

THE SINGLE MONAD MODEL / DUALITY OF TIME THEORY

Duality of Time: generation, completion, and physical clocks

One generative process, two temporal roles, and a concrete question: how do the operations that form a configuration become the events and durations that an observer can read?

Complete printable foundation guide
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<https://www.smonad.com/time/index.html>

The central idea

Inner order describes generation. Outer order concerns completed records. Six nested roles can organize the first, while a completion interface makes the second available. Physical duration requires a specified clock and calibration.

Contents

1. Generation, completion, and duration	2
2. Six nested roles and the seventh completion	2
3. A counter model with an exact rank calculation	3
4. The binary example: 64 addresses, 27 sites	4
5. What makes a return a completion?	5
6. From record order to a clock	5
7. Ordinary complex phase and split-complex geometry	6
8. Why recurrence alone does not choose a future	7
9. A short derivation of memory after projection	7
10. Reading different DTT formulations together	8
Further reading	9

1. Generation, completion, and duration

DTT distinguishes the activity through which a configuration is formed from the completed configuration available for observation. The first role is called inner or generative time; the second concerns outer completion and the succession of accessible records. This distinction asks us to account for the formation of the observable world, including the clocks within it.

Three notions should be kept separate. **Order** tells us which operation or event precedes another. **Completion** tells us when an admissible result has been produced. **Duration** compares an interval with a physical standard. A list of completed events can have an order even when no equal-duration tick has been established.

In a state-update model, an iteration label n tracks applications of a map U . A clock reading T is an observable of the model's state or records. If T advances uniformly with n in a specified regime, that is a property to demonstrate. If the number of internal operations per completed event varies, event count and duration can also vary independently.

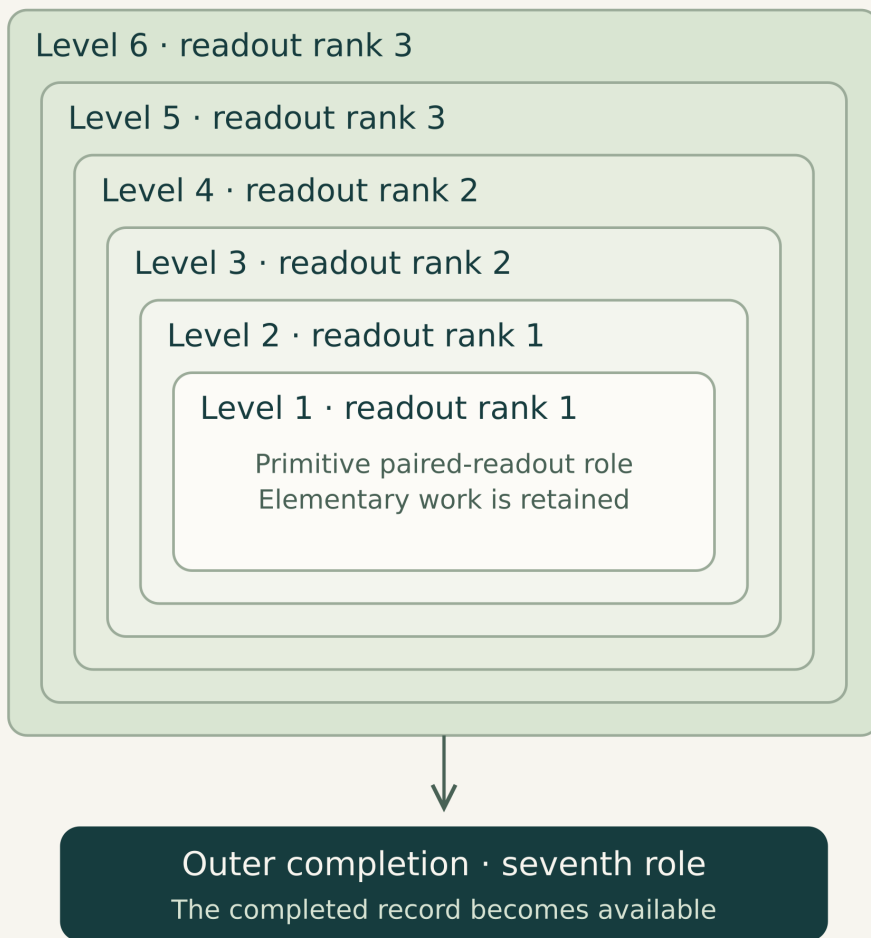
2. Six nested roles and the seventh completion

The six inner levels are organized by dependency: a higher stage uses or completes work organized at lower stages. This can be represented by carry periods, composed operations, or successively available records. The seventh role is the interface at which the assembled result becomes a completed observable configuration.

