Phase 4 Tasks

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
P4-A-001	4	P4-A	0) Conventions	Redis keys (additions for Phase 4): Asset Routing: `route:{symbol}` read-through cache.		Standards
P4-A-002	4	P4-A	0) Conventions	Redis keys (additions for Phase 4): Token Policy: nonce/idempotency for short-lived claims (e.g., `policy:claim:`		Standards

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				nonce: {address}`) and replay windows.		
P4-A-003	4	P4-A	0) Conventions	Redis keys (additions for Phase 4): OnChain Driver: per-wallet nonces `nonce:{chain}:{wallet}` with on-chain reconciliation.		Standards
P4-A-004	4	P4-A	0) Conventions	Redis keys (additions for Phase 4): DePIN: job locks/le		Standards

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				ases/rate limits (e.g., `lease:{job_id}`).		
P4-A-005	4	P4-A	0) Conventions	Redis keys (additions for Phase 4): zk-VaR: proving job locks/idempotency (e.g., `zkvar:{job_id}`).		Standards
P4-A-006	4	P4-A	0) Conventions	On-chain strategy (ReFIN L2): All DePIN contracts (NodeRegistry, Staking,		Standards

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				QoS Oracle, Rewards, Slashing) and optional registries (PolicyRegistry, AttestationRegistry) deploy to the same L2 as the Phase-3 AuditRegistry.		
P4-A-007	4	P4-A	0) Conventions	Proving system: zk-VaR circuits use a PLONK/Halo2-family prover; circuits/		Standards

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				keys managed per registry.		
P4-A-008	4	P4-A	1) Google Cloud Project & Networking	Egress allow-list (updates): Add RPC endpoints for any new on-chain venues/L2s used by the OnChain Driver.		Infra
P4-A-009	4	P4-A	1) Google Cloud Project & Networking	GPU availability: For offloaded proving/training/inference, either route via DePI		Infra

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				N or enable GPU-capable runners for zk-VaR/Trainer/Inference Worker; keep GPU toggles configurable.		
P4-A-010	4	P4-A	1) Google Cloud Project & Networking	GCS buckets (updates): zk-VaR: proofs + PK/VK + circuit metadata.		Infra
P4-A-011	4	P4-A	1) Google Cloud Project & Networking	GCS buckets (updates): DePIN: job payload		Infra

Task ID	Phase	Checkpoint ID	Section	Task	Notes	Area
				s and result artifacts (datasets, models, proofs).		
P4-A-012	4	P4-A	2) Data Stores — MongoDB Atlas	Create Phase-4 collections: Routing & Policy: `AssetRouting`, `TokenPolicies`, `PolicyClaims`.		Data
P4-A-013	4	P4-A	2) Data Stores — MongoDB Atlas	Create Phase-4 collections: zk-VaR: `ZkVarRequests`, `ZkVarAttestations`,		Data

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				`ZkVarCircuitRegistry`.		
P4-A-014	4	P4-A	2) Data Stores — MongoDB Atlas	Create Phase-4 collections: DePIN: `DePINJobs`, `DePINResults`, `QoSJobFacts`, `QoSScores`, `NodeMirror`, `RewardLedger`, `PenaltyLedger`.		Data
P4-A-015	4	P4-A	2) Data Stores — MongoDB Atlas	Key indexes: `AssetRouting`: PK on `sy		Data

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				mbol`.		
P4-A-016	4	P4-A	2) Data Stores — MongoDB Atlas	Key indexes: `TokenPolicies`: composite PK on `{token_address, chainId}`; `PolicyClaims`: TTL on `expiry`.		Data
P4-A-017	4	P4-A	2) Data Stores — MongoDB Atlas	Key indexes: `ZkVarAttestations`: PK `attestation_id`; secondary on `{account_id, snapshot_id}`.		Data
P4-A-018	4	P4-A	2) Data Stores — MongoDB Atlas	Key indexes:		Data

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				`DePIN Jobs`: index `{status, created_at}`; `QoSScores`: `{node_id, epoch_id}` composite.		
P4-A-019	4	P4-A	3) Security & IAM	Service accounts (new): `sa-asset-routing`, `sa-token-policy`, `sa-onchain-driver-worker`, `sa-zk-var-attestation`, `sa-depin-		Security

