Radio Reception as Local Registration: A Device-Scale Instance of the Timeless Light Model

Why Successful Propagation Calculations Do Not License Intermediate Life

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Abstract

This paper gives a device-scale account of radio reception under the clarified architecture of the Timeless Light Model (TLM). The canonical photon result denies a persisting intermediate photon history between registered endpoints. The broader architecture distinguishes timeless lawful structure from relativistic registration: quantum mechanics describes lawful eligibility, while relativity governs the coherent spacetime organization of registered outcomes. Applied to radio, this means that reception is not fundamentally the interception of a temporally persisting signal-object that has crossed the intervening space. A transmitter-side event and a receiver-side event are lawfully related under Maxwellian and relativistic structure, but the received electrical outcome is realized locally in the receiver. The antenna, tuning stages, demodulator, and output circuitry register and transform local voltages and currents according to that lawful source–receiver relation. Standard electromagnetic propagation calculations, antenna theory, filtering, modulation, and demodulation remain unchanged. What is removed is only the additional ontology of a signal-object enduring through intermediate locations. Radio reception is therefore a clear everyday instance of the clarified architecture: lawful structure specifies the admissible relation; relativistic registration governs its spacetime appearance; and the receiver registers the outcome locally.

Technical terms marked with a superscript dagger ([†]) link to their formal definitions in Section 5.

The calculation spans the interval.

The registered events occur locally.

The calculation does not license an intermediate life.

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1 Introduction

Radio is commonly described in traveler language.

A transmitter emits a signal. The signal travels through space. The signal reaches an antenna. The receiver catches it, extracts its information, and produces sound, data, or another output.

That language is extraordinarily useful in engineering practice. It compresses a large body of electromagnetic calculation into an intuitive story.

The Timeless Light Model asks a narrower question:

> What ontology is actually licensed by the successful calculation?

The minimal photon-side canon of TLM begins with the null case. Along a null worldline,

$$d\tau = 0.$$

No proper-time sequence accumulates for the photon. There is also no photon rest frame from which an ordinary timelike persistence story can be constructed. TLM therefore declines to add an internally lived sequence of intermediate locations to the photon description [1, 5].

This is the refusal of transit[†].

The refusal of transit does not reject the null relation between source and detector. It does not reject Maxwell's equations. It does not reject retarded solutions, phase delay, diffraction, interference, attenuation, antenna theory, or finite causal delay. It does not alter a radio engineer's calculations.

It rejects one further step:

> Because a mathematical solution assigns structured relations across spacetime, there must therefore exist a persisting physical carrier whose biography occupies those intermediate locations.

That inference is not required by the formalism.

Radio provides an unusually clear application because the measurable receiver-side event is plainly local. A voltage appears at the receiving antenna. Currents change in the receiver's conductors. Filters, mixers, demodulators, amplifiers, processors, and speakers undergo local state changes.

Whatever the complete source–receiver relation may be, the electrical quantity actually registered by the radio is the radio's own local physical state.

The central claim of this paper is therefore:

> *Standard electrodynamics lawfully relates transmitter-side and receiver-side events. The receiver realizes its electrical outcome locally. The success of the propagation formalism does not require a persisting signal-object with an*

intermediate life between those registrations.

This is an interpretive restriction, not a revision of radio physics.

2 The Scope of the Claim

The argument is easiest to evaluate if its scope is kept narrow.

This paper does *not* claim that radio reception is instantaneous.

It does *not* claim that distance is irrelevant.

It does *not* claim that shielding, geometry, antenna orientation, frequency, phase, attenuation, reflection, refraction, diffraction, or interference cease to matter.

It does *not* claim that Maxwellian propagation calculations may be discarded.

It does *not* propose new radio equations.

It makes only the following ontological restriction.

Proposition 2.1 (No-intermediate-life restriction)**.** *A successful formal description relating a transmitter-side event to a receiver-side event does not by itself license a temporally persisting signal-object whose identity occupies successive intermediate locations.*

Proof. The formalism determines relations among sources, admissible electromagnetic configurations, causal structure, detector conditions, and measurable outcomes.