In the paired readout used in several explanatory constructions, the successive ranks are 1, 1, 2, 2, 3, 3. Two roles support one signed direction, then another pair supports a second direction, then the final pair a third. The rank sequence describes that architecture. It is not a list of six independent laboratory clocks, and the outer completion is not a seventh spatial coordinate.

Six inner roles; one completion interface

Nested dependencies, not independent time axes



Each higher enclosure depends on lower-level work. The rank labels belong to the paired-readout example explained below. The drawing illustrates a dependency hierarchy, not six spatial shells or independent time axes.

[Open the full-size diagram →](#)

The hierarchy can be used in a finite mathematical realization while its physical selection remains a further question. To show necessity, one must identify which source assumptions require the pairing, the allowed primitive channels, and one channel per level. Merely naming six stages does not establish that alternatives are impossible.

3. A counter model with an exact rank calculation

Let q be an integer radix at least 2. Write a single counter in six digits $d_1, \dots, d_6$, with the lowest digit changing most often. The higher digits advance after completed lower-digit cycles. This is one update sequence with nested periods $q^0, q^1, \dots, q^5$.

$$n = \sum_{a=1}^6 q^{a-1} d_a, 0 \leq d_a < q.$$

$$Q(d) = \ell[(d_1-d_2)e_1 + (d_3-d_4)e_2 + (d_5-d_6)e_3].$$

Q is a supplied spatial readout. The independent vectors e_1, e_2, e_3 , their pairing, and the length scale ℓ are inputs to this example.

During the first q^a counter addresses, the first a digits vary freely and the remaining digits are zero. The first digit varies along e_1 ; its partner changes the same coordinate with the opposite sign. The third digit introduces e_2 , and the fifth introduces e_3 . Hence the affine rank of that prefix is $\lceil a/2 \rceil$.

The paired-readout rank sequence

Available digits	Independent readout directions	Rank
d_1	e_1	1
d_1, d_2	e_1	1
$d_1, \dots, d_3$	e_1, e_2	2
$d_1, \dots, d_4$	e_1, e_2	2
$d_1, \dots, d_5$	e_1, e_2, e_3	3
$d_1, \dots, d_6$	e_1, e_2, e_3	3

The derivation is exact for this map. It exhibits how nested work can open successively higher-rank records. Because the three-direction frame was supplied in Q , it is not a proof that an unstructured source selects three-dimensional physical space. The selection problem asks why an appropriate map and stable local relations should follow from the source dynamics.

4. The binary example: 64 addresses, 27 sites

Set $q = 2$. Each digit is either zero or one, so the source counter has $2^6 = 64$ addresses. Each paired difference can take the values $-1, 0$, or 1 . The completed readout therefore has $3^3 = 27$ distinct sites in the chosen frame.

A zero difference has two representations, $(0,0)$ and $(1,1)$, whereas $+1$ and -1 each have one. Across three pairs, the central site has $2^3 = 8$ source addresses, while a corner has one. Uniform visitation of addresses consequently does not produce a uniform probability over sites.

Why this matters

A record rule might retain the multiplicity, average over it, or choose one representative per site. Those choices give different observable statistics. A proposed spatial measure therefore needs its own derivation; a picture of 27 regularly arranged sites does not determine it.

The counter's private scan also need not represent a particle trajectory. Carry operations can reset several digits and make large jumps in Q . Physical transport requires a law for propagation between retained records, together with a clock and a bound on the allowed influence.

Generation order and matter motion should be connected through that law rather than identified by their labels.

