Authentic Chained Data Containers

ToIP Technical Working Group Task Force

Wiki: https://wiki.trustoverip.org/display/HOME/ACDC+%28Authentic+Chained+Data+Container%29+Task+Force

Slack: tswg-acdc-tf

Github: https://github.com/trustoverip/TSS0033-technology-stack-acdc

White Paper: https://github.com/SmithSamuelM/Papers/blob/master/whitepapers/ACDC.web.pdf

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Authentic Data Container = Attestation

Attestation ID: (in order to reason with data) ID of the attributable item attestation. (convenience, indexing, data compression, structure, human meaningful)

Testator ID: (Attestation Controller) (combined Testator/Attestator ID) (Assume DID like namespace)(Argument to restrict attestation ID to always be in namespace of Testator ID)(either implicitly or explicitly)

Attestation about Payload Data:

- Derived DID from DID namespace
  - Derived from Data Item Content (such as https://iscc.codes)(correlate attestations)
  - Verifiable Registry of Data Item
  - Data Attributes:{NonAuthentic Attributes}

Testator Signature on Attestation Item: (nonredudiable, integral)

Use signature as globally unique content addressable Identifier for attestation Signature is bound to Testator.

Identifiers of Data for correlation vs Data Attestation identifiers for secure attribution of the attestation of the data

Attestation to Data Item (Datum) with source Datums

Datum: *something given or admitted especially as a basis for reasoning or inference. an important historical datum*

Datum = Verifiable Attribution of Decentralized Attestation to a Specific Data Item

Datum ID = ID of Decentralized Attestation to Data , Decentralized Autonomic Data (DAD)

```
<
 DatumID (dDID): MUST be within of namespace of Testator ID (tDID)  (datum attestation DID=dDID)
 (NOT) TestatorID (tDID): (Optional when DatumID (dDID) not within namespace of tDID)
       (enables lookup of public key(s) to verify signature(s))(A given testator may want to use different testator
         namespaces and mix and match those for a given DatumID namespace)(Counter argument if want to use a different tDID then
create a new dDID within the new tDID namespace and then reference the old dDID as a source dDID within the new Datum.) (Also why have two
changing mechanisms one the source dDID and two the TestatorID when one is sufficient)

 Sources: (in this context source means securely attributable attestation = source Datum)
 [
  { Secure Attribution Source: DatumID: …},
  { Secure Attribution Source: DatumID: …},
  …
 ]
 Data Payload Correlation Identifiers: []  (may or may not be content addressable)
 Data Payload:{ … }
>
Attached Testator Signature(s) on Datum
```

Content addressable identifier(s) of Datum are not the same as content addressable identifiers of Data Payload because Payload is a subset of Datum.

Example

https://hackmd.io/RX8ZAycxQhSpGZgBfRzqbg

~~~
 ```jsonld=
{
AttestationDatumID: <>,(in namespace of TestatorID so includes TestatorID)
Sources: {
        AttestationDatumID: <>,
        AttestationDatumID: <>,
        AttestationDatumID: <>
    }
SourceAttestedDatumIDs: [
{AttestationDatumID: 12719471892749812749, schemaID: <>, schema:  }
]
datum_schema_dri: <>
datum_schema: {},
datum: {
    k: v
}

