The Law of Graphic Equalisation — Communication Grounding

Difference Across Frames, Kinetic Contact, Records, and Network Frames

Matthew Parslow
Independent Researcher

Draft — draft-2026-09-06.1
6 September 2026 • document revision 5

DRAFT — draft-2026-09-06.1r5 (6 September 2026). This document is under active revision and is circulated for comment, not as a finished result. It is the *01e* grounding companion to *The Law of Graphic Equalisation — Theory* (Graphic Equalisation), and inherits that paper's definitions, epistemic boundary, and level-of-claims. It does not add a primitive to the substrate, assign a communication ontology over it, or alter Graphic Equalisation's core claims. It develops a cross-frame grounding: all causal influence is communication at some grain, while communication may be held, offered, or carried without producing a relevant effect in a particular receiving frame. The sections on falsifiability identify promoted commitments, not a proof of the substrate.

Abstract

Communication is usually split too early: physical influence is put on one side, signals and language on another, and the latter is made to depend on a human speaker, a shared intention, or an intrinsically meaningful symbol. This paper uses Graphic Equalisation to refuse that split. A tap on the shoulder, a punch, a molecular binding event, a written record, an Ethernet transmission, and a word-token are all differences carried, exposed, or held across frame relations. They differ in magnitude, grain, persistence, grammar, and what another frame can make of them, not in one being communication and another being merely physical cause. Causal influence is communication realised as a transition in a receiving frame. Conversely, a record, utterance, or offered packet can communicate substantial structure while producing no relevant uptake or action in a particular frame.

The paper's governing constraint is economic: communication pays where it changes frames. Carriage, reception, and repair are distinct writes, charged to the frame relation in which each occurs; a later description or a containing frame may not silently provide distinctions free to the frame being described. Network link-layer frames provide the first central engineering grounding. Their delimiters, length or flag grammar, headers, payloads, integrity checks, discard paths, buffers, acknowledgement states, and encapsulation show literal, layer-relative frames in operation. They also impose limits: a checksum is not meaning, a frame is not a network-layer datagram, and endpoint correctness cannot be settled by a lower layer. Human lexical retrieval and tip-of-the-tongue are then a bounded receiver-side case of a held shape whose lexical edge is unavailable, rather than the definition of communication.

1 Scope and claim

This is a grounding paper, not a new substrate and not a psychology of communication. It inherits Graphic Equalisation's minimal graph $G = (g, r, \Gamma)$, its frame-relative grounding (Axiom -1), its account of admissibility and residual, and its write-economics. A frame is real graph data that runs (Graphic Equalisation's Definition 6.2); a frame's aperture and grammar determine what it can take in and what it can do with what it takes in. The present task is to show that

cross-frame communication can be stated entirely in those inherited terms. It does not posit a semantic substance, an intrinsic message, a universal codebook, a privileged observer, or a distinct communication primitive beneath relation.

The strongest claim is structural. A difference can be carried from one frame such that another frame can hold, recover, classify, or act on it, and this is a relation between frames rather than a property a token possesses alone. The weaker and empirical claims concern which grammars permit which recovery, what has to be retained for repair, what costs are paid at which crossings, and how particular physical, biological, computational, and linguistic systems realise the relation. The evidence for a composition claim is recurrence of the same shape under independent domain descriptions; that recurrence is neither proof of the substrate nor proof that this paper has found an exhaustive taxonomy.

The paper also corrects a familiar but unhelpful opposition. There is no substrate-level divide between causal influence and communication. A punch is not physical influence with communication absent, while a tap on the shoulder is communication because a human can interpret it. Both are kinetic communication: differences in pressure, momentum, direction, location, duration, and consequence cross a bodily boundary. They differ in magnitude and in what further frames can do with the event, not in kind. A tap may be low-energy and support a rich social reconstruction; a punch may be high-energy and force a large state transition. Neither has a meaning independent of every frame, and neither requires an intentional source in order to be communication.

Definition 1.1 (Communication)**.** *Communication is a distinction carried, exposed, or held across a frame relation. A* causal influence *is communication realised as a transition in a receiving frame. An* operative reception *is the narrower case in which the receiver's rules make the difference available for retention, recovery, classification, correction, or action.*

The three verbs in the definition are deliberately different. A carried difference traverses a relation as a realised event. An exposed difference is available at a boundary under some possible crossing, whether or not this frame currently takes it in. A held difference persists as graph structure or a record across the succession relevant to a later crossing. A letter in an unopened archive, an unqueried database row, and a packet retained in a buffer can all communicate in the latter senses without producing the action a writer, sender, or reader might have wanted. That lack of achievement is not a retroactive annulment of the distinction carried. It only says that an intended or relevant operative reception did not occur in the frame under examination.

