

GDL v1.0 — GhostLink Difference Language (Substrate Contract)

Types (SIMD-friendly)

`lattice<N>`, `mask<N>` (bitset), `f32<N>` (SoA float field), `u8<N>` (state), `rng<N>` (per-cell RNG), `global<f32[K]>` (SELF), topology (CSR/stencil).

Operators (9 verbs)

`SELECTA`, `MAPNBR`, `SELFENC`, `SCORE`, `SOFTMAX/DRAW`, `WRITE`, `RECYCLE`, `TRACE`, `ORDER`.

Grammar (minimal)

Program ::= Header Topology Fields Rules Pipeline. Rules set p₀, alpha_c, energy expressions with SELF; tick composes the nine ops. Expressions are pointwise or neighbor-reduce only for determinism & vectorization.

IR / Bytecode (16 ops)

0x01 BUILD_DELTA, 0x02 NB_REDUCE, 0x03 SELF_ENC, 0x04 ENERGY, 0x05 SOFTMAX, 0x06 SAMPLE_CAT, 0x07 WRITE_STATE, 0x08 RECYCLE, 0x09 TRACE_DECAY, 0x0A TRACE_ACCUM, 0x0B SCHED_UPDATE, 0x0C ORDER_APPLY, 0x0D LOG_EVENTS, 0x0E RNG_SPLIT, 0x0F MASK_FILTER. See `gdl_ir_opcodes.json`.

Operational semantics

Snapshot read → compute fields/energies → sample with per-cell RNG → single-writer WRITE → RECYCLE → TRACE. Determinism tiers: D0 (no RNG), D1 (seeded per-cell), D2 (parallel assoc ops).

Memory model

SoA arrays, compressed Δ_t index buffer, CSR topology or stencil, tiled execution for cache/NUMA; ORDER uses branchless table select.

SELF channel & Safety

SELF = $\text{Encode}(|\Sigma|/N, p^-, \kappa^-, \text{integration}, \text{activity})$. Energies $\doteqdot \theta_{\text{self}}(W, \text{SELF})$. Invariants: alphabet total, one writer/cell/tick, bounded RNG use, traces in [0,1].

FFI & Proof hooks

extern fields for I/O; extern log for legacy; activity/Σ counters; snapshots & events for origin min-cut.

Example

See `gdl_example.gdl` for a complete tick pipeline on spherical topology (icosahedral subdivision).