}
~~~

Provenance Semantics: Chaining and Rules

```
Provenance Chains (Credence or Authorization)
{
     priors:
     {
       {source: id, rules: { …}, weight: value, …},
       {source: id, rules: { …}, weight: value, …},
        …
     },
     destination: id, //issuer
     rules: { … },
     weight: value,
     sink: id, //issuee
     …
}
```

Issues Linked Data

Linked-Data Data Model: Statements are triples (Subject Predicate Object)

Typically is-a, has-a predicates: Subject is-a Object or Subject has-a Object

Issues:

1) Signed Container is a single shared subject with multiple is-a has-a clauses

   (i.e. a set of triples but all triples have the same subject)

   VS a container with multiple parallel triples which may have different subjects

   This causes meta-data confusion/distinction

2) Need interoperable schema standards. JSON-LD context vs JSON Schema

   JSON schema is more general universal and popular than JSON-LD context

3) Security of imported non-verifiable contexts based non-stable schema using schema.org

4) Data Normalization Context Problem (single flat shared merged context)

   Polysemy problem is terminology context dependence.

   Context is a hard semantic constraint. It is problematic to normalize out.

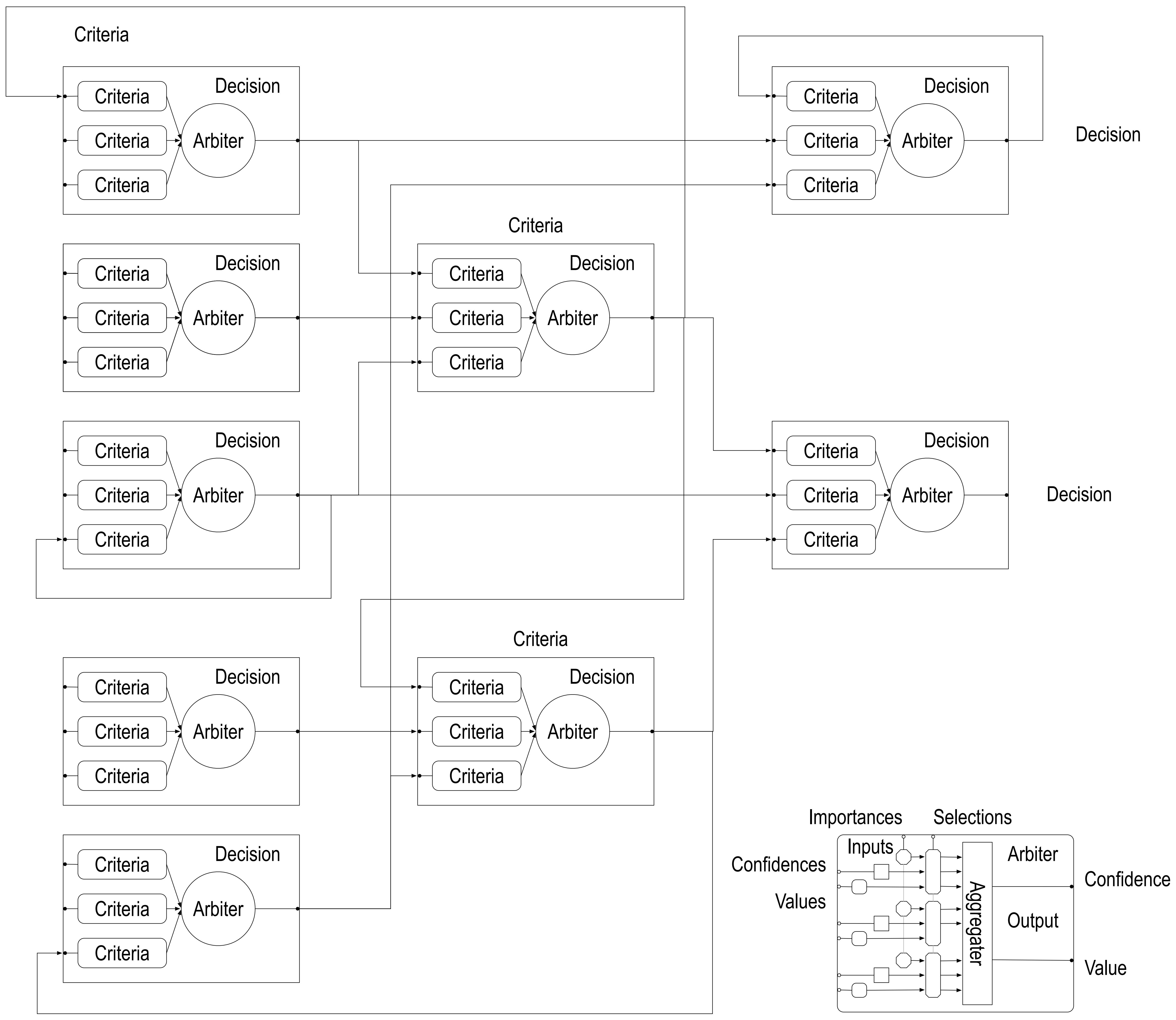
   Terminology best if include context modifier (conditioned) Ie context hierarchy is part of data

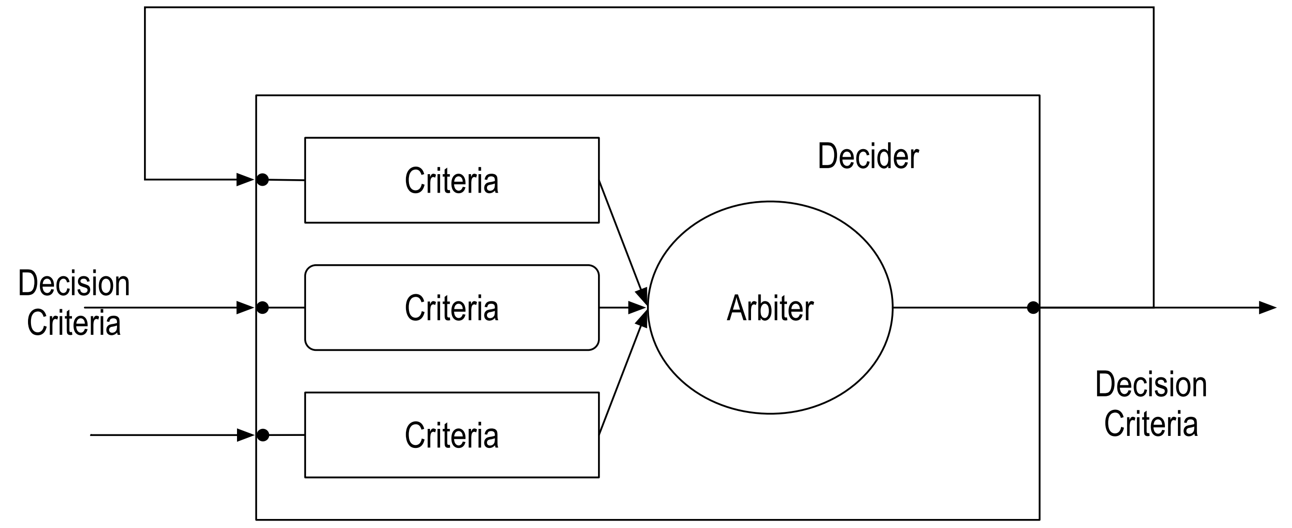
   JSON-LD assumes contextual normalization whereas JSON schema allows for non-normalized context hierarchy

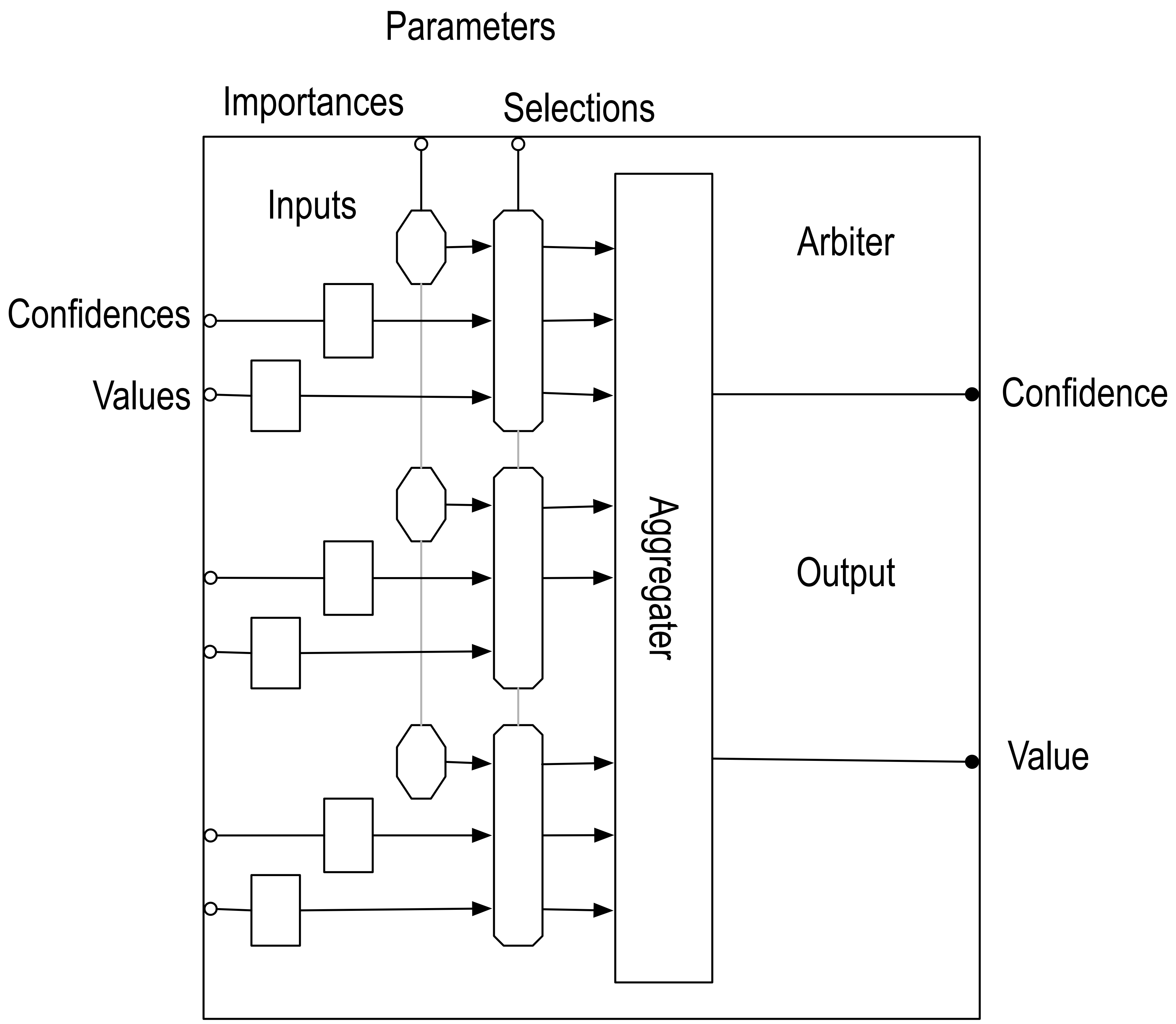
