

M E N D E L

P R O T O C O L

A Coordination Layer for Verifiable AI Task Outputs

Technical Whitepaper

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1. Abstract

Mendel is a protocol designed to coordinate the exchange of verifiable AI task outputs. As artificial intelligence systems become increasingly embedded in commercial and industrial workflows, the volume of computational work performed by these systems continues to grow. A significant portion of this work is redundant: identical or near-identical tasks are executed independently by separate parties, consuming resources without producing novel value. Mendel addresses this inefficiency by introducing a structured marketplace where AI-generated outputs can be listed, discovered, priced, and settled between participants.

The protocol operates as a coordination layer rather than as an execution environment. Mendel does not run AI models, host inference infrastructure, or manage compute resources directly. Instead, it provides the mechanisms by which outputs produced by external AI systems can be packaged with minimal verification proofs, listed on a marketplace, and transacted using the MENDEL token as the unit of settlement. On-chain activity is limited to anchoring cryptographic proofs and recording settlement finality, while the bulk of data exchange and task metadata is handled off-chain.

The core objective of the Mendel protocol is to reduce redundant AI task recomputation across participants in a shared economy. By enabling the resale and licensing of previously computed outputs, Mendel introduces a secondary market for AI work products. This has the potential to lower aggregate compute expenditure, improve access to high-quality outputs for smaller participants, and establish price discovery mechanisms for AI-generated work. The protocol is designed to be model-agnostic, chain-minimal, and extensible, with a fixed-supply ERC-20 token serving as the sole medium of settlement and access within the system.

This document describes the architecture, mechanisms, token economics, and development trajectory of the Mendel protocol. It is intended as a technical reference and does not constitute financial advice, a solicitation of investment, or a guarantee of any particular outcome.

2. Problem Statement

2.1 Redundant Computation in AI Workflows

Modern AI systems are increasingly tasked with producing structured outputs: summaries, classifications, translations, embeddings, predictions, code generations, image analyses, and other forms of machine-generated work. In many cases, these tasks are not unique to a single requester. Multiple organizations or individuals may independently submit identical or functionally equivalent prompts to inference providers, each paying the full cost of computation for a result that has already been produced elsewhere.

This redundancy is a direct consequence of the current AI services model, which operates predominantly on a request-response basis. Each API call is treated as an isolated transaction. There is no persistent layer through which previously computed results can be discovered, verified, and reused. The result is systemic waste: computational resources are expended repeatedly to produce outputs that already exist in equivalent form.

2.2 Absence of a Verification and Exchange Layer

Even where parties might be willing to exchange AI outputs rather than recompute them, no standardized mechanism exists to facilitate this. The challenges are threefold. First, there is no common format for packaging AI outputs with sufficient metadata to allow a prospective buyer to evaluate relevance and quality without accessing the full output. Second, there is no trust layer that allows a buyer to verify that an output was produced by a specific model, under specific parameters, without requiring the buyer to re-execute the task. Third, there is no settlement infrastructure purpose-built for this type of exchange.

Existing marketplaces for digital goods are not well-suited to this problem. General-purpose data marketplaces lack the schema specificity required for AI task outputs. Blockchain-based compute networks focus on execution rather than output exchange. API aggregators provide access to inference but not to previously generated results. The gap is structural: what is missing is a protocol-level coordination layer that connects output producers with output consumers, anchored by verifiable proofs and settled through a dedicated token.

2.3 Pricing Opacity

The cost of AI inference is determined by providers on a per-token or per-request basis, but the market value of a specific output is rarely reflected in these prices. A complex analytical report and a trivial text completion may cost similar amounts to generate but differ dramatically in downstream utility. Without a marketplace that enables price discovery based on output characteristics, there is no mechanism for the market to allocate value to AI work products according to their actual utility.

Mendel is designed to address these three problems: redundant computation, the absence of a verification and exchange layer, and pricing opacity for AI-generated outputs.

3. Protocol Architecture

3.1 Design Principles

The Mendel protocol is built on several foundational design principles. The first is chain-minimalism: on-chain activity is restricted to what is strictly necessary for trust and finality, specifically the anchoring of cryptographic proofs and the recording of settlement transactions. All other operations, including output storage, metadata indexing, and search, occur off-chain. This approach minimizes gas costs, reduces latency, and avoids burdening the base layer with data that does not require the security guarantees of a blockchain.

