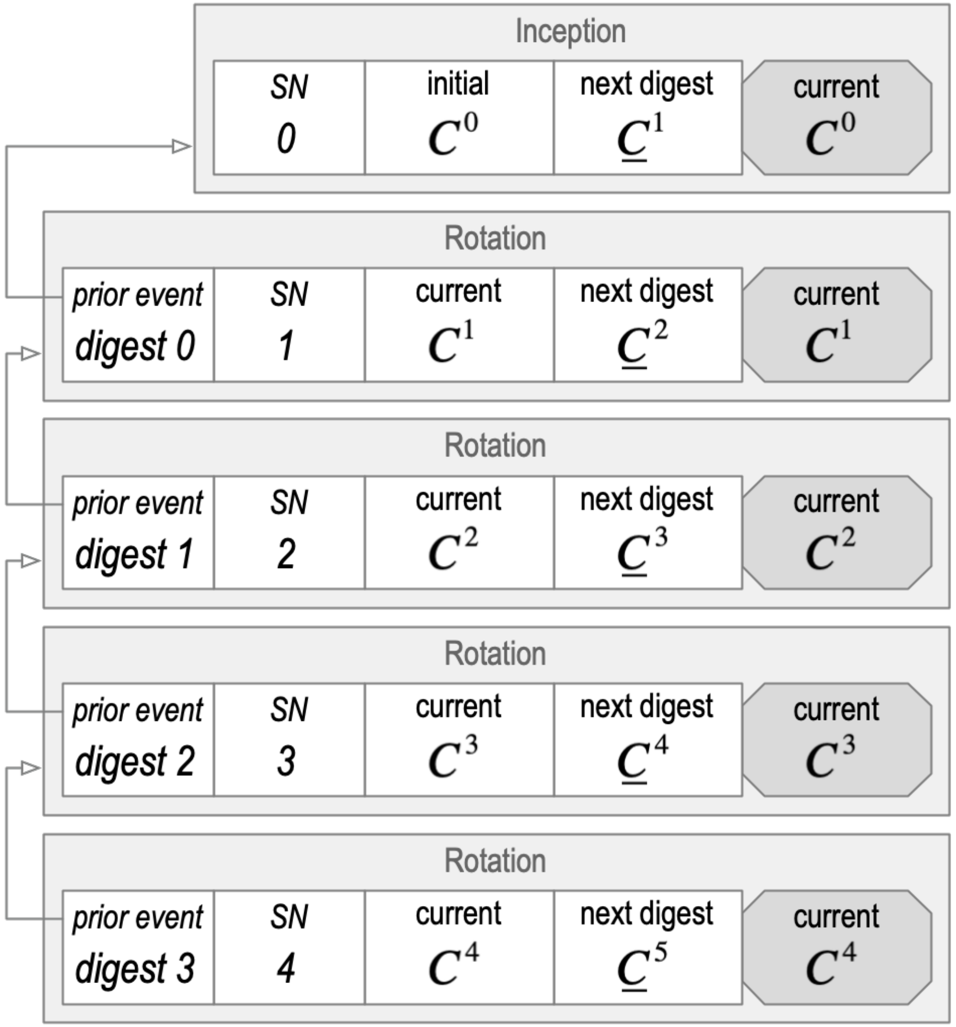
Security – Key Rotation addressing flaw of PKI (DNS/CA)



- Use of private keys exposes them to side-channel attack.
  - Over-time, exposure makes private keys weak.
- Therefore, from time to time must revoke and replace the controlling private keys for a given identifier
  - Hence key rotation
  - Existing PKI must re-establish the root-of-trust with each rotation thereby making it vulnerable to attack
  - Re-establishment breaks the chain of trust of control over the identifier

Security - Solution: Key Pre-Rotation

Forward commitment to next one-time use rotation key(s)



Inception

SN 0 | initial C^0 | next digest $\underline{C}^1$ | current C^0

Rotation

prior event digest 0 | *SN 1* | current C^1 | next digest $\underline{C}^2$ | current C^1

Rotation

prior event digest 1 | *SN 2* | current C^2 | next digest $\underline{C}^3$ | current C^2

