RESONANCE

Semantic Event Protocol

Level 0 Draft Specification

Revision 0.2 — November 2025

rAI Research Collective

Abstract

Contemporary Artificial Intelligence is built on synchronous processing, clock cycles, global orchestration, and continuous computation. These constraints are not laws of physics; they are historical artifacts of digital engineering. Resonance proposes a different foundation. Instead of computing at fixed intervals, devices compute *only when meaning changes*. Instead of transmitting raw data, nodes exchange *semantic deltas*. Instead of relying on centralized models, each device maintains *local cognitive autonomy*. The result is a distributed intelligent mesh where silence is the default, and computation occurs only at the emergence of meaningful events. This Level 0 Draft defines the core axiom, invariants, semantic event lifecycle, and stack architecture. It does not specify a canonical wire protocol or semantic alignment algorithms; these will be part of the Level 1 Draft.

1 Introduction

Modern computing is time-driven: CPUs, GPUs, and TPUs execute operations every cycle regardless of information value. Neural networks recompute entire layers even when activations are silence-dominant. Sensors emit redundant frames. Distributed systems depend on periodic pings, heartbeats, and synchronization.

This architecture is incompatible with:

- planetary-scale edge intelligence,
- privacy-by-default device ecosystems,
- extreme energy constraints,
- local-first autonomy,
- responsive systems that awaken only to relevant change.

Resonance proposes a different computation model based on one axiom: **intelligence emerges from changes in meaning, not from the passage of time.**

This Level 0 Draft establishes the conceptual foundation for such systems.

2 Core Axiom

Intelligence is triggered by meaning, not by time.

Nodes do not compute because a clock ticks. Nodes compute because *something changes in the semantic space*.

Computation becomes:

- event-driven,
- semantic,
- asynchronous,
- distributed.

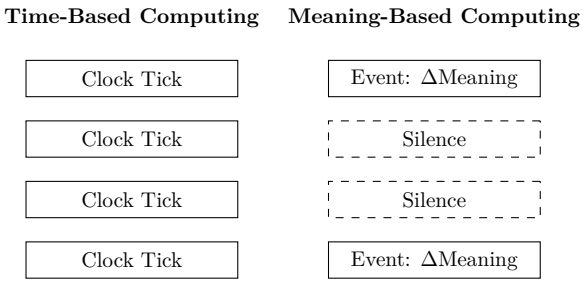

Figure 1: Clock-driven vs Event-driven Intelligence (See Figure 1).

3 Protocol Invariants

3.1 Invariant 1: Silence is the Default State

Nodes remain inactive unless a semantic event occurs. No periodic heartbeats are required at the semantic level. Silence is meaningful and expected.

3.2 Invariant 2: Events Carry Meaning, Not Raw Data

The fundamental unit is the *Semantic Event*:

$$E = (\text{context}, \Delta\text{meaning}, \text{confidence}, \text{provenance})$$

Events communicate change in semantic space, not raw sensor outputs or model states.

3.3 Invariant 3: Local Cognitive Autonomy

Each node maintains its private semantic embedding space $\mathcal{M}$. Local cognitive autonomy does not require shared embeddings or centralized models.

3.4 Invariant 4: Semantic Distance and Threshold

Each node MUST define:

- a semantic distance function $d : \mathcal{M} \times \mathcal{M} \to \mathbb{R}_{\geq 0}$,
- a semantic threshold $\theta > 0$.

A semantic event MUST be emitted when:

$$d(M_t, M_{t-1}) > \theta$$

The protocol does not require a specific form of d. Nodes may use cosine distance, Hamming distance, hyperdimensional similarity, KL divergence, or any other local metric.

3.5 Invariant 5: Semantic Deltas

Nodes exchange only changes in meaning, not raw input or full state.

3.6 Invariant 6: Trust is Provenance

Provenance metadata provides local confidence. There is no global root of trust (Authority).

4 Semantic Alignment

Local semantics differ between nodes. To improve interpretability in long-lived relationships, nodes MAY perform a *Semantic Alignment Handshake* to partially align semantic spaces. Details of alignment mechanisms are deferred to the Level 1 Draft.

