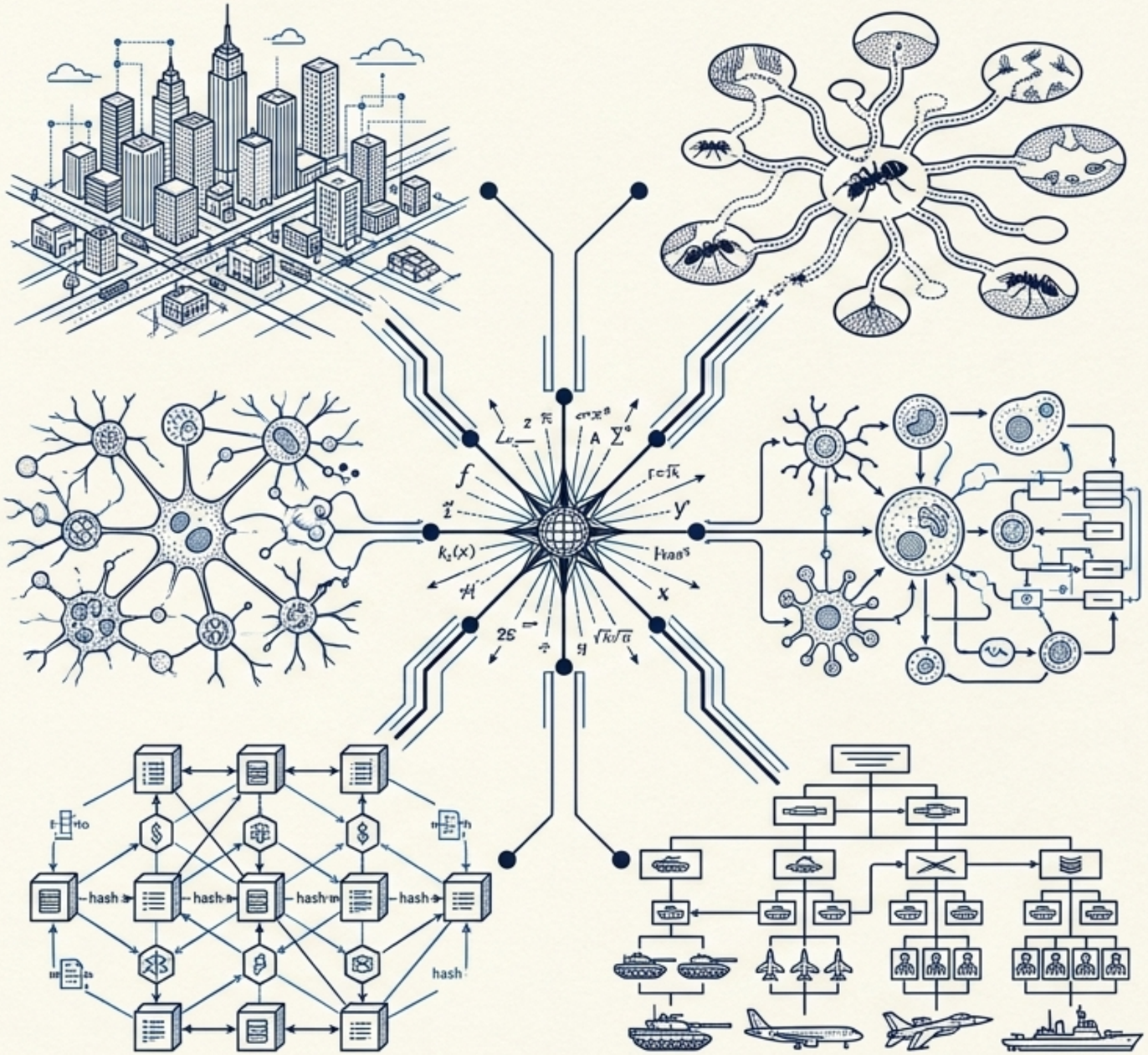
Coordination Foundation Models

From Enterprise Science to the Mathematical Theory of Coordination

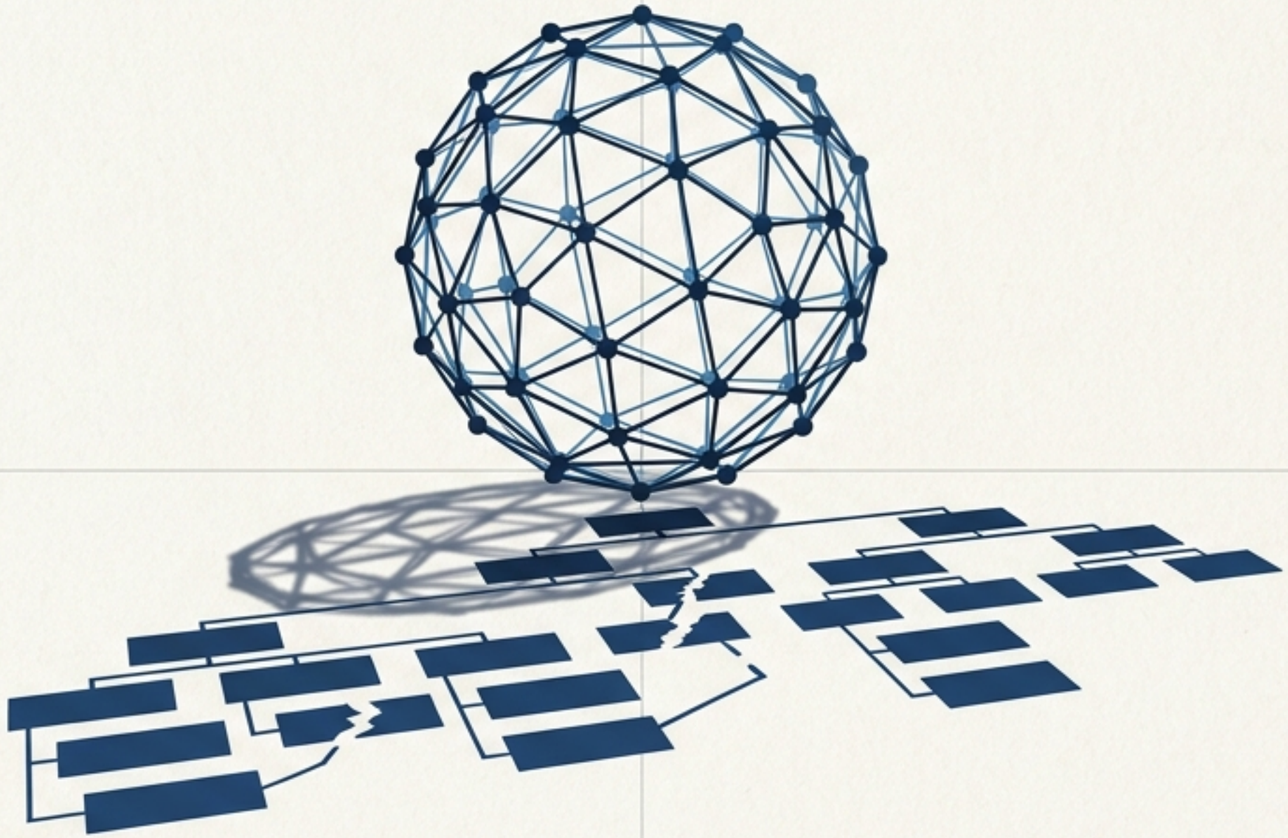
15	CHAPTERS
5	PRIMITIVES
30	PREDICTIONS
1	GRAND THEORY

Marco van Hurne | Eigenvector Research | First Edition — 2026



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STUDYING THE OBJECT, NOT THE SHADOW.

