Anonymous Institution anon@example.com

KAPnet: A Semantic Coordination Substrate for Post-Consensus Distributed Systems

Anonymous Author(s)

February 2026

Abstract

KAPnet is a semantic coordination substrate designed to extend proof-of-work networks beyond monetary consensus into generalized human–machine coordination. By treating nodes as semantic routers and decentralized autonomous organizations (DAOs) as the sole data type, KAPnet enables decentralized governance, distributed cognition, and composable coordination markets. This paper formalizes the architecture, mathematical models, game-theoretic properties, and protocol specifications necessary to evaluate KAPnet as a coordination layer for decentralized societies.

1 Introduction

Proof-of-work systems provide robust consensus but lack native coordination primitives. KAPnet introduces a semantic layer enabling structured intent routing, DAO-native governance, and attention-weighted coordination markets.

2 Architecture Overview

2.1 Layered Model

ASCII fallback:

```
Human & Machine Agents
DAO Applications
KAPnet Coordination Layer
Proof-of-Work Base Layer
```

3 Node Architecture

ASCII fallback:

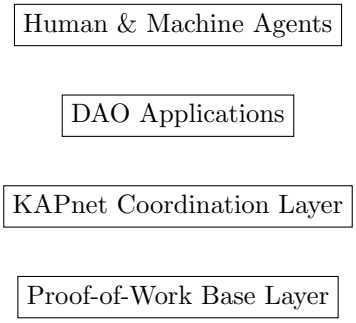

Figure 1: KAPnet layered architecture.

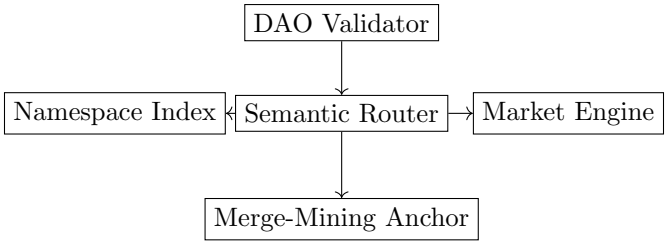

Figure 2: KAPnet node architecture.

```
        DAO Validator
             |
       Semantic Router
      /       |       \
Namespace   Market   Anchor
```

4 DAO State Machine

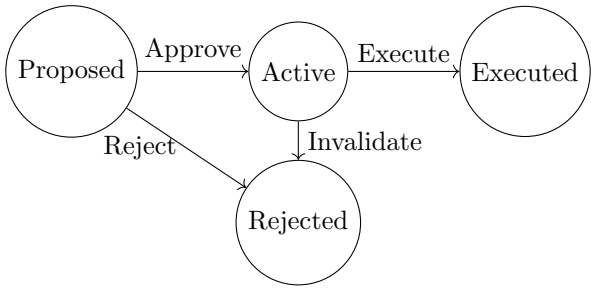

Figure 3: DAO proposal lifecycle.

ASCII fallback:

```
Proposed --> Active --> Executed
    |           |
    v           v
 Rejected <-----
```

5 Merge-Mining Coordination Tags

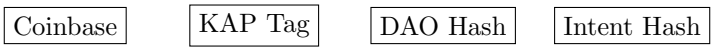

Figure 4: Merge-mining coordination tag structure.

ASCII fallback:

```
[Coinbase][KAP Tag][DAO Hash][Intent Hash]
```

6 Architecture Overview

6.1 Layered Model

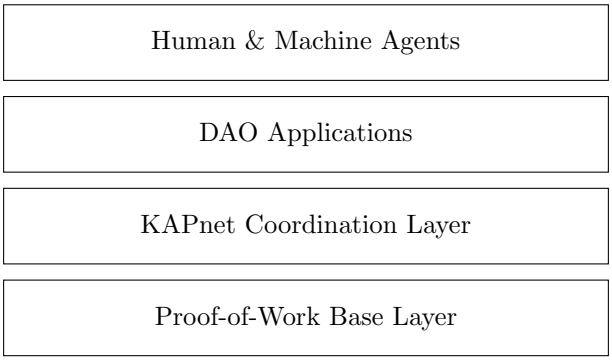

Figure 5: KAPnet layered architecture.