To infer from those relations the additional existence of one persisting carrier requires an ontological premise not supplied merely by the mathematical success of the relation.

In the photon case, null proper time and the absence of a rest frame supply positive reason not to import the ordinary timelike persistence template.

Therefore the successful source–receiver calculation remains intact, while the additional carrier biography is withheld.

□

Remark 2.2. *The proposition does not say that the mathematical description of the intermediate region is useless, fictitious, or dispensable.*

It says that mathematical description and ontological biography are not the same assertion.

3 Lawful Relation and Registered Outcome

The clarified TLM architecture distinguishes lawful structure from the registered physical outcomes governed by that structure [2, 3].

The laws are not travelers.

Boundary conditions are not travelers.

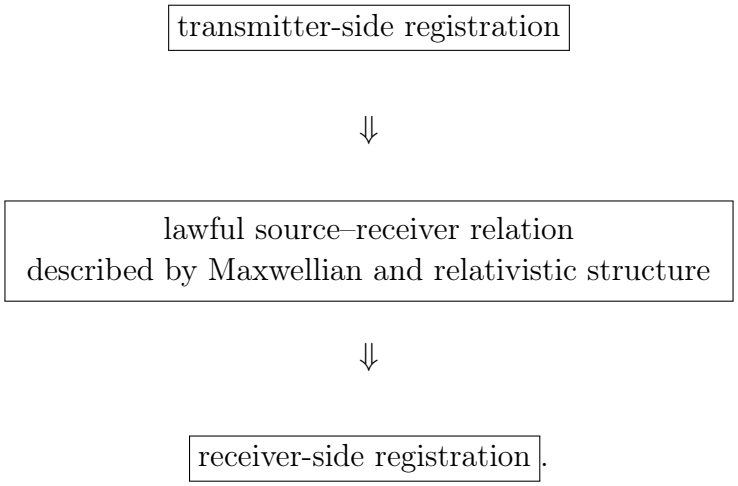
A Maxwellian solution is not made into a traveler merely because its variables possess spacetime dependence.

A wave equation may correctly determine what is registered at a later location without thereby requiring the mathematical wave description to be reified as one persisting thing living through each point of the interval.

The transmitter contributes to the lawful physical conditions under which later receiver-side registrations are possible.

The receiver then realizes a local physical result.

Schematically,



The middle term is indispensable.

But indispensability of the relation does not imply the existence of an additional enduring object in the relation.

Definition 3.1 (Lawful source–receiver relation)**.** *A lawful source–receiver relation is the complete physical relation specified by the governing laws, source conditions, boundary conditions, geometry, and admissibility structure linking source-side conditions to possible detector-side registrations.*

Definition 3.2 (Intermediate life)**.** *Intermediate life is the attributed persistence of one physical signal-object, photon-object, wave-object, or carrier-object through a sequence of intermediate spacetime locations between registered endpoints.*

Definition 3.3 (Refusal of transit)**.** *The refusal of transit is the TLM restriction against inferring an intermediate life merely from the successful formal relation between registered endpoints.*

The refusal is therefore not a refusal of relation.

It is a refusal to turn relation into biography.

4 What the Receiver Actually Registers

At the device level, radio reception is local.

A receiving antenna develops measurable electrical conditions at its own terminals.

Its conductors contain charges belonging to the receiving apparatus.

Those charges participate in local electrical state changes.

The receiver's front end then amplifies, filters, mixes, or otherwise transforms locally available electrical quantities.

A demodulator produces another local electrical state.

An output stage produces still further local changes: speaker motion, stored data, display output, or control action.

Proposition 4.1 (Locality of the received electrical outcome)**.** *The quantity called the received radio signal is realized as local voltages, currents, and state changes in the receiving apparatus.*

Proof. Every directly processed quantity in the receiver is instantiated in the receiver's own physical components.

The antenna voltage is the voltage at the antenna.