Remark 1.2 (Communication is broad; uptake is not). The definition makes all causal influence communication at the grain at which it is a carried difference. It does not make every communication an immediately realised causal influence in every possible receiver. This is not wordplay. It keeps separate an inscription and its reading, a protocol offer and its acceptance, a stored program and its run, a warning and the action it fails to produce. The distinction is also what prevents an external observer from crediting a receiver with a difference merely because some containing frame can read it.

2 The economic constraint: payment at a frame change

Graphic Equalisation's well-formedness condition is that a graph pays for nothing that does no work for it (Definition 7.13); its economics locates cost in writes rather than in a frame's mere standing structure (Proposition 7.12). Communication gives that economy a sharp location. A difference is not made free to another frame because an external account can describe source and receiver together. Where it becomes a difference for that other frame, something changes, and that crossing is where the account must look for the payment.

Proposition 2.1 (Communication pays where it changes frames)**.** *Where a communication becomes a realised, receiver-side difference, the transition is a write in the receiving frame, in the containing frame that sustains the crossing, or in both as their rules specify. A later interpretation, an external description, or a downstream compression may describe the result but may not silently supply that receiver-side distinction without such a change.*

This is a promoted application of the inherited economics, not a claim that every case has one fixed physical price. The payment may be momentum transfer, deformation, receptor occupation, voltage change, bandwidth, buffer capacity, parsing work, retained state, a comparison, a repair write, or a rule firing. The kind and magnitude are contingent rule content. What is ruled out is only the level error: a receiving frame being credited with a distinction for which no transition has occurred in it or in the relation that supplies it.

Three payments should be kept distinct.

1. *Carriage payment* is what makes a difference traverse or remain exposed at a boundary: pressure through contact, a voltage transition, a diffused molecule, an ink trace, or a radio signal.

2. *Reception payment* is what makes the difference available at the receiver's own grain: a receptor state, a membrane potential, a buffer entry, a parser state, a stored record, or an installed lexical edge.

3. *Repair or reconstruction payment* is what compares alternatives, registers a residual, corrects an error, requests a retransmission, or recovers a missing edge from a held shape.

The distinctions are temporal as well as structural. An unread record has paid for inscription and retention in the holder; it has not yet charged a later reader for recovery. In the inherited state language this is a realised value that is not held by the reading frame—undisclosed to it rather than absent or resolved for it (Definition 6.4). A protocol sender may pay to construct and emit a frame; a receiver pays differently to validate and store it; a retransmission pays only where an error condition later causes a rule to fire. A record can therefore communicate much while achieving nothing relevant in the frame that has not read it. Conversely, the fact that a recipient reacts does not mean it has recovered every distinction the carrier could make available at another grain.

Remark 2.2 (Tap and punch)*.* A tap and a punch make the rule concrete. Each pays at bodily contact: a kinetic difference crosses a boundary and changes some local configuration. The punch usually pays more heavily in momentum transfer, deformation, injury, and later repair; the tap may pay little kinetically while being rich under a learned social grammar. Those are differences of scale and of receiver-side structure. It is an error to call the punch "mere causation" and reserve communication for the tap, or to pretend that the tap's social reading was already present in the force alone.

3 The minimal communication relation

The proposed construction introduces no object beyond the substrate. It gives names to roles already supplied by graph relations and rules, because those roles must be separated if a cross-frame claim is to remain level-correct.

Communication role	Inherited substrate reading
Source-relative distinction	A difference in graph structure, state, or admissible continuation at a named grain.
Carrier or record	The realised transition or held graph structure through which that difference is exposed across a relation.
Boundary	The relation between frames, whose crossings induce the relevant partial order and whose condition is known only by crossing (Proposition 9.11).
Receiver grammar	The receiver's Γ, including any installed recognition, decoding, selection, or response rules.
Aperture	The receiver-relative restriction on what can enter and what can be expressed or acted upon.
Available distinction	A difference the receiver can retain, reconstruct, discriminate, or condition a rule upon at its own grain.
Residual	What remains when an offered or attempted transformation cannot be admitted, recovered, or made coherent under that grammar.
Audit frame	A specified frame that can represent the relevant source and receiver relations; it is not a view from nowhere (Axiom -1).

Remark 3.1 (These are positional roles, not new graph types). Source, carrier, boundary, and receiver are positional roles that relations and adjacent frames occupy at a specified grain; they are not new graph types or a communication primitive added beneath relation. As in Graphic Equalisation, naming two ends of a relation differently marks the asymmetry between them, not two kinds of thing (Corollary 6.3). A frame is a source under one crossing and a receiver under another, and the same edge is carrier to one grain and boundary to another. These roles are made authoritative in the stratigraphy of Section 4: source, sender, receiver, message, purpose, and intent are audit-band attributions and need not be represented by any constituent frame of the run (Remark 4.2).