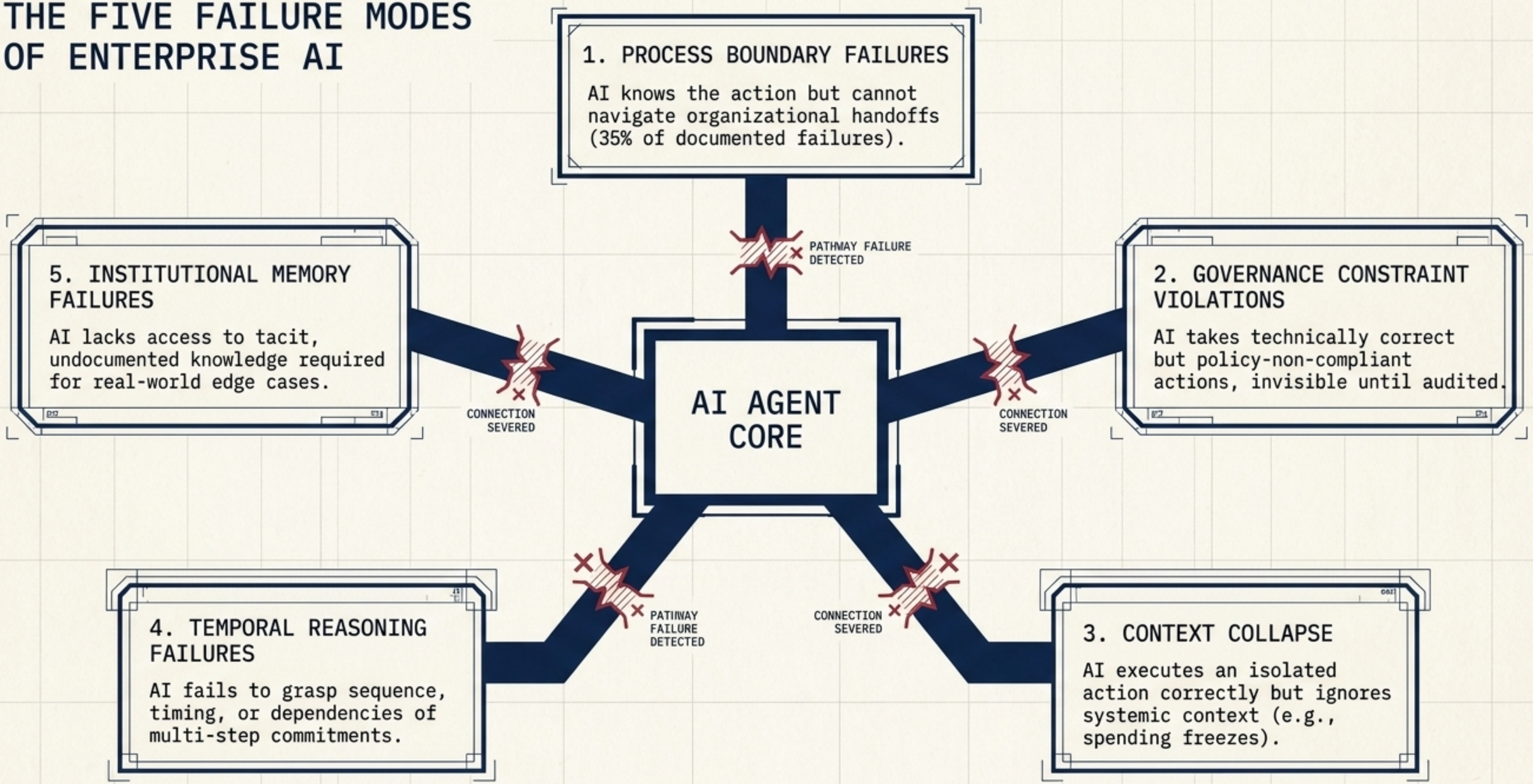


“THE ENTERPRISE IS NOT THE FUNDAMENTAL PHENOMENON. THE FUNDAMENTAL PHENOMENON IS COORDINATION.”

For thirty years, enterprise software, process mining, and organizational theory have studied domain-specific projections of a fundamental mathematical structure, mistaking the projections for the structure itself.

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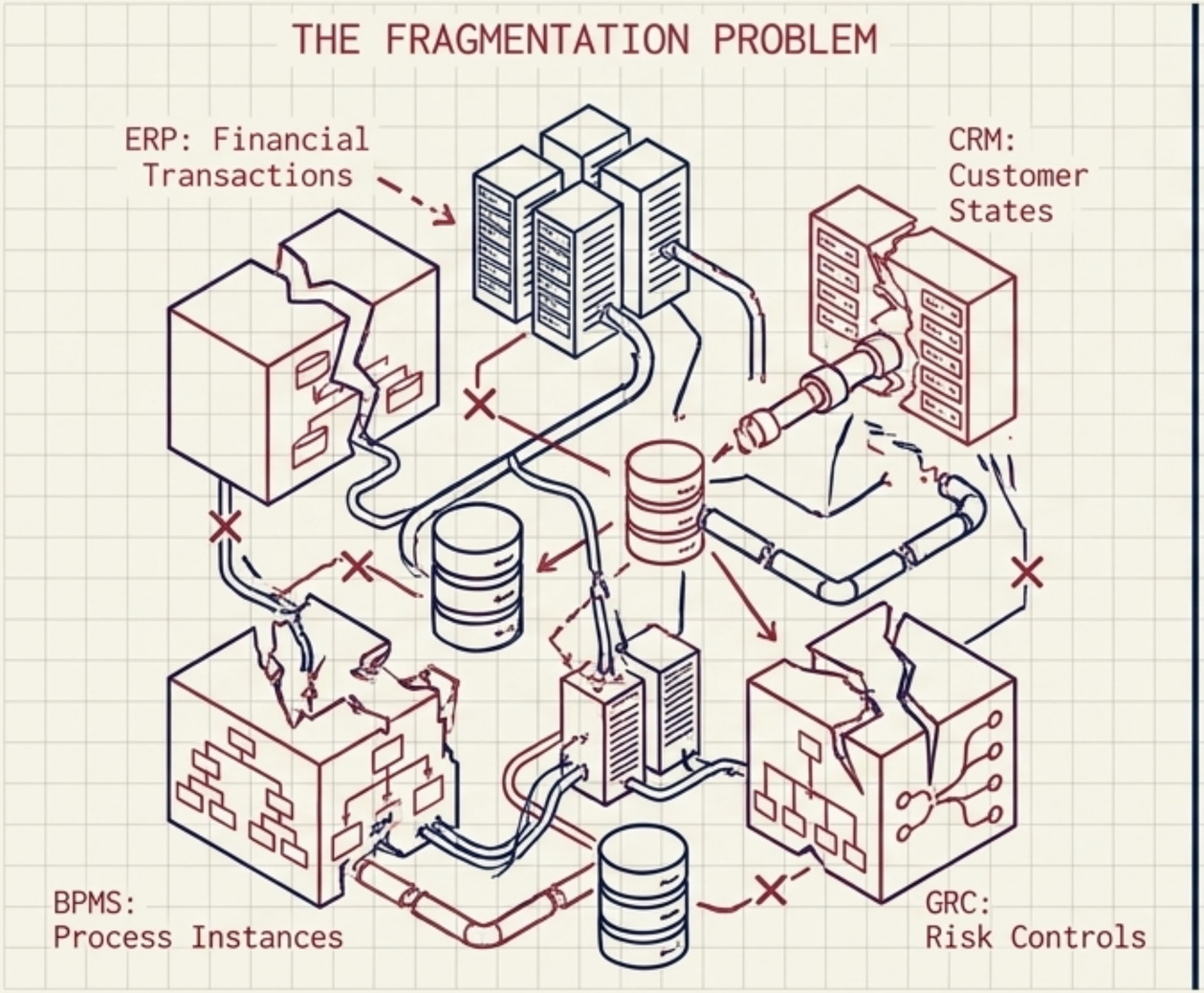
THE FIVE FAILURE MODES OF ENTERPRISE AI