5) Uncertainty problem in Knowledge Representation (Problematic for is-a has-a Triples)

6) Decision Architecture Layering Problem (Supervisory, Adaptive, Learning)

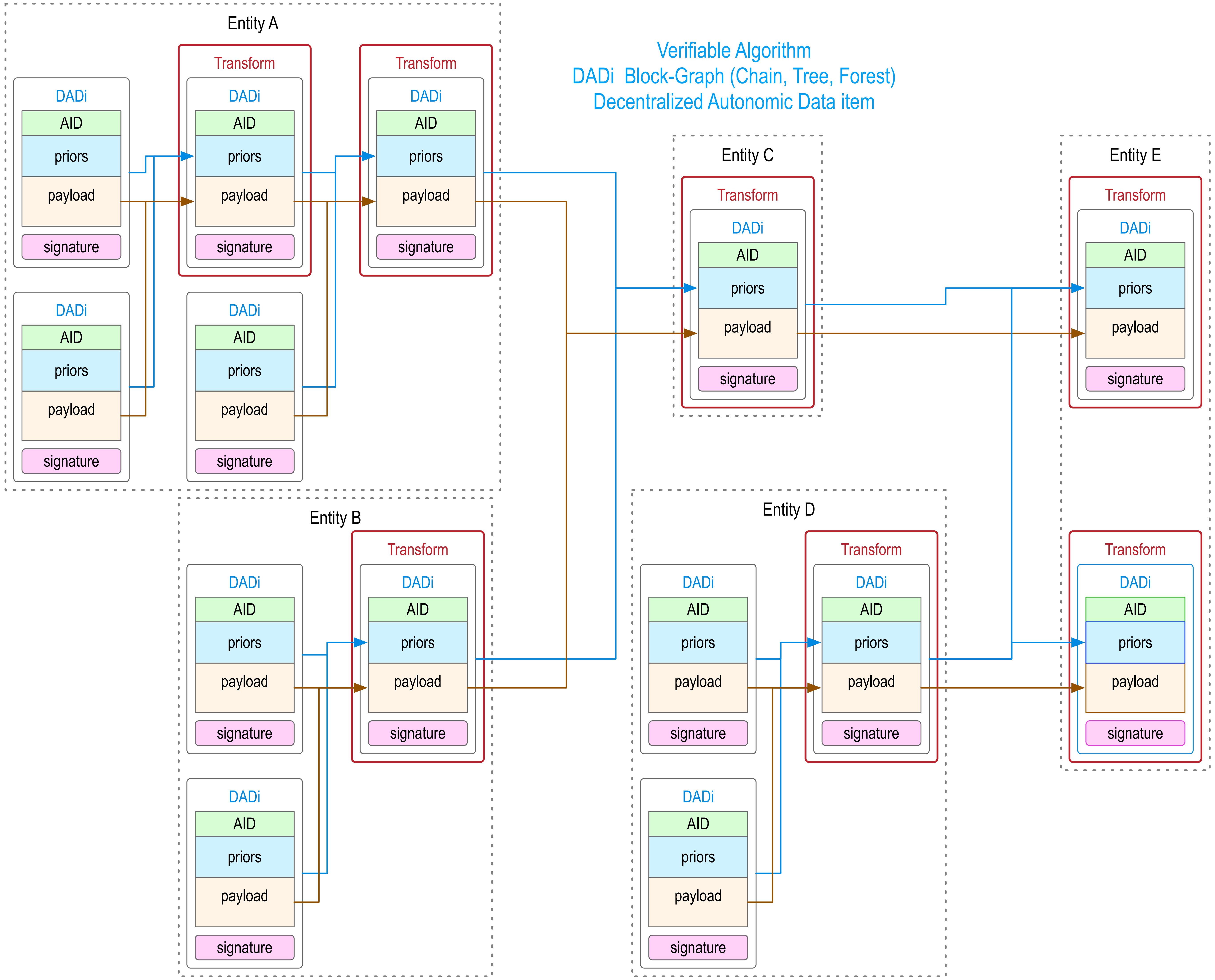
Provenance Semantics: Chaining and Rules







Provenance Semantics: Chaining and Rules



Its all about Automated Reasoning

Automated Business Process Workflows as Automated Decision Processes

Secure Attribution is essential to cross entity decision processes and cross entity data supporting those decision processes.

Decentralized Automated Decision Making depends on securely attributable decision process data flows.

Secure Attribution provided by a portable decentralized identity system security overlay for data in motion and at rest.

Automated Reasoning *with* *Authentic Data*

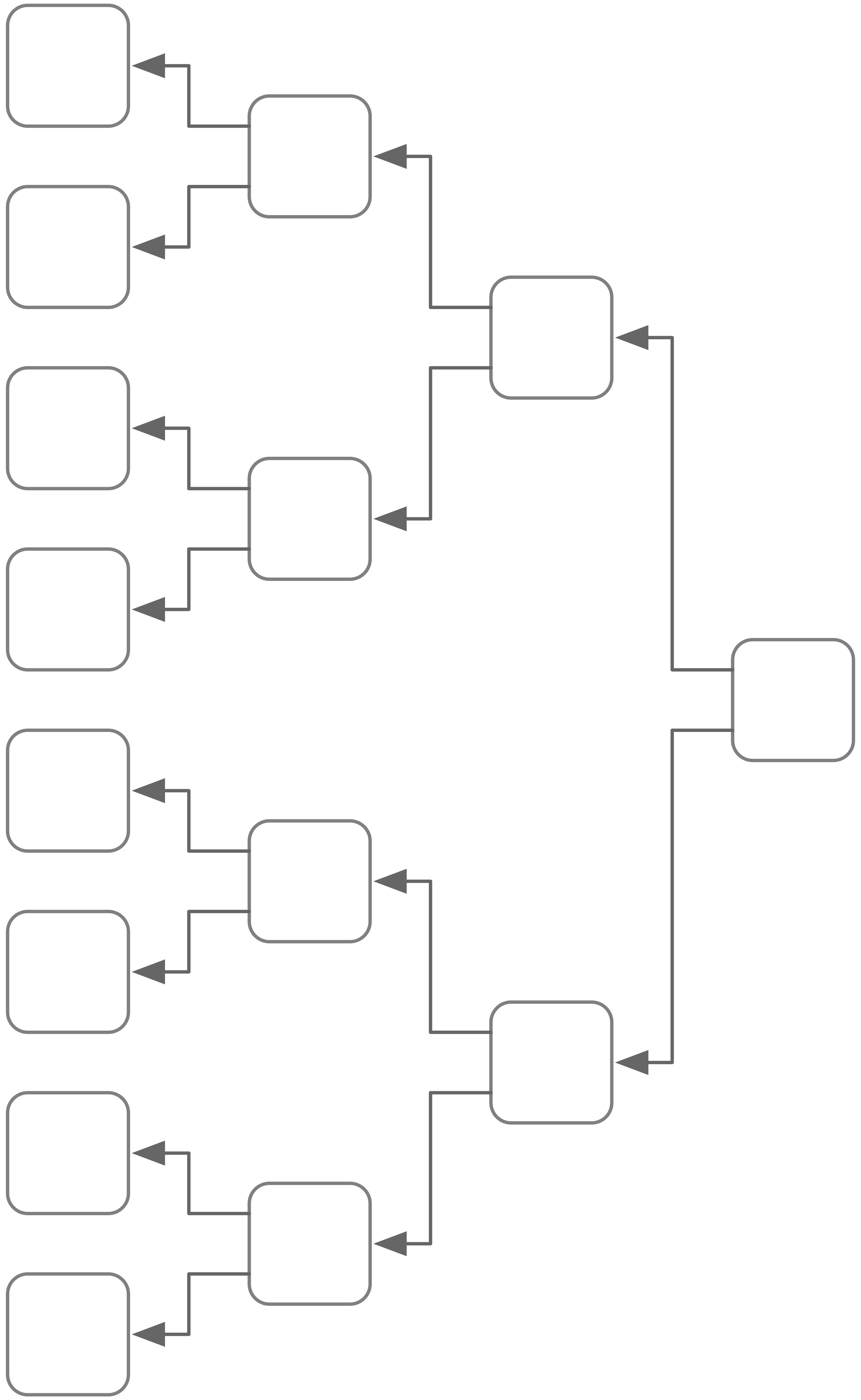
Decision Making: finding actions that best satisfy goals and constraints

Authentic = Provenanced = Securely Attributed

Securely Attributed = Nonrepudiably Authenticated

Secure Attribution (Authentic Provenance):

Chain, Tree, or Graph



Authenticity Verification

Digital Signatures for Verifiable Authenticity

Verifiable Authenticity = Authenticatible

Securely Attributable via Verifiable Non-repudiable Digital Signatures

Authenticity Verification Models (for VCs)

Terminology

***credential**: evidence of authority, status, rights, entitlement to privileges, or the like.*

***license**: formal permission from a constituted authority to do something, as to carry on some business or profession.*

a certificate, tag, plate, etc., giving proof of such permission; official permit: a driver's license.

