Concept Paper

A Time Dependent Graph Theoretic Model of Interacting Consciousness: The “United States of the Earth (USE)”

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A Time Dependent Graph Theoretic Model of Interacting Consciousness: The "United States of the Earth (USE)"

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Abstract

We model conscient entities as vertices of a Graph; and its edges, as the interaction between the them. We further introduce a two-layer multiplex network structure coupling the micro-level soul graph with a macro-level nation graph, enabling the study of how individual interactions aggregate to shape inter-nation relationships, and conversely, how geopolitical events influence individual states. The model includes concepts such as cultural entanglement, and virtue field restoration, providing a unified graph-theoretic treatment of both spiritual and geopolitical evolution. By combining deterministic evolution laws with graph Laplacian operators, the model captures the cyclical patterns of cooperation, fragmentation, and reunification across epochs. This work not only bridges ancient spiritual narratives with modern mathematical formalisms but also lays the foundation for quantitative simulations of the socio-political dynamics of humanity across Time.

Keywords: time dependent graphs; human relationships; international unity

1. Introduction

This paper develops a mathematical framework to capture the dynamic evolution of the consciousness's journey across Time. The conscient entities are treated as nodes in a time-dependent graph, with their mutual interactions represented as weighted edges. The transitions between ages are modeled as phase changes, akin to those in thermodynamic and condensed matter systems. Analytical tools from graph theory, spectral dynamics, and nonlinear systems are employed to formalize these transitions.

An important extension of this work incorporates the macro-social dimension by modeling nations as higher-order nodes in a corresponding nation-level graph. In its idealized form, the beginning of the Golden Age corresponds to a planetary state referred to here as the "United States of Earth" (USE), characterized by a fully connected, harmonious network with one world government and one shared spiritual foundation. Over the course of the Time Cycle, this unified trunk of the World Tree diversifies into branches representing the fragmentation of political and religious unity. The USE serves both as a symbolic and mathematical initial condition from which subsequent historical and karmic diversifications emerge.

The interplay between the micro-level consciousness graph and the macro-level nation graph forms a multiplex network, where individual karmic patterns collectively influence international relations, and global political events reciprocally alter the karmic states of individuals. This dual structure allows the model to capture the feedback loops between personal virtue, collective behavior, and historical transformation. By integrating concepts such as virtue fields, cultural entanglement, and karmic shockwaves into this coupled network formalism, we obtain a unified, quantitative perspective on the cyclical evolution of spiritual and geopolitical systems.

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In the following sections, we develop the mathematical formalism for both the consciousness and nation graphs, analyze their time evolution through the the Time Cycle, and demonstrate how the USE serves as both an initial condition and an attractor state in the larger cyclical process. This work aims to bridge ancient spiritual cosmology with modern mathematical modeling, providing an enriched lens for understanding the deep structure of human and planetary history.

2. Philosophical Basis and the 5000-Year Time Cycle

The Brahma Kumaris philosophy presents time as a repetitive and eternal cycle consisting of 5000 years, which is divided equally into four Yugas or ages, each lasting approximately 1250 years. The Golden Age is characterized by complete purity and divinity in human consciousness. In this phase, the soul is in its highest spiritual state. The Silver Age maintains much of this spiritual clarity, though a subtle decline begins. The Copper Age marks a sharp decline, where the soul forgets its divine identity and becomes entangled in duality and materialism. The Iron Age, the final and darkest period, is marked by the soul's complete spiritual ignorance and the dominance of vices.

The Confluence Age, which bridges the Iron Age and the Golden Age, is a relatively short period but carries immense transformative significance. During this phase, the soul undergoes a rapid reawakening through spiritual knowledge and practice, most notably as taught in the Raja Yoga tradition of the Brahma Kumaris. It is during this age that the process of regaining divine virtues and spiritual power is initiated.

This cosmological concept can be symbolized as a sequence of descending and ascending states, with the 84 births representing a linear degeneration in purity.The Brahma Kumaris philosophical worldview presents a cyclical cosmology in which the drama of the world unfolds over a fixed period of 5000 years. Within this framework, every soul experiences a sequence of 84 births, traversing four major ages: the Golden Age (Satyuga), the Silver Age (Tretayuga), the Copper Age (Dwaparyuga), and the Iron Age (Kaliyuga), culminating in the brief yet decisive Confluence Age. This cyclical process is vividly illustrated in the "84 Birth Staircase" painting by Nirwair Bhai, where each downward step represents the soul's progressive journey from a state of perfect purity to increasing entropic degradation. The model does not end with decay; rather, it predicts a return to a pristine state through spiritual renewal, thereby closing the eternal cycle. Nirwair Bhai's visual portrayal of this sequence as a staircase reinforces the notion of structured descent. The transition points between the Silver and Copper Ages, and between the Iron Age and Confluence Age, signify critical thresholds or "phase transitions," analogous to those found in physical systems, such as from liquid to gas or from order to disorder.

The structure and transitions described here are deeply embedded in the Brahma Kumaris literature [1], and supported by contemporary explorations into cyclic time theory [2], and thermodynamic analogies in spiritual transformation [3]. These transitions provide fertile ground for mathematical modeling, where variables such as entropy, consciousness, and purity can be abstracted into formal equations.

3. Mathematical Modelling of the Descent and Ascent of the Soul

The descent of the soul through 84 births can be modeled using a staircase or step function. Let $S(n)$ represent the soul's spiritual power or purity after the n-th birth. Assuming a constant rate of decline over 84 births, we can express this as a discrete function:

$$S(n) = S_0 - \delta n, \quad n = 0, 1, 2, ..., 84 \tag{1}$$

Here, S_0 is the initial spiritual power (at birth 0 in the Golden Age), and δ represents the incremental loss in power per birth. This function results in a linear descent and maps well to the visual staircase used in the Brahma Kumaris depiction.

However, the transitions between phases cannot be captured by a linear function alone. Particularly, the shift at the start of the Copper Age and the rise during the Confluence Age can be better

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understood through phase transition models. The transition into the Copper Age, where the soul forgets its divine identity, can be modeled using the Heaviside theta function:

$$\Theta(t - t_1) = \begin{cases} 0 & \text{if } t < t_1 \\ 1 & \text{if } t \geq t_1 \end{cases} \tag{2}$$

Where t_1 marks the beginning of the Copper Age. The introduction of vices can be viewed as an abrupt shift in entropy, modeled through this discontinuity.

Similarly, the Confluence Age can be modeled as a sigmoid or logistic growth function, representing a rapid increase in spiritual power:

$$R(t) = \frac{L}{1 + e^{-k(t-t_c)}} \tag{3}$$

In this equation, L is the maximum spiritual power that can be regained, t_c is the center of the Confluence Age, and k controls the steepness of the rise. This sigmoid shape aligns well with the rapid transformation taught in Raja Yoga, where the soul quickly sheds vices and returns to its original nature.

From a thermodynamic perspective, these transitions resemble entropy shifts in systems undergoing phase changes. The soul's descent can be analogized with an increase in entropy or disorder, consistent with Prigogine's irreversible systems theory [2]. The return during the Confluence Age symbolizes a reversal of entropy, a concept rarely seen in physical systems but posited in spiritual transformation theories [3].

Thus, the entire cycle can be framed mathematically as a hybrid of discrete and continuous models: a stepwise descent punctuated by sharp transitions and a nonlinear ascent, all within a fixed temporal span.

4. Graph Representation of Souls and Karmic Accounts

In the context of spiritual cosmology as articulated by the Brahma Kumaris, each soul undertakes a journey across multiple lifetimes within a 5000-year cyclic time frame. This journey involves continuous interaction with other souls through what are referred to as karmic accounts. To formalize this spiritually motivated idea using mathematical tools, we model the entire structure as a time-dependent graph $G(t)$. Formally, we define the graph at a given time t as follows:

$$G(t) = (V, E, P_V(t), P_E(t))$$

where V is the set of nodes or souls, and $E \subseteq V \times V$ is the set of edges, which represent karmic relationships between souls. In addition to this topological structure, two time-dependent scalar functions are defined: $P_V(t) : V \to [0, 1]$, which denotes the purity of each soul at time t, and $P_E(t) : E \to [0, 1]$, which denotes the purity or integrity of the karmic relationship between souls. Both of these functions evolve as the cycle progresses.

Each vertex $v_i \in V$ is a soul that exists within the 5000-year cycle. The number of vertices can be assumed to be constant, reflecting the Brahma Kumaris' position that all souls exist eternally and simultaneously in a subtle sense, even though their manifestation in physical form is staggered over time. Each soul begins its journey in a high state of purity in the Golden Age, and this purity gradually diminishes through successive births due to the accumulation of karma. The edges $e_{ij} \in E$ represent karmic accounts between pairs of souls v_i and v_j. These karmic accounts are established through actions, thoughts, and emotional exchanges. The karmic account thus acts as a conduit through which the impact of one soul's action influences another. The intensity and moral quality of these interactions can be quantified through the function $P_E(e_{ij}, t)$, which depends dynamically on the purity levels of the connected souls.