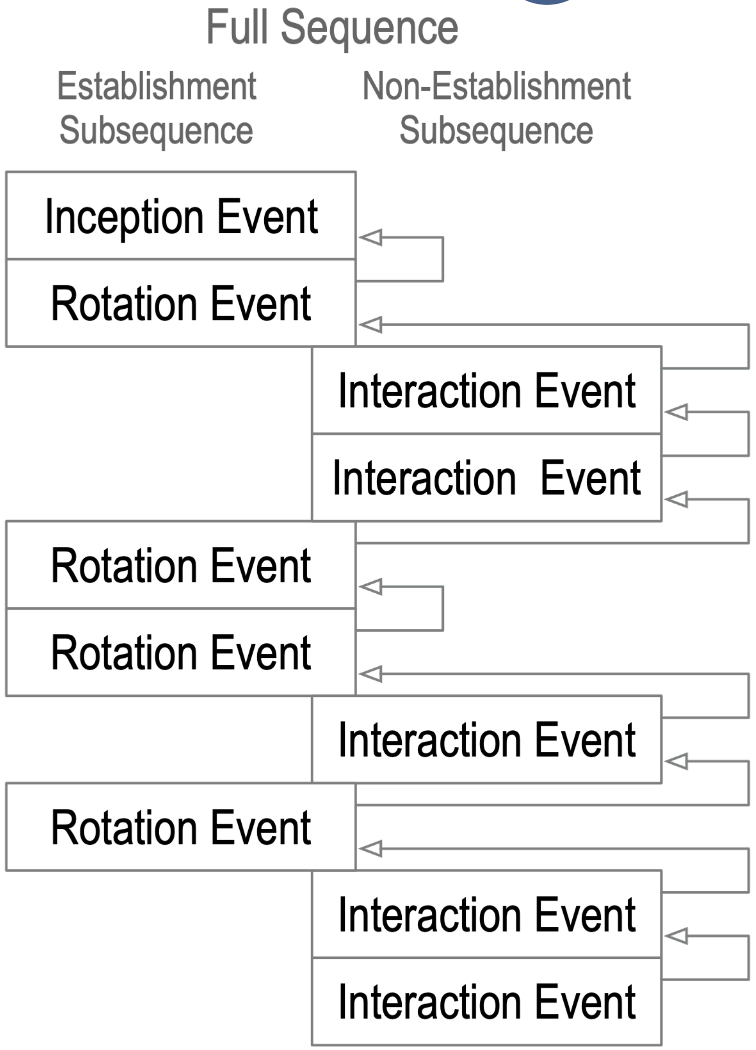
Rotation

prior event digest 2 | *SN 3* | current C^3 | next digest $\underline{C}^4$ | current C^3

Rotation

prior event digest 3 | *SN 4* | current C^4 | next digest $\underline{C}^5$ | current C^4

Duplicity evident
verifiable data structure



Full Sequence

Establishment Subsequence

Non-Establishment Subsequence

Inception Event

Rotation Event

Interaction Event

Interaction Event

Rotation Event

Rotation Event

Interaction Event

Rotation Event

Interaction Event

Interaction Event

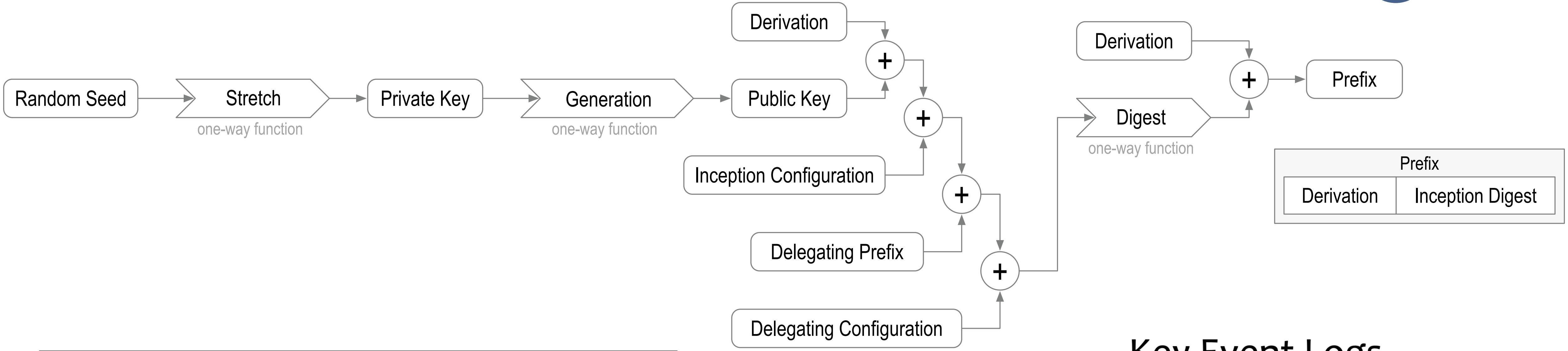
Digest of *next* key(s) makes pre-rotation post-quantum secure

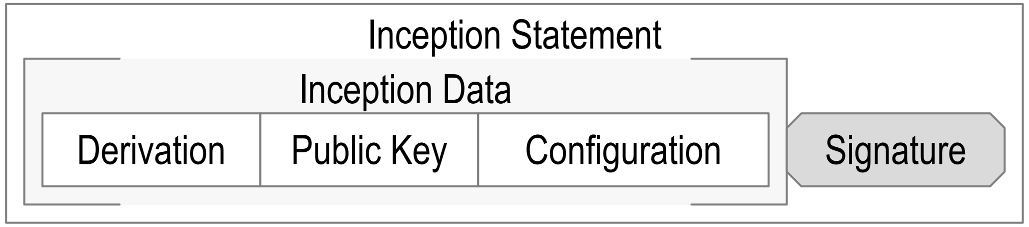
Security - Multi-Signature

- Each identifier has multiple controllers each with its own private key.
- Convenient mechanisms for managing multiply signed events.
- Enterprise grade fractionally weighted signing thresholds.

