Canonical Stability Equation Specification

RLE–LTP–RSR (Stability Triangle) with Rate Normalization

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1. Scope

This document defines a single, dimensionless stability/efficiency equation built only from three invariants (RSR, LTP, RLE) plus an external time base (Δt). It specifies: variables, domains, core identities, rate scaling, and the minimal diagnostic logic gate.

2. Variables and Domains

Symbol	Domain	Meaning (minimal)
Δt	$(0, \infty)$	Observer-defined sampling interval (refresh rate).
f	$(0, \infty)$	Update frequency (cycles/sec). $f = 1/\Delta t$. If using RPM: $f = RPM/60$.
E_n	$(0, \infty)$	Usable capacity before transition $n \to n+1$ (resource-agnostic).
U_n	$[0, E_n]$	Irrecoverable loss incurred during transition $n \to n+1$.
RLE_n	$[0, 1]$	Retained usable fraction across transition $n \to n+1$.
RSR_n	$[0, 1]$	Reconstruction fidelity at step n (how trustworthy the system's self-state is).
$\blacksquare_n$	$(0, \infty)$	Structural support available at the current representation/layer.
d_n	$(0, \infty)$	Compression demand (required precision/coordination burden).
LTP_n	$[0, 1]$	Structural adequacy index at step n.
S_n	$[0, 1]$	System Stability / System Efficiency at step n (the bounded health scalar).

3. Core Equations (Triangle Definitions)

3.1 Recursive Loss Equation (RLE)

RLE is the transition invariant (retained usable fraction):

$RLE_n \equiv (E_{n+1} - U_n) / E_n$, with $RLE_n \in [0,1]$.

Derived loss fraction: $\Lambda_n \equiv 1 - RLE_n$.

3.2 Layer Transition Principle Index (LTP)

LTP is used operationally as a bounded adequacy index:

$LTP_n \equiv \min(1, \blacksquare_n / d_n)$, with $LTP_n \in [0,1]$.

Interpretation: if $\blacksquare_n \geq d_n$ then $LTP_n = 1$ (structure meets demand). If $\blacksquare_n < d_n$ then $LTP_n < 1$ (structural strain; descent may be required).

3.3 Recursive State Reconstruction (RSR)

RSR measures reconstruction fidelity (trustworthiness of present state estimate):

Let y_n be the current observable input, and $■_n$ be the system's reconstruction (filtered/delayed echo) of the prior output/state. Choose any normalized discrepancy $D(\cdot,\cdot)$ with range [0,1]. Then:

$$RSR_n \equiv 1 - D(y_n, ■_n), \text{ with } RSR_n \in [0,1].$$

RSR does not predict; it detects onset of divergence (phase/lag/echo becoming structure).

4. The Stability Equation (System Efficiency Scalar)

Define the bounded system stability/efficiency scalar as the multiplicative closure of the triangle:

$$S_n \equiv RSR_n \cdot LTP_n \cdot RLE_n, \text{ with } S_n \in [0,1].$$

Unity Baseline: $S_n = 1$ indicates the system is nominally aligned at the current layer and sampling interval (no detectable reconstruction drift, no structural inadequacy, and full retained fraction across the last transition). Any $S_n < 1$ indicates hidden loss/strain somewhere in the triangle.

5. Rate Normalization (Changing Δt / RPM)

The time base is external: Δt is chosen by the observer. Convert RPM to frequency as:

$$f = 1/\Delta t \text{ (Hz) or } f = RPM/60.$$

If you change the rate by a multiplier m ($m = f_{new} / f_{old} = \Delta t_{old} / \Delta t_{new}$) while holding internal structure fixed, the *expected* normalized stability scales approximately as:

$$S_{expected}(new) \approx S_{old} / m.$$

This is a diagnostic scaling law: deviations indicate that per-cycle losses, reconstruction drift, or structural adequacy are changing under the new rate.

Define a divergence indicator:

$$\Delta S = S_{observed}(new) - S_{expected}(new).$$

Interpretation: $\Delta S < 0$ suggests the system cannot maintain the new rate without accumulating additional loss (feedback onset risk). $\Delta S \geq 0$ indicates headroom at that rate.

6. Minimal Diagnostic Logic Gate (Operational Loop)

At each step n (each sample):

1) Compute RSR_n (foreground signal).
2) If RSR_n is below threshold, evaluate LTP_n (structure vs demand).
3) If $LTP_n < 1$, perform mandatory descent / structural expansion (layer change).
4) After any action/transition, compute RLE_n and update S_n.

Reference pseudologic:

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IF S_n == 1: continue (RSR loop)
ELSE: locate which factor is non-unitary (RSR, LTP, or RLE) and intervene at that
layer.
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7. Notes and Non-Claims (kept strict)

- S_n localizes strain but does not uniquely identify a physical component; many mechanisms can map to the same factor drop.
- Δt changes the resolution of reconstruction; comparing S across different Δt requires explicit rate normalization (Section 5).
- This spec defines a dimensionless stability scalar and its lawful use; it does not assert empirical universality by itself.