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We propose that the purity function for each node, denoted as $P_V(v_i, t)$, can be modeled as a decreasing function during the majority of the cycle, followed by an abrupt rise during the Confluence Age. A linear degradation model can be adopted for most of the cycle as follows:

$$P_V(v_i, t) = \max(0, 1 - \alpha_i \cdot f_i(t)) \tag{4}$$

where α_i is a soul-specific decay constant, and $f_i(t)$ represents the cumulative number of births or karmic entanglements undergone by soul v_i up to time t. This function ensures that the purity value remains within the domain $[0, 1]$, where 1 represents complete purity and 0 represents total degradation.

During the Confluence Age, however, the model must account for the process of spiritual reawakening as taught in the Raja Yoga tradition. This rapid transformation can be represented using a sigmoid function:

$$P_V(v_i, t) = \frac{1}{1 + e^{-k(t - t_c)}} \tag{5}$$

In this equation, t_c is the temporal center of the Confluence Age and k controls the steepness of the transition. This form reflects the nonlinear and accelerated re-acquisition of spiritual virtues.

The edges, or karmic accounts, are influenced by the purity of the interacting souls. Hence, we define the edge purity function $P_E(e_{ij}, t)$ as the arithmetic mean of the purities of the connected souls, scaled by a constant factor $\gamma \in [0, 1]$:

$$P_E(e_{ij}, t) = \gamma \cdot \frac{P_V(v_i, t) + P_V(v_j, t)}{2} \tag{6}$$

This formulation assumes that the karmic account between two souls is as pure as their average state, but modulated by γ, which may encode the nature or weight of their interaction.

This dynamic graph representation provides a scalable framework for analyzing how spiritual states evolve over time not only individually but also collectively. The structural evolution of this graph across the time cycle reflects the philosophical understanding that souls and their relationships are not static entities, but rather co-evolving components of a cosmological drama. By adopting this approach, one can simulate various hypothetical scenarios: for instance, evaluating how the collective purity of a group of souls changes when one member undergoes spiritual awakening. Additionally, the framework allows for the identification of souls that may serve as hubs of spiritual transformation due to their high connectivity and purity, analogous to influence maximization in social networks [5].

5. Karmic Entropy $H(t)$: A Measure of Collective Disorder

The concept of entropy, originally developed within the framework of thermodynamics and later extended to information theory and statistical mechanics, offers profound insights when applied to the domain of spiritual systems. In the context of the graph-theoretic representation of souls and their karmic interactions, as introduced earlier, we now define and investigate a quantity termed *Karmic Entropy* $H(t)$. To construct this measure, we consider the time-evolving graph $G(t) = (V, E, P_V(t), P_E(t))$, where V denotes souls, E denotes karmic relationships, $P_V(t)$ is the node-level purity function, and $P_E(t)$ is the edge-level purity function. We assume that karmic disorder is highest when the karmic accounts are most impure, and lowest when they are pure. Thus, we define karmic entropy as the complement of the average edge purity over the network:

$$H(t) = 1 - \frac{1}{|E|} \sum_{e \in E} P_E(e, t) \tag{7}$$

This function maps the state of the entire karmic network onto a scalar value in the range $[0, 1]$, where $H(t) = 0$ indicates perfect purity (e.g., Golden Age), and $H(t) = 1$ represents maximum karmic degradation (e.g., late Iron Age).

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The edge purity $P_E(e_{ij}, t)$, as defined earlier, is given by the average of the node purities of the souls connected by the edge:

$$P_E(e_{ij}, t) = \gamma \cdot \frac{P_V(v_i, t) + P_V(v_j, t)}{2} \tag{8}$$

Substituting this into the entropy formula yields:

$$H(t) = 1 - \frac{\gamma}{2|E|} \sum_{(i,j)\in E} \left(P_V(v_i, t) + P_V(v_j, t)\right) \tag{9}$$

This can be rearranged as:

$$H(t) = 1 - \frac{\gamma}{|E|} \sum_{(i,j)\in E} P_V(v_i, t) \tag{10}$$

assuming symmetry in edges and equal contribution of each soul's purity to each of its karmic accounts. This perspective indicates that the global karmic entropy is inversely related to the cumulative purity of souls, weighted by their connectivity in the karmic graph.

In practice, the degree d_i of each node v_i also affects its contribution to the global entropy. Thus, a refined version of entropy includes node degree:

$$H(t) = 1 - \frac{\gamma}{\sum_i d_i} \sum_{i\in V} d_i \cdot P_V(v_i, t) \tag{11}$$

This version reflects the idea that highly connected souls, or those involved in many karmic accounts, have greater influence over the collective disorder. Such an idea aligns with concepts in network theory and social influence models, particularly in the works of Holme and Saramäki (2012), where time-dependent interactions affect global properties of networks [4].

From a dynamical systems perspective, the evolution of $H(t)$ is not linear across the 5000-year cycle. Let us consider $P_V(v_i, t)$ to follow a degradation and restoration pattern:

$$P_V(v_i, t) = \begin{cases} 1 - \alpha_i t, & 0 \le t < t_c \\ \frac{1}{1+e^{-k(t-t_c)}}, & t \ge t_c \end{cases} \tag{12}$$

where t_c marks the beginning of the Confluence Age. The entropy curve derived from this will have a convex profile with a peak near $t = t_c$, followed by a sharp decline. This behavior is analogous to entropy generation in irreversible physical systems as described by Prigogine in his thermodynamic studies [2].

Furthermore, the interpretation of karmic entropy fits with the spiritual metaphor of the soul falling asleep and becoming entangled in complexity and duality over time. As each soul accumulates more karma, and as karmic accounts compound, the system becomes increasingly entropic. The spiritual process of purification, or the awakening of soul consciousness as taught in Raja Yoga, serves as a systemic reversal of entropy. It is important to observe that this entropy framework also allows for empirical simulation. By assigning values to α_i, γ, and the graph structure itself, one can track the evolution of karmic entropy numerically. Doing so may offer insights into collective tipping points or phase transitions in consciousness, analogous to synchronization phenomena in coupled oscillators or agent-based models [6].

This dual engagement of thermodynamic formalism and spiritual metaphysics provides a unique way to describe the temporal dynamics of soul networks. The function $H(t)$ becomes a powerful tool for both conceptual visualization and quantitative investigation of the rise and fall of collective spiritual order.

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6. Karmic Graph Reconfiguration Upon the Passing Away of a Central Soul

In karmic graph theory, the relationships between embodied souls are modeled as a time-evolving graph $G(t) = (V, E, P_V(t), P_E(t))$, where V is the set of incarnate souls (vertices), $E \subseteq V \times V$ is the set of karmic interactions (edges), and $P_V(t)$, $P_E(t)$ are scalar-valued functions representing the purity of the souls and their relationships, respectively. Let us consider a prototypical case where the mother, denoted $v_m \in V_f$, is a central soul within the family network. Her centrality can be quantitatively expressed by her degree $d(v_m)$, defined as:

$$d(v_m) = |\{v_j \in V_f : (v_m, v_j) \in E_f\}| \tag{13}$$

The degree measures the number of direct karmic accounts that soul v_m maintains at time t. In many traditional families, the mother serves not only as an emotional nucleus but also as a regulator of inter-member dynamics, meaning her karmic influence is often of high magnitude. If we assign weight or strength $s_{ij}(t)$ to each edge $e_{ij} \in E_f$, then the weighted degree of the mother becomes:

$$w(v_m, t) = \sum_{j:(v_m,v_j)\in E_f} s_{mj}(t) \tag{14}$$

A high $w(v_m, t)$ implies both a large number and strong quality of karmic connections.

Now consider the event of the mother's physical passing away at time $t = t_d$. This corresponds to the removal of the node v_m from the embodied graph:

$$V_f(t_d^+) = V_f(t_d^-) \setminus \{v_m\} \tag{15}$$

Consequently, all edges associated with the mother are instantaneously removed:

$$E_f(t_d^+) = E_f(t_d^-) \setminus \{(v_m, v_j) \in E_f : v_j \in V_f\} \tag{16}$$

This abrupt removal results in a topological rupture in the karmic subgraph $G_f(t)$, which in turn creates a disequilibrium among the remaining vertices. The network enters a transitional state characterized by the reallocation or diffusion of relational load. Specifically, the loss of the mother's mediating influence leads to both strengthening and weakening of remaining edges, depending on the compensatory dynamics adopted by other family members.

We define the localized karmic entropy of the family at any time t as:

$$H_f(t) = 1 - \frac{1}{|E_f(t)|} \sum_{e\in E_f(t)} P_E(e, t) \tag{17}$$

Immediately following the mother's departure, the entropy increases:

$$\Delta H_f = H_f(t_d^+) - H_f(t_d^-) > 0 \tag{18}$$

This represents a degradation in collective relational purity or harmony, and is typically observed in the forms of grief, confusion, or structural realignment.

Over time, the remaining nodes may form new connections or reinforce existing ones. Let $\Delta E_f(t)$ represent the set of newly formed or strengthened karmic edges:

$$\Delta E_f(t) = \{(v_i, v_j) \in V_f(t)^2 : s_{ij}(t) > s_{ij}(t_d^+)\} \tag{19}$$

This adaptation process may be interpreted as a healing mechanism that reduces entropy:

$$\frac{dH_f(t)}{dt} < 0 \quad \text{for} \quad t > t_d \tag{20}$$

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The family graph thus undergoes a re-equilibration process. Certain members may assume expanded karmic roles, as evidenced by increasing degrees or relational weights. For instance, an eldest child may begin to occupy the central role formerly held by the mother, forming new edges of care, responsibility, or emotional support.

