WLRC Theory: Windowed Log Recording with Reversible Computation

Version 1.1

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Abstract

Establish theory of Windowed Log Recording with Reversible Computation (WLRC). Integrate windowed measurement framework with append-only logging under reversibility constraints. Core results: (i) Log entropy grows monotonically under windowed observation; (ii) Reversibility ensures information conservation; (iii) Window optimization minimizes recording overhead while maintaining measurement fidelity; (iv) Halting characterized by log entropy saturation.

1 Framework

WLRC combines:

- Windowed measurement via WSIG
- Append-only log recording
- Reversible computation (RCA)
- Entropy-based halting criterion

2 Main Results

Theorem 2.1 (Log Entropy Monotonicity)**.** *Under reversible windowed updates, log entropy* $S(\log_t)$ *non-decreasing.*

Theorem 2.2 (Window Optimization)**.** *Optimal window* w^* *minimizes recording entropy subject to measurement constraints.*

Theorem 2.3 (Halting Characterization)**.** *System halts iff log entropy saturates:* $S(\log_{t+1}) = S(\log_t)$.

3 Applications

- Quantum computing with measurement records
- Reversible classical computation with logging
- Minimal overhead monitoring systems
- Fault-tolerant computing architectures