5. What makes a return a completion?

A phase may return to its starting point without any result having been formed. To use recurrence as a completion marker, the model must connect the phase root to a certificate that the record is ready. In a simple notation, $\kappa(z) = 1$ marks completion and $\phi(z) = 0$ marks the selected phase root. The desired compatibility is that these conditions agree on the relevant states.

$$\phi(z) = 0 \Leftrightarrow \kappa(z) = 1.$$

A compatibility requirement to establish for a chosen completion mechanism. A decorative phase variable is not itself a certificate.

A finite verification stage can check a parity condition, consistency relation, or return to a designated interface. A quantum description may use a completion instrument with accepted, rejected, and incomplete outcomes. The state changes associated with those outcomes and their probabilities belong to the model. Looking only at successful records can hide both a resource cost and a selection effect.

The outer role becomes meaningful when this mechanism makes the completed result accessible and retained. It can organize a record sequence without assuming that an observer directly measures every internal operation.

6. From record order to a clock

Assigning positive delays to allowed advances can turn a record sequence into a numerical timing model. For composed advances, a natural condition is additivity. For a global event-time function, one needs the delay of an advance to be a difference of event values.

$$\Delta T(a \circ b) = \Delta T(a) + \Delta T(b).$$

$$\Delta T(a) = T(\text{target } a) - T(\text{source } a).$$

Additivity and an exact event-time assignment are distinct requirements. Positive delays around a directed cycle obstruct such a global assignment.

If every nontrivial allowed advance has strictly positive exact delay, two distinct events cannot each be later than the other. Otherwise adding the two positive delays would give a positive total for a return to the same event, contradicting exactness. This is a short route from a clock condition to an acyclic event order.

Physical calibration remains necessary. The scale of T must be linked to a repeatable process, and the same law should account for how clocks respond to the relevant source operations. A clock that ignores branch-generation activity and a clock that accumulates it can assign different durations to the same completed configuration. The [clock-independence article](#) and the [joint clock-band construction](#) explore this issue.

7. Ordinary complex phase and split-complex geometry

Two different algebras appear in discussions of DTT. Ordinary complex numbers use $i^2 = -1$ and describe circular phase rotations. Split-complex numbers use $j^2 = +1$ and support a hyperbolic quadratic form. Their similar notation can hide an important distinction.

$$e^{i\theta} = \cos \theta + i \sin \theta, i^2 = -1.$$

$$e^{j\eta} = \cosh \eta + j \sinh \eta, j^2 = +1.$$

For $z = u + jv$, multiplication by $e^{j\eta}$ gives $u' = u \cosh \eta + v \sinh \eta$ and $v' = u \sinh \eta + v \cosh \eta$. Substitution verifies $u'^2 - v'^2 = u^2 - v^2$. This algebra realizes a one-plus-one-dimensional hyperbolic transformation. Connecting u and v to physical clock and displacement measurements requires a separate interpretation and unit convention.

Two algebras, two different roles

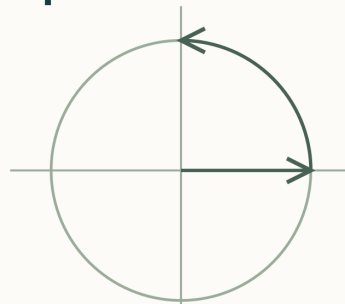
Ordinary complex phase

$$i^2 = -1$$

Circular rotation

$$J(x,y) = (-y,x)$$

$x^2 + y^2$ preserved



A quarter turn twice gives $-I$

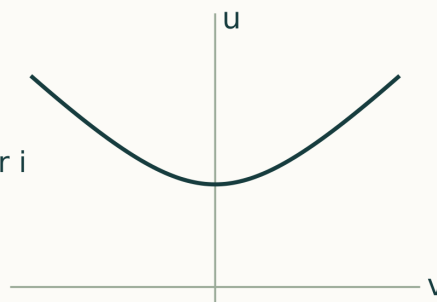
Split-complex hyperbolic geometry

$$j^2 = +1$$

Hyperbolic mixing

$u^2 - v^2$ preserved

No substitution of j for i



Two exact algebraic patterns, with different squared units and preserved forms. The diagrams do not identify quantum phase with a spacetime coordinate.