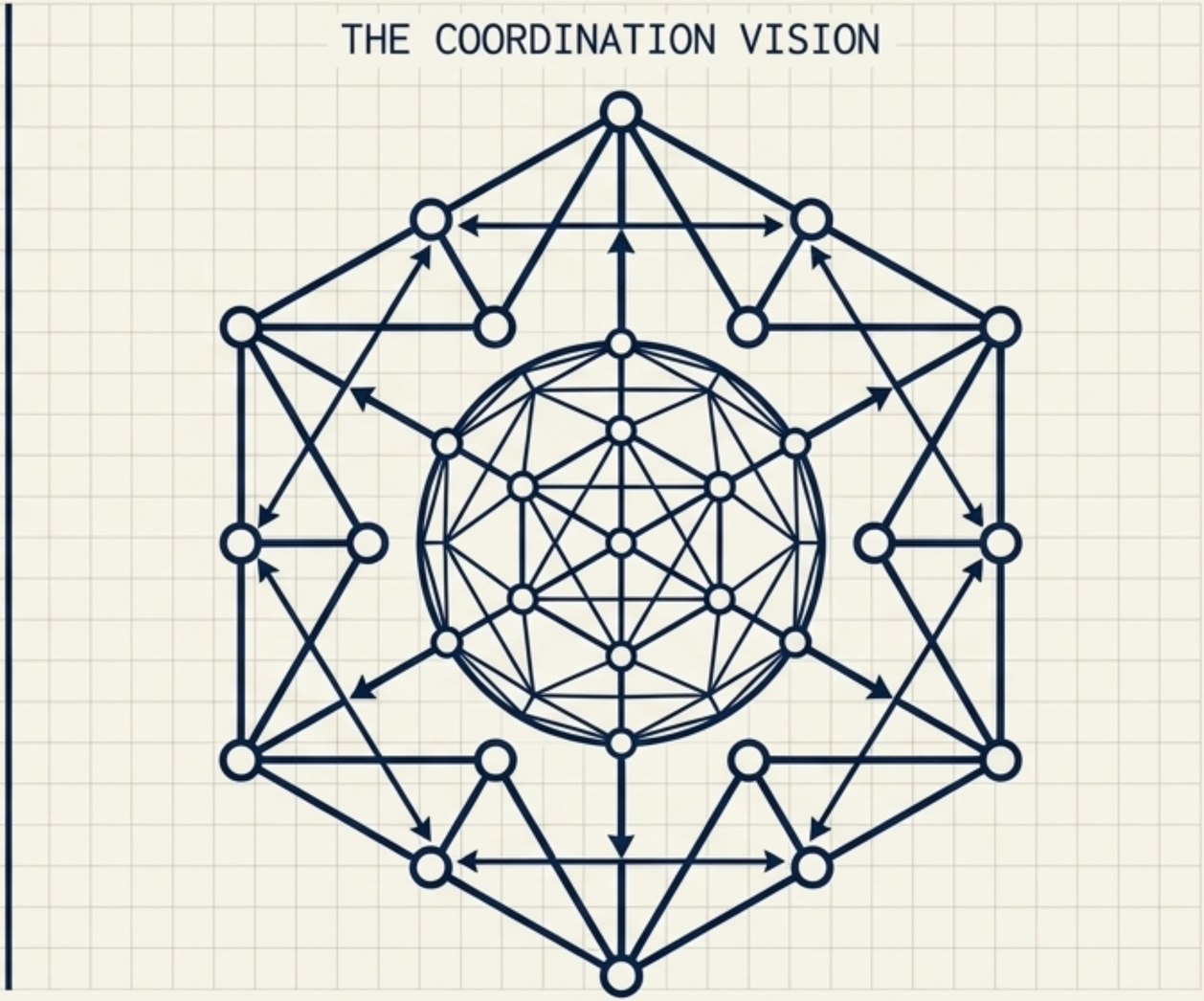


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THE FRAGMENTATION PROBLEM

Every enterprise system represents a different slice of reality using incompatible representations.
To survive, an AI must reconcile four incompatible realities without a shared theoretical foundation.





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THE LANGUAGE MODEL TRAP

■ THE ILLUSION:

Generating text that sounds like a business process is not organizational reasoning.

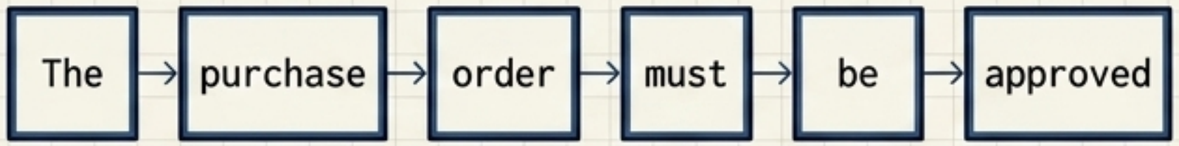
■ THE REALITY:

LLMs model token sequences. Organizations are networks of commitments constrained by policies.

■ THE RESULT:

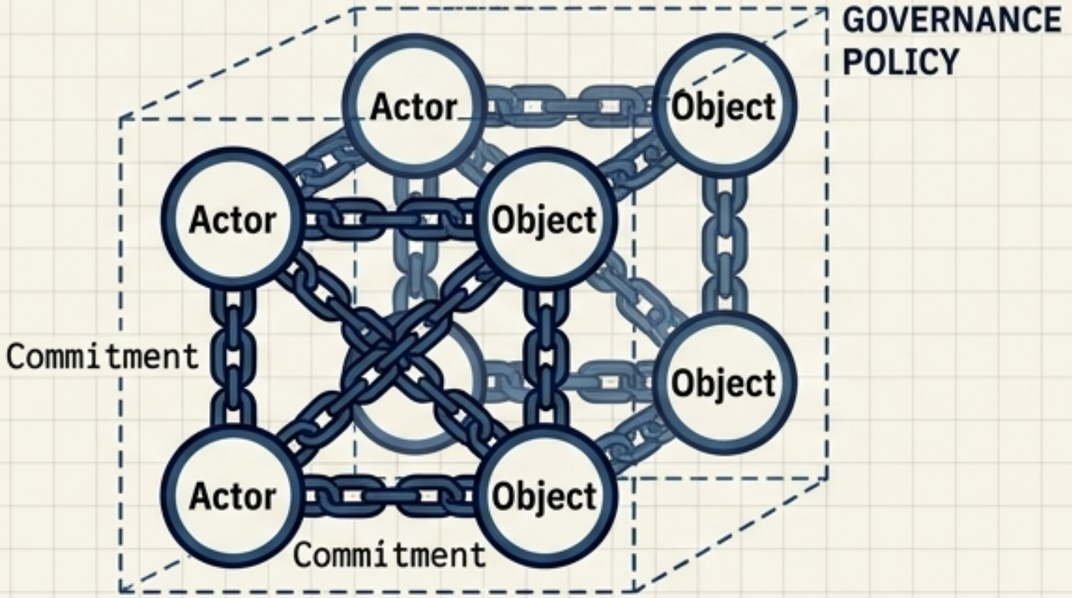
Systematic hallucinations of facts and native inability to enforce binding constraints.

STATISTICAL SEQUENCE MODELING



⚠ MODELS A SEQUENCE OF TOKENS.

