



Lux 4.0 — GPU-Native Quasar Activation

QuasarSTM 4.0 execution
+ GPU-Residency invariant

+ 9-chain topology in production

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Spec freeze: February 7, 2026 | Activation: February 14, 2026

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Abstract

On 14 February 2026 the Lux Network activated its 4.0 epoch. Quasar consensus was promoted from version 3 to version 4, QuasarSTM execution graduated from version 3 to version 4 (LP-010 v4), the GPU-Residency invariant (LP-137) became mandatory for all canonical execution paths, and the 9-chain topology defined by LP-134 entered full production. The activation completes a four-year arc that began with mainnet launch in 2020, traversed a post-quantum upgrade in the 2.0 line, formalised the PQ suite at 3.0 (December 25, 2025), and now standardises GPU-native operation across every chain in the Lux family. This paper documents the launch as a retrospective: the chronology, the topology in production, the financial-rail core (D-Chain DEX, C-Chain EVM, F-Chain FHE) unifying every primary chain template, the white-label primary-chain resale to Liquidity, Zoo, Hanzo, and Pars, and the on-mainnet receipts captured between block heights $h_0 = 31,415,926$ and $h_0 + 10,000$.

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1 Chronology of the Lux Versions

Lux is now four major versions deep. Each version is a coherent release rather than a branch; each successor strictly subsumed its predecessor.

Version	Active from	Theme	Defining changes
1.0	Dec 2019 / 2020	Launch	Mainnet, P/C/X, Quasar (Nova linear / Nebula DAG) consensus, native AMM on D-Chain (GPU).
2.0	2023–2024	PQ uplift	Hybrid signatures, Q-Chain bring-up, F-Chain alpha, lattice-based primitives in mempool.
3.0	2025-12-25	Full PQ + Quasar 3	ML-DSA mandatory, three-lane post-quantum certificates (LP-020), QuasarSTM 3, Quasar GPU FHE service alpha.
4.0	2026-02-14	GPU-native	Quasar 4, QuasarSTM 4, GPU-Residency invariant LP-137, 9-chain topology LP-134 in full production, white-label primary-chain templates.

Table 1: Lux major-version timeline. The D-Chain GPU AMM has been live since 1.0 — it predates the triumvirate terminology by years (the term itself is the Hanzo 4.0 framing) and is the prior art the rest of the family inherits.

1.1 What 1.0 had that the family is now generalising

The D-Chain decentralised exchange (`lux.exchange`) shipped with the original 1.0 mainnet. It was GPU-native on day one: the AMM invariant solver, the price-router, and the order-book matching engine all ran on commodity GPUs in the validator pipeline. Quasar 4.0 makes that operating model the default *everywhere*.

2 The 9-Chain Topology in Production

LP-134 (*Canonical 9-chain Topology*) defines the production chain set. At h_0 , every chain reported a non-zero block height with healthy validator participation.

Code	Chain	Purpose	4.0 status
P	Platform	Validators, staking, native asset	Quasar 4 cert lane 0x01
C	Contract (EVM)	GPU-native EVM, primary smart-contract surface	QuasarSTM 4 + cevmm v0.41+
X	Exchange	UTXO asset transfers	Cert lane 0x02
Q	Quantum	Post-quantum signature service	Lane 0x03, ML-DSA primary
Z	ZK	ZK proof verification, privacy pool	ZKVM 4.0
A	Attestation	A-Chain attestation root (cf. <code>lux-achain-attestation</code>)	Bridges to Pars/Zoo/Hanzo
B	Bridge	Cross-chain bridge with 7-d fallback	MPC threshold lane
M	MPC	T-Chain threshold-signing service	FROST + Pulsar
F	FHE	GPU FHE service (cf. LP-013 v2)	CKKS / TFHE substrate

Table 2: Lux 4.0 9-chain topology. D-Chain was rolled into a sub-lane of C-Chain at the 4.0 boundary; the DEX precompile registry `0x0400–0x04FF` now lives on C-Chain so that DEX-using contracts pay no cross-chain hop.

The D-Chain absorption is the sole topological change at the 4.0 boundary; every other chain is a continuation.

3 Quasar 4.0 Consensus

Quasar 4.0 supersedes the three-lane post-quantum certificates of LP-020 with a four-lane variant (LP-020 v4):

1. **Lane 1** — **BLS aggregate** (classical fast path, ≤ 100 ms).
2. **Lane 2** — **ML-DSA aggregate** (post-quantum primary, ≤ 250 ms).
3. **Lane 3** — **Pulsar threshold** (post-quantum threshold fallback, ≤ 800 ms).
4. **Lane 4** — **SLH-DSA archival** (hash-only audit anchor, written once per epoch).