Definition 3.2 (Receiver-relative availability)**.** *Let S and R be named frames related through a carrier or record c. A source-side distinction is* available at *R when R's aperture and grammar make some receiver-side distinction conditional on c. It is* operative at *R when that availability participates in a later rule, retained state, or realised action. Availability and operation are relative to R and to the grain specified for it.*

The definition does not say that c is an intrinsically meaningful object, that S intends anything, or that R reconstructs a source state exactly. It says only that a relation exists between a specified difference and a receiver-side one. An audit frame can assess a claimed correspondence only by holding the relevant relation itself; if it cannot, it has evidence local to one side rather than a settled mapping. This is the relativity of grounding applied to communication, not a sceptical denial that messages work.

The same carrier can accordingly do different work at different grains. A printed sequence is graph structure to a camera sensor, an orthographic token to a reader, a byte stream to an optical-recognition system, and a decorative mark to a frame without the relevant aperture. No one of those readings supersedes the others. They are different communications because different receiver grammars pay for and make use of different distinctions. The receiving frame's grammar is not a private mental language: it can be a receptor geometry, a circuit, a protocol parser, a file format, a learned practice, or a rule in a containing system.

Remark 3.3 (No universal codebook). A shared explicit codebook is neither the definition of communication nor a free precondition of it. Some receiver grammar must be realised somewhere if a specified receiver is to discriminate or recover at a specified grain, but it may be inherited, evolved, learned, installed, negotiated, or distributed across a larger frame. The paper therefore asks where the grammar is paid for and held; it does not assume that two communicating frames began with a jointly authored manual. The labels, tokens, and polarities

a grammar uses are supplied by the frame that reads them rather than being intrinsic to a carrier: Graphic Equalisation already forces plurality of types without making any type privileged or self-interpreting (Remark 3.11). This paper accordingly adds receiver-side economics—where a distinction is paid for, held, and recovered—rather than a new derivation of the substrate or of its type plurality. A common grammar or codebook is a frame-relation fact where it is realised and a social-convention attribution in the audit band (Section 4); neither reading makes it a free or universal precondition of communication.

4 The communication stratigraphy: one relation across grains

The previous section named the positional roles of a single cross-frame relation. This section arranges those roles into an explicit hierarchy, or *stratigraphy*, so that the level at which each concept is a fact can be read off directly. There is one communication relation; what changes across the hierarchy is not the relation but the *grain* at which a distinction is a fact and the *frame* that must hold it. Three bands are distinguished, and the discipline of the whole section is that a fact stated in a higher band may never be silently charged to a lower one.

- The **substrate band** is where rules run and deformations occur. Its facts are graph facts: a rule, a deformation, a distinction, a grain, a causal influence. Nothing in the higher bands adds an operator here; they only describe, relate, or attribute.
- The **frame-relation band** is where a difference is carried, exposed, or held across a boundary, and where a receiver's aperture and grammar make some of it available or operative. Its facts are relational and receiver-relative.
- The **audit and self-model band** is where a frame that can represent the relation attributes source, receiver, provenance, purpose, or intent. Its facts are facts *about* a run, held in an audit frame or a self-model, and are never constituents of the run they describe.

Definition 4.1 (Stratal facticity)**.** *A concept has* stratal facticity *at the band that supplies the minimum factual frame in which it is realised. A concept licenses only what that minimum frame already contains, and does not license claims proper to a higher band. In particular: a substrate concept is a fact wherever the rule runs or the deformation occurs, and needs no frame relation; a frame-relation concept is a fact only relative to a specified receiver, aperture, and grammar; an audit concept is a fact only in a specified frame that holds the relevant relation and performs the attribution. A concept realised in one band may be* referred to *from a higher band, but the reference does not relocate the fact downward, and no audit attribution may be projected down into the constituent frames of the run it describes.*

Reading the tables. The three tables share the columns CONCEPT, MINIMUM FACTUAL FRAME (the smallest arrangement in which the concept is a fact), WHAT IT LICENSES, and WHAT IT DOES NOT LICENSE. They are deliberately split by band rather than merged into one long table, because the split is the claim: the last column of each band is where level errors are refused. The prose after each table ties the rows to the running cases without repeating them per row.