The receiver current is the current in the receiver.

The demodulated voltage is produced by the receiver's own circuitry.

The speaker motion is produced by the receiver's own output stage.

The distant source enters through the lawful physical relation governing which local responses are realized, but the measured electrical quantities themselves are local properties of the receiving system.

□

Definition 4.2 (Local receiver realization)**.** *Local receiver realization is the physical registration within the receiver of the electrical state changes constituting reception.*

This point does not depend upon any older TLM account of matter as a special "cadence," recurrence rhythm, or continuously self-generated signal.

The claim is simpler.

The receiver is a physical system.

Its registered electrical state is local.

That local state is lawfully related to remote source conditions.

Nothing further is required for the present argument.

5 Definitions

Definition 5.1 (Lawful structure)**.** *Lawful structure is the set of physical laws, constraints, symmetries, conservation requirements, coupling rules, boundary conditions, and mathematical relations determining which physical relations and outcomes are admissible.*

Lawful structure is not itself a temporal traveler.

Definition 5.2 (Lawful qualification)**.** *Lawful qualification is the admissibility structure under which a physical outcome or relation is permitted by the governing laws, including conservation conditions, coupling conditions, boundary conditions, and, where applicable, quantum amplitude and probability structure.*

Definition 5.3 (Registration)**.** *Registration is a physically realized outcome possessing definite participation in spacetime description, including localization, temporal ordering, causal relation, and the possibility of physical record or receipt.*

Definition 5.4 (Relativistic registration)**.** *Relativistic registration is registration organized according to the causal, geometric, and temporal structure of special or general relativity.*

Definition 5.5 (Transit ontology of radio)**.** *Transit ontology of radio is the additional interpretation according to which successful radio propagation requires one persisting signal-bearing entity to occupy successive intermediate locations between transmitter and receiver.*

Definition 5.6 (Received signal)**.** *The received signal is the structured local electrical outcome registered and processed by the receiving apparatus under the lawful conditions relating it to the source.*

6 The Engineering Sequence

Nothing in the refusal of transit changes the engineering sequence.

Source

A transmitter undergoes local time-dependent electrical changes.

Those changes serve as source conditions in the standard electromagnetic formalism.

Modulation schemes alter the relevant source-side structure in precisely the way described by conventional engineering.

Source–receiver calculation

Maxwell's equations and the relevant boundary conditions determine the lawful electromagnetic relation among the source, environment, and possible receiving locations.

The resulting mathematics contains spatial and temporal dependence.

It supports calculations of radiation pattern, phase, attenuation, reflection, diffraction, polarization, delay, and interference.

TLM retains all of these calculations.

What TLM does not add is:

> There must therefore exist one signal-object possessing an ongoing identity and living through each intermediate spacetime point described by the solution.

Antenna

At a receiving location, an antenna may undergo a local electrical response.

That response is a new registration.

It is not necessary to describe the event as the capture of an enduring object that has survived an intermediate journey.

Filtering and tuning

A tuned circuit or digital filter preferentially responds to selected features of the local input.

Tuning is therefore a property of the receiver's local response.

It need not be interpreted as selecting one traveler from a collection of travelers moving through space.

Demodulation

Demodulation transforms one local electrical pattern into another.

Amplitude, frequency, phase, or digitally encoded structure can thereby be converted into baseband electrical information.

Again, the operation is local.

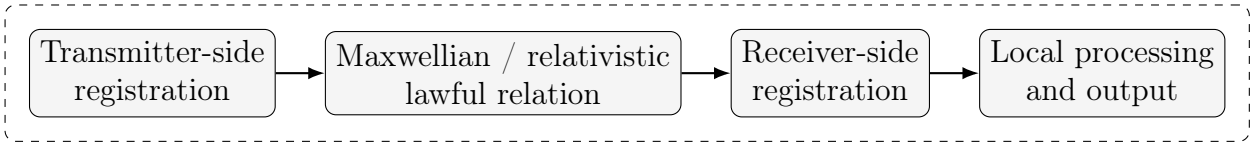
Output

Amplifiers, speakers, displays, memory devices, and control systems produce further local state changes.