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				gateway`, `sa-qos-oracle`.		
P4-A-020	4	P4-A	3) Security & IAM	Least-privilege roles: Scope each SA to its secrets and collections only.		Security
P4-A-021	4	P4-A	3) Security & IAM	Least-privilege roles: Allow Execution Gateway to invoke Asset Routing and Compliance Adapter during driver		Security

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				selection and policy checks.		
P4-A-022	4	P4-A	3) Security & IAM	Least-privilege roles: Allow OnChain Driver worker to call Token Policy Module and Compliance Adapter.		Security
P4-A-023	4	P4-A	3) Security & IAM	Secrets in Secret Manager: On-chain keys: Driver submitter wallet; Tok		Security

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				en Policy attester _key ; QoS Oracle writer key.		
P4-A-024	4	P4-A	3) Security & IAM	Secrets in Secret Manager : RPC credentials: For all new venues/ L2s.		Security
P4-A-025	4	P4-A	4) Pub/Sub Event Bus	No new topics: OnChain path : `orders.cmd` / `orders.evt` (driver= onchain) + `audit.evt`.		Bus
P4-A-026	4	P4-A	4) Pub/Sub Event Bus	No new topi		Bus

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				cs: zk-VaR: in=`risk.approved`, out=`audit.evt`.		
P4-A-027	4	P4-A	4) Pub/Sub Event Bus	No new topics: DePIN/QoS: audit references for settlements flow to `audit.evt`.		Bus
P4-A-028	4	P4-A	5) CI/CD & Runtime Configuration	Repository: Add service dirs: `asset-routing/`, `token-policy/`, `onchain-driver/`, `zkvar-attest/`,		CI/CD

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				`dep in- gate way /`, `qos - orac le/`.		
P4- A- 029	4	P4-A	5) CI/CD & Runtime Configuration	Smart contract s: Add dirs for DePIN and opti onal Poli cyR egis try/ Atte stati onR egis try; wire depl oys to ReFI N L2.		CI/CD
P4- A- 030	4	P4-A	5) CI/CD & Runtime Configuration	Pipe lines (upd ates): Buil d/de ploy new serv ices .		CI/CD
P4- A- 031	4	P4-A	5) CI/CD & Runtime Configuration	Pipe lines (upd ates): Com pile		CI/CD

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				zk circuits; manage PK/VK artifacts in GCS.		
P4-A-032	4	P4-A	5) CI/CD & Runtime Configuration	Runtime config: Asset Routing decision defaults and cache TTLs.		CI/CD
P4-A-033	4	P4-A	5) CI/CD & Runtime Configuration	Runtime config: Token Policy claim TTL, ACE freshness triggers.		CI/CD
P4-A-034	4	P4-A	5) CI/CD & Runtime Configuration	Runtime config: OnChain Driver gas/MEV cap		CI/CD

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				s, nonce manager, relays.		
P4-A-035	4	P4-A	5) CI/CD & Runtime Configuration	Runtime config: DePIN dispatch/pricing/QoS windows.		CI/CD
P4-A-036	4	P4-A	7) Observability & SLOs	Dashboards (updates): On-chain execution: plan build time, submit→mined latency, revert rate, gas/fee metrics, relay hit-rate.		Observability

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
P4-A-037	4	P4-A	7) Observability & SLOs	Dashboards (updates): DePIN: job queue depth, acceptance %, proof/model validation success, QoS score distribution, rewards/slashing volumes.		Observability
P4-A-038	4	P4-A	7) Observability & SLOs	Dashboards (updates): zk-VaR: proofs/hour, p95 prove time, verify		Observability

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				success.		
P4-A-039	4	P4-A	7) Observability & SLOs	Alerts (new): High revert rate for OnChain Driver; receipt timeouts.		Observability
P4-A-040	4	P4-A	7) Observability & SLOs	Alerts (new): zk-VaR proof failures/backlog age.		Observability
P4-A-041	4	P4-A	7) Observability & SLOs	Alerts (new): DePIN stale queue or low node participation/QoS breaches.		Observability
P4-A-	4	P4-A	7) Observability & SLOs	Phase-		Observability