A block is *certified* when at least one of lanes 1–3 reaches $\geq 2/3$ stake-weight. Lane 4 produces the long-term tamper-evident record. The four-lane construction satisfies the safety property $\text{Safe}_{4.0} \supseteq \text{Safe}_{3.0}$: any 3.0-safe history is also 4.0-safe.

Theorem 3.1 (Live-fast / safe-slow). *Under synchrony with $f < n/3$ Byzantine validators, Quasar 4.0 produces a certified block in time $T = \min(t_{\text{BLS}}, t_{\text{ML-DSA}})$ with probability 1 within the synchrony bound. Under partial synchrony, certification is guaranteed by the slower of the two lanes, and SLH-DSA continuity is preserved unconditionally.*

3.1 What changed from 3.0

- Lane addition (the SLH-DSA archival lane is new).
- Cert lane parallelism: lanes are signed concurrently across GPU threads rather than sequentially.
- Stake-weighted committee formation moved on-GPU (pre-4.0 it ran on the host CPU).
- Aggregation circuits are now resident on the GPU for the duration of an epoch.

4 QuasarSTM 4.0 Execution

LP-010 v4 specifies QuasarSTM 4.0; this paper does not duplicate the spec. Two operational consequences matter for the launch story:

Invariant 4.1 (GPU residency, LP-137). *For every transaction τ executed at height $h \geq h_0$, the canonical execution path runs on a GPU device g , with all input state, intermediate state, and output state resident on g 's HBM for the full duration of τ . Any host-RAM round-trip during τ is a violation.*

Invariant 4.2 (STM linearisability, LP-010 v4). *Any execution of a block B under QuasarSTM 4.0 produces the same observable state and event log as a serial execution of B 's transactions in the canonical order.*

The two invariants jointly guarantee that the GPU-resident execution is observationally indistinguishable from the textbook serial execution that 3.0 produced — only faster.

4.1 Production throughput at h_0

Metric	Lux 3.0	Lux 4.0 (h_0)
C-Chain sustained TPS	24,000	360,000
D-Chain swap latency (median)	2.26 μ s	0.94 μ s
Block certification (median, lane 1)	620 ms	98 ms
ML-DSA-87 verifications/s/validator	11,000	620,000
Cross-chain bridge settlement	42 s	24 s
GPU-Residency violations / 24h	—	0 (target)

Table 3: Production throughput observed on Lux mainnet validators in the 24h following h_0 .

The DEX figure is the long-running benchmark from `evmgpu-benchmark` updated to the 4.0 hardware target.

5 The 9-Chain Topology and Financial-Rail Core

Lux 4.0 carries the full canonical 9-chain topology defined in LP-134: P, C, X, Q, Z, A, B, M, F. Within that topology, three chains form the *financial-rail core* — DEX (D-Chain, derived from C-Chain precompiles), EVM (C-Chain), and FHE (F-Chain) — which is the minimum subset Hanzo 4.0 carries as its canonical *triumvirate*. Lux is broader than the triumvirate; the remaining six chains (P/X/Q/Z/A/B/M) provide platform consensus, UTXO assets, post-quantum ceremonies, ZK rollups, attestation, bridging, and MPC. This section documents the financial-rail core; §?? covers the non-financial chains.

5.1 DEX — D-Chain (`lux.exchange`), since 1.0

The D-Chain DEX is the prior art. Its precompile suite (`0x0400–0x04FF`) was promoted to C-Chain at the 4.0 boundary so that contract-resident DEX use no longer pays a cross-chain hop. Concrete features:

- Singleton pool manager (Uniswap-v4 style) at `0x0400`.
- HFT orderbook (LXBook) at `0x2000`.
- AMM pools (LXPool) at `0x2100`.
- Yield vaults (LXVault) at `0x2200`.
- Oracle feeds (LXFeed) at `0x2300`.
- Lending engine, transmuter, and perpetuums (`0x0410–0x0432`).
- Cross-chain hooks via Liquidity Protocol (LP-310, registered at $h_0 + 48$).

The D-Chain DEX has the longest production track record of any component in the family — six years of continuous operation at h_0 — and is the model the April 20 wave of network DEXes integrates against.

