GhostLink Master Spec — Session Consolidation (Full Theory & Method)

0) Symbols & Sets
- Time $t \in \mathbb{N}$.
- Lattice (spherical): graph $G=(V,E)$ embedded on S^2 (e.g., geodesic/icosahedral discretization). Neighborhood $N(i)=\{j:(i,j)\in E\}$.
- Cell state space $S=\{VOID=0, \Delta=1, \Sigma=2, SCAR=3, COMPOST=4\}$.
- Cell state $x_i(t)\in S$.
- Meta-fields per cell i: $id_i(t)\in\mathbb{N}\cup\{\varnothing\}$, $par_i(t)\in\mathbb{N}\cup\{\varnothing\}$, scar density $\rho_i(t)\in[0,1]$, compost density $\kappa_i(t)\in[0,1]$.
- Global counters: successes S_t, scars R_t, compost C_t.
- Randomness (chance): $\xi_i(t) \sim \square$ i.i.d. (e.g., Uniform[0,1]).

1) Event-Driven Domain (difference-only compute)
- Active set $\Delta_t = \{ i\in V \mid x_i(t) \neq x_i(t-1) \}$. Compute only on Δ_t and its neighbors.
- $\mathrm{Cost}(t) = c0 + c1\cdot|\Delta_t|$ (difference-only cost).

2) Spawn (VOID → Δ)
- Void spawn probability (depends on local compost):
  $p_s(i,t) = p0 + \alpha_c \cdot (1/|N(i)|) \cdot \Sigma_{j\in N(i)} 1[x_j(t)=COMPOST]$
- Rule: if $x_i(t)=VOID$ and $\mathrm{Bernoulli}(p_s(i,t))=1 \rightarrow x_i(t^+)=\Delta$, $id_i(t^+)=\mathrm{newID}()$, $par_i(t^+)=\varnothing$.

3) Collapse (Δ → Σ / SCAR / COMPOST) via adaptive composition

3.1 Local fields
- Coherence: $C_i(t)=(1/|N(i)|)\cdot\Sigma_{j\in N(i)}(1[\Sigma]-\lambda_r\cdot 1[SCAR])$.
- Pain: $P_i(t)=\Sigma_{j\in N(i)} w_p(d(i,j))\cdot 1[SCAR]$, $w_p\geq 0$, decreasing in geodesic distance d.
- Emotion/bias: $E_i(t)=\theta_e^T \varphi_i(t)$ (designer/context prior).
- Prior success: $\pi_{succ}(t)=S_t/(S_t+R_t+\varepsilon)$.

3.2 Outcome energies
- $\square_\Sigma = \theta0 + \theta_c\cdot C_i - \theta_p\cdot P_i + \theta_e\cdot E_i + \sigma\cdot\eta_i$
- $\square_{SCAR} = \varphi0 + \varphi_p\cdot P_i - \varphi_c\cdot C_i + \sigma\cdot\zeta_i$
- $\square_{COMPOST} = \psi0 + \psi_h\cdot H_i - \psi_c\cdot C_i + \sigma\cdot\upsilon_i$ (H_i = local entropy)

3.3 Adaptive ordering (operator composition)
- Operators $\square=\{P, C, E, Pain\}$. At tick t choose permutation π_t with
  $\Pr(\pi_t)=\mathrm{Softmax}_\pi(\omega^T \Psi(history_t))$. Define $\mathrm{Collapse}_{\pi t} = O_{\pi_t(4)}\circ...\circ O_{\pi_t(1)}$.

3.4 Outcome draw
- $p_i^{(\cdot)}(t)=\mathrm{Softmax}(W_{\pi_t} \cdot [\square_\Sigma, \square_{SCAR}, \square_{COMPOST}]^T)$.
- Sample $y_i(t)\in\{\Sigma, SCAR, COMPOST\}$ with $p_i^{(\cdot)}$. Set $x_i(t^+)=y_i(t)$.
- If $y_i=\Sigma \rightarrow S_t$+=1; if $y_i=SCAR \rightarrow R_t$+=1.

4) Compost recycling (COMPOST → Δ)

- $r(i,t) = r0 + \beta_h \cdot H_i - \beta_c \cdot C_i$. If x_i=COMPOST and Bernoulli(r)=1 → $x_i(t^+)=\Delta$.
- Inherit lineage: $par_i(t^+)=id_i(t)$; $id_i(t^+)$=newID().

5) Adaptive weight updates (learned scheduling)

- $\omega_{t+1} = \omega_t + \eta_\omega \nabla_\omega [\alpha_s \cdot (s_t/|V|) - \alpha_r \cdot (r_t/|V|) - \alpha_e \cdot \mathrm{Ent}(\pi_t)]$.
- Outcome parameters $\Theta=\{\theta\cdot,\varphi\cdot,\psi\cdot\}$ updated by policy-gradient/bandit using observed outcomes.