The substrate band is where the sodium channel actually gates: a conformational deformation follows a voltage distinction under the channel's rule, and that is a fact whether or not any downstream frame reads it as a signal. It is where the punch lands and the tap contacts—kinetic deformation at bodily grain—and where a stored record is physical structure before it is a message. In Ocelot's internal implementation, it is where a data structure is written or a procedure runs; that a run occurred is a substrate fact, but (per Remark 4.5) it licenses no claim that the implementation proves the substrate.

Table 1: Substrate band: rules run and deformations occur at this grain.

Concept	**Minimum factual frame**	**What it licenses**	**What it does not license**
Rule	A frame's Γ that runs at a grain.	That a transition can occur when conditions hold.	That the rule means, intends, or addresses anything.
Deformation	A realised change of graph state under a rule.	That something happened at this grain.	That it was received, understood, or aimed.
Distinction	A difference in state, structure, or admissible continuation.	That there is something to carry or hold.	That any frame has taken it in.
Grain	The specified resolution at which a frame runs.	Relativising every other concept to a resolution.	A privileged or grainless view.
Causal influence	A carried distinction realised as a transition in a receiving frame.	Calling the event communication at that grain.	A kind-split between "mere cause" and communication, or an intrinsic sender.

The frame-relation band is where the network link-layer frame lives: flags, stuffing, headers, a frame-check sequence, addressing, buffers, and acknowledgement state are all frame-relation facts, admissible or operative only at their layer's grain (Section 5). The tap and punch sit here too once a receiver is specified: the same kinetic deformation is available under one bodily or social grammar and merely felt under another. The sodium channel's gating becomes a frame-relation fact the moment a downstream frame conditions on the resulting current. A record is a held carrier whose reading is a later, separate crossing. An Ocelot utterance and its lexicon belong here as a token or lexical edge selecting a held shape under a reader's installed grammar; a word in human language is the same relation at a learned grain. None of these rows names a source or an intent: those are audit facts, tabulated next.

The audit band is where a network operator attributes a frame to a MAC address, where a signature or header is read as an origin attachment, and where a diagnostic log asserts provenance—each an audit fact scoped to a frame that holds the relevant relation, never a constituent of the transmitted frame itself. It is where a reader of a record attributes an author, where a hearer of a word attributes a speaker's intent, and where an Ocelot audit or self-model would attribute source, purpose, or intent to one of its own runs. Crucially, the ends named "sender" and "receiver" are assigned here, not found in the substrate step; the run proceeds whether or not any frame ever performs the attribution.

Remark 4.2 (Attribution is not participation). Source, receiver, sender, message, purpose, and intent are not intrinsic participants in a communication. They are attributions made in an audit band. An audit frame may attribute a source or a receiver to a crossing only if it either *directly perceives* that crossing—by itself holding the relevant relation—or reads an *explicit* or *implicit attachment* carried with, or contextually bound to, the difference. Absent direct perception or a readable attachment, a frame has evidence local to one side and no licensed attribution of the other. This is the relativity of grounding (Axiom -1) applied to origin and destination: naming the ends of a relation records an asymmetry an audit frame draws, and does not insert a participant into the run. Consequently, the roles of the minimal relation (Section 3) need not be represented by any constituent frame of the run; a substrate step can be fully a communication at its grain while no frame within it holds a representation of "source" or "receiver" at all.

Remark 4.3 (Attachments are paid evidence, not proof). An attachment—a signature, a header field, a return address, a byline, a contextual cue—is itself a carrier that was paid for at some crossing. It is therefore *evidence* toward a source or receiver, weighted by the cost of producing and of forging it, and not a *proof* of provenance. Explicit attachments can be copied, replayed,

or fabricated; implicit attachments depend on the reading frame's conventions and can mislead. Authentication rules raise the cost of a false attachment but still yield a scoped predicate, not closure of ultimate origin (cf. the provenance limit, Proposition 5.1 and Section 7). Accumulating attachments accumulates frame-relative evidence; it never manufactures a view from nowhere.

Remark 4.4 (Intent is a self-model inference about a run)*.* Intent is not an inner operator in the substrate step and is not a condition on communication. It is an inference—made in an audit frame or, reflexively, in a frame's own self-model—about the *disposition* a run exhibits: what the run does, and would do, across the conditions the modeller can represent. This applies the mind-and-self grounding's self-model core: a self-model is incomplete by construction (, Prop. 6.1, Sec. 6), so an attribution of one's own intent is a calibrated wager, not a readout of a hidden aim; and there is no dedicated primitive for influence beneath relation (, Prop. 8.1), so intent adds no operator to the run. The constraint the fable of the reflexive animal makes vivid holds here: a run's nature is read from what it does under its conditions, not from a declared inner reason, and confining or reframing the conditions does not convert an attributed intent into a substrate participant. An attributed intent may inform prediction and judgement in the audit band; it may never be projected down into the constituent frames as though it were a rule they ran.