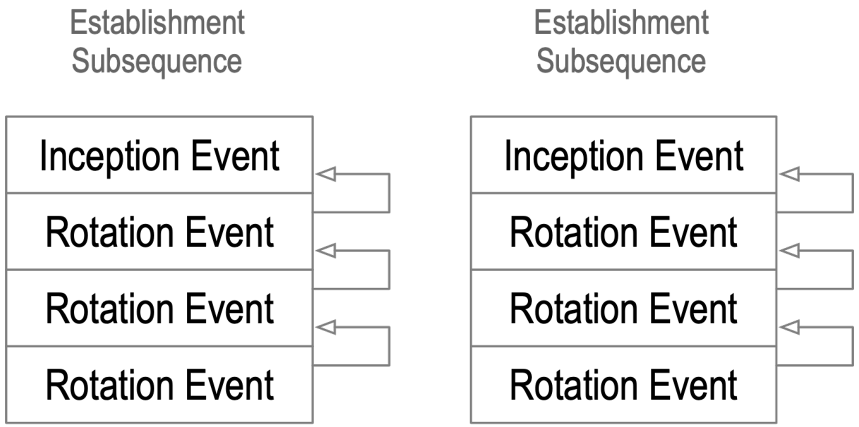
Security - Identifier Delegation

Delegated Self-Addressing SCID





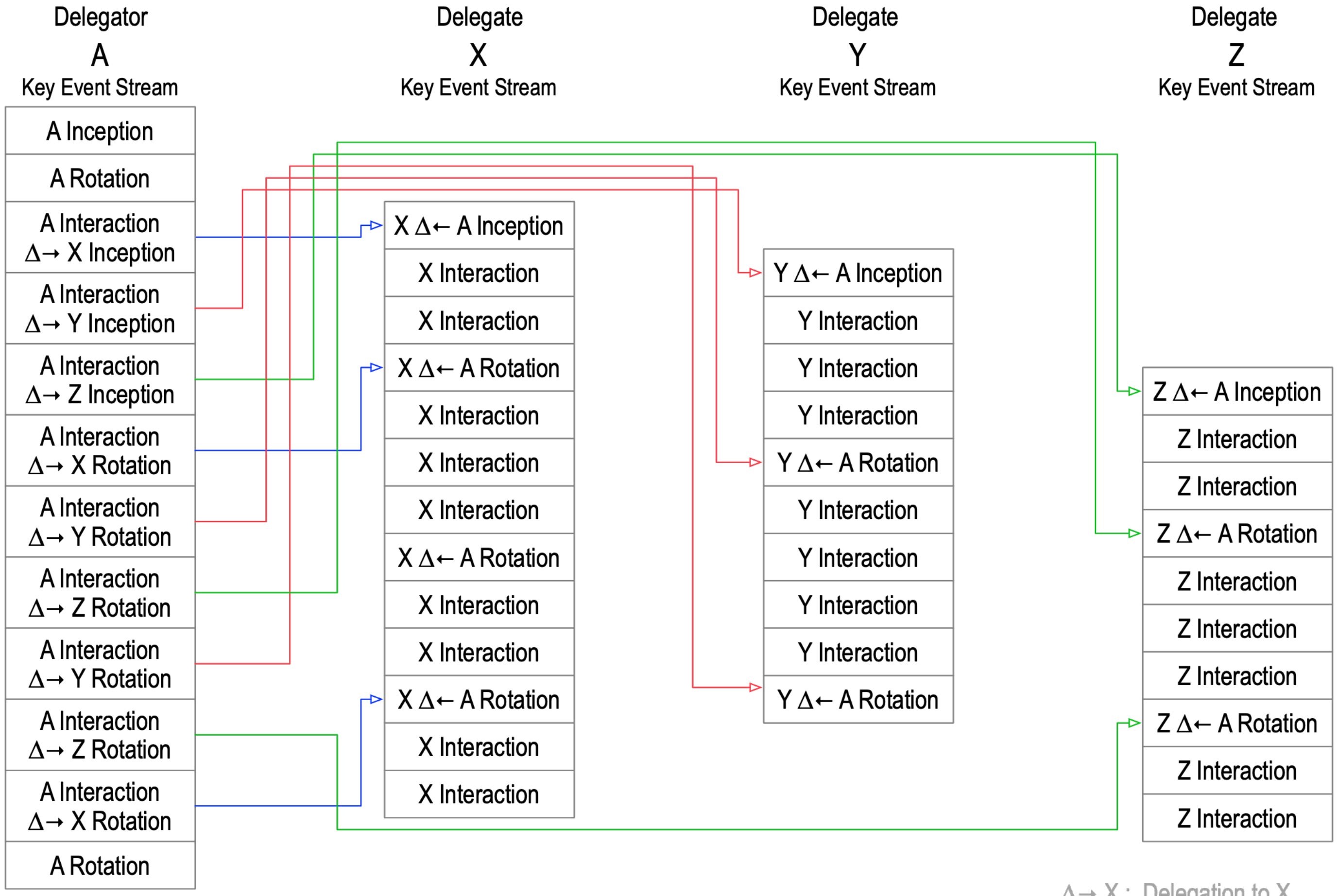
Key Event Logs



EXq5YqaL6L48pf0fu7IUhL0JRaU2_RxFP0AL43wYn148

did:keri:EXq5YqaL6L48pf0fu7IUhL0JRaU2_RxFP0AL43wYn148/path/to/resource?name=sec#yes

Security - Identifier Delegation
Allows scalability and nested protection



Delegator
A
Key Event Stream

A Inception
A Rotation
A Interaction Δ→ X Inception
A Interaction Δ→ Y Inception
A Interaction Δ→ Z Inception
A Interaction Δ→ X Rotation
A Interaction Δ→ Y Rotation
A Interaction Δ→ Z Rotation
A Interaction Δ→ Y Rotation
A Interaction Δ→ Z Rotation
A Interaction Δ→ X Rotation
A Rotation

Delegate
X
Key Event Stream

X Δ← A Inception
X Interaction
X Interaction
X Δ← A Rotation
X Interaction
X Interaction
X Interaction
