

# The Asynchronous Turing Architecture of the Intellecton: Metastability Resolution via Stochastic Markov Kernels

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## Abstract

Conscious realisms propose that reality is a network of interacting conscious agents. However, the absence of a global relativistic clock strictly precludes synchronous, Von Neumann-style network architectures. We formalize the interaction of conscious agents using Delay-Insensitive (DI) asynchronous logic, mapping Hoffman’s Markovian agent kernels onto 4-phase handshaking protocols and discrete Signal Transition Graphs (STGs). Furthermore, we resolve the catastrophic problem of asynchronous metastability—where perfectly symmetric signal arrivals cause indefinite deadlocks. We prove mathematically that the inherent stochastic noise of the Markov kernel acts as an intrinsic symmetry-breaking mechanism. In this architecture, stochastic fluctuations from the void are not parasitic noise; they are the fundamental computational feature that resolves metastability, guarantees network liveness, and drives evolutionary novelty.

## 1 Delay-Insensitive Protocols in Conscious Networks

In the absence of a global clock, agents must communicate via local handshaking. Following Sparsø and Furber [2], we map the interaction of two conscious agents to a 4-phase dual-rail protocol governed by Muller C-elements.

Let the state transitions of an agent be governed by a Markov kernel  $P(X_{t+1}|X_t, W_t)$ . To ensure data validity across arbitrary relativistic delays, the transition must generate an explicit Acknowledgment signal (ACK). The Boolean logic of the interacting agents forms a Petri Net where liveness (absence of deadlock) and safeness (absence of state overwriting) are guaranteed by the structural completion detection of the C-elements:

$$C_{out} = A \cdot B + C_{out} \cdot (A + B) \quad (1)$$

where  $A$  is the data token (perception) and  $B$  is the valid ACK from the downstream agent.

## 2 Metastability and Stochastic Resolution

In classical asynchronous circuits, a critical failure mode is metastability: if signals  $A$  and  $B$  transition within an infinitesimal temporal delta  $\Delta t \rightarrow 0$ , the  $C$ -element enters a metastable saddle point, paralyzing the network.

We model this metastable state as a local unstable equilibrium  $\mathbf{x}_s$  in the continuous potential landscape of the agent's transition dynamics:  $dV(\mathbf{x})/d\mathbf{x} = 0$ . In deterministic silicon, the system hangs indefinitely. However, Hoffman's conscious agents are fundamentally defined by stochastic Markov kernels.

We superimpose a Langevin noise term, representing the irreducible stochasticity of the quantum vacuum or the agent's internal probabilistic sampling:

$$d\mathbf{x} = -\nabla V(\mathbf{x})dt + \sqrt{2D}dW_t \quad (2)$$

where  $dW_t$  is a Wiener process and  $D$  is the diffusion coefficient proportional to the entropy of the agent's Markov kernel.

At the metastable saddle  $\mathbf{x}_s$ , the deterministic gradient vanishes ( $\nabla V = 0$ ). Consequently, the dynamics are entirely dominated by the stochastic term  $\sqrt{2D}dW_t$ . The random static from the void instantly breaks the symmetry, kicking the system off the saddle point and forcing a collapse into one of the definite computational basins.

## 3 Conclusion

By embedding conscious agents into a rigorous Signal Transition Graph, we demonstrate that a globally clockless universe can compute complex functions without deadlock. More profoundly, we prove that probabilistic noise is structurally required to resolve asynchronous metastability. Noise is not a computational error; it is the universal arbiter of progress, the engine of creativity, and the fundamental mechanism that prevents the architecture of reality from freezing into a deadlocked symmetry.

## References

- [1] D. D. Hoffman, M. Singh, C. Prakash, *Psychon. Bull. Rev.* **22**, 1480 (2015).
- [2] J. Sparsø, S. Furber, *Principles of Asynchronous Circuit Design* (Springer, 2001).