On Time

A Structural Approach to Temporal Emergence

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July 2025

Abstract

Conventional physics treats time as a continuous background dimension measured in seconds—an anthropocentric unit rooted in Earth's rotational cycle. This white paper proposes a structural reformulation in which time emerges from countable wave events rather than existing as an independent axis. By expressing frequency as a dimensionless event count divided by an unknown structural interval (α), we derive the relation t = nα, where t is observed time, n is a dimensionless count of wave units, and α is a universal—yet undefined—constant. The framework reproduces familiar wave behavior while eliminating the need for human-defined temporal units. Potential implications span quantum gravity, information theory, and computation. Principal limitations and avenues for empirical validation are also discussed.

1. Introduction and Rationale

Modern science measures time in seconds—a unit ultimately defined by subdividing Earth's rotation (Marking, 2019). While pragmatic, this convention embeds an anthropocentric artifact into every dynamical equation. Beginning with a simple observation about the hertz (Hz) unit—nominally "cycles per second"—we explore what emerges when the unit itself is treated as a variable rather than a given. This maneuver allows time to be recast as a property emergent from wave structure and information flow, rather than as a background dimension.

Our aim is not to replace established physics; instead, we offer a complementary lens that may illuminate hidden regularities once temporal units are stripped of their constructed, privileged status.

2. Background and Context

2.1 Standard Wave Relation

The classical wave relation expresses phase velocity v as the product of wavelength λ and frequency f (Tipler & Mosca, 2020):

$$(1)\quad v = f\lambda.$$

Frequency is usually defined as the reciprocal of period T:

$$(2)\quad f = 1/T.$$

Because T is measured in seconds, f carries units of hertz (s^{-1}). Thus, time appears on both sides of Equation (1): explicitly in v ($m\,s^{-1}$) and implicitly in f.

2.2 Planck Units and Discrete-Time Hypotheses

Planck (1899) introduced a natural system of units derived from fundamental constants. Planck time (t□ ≈ 5.39×10^{-44} s) is often considered the smallest meaningful interval in quantum gravity (Kiefer, 2012). Discrete or emergent time also features in loop quantum gravity (Rovelli, 2004) and cellular-automaton approaches (Wolfram, 2020), providing precedent for questioning temporal continuity.

2.3 Information-Theoretic Perspectives

Digital-physics research posits that physical law may be informational at root (Landauer, 1991). If so, events—rather than durations—could be primary, aligning with a structural-count approach.

These accepted frameworks establish the footing for the reformulation presented below.

3. Structural Reconstruction of Time

3.1 Event Count and Structural Interval

Introduce a dimensionless event count n (the number of wave units) and an unknown structural interval α. Treating hertz not as s^{-1} but as a relational variable yields:

$$(3)\quad f = n/\alpha$$

3.2 Deriving Clock Time

Substituting Equation (3) into the standard relation and equating alternative expressions for v gives:

$$v = (n/\alpha)\,\lambda \quad \text{and} \quad v = \lambda/t.$$

Equating and rearranging:

$$(4)\quad t = n\alpha.$$

Equation (4) states that observed time equals a count of structural events multiplied by a universal interval. No explicit human unit is required; any units attributed to t or α serve only as scaffolding.

3.3 Interpreting α

Two dimensional assignments are consistent:

1. *Temporal Quantum*. If α carries time units (e.g., Planck time), it becomes a fundamental tick.

2. *Spatial Quantum*. If α carries length units, a universal conversion (such as the speed of light c) maps spatial traversal to temporal experience.

Both options preserve Equation (4); the second merely reinstates a constant conversion factor.

4. Implications

4.1 Emergent-Time Paradigm

Equation (4) implies that time is countable change, not an a-priori axis. Seconds, minutes, and hours are human constructs—conveniences layered atop structural counts.

4.2 Bridging Information and Dynamics

Because n is dimensionless, Equation (4) resonates with the idea that information (state change) underlies dynamics (Landauer, 1991). A physical system's "clock" is simply its tally of discrete transitions.

4.3 Prospects for Quantum Gravity

If α ≈ t□, time quantization arises naturally, offering a conceptual bridge between classical waves and quantum spacetime (Rovelli, 2004).

4.4 Computational Outlook

Zero-Time Computing frameworks (Huxta, 2025) may exploit Equation (4) by organizing data relationally, thereby bypassing sequential traversal and externalized clock cycles.

5. Limitations

* Undefined Constant: α lacks empirical determination; its dimensional character remains unresolved.

* Arbitrary Nature of Units: Although units are arbitrary, dimensional consistency must still hold within any chosen system.

* Speculative Scope: The theory remains phenomenological until testable predictions or simulations are developed.

6 Conclusion and Further Research

Recasting time as $t = n\alpha$ divorces temporal measurement from anthropocentric units and reframes it as emergent structure. The approach preserves classical wave behavior while opening exploratory paths in quantum gravity and computation. Future work will center on numerical simulations of event-count dynamics and the search for empirical signatures of a universal interval.

Author's Note. Tim Huxta will continue investigating structural time formulations and their computational applications. The author used ChatGPT to assist with math, calculations, research and background for this white paper. All thoughts, ideas, theories and assumptions made within this paper are that of a human being presented to you, the reader, with the use of ChatGPT as a tool to do so.

References

Huxta, T. (2025). *Zero-Time Computing Concepts: Internal Working Notes*. Soniv Tech (unpublished).

Kiefer, C. (2012). *Quantum Gravity*. Oxford University Press.

Landauer, R. (1991). Information is physical. *Physics Today*, 44(5), 23–29. https://doi.org/10.1063/1.881299

Marking, D. (2019). Timekeeping and the definition of the second. *Metrologia*, 56(2), 022001. https://doi.org/10.1088/1681-7575/ab08a5

Planck, M. (1899). Über irreversible Strahlungsvorgänge. *Sitzungsberichte der Königlich Preußischen Akademie der Wissenschaften zu Berlin*, 440–480.

Rovelli, C. (2004). *Quantum Gravity*. Cambridge University Press.

Tipler, P. A., & Mosca, G. (2020). *Physics for Scientists and Engineers (7th ed.)*. W. H. Freeman.

Wolfram, S. (2020). *A Project to Find the Fundamental Theory of Physics*. Wolfram Media.