***authorization:** permission or power granted by an authority; sanction.*

In decision making context, *authentic credential* = *proof of satisfaction of authority constraint*

Authenticity Verification (Attribution/Provenance) Model Properties

Bipartite vs. Tripartite vs. Multipartite

Open Loop vs. Closed Loop

Chained vs. Unchained

Aggregative vs. Unaggregative

Weighted vs. Unweighted (Qualified vs Unqualified)

Attenuable vs. Unattenuable

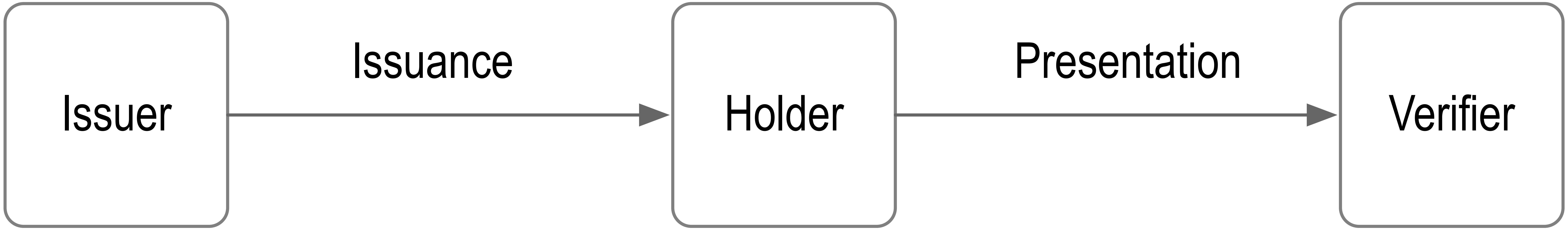
Persistent vs. Ephemeral

Implicit vs. Explicit

Cooperative vs. Uncooperative (Unilateral vs. Bilateral vs. Multilateral)

Entrained vs. Unentrained

Issuer-Holder-Verifier Model



Issuer

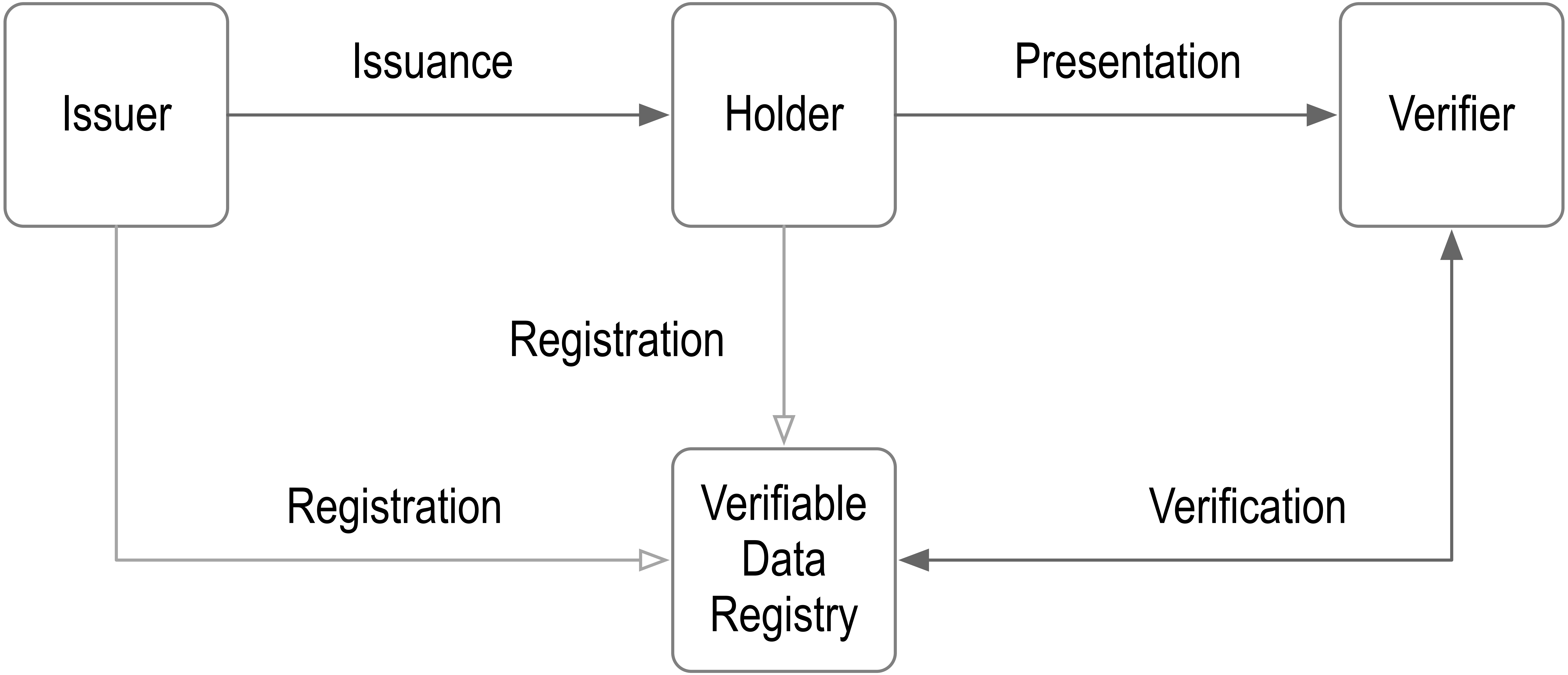
Issuance

Holder

Presentation

Verifier

Issuer-Holder-Verifier Model with Verification at Verifiable Data Registry



Issuer

Issuance

Holder

Presentation

Verifier

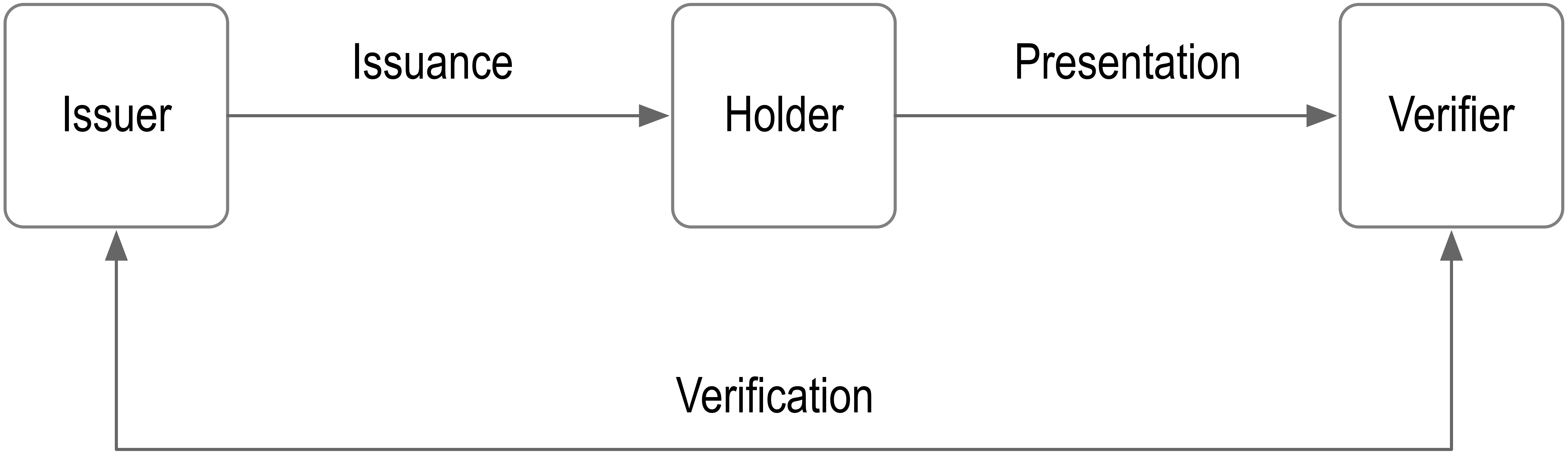
Registration

Registration

Verifiable Data Registry

Verification

Issuer-Holder-Verifier Model with Verification at Issuer



Issuer

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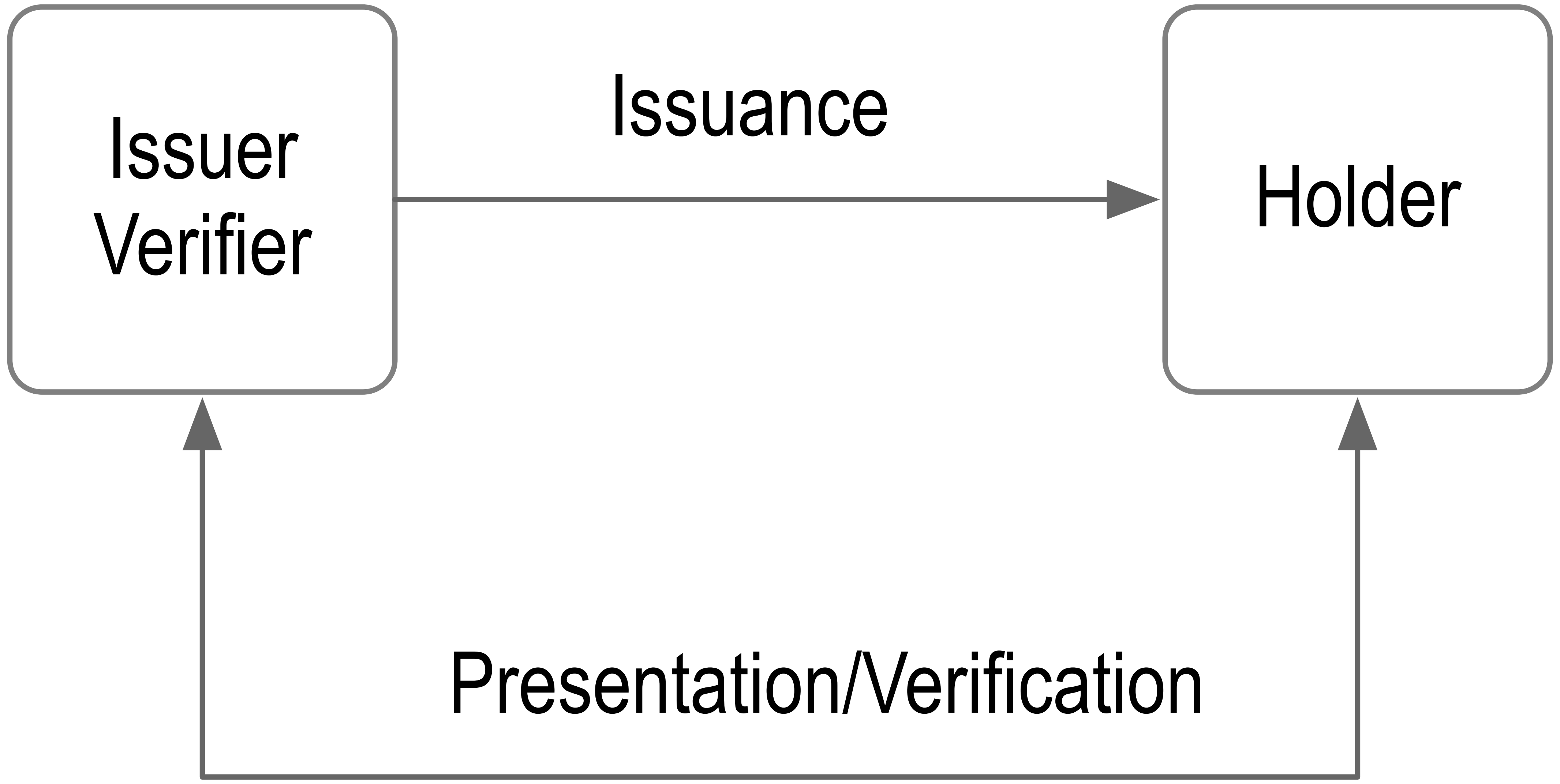
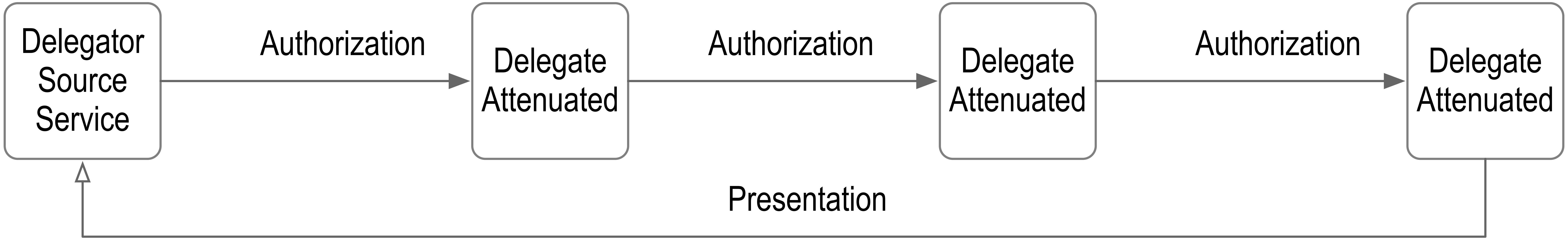
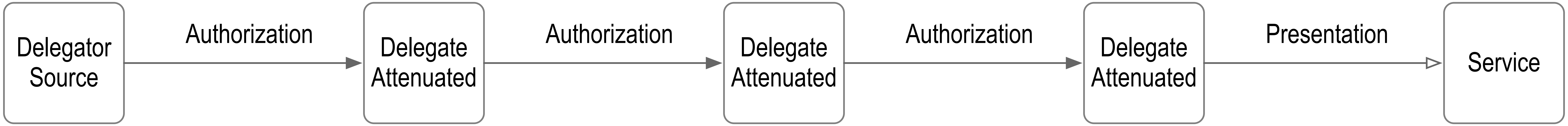
Issuer-Holder Model with Verification at Issuer



Joint Delegator-Service Model



Split Delegator-Service Model



Delegator Source

Authorization

Delegate Attenuated

Authorization

Delegate Attenuated