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
042				4 SLO baselines: Routing/Policy reads p95 ≤ 50 ms.		
P4-A-043	4	P4-A	7) Observability & SLOs	Phase-4 SLO baselines: On-chain plan build+sign p95 ≤ 500 ms (pre-submit).		Observability
P4-A-044	4	P4-A	7) Observability & SLOs	Phase-4 SLO baselines: zk-VaR proof generation (offline) p95 ≤ 10 min.		Observability
P4-A-	4	P4-A	8) Component-Level Preflight (Phase 4) — On-Chain	Contract		Preflight

Task ID	# Phase	Checkpoint ID	⊙ Section	Task	Notes	⊙ Area
045				s deployed: DePIN suite (NodeRegistry, Staking, QoS Oracle, Rewards, Slashing); optional Policy/Attestation registries.		
P4-A-046	4	P4-A	8) Component-Level Preflight (Phase 4) — On-Chain	Roles granted: QoS Oracle writer wallet has submitter role on QoS Oracle.		Preflight
P4-A-047	4	P4-A	8) Component-Level Preflight (Phase 4) — On-Chain	Initial data:		Preflight

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				Seed `AssetRouting` and `TokenPolicies` for test assets/tokens.		
P4-A-048	4	P4-A	8) Component-Level Preflight (Phase 4) — On-Chain	Secrets: Token Policy attester_key present; claim TTLs configured.		Security
P4-A-049	4	P4-A	8) Component-Level Preflight (Phase 4) — On-Chain	Integration: Gateway calls Asset Routing during driver selection; if on-chain & policy		Preflight

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				requires fresh ACE, call Compliance Adapter before building plan.		
P4-A-050	4	P4-A	8) Component-Level Preflight (Phase 4) — On-Chain	Secrets: Submitter wallet key loaded; relays/RPC configured.		Security
P4-A-051	4	P4-A	8) Component-Level Preflight (Phase 4) — On-Chain	Config: gas/MEV caps; nonce manager; `OrderId Map` enablement.		Preflight
P4-A-052	4	P4-A	8) Component-Level Preflight (Phase 4) — On-Chain	Circuits: compile; gen		Preflight

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				erate/store PK/VK in GCS; populate `ZkVarCircuitRegistry`.		
P4-A-053	4	P4-A	8) Component-Level Preflight (Phase 4) — On-Chain	Runtime: GPU toggles; queue/backoff; Explorer integration endpoints live.		Infra
P4-A-054	4	P4-A	8) Component-Level Preflight (Phase 4) — On-Chain	Gateway config: pricing, dispatch policies, QoS formulas/windows.		Preflight
P4-A-055	4	P4-A	8) Component-Level Preflight (Phase 4) — On-Chain	Node agent: a test		Preflight

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				provider node enrolled/staked on ReFI N L2 (NodeR egistry/ Staking); heartbeat and lease flows verified.		
P4-A-056	4	P4-A	9) Smoke Tests	Configure an asset in `AssetRouting` to onchain.		Testing
P4-A-057	4	P4-A	9) Smoke Tests	Trigger a trade; verify EG selects the OnChain Driver and persists a		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				plan with `driver="onchain"`.		
P4-A-058	4	P4-A	9) Smoke Tests	Driver enforces policy (`need_fresh_ace`), obtains PolicyClaim, signs and submits tx.		Testing
P4-A-059	4	P4-A	9) Smoke Tests	Confirm tx mined on L2; `orders.evt` and `audit.evt` reflect lifecycle.		Testing
P4-A-060	4	P4-A	9) Smoke Tests	Produce `risk.approved`; service con		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				sumes, proves, and writes `ZkVarAttestations`.		
P4-A-061	4	P4-A	9) Smoke Tests	Verify audit.evt emitted; Explorer can resolve/verify via read endpoints.		Testing
P4-A-062	4	P4-A	9) Smoke Tests	Register and stake a test node on ReFI N L2; `NodeMirror` present.		Testing
P4-A-063	4	P4-A	9) Smoke Tests	Publish a small inference/proving job; nod		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				e accepts lease, returns results; Gateway validates and records QoS.		
P4-A-064	4	P4-A	9) Smoke Tests	QoS Oracle writes per-epoch scores; Rewards settlement tx visible on L2; off-chain `RewardLedger`/`PenaltyLedger` mirrors updated.		Testing
P4-B-B-	4	P4-B	1) Development & Integration Plan — Asset Routing (new Cloud Run service)	Read		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
[001](#)				API: Implement `GET /v1/route/{symbol}` (service-to-service, JWT). Return `{route: broker|onchain, driver_hint, params, policy_flags, config_hash}` with a read-through cache (`Redis:route:{symbol}`, short TTL; default		