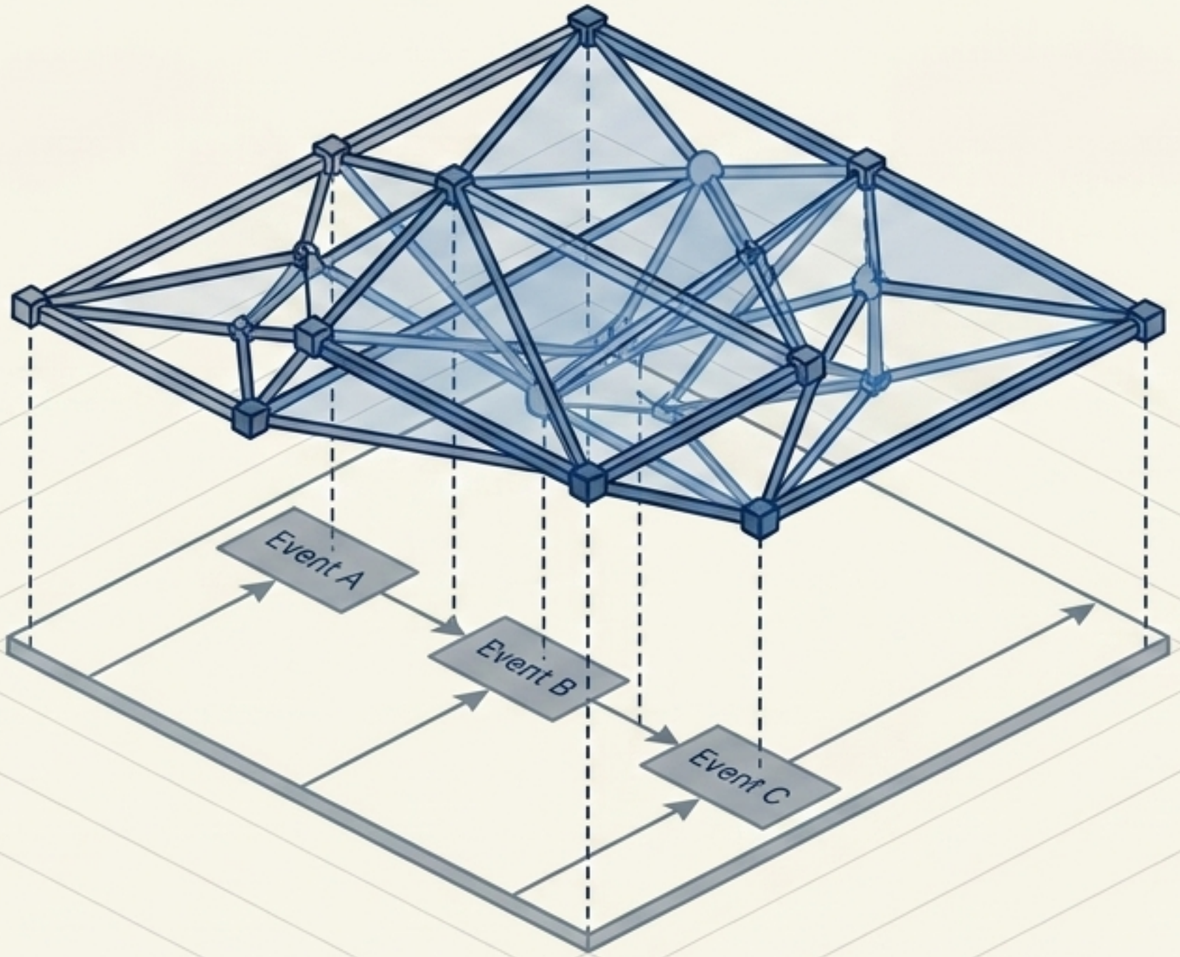
TOPOLOGICAL CONSTRAINT SATISFACTION



MODELS ORGANIZATIONAL REALITY

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THE PROCESS MINING PARTIAL SOLUTION



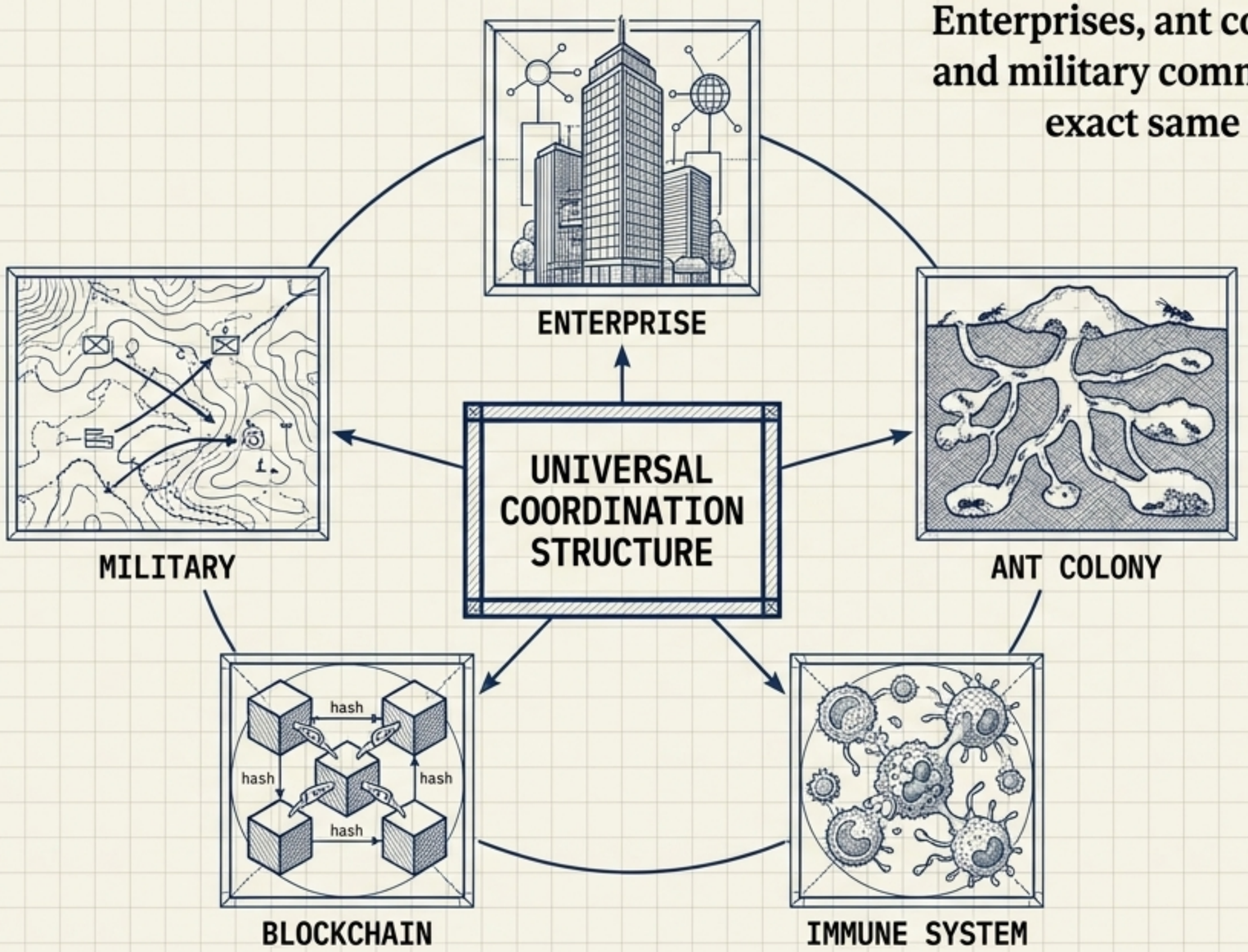
Coordination Science:
Models the "Why"
(Commitments & Constraints)

Process Mining:
Observes the
"What" (Sequence)

Process mining is a powerful empirical tool for measuring traces of coordination. However, it relies on formalisms that capture the sequential structure of processes, but not their coordination-theoretic content. It is a physics simulation without the laws of gravity.

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THE COORDINATION GENERALIZATION



Enterprises, ant colonies, immune systems, blockchains, and military command structures are all instances of the exact same underlying mathematical object.

THE 5 UNIVERSAL PROPERTIES

1. Multiple agents with limited info.
2. Shared environment with scarce resources.
3. Mechanisms for making/ fulfilling obligations.
4. Signals that trigger behavioral responses.
5. Constraints restricting permissible behaviors.