These dynamic reconfigurations are consistent with principles in both network theory and spiritual anthropology. In network theory, such rewirings are often modeled in terms of resilience and robustness to node failure [7]. In the spiritual domain, similar phenomena are discussed in terms of karmic inheritance and dharmic repositioning [3]. The departure of a central soul also alters the flow of spiritual influence. In many cases, the mother is seen as a stabilizing channel of divine virtues. Her absence may prompt surviving members to seek spiritual anchoring directly from divine remembrance, a principle emphasized in Brahma Kumaris literature [1]. The resulting internalization of virtues leads not only to individual upliftment but also to the gradual reordering of the karmic web.

Thus, the passing away of a central soul is not merely a biographical event; it is a topological and energetic reconfiguration within the karmic graph. The transformation of edges is both structural and spiritual. While entropy increases momentarily, the karmic system exhibits an inherent capacity for restoration and transcendence, reflective of both dynamic network behavior and metaphysical resilience.

7. Multidimensional Expansion of Karmic Graphs During the Descent of Souls from Paramdham

As per the Brahma Kumaris cosmological framework, the metaphysical realm known as Paramdham serves as the eternal residence of all souls prior to their descent into the physical dimension. This descent initiates the unfolding of the World Drama Time Cycle. In this section, we propose a rigorous mathematical formalization of how the karmic graph dynamically expands as souls incarnate one by one over time. Let $\mathcal{G}(t) = (V(t), E(t), \mathbf{P}_V(t), \mathbf{P}_E(t))$ denote the evolving karmic graph at time t, where $V(t)$ is the set of embodied souls, $E(t) \subseteq V(t) \times V(t)$ is the set of directed or undirected edges representing karmic relationships, $\mathbf{P}_V(t)$ assigns each soul a vector of internal attributes, and $\mathbf{P}_E(t)$ assigns each edge a multidimensional vector describing relational properties.

Each vertex $v_i \in V(t)$ carries a soul-specific feature vector:

$$\mathbf{P}_V(v_i, t) = \begin{bmatrix} p_i^{\text{purity}}(t) \\ p_i^{\text{experience}}(t) \\ p_i^{\text{awareness}}(t) \end{bmatrix} \in \mathbb{R}^3 \tag{21}$$

Similarly, each edge $e_{ij} = (v_i, v_j) \in E(t)$ is associated with a relationship vector:

$$\mathbf{P}_E(e_{ij}, t) = \begin{bmatrix} w_{ij}^{\text{karmic}}(t) \\ w_{ij}^{\text{emotional}}(t) \\ w_{ij}^{\text{obligation}}(t) \\ w_{ij}^{\text{affection}}(t) \end{bmatrix} \in \mathbb{R}^4 \tag{22}$$

As time progresses and more souls descend from Paramdham, the vertex set expands. Let $N(t) = |V(t)|$ be the total number of incarnated souls. We postulate a strictly increasing function:

$$\frac{dN}{dt} > 0, \quad \forall t \in [0, T] \tag{23}$$

where $T = 5000$ years denotes the duration of one complete cycle. During the early Golden Age, $\frac{dN}{dt}$ is small, corresponding to slow population growth. In the Copper and Iron Ages, this rate increases substantially due to higher birth frequencies, consistent with the observed historical population curve [8].

Each soul is indexed according to its descent order from Paramdham:

$$\phi : \mathbb{N} \to V(t), \quad \phi(n) = v_n \tag{24}$$

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This injective mapping helps us identify the sequence in which souls enter the physical domain. For instance, v_1 denotes the first soul to descend, often considered the original deity soul in Brahma Kumaris teachings [1].

The creation of relationships is modeled as time-dependent edge formation. Let the relational probability between any two souls v_i and v_j be given by:

$$\mathbb{P}\big((v_i, v_j) \in E(t)\big) = f\big(\|\mathbf{P}_V(v_i, t) - \mathbf{P}_V(v_j, t)\|\big) \tag{25}$$

Where $f(\cdot)$ is a decreasing function, such that souls with similar vibrational or purity vectors are more likely to form connections. This reflects the principle of vibrational affinity mentioned in spiritual discourses [3].

The entropy of the relational graph at time t is now defined over multidimensional edge weights. Let:

$$H_E(t) = -\frac{1}{|E(t)|} \sum_{e \in E(t)} \sum_{k=1}^{4} \tilde{p}_k(e, t) \log \tilde{p}_k(e, t) \tag{26}$$

where $\tilde{p}_k(e, t)$ is the normalized component of the k-th edge feature. This captures the structural and emotional complexity of the karmic network as it evolves. A sharp increase in $H_E(t)$ during the Copper Age indicates chaotic expansion of relationships as souls begin forming bonds in ignorance of their original purity [2].

The function governing edge strength over time can also be modeled. Let the total relational strength of a soul v_i at time t be:

$$W(v_i, t) = \sum_{j:(v_i, v_j) \in E(t)} \|\mathbf{P}_E(e_{ij}, t)\|_2 \tag{27}$$

This captures the magnitude of karmic and emotional commitments a soul bears. During later births in the Iron Age, $W(v_i, t)$ tends to be high, reflecting entangled, dense relational karma.

To summarize, the descent of souls leads to both quantitative and qualitative growth in the karmic graph. This expansion is not merely topological but also affects the information content, relational complexity, and entropy of the network. The transition points, especially between Silver and Copper Ages and from Iron Age to Confluence Age, reveal significant shifts in graph density and edge composition. These are consistent with phase transitions in dynamical systems and corroborated by irreversible entropy theories [2].

8. Time Evolution of the Karmic Graph with Birth, Passing Away, and Descent from the Soul World

In the metaphysical framework of the Brahma Kumaris, the karmic relationships among souls embodied in the Physical Universe are subject to constant transformation. This transformation results from the dynamic interplay of three critical events: the passing away of embodied souls, the birth or rebirth of existing souls, and the descent of new, pure souls from Paramdham, the Meta-Physical Soul World. The karmic graph describing the network of embodied souls in the Physical Universe undergoes continual transformation as a consequence of soul-level events such as birth, passing away, and descent from the metaphysical dimension known as Paramdham. This section introduces a multidimensional, temporally-evolving mathematical model that integrates these transitions while accounting for their emotional, karmic, and spiritual consequences. Let the karmic graph at time $t \in [0, T]$, where $T = 5000$ years, be denoted by:

$$\mathcal{G}(t) = (V(t), E(t), \mathbf{P}_V(t), \mathbf{P}_E(t)) \tag{28}$$

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Here, $V(t)$ represents the set of currently embodied souls, and $E(t) \subseteq V(t) \times V(t)$ is the set of edges capturing all relational, karmic, and emotional connections. Each node $v_i \in V(t)$ is assigned a vector:

$$\mathbf{P}_V(v_i, t) = \begin{bmatrix} p_i^{\text{purity}}(t) \\ p_i^{\text{awareness}}(t) \\ p_i^{\text{resilience}}(t) \end{bmatrix} \in \mathbb{R}^3 \tag{29}$$

Likewise, each edge $e_{ij} \in E(t)$ carries a vector:

$$\mathbf{P}_E(e_{ij}, t) = \begin{bmatrix} w_{ij}^{\text{karmic}}(t) \\ w_{ij}^{\text{emotional}}(t) \\ w_{ij}^{\text{duty}}(t) \\ w_{ij}^{\text{joy}}(t) \end{bmatrix} \in \mathbb{R}^4 \tag{30}$$

When a soul exits the physical realm due to passing away at time t_d, its node and associated edges are removed:

$$V(t_d^+) = V(t_d^-) \setminus \{v_i\} \tag{31}$$

$$E(t_d^+) = E(t_d^-) \setminus \{(v_i, v_j) \in E(t_d^-)\} \tag{32}$$

The family's emotional system is perturbed. Let the sorrow impulse upon passing away be:

$$\Delta S(t_d) = \beta \cdot \mathbf{P}_V(v_i, t_d) \cdot \chi_{\text{passing away family}}(t_d) \tag{33}$$

Here, $\beta \in \mathbb{R}$ is a sorrow sensitivity coefficient, and χ is an indicator function active for the passing away-afflicted subgraph.

The same soul, after an interlude Δt, re-enters through rebirth:

$$t_b = t_d + \Delta t \tag{34}$$

$$V(t_b^+) = V(t_b^-) \cup \{v_i'\} \tag{35}$$

$$\mathbf{P}_V(v_i', t_b) = \theta \cdot \mathbf{P}_V(v_i, t_d) \tag{36}$$

where $0 < \theta < 1$ models degradation in spiritual attributes across births due to karmic entropy.