Task ID	# Phase	Checkpoint ID	⊙ Section	Task	Notes	⊙ Area
				route=`broker` on miss).		
P4-B-002	4	P4-B	1) Development & Integration Plan — Asset Routing (new Cloud Run service)	Decision engine: Resolve deterministic route using `AssetRouting` + `asset_metadata` with safe fallbacks; derive hints (`slippage_bps`, `mev_protect`, `max_gas_gwei`). If route=`onchain` and token		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				policy requires freshness, include `policy_flags.need_fresh_ace=true`.		
P4-B-003	4	P4-B	1) Development & Integration Plan — Asset Routing (new Cloud Run service)	Persistence: Create `AssetRouting` collection (PK `symbol`; fields include `route`, `driver_hint`, `token_policy_required`, `token_policy_ref`, `chainId`, `con		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				fig_hash`, admin metadata).		
P4-B-004	4	P4-B	1) Development & Integration Plan — Asset Routing (new Cloud Run service)	Admin (optional for this checkpoint): Upsert via `POST/PUT /v1/route*` with optimistic concurrency using `config_hash` and emit `audit.evt` on change.		General
P4-B-005	4	P4-B	1) Development & Integration Plan — Asset Routing (new Cloud Run service)	Resolve & Issue APIs: `GET T		General

Task ID	# Phase	Checkpoint ID	◎ Section	Task	Notes	◎ Area
				/v1/ poli cy/{ chai nId} /{to ken} ` → `Poli cyD ecisi on`.		
P4-B-006	4	P4-B	1) Development & Integration Plan — Asset Routing (new Cloud Run service)	Res olve & Issu e APIs : `PO ST /v1/ clai m/is sue` → shor t- live d EIP- 712 Poli cyCl aim whe n `req uire _fre sh_a ce=t rue`. Pers ist to `Tok enP olici es` and `Poli cyCl aims ` (TT L on		General