The second principle is model agnosticism. Mendel does not prescribe or require any specific AI model, framework, or inference provider. Outputs from any model can be listed on the protocol, provided they conform to the required metadata schema and are accompanied by a valid proof structure. This ensures broad compatibility and avoids vendor lock-in at the protocol level.

The third principle is composability. The protocol is designed so that its components, including the proof anchoring mechanism, the marketplace indexer, and the settlement logic, can be upgraded, extended, or replaced independently. This modular architecture supports long-term adaptability as both AI capabilities and blockchain infrastructure evolve.

3.2 Layer Structure

Mendel operates across three conceptual layers. The settlement layer is where the MENDEL ERC-20 token contract is deployed and where proof anchors and settlement records are stored. The coordination layer is an off-chain system responsible for indexing listed outputs, managing metadata, facilitating search and discovery, and orchestrating the handshake between buyers and sellers. The client layer consists of the tools and interfaces through which participants interact with the protocol, including SDKs, APIs, and front-end applications.

The settlement layer handles only two categories of on-chain transactions: proof anchoring and token transfers. Proof anchoring involves storing a cryptographic hash that commits to the content of an AI output, along with relevant metadata such as the model identifier, task type, and timestamp. Token transfers occur when a buyer purchases access to a listed output, at which point MENDEL tokens are transferred from the buyer to the seller according to the listed price, minus any applicable protocol fees.

3.3 Proof Structure

Each output listed on the Mendel marketplace is accompanied by a proof package. This package includes a content hash derived from the full output, a metadata descriptor specifying the model used, the task type, input parameters (or a hash thereof), and the timestamp of generation. Where available, it may also include provider attestation data, such as a signed response from an inference API that confirms the output was generated by the claimed model and provider.

The proof package is designed to be lightweight. Only the content hash and a compact metadata fingerprint are anchored on-chain. The full proof package is stored off-chain and made available to prospective buyers during the discovery phase. This design balances verifiability with cost efficiency: the on-chain anchor provides a tamper-evident commitment, while the off-chain package provides the detail needed for informed purchasing decisions.

It is important to note that this proof structure provides cryptographic commitment to output integrity, not a guarantee of output correctness. The protocol can verify that an output has not been altered since it was listed and that the listed metadata is consistent with the anchored proof. It cannot independently verify that the output was produced by a specific model without cooperation from the inference provider. Future extensions may incorporate more robust attestation mechanisms as they become available, but the current design is intentionally conservative in the claims it makes about verification.

4. Marketplace Mechanism

4.1 Listing Process

A seller on the Mendel marketplace is any party that has produced an AI output and wishes to make it available for purchase. To list an output, the seller submits the output along with its proof package to the coordination layer. The coordination layer validates the proof structure, indexes the metadata, and publishes the listing to the marketplace. Simultaneously, the content hash and metadata fingerprint are anchored on the settlement layer. The seller sets a price denominated in MENDEL tokens and may specify additional terms, such as whether the listing is for a single-use license or unlimited access.

Listings are categorized by task type, model family, and other metadata attributes to facilitate discovery. The coordination layer maintains a searchable index that allows buyers to query for outputs matching specific criteria. Sellers retain full control over their listings and may update prices, add additional metadata, or delist outputs at any time.

4.2 Discovery and Evaluation

Buyers interact with the marketplace through the client layer, querying the coordination layer for outputs that match their requirements. Search queries can specify task type, model, date range, and other parameters. The coordination layer returns matching listings along with their metadata descriptors.

Before purchasing, a buyer can evaluate the metadata and proof package associated with a listing to assess relevance and provenance. In some configurations, the protocol may support partial previews or summary descriptors that allow buyers to assess output quality without accessing the full content. The extent and format of preview functionality is determined by the seller when creating a listing.

4.3 Settlement

When a buyer decides to purchase a listed output, the settlement process proceeds as follows. The buyer initiates a purchase transaction through the client layer, which triggers a token transfer on the settlement layer. MENDEL tokens equal to the listed price are transferred from the buyer to a protocol-managed escrow. Upon confirmation of the token transfer, the coordination layer releases the full output to the buyer. Once the buyer confirms receipt, or after a predefined timeout period, the

escrowed tokens are released to the seller. If a dispute arises during the settlement window, the protocol provides a resolution mechanism, the specifics of which will be defined in a subsequent protocol specification.