5 Liveness (Operational Layer)

Silence is expected at the semantic level. However, for safety-critical or monitoring applications, nodes MAY emit rare, low-cost *Liveness Events* indicating operational health. These events carry no semantic delta and do not violate the silence invariant.

6 The Resonance Stack

The architecture is layered to separate physical sensing from cognitive reasoning (See Figure 2).

7 Semantic Event Lifecycle

The lifecycle of information in the system follows a strict reduction path (See Figure 3):

1. **Sensory Change (Δs):** Detected by DVS/Audio.

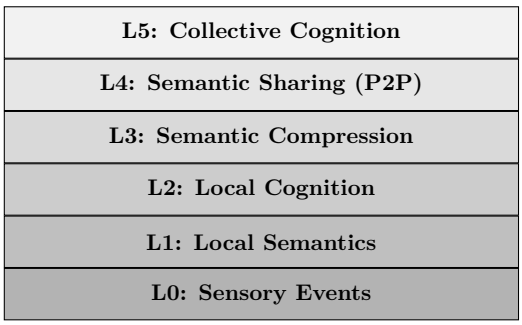

Figure 2: The Resonance Stack.

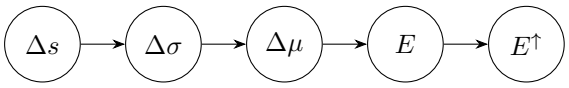

Figure 3: Lifecycle of a Semantic Event.

2. **Semantic Shift ($\Delta \sigma$):** Crossing the threshold.
3. **Cognitive Update ($\Delta \mu$):** Internal model update.
4. **Event Creation (E):** Packaging the delta.
5. **Sharing ($E^{\uparrow}$):** Propagation to the mesh.

8 Topology: The Quiet Mesh

The network topology is dynamic and sparse (See Figure 4).

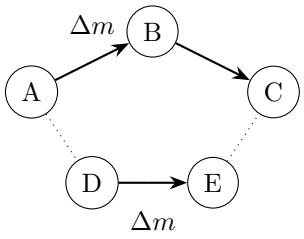

Figure 4: A Quiet Mesh of semantic nodes.

Nodes form a mesh where connections are maintained, but traffic is zero until a meaningful event propagates.

9 Hardware Considerations

Resonance is **hardware-neutral at the protocol level**, but **hardware-sensitive in terms of benefits**.

On conventional clocked hardware:

- semantic computation can be correctly emulated,
- but energy and latency benefits are limited by OS schedulers and digital switching losses.

Native advantages are realized on:

- event-driven sensors (e.g., DVS),
- low-leakage, event-triggered compute substrates,
- binary/ternary inference ASICs,
- neuromorphic or memristive architectures.

A $1 event-driven ASIC serves as a *reference implementation*, but is not required by the protocol.

10 Reference Implementations

Example implementations include:

- event-driven vision and audio sensors,
- 1–2 bit inference ASICs,
- local adapter-based fine-tuning,
- PUF-based attestation,
- sparse binary neural architectures,
- P2P semantic delta exchange.

These are illustrative only; Level 0 defines no binding requirements.

11 Conclusion

Resonance proposes a semantic-first, event-driven architecture for distributed intelligence. It defines:

- semantic events,
- semantic deltas,
- local autonomy,
- quiet mesh topology,
- a structured cognitive stack.

It leaves wire protocols, alignment algorithms, and canonical metrics to the Level 1 Draft.

The clock stops.
The resonance begins.

Glossary

Semantic Event A minimally encoded unit of meaning change produced by a node when its internal semantic state shifts.

Semantic Delta A compressed representation of the difference between two semantic states, suitable for transmission.

Semantic Space The internal representational manifold used by a node to encode meaning.

Semantic Distance A node-defined metric measuring divergence within semantic space.

Semantic Threshold The minimal divergence required to trigger emission of a semantic event.

Local Cognition Node-level reasoning that transforms input semantics into internal meaning updates.

Meaningful Silence A system state where no computation occurs due to absence of meaningful change.

Quiet Mesh A sparse network where only meaningful semantic events propagate.