Upon birth, new edges form between v_i' and family members:

$$E(t_b^+) = E(t_b^-) \cup \{(v_i', v_j) : v_j \in \text{birth family}\} \tag{37}$$

The corresponding joy impulse is:

$$\Delta J(t_b) = \gamma \cdot \mathbf{P}_V(v_i', t_b) \cdot \chi_{\text{birth family}}(t_b) \tag{38}$$

Alongside rebirths, new souls also descend from Paramdham. These are pristine souls, never before embodied:

$$\Phi(t) \subset V(t) \tag{39}$$

Their state vectors reflect maximal purity:

$$\mathbf{P}_V(v_n, t) = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}, \quad \forall v_n \in \Phi(t) \tag{40}$$

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Their birth probability into family F depends on spiritual compatibility:

$$\mathbb{P}(v_n \in F) \propto \frac{1}{H_F(t)} \cdot \bar{P}_F(t) \tag{41}$$

Here, $H_F(t)$ is entropy of family F, and $\bar{P}_F(t)$ is average purity of its members.

The descent rate of new souls decays exponentially:

$$R_\Phi(t) = \alpha e^{-\lambda t}, \quad \alpha, \lambda > 0 \tag{42}$$

The net change in the karmic graph is:

$$\frac{d\mathcal{G}}{dt} = \mathcal{B}(t) + \mathcal{R}(t) + \mathcal{D}(t) \tag{43}$$

where:

$$\mathcal{B}(t) = \text{Node and edge additions from births and descents} \tag{44}$$

$$\mathcal{R}(t) = \text{Rebirth additions, possibly partial inheritance of prior state} \tag{45}$$

$$\mathcal{D}(t) = \text{passing aways and deletions of nodes/edges} \tag{46}$$

To quantify disorder, we define edge entropy:

$$H_E(t) = -\frac{1}{|E(t)|} \sum_{e \in E(t)} \sum_{k=1}^{d_e} \tilde{p}_k(e,t) \log \tilde{p}_k(e,t) \tag{47}$$

where $\tilde{p}_k(e,t)$ is the normalized k-th component of the edge vector. High entropy in later Yugas represents relational complexity and degradation in divine order, consistent with spiritual entropy frameworks [2,3].

This formulation provides a holistic map of spiritual and relational evolution. Souls arrive, depart, and reincarnate, with each such transition reshaping the underlying karmic structure. The dynamic graph captures this fluidity in mathematical terms, enabling future investigations into soul trajectories, emotional resonance propagation, and karmic feedback loops, rooted in the Brahma Kumaris vision of the eternal World Drama Cycle [1].

9. Illustrations of Karmic Correspondence and Mathematical Formulation

The teachings of the Brahma Kumaris, as conveyed by Brahma Baba, often use clear and relatable examples to illustrate the law of karma. These examples demonstrate the principle that the nature and quality of actions performed in one birth directly influence the circumstances and attributes experienced in the next birth. This concept, referred to as karmic correspondence, posits that the outcome is not merely proportional in magnitude to the action but is also correlated in kind. A classical example given in the teachings is that if one offers a lot to charity in a given life, then in the next life one is born into a wealthy family. The act of charity generates a karmic return in the form of abundance, based on the idea that giving away material wealth selflessly in one birth creates the conditions for material affluence in another. Similarly, if one opens a hospital to serve the sick, the karmic return manifests as very good health in the next birth. These examples can be interpreted as instances of a general karmic mapping between domains of action and domains of return. In mathematical terms, let us define for each soul a state vector:

$$\mathbf{P}_V^{(n)} = \begin{bmatrix} w^{(n)} \\ h^{(n)} \\ i^{(n)} \end{bmatrix} \tag{48}$$

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where $w^{(n)}$ represents wealth in birth n, $h^{(n)}$ represents health, and $i^{(n)}$ represents intellect or educational attainment. Actions taken in birth n can be represented by an action vector:

$$\mathbf{A}^{(n)} = \begin{bmatrix} a_c^{(n)} \\ a_m^{(n)} \\ a_e^{(n)} \end{bmatrix} \tag{49}$$

where $a_c^{(n)}$ is the magnitude of charitable actions, $a_m^{(n)}$ represents medical or health-related service actions, and $a_e^{(n)}$ represents educational service actions.

The karmic transformation from one birth to the next can then be modeled as:

$$\mathbf{P}_V^{(n+1)} = \mathbf{P}_V^{(n)} + \mathbf{T} \cdot \mathbf{A}^{(n)} \tag{50}$$

where $\mathbf{T}$ is a karmic transition matrix. For the specific examples provided by Brahma Baba, this matrix might take the form:

$$\mathbf{T} = \begin{bmatrix} \alpha_c & 0 & 0 \\ 0 & \alpha_m & 0 \\ 0 & 0 & \alpha_e \end{bmatrix} \tag{51}$$

Here, α_c is the proportionality constant linking acts of charity to wealth in the next birth, α_m links acts of healing to health, and α_e links educational service to intellect.

The proportionality constants α_c, α_m, and α_e capture the strength of karmic correspondence in each domain. In the spiritual narrative, these constants are determined by the moral quality, purity of intention, and the impact of the actions. In physical analogy, this mapping is reminiscent of a transfer function in systems theory, where the input (actions) is transformed into output (attributes) across successive states.

It is important to note that the karmic mapping described here is not necessarily linear in the strict mathematical sense. In more general cases, the transformation could involve nonlinear terms, saturation effects, or cross-domain influences. For instance, extraordinary acts of charity might not only enhance wealth in the next birth but also increase social capital that indirectly supports health or intellect. This can be modeled as:

$$\mathbf{P}_V^{(n+1)} = f(\mathbf{P}_V^{(n)}, \mathbf{A}^{(n)}) \tag{52}$$

where f is a nonlinear function capturing both direct and indirect karmic effects.

If we allow for cross-domain coupling, the transition matrix $\mathbf{T}$ becomes fully populated:

$$\mathbf{T} = \begin{bmatrix} \alpha_{cc} & \alpha_{cm} & \alpha_{ce} \\ \alpha_{mc} & \alpha_{mm} & \alpha_{me} \\ \alpha_{ec} & \alpha_{em} & \alpha_{ee} \end{bmatrix} \tag{53}$$

In this representation, α_{cm} would quantify how medical service influences wealth, while α_{em} would represent how educational service influences health, and so on. Such a model is more faithful to the complex interplay of karmic returns as understood in a broader philosophical context [1,2].

From the perspective of the karmic graph formalism, each birth can be seen as a discrete time step in the evolution of a vertex's attribute vector. The edges represent karmic interactions with others, while the vertex state is updated based on the aggregate of these interactions. This framework naturally incorporates the principle that the soul carries forward sanskars—subtle imprints of past actions—that shape the trajectory of future births. In conclusion, the examples given by Brahma Baba illustrate a structured mapping between domains of service and domains of return, which can be expressed formally through a state-transition model in the space of soul attributes. This not only bridges the spiritual and mathematical perspectives but also opens the door to further exploration of karmic processes using tools from systems theory and network dynamics.

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10. The Concept of the World Tree in Spiritual Cosmology and Mathematical Representation

In ancient Indian scriptures, and further clarified in the teachings of the Brahma Kumaris, the metaphor of the *World Tree* (also known as the Kalpa Vriksha) serves as a profound illustration of the spiritual and historical relationships among souls. This imagery is drawn from the Vedic description of an inverted tree whose roots are above and branches are below, as mentioned in the Bhagavad Gita [1]. In the incorporeal form, the tree exists in Paramdham, the metaphysical Soul World, where every soul is represented as a point of light connected in a vast inverted structure. The *roots* symbolize the connection to the Supreme Soul, who is the source of purity, peace, and knowledge. In the corporeal form, the same souls descend from their incorporeal state into the physical world to enact their roles in the World Drama, which spans a cyclic 5000-year period. The branches of the tree now correspond to historical developments, migrations, and the expansion of religions over time. From a mathematical perspective, the World Tree can be represented as two interconnected graphs. Let the incorporeal graph be defined as

$$G_I = (V_I, E_I) \tag{54}$$

where V_I represents souls in Paramdham and E_I represents their metaphysical relations, such as shared origins within a religious branch. The corporeal graph is defined as

$$G_C = (V_C, E_C) \tag{55}$$

where V_C represents the incarnated forms of the same souls and E_C represents their historical interactions, such as teacher-disciple lineages or religious conversions.

The mapping from incorporeal to corporeal states can be formalized as a bipartite relation

$$M : V_I \to V_C \tag{56}$$

where each $v_i \in V_I$ corresponds to exactly one $v_c \in V_C$ during a given birth in the Time Cycle. Over the span of multiple births, this mapping evolves in accordance with the rules of the World Drama, where time is discrete and cyclic:

$$M_t : V_I \to V_C^{(t)}, \quad t \in \{0, 1, \ldots, T-1\}, \quad V_C^{(0)} \cong V_C^{(T)} \tag{57}$$

Here T is the period of the World Drama, typically taken as 5000 years in Brahma Kumaris philosophy [9].

Each branch in the incorporeal tree can be indexed by a religion label r_k, $k = 1, 2, \ldots, R$, where R is the total number of religious branches. Within branch r_k, the founding father is the first leaf $l_{k,1}$, followed by successive leaves $l_{k,2}, l_{k,3}, \ldots$ representing followers. In graph-theoretic terms, a branch can be represented as a rooted subtree:

$$B_k = (V_k, E_k), \quad V_k = \{l_{k,j} \mid j \geq 1\}, \quad E_k = \{(l_{k,j}, l_{k,j+1})\} \tag{58}$$

The mapping M ensures that each $l_{k,j} \in V_I$ is mapped to an individual in V_C at a specific historical epoch.