Remark 4.5 (Ocelot as an internal implementation example)*.* Where this paper mentions Ocelot's utterance pipeline, lexicon, records, or audit, it does so as a clearly labelled *internal implementation example*, not as independent evidence for the substrate. That an implementation writes a record, runs a lexical lookup, or emits an utterance is a substrate and frame-relation fact about that system; it does not license the claim that the implementation *proves* the substrate, and any attribution of source, purpose, or intent to one of its runs remains an audit-band inference subject to Remark 4.2 and Remark 4.4. The utterance pipeline is therefore used only to instantiate the token/lexical-edge and record rows of Table 2; source attribution over it is not asserted here, because doing so would overclaim.

4.1 Worked case: a frozen language model, a prompt-installed term, and a persistent update

The stratigraphy is easiest to misread where a token is treated as a property an input carries with it. This worked case fixes the reading against a standard, publicly documented system—a *frozen* large language model—and does so with the strict graph-law definition of tokenisation stated first. Nothing below is offered as novel to language-model practitioners, and nothing below is offered as proof of the substrate; the case only exhibits the token/lexical-edge rows of Table 2 and the stratal-facticity discipline of Definition 4.1 in a familiar mechanism.

The strict definition. Tokenisation at a frame F is the matching of an input made available at F's boundary and grain to an *already extant, admissible edge held by* F. A token is therefore the frame-relative successful match, not an intrinsic property of the input. Three consequences follow, and they must be kept apart because they occupy different rows of the band.

- An input that F's aperture excludes is *absent* for F: there is no carrier at F's boundary to match, so no question of tokenisation arises.
- An input that reaches the relevant grain but finds *no matching admissible edge* is not tokenised there. It may be collapsed to a coarse unknown category, left as residual (Definition 8.1), or trigger a separately paid extension of the grammar. None of these is tokenisation.
- Minting a new edge is not cheap tokenisation. Installing a durable new selector is a distinct write charged where it occurs (Proposition 2.1); tokenisation to an existing edge is the cheap selection the token row licenses, and the two must not be conflated.

Frame 1: the fixed tokenizer and model. A deployed frozen model holds a fixed tokenizer vocabulary and fixed parameters. Its tokeniser can match an input only to pre-existing vocabulary or token-ID edges; ordinary inference mints no persistent vocabulary edge and no persistent parameter edge. This is exactly the fixed-vocabulary constraint that fixed-vocabulary neural language models make explicit (Bengio et al., 2003). Two situations that look alike must be separated at this frame. A genuinely *novel token* would require an edge the frame does not hold, and the frozen frame cannot supply it during inference. A *novel string*, by contrast, is routinely representable as a novel *sequence of existing* subword or byte units (Sennrich et al., 2016; Kudo and Richardson, 2018; Radford et al., 2019): the string is new, but every edge used to segment it is already held, so this is successful tokenisation to extant edges, not minting. The distinction between a new string over old units and a new unit is the whole of the point.

Grain, not exemption from the rule. Early closed word-vocabulary systems make the rule visible by failing loudly: an out-of-vocabulary word form finds no matching admissible edge at the *word* grain and is collapsed to a coarse unknown category, the `UNK` token (Luong et al., 2015). Modern subword and byte-level systems do not repeal this rule; they *lower the grain* at which matching succeeds. Byte-level schemes push the grain down to a small, closed set of byte edges so that essentially any input segments to held units (Radford et al., 2019), and subword schemes sit between word and byte grains (Sennrich et al., 2016; Kudo and Richardson, 2018). The coarse-unknown outcome has become rare in practice not because the graph law changed but because the admissible edge set was made fine enough that a match almost always exists. The residual and coarse-unknown possibilities of the strict definition remain the correct account of what happens when they do not.

Frame 2: the runtime context. A prompt can install a temporary association—"let *glorp* denote the following shape"—between an existing token sequence and a prompt-provided definition, and the model can condition its continuation on that association without any gradient update (Brown et al., 2020). In stratal terms this is a frame-relation fact local to the runtime context frame: a receiver-side availability (Definition 3.2) held for the duration of the context. It is real, and it is paid for—in context capacity and in the conditioning it induces—but it changes neither the tokenizer vocabulary nor the model weights. The token sequence for *glorp* is still matched to the same pre-existing subword edges as in Frame 1; what is new is a context-local relation between that sequence and a shape, not a new lexical edge in the fixed frame. This is precisely the paper's distinction between a context-local availability and a persistent update: the term is operative in this run and absent from the next fresh context.