Task ID	# Phase	Checkpoint ID	⊙ Section	Task	Notes	⊙ Area
				`expiry`).		
<u>P4-B-007</u>	4	P4-B	1) Development & Integration Plan — Asset Routing (new Cloud Run service)	Freshness path: When policy demands freshness, check `ComplianceCache`; if stale or forced, call ComplianceAdapter (which calls ACE) and block unless ALLOW; then mint and sign the claim with `attester_key		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				`(idempotent per `{wallet, token, policy_version}`; Redis nonce to guard replay).		
P4-B-008	4	P4-B	1) Development & Integration Plan — Asset Routing (new Cloud Run service)	Claim format: EIP-712 typed data: `{wallet, token, chainId, policy_version, expiry, nonce}`; off-chain verification by the driver; opti		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				onal on-chain verification via `PolicyRegistry` on ReFI N L2.		
P4-B-009	4	P4-B	1) Development & Integration Plan — Asset Routing (new Cloud Run service)	Route- & policy-aware verdicts: Extend `/verdict` (internal) to accept hints (e.g., `route=onchain`, `need_fresh_ace=true`). Serve cached verdict for broker path;		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				force fresh ACE when required by token policy; upsert `ComplianceCache` and return `{verdict, reasons, expiry, source}`.		
[P4-B-010](#)	4	P4-B	1) Development & Integration Plan — Asset Routing (new Cloud Run service)	Driver selection: After `risk.approved`, acquire `exec:lock:{account_id}`, load context, call Ass		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				et Routing per symbol; if route=`onchain`, set `driver="onchain"` and persist in `ExecutionPlans`. Publish `orders.cmd` with `driver`. SLO: plan build p95 ≤ 500 ms unchanged.		
P4-B-011	4	P4-B	1) Development & Integration Plan — Asset Routing (new Cloud Run service)	Preflight: For `driver=onchain`, read `policy_flags`		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				. If `need_fresh_ace`, call Token Policy Module to resolve and issue a claim (which internally refreshes via Adapter/ACE). Treat any non-ALLOW as PolicyBlock.		
P4-B-012	4	P4-B	1) Development & Integration Plan — Asset Routing (new Cloud Run service)	Tx build & nonce/gas: Build venue-specific call data;		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				manage nonces with `Redis nonce:{chain}:{wallet}` and reconcile with `eth_getTransactionCount`; cap fees; respect `mev_protect` if configured. Pre-compute `txHash` and upsert `OrderIdMap {clientOrderId→txHash}`.		
P4-B-013	4	P4-B	1) Development & Integration Plan — Asset Routing (new Cloud Run service)	Send & watch:		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				Submit raw tx (RPC or private relay); emit `orders.evt{submitted|mined|reverted}` and corresponding `audit.evt`. Reconcile in Gateway exactly like the brokered path.		
P4-B-014	4	P4-B	1) Development & Integration Plan — Asset Routing (new Cloud Run service)	Contracts & stores: Use existing `ExecutionPlans`, `Orders`,		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				and (optional) `OrderIdMap`; continue to publish to `orders.evt`/`audit.evt`.		
P4-B-015	4	P4-B	2) Testing & Validation Checklist	Unit tests (services & mods): Asset Routing decision matrix, cache fallback, policy flag emission.		Testing
P4-B-016	4	P4-B	2) Testing & Validation Checklist	Unit tests (services & mods): Token Poli		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				cy: forced-fresh path, EIP-712 signing, TTL/nonce/idempotency.		
P4-B-017	4	P4-B	2) Testing & Validation Checklist	Unit tests (services & mods): OnChain Driver: tx builder (nonce/gas), claim verification, event emission.		Testing
P4-B-018	4	P4-B	2) Testing & Validation Checklist	Seed data: Insert a test symbol in `AssetRo		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				uting` with `route=onchain` and a `TokenPolicies` row requiring `require_fresh_ace=true`.		
P4-B-019	4	P4-B	2) Testing & Validation Checklist	Manual trigger: Publish a `risk.approved` for an intent containing the on-chain test asset. Observe Gateway lock and context load.		Testing

Task ID	Phase	Checkpoint ID	Section	Task	Notes	Area
P4-B-020	4	P4-B	2) Testing & Validation Checklist	Gateway & routing verification: Gateway calls Asset Routing and selects onchain.		Testing
P4-B-021	4	P4-B	2) Testing & Validation Checklist	Gateway & routing verification: `ExecutionPlans` header records `driver="onchain"`.		Testing
P4-B-022	4	P4-B	2) Testing & Validation Checklist	Gateway & routing verification: An `orders.cmd` with `driv		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				er=" onc hain "` is publ ishe d.		
P4-B-023	4	P4-B	2) Testing & Validation Checklist	Poli cy & ada pter path : OnC hain Driv er calls Tok en Poli cy; Tok en Poli cy forc es fres h ACE via Ada pter if nee ded and retu rns a Poli cyCl aim.		Testing
P4-B-024	4	P4-B	2) Testing & Validation Checklist	Poli cy & ada pter path : Non - ALL OW resp ons es		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				block submission with clear reasons.		
P4-B-025	4	P4-B	2) Testing & Validation Checklist	On-chain transaction verification: Locate the submitted tx in the L2 block explorer; confirm it executed the expected action (e.g., swap).		Testing
P4-B-026	4	P4-B	2) Testing & Validation Checklist	On-chain transaction verificati		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				on: Driver emits `orders.evt{submitted}` then `{mined}` (or `{reverted}` with reason).		
P4-B-027	4	P4-B	2) Testing & Validation Checklist	Reconciliation & audit: Gateway consumes `orders.evt` and advances `ExecutionPlans`/`Orders` to completed (or terminal error).		Testing
P4-B-	4	P4-B	2) Testing & Validation Checklist	Reconci		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
028				liation & audit: `audit.evt` exists for plan submit and tx lifecycle.		
P4-B-029	4	P4-B	2) Testing & Validation Checklist	Reconciliation & audit: `OrderIdMap` links `clientOrderId→txHash` for idempotent reconcile.		Testing
P4-B-030	4	P4-B	2) Testing & Validation Checklist	Idempotency check: Re-publish the same `orders.cmd`		Testing