[Open the full-size diagram →](#)

In real-Hilbert phase selection, the imaginary unit is represented by an operator J satisfying $J^2 = -I$. Under appropriate assumptions it can be selected from an oriented real generator. That

construction and the split-complex hyperbolic description address different mathematical tasks. A physical theory must specify their common origin or their interface rather than interchange i and j .

8. Why recurrence alone does not choose a future

Let a reversible group G act on a phase space and choose a root o . The returns $H = \{g : g \cdot o = o\}$ form a subgroup. In particular, if g returns to o , so does g^{-1} . A rule that checks only return to the root therefore accepts both orientations. Recurrence supplies repetition, but not a one-sided arrow.

An ordered availability of records can add the missing asymmetry. If a completed operation preserves or increases what an observer can retain and access, it can count as a forward advance. Its inverse may remove available records and therefore fail that condition. The observable forward operations can form a monoid even when the underlying reversible returns form a group.

The origin of the asymmetry is then explicit: a preparation, a memory mechanism, an access restriction, or a boundary condition. A record arrow is not automatically a thermodynamic entropy theorem. To establish entropy production, the model must specify states, probabilities, the chosen entropy, and an appropriate balance or monotonicity argument.

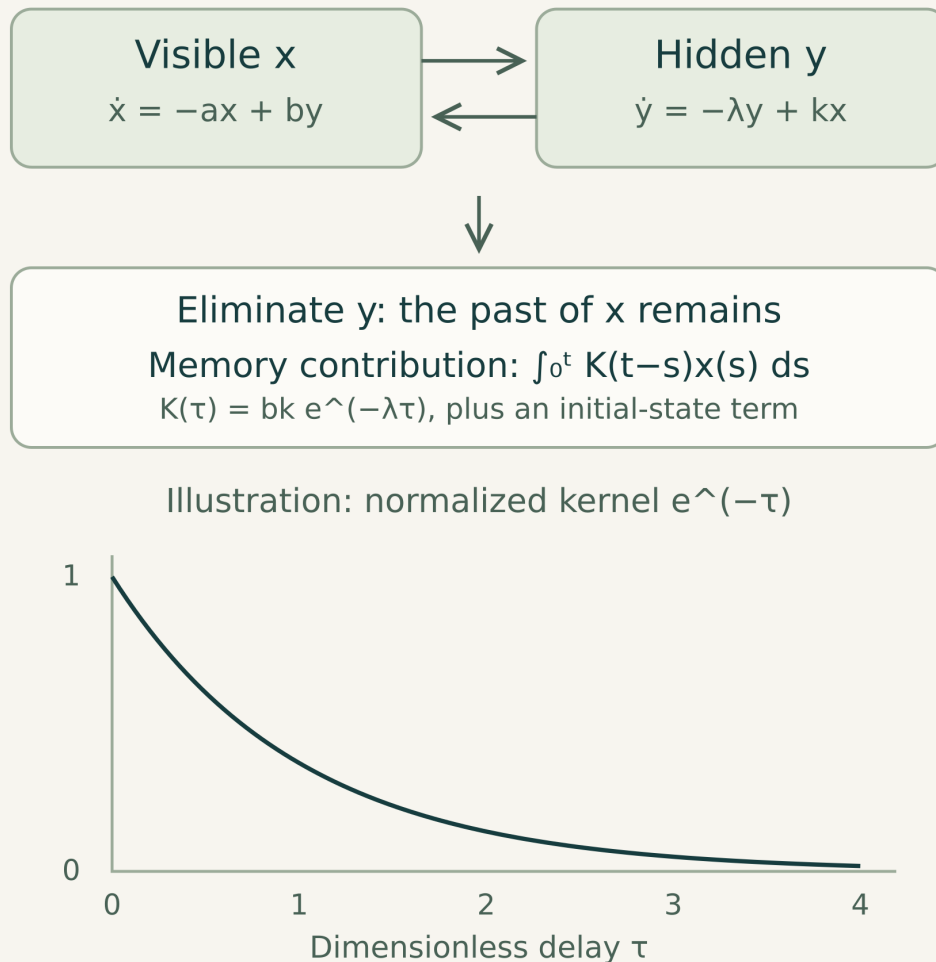
9. A short derivation of memory after projection