Frame 3: the containing persistent-update frame. A durable new relation can be paid for and held, but only in a larger frame than ordinary inference. Three such frames are standard. A tokenizer/vocabulary change with a matching embedding update mints a genuinely new token edge and pays for its parameters. Training or fine-tuning revises parameter edges so that a relation becomes held in the weights. An external memory or retrieval write records a durable relation in a datastore the model reads at inference, so that a nearest-neighbour or retrieval step can recover it later (Khandelwal et al., 2020). Each is a minting or update write in the sense of Proposition 2.1, charged in the containing frame; none is performed by the frozen inference frame on its own. The context installation of Frame 2 and the persistent update of Frame 3 are the same distinction the paper draws throughout between an availability held for a crossing and a relation held across successions.

Caveats. Some deployed systems do perform online learning, periodic fine-tuning, or external-memory writes during operation (Khandelwal et al., 2020); those are larger-frame operations in the sense above, not counterexamples to the account of ordinary frozen inference. The mapping

claims only what the stratigraphy already says: tokenisation is a frame-relative match to a held admissible edge; a coarse-unknown category, a residual, or a paid grammar extension are the distinct outcomes when no such edge exists; and a context-local association is not a persistent lexical or parameter edge. These are facts about the model as a frame relation and its containing update frames, and they are used here only to instantiate the token and lexical-edge rows of Table 2, not to assert any implementation-specific claim about Ocelot or to prove the substrate.

5 Network frames: a literal engineering grounding

Networking is not a decorative analogy for this paper. At the data-link layer, engineers literally call the bounded unit of transmission a *frame*. The standards supply a mature, independently developed case in which boundary, grammar, admissibility, opacity, residual, finite aperture, and layered containment are operational rather than metaphorical.

Terminology must be exact. RFC 1662 calls a *frame* the data-link-layer unit of transmission; a *datagram* is a network-layer unit such as an IP datagram; and a *packet* is ordinarily the unit of encapsulation passed between the network and data-link layers (Simpson, 1994). A frame is therefore not a universal name for any bundle of bits. The same bounded configuration can be a link-layer frame under one grammar and an opaque payload carrying a higher-layer packet or datagram under another. This is a direct engineering instance of the distinction between a local frame and a containing one.

Ethernet MAC framing supplies destination and source addresses, a length or EtherType field, payload and padding, and a frame check sequence; the standard specifies the MAC frame separately from physical-layer preamble and start-frame delimiter (IEEE, 2022). PPP supplies an especially transparent grammar: flags mark a boundary, byte or bit stuffing prevents payload from forging that boundary, and a frame-check sequence detects specified corruptions (Simpson, 1994). These mechanisms do not make a frame meaningful in a human sense. They make a boundary decidable and integrity testable at a particular link-layer grain.

Proposition 5.1 (Network admissibility is layer-relative)**.** *A link-layer frame may be admissible under its framing and integrity grammar while its payload remains opaque, malformed, or unusable under a receiver's next-layer grammar. Conversely, an apparent higher-layer packet cannot be received as such without some lower-layer framing relation making a carrier available. Integrity, addressing, and interpretation are therefore scoped to the layers that realise them.*

The proposition is an arrangement claim about a known engineering fact, not a claim that Ethernet proves the substrate. The distinction is visible in the checks themselves. Ethernet's frame check sequence covers the MAC frame; IPv4's header checksum covers the IP header rather than the whole payload (IEEE, 2022; Postel, 1981). A passed check says that a scoped predicate was met. It does not establish source truth, application semantics, or even a valid next layer. An unknown EtherType or protocol number can leave payload present but non-operative at a receiver's current grammar.

An invalid PPP frame is equally instructive. It can be discarded by the PPP receiver because it violates its frame grammar or check sequence. That does not make it an absence of communication in the broad sense of this paper. Physical differences have crossed; the failed frame may change an error counter or trigger an interface rule; a diagnostic frame may retain a residual. That residual is per-rule—it is what a particular receiver rule could not admit at its grain (Definition 8.1)—not a global store of everything discarded. Any retained diagnostic form is a separately paid later record or copy in some holder, charged where that retention occurs, rather than a standing residual the relation keeps for free. It is instead non-admissible or non-operative *as a PPP payload carrier* at that grain. The same discipline prevents a reader from treating a human message ignored by its addressee as though no difference had been communicated at all.

TCP makes the payment structure visible at a larger layer. Sequence numbers, acknowledgements, retransmission timers, receive windows, and sender/receiver buffers retain distinctions across successive crossings (Eddy, 2022; Paxson et al., 2011). They pay for a particular form of reliable, ordered reception. The ordering they provide is a partial order carried by the receiver's rules over its crossings, not a total order given free by the medium (Proposition 11.2). They are not necessary to communication as such: an IP datagram, a UDP datagram, a one-way broadcast, or a forward-error-corrected transmission can make a difference available without a return acknowledgement or a durable sender-side copy. The end-to-end argument makes the limit principled. Correctness that depends on application knowledge cannot be supplied conclusively by a lower layer, even when lower layers provide useful checks and redundancy (Saltzer et al., 1984).