Furthermore, the transition from incorporeal to corporeal form can be modeled as a projection operation π on a higher-dimensional space of soul attributes:

$$\pi : \mathbb{R}^d \to \mathbb{R}^m, \quad m < d \tag{59}$$

where the d-dimensional vector in the incorporeal state represents all latent qualities of the soul, while the m-dimensional corporeal vector represents the manifest qualities in a given birth. This mathematical formalism captures the philosophical teaching that not all soul qualities are expressed in every incarnation, but only those suited to the role in the World Drama.

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In summary, the World Tree provides both a symbolic and structural framework to understand the evolution of souls and religions through time. The incorporeal form describes the eternal identity and relationships of souls in Paramdham, while the corporeal form represents their dynamic interplay within human history.

11. The World Tree: From the United States of Earth Trunk to Religious-Political Diversity

In the philosophical framework presented by the Brahma Kumaris and inspired by ancient Indian scriptures, the World Tree is more than a symbolic illustration of the descent of souls from the incorporeal Soul World to the corporeal plane. It also encodes the history of human civilization from an initial unified state to the diverse array of religions, cultures, and political systems we see today. The trunk of the World Tree, therefore, symbolizes a fully unified civilization in both political and spiritual terms. In graph-theoretic language, this phase can be represented as a connected graph $G_{unity} = (V, E)$ in which all vertices (souls) share identical attributes in the dimensions of governance and religion. Every edge represents a harmonious interaction free of conflict, and the network is maximally connected in the sense that there are no partitions by ideology or territorial control. As time progresses into the later stages of the World Drama, the unity symbolized by the trunk begins to fragment. This fragmentation corresponds to the emergence of distinct branches, each representing a religious-political identity. Mathematically, the graph G_{unity} undergoes a partition into subgraphs:

$$G_{unity} \longrightarrow \bigcup_{k=1}^{B(t)} G_{r_k} \tag{60}$$

where $B(t)$ is the number of branches at time t, and each G_{r_k} corresponds to a community or civilization defined by a distinct religion and political structure. The initial condition for this evolution is:

$$B(t) = 1 \quad \text{for} \quad t < t_c \tag{61}$$

where t_c is the critical time marking the onset of diversity.

The growth of branches after t_c can be modeled as a branching function:

$$B(t) = 1 + \beta(t - t_c) \tag{62}$$

where β is the branching rate. In the symbolic language of the World Tree, each new branch is seeded by a founding father of a religion, such as Christ, Buddha, Mahavira, Guru Nanak, or Mohammed, whose followers form the successive leaves of that branch [1,9].

The branching process can also be understood in terms of a state transition function for the attribute vector of a civilization. Let $\mathbf{C}(t)$ denote the civilization attribute vector at time t, encompassing governance type, spiritual doctrine, and cultural norms. The evolution equation is then:

$$\mathbf{C}_k(t+1) = F(\mathbf{C}_k(t), \mathbf{I}_k(t)) \tag{63}$$

where $\mathbf{I}_k(t)$ represents internal influences (such as philosophical developments) and external influences (such as migrations or inter-cultural exchanges). The function F encapsulates the transformation rules that generate diversity from unity.

In the context of the incorporeal and corporeal forms of the World Tree, the trunk phase corresponds to a situation in the incorporeal graph G_I where all vertices are linked to a single religious-spiritual root. The mapping M_t from G_I to the corporeal graph G_C during the trunk phase is:

$$M_t : V_I \to V_C^{(t)}, \quad \forall v_i \in V_I,\ \text{Rel}(v_c) = R_0 \tag{64}$$

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where $\mathrm{Rel}(v_c)$ denotes the religion attribute of v_c and R_0 is the singular religion of the USE era. After t_c, the mapping evolves into:

$$M_t : V_I \to V_C^{(t)}, \quad \mathrm{Rel}(v_c) \in \{R_1, R_2, \ldots, R_{B(t)}\} \tag{65}$$

representing the onset of multi-religious and multi-political identities.

The model also allows for the quantification of diversity using entropy-like measures. Let $p_k(t)$ be the proportion of the population in branch k at time t. The religious-political diversity can then be defined as:

$$H(t) = -\sum_{k=1}^{B(t)} p_k(t) \log p_k(t) \tag{66}$$

which starts at $H(t) = 0$ for the unified trunk phase and increases as branches multiply and populations distribute among them.

In summary, the trunk of the World Tree represents the idealized period of the United States of Earth, a state of total unity in governance and religion. The subsequent emergence of branches mathematically models the inevitable diversification of human society over the Time Cycle.

12. United States of Earth and the Language Tree: From Unity to Diversity

In the early stages of the World Drama Cycle, corresponding to the Golden Age and Silver Age in Brahma Kumaris philosophy, the trunk of the World Tree represents the United States of Earth (USE), a unified global civilization with one government, one religion, and one universal language [9]. This universal language served as the perfect medium for the transmission of knowledge, cultural values, and spiritual understanding. Mathematically, this situation can be represented as a linguistic network $L(t) = (V_L, E_L)$ where V_L denotes all speakers and E_L denotes the perfect mutual intelligibility links between them. At $t = 0$ (start of the Golden Age), the network is complete:

$$E_L(t = 0) = \{(v_i, v_j) \mid \forall i, j \in V_L, i \neq j\} \tag{67}$$

and the linguistic distance function $d_L(i, j, t)$ between any two individuals i and j satisfies:

$$d_L(i, j, 0) = 0 \tag{68}$$

indicating total mutual intelligibility.

As the Time Cycle moves into the Copper Age (t_c) and beyond, the political and religious unity of USE begins to fragment. Geographic dispersal of populations leads to a breakdown of linguistic unity, initiating a process of language divergence. We can model the linguistic distance between two speech communities as growing linearly with time after separation:

$$d_L(i, j, t) = \gamma\,(t - t_s) \tag{69}$$

for $t \geq t_s$, where t_s is the time of separation and γ is the divergence rate constant. This divergence rate is influenced by geographical distance, environmental adaptation, and cultural isolation.

The number of distinct languages $N_L(t)$ at time t can be modeled analogously to the branching of the World Tree's religious-political diversity:

$$N_L(t) = 1 \quad \text{for} \quad t < t_c \tag{70}$$

$$N_L(t) = 1 + \lambda(t - t_c) \quad \text{for} \quad t \geq t_c \tag{71}$$

where λ is the linguistic branching rate, determined by how quickly new speech forms become mutually unintelligible with their parent languages.

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If we let $p_k(t)$ represent the proportion of the population speaking language k at time t, the linguistic diversity index can be expressed using an entropy measure:

$$H_L(t) = -\sum_{k=1}^{N_L(t)} p_k(t) \log p_k(t) \tag{72}$$

In the USE era, $H_L(t) = 0$, since $p_1(t) = 1$. As time progresses, $H_L(t)$ increases, reflecting the fragmentation of the linguistic landscape. This mirrors the philosophical teaching that the purity and unity of the early ages give way to diversity and complexity in later ages [1,11].

From a graph-theoretic viewpoint, the linguistic network transitions from a complete graph K_n during the USE period to a forest of disconnected subgraphs as linguistic communities lose mutual intelligibility. The language tree itself can be formalized as a rooted tree $T_L = (V_T, E_T)$, where the root represents the universal language of USE and each branching point represents a linguistic split. In conclusion, the language tree offers a parallel structural narrative to the World Tree. Both begin with unity — in governance, religion, and language — during the USE era, and both diversify over time as physical, cultural, and spiritual distances grow. By modeling this process with formal mathematical tools, one can quantify the rates and structures of diversification while preserving the symbolic depth of the original spiritual teaching.

13. The British Empire as a Historical Analogy for the USE Language Unification

In considering the concept of the United States of Earth (USE) in the early Golden and Silver Ages of the World Drama Cycle, it is useful to examine historical analogies in which political and economic unity fostered linguistic unification. One of the most compelling parallels is the British Empire, which, at its height, spanned continents and was described by the expression "the sun never sets on the British Empire" [12]. The British Empire's global reach established English as a linguistically dominant language across vast regions of the globe, much as the USE era would see a universal language used worldwide.

In the case of the British Empire, political unity was partial rather than complete. Multiple languages coexisted within its territories, yet English became the dominant language of administration, trade, diplomacy, and education. This can be compared to the USE era, in which one universal language serves as the medium for all interactions across the globe. In both cases, centralized governance facilitated a high degree of linguistic standardization.

Let $L(t)$ represent the number of distinct languages in a political entity at time t. In the USE era, we have:

$$L_{USE}(t) = 1, \quad \forall t < t_c \tag{73}$$

where t_c marks the onset of cultural and geographic separation that leads to language diversification. For the British Empire, however, the number of languages $L_{BE}(t)$ remained significantly greater than one:

$$L_{BE}(t) > 1, \quad \forall t \tag{74}$$

even during its period of greatest territorial integration.