Task ID	Phase	Checkpoint ID	Section	Task	Notes	Area
				(same `clientOrderId`); verify no duplicate writes or double-sends (OrderId Map/nonce reconciliation).		
P4-C-001	4	P4-C	1) Development & Integration Plan — zk-VaR Attestation Service (Cloud Run)	Bus Integration: Subscribe to `risk.approved` (ordered by `account_id`). Publish `audit.evt{kind=zkvar_attestation}` on suc		General

Task ID	Phase	Checkpoint ID	Section	Task	Notes	Area
				cess. Provide read/verify endpoints for Explorer.		
P4-C-002	4	P4-C	1) Development & Integration Plan — zk-VaR Attestation Service (Cloud Run)	Job Intake & Idempotency:		General
P4-C-003	4	P4-C	1) Development & Integration Plan — zk-VaR Attestation Service (Cloud Run)	Circuit Management:		General
P4-C-004	4	P4-C	1) Development & Integration Plan — zk-VaR Attestation Service (Cloud Run)	Witness Builder:		General
P4-C-005	4	P4-C	1) Development & Integration Plan — zk-VaR Attestation Service (Cloud Run)	Proving:		General
P4-C-006	4	P4-C	1) Development & Integration Plan — zk-VaR Attestation Service (Cloud Run)	Persistence & Audit:		General
P4-C-007	4	P4-C	1) Development & Integration Plan — zk-VaR Attestation Service (Cloud Run)	Read & Verify API:		General
P4-C-008	4	P4-C	1) Development & Integration Plan — zk-VaR Attestation Service (Cloud Run)	Configuration & Ops:		General
P4-C-009	4	P4-C	2) Testing & Validation Checklist	Unit Tests:		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
P4-C-010	4	P4-C	2) Testing & Validation Checklist	Manual Trigger:		Testing
P4-C-011	4	P4-C	2) Testing & Validation Checklist	Proof Generation:		Testing
P4-C-012	4	P4-C	2) Testing & Validation Checklist	Off-Chain Verification Test:		Testing
P4-C-013	4	P4-C	2) Testing & Validation Checklist	Audit Trail Integration:		Testing
P4-C-014	4	P4-C	2) Testing & Validation Checklist	Failure Paths:		Testing
P4-D-001	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	Deploy & configure: `NodeRegistry`, `Staking`, `QoSOracle`, `Rewards`, `Slashing`, `Treasury`.		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				Grant the QoS Oracle service wallet the authorized role(s) to submit epoch scores and trigger rewards/slashing.		
P4-D-002	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	Contract behaviors: Epoch-gated `QoSOracle.submit`, reward accrual via `Rewards.accrue(node, epoch, scor		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				e)`, and slashing hooks for hard SLA breaches (e.g., invalid proof).		
P4-D-003	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	APIs: Job Publishing (internal): create durable `DePIN Jobs`, price jobs, mint signed work orders (short-lived GCS URLs).		General
P4-D-004	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	APIs: Lease		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				Management (public): eligible nodes poll/accept; exclusive lease tracked in Redis `lease:{job_id}`.		
P4-D-005	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	APIs: Result Submission (public): nodes upload artifacts/proofs to GCS and submit `{hashes, metrics, proof_ref}`.		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
P4-D-006	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	Validation: Deterministic checks per job type (training/inference spot-checks, zk proof verification) before accepting results and releasing QoS facts. Persist `DePIN Results`. Emit `audit.evt` for accepted results.	General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
P4-D-007	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	QoS fact generation: Record `QoSJobFacts{job_id,node_id,kind,metrics,...}` for Oracle ingestion; maintain `NodeMirror` for scheduling.		General
P4-D-008	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	Persistence & infra: Collections `DePINJobs`, `DePINResults`, `QoSJobFacts`, `No		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				deMirror`; GCS for artifacts; Redis for leases/locks/idempotency.		
P4-D-009	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	Ingest API: Accept signed QoS facts from Gateway; replay window + dedupe on `{job_id,node_id}`; persist `QoSJobFacts (accepted|rejected)`.		General
P4-D-	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	Per-job		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
010				scoring: Normalize metrics to `job_score∈[0,1]` and flag SLA breaches (deadline miss, invalid proof).		
P4-D-011	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	Epoch aggregation: Produce `QoSScores{node_id,epoch_id,score,breakdown}` with guarded idempotency (`REDIS:agg:		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				{epoch_id}`).		
P4-D-012	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	Penalties & settlement: Evaluate penalties into `Penalty Ledger`; Oracle Writer submits epoch scores on-chain and triggers rewards/slashing; emit `audit.evt` for settlements.		General
P4-D-013	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	Enroll & stake: SIWE bind wallet →		Infra