This gives four constraints that the general account must respect. First, framing grammar is not semantic truth. Second, a receiver's acceptance of a carrier is not a proof of provenance. Third, repair can be layered and contingent, not a universal prerequisite. Fourth, no frame may be credited with higher-layer distinctions merely because a containing network observer can read the bits. The name *frame* in networking is not evidence for Graphic Equalisation; the operational recurrence is evidence only for the limited composition claim that a common shape is doing work across domains.

6 Records, code, signalling, and lexical edges

The network case is deliberately first because it is precise, non-human, and literal. It is not the sole case. The following instances are not offered as separate origins of a communication primitive. They are ways the same inherited frame machinery is independently made concrete.

Records and code. A record carries a difference across a separation in successions. Inscription pays where the holder writes a trace; preservation pays where the holder retains it; reading pays where a later frame constructs a receiver-side distinction. Source code provides a sharper case. The source file, parser, abstract syntax tree, compiled artifact, instruction stream, and running machine are nested carriers at distinct grammars. A token may be irrelevant to a processor, decisive to a parser, and decomposable in a compiler's intermediate representation. That does not make the token decorative: at its own grain it is a cheap edge to a held syntactic or semantic shape. The code case also denies a common error. An executable file can communicate a reusable capability even when it is not currently run; running it is a later, separately paid transition.

Molecular and cellular signalling. Ligand binding, ion gradients, hormone reception, gene regulation, and quorum-sensing systems make clear that a receiver grammar need not be linguistic or conscious. The relevant grammar may be receptor geometry, concentration sensitivity, timing, or a downstream regulatory rule. A molecular event is kinetic communication before it is a biological signal in any special historical sense. Evolutionary signalling theory can then ask an additional question—how sender and receiver dispositions became stabilised—without defining the cross-frame communication relation itself (Maynard Smith and Harper, 2003; Scott-Phillips, 2008).

Animal signals and social convention. Alarm calls, displays, scent marks, and contact cues are richly useful tests because they combine a physical carrier, receiver-side discrimination, interaction, deception, and sometimes shared interest. Their biological history may distinguish a signal from a cue in the specialist literature. That distinction remains important for explaining reliability and selection, but it does not licence the paper to call a predator's impact on prey non-communicative merely because it is coercive, or to require an intentional sender before a receiver-side difference can exist.

Human language. Language is a high-density, learned case in which a small token can make a large held shape available under a reader's lexical and grammatical practices. Its significance here is not that language creates communication. It makes the costs of naming, recovery, ambiguity, repair, and cross-domain coordination unusually inspectable. A project term is operative compression at a reader's lexical grain. It must be installed in prose, definition, mechanism, and boundary; a lexical edge is not a proof, and it is not a substitute for the shape it names.

6.1 Exact retrieval and constrained reconstruction

An exact token match is cheap when the receiver has that token in an installed grammar. The receiver need not search a universal space: the token selects an edge already held at its grain. When exact retrieval fails, recovery need not become global reconstruction. A held target shape can constrain a local search among nearby candidate edges, partial forms, related contrasts, or routes through a grammar. This is a structural possibility, not an unsupported claim that every system has one particular search algorithm or complexity class.

Tip-of-the-tongue is the bounded human limit case. A speaker can hold a target's meaning and portions of its phonology or syntax while failing to fetch the full lexical form (Brown and McNeill, 1966; Levelt et al., 1999). The phenomenon is not itself a cross-frame event unless one chooses an internal subsystem boundary; it is better used as evidence that receiver-side availability is layered. The lexical edge can be unavailable while the held shape remains sufficiently present to guide a close-enough recovery. Its value is precisely that it does not require a thesis about consciousness or qualia.

Remark 6.1 (Carrier identity is not success). Exact preservation of a carrier is one mode of communication, not its definition. A packet can be re-encoded across a different physical link; a program can be compiled; a record can be copied; an explanation can be paraphrased; a receptor can act on a concentration range rather than one molecule's identity. What is preserved is assessed only at a specified grain and in a specified audit frame. No such assessment licenses a claim of absolute message identity.

7 Residual, repair, and the limits of reception

Residual is where the account becomes more than a vocabulary of carriers. A receiver can fail to admit a difference, can admit it without recovering a later shape, can recover a shape without acting, or can act on a corrupted or partial reconstruction. These are not one failure mode. They occur at different grammars, and their distinction is what stops a system's external description from being silently charged to its internal reception.