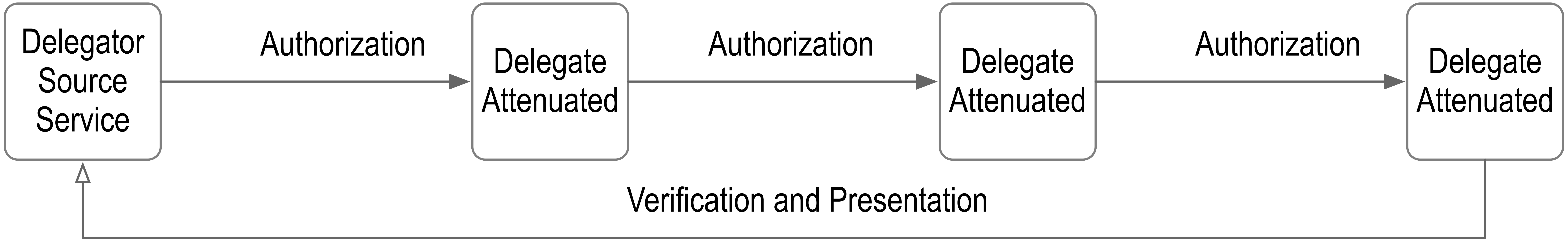
Authorization

Delegate Attenuated

Presentation

Service

Closed Loop Joint Model



Delegator Source Service

Authorization

Delegate Attenuated

Authorization

Delegate Attenuated

Authorization

Delegate Attenuated

Verification and Presentation

Closed Loop Split Model

Delegator Source

Authorization

Delegate Attenuated

Authorization

Delegate Attenuated

Authorization

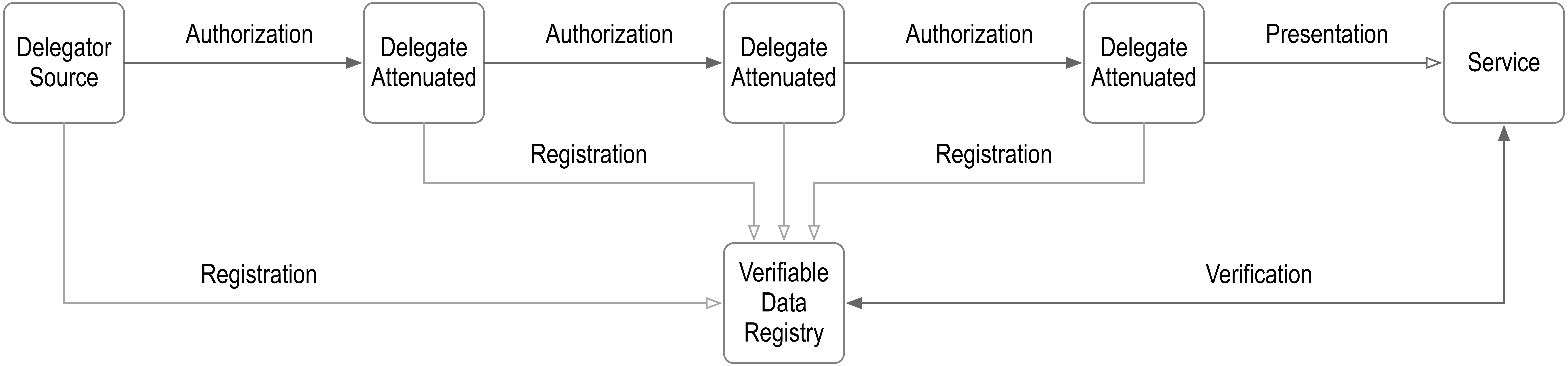
Delegate Attenuated

Presentation

Service

Verification

Open Loop Split Model



Delegator Source

Authorization

Delegate Attenuated

Authorization

Delegate Attenuated

Authorization

Delegate Attenuated

Presentation

Service

Registration

Registration

Registration

Verifiable Data Registry

Verification

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Object Capabilities vs VC Authorizations

ObjCap:

Most useful for computer OS security, does not translate easily to many real world use cases

Not VC Native

explicit, ephemeral, attenuable, chained, unaggregative, unweighted, uncooperative, closed-loop

VC:

No standard model for authorization, chaining, delegation etc.

Implicit, persistant or not, unattenuable, unchained, unaggregative, unweighted, uncooperative, open-loop

Verifiable Chains

Verifiable Credential *Native:*

Chaining Semantics:

Provenance

Credence (Trust)

Confidence

Data Custody

Authorization

Consent

Custodian Governance

TADA^3!

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Verifiable C…

Verifiable (integrity & attribution) Container of ?