Nevertheless, the spread of English in the British Empire can be modeled as a diffusion process. Let $p_E(t)$ be the proportion of the empire's population that is proficient in English at time t. This follows a logistic growth model:

$$\frac{dp_E}{dt} = \alpha p_E(t) \left[1 - \frac{p_E(t)}{K}\right] \tag{75}$$

where α is the adoption rate and $K \leq 1$ is the maximum attainable proportion of English speakers, constrained by cultural and political factors. In the USE model, $K = 1$ by definition, as universal language adoption is complete.

When the British Empire dissolved, the political unity that had supported the spread of English was replaced by national independence movements. This is analogous to the fragmentation of USE

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in the Copper Age, except that in the USE model, the original unity is total and its fragmentation is gradual and cyclic. After dissolution, the English language remained globally influential, much like how in the later World Drama Cycle, the original USE language may continue to influence linguistic descendants.

The persistence of English post-empire can be described by a survival function for linguistic influence:

$$S(t) = e^{-\mu(t-t_d)} \tag{76}$$

where t_d is the time of political dissolution and μ is the decay constant representing the rate at which linguistic influence diminishes. For English, μ has been very small due to the language's entrenched role in global trade, science, and media [11]. In the USE scenario, a similarly low decay constant could be expected, given the deeply embedded role of the universal language in spiritual and cultural life.

The analogy between the British Empire and USE, therefore, is instructive. In both cases, political integration facilitates linguistic standardization. The main differences lie in the completeness of unity (total in USE, partial in the British Empire) and in the cyclic nature of fragmentation in USE as opposed to the linear historical trajectory of the British Empire. Both, however, illustrate the powerful link between political structures and language dominance over wide geographic areas.

14. Graph-Theoretic Modeling of Nations and Their Relationships in Time Evolution

In extending the karmic account model of souls to the geopolitical domain, we can represent the world order at any given point in history as a time-dependent graph $G_N(t)$ in which vertices correspond to nations and edges correspond to relationships between them [10]. These relationships can take many forms, including alliances, trade partnerships, defense agreements, rivalries, and conflicts. The time evolution of such a graph reflects the dynamic nature of international relations, influenced by cultural shifts, economic demands, and historical cycles.

Formally, we define:

$$G_N(t) = \big(V_N(t), E_N(t), w_t\big) \tag{77}$$

where $V_N(t)$ is the set of nations at time t, $E_N(t)$ is the set of relationships between them, and $w_t : E_N(t) \to \mathbb{R}$ assigns a signed weight to each relationship, positive for cooperative interactions and negative for hostile interactions. The magnitude of w_t quantifies the intensity of the relationship. For example, high positive values might represent deep economic and cultural integration, while high negative values could represent armed conflict or severe sanctions.

The dynamic nature of $G_N(t)$ can be expressed in terms of its adjacency matrix $A_N(t)$, where $A_{ij}(t) = w_t(e_{ij})$ if a relationship exists between nations i and j at time t, and 0 otherwise. The temporal change in the adjacency matrix can be modeled as:

$$\frac{dA_N(t)}{dt} = F\big(A_N(t), X(t)\big) \tag{78}$$

Here, F is a function that encapsulates the rules of interaction, and $X(t)$ represents external drivers such as technological developments, climate change, shifts in resource availability, or ideological movements. The modeling of F can range from linear differential systems to agent-based simulations depending on the level of complexity required [13].

The evolution of the number of nations $|V_N(t)|$ is itself a dynamic process influenced by unification and fragmentation events. In a unified stage such as the United States of Earth (USE) era, we have:

$$|V_N(t)| = 1 \quad \text{for} \quad t < t_c \tag{79}$$

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where t_c is the onset of political fragmentation. After t_c, $|V_N(t)|$ increases as regions declare independence or as empires dissolve:

$$\frac{d|V_N(t)|}{dt} = \eta_f - \eta_u \tag{80}$$

where η_f is the fragmentation rate and η_u is the unification rate. In a stable fragmented world, these two rates may balance, while in periods of imperial expansion or global governance they may shift drastically.

The cooperative and competitive balance in the global system can be quantified using a cooperation index $C(t)$ defined as:

$$C(t) = \frac{\sum_{i<j} \max\left(0, A_{ij}(t)\right)}{\sum_{i<j} |A_{ij}(t)|} \tag{81}$$

which gives the fraction of the total relationship weight that is cooperative. In the USE period, $C(t) = 1$, as all relations are cooperative by definition. Over time, as competition and conflict emerge, $C(t)$ declines.

In analogy with the karmic account model for souls, where the network captures spiritual and moral exchanges, the nation-relationship graph captures the ebb and flow of geopolitical capital. Just as karmic debt or credit accumulates through repeated interactions, nations accumulate trust or hostility in proportion to the sum of weighted interactions over time. This can be expressed as:

$$K_i(t) = \sum_{j \neq i} \int_0^t A_{ij}(\tau)\, d\tau \tag{82}$$

where $K_i(t)$ is the cumulative geopolitical standing of nation i up to time t. Positive values of $K_i(t)$ correspond to a history of cooperation, while negative values indicate a history of hostility.

Such a formal model allows for the exploration of cyclical patterns analogous to the World Drama Cycle in spiritual philosophy [9]. Periods of high unity correspond to densely connected, cooperative graphs, while periods of disunity correspond to fragmented graphs with heterogeneous edge weights. By integrating historical data into this framework, one can model not only the present structure of the world system but also predict possible trajectories, given assumptions about the functional form of F.

15. Modeling the National Pain Body within the Time-Evolving Nation Relationship Graph

Eckhart Tolle's concept of the *pain body* describes the accumulation of unresolved emotional pain within individuals and collectives, which can be triggered by certain stimuli, causing disproportionate emotional responses [14]. This concept can be extended to nations, treating the historical and cultural memory of collective trauma — such as wars, colonization, economic depression, or political oppression — as a *national pain body*. To integrate the pain body into the nation relationship graph, let $G_N(t) = (V_N(t), E_N(t), w_t)$ represent the geopolitical network at time t, where $V_N(t)$ is the set of nations, $E_N(t)$ is the set of international relationships, and w_t assigns weights to these relationships. Unlike simple scalar weights, we can model $w_{ij}(t)$ as a multidimensional vector capturing various aspects of the relationship between nations i and j:

$$w_{ij}(t) = \left(T_{ij}(t), R_{ij}(t), M_{ij}(t), D_{ij}(t)\right) \tag{83}$$

where $T_{ij}(t)$ denotes the trade index, $R_{ij}(t)$ denotes the sports rivalry index, $M_{ij}(t)$ denotes the military index, and $D_{ij}(t)$ denotes the diplomatic relations index. Positive values in each dimension indicate cooperative or friendly relationships, while negative values indicate rivalry or hostility.

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Let $P_i(t)$ represent the size or intensity of the national pain body for nation i at time t. The rate of change of $P_i(t)$ can be modeled as:

$$\frac{dP_i(t)}{dt} = \alpha \sum_{j \neq i} \Theta\big(-M_{ij}(t)\big) + \beta H_i(t) - \gamma C_i(t) \tag{84}$$

where Θ is the Heaviside function that activates when military interactions are hostile, $H_i(t)$ represents the historical unresolved grievances, and $C_i(t)$ represents the level of reconciliation or conflict resolution. The constants α, β, γ denote, respectively, the sensitivity of the pain body to new hostile events, the persistence of historical trauma, and the healing rate due to reconciliation efforts.

The pain body can in turn influence the evolution of edge weights in the nation relationship graph. For example, the military relationship index can evolve according to:

$$\frac{dM_{ij}(t)}{dt} = -\lambda_1 P_i(t) - \lambda_2 P_j(t) + \delta_{ij}(t) \tag{85}$$

where λ_1 and λ_2 measure the degree to which the pain bodies of nations i and j increase hostility, and $\delta_{ij}(t)$ represents external cooperative events such as joint peacekeeping missions.

Similarly, diplomatic relations can be modeled as:

$$\frac{dD_{ij}(t)}{dt} = \rho_{ij}(t) - \mu\big[P_i(t) + P_j(t)\big] \tag{86}$$

where $\rho_{ij}(t)$ accounts for diplomatic engagement (treaties, summits, trade agreements), and μ measures the extent to which activated pain bodies erode diplomatic goodwill.

This coupled system of equations represents a feedback loop between historical memory, present actions, and the structural evolution of the geopolitical network. Just as karmic accounts between souls evolve with interaction, the national pain body influences and is influenced by the state of inter-nation relationships.

In the World Drama Cycle analogy [9], periods of unity such as the United States of Earth (USE) correspond to minimal or zero national pain bodies, with $P_i(t) \approx 0$ for all i. Over time, as fragmentation occurs and historical grievances accumulate, $P_i(t)$ grows, influencing the overall cooperation index of the network:

$$C(t) = \frac{\sum_{i<j} \max\big(0, D_{ij}(t)\big)}{\sum_{i<j} |D_{ij}(t)|} \tag{87}$$

High $C(t)$ values in early ages give way to lower $C(t)$ values as pain bodies are triggered and hostile relations develop.

The introduction of the national pain body concept into the time-evolving nation relationship graph thus provides a formalism for capturing the qualitative insights of Tolle's philosophy within a rigorous mathematical and geopolitical framework. It enables the modeling of non-linear and memory-dependent effects in the evolution of international relations, helping explain why certain conflicts persist for centuries while others resolve rapidly.