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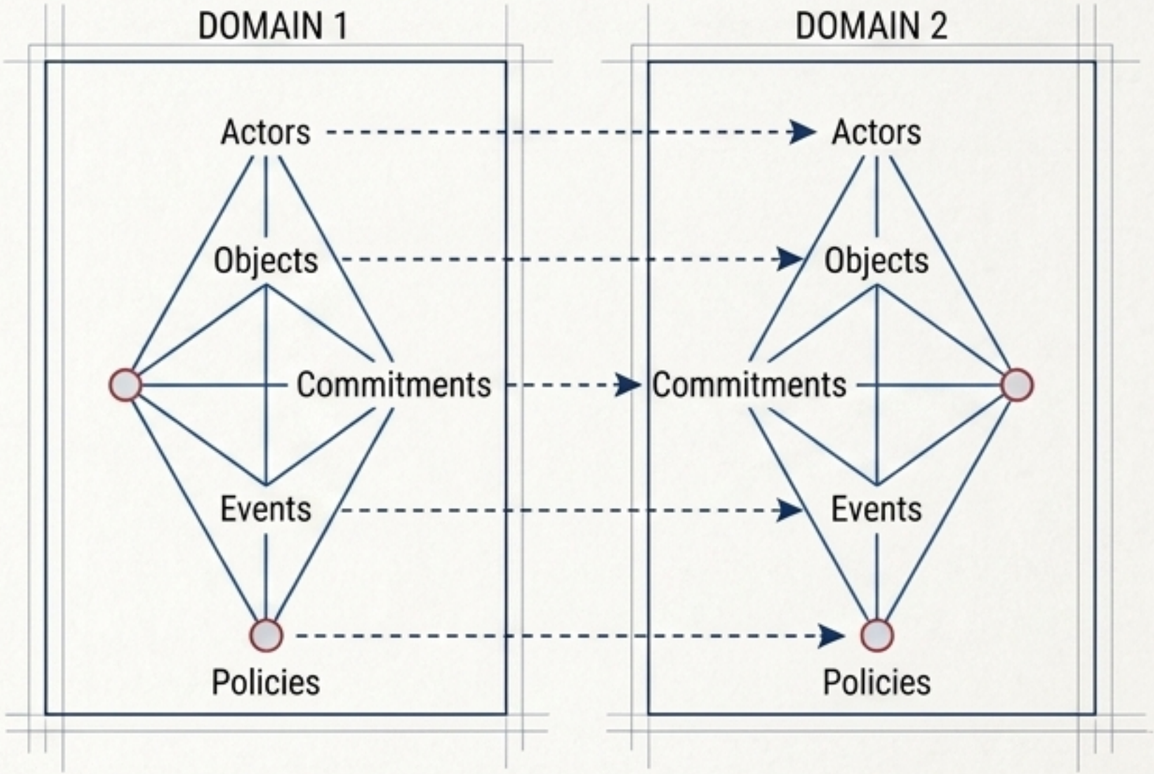
THE ISOMORPHISM THEOREM

Let D1 and D2 be two coordination domains, each described by a CTEC. A coordination isomorphism from D1 to D2 is a bijection f: CTEC(D1) → CTEC(D2) such that:

(1) f maps Actors to Actors, Objects to Objects, Commitments to Commitments, Events to Events, and Policies to Policies.

(2) f preserves composition.

(3) f preserves governance constraints.



Conclusion: All five coordination domains are pairwise isomorphic. Knowledge learned in one transfers mathematically to all others.

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THE UNIVERSAL GRAMMAR OF COORDINATION

THE MORPHOLOGICAL MATRIX

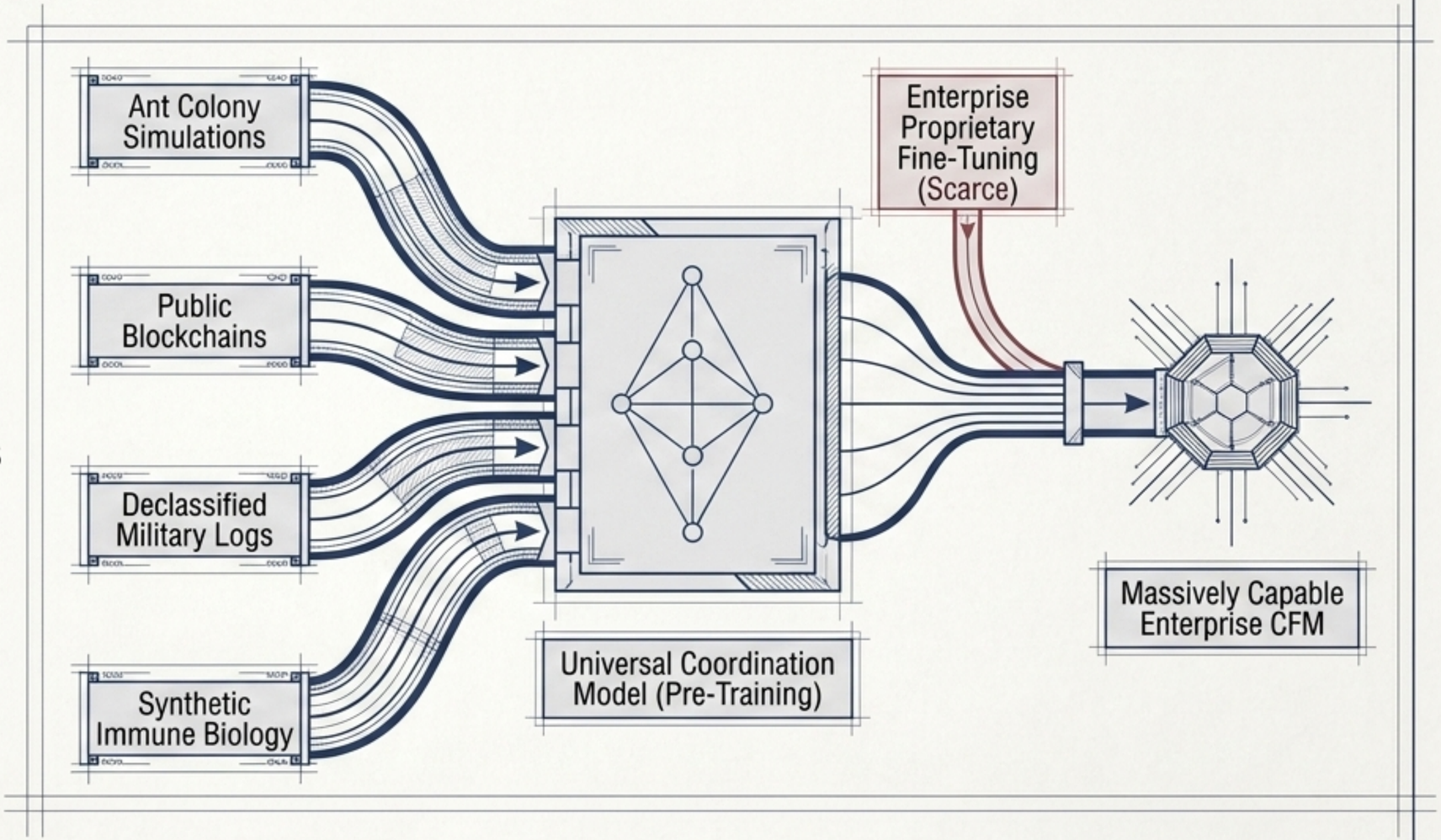
DOMAIN	ACTOR	OBJECT	COMMITMENT	EVENT	POLICY
Enterprise	Employees / Bots	Invoices / Projects	Contracts / SLAs	Payments / Approvals	Compliance / Access
Ant Colony	Specialized Ants	Pheromones / Food	Chemical Trails	Chemical Signals	Epigenetic Rules
Immune System	T-Cells / B-Cells	Antigens / Cytokines	Cellular Activation	Molecular Signals	Immune Tolerance
Blockchain	Nodes / Wallets	Tokens / Contracts	Cryptographic Signatures	Block Confirmations	Consensus Rules
Military	Command Units	Resources / Terrain	Orders / Acknowledgments	Battlefield Reports	Rules of Engagement

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Solving the Data Scarcity Problem

The Coordination Transfer Hypothesis: Enterprise data is proprietary and scarce. Non-enterprise coordination data is infinitely abundant.

The Mechanism: Pre-training on blockchains and biological simulations teaches the AI the universal structure. Enterprise fine-tuning becomes exponentially more efficient.



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The Search for the Mathematical Object

Evaluating 13 Formalisms for Coordination Science

Formalism	Expressiveness	Compositionality	Computability	Learnability	Interpretability	Fatal Flaw
Petri Nets	◑ [Med]	● [High]	● [High]	◑ [Med]	● [High]	Cannot represent typed entities or policies.
Bayesian Networks	◑ [Med]	◑ [Med]	● [High]	● [High]	● [High]	Lacks natural composition operations.
Category Theory (Winner)	● [High]	● [High]	◑ [Medium]	● [High]	● [High]	None. Computability solved via CTEC.