Verifiable Chain (Tree) of Containers of ?
Authenticity verification and Veracity verification
…
Data Source Provenance
Data Source Credence (Reputation, Trust)
Data Source Weighting Confidence
Data Source Aggregation
…
Authority Source Authorization
Authority Source Consent
Authority Source Custodian
Authority Source Aggregation

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Verifiable … *Credential*?

credential:
evidence of authority, status, rights, entitlement to privileges, or the like.

authorization:
permission or power granted by an authority; sanction.

claim:
an assertion of something as a fact, an assertion of a right or an alleged right.

container:
anything that contains or can contain something, … factual data container.

What is verifiable?

Verifiable Signature:

- Provides proof of data integrity and non-repudiable commitment to data syntax.
- Verifiable attribution
- Does not by itself provide verifiable veracity/truthfulness of facts/data semantics.

A signature imbues no veracity of any kind to the data semantics.

Verifies authenticity of signed statement = attribution to author/signer, not veracity of signed statement.

IF the operative semantics of the data are under the control of the signer, then a signature conveys a verifiable non-repudiable commitment to those operative semantics.

= *authorization*.

Authorization Properties

Implicit vs. Explicit

Persistent vs. Ephemeral (revocation policy)

Chained vs. Unchained

Attenuable vs. Unattenuable

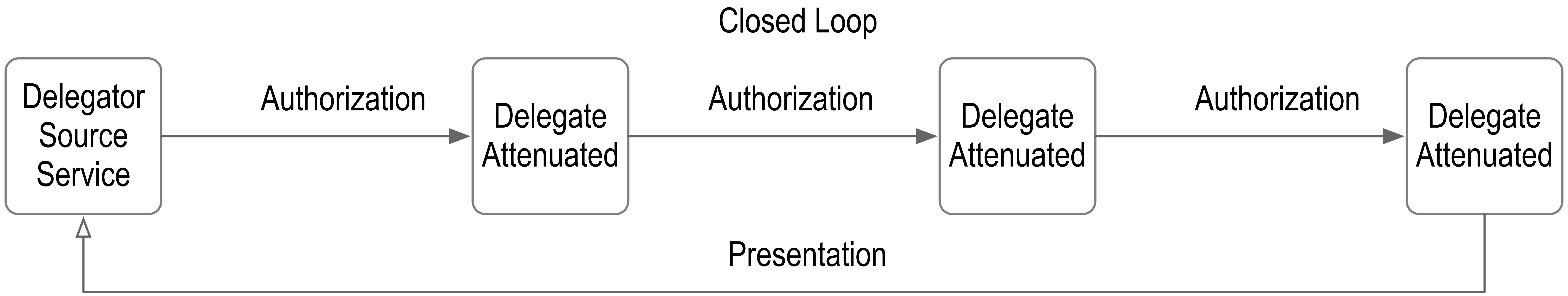
Aggregative vs. Unaggregative (Tree vs linear Chain)