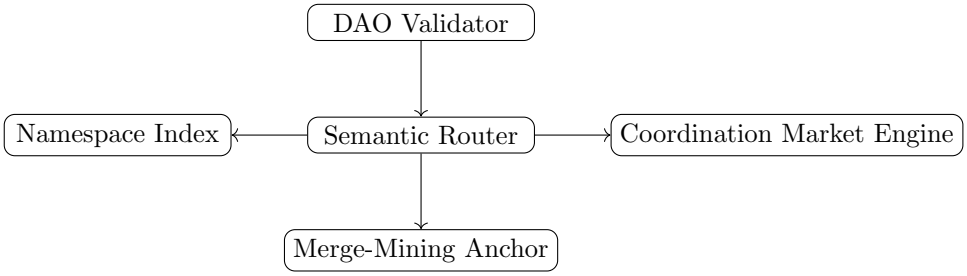

Figure 6: KAPnet node architecture.

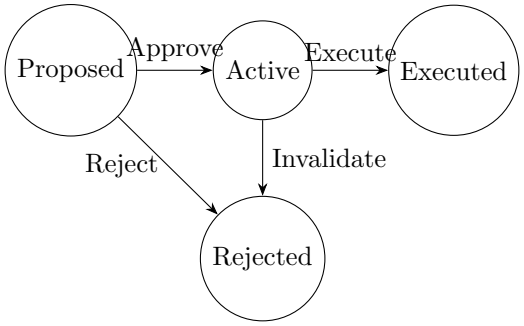

Figure 7: DAO proposal lifecycle.

7 Node Architecture

8 DAO State Machine

9 Merge-Mining Coordination Tags

10 Mathematical Model of Weak Work

Weak Work (WW) is a cost function used to prioritize coordination intents.

10.1 Definition

Let:

$$WW_i = \frac{H_i}{R_i + \epsilon}$$

Where:

- H_i = computational effort expended
- R_i = reputation weight

Figure 8: Merge-mining coordination tag structure.

- ϵ = Sybil resistance constant

Lower WW_i indicates higher priority.

10.2 Properties

- Sybil resistance via reputation denominator
- Incentivizes efficient signaling
- Compatible with off-chain ordering

11 Game-Theoretic Analysis

11.1 Coordination Market as a Signaling Game

Players:

- DAOs (signal demand)
- Participants (signal supply)
- Nodes (order signals)

11.2 Equilibrium Properties

Proposition 1: Honest signaling is a Nash equilibrium when reputation impacts future coordination access.

Sketch: Participants maximize long-term coordination rewards by maintaining reputation, discouraging spam.

11.3 Attack Analysis

Sybil Attack Cost:

$$Cost_{sybil} = n \cdot \epsilon$$

Where n is number of identities required to influence ordering.

12 Formal Protocol Specification

12.1 DAO Object

```
DAO {
  id: Hash,
  members: MerkleRoot,
  rules: Script,
  treasury: UTXO_Set,
  state: StateRoot
}
```

12.2 Coordination Intent

```
Intent {
  dao_id: Hash,
  action: Script,
  hedls: uint64,
  weak_work: uint64,
  signature: Schnorr
}
```

13 Coordination Market Workflow

1. DAO publishes intent.
2. Participants signal HEDL-bits.
3. Weak Work orders intents.
4. Merge-mined tag anchors coordination.
5. DAO executes state transition.

14 Security Analysis

14.1 Threat Model

- Sybil signaling
- Namespace capture
- DAO governance collusion

14.2 Mitigations

- Reputation weighting
- Weak Work cost functions
- Proof-of-Work anchoring

15 Distributed Cognition

KAPnet enables modular task decomposition via DAO-mediated workflows.

15.1 Corning Crowds Model

Large problems are divided into independent micro-coordination units.

16 Evaluation Metrics

- Coordination throughput
- Intent latency
- Namespace scalability
- Sybil resistance cost

17 Future Research Directions

- Formal verification of DAO scripts
- Namespace routing algorithms
- Hardware wallet DAO interfaces
- Cognitive market efficiency
- Cross-chain coordination membranes

18 Conclusion

KAPnet redefines proof-of-work networks as coordination substrates. By introducing semantic routing, DAO-native governance, and attention-weighted markets, it provides a foundation for decentralized societies and distributed cognition.

References

[1] S. Nakamoto. Bitcoin: A Peer-to-Peer Electronic Cash System. 2008.

[2] V. Buterin. Ethereum Whitepaper. 2014.

A Protocol Message Formats

A.1 Merge-Mining Tag Encoding

```
KAP_TAG = OP_RETURN <version> <dao_hash> <intent_hash>
```

B Weak Work Parameter Recommendations

- $\epsilon = 10^{-6}$
- Reputation decay: exponential
- HEDL emission: logarithmic scaling