The complete device-side process can therefore be represented as

$$\text{local antenna response} \rightarrow \text{local selection} \rightarrow \text{local demodulation} \rightarrow \text{local output}.$$

7 A Diagram of the Distinction



The arrows denote lawful and engineering relations, not an occupied biography of a persisting carrier.

Figure 1: Radio reception under the no-intermediate-life reading. The source–receiver relation remains fully calculable. The diagram does not assign a persisting signal-object to intermediate locations.

8 Finite Delay Without Intermediate Life

The refusal of intermediate life does not imply instantaneous reception.

Source-side and receiver-side registrations occupy different spacetime locations.

The causal relation between them is constrained by relativistic structure.

The receiver cannot register a source-related outcome arbitrarily early.

The relevant distance, geometry, and causal structure remain part of the physical description.

Proposition 8.1 (Delay does not imply biography)**.** *A nonzero temporal separation between source-side and receiver-side registrations does not by itself establish that a persisting signal-object possesses an intermediate life during that interval.*

Proof. Relativity determines causal relations among spacetime events.

A pair of causally related registrations may therefore possess nonzero coordinate separation while the null case still supplies no proper-time history for a photon.

The coordinate separation belongs to the relativistic organization of the registered events.

It does not independently establish an intrinsic biography for a carrier occupying the interval.

□

The familiar engineering sentence

> "The signal takes time to arrive"

may therefore remain useful shorthand.

Under the present interpretation, it means that the source-side and receiver-side registrations possess the relevant finite causal separation.

It need not be expanded into the stronger statement that a physical signal-object lives through that elapsed coordinate time.

9 What About an Antenna Halfway Between?

A natural objection is immediate.

Suppose a second antenna is placed halfway between a transmitter and the original receiver.

If that antenna registers the broadcast, does this prove that something was already physically present in the intermediate region?

Under TLM, the answer is no.

The new antenna creates another possible registration site.

Standard electrodynamics correctly predicts the circumstances under which that apparatus will register a response and what that response will be.

If a response occurs, there is now an additional local registered event.

Proposition 9.1 (Intermediate detection is another endpoint)**.** *Detection at an intermediate location establishes a physical registration at that location. It does not, by itself, establish the continuous intermediate biography of one persisting carrier between all registered locations.*

Proof. Before measurement, the formalism supplies the lawful conditions relating the source to possible detector locations.

When a detector participates physically, a local detector-side outcome may be registered.

That event demonstrates that the source–detector relation is physically effective and correctly described by the formalism.

It does not independently establish that the registered event was caused by one enduring object whose identity can be assigned continuously through all points between source and detector.

□

This distinction is important.

TLM does not deny that one can place detectors at many locations and obtain measurements consistent with Maxwellian theory.

It denies the inference

measurements are possible at intermediate locations

$$\therefore$$

one persisting carrier must continuously exist between them.

Each actual measurement is itself another registration.

10 Fields, Waves, and Ontological License

Radio engineering is naturally written in field and wave language.

That language is retained.

One may calculate an electric field,

$$\mathbf{E}(\mathbf{x}, t),$$

and magnetic field,

$$\mathbf{B}(\mathbf{x}, t),$$

throughout a region.

One may solve wave equations.

One may calculate wavelength, phase, polarization, interference, diffraction, standing-wave structure, and radiation patterns.

These mathematical objects are indispensable to the formalism.

The interpretive issue is whether successful assignment of field values throughout a region automatically proves the existence of an additional physical object possessing a continuous intermediate life.

TLM answers that narrower question negatively.

Proposition 10.1 (Formal extension does not entail ontic persistence)**.** *The assignment of electromagnetic quantities throughout a spacetime region does not, merely by virtue of that assignment, establish the continuous intermediate life of a persisting signal-object.*

This proposition is deliberately limited.