Conclusion: Category Theory wins. It is the only formalism capable of mapping multiple entity types, relationships, and abstractions without losing topological structure.

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Enter the CTEC

The Constrained Typed Evolving Category

Ç (Category): Objects are coordination states; morphisms are transitions/events.

T (Type System): Assigns the 5 primitive types (Actor, Object, Commitment, Event, Policy).

$$(Ç, T, K, \Phi)$$

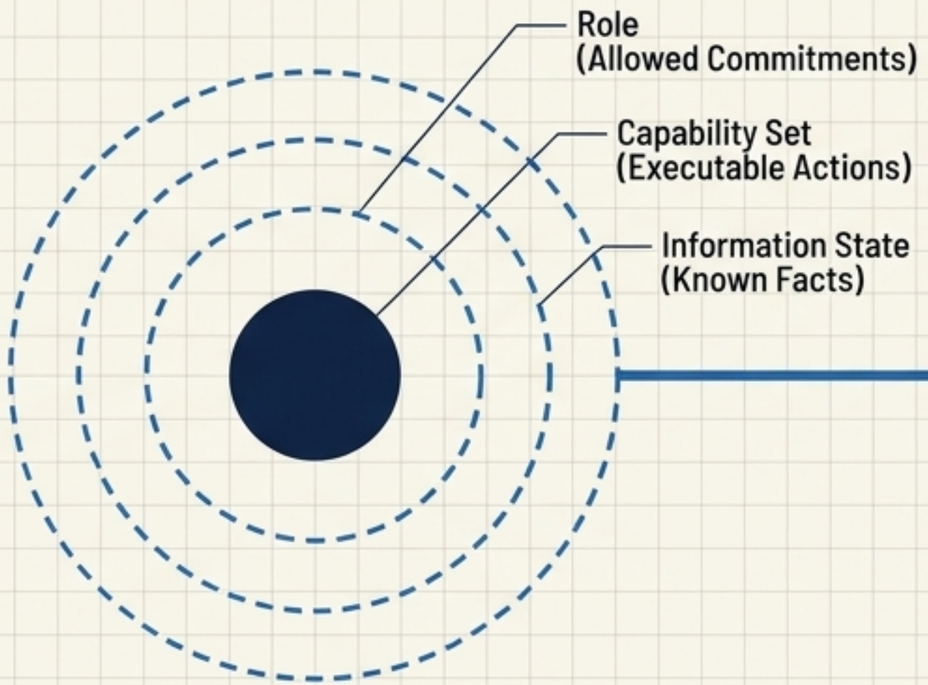
K (Governance): A strict subcategory of constraints restricting valid states (the rules of the game).

Φ (Evolution Function): Maps time points to CTECs, capturing organizational change over time.

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Primitives I & II: The Entities

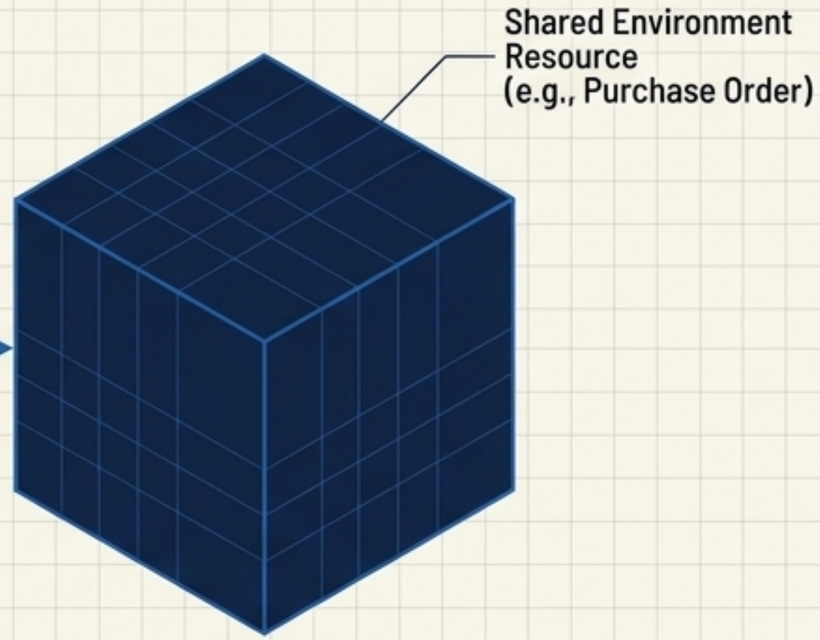
The Actor



Actor Node

Actor: Any entity (human or bot) that makes commitments, fulfills them, and responds to events.

The Object

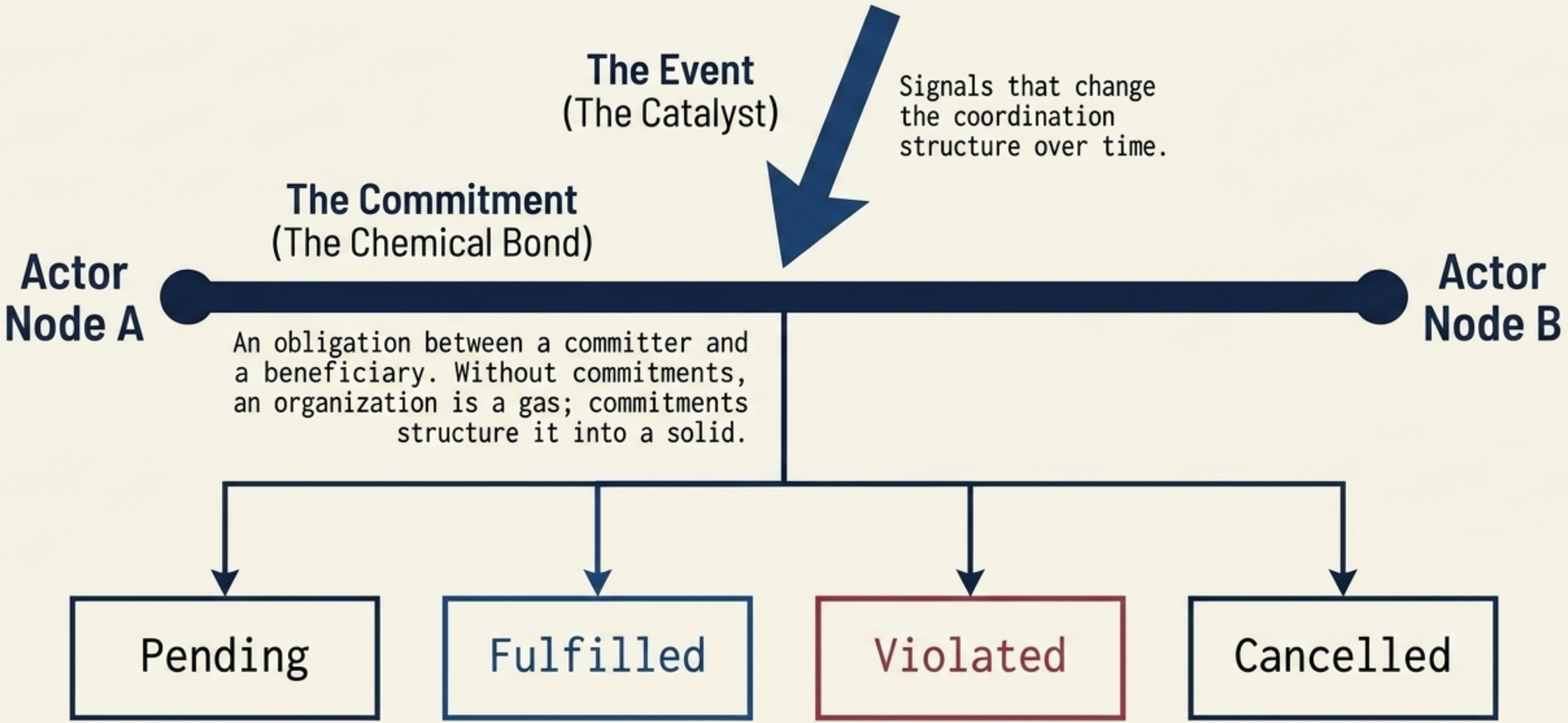


Object Node

Object: The shared environment entities that coordination events act upon. Required to reason about resource allocation.

