Lux Network: A 12-Chain Architecture for Orthogonal, Composable Blockchain Infrastructure

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Abstract

We present the complete multi-chain architecture of Lux Network: 11 consensus chains plus one read-only query layer, each with dedicated global state, transaction types, and ZapDB storage. The primary network (P, X, C) provides the consensus foundation. Nine specialized chains (A, B, D, I, K, M, Q, Z, and G) each handle exactly one concern with no functional overlap. Cross-chain composition occurs via Warp messages at the consensus level [4]. The D-Chain DEX [3] serves as a universal price oracle enabling gas payment in any listed asset across all chains. Quasar consensus [1] coordinates C+Q+M+Z for post-quantum triple-signature receipts. This paper defines each chain's state model, transaction types, fee structure, and inter-chain composition protocol.

1 Design Principles

1. **One and one way only.** Each concern has exactly one chain. No redundancy.
2. **Separation of concerns.** Each chain owns its domain completely.
3. **Orthogonal.** Chains do not share mutable state. Changes on one cannot corrupt another.
4. **Composable.** Any chain can invoke any other chain's capabilities via Warp messages.
5. **Complete.** Every operation in the ecosystem has a canonical home chain.

2 Chain Registry

2.1 Primary Network

ID	Chain	VM	Gas	State
P	Platform	PlatformVM	LUX	Validator set, staking balances, subnet configs, delegation
X	Exchange	XVM	LUX	UTXO set, atomic swap state, NFT ownership
C	Contract	EVM	LUX†	Accounts, contract storage, precompile state

Table 1: Primary network chains. †: C-Chain accepts any DEX-listed asset as gas payment.

2.2 Specialized Chains

2.3 Read-Only Layer

3 Universal Gas Payment via D-Chain

Every Lux chain denominates fees in LUX but accepts any asset listed on the D-Chain DEX:

Definition 1 (Universal Gas Payment)**.** *For a transaction on chain $\mathcal{C}$ with gas cost g LUX and a user holding asset A:*

1. *Fee manager queries D-Chain for the A/LUX spot price p.*
2. *User's A balance is debited $g \cdot p$ units of A.*
3. *Validator receives g LUX equivalent.*

ID	Chain	Concern	Gas	State
A	Attestation	TEE proofs	LUX	Attestation records, compute proofs, NVTrust certificates
B	Bridge	Cross-chain	LUX	Pending transfers, MPC signer sets, liquidity pools, route state
D	DEX	Trading	LUX†	Orderbook, pool state, positions, margin accounts
I	Identity	DIDs/VCs	LUX	DID documents, credential registries, revocation lists
K	Keys	Key mgmt	LUX	Public key records, rotation history, policy rules
M	MPC	Threshold	LUX	DKG session state, key shares, threshold group configs
Q	Quantum	Post-quantum	LUX	Ringtail key state, NTT tables, PQ sig aggregation
Z	ZK	Proofs	LUX	Proof registry, receipt Merkle tree, circuit registry

Table 2: Specialized consensus chains. †: D-Chain fees paid in the traded pair.

ID	Chain	Concern	Gas	State
G	Graph	Query	None	Read-only index of all chains. No consensus participation. Can run anywhere.

Table 3: Read-only query layer.

4. The operation is atomic—no separate swap transaction visible to the user.

Accepted gas assets include but are not limited to: LUX, LUSD, LETH, LBTC, ZOO, PARS, and any ERC-20 with a D-Chain liquidity pool.