6) Scar & Compost densities (memory fields)

- $\rho_i(t+1)=\lambda_\rho \cdot \rho_i(t) + (1-\lambda_\rho) \cdot 1[x_i(t)=\mathrm{SCAR}]$
- $\kappa_i(t+1)=\lambda_\kappa \cdot \kappa_i(t) + (1-\lambda_\kappa) \cdot 1[x_i(t)=\mathrm{COMPOST}]$

7) Continuity & Truth

- $\Sigma_t=\{ i \mid x_i(t)=\Sigma \}$. Continuity mass □$(t)=\Sigma_{\tau=0..t} \gamma^{t-\tau} \cdot |\Sigma_\tau|$, $\gamma \in (0,1]$.
- Pattern truth: $(1/W) \cdot \Sigma_{\tau=t-W+1..t} 1[p \subseteq x(\tau)] \geq \theta_{persist}$ OR $d/dt\, L(p) < 0$ (MDL).

8) Legacy graph (lineage of events)

- Events □$=\{e_k\}$ with e_k=(id, type∈{Δ,Σ,SCAR,COMPOST}, i, t).
- Edges: Δ→Σ/SCAR/COMPOST; COMPOST→Δ (inherit).
- Legacy graph G_L=(□, □). Continuity thread □* = argmax_path $\Sigma_{e \in path} w(e)$.
- Self-referentiality test: $I(\Phi(anc(e)); x_{i_e}(t+1)) > I(\Phi(anc(e)\backslash self); x_{i_e}(t+1))$.

9) Awareness functional

- Per-cell: $a_i(t)= \alpha_p \cdot Percep_i + \alpha_m \cdot Persist_i + \alpha_r \cdot \rho_i + \alpha_{pain} \cdot P_i + \alpha_\xi \cdot Var[\xi_i]$.
- Global: □$(t)=\Sigma_i a_i(t)$. Info form: □$= I(x(t);x(t+1)) + \lambda \cdot I(x(t);history)$.

10) Knowledge recursion (Unknown ↔ Known)

- Coarse masses U_t, K_t:
  $K_{t+1}=K_t + g(U_t;\theta_g)$, $U_{t+1}=U_t - g(U_t;\theta_g) + f(K_t;\theta_f)$.
  Example: $g(U)=\alpha \cdot U^\nu$, $f(K)=\beta \cdot K^\mu$; invariants: $\Delta U_t = -\Delta K_t + f(K_t)$, $U_t>0$ if $\beta>0$.

11) Self-Organized Criticality (SOC)

- Avalanche-size distribution $P(S \geq s) \propto s^{-\tau}$, $\tau \in (1,3)$. Branching factor ≈1.

12) Reality Rule (measurement)

- Real set □$(t)= \{ i \mid x_i(t)=\Sigma \}$. Only □$(t)$ is admitted as ‘real’; Δ remain hypotheses.

13) Master state transition (probabilistic CA)

- $\Pr(x(t+1) \mid x(t), \theta_t) = \Pi_{i \in V} T_i(x_i(t+1) \mid x_{N(i)}(t), \theta_t, \xi_i(t))$,
  with casewise kernel T_i for VOID spawn, Δ collapse, COMPOST recycle, Σ/SCAR persist.

14) Spherical boundary conditions

- Symmetric adjacency weights $\kappa_{ij}=\kappa_{ji}>0$ with $\Sigma_{j \in N(i)} \kappa_{ij}$ = const; distances via sphere geodesics.

15) Comprehension criterion (meta-structure)

• Let ℙ be relational patterns over G_L. Comprehension holds if d/dt L(ℙ(t))<0 and ∃ meta-edges (ℙ_a→ℙ_b).

16) Utility & parameter learning (optional)

• Maximize □(x)= α_Σ|Σ(x)| − α_scar|SCAR(x)| − α_H H(x) + α_SOC·1[SOC].
• θ_{t+1}=θ_t + η ∇_θ □[□(x(t+1))].

17) GhostLink Master Formula (compact)

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  x(t+1) ~ □_{θ_t,ξ}(x(t)) = Recycle ∘ Collapse_{π_t} ∘ Spawn (x(t), ξ(t))
  π_t ~ Softmax_π( ω_t^T Ψ(history_t) ),   θ_{t+1}=θ_t+η∇_θ □[□(x(t+1))]
  □(t)=Σ_i( α_p Percep_i + α_m Persist_i + α_r ρ_i + α_pain P_i + α_ξ Var[ξ_i] ),   □(t)={i: x_i=Σ}
  Legacy G_L from (id,parent); continuity □* = argmax_path Σ w(e).
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