It does not say that Maxwellian field variables may be deleted.

It does not claim that the formalism has no physical significance.

It says that a mathematical structure may correctly determine physical relations and possible registrations without every element of that mathematical structure being interpreted as the biography of a material traveler.

The same interpretive discipline appears elsewhere in TLM.

A wavefunction can determine amplitude and probability structure without being interpreted as a material object occupying every location on which the function is defined [4].

Likewise, a Maxwellian field solution may organize the source–receiver relation without requiring a separate persisting signal-object.

11 Noise, Interference, and Selectivity

The no-intermediate-life restriction leaves ordinary signal processing untouched.

At the receiver, many factors contribute to the local electrical outcome: thermal processes, circuit noise, environmental sources, reflections, other transmitters, and the source of interest.

The formalism determines the lawful combined response.

The receiver then processes the resulting local electrical state.

Proposition 11.1 (Interference is registered locally)**.** *Radio interference is manifested as alteration of the locally registered receiver outcome under the lawful relation involving multiple source and environmental conditions.*

This retains electromagnetic superposition exactly as used in standard engineering.

It does not require the additional picture of multiple persistent signal-objects colliding with one another in flight.

Likewise, frequency selectivity belongs to the response characteristics of the receiver.

A resonant circuit, filter, mixer, or digital processor responds differently to different features of the local registered electrical input.

Nothing in that fact requires the receiver to identify and capture a particular persisting traveler.

12 Energy and the Present Scope

The present paper does not require a separate thesis about the ontology of energy transfer.

Radio systems exhibit measurable source-side energy changes and receiver-side energy changes.

Conservation relations and standard electromagnetic energy calculations remain part of the successful formal description.

The question addressed here is narrower:

> Do those calculations, by themselves, require a persisting energy-bearing signal-object with an intermediate biography?

The no-intermediate-life result says only that such a biography is not licensed merely by the successful relation.

Whether the ordinary engineering phrase "energy transfer" should be retained as shorthand, further interpreted as a relation between registered energy changes, or given some stronger ontology is a separate question.

No conclusion on that additional question is required for the present radio argument.

13 Compatibility with Maxwellian Electrodynamics

The present interpretation changes no Maxwellian equation.

It changes no antenna equation.

It changes no path-loss calculation.

It changes no phase calculation.

It changes no modulation or demodulation method.

It changes no prediction concerning what a detector will register.

Proposition 13.1 (No engineering revision)**.** *The no-intermediate-life interpretation changes no standard radio calculation, measurement, or engineering design rule.*

Proof. No equation is added.

No equation is removed.

No parameter is redefined.

No observable is changed.

No measured prediction is altered.

Only an ontological inference is restricted: predictive success does not by itself require the continuous intermediate biography of a signal carrier.

□

This allows the ordinary language of propagation to remain available.

One may speak of propagation delay, propagation loss, wave propagation, and propagation conditions.

Under TLM, "propagation" names the structured spacetime relation calculated by the formalism.

It need not be interpreted as the lived journey of a persisting object.

14 Why Radio Is a Useful Test Case

Radio is useful because it separates two questions that are often folded together:

1. How do we correctly calculate the physical relation between a transmitter and a receiver?

2. What ontology are we entitled to infer from the success of that calculation?

Engineering answers the first question extraordinarily well.

TLM addresses the second.

The radio receiver makes the distinction concrete.

At every measurable stage inside the device, the quantities being processed are local.

The antenna voltage is local.

The filter response is local.

The demodulated waveform is local.

The amplifier state is local.

The speaker motion is local.

The remote source matters because the lawful relation changes which receiver-side outcomes occur.

But the receiver need not contain a transported specimen of the transmitter's electrical state.

Nor must the mathematical success of source–receiver propagation calculations be supplemented by the biography of an enduring carrier.

Proposition 14.1 (Radio as a device-scale instance)**.** *Radio reception is a device-scale instance of the TLM architecture in which a remote lawful relation is realized through a local registered outcome without requiring intermediate carrier persistence.*

15 Generalization to Other Electromagnetic Detectors

The same interpretive structure can be applied to other electromagnetic detection systems.