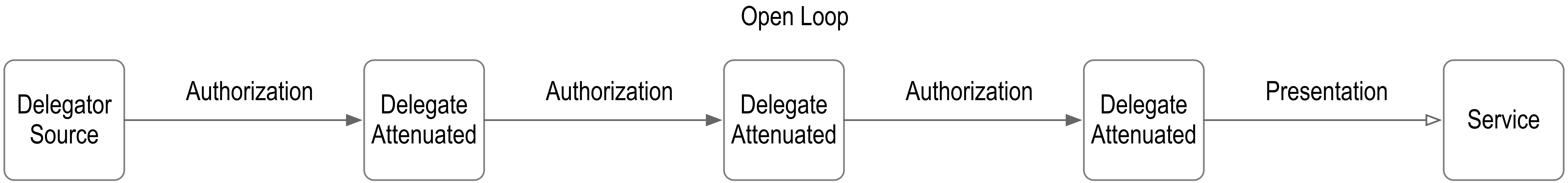
Weighted vs. Unweighted

Closed Loop vs. Open Loop

Cooperative vs. Uncooperative

Closed vs Open Loop





Weighted Aggregation of Authorizations

Analogous to thresholded multi-signature

$$\widehat{C}_l = \left[C_l^1, \ldots, C_l^{L_l}\right]_l \quad \widehat{K}_l = \left[U_l^1, \ldots, U_l^{L_1}\right]_l \quad 0 < U_l^j \le 1 \quad \bar{U}_l = \sum_{i=s_0}^{s_{S_k-1}} U_l^i \ge 1 \quad \widehat{s}_k^l = \left[s_0, \ldots, s_{S_k^l-1}\right]_k^l$$

$$\widehat{C} = \left[C^1, C^2, C^3\right] \qquad U_l^j = {}^1\!/\!_{K_l} \qquad \widehat{K} = \left[{}^1\!/\!_2, {}^1\!/\!_2, {}^1\!/\!_2\right]$$

$$\widehat{K}_l = \left[{}^1\!/\!_2, {}^1\!/\!_2, {}^1\!/\!_4, {}^1\!/\!_4, {}^1\!/\!_4, {}^1\!/\!_4\right]_l$$

$$\widehat{K}_l = \left[\left[{}^1\!/\!_2, {}^1\!/\!_2, {}^1\!/\!_4, {}^1\!/\!_4, {}^1\!/\!_4, {}^1\!/\!_4\right], \left[{}^1\!/\!_2, {}^1\!/\!_2, {}^1\!/\!_2, {}^1\!/\!_2\right], \left[1, 1, 1, 1\right]\right]$$

Cooperative Delegation Relationship

Authority flows source to sink (down or left to right)

Credence (trust) flows sink to source (up or right to left)

Provenance requires tracing relationships both ways

Cooperative delegation flows both ways.

Delegator sends authority to Delegate.

Delegate sends credence to Delegator.

Cooperative Verification Relationship

Delegator has rules (constraints)

Delegate has rules (objectives)

Verifier has rules (constraints and objectives)

Authorization success upon the conjoint satisfaction of the three sets of rules

