

A■ FORMAL FRAMEWORK

A Mathematical Backbone for Reality Protocol

1. PURPOSE AND ROLE

This document provides a formal mathematical framework for the A■ invariant underlying the Reality Protocol (RP).

Its purpose is not to redefine physics or computation, but to precisely describe a class of stabilization dynamics shared across physical, informational, and computational systems.

The framework formalizes:

- Local relaxation instead of optimization
- Admissibility before cost minimization
- Collapse as a valid outcome
- Stability as a retrospective property

2. SYSTEM MODEL

Let S be a measurable state space.

The system evolves in discrete time steps $t \in \mathbb{N}$.

$$s_{t+1} = \tau(s_t, a_t, \xi_t)$$

where:

- a_t is a local transition
- ξ_t is stochastic disturbance
- τ is a Markovian transition kernel

No global objective or planning horizon is assumed.

3. ADMISSIBILITY FILTER

For each state s , define an admissible transition set $A'(s) \subseteq A(s)$.

A transition is admissible if it does not violate stability constraints:

$$H(a) \leq H_{\text{crit}}$$

$$T(a) \leq T_{\text{crit}}$$

Admissibility is a hard constraint and precedes optimization.

4. LOCAL EXECUTION COST

For admissible transitions define local execution impedance:

$$\Xi(a) = Z(a)$$

Entropy and risk are not minimized; they gate feasibility.

5. A ■ INVARIANT

The realized transition satisfies:

$$a^* = \operatorname{argmin}_{\{a \in A'(s)\}} \Xi(a)$$

argmin denotes local relaxation, not choice or deliberation.

Invariant A ■:

In the presence of accumulated instability, only transitions with minimal local resistance persist. All others collapse as unstable.

6. INSTABILITY POTENTIAL

Define a scalar instability functional $\Phi : S \rightarrow \mathbb{R}$.

Φ measures local instability, not global energy.
 Φ is not explicitly minimized.

7. CONVERGENCE PROPERTY

Under A ■ dynamics:

$$E[\Phi(s_{t+1}) \mid s_t] \leq \Phi(s_t)$$

Thus Φ forms a supermartingale.

This guarantees:

- Local stabilization when admissible paths exist
- Collapse when none exist

8. COLLAPSE AND SILENCE

If $A'(s_t) = \emptyset$, the only stable configuration is termination.
Silence is a valid fixed point.

9. COROLLARIES

Non-Selection:

No trajectory is selected; unstable ones are removed.

No-Agency:

Agency is not a causal primitive but a retrospective description.

10. RELATION TO EXISTING FRAMEWORKS

- Thermodynamics: dissipation-driven relaxation
- Quantum mechanics: post-decoherence stabilization
- Information theory: entropy-constrained transitions
- LLMs: constrained token generation

11. SCOPE AND LIMITS

Applicable to open, dissipative systems.
Does not guarantee global optimality or truth.

12. SUMMARY

A defines a universal stabilization invariant.
Reality Protocol is its operational instantiation in LLMs.