All settlement occurs in MENDEL tokens. The protocol does not support settlement in other currencies or tokens. This constraint simplifies the settlement logic, ensures a consistent unit of account within the marketplace, and establishes a clear relationship between marketplace activity and token utility.

4.4 Fee Structure

The protocol may charge a small fee on each transaction to fund ongoing development and infrastructure maintenance. The fee structure, including the percentage and the allocation of collected fees, will be defined transparently and may be subject to governance mechanisms as the protocol matures. Any fees collected are denominated in MENDEL tokens and are deducted from the settlement amount before the remainder is released to the seller.

4.5 Output Licensing

The Mendel marketplace supports multiple licensing models for listed outputs. A seller may offer a single-use license, which grants the buyer access to the output for a single application. Alternatively, a seller may offer an unlimited license, which grants the buyer unrestricted use of the output. The licensing terms are recorded in the listing metadata and enforced at the protocol level to the extent technically feasible. Off-chain enforcement of licensing terms remains the responsibility of the transacting parties, and the protocol does not claim to provide comprehensive digital rights management.

5. Token Design

5.1 Token Parameters

The MENDEL token is deployed as an ERC-20 token on Ethereum mainnet, built on battle-tested OpenZeppelin primitives with additional governance and safety layers designed for long-term ecosystem health.

Parameter	Value
Token Name	Mendel
Symbol	MENDEL
Standard	ERC-20 + EIP-2612 Permit
Network	Ethereum Mainnet
Total Supply	10,000,000
Decimals	18
Minting	None after deployment
Transaction Tax	None

5.2 Contract Features

The MENDEL token contract includes several features designed for ecosystem protection and controlled launch mechanics:

- **EIP-2612 Permit** — Gasless approvals via off-chain signatures, allowing users to approve token spending without a separate transaction.
- **Role-Based Access Control** — Three distinct roles govern contract administration: Admin (full control), Editor (manages lists and trading parameters), and Emergency (token recovery only).

- **Address Blacklist** — Blocked addresses cannot send or receive MENDEL tokens. Used for ecosystem protection against malicious actors.
- **Address Whitelist** — Privileged addresses exempt from trade-time restrictions during controlled launch phases.
- **Trade-Time Gating** — Configurable start time and maximum transfer amount for controlled launches. Prevents sniper bots from front-running public trading.
- **Deflationary Burn** — Token holders may permanently burn their own tokens, reducing total supply over time.
- **Emergency Token Recovery** — Allows recovery of ERC-20 tokens accidentally sent to the contract address.

5.3 Supply Immutability

The entire 10,000,000 MENDEL supply is minted at deployment to the deployer address. There is no mint function, no rebasing mechanism, and no proxy upgrade pattern. This immutability eliminates the risk of post-deployment supply manipulation and ensures the economic properties of the token are fully transparent from genesis.

5.4 Allocation Structure

The fixed supply of 10,000,000 MENDEL tokens is allocated as follows:

Allocation	Percentage	Tokens
Liquidity Provision	50%	5,000,000
Core Team (Vested)	25%	2,500,000
Ecosystem Rewards	10%	1,000,000
Treasury	10%	1,000,000
Marketing & Growth	5%	500,000

Team allocation is subject to structured vesting schedules to ensure long-term alignment. No allocation may exceed these percentages. The distribution model is fixed at launch.

5.5 Supply Rationale

A fixed supply of 10 million tokens creates a simplified economic framework with transparent scarcity. The protocol does not employ inflationary emissions or algorithmic supply adjustments. The optional burn mechanism allows organic supply reduction driven by token holder decisions, not protocol-mandated deflation. This design prioritizes predictability, clarity, and structural simplicity during early protocol development.

6. Phase Roadmap

The Mendel protocol is structured around staged functional expansion. Each phase represents a validated milestone. Timelines are indicative and subject to technical and operational realities.

Phase 1: Core Token & Settlement Foundation

The initial phase focuses on deploying the MENDEL ERC-20 token and establishing a minimal, transparent settlement layer. During this stage, Mendel operates as a structurally simple coordination and settlement token while infrastructure groundwork for the marketplace layer is developed. The objective of Phase 1 is stability, distribution, and ecosystem formation.

Phase 2: Marketplace Infrastructure

Phase 2 introduces a functional marketplace coordination layer. This includes:

- Output listing framework
- Metadata indexing system
- Proof anchoring mechanics
- Structured settlement flows

The marketplace design is deliberately conservative at inception, prioritizing functional reliability over complexity.