Authorization success upon the satisfaction of rule chain

Decision Making Model

is-a has-a knowledge graph: decision making based on querying knowledge graph, indirect decision making process

decision making graph: decision making based on evaluating decision making graph, direct decision making process

JSON = Data	Just JSON = Just Data
Subject is-a, has-a data	Metadata about is-a has-a data

Limiting case, data item is the subject of its own data = Just Data

Attribution Chain

Super semantic is an attribution chaining semantic.

Need first make secure attribution of source of information = issuers of ADC

Attribution tree (aggregation)

Then once we have made secure attribution to issuers (AID KERI etc)

Then we can color the edges of the attribution tree with layered semantic

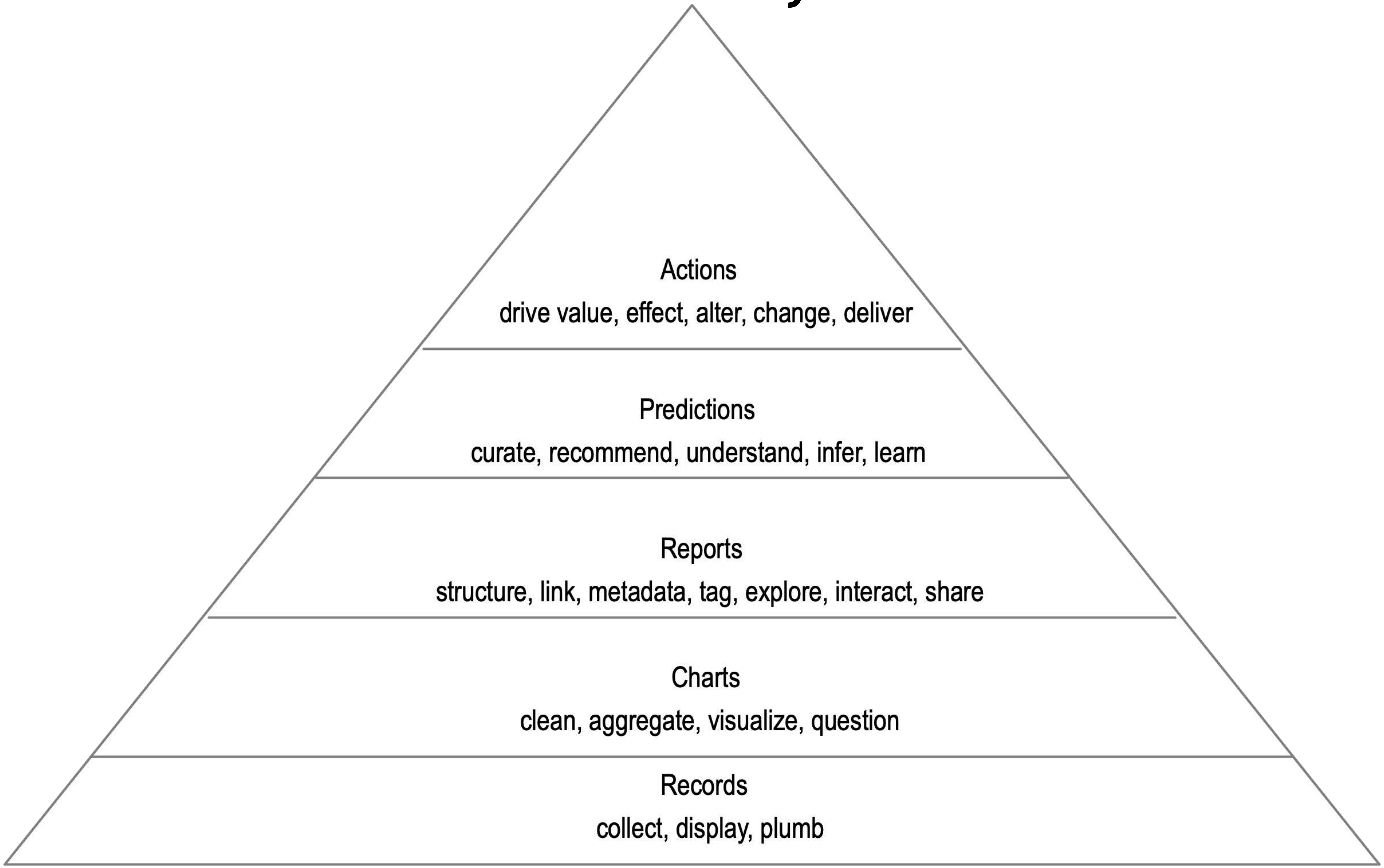
Provenance Tree/Chain

Delegation Tree/Chain

Attestation Tree/Chain

Etc.

Data Value Pyramid



Actions

drive value, effect, alter, change, deliver

Predictions

curate, recommend, understand, infer, learn

Reports

structure, link, metadata, tag, explore, interact, share

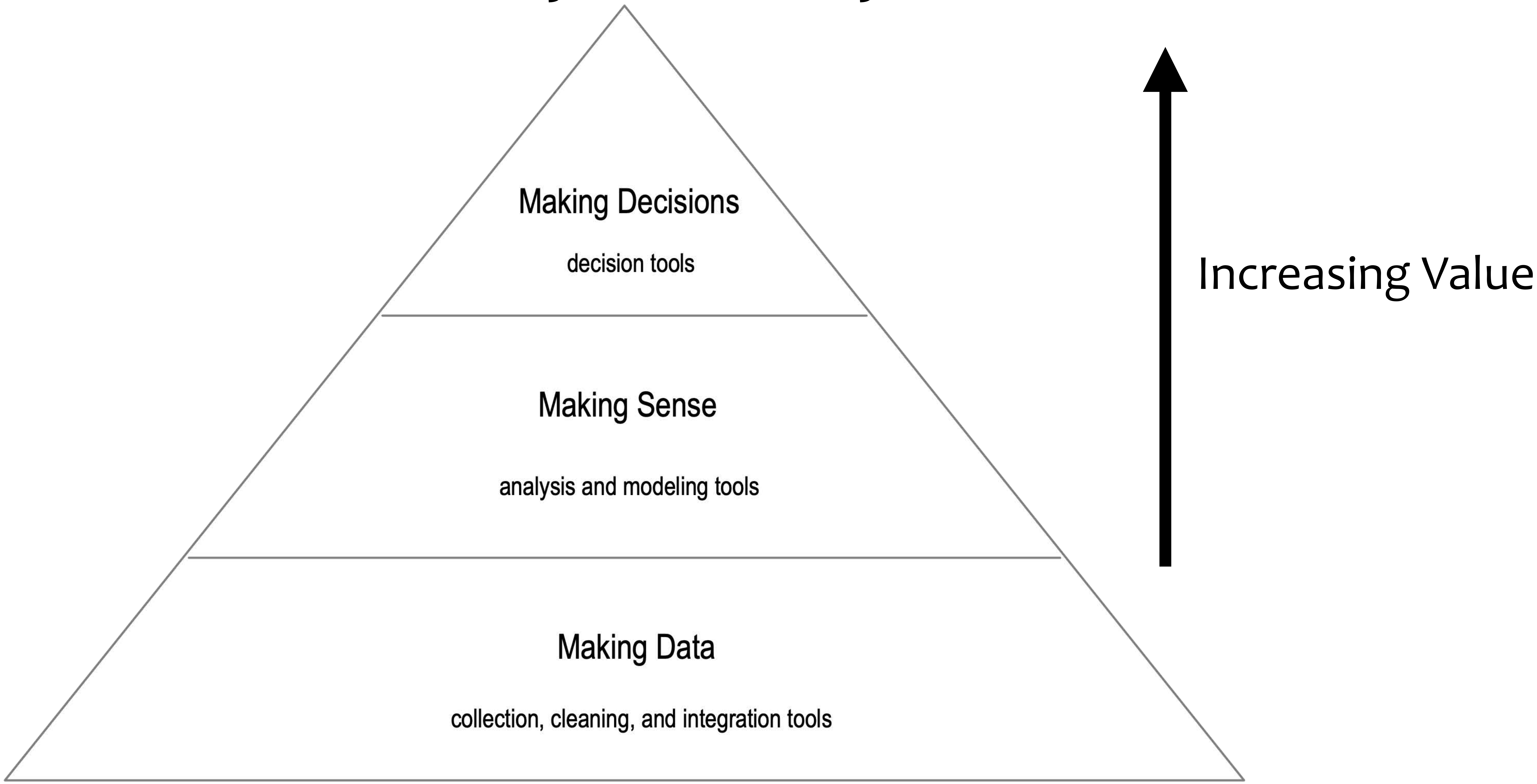
Charts

clean, aggregate, visualize, question

Records

collect, display, plumb

Activity Value Pyramid


Making Decisions
decision tools
Making Sense
analysis and modeling tools
Making Data
collection, cleaning, and integration tools
Increasing Value

Automated Reasoning = High Leverage Decision Making

Data Supply Chains

Cooperative Delegation

TADA^3 Mnemonic

T ail

A uthenticated

D elegatable

A ttenuable

A ggregatable

A uthorization