16. The Virtue Field Concept for Nations and Souls

In the study of moral and spiritual dynamics across both individual and collective entities, it is instructive to introduce the concept of a *virtue field*, analogous to the gravitational or electromagnetic field in physics [15]. Just as a physical field quantifies the influence of a mass or charge on its surroundings, the virtue field quantifies the moral and spiritual influence exerted by a soul or nation over others. We denote the virtue field of an entity located at position $\mathbf{r}_0$ at time t as $V(\mathbf{r}, t)$, where

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$\mathbf{r}$ represents the spatial position at which the field is measured. The general form of the virtue field generated by a soul or nation i with virtue strength $Q_i(t)$ can be written as:

$$V_i(\mathbf{r}, t) = \frac{Q_i(t)}{\|\mathbf{r} - \mathbf{r}_i\|^n} \tag{88}$$

where n is the decay exponent of the field, analogous to the inverse-square law ($n = 2$) in gravitation and electrostatics, and $\mathbf{r}_i$ is the position of the entity in the relevant space. For soul-level interactions, $\mathbf{r}$ can be interpreted as a position in a moral or karmic configuration space rather than physical space [9].

The virtue strength $Q_i(t)$ is not constant; it evolves over the World Drama Cycle. In the Golden Age, $Q_i(t)$ is maximal, reflecting perfect virtue. As the Iron Age approaches, $Q_i(t)$ decays due to the accumulation of vices and loss of spiritual awareness. This can be modeled as an exponential decay:

$$\frac{dQ_i}{dt} = -\lambda Q_i(t) \tag{89}$$

with solution

$$Q_i(t) = Q_i(0)e^{-\lambda t} \tag{90}$$

where λ is the virtue decay constant. In the Confluence Age, there is a rapid restoration of virtue, modeled by a logistic growth equation:

$$\frac{dQ_i}{dt} = \alpha Q_i(t)\left[1 - \frac{Q_i(t)}{Q_{\max}}\right] \tag{91}$$

where α is the restoration rate and $Q_{\max}$ is the maximal attainable virtue strength.

The virtue field modifies the interaction weights in the karmic or nation relationship graph. If $A_{ij}(t)$ is the adjacency matrix representing the connection between nodes i and j, the virtue field influence can be introduced as a multiplicative bias:

$$A_{ij}^{\text{virtue}}(t) = A_{ij}(t) \cdot \left[1 + \kappa \frac{V_i(\mathbf{r}_j, t) + V_j(\mathbf{r}_i, t)}{2}\right] \tag{92}$$

where κ is a coupling constant measuring the sensitivity of relational dynamics to virtue influence. This term ensures that when two entities have strong virtue fields, their relationship weight is biased toward cooperation.

The cumulative virtue field in the system at any time t can be expressed as the superposition:

$$V_{\text{total}}(\mathbf{r}, t) = \sum_i V_i(\mathbf{r}, t) \tag{93}$$

This allows for the study of large-scale moral landscapes in which cooperative clusters emerge in regions where the virtue field is strong, and competitive or hostile regions arise where the virtue field is weak or absent.

Over time, the virtue field's evolution in the karmic graph can be seen as the driver of phase transitions in collective behavior. In the early Golden Age, V_{total} is uniform and maximal, corresponding to a fully cooperative network. In the Iron Age, V_{total} becomes heterogeneous and diminished, allowing hostile interactions to develop. In the Confluence Age, rapid virtue restoration shifts the network back toward full cooperation.

This formalism bridges the gap between spiritual philosophy and quantitative network modeling, providing a tool to capture the intangible but impactful role of moral and spiritual qualities in shaping the structure and dynamics of both soul and nation relationships.

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17. Network Phase Transitions and the World Drama Cycle

The evolution of the karmic and nation relationship graphs over the World Drama Cycle can be formally modeled using the concept of *graph-theoretic phase transitions* [16]. In statistical physics, a phase transition is a qualitative change in the macroscopic properties of a system resulting from a continuous change in some control parameter. We define the karmic or nation network at time t as $G(t) = (V(t), E(t), w_t)$, with $|V(t)|$ representing the number of nodes (souls or nations) and $E(t)$ the set of edges (relationships). The *USE Era* corresponds to a fully connected cooperative graph, where every pair of nodes is linked by a positive-weight edge. This is a *complete graph* K_N with $N = |V(t)|$:

$$|E(t)| = \frac{N(N-1)}{2}, \quad A_{ij}(t) > 0 \quad \forall i \neq j \tag{94}$$

This state is stable in the Golden and Silver Ages, reflecting the unified and harmonious nature of relationships.

Fragmentation occurs when cooperative ties are lost and the network undergoes a percolation transition. Let p denote the probability that any given cooperative edge remains intact as time progresses into the Copper and Iron Ages. The critical percolation threshold p_c is the value of p at which the network loses its *giant component* [17]:

$$p_c \approx \frac{1}{\langle k \rangle} \tag{95}$$

where $\langle k \rangle$ is the average degree of the network. When $p < p_c$, the network breaks into multiple disconnected components, corresponding to the fragmentation of the United States of Earth (USE) into multiple political, cultural, and religious groups.

The size of the largest connected component $S(t)$, normalized by the total number of nodes, serves as an order parameter for the phase transition:

$$S(t) = \frac{|C_{\max}(t)|}{|V(t)|} \tag{96}$$

In the USE Era, $S(t) = 1$. As fragmentation proceeds and p decreases, $S(t)$ drops sharply around p_c.

Restoration occurs in the Confluence Age, where cooperative ties are rapidly re-established. This re-percolation process can be modeled as:

$$\frac{dp}{dt} = \alpha(1 - p) \tag{97}$$

with solution:

$$p(t) = 1 - [1 - p(t_0)]e^{-\alpha(t-t_0)} \tag{98}$$

where α is the cooperation restoration rate. As $p(t)$ surpasses p_c during the Confluence Age, the giant component re-emerges and $S(t)$ returns toward unity.

The interplay between virtue field dynamics and percolation thresholds creates a deeper connection between spiritual and graph-theoretic models. The decay of the virtue field in the Iron Age effectively reduces p, pushing the network toward fragmentation. Conversely, the rapid restoration of virtue in the Confluence Age increases p, driving the network back through the percolation threshold into a unified state.

This modeling approach not only provides a mathematical lens through which to view the cyclical unity and disunity described in the World Drama Cycle [9], but also allows quantitative predictions of the resilience and restoration potential of cooperative networks in both spiritual and geopolitical contexts.

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18. Cultural Entanglement Between Nations

The concept of *cultural entanglement* draws inspiration from quantum entanglement, where the quantum states of two or more particles remain correlated even when they are spatially separated [18]. In a geopolitical and sociocultural context, pairs or groups of nations can develop and maintain deep cultural linkages — shared values, artistic traditions, linguistic heritage, or historical narratives — that persist despite fluctuations in political or economic ties. Let $G_N(t) = (V_N(t), E_N(t), w_t)$ be the nation relationship graph, where $w_{ij}(t)$ encodes the strength and nature of the relationship between nations i and j. We introduce a *cultural entanglement coefficient* $E^c_{ij}(t)$ to represent the degree of shared cultural heritage between nations i and j at time t. This coefficient acts as a latent variable that modifies the effective edge weight:

$$w^{\text{eff}}_{ij}(t) = w_{ij}(t) + \eta E^c_{ij}(t) \tag{99}$$

where η is a coupling constant that determines how strongly cultural entanglement influences the overall relationship.

The cultural entanglement coefficient evolves slowly compared to political or economic variables, as cultural traditions and shared histories change on generational or even civilizational timescales. Its time evolution can be modeled as:

$$\frac{dE^c_{ij}}{dt} = -\lambda_c E^c_{ij}(t) + \mu_c I_{ij}(t) \tag{100}$$

where λ_c is the natural decay rate of entanglement in the absence of cultural exchange, and $\mu_c I_{ij}(t)$ represents reinforcement through active interaction $I_{ij}(t)$, such as exchange programs, artistic collaborations, or migration flows.

In analogy to the density matrix formalism of quantum mechanics, the cultural state of the system can be represented by a symmetric matrix $\rho^c(t)$, where $\rho^c_{ij}(t) = E^c_{ij}(t)$ for $i \neq j$, and $\rho^c_{ii}(t)$ measures a nation's cultural self-coherence. The normalization condition can be imposed as:

$$\text{Tr}(\rho^c(t)) = N \tag{101}$$

where N is the number of nations. This structure allows us to compute *cultural entanglement entropy*:

$$S_c(t) = -\sum_k \lambda_k(t) \log \lambda_k(t) \tag{102}$$

where $\lambda_k(t)$ are the eigenvalues of $\rho^c(t)$. A high value of $S_c(t)$ indicates a richly entangled and culturally interconnected world, while low $S_c(t)$ corresponds to cultural isolationism.