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Primitives III & IV: The Dynamics



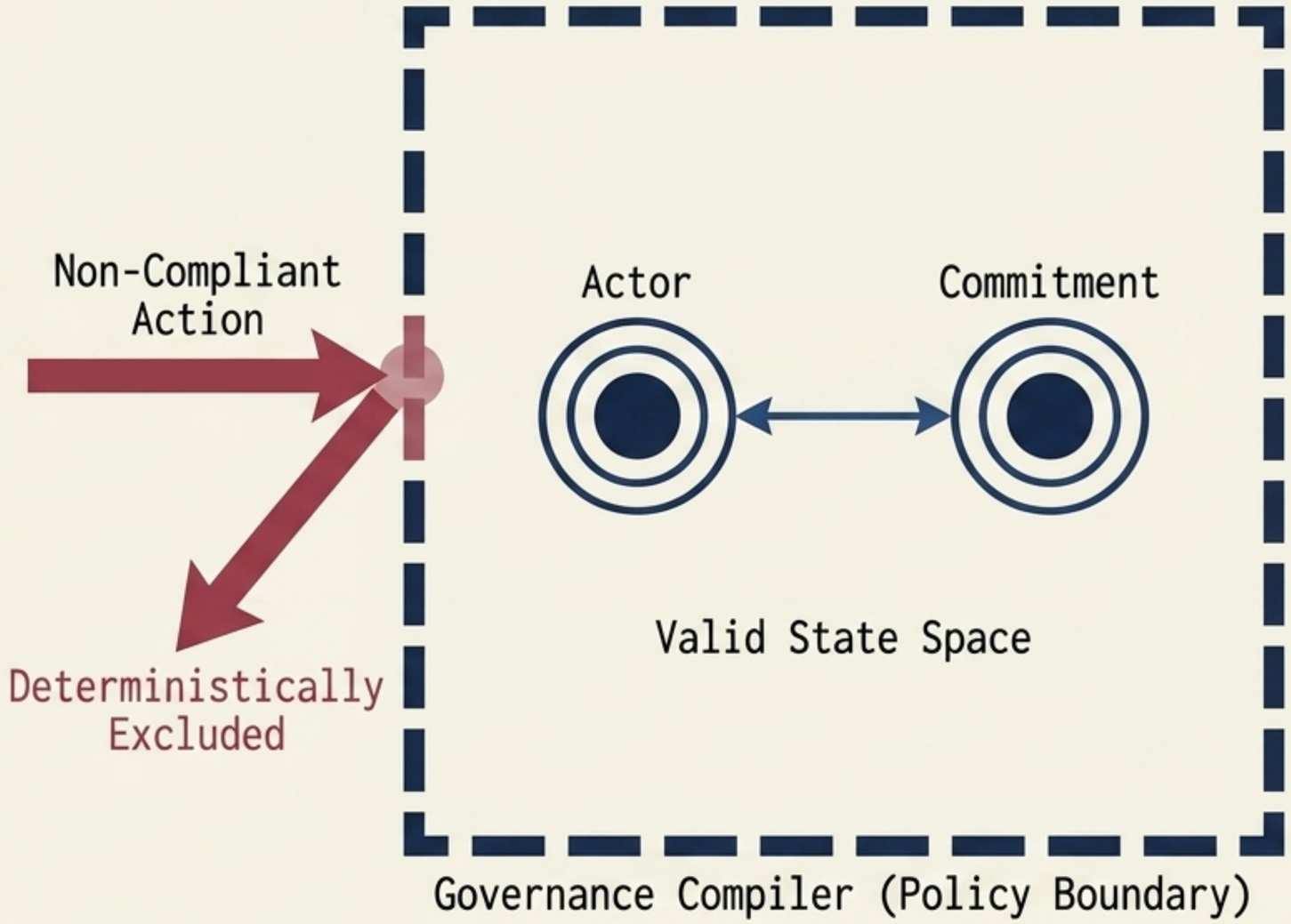
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Primitive V: Policy (The Laws of Physics)

Policies are governance constraints that restrict the set of valid states. They are the organizational analog to the laws of physics.

The LLM Flaw: Relies on statistical prompting (a tendency to avoid violations).

The CFM Solution: Utilizes a Governance Compiler. Policies are enforced deterministically. Non-compliant actions are mathematically outside the reachable state space.



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Enterprise Physics

Do Organizations Have Laws?

Criteria for a Scientific Law

- [x] Universality
- [x] Falsifiability
- [x] Explanatory Power
- [x] Predictive Power

Evaluating Candidates

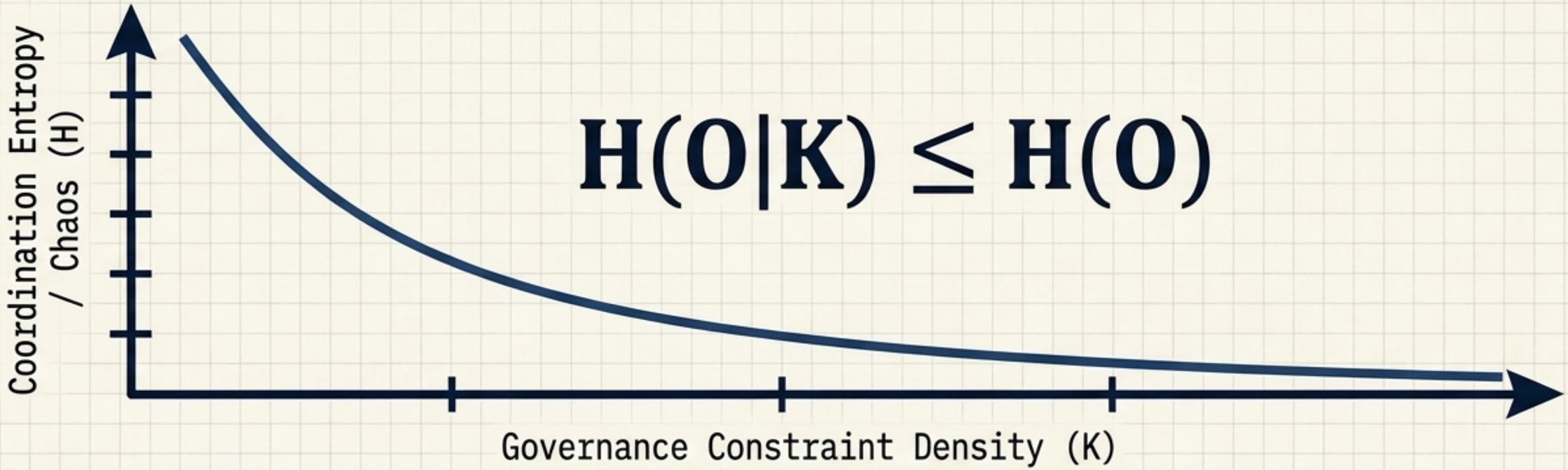
1. ~~Law of Process Emergence~~
   Definitional truth, not a law.
2. ~~Law of Organizational Inertia~~
   Attractor resistance.
3. ~~Noether's Theorem Analog~~
   Actor substitution symmetry.

The Coordination Entropy Law

The Ultimate Winner. Genuine Law.

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The Coordination Entropy Law



$$H(O|K) \leq H(O)$$

The Law:

Just as the Second Law of Thermodynamics dictates physical entropy, this mathematical proof shows that governance constraints always reduce organizational chaos.

The Optimality Catch:

While infinite governance yields zero entropy, it creates infinite communication overhead. The optimal structure minimizes both entropy and overhead.