A reduced observer can experience history dependence even when the larger system has local first-order equations. Let x be visible and y a hidden relaxation mode, with $\lambda > 0$. Consider the supplied linear model below.

$$\begin{aligned}\dot{x} &= -a x + b y, \quad \dot{y} = -\lambda y + k x. \\ y(t) &= e^{-\lambda t} y(0) + k \int_0^t e^{-\lambda(t-s)} x(s) ds. \\ \dot{x}(t) &= -a x(t) + b e^{-\lambda t} y(0) + b k \int_0^t e^{-\lambda(t-s)} x(s) ds.\end{aligned}$$

The second line follows by multiplying the y equation by $e^{\lambda t}$ and integrating; substituting into the x equation gives the third line. The memory kernel is $K(\tau) = b k e^{-\lambda \tau}$. The initial hidden state contributes a separate transient. Thus eliminating y has not made its effects disappear: they enter through the past of x and the hidden initial condition.

Projection can produce memory



An illustrative linear reduction. The plotted curve shows $e^{-\tau}$ for dimensionless delay; its amplitude and decay rate in a physical model depend on the specified couplings.

[Open the full-size diagram →](#)

Memory alone does not establish dissipation. For $a > 0$ and $\lambda > 0$, the two-variable system is asymptotically stable when $a\lambda - bk > 0$; that condition follows from the trace and determinant of its evolution matrix. An entropy law would require additional structure. The calculation instead demonstrates the precise DTT-relevant distinction between the complete generative state and the smaller visible state.

10. Reading different DTT formulations together

The published temporal-asymmetry work uses two coupled temporal parameters and a projection to observable evolution. The newer same-cycle and nested-stage formulations seek a more restrictive organization in which generative activity and completed records are roles of one source process. These formulations share a motivation, but their variables and assumptions must be translated explicitly.

A theorem for a two-parameter manifold cannot automatically be imported into a one-counter model. Conversely, the nested counter example does not establish the full connection or

curvature structure of the published model. A careful comparison identifies the state space, the evolution law, the completion map, and the observables on each side.

That comparison is productive: it identifies which ideas are reusable and which additional result would unify them. The [temporal-asymmetry paper guide](#) develops the reduction viewpoint, while the postulate guide below gives a compact checklist for a concrete source model.

Further reading

Continue with the individual articles and their source references.

- [One action, two temporal roles](#)
Explain the draft's same-cycle foundation: inner action is primitive, while outer record order comes from completed observable returns. Neither role automatically supplies a second readable laboratory clock.
- [Why recurrence alone does not select a future](#)
Explain the root-only no-arrow result for reversible recurrence. A return to the same phase does not by itself distinguish temporal advance from reversal.
- [From available records to a temporal arrow](#)
Introduce record-positive returns as the steps that preserve or advance accessible records. Explain the conditions under which they define an effective forward action.
- [When an additive clock is unique](#)
Explain the conditional uniqueness of a scalar clock up to positive rescaling for ordered rank-one returns. Distinguish additive delays from a globally defined event time.
- [Nested operations and clock independence](#)
Investigate whether branch invisibility survives arbitrary interleaving of operations. Explain why checking one isolated operation is weaker than checking the complete admitted sequence language.
- [From record refinement to a joint clock-band relation](#)
Introduce the conditional relation connecting geometry, clock response, and matter transport. Explain why the interfaces and coefficients must be independently calibrated.
- [Six inner stages and one publication interface](#)
Explain the hierarchy of readout ranks 1, 1, 2, 2, 3, 3 followed by completion. These are nested functional roles rather than six independently readable temporal coordinates.
- [What spatial readout forgets](#)
Investigate information lost when a full generative state is reduced to spatial records. Explain why an apparently complete geometry may still be insufficient for autonomous prediction.
- [Real-commutant phase selection: a paper guide](#)
Introduce the paper's phase-selection question in real Hilbert representations. Prepare an accessible route from the commutant to compatible complex structures and their physical interpretation.
- [Temporal asymmetry: reading the published model](#)
A reading guide to the published temporal-asymmetry model. Organize its geometrical assumptions, reduction mechanism, and interpretation before comparing it with later working drafts.

Continue the connection. Follow the next guide, or return to the reading paths.

[Read the postulate guide](#) →