Phase 3: Enhanced Verification & Attestation

Following team expansion and budget scaling, Mendel may integrate enhanced verification mechanisms. This includes research into advanced proof systems, provider-level attestations, and zero-knowledge verification primitives. At this stage, cryptographic extensions (including zk-based verification frameworks) may be evaluated for implementation, subject to feasibility, auditability, and regulatory considerations.

No zero-knowledge privacy functionality is live at initial launch.

Phase 4: Expanded Mendel Marketplace

Upon validation of early marketplace activity and resource growth, the protocol intends to expand into a fully structured Mendel Marketplace. This expansion may include:

- Advanced licensing models
- Verticalized task categories
- Cross-layer integrations
- Enterprise-oriented settlement APIs

Marketplace expansion is considered a practical and near-term objective, contingent on demonstrated demand and capital efficiency.

7. Security Considerations

7.1 Smart Contract Security

The MENDEL token contract is built on OpenZeppelin's battle-tested ERC-20 implementation with additional governance layers. The contract implements role-based access control, ensuring that administrative functions are restricted to authorized addresses. There is no owner-controlled mint function and no proxy upgrade pattern. This immutability reduces the attack surface and eliminates the risk of post-deployment supply manipulation.

The blacklist and whitelist functionality is protected by role-based access control. Only addresses with the Editor role can modify these lists. The trade-time gating mechanism provides additional protection during launch, preventing unauthorized trading until the designated start time. Prior to mainnet deployment, all smart contracts undergo independent security review. Bug bounty programs may be established to incentivize ongoing security review by the broader community.

7.2 Off-Chain Security

The coordination layer, which operates off-chain, presents a different security profile than the on-chain components. The primary risks include unauthorized access to the metadata index, manipulation of search results, and denial-of-service attacks against the coordination infrastructure. These risks are mitigated through standard security practices including access control, rate limiting, encryption of data in transit and at rest, and redundant infrastructure deployment.

Because the coordination layer does not hold funds or control token transfers directly, a compromise of the off-chain infrastructure does not result in a loss of user funds. Token transfers occur exclusively on-chain through the settlement contract, and proof anchors are immutable once recorded. The off-chain layer is designed to be rebuildable from on-chain data in the event of a catastrophic failure.

7.3 Proof Integrity

The proof structure used by Mendel provides integrity guarantees, not correctness guarantees. The on-chain content hash ensures that a listed output has not been modified since it was anchored. The metadata fingerprint ensures that the listed attributes are consistent with what was committed at the time of listing. However, the protocol cannot independently verify that an output was produced by a

claimed model without external attestation.

This limitation is explicitly acknowledged. Users should understand that purchasing an output on the Mendel marketplace constitutes trust in the seller's claimed provenance to the extent that it is not independently attested. As provider-side attestation standards mature in the broader AI industry, the protocol intends to incorporate stronger verification mechanisms.

7.4 Economic Security

The fixed-supply, no-tax design of the MENDEL token eliminates several categories of economic attack that affect tokens with dynamic supply or fee-on-transfer mechanisms. There is no inflation risk from unauthorized minting, and no hidden value extraction through transfer taxes. The economic properties of the token are fully transparent and immutable from the moment of deployment.

The escrow mechanism used during settlement introduces a temporary lockup of buyer funds. The protocol manages this risk by enforcing deterministic timeout periods: if a settlement is not completed within the specified window, funds are returned to the buyer. This prevents indefinite lockup of tokens in disputed or abandoned transactions.

8. Long-Term Vision

Mendel is architected with extensibility in mind. While the initial deployment prioritizes structural simplicity and transparent ERC-20 settlement mechanics, the long-term objective includes the integration of advanced cryptographic verification systems.

As the protocol scales in adoption and capital resources, Mendel may evaluate the incorporation of zero-knowledge proof systems to enhance output verification and selective data disclosure mechanisms within the marketplace environment.

Such integrations require:

- Formal cryptographic audits
- Economic viability analysis
- Infrastructure scaling
- Expanded development resources

Accordingly, privacy-enhanced and zk-based components are considered future-phase research initiatives rather than launch-stage functionality.

The immediate objective remains the development of a robust, economically coherent marketplace for AI task outputs. Mendel's long-term trajectory is iterative and capital-dependent. Expansion into deeper cryptographic layers will occur only when operational maturity justifies the complexity.

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