4 Subnet Integration

Subnets (Zoo, Pars, Hanzo, custom L1s) participate in the architecture as follows:

- Each subnet has its own native coin (ZOO, PARS, AI, etc.)
- Subnet validators may be a subset of Lux primary validators or independent
- Cross-subnet communication uses Warp messages via B-Chain
- Subnet coins are tradeable on D-Chain for gas flexibility
- D-Chain oracle provides the price feed for cross-subnet gas payment

5 Quasar Consensus

The Quasar consensus protocol [1] spans four chains for post-quantum block finality:

$$\text{Quasar} = \text{ZKP}\left(\text{BLS}_C \parallel \text{Ringtail}_Q \parallel \text{ML-DSA}_K\right)$$

1. **C-Chain**: Validators produce BLS12-381 aggregate signatures (fast path).
2. **Q-Chain**: Validators produce Ringtail LWE threshold signatures (PQ path).
3. **K-Chain**: ML-DSA keys sign the block hash (NIST PQ standard path).
4. **M-Chain**: Coordinates threshold signing across all three protocols.
5. **Z-Chain** [5]: Wraps all three verifications in a STARK receipt. The receipt is the proof of finality.

Theorem 1 (Quasar Finality)**.** *A block is final when the Z-Chain receipt attests to valid signatures from all three paths with* $\geq 67\%$ *validator agreement on each. Under the assumption that at least one of BLS12-381, Ringtail-LWE, or ML-DSA [2] remains secure, finality cannot be forged.*

6 Fee Schedule

Chain	Operation	Base Fee	Unit
P	Create validator	0	LUX
P	Add delegator	0	LUX
X	Transfer	0.001	LUX
C	EVM transaction	dynamic	LUX (EIP-1559)
A	Submit attestation	0.01	LUX
B	Initiate bridge transfer	0.05	LUX
D	Place order (maker)	0	traded pair
D	Fill order (taker)	0.001%	traded pair
D	Add liquidity	0.01	LUX
I	Register DID	0.1	LUX
I	Issue credential	0.01	LUX
K	Register public key	0.05	LUX
K	Rotate key	0.02	LUX
M	DKG session	1.0	LUX
M	Threshold sign	0.1	LUX
Q	Ringtail verify	0.5	LUX
Q	NTT batch	0.2	LUX
Z	STARK verify	0.5	LUX
Z	Groth16 verify	0.2	LUX
Z	Issue receipt	0.1	LUX
G	Query	0	free (read-only)

Table 4: Fee schedule by chain and operation.

7 ZapDB Storage

Each chain stores its state in ZapDB, Lux's native embedded database:

- **P-Chain**: Validator records, delegation state, subnet membership (UTXO model)
- **X-Chain**: UTXO set with asset metadata

- **C-Chain**: MPT state trie (Ethereum-compatible)
- **A-Chain**: Attestation Merkle tree (append-only)
- **B-Chain**: Transfer queue + signer set + liquidity accounting
- **D-Chain**: Orderbook B-tree + AMM pool state + position trie
- **I-Chain**: DID document store + credential index + revocation bitmap
- **K-Chain**: Key registry trie + policy rules + rotation log
- **M-Chain**: Session state + share commitments + group configs
- **Q-Chain**: NTT coefficient tables + Ringtail aggregation buffer
- **Z-Chain**: Receipt Merkle tree + circuit registry + proof cache
- **G-Chain**: Read-only aggregate index (no consensus writes)

8 Conclusion

Lux Network's 12-chain architecture provides complete separation of concerns with orthogonal, composable chains. Each chain owns exactly one domain, stores its own state in ZapDB, defines its own transaction types, and sets its own fee schedule. The D-Chain DEX enables universal gas payment in any listed asset. Quasar consensus coordinates C+Q+M+K+Z for post-quantum finality. G-Chain provides a free, read-only query layer that requires no consensus participation. Warp messages compose chains at the protocol level without shared mutable state.

References

[1] Kelling, Z., "Quasar Hybrid Consensus on Lux Network," Lux Industries, 2024.

[2] Kelling, Z., "Post-Quantum Cryptography Suite for Lux Network," Lux Industries, 2024.

[3] Kelling, Z., "Lux DEX: Native CLOB + AMM Precompiles," Lux Industries, 2024.

[4] Kelling, Z., "Lux Bridge: Warp and Teleport Protocols," Lux Industries, 2024.

[5] Worring, A., Kelling, Z., "Z-Chain: Universal ZK Proof Platform," Zoo Labs Foundation, 2026.