Cultural entanglement acts as a stabilizing factor in the nation graph. Even if political relations become strained, a high $E^c_{ij}(t)$ ensures that cooperative interactions can be restored more easily, as shared cultural frameworks provide a foundation for reconciliation. This is particularly relevant in the context of the World Drama Cycle [9], where fragmentation in the Copper and Iron Ages may sever political ties but leave underlying cultural bonds intact. From a dynamical perspective, the interplay between political adjacency $A_{ij}(t)$ and cultural entanglement $E^c_{ij}(t)$ can be modeled as a coupled system:

$$\frac{dA_{ij}}{dt} = f(A_{ij}, E^c_{ij}, X(t)), \quad \frac{dE^c_{ij}}{dt} = g(E^c_{ij}, I_{ij}(t)) \tag{103}$$

where $X(t)$ encodes external drivers such as economic shifts or geopolitical events. Functions f and g can be tailored to specific scenarios, enabling simulations of how cultural resilience mediates the effects of transient political shocks.

This formalism offers a way to mathematically capture the long-lived, often hidden structures of interdependence between nations. By recognizing cultural entanglement as a key dimension of international relationships, it becomes possible to predict and understand the persistence of cooperation in the face of temporary political disunity.

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19. Karmic Shockwaves in the Network

In the dynamics of both the soul network and the nation relationship graph, certain events act as *shockwaves*, producing immediate and widespread effects on relationships far beyond their point of origin. Historical examples include wars, revolutions, spiritual awakenings, and transformative inventions such as the printing press or the internet. Mathematically, these shockwaves can be modeled using wave equations on graphs [19], where the propagation medium is the network itself. Let $w_{ij}(t)$ denote the weight of the relationship between nodes i and j (souls or nations) at time t. The time evolution under the influence of a shockwave can be written as:

$$\frac{\partial^2 w_{ij}(t)}{\partial t^2} - c^2 \nabla_G^2 w_{ij}(t) = S_{ij}(t) \tag{104}$$

where c is the propagation speed of influence through the network, ∇_G^2 is the graph Laplacian operator capturing the discrete spatial structure of the network, and $S_{ij}(t)$ is a source term representing the initiating event.

The graph Laplacian L for a network with adjacency matrix A and degree matrix D is defined as:

$$L = D - A \tag{105}$$

and its action on a function f defined on the nodes of the graph is given by:

$$(\nabla_G^2 f)_i = \sum_j A_{ij}[f_i - f_j] \tag{106}$$

This operator naturally encodes the notion of influence diffusion across the network, making it well-suited to modeling shockwave propagation.

The solution to the wave equation on a graph can be expressed in terms of the spectral decomposition of the Laplacian. Let $\{\lambda_k, \phi_k\}$ be the eigenvalues and eigenvectors of L. Then the general solution for the homogeneous equation ($S_{ij}(t) = 0$) is:

$$w_{ij}(t) = \sum_k \left[a_k \cos\left(c\sqrt{\lambda_k} t\right) + b_k \sin\left(c\sqrt{\lambda_k} t\right) \right] \phi_k(i,j) \tag{107}$$

where the coefficients a_k and b_k are determined by initial conditions.

The source term $S_{ij}(t)$ models the event generating the shockwave. For example, a sudden war between nations p and q can be represented as:

$$S_{ij}(t) = \delta_{ip}\delta_{jq} \cdot A_0 e^{-\beta t} \tag{108}$$

where A_0 is the amplitude of the shockwave and β is a damping constant describing how quickly its direct influence fades over time. In spiritual networks, a mass meditation event or major teaching revelation can be modeled as a positive shockwave, with $A_0 > 0$, leading to increased cooperation and virtue field restoration.

The total energy of the shockwave in the network can be defined analogously to classical wave systems as:

$$E(t) = \frac{1}{2} \sum_{i,j} \left[\left(\frac{\partial w_{ij}}{\partial t} \right)^2 + c^2 \left\| \nabla_G w_{ij} \right\|^2 \right] \tag{109}$$

This energy decays over time due to damping and network dispersion, but its distribution at intermediate times reveals the reach and impact of the original event.

In the framework of the World Drama Cycle [9], karmic shockwaves play a pivotal role in driving rapid structural changes in the network. In the Iron Age, wars and disasters produce negative shockwaves that weaken cooperative bonds, while in the Confluence Age, spiritual awakenings generate positive shockwaves that rapidly restore unity.

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20. Coupling Between the Soul Graph and the Nation Graph

The soul network and the nation relationship network have thus far been modeled as separate entities. However, in reality, these two systems are deeply interwoven. The karmic interactions of individual souls, accumulated over successive births, aggregate to shape the relationships between nations. Conversely, nation-level conflicts, alliances, and cultural exchanges feed back into the karmic accounts of the individuals within those nations. This interdependence can be formally modeled as a *two-layer multiplex network*.

Let the soul layer be represented by the graph $G_S(t) = (V_S, E_S, w_S(t))$, where V_S is the set of souls, E_S is the set of soul-to-soul interactions, and $w_S(t)$ gives the karmic weight of each interaction. The nation layer is given by $G_N(t) = (V_N, E_N, w_N(t))$, where V_N is the set of nations, E_N is the set of inter-nation relationships, and $w_N(t)$ measures political, economic, or diplomatic strength.

We introduce an inter-layer coupling matrix $C(t)$, where each element $C_{a\alpha}(t)$ represents the association between soul $a \in V_S$ and nation $\alpha \in V_N$ at time t. The full multiplex network can thus be represented as:

$$\mathcal{G}(t) = \begin{bmatrix} G_S(t) & C(t) \\ C^\top(t) & G_N(t) \end{bmatrix} \tag{110}$$

The dynamics of the multiplex network are governed by the interaction of intra-layer and inter-layer influences. The evolution of the soul-layer edge weights can be modeled as:

$$\frac{dw_{S,ab}}{dt} = F_S(w_{S,ab}, Q_a, Q_b) + \gamma_S \sum_{\alpha,\beta} C_{a\alpha} C_{b\beta} w_{N,\alpha\beta} \tag{111}$$

where Q_a and Q_b are the virtue strengths of souls a and b respectively, F_S models the intrinsic karmic dynamics, and the second term represents the influence of nation-level relationships on individual karmic ties. The parameter γ_S measures the strength of top-down influence from nations to souls.

Similarly, the evolution of nation-layer edge weights can be expressed as:

$$\frac{dw_{N,\alpha\beta}}{dt} = F_N(w_{N,\alpha\beta}, E^c_{\alpha\beta}) + \gamma_N \sum_{a,b} C_{a\alpha} C_{b\beta} w_{S,ab} \tag{112}$$

where F_N models the intrinsic nation-to-nation dynamics, $E^c_{\alpha\beta}$ is the cultural entanglement coefficient between nations α and β, and the second term aggregates the bottom-up effect of soul interactions on nation relationships. The parameter γ_N quantifies this aggregation strength.

In matrix form, the coupled dynamics of the multiplex network can be compactly written as:

$$\frac{d}{dt}\begin{bmatrix} W_S \\ W_N \end{bmatrix} = \begin{bmatrix} F_S(W_S) \\ F_N(W_N) \end{bmatrix} + \begin{bmatrix} 0 & \gamma_S \mathcal{A}_{SN} \\ \gamma_N \mathcal{A}_{NS} & 0 \end{bmatrix} \begin{bmatrix} W_S \\ W_N \end{bmatrix} \tag{113}$$

where $\mathcal{A}_{SN}$ and $\mathcal{A}_{NS}$ are aggregation operators mapping between layers.

This framework allows for the simulation of scenarios where, for example, prolonged war between two nations degrades the karmic ties among their respective citizens, or where a mass spiritual awakening in a subset of souls strengthens diplomatic bonds between their nations. By capturing the bidirectional coupling between the micro-level soul graph and the macro-level nation graph, the multiplex model provides a holistic representation of the moral and political fabric of the world, allowing for predictive and explanatory insights into its cyclical evolution.

21. Conclusion

This work has developed an integrative framework that models the intertwined journeys of individual souls and collective nations within the cyclical 5000-year World Drama Cycle as described in the Brahma Kumaris tradition. Souls were represented as nodes in a karmic interaction graph, with edges encoding the sign and magnitude of their relationships based on karmic exchanges. A

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central theme introduced was the concept of the "United States of Earth" (USE), representing the initial state of complete planetary unity in the Golden Age and its eventual re-manifestation during the Confluence Age. In this state, both the soul graph and the nation graph exhibit maximal connectivity and cooperation, symbolizing harmony between spiritual virtues and political structures. Innovations in the modeling include the formulation of virtue fields, which quantify the radiative influence of virtues such as truth and compassion across the network, the concept of cultural entanglement coefficients to capture deep-rooted shared traditions, and the introduction of karmic shockwaves to describe how major events ripple through the soul and nation graphs. The dual-layer model provides a versatile foundation for future exploration. Potential directions include empirical calibration of model parameters with historical and sociological data, simulation of various karmic and geopolitical perturbations, and application of spectral graph theory to study stability and resilience across the ages. By merging spiritual cosmology with rigorous graph-theoretic formalism, this paper has aimed to create a bridge between ancient metaphysical understanding and modern analytical science. In doing so, it invites further dialogue between scholars of mathematics, physics, philosophy, and spirituality to collectively envision the return of a fully connected, cooperative, and virtuous planetary society—embodied in the eternal recurrence of the United States of Earth.

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