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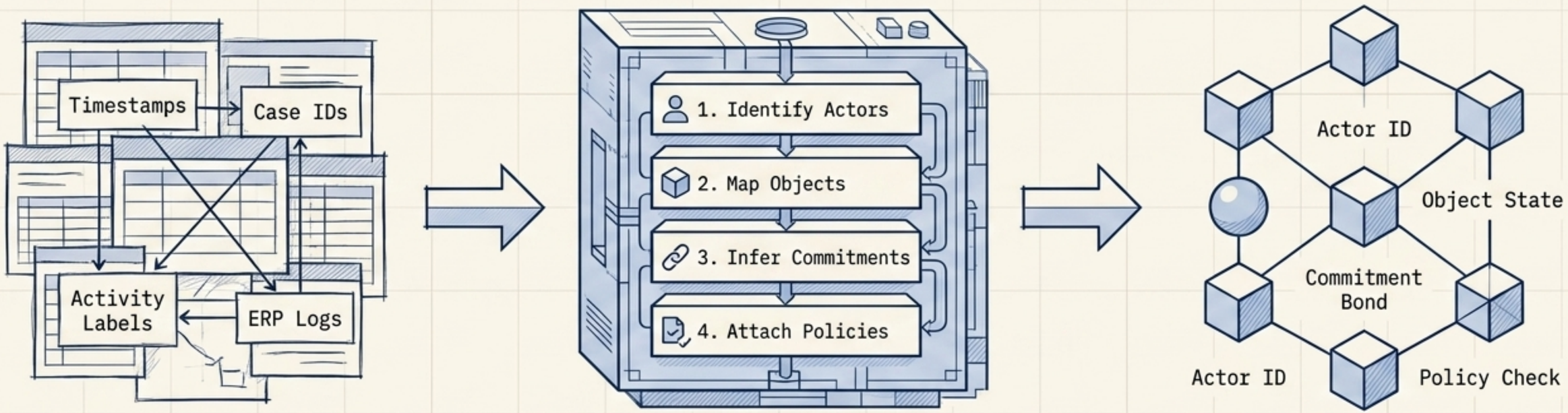
The Measurement Bridge

Category theory is abstract. To train a model, we map observable, messy enterprise phenomena into pristine categorical structures.

Stage 1
Messy Reality

Stage 2
The Measurement Bridge

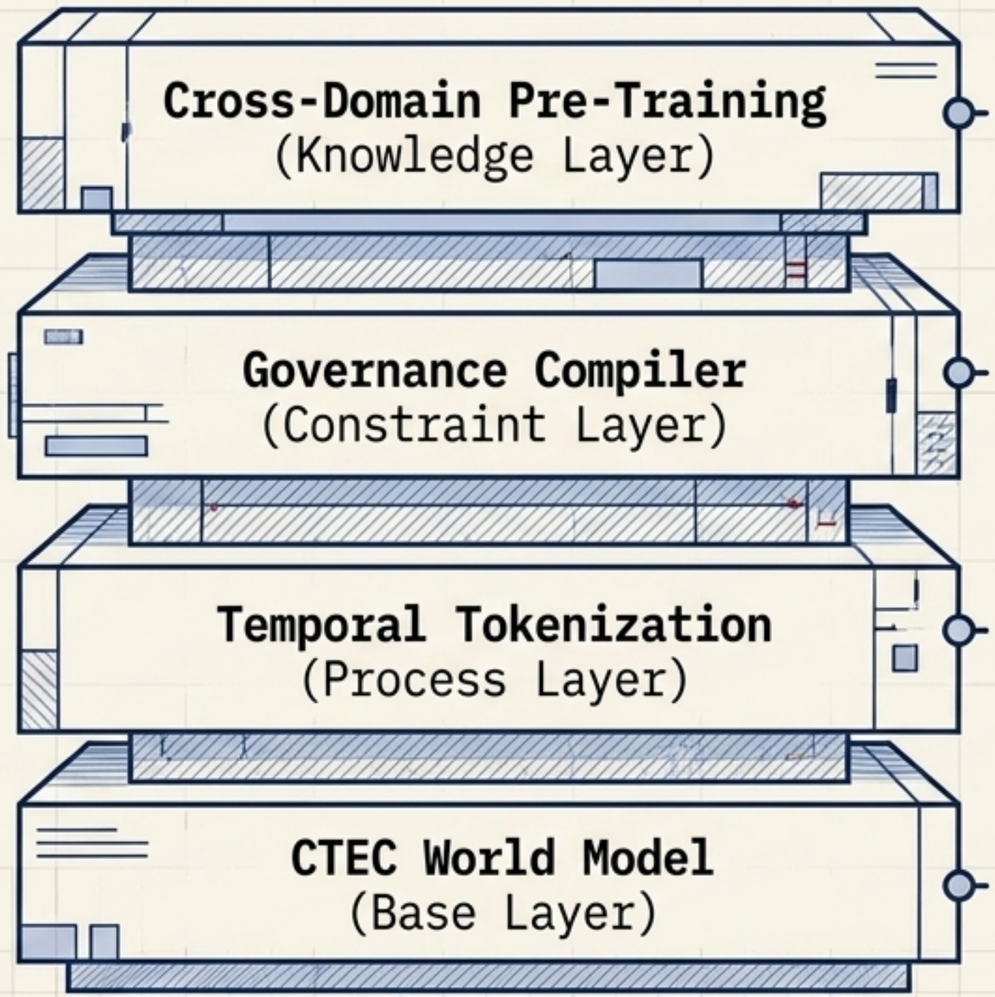
Stage 3
CTEC Tokens



Ready for AI Ingestion

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The CFM Architecture (Synthesis)



Solves Institutional Memory Gap (Model infers missing logic via universal transfer).

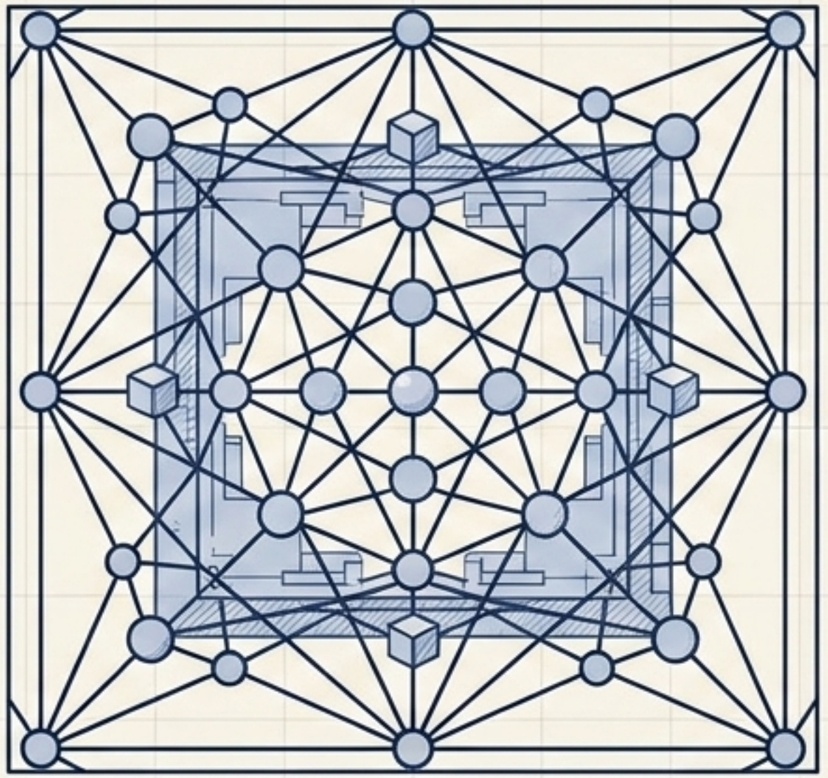
Solves Governance Violations (Deterministic enforcement prevents policy breaches).

Solves Temporal & Process Boundary Failures (Agent grasps sequences and handoffs).

Solves Context Collapse (Agent understands organizational state).

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The Future is Coordination Science



The next generation of Enterprise AI will not be built on systems that model language. It will be built on systems that mathematically understand the obligations, constraints, and events that bind human endeavor together.

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