X Δ← A Rotation
X Interaction
X Interaction
X Δ← A Rotation
X Interaction
X Interaction

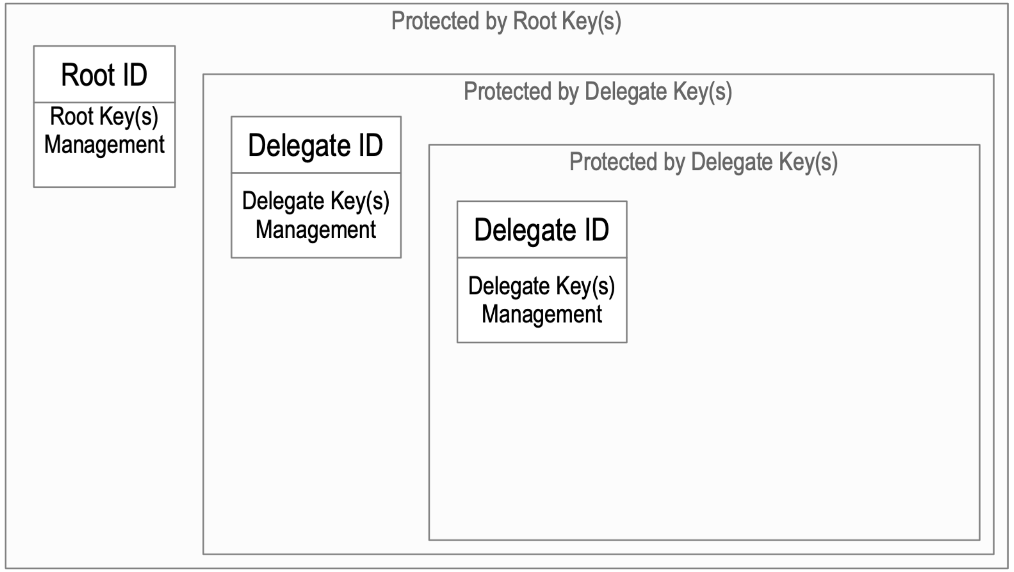
Delegate
Y
Key Event Stream

Y Δ← A Inception
Y Interaction
Y Interaction
Y Interaction
Y Δ← A Rotation
Y Interaction
Y Interaction
Y Interaction
Y Interaction
Y Δ← A Rotation

Delegate
Z
Key Event Stream

Z Δ← A Inception
Z Interaction
Z Interaction
Z Δ← A Rotation
Z Interaction
Z Interaction
Z Interaction
Z Δ← A Rotation
Z Interaction
Z Interaction

Δ→ X : Delegation to X
Δ← A : Delegation from A



Protected by Root Key(s)

Root ID
Root Key(s) Management

Protected by Delegate Key(s)

Delegate ID
Delegate Key(s) Management

Protected by Delegate Key(s)

Delegate ID
Delegate Key(s) Management

vLEI sandbox demo

Next steps

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