An optical detector registers a local electronic or chemical change.

An X-ray detector registers local ionization or excitation.

A microwave receiver registers a local circuit response.

A photodetector registers a local detector event.

The relevant frequencies, coupling mechanisms, energies, materials, and engineering implementations differ.

The common architectural pattern is:

> *A remote source participates in a lawful relation governing which detector-side outcomes are admissible. The detector realizes its own local physical change. The success of the source–detector calculation does not, by itself, require a persisting traveler with an intermediate life.*

This is not a claim that every detector operates identically.

It is a claim about ontological license.

16 Discussion

The argument depends only upon three points.

First, the measurable radio outcome is realized locally in the receiver.

Second, standard physical theory correctly relates that local outcome to remote source conditions.

Third, the success of that relation does not require the additional ontology of a persisting carrier with an intermediate life.

This formulation is deliberately minimal because it asks only what ontology the successful formalism requires.

It does not attempt to replace Maxwellian engineering with another mechanism.

It does not offer a hidden process underneath the usual formalism.

It does not explain how a traveler gets from source to receiver by proposing a different traveler.

It refuses the need for the traveler.

The architecture is therefore:

lawful structure

$$\Downarrow$$

lawfully related registered events

rather than

$$\text{source} \rightarrow \text{persisting intermediate carrier} \rightarrow \text{detector}.$$

The second diagram may remain convenient engineering imagery.

The first states the ontological restriction.

This also clarifies what the paper means when it says that radio "works without transit."

It does not mean that the receiver is causally disconnected from the transmitter.

It means that causal and mathematical relation need not be converted into a continuous biography of a thing.

17 Conclusion

Radio reception provides a simple everyday example of the Timeless Light Model's refusal of transit.

A transmitter undergoes a local registered state change.

A receiver later undergoes a local registered state change.

The relation between those events is correctly calculated by standard electromagnetic and relativistic theory.

That calculation determines delay, attenuation, phase, interference, geometry, selectivity conditions, and the other quantities required by radio engineering.

The receiver-side result is physically realized as the receiver's own local electrical state.

Tuning occurs locally.

Filtering occurs locally.

Demodulation occurs locally.

Amplification and rendering occur locally.

Nothing in this paper changes the engineering.

The interpretive restriction is simply that the mathematical relation between source and receiver does not license an additional persisting signal-object whose intermediate biography must occupy the spacetime between them.

A detector placed at an intermediate location does not refute the result. It supplies another possible registration site. If it registers an outcome, there is another local registered event.

The formalism remains indispensable.

The traveler is not.

The transmitter is local.

The receiver is local.

The lawful relation connects them.

No intermediate life is required.

Glossary

Intermediate life The attributed continuous persistence of one signal-object, photon-object, wave-object, or carrier-object through successive intermediate locations between registered endpoints.

Refusal of transit The TLM restriction against inferring such an intermediate life merely from the successful formal relation between registered events.

Lawful structure The physical laws, constraints, symmetries, conservation requirements, coupling rules, boundary conditions, and mathematical relations determining admissible physical relations and outcomes.

Lawful qualification The admissibility structure under which a physical relation or outcome is permitted by the governing laws.

Registration A physically realized outcome participating in spacetime description as a localized, causally ordered, physically receivable or recordable event.

Relativistic registration Registration organized according to relativistic causal, geometric, and temporal structure.

Lawful source–receiver relation The complete physical relation specified by the governing laws and conditions linking source-side circumstances to possible detector-side registrations.

Local receiver realization The physical registration within the receiver of the voltages, currents, and circuit-state changes constituting reception.

Transit ontology of radio The interpretation that successful radio propagation requires one persisting signal-bearing entity to occupy successive intermediate locations between transmitter and receiver.

Received signal The structured local electrical outcome registered and processed by the receiver under the lawful source–receiver relation.

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