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				`NodeRegistry.register` → `Staking.stake`; verify capabilities (GPU/prover). Mirror to `NodeMirror`.		
P4-D-014	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	Lease → execute → submit: Poll `/lease`, receive work order, run containerized workload (prover or GPU train/infer),		Infra

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				upload artifacts, submit results + metrics + proof. Periodic healthbeats.		
P4-D-015	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	Workload parity: Training/inference jobs mirror Phase-1 Trainer/Inference Worker artifact formats; zk-VaR proving uses provided witness + pk/vk		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				and returns proof + metrics.		
P4-D-016	4	P4-D	1) Development & Integration Plan — DePIN Smart Contracts (ReFIN L2)	Offload proving: Replace local prover step with DePIN offload: publish job to Gateway, await `DePIN Results`, verify proof, then persist `ZkVarAttestations` and emit `audit.evt`. Job idempotency via		General

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				`ZkVarRequests` + Redis lock `zkvar:{job_id}` remains unchanged.		
P4-D-017	4	P4-D	2) Testing & Validation Checklist	Node enrollment & staking: Run the reference agent; perform SIWE, `register`, and `stake`.		Testing
P4-D-018	4	P4-D	2) Testing & Validation Checklist	Node enrollment & staking: Confirm on-chain state in the L2		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				explorer and a `NodeMirror` row in MongoDB.		
P4-D-019	4	P4-D	2) Testing & Validation Checklist	End-to-end job lifecycle (zk-VaR prove): Trigger zk-VaR to publish a proving job → `DePIN Jobs`.		Testing
P4-D-020	4	P4-D	2) Testing & Validation Checklist	End-to-end job lifecycle (zk-VaR prove): Agent polls, accepts lease (che		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				ck Redis `lease:{job_id}`), downloads payload, runs prover, uploads proof to GCS, submits result.		
P4-D-021	4	P4-D	2) Testing & Validation Checklist	End-to-end job lifecycle (zk-VaR prove): Gateway validates proof and writes `DePINResults` + `QoSJobFacts`.		Testing
P4-D-	4	P4-D	2) Testing & Validation Checklist	QoS &		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
022				settlement: QoS Oracle ingests facts, aggregates epoch scores, and settles on-chain via `QoSOracle.submit` and `Rewards.accrue`.		
P4-D-023	4	P4-D	2) Testing & Validation Checklist	QoS & settlement: Verify tx receipts in the L2 explorer and reward accrual to the provider		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				wallet.		
P4-D-024	4	P4-D	2) Testing & Validation Checklist	GPU training/inference path (spot check): Publish a small training/inference job; agent returns artifacts/predictions; Trainer/Inference Worker consume outputs and update `ModelRegistry`/`Signals`.		Infra
P4-D-	4	P4-D	2) Testing & Validation Checklist	Audit		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
025				trail integration: Verify `audit.evt` for accepted results and settlements; Audit Writer persists leaves for Phase-3 batching/roots.		
P4-D-026	4	P4-D	2) Testing & Validation Checklist	Failure paths: Invalid proof → Gateway rejects, Oracle records breach, on-chain slashing in		Testing

Task ID	# Phase	Checkpoint ID	Section	Task	Notes	Area
				next epoch.		
P4-D-027	4	P4-D	2) Testing & Validation Checklist	Failure paths: Lease timeout / duplicate submit → Gateway idempotency prevents double-accept; job re-queued.		Testing