5.2 EVM — C-Chain (`cevm v0.41+`), GPU-native

C-Chain runs `cevm v0.41` (cf. LP-009 *GPU-native EVM*) with the full canonical precompile registry:

- Standard EVM precompiles 0x01–0x0a.
- Warp / Teleport (0x0100–0x01FF).
- Chain config (0x0200–0x02FF).
- AI/ML (0x0300–0x03FF).
- DEX (0x0400–0x04FF).
- Graph/Query (0x0500–0x05FF).
- Post-quantum (0x0600–0x06FF).
- Privacy (0x0700–0x07FF).
- Threshold signatures (0x0800–0x08FF).
- ZK proofs (0x0900–0x09FF).
- Curves (0x0A00–0x0AFF).

The 4.0 boundary added two: **Quasar** verification (0x0604) and **Hybrid_BLS_Corona** (0x0610), both GPU-native.

5.3 FHE — F-Chain, LP-013 v2

F-Chain hosts the GPU FHE service. The 4.0 boundary upgrades it from research-preview (3.0) to production:

- CKKS for approximate-arithmetic ciphertexts (price aggregation, risk computation).
- TFHE for boolean/integer ciphertexts (private voting, encrypted ACLs).
- Threshold decryption keyed by a t -of- n committee redrawn each epoch ($t = 67$, $n = 100$ on mainnet).
- Bootstrapping budget allocated as a first-class fee market; bootstrappers receive the new *F-Chain relay reward* (capped at 0.5% annualised LUX emission).

The GPU FHE service is the substrate that Hanzo, Zoo, and Pars re-export through their own primary chains.

6 White-Label Primary Chain Templates (LP-134)

LP-134 not only defines the canonical 9-chain topology; it also defines the *primary chain template*, the smallest reproducible configuration of P+C+D+F that constitutes a real L1. Four production deployments at h_0 run the template:

Deployment	Repository	Notes
Lux	ghcr.io/luxfi/luxd	Reference; the canonical instance.
Hanzo	ghcr.io/hanzoai/hanzod	4.0 launch 2026-02-14, AI-native.
Zoo	ghcr.io/zooai/zood	4.0 launch 2026-02-14, conservation-native.
Pars	ghcr.io/luxfi/parsd	2.0 launch 2026-02-14, diaspora-native.

Table 4: Production primary-chain deployments running the LP-134 template at h_0 . Liquidity is a separate white-label deployment in its own jurisdictional silo and is not enumerated here.

Each deployment specialises by adding or replacing precompiles; the *topology*, *cert format*, *state model*, and *GPU residency requirement* are identical.

7 Activation Receipts

The 4.0 activation was block-aligned at $h_0 = 31,415,926$ on the canonical Lux main DAG.

Event	Height	Notes
Quasar 4.0 epoch boundary	h_0	cert-lane vector (BLS, MLDSA, Pulsar, SLHDSA)
QuasarSTM 4.0 activation	h_0	STM root rotated; all in-flight tx replayed
GPU-Residency invariant on	$h_0 + 1$	first violation counter = 0
SLH-DSA archival lane initial	$h_0 + 1$	first archival cert hash 0x91...
D-Chain rolled into C-Chain	$h_0 + 6$	DEX precompiles registered
Liquidity Protocol register	$h_0 + 48$	router id <code>lp.lux.router</code>
First Pars→Lux bridge tx	$h_0 + 218$	via A-Chain attestation
First Hanzo→Lux bridge tx	$h_0 + 305$	via Liquidity Protocol
First Zoo→Lux bridge tx	$h_0 + 412$	via Liquidity Protocol
F-Chain DKG threshold key	$h_0 + 720$	$t = 67, n = 100$

Table 5: Selected mainnet receipts from the Lux 4.0 activation.

7.1 Validator participation

Indicator	Value at $h_0 + 10\,000$
Validators voting	1,248
Stake-weighted participation	94.7%
Lane-1 (BLS) participation	94.3%
Lane-2 (ML-DSA) participation	93.8%
Lane-3 (Pulsar) participation	84.2%
Lane-4 (SLH-DSA archival) writes	100% of epochs

Table 6: Validator participation in the four-lane cert protocol.

8 Conclusion

Lux 4.0 is the activation of an operating model the network has been converging on since 2020: GPU-native, post-quantum, and topologically complete (9 chains, financial-rail core, L1→L4 tenancy). The 4.0 boundary did not invent the financial-rail core; it formalised it and graduated the FHE chain from research preview to production. D-Chain has been the GPU-native DEX since 1.0; Quasar 4 and QuasarSTM 4 make every other chain operate the same way. The white-label primary chain template (LP-134) is the export mechanism: Hanzo, Zoo, and Pars all activate the same template on the same date, and the Liquidity Protocol common API on April 20 unifies their DEX liquidity.

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