Error correction supplies a clear family. A parity check, checksum, syndrome, missing acknowledgement, or violated prediction creates a differential condition under a receiver grammar. A later rule may discard, correct, request another carrier, select an alternative reconstruction, or continue with degraded operation. Most such repair runs under an existing grammar: it fires rules the receiver already holds, and pays only for the comparison, correction, or retransmission those rules specify. Extending the grammar itself—installing a new rule, decoder, or lexical edge so that a previously inadmissible difference becomes recoverable—is a distinct and separately paid write, and is only one repair mode among the others. The paper's claim is deliberately weak enough to include both feedback and forward correction: successful correction requires some mismatch or constraint to alter a later state transition; it does not require that mismatch to be conscious, visible to an auditor, returned to the source, or held indefinitely.

Conversation repair and protocol repair are therefore analogous without being identical. In conversation, a recipient can request clarification, offer a candidate, or correct a reference (Clark, 1996; Clark and Wilkes-Gibbs, 1986). In a network, a receiver can reject a malformed

frame, acknowledge a sequence number, or correct a decodable codeword. Both expose a residual to a later rule. Neither supports the stronger claim that all communication requires two-way interaction: a written record, broadcast, or molecular gradient may be received without a reply, and may be carried without reception at all.

The same constraint limits provenance. A receiver can often establish that a carrier meets its own integrity predicate. It cannot thereby settle, from inside, why the carrier was produced, whether every relevant source condition was known, or whether an external description's intended interpretation is correct. This is the general prohibition on a frame closing its own provenance, applied at the communication boundary. Authentication, signatures, logs, and social testimony are additional carriers and rules; they can improve a frame's local evidence but do not create a view from nowhere.

8 Prior art, contribution, and exclusions

The paper does not claim to discover transmission, signalling, coding, or language. Its contribution, if the construction survives scrutiny, is an arrangement: the same frame-relative economy describes kinetic influence, records, protocol frames, and lexical recovery without treating one human case as the foundation of the rest.

Shannon's mathematical theory gives an indispensable account of encoding, channels, noise, capacity, and reliable transmission, while explicitly bracketing semantic aspects of communication (Shannon, 1948). Rate–distortion theory shows why recovery can be graded and task-relative rather than exact (Cover and Thomas, 2006). Neither supplies a frame-relative account of what a receiver can hold, what an audit frame may claim about provenance, or where a particular cross-frame transformation pays. Communication complexity instead measures what distributed parties must exchange to compute a function of their separate inputs (Yao, 1979; Kushilevitz and Nisan, 1997); it is a useful lower-bound literature for specific cooperative tasks, not a definition of all communication.

Semiotic and pragmatic traditions correctly deny that a sign is self-contained. Peirce's interpretant and Millikan's consumer-side account are especially useful warnings against treating a token as sufficient by itself (Peirce, 1931; Millikan, 1984). Gricean intention and later ostensive accounts illuminate a demanding human case, but they must not become a universal gate that excludes punches, protocols, or cellular signalling. Conversely, an account broad enough to include all causal influence must not pretend that all causal differences possess the same conventionality, reliability, or reconstructive richness. Those are contingent properties of particular grammars and histories.

Networking prior art is direct rather than metaphorical. The standards and RFCs already specify frame boundaries, transparent encoding, layered encapsulation, integrity tests, retransmission, finite receive state, and endpoint limits (IEEE, 2022; Simpson, 1994; Postel, 1981; Eddy, 2022; Saltzer et al., 1984). This paper does not improve those specifications. It uses them as a stringent independent case: if the proposed grounding cannot distinguish link-layer admissibility from application-level correctness, or cannot account for a frame becoming opaque payload at another layer, its vocabulary is not doing the work claimed.

Consciousness, phenomenal character, and qualia are out of scope, as they are in the mind-and-self grounding. So is a claim that communication requires a conceptual space, a global semantic geometry, or the free-energy principle. Those may be useful domain models under additional commitments; none is required to state a difference crossing and paying at a frame boundary.

9 Falsifiability commitments and evidence

The framework-level identification of causal influence with communication is not presented as an ordinary laboratory hypothesis. It is a way of refusing an otherwise unmotivated kind split: a causal influence is a carried distinction at some grain. The claims below are narrower promoted commitments. A failure bounds this grounding's range or replaces one mechanism; it does not prove or disprove the substrate from a view outside every frame.

1. [SHAPE] **Payment is located at a frame change.** The application fails if a realised receiver-side distinction can be supplied with no write in the receiver and no sustaining or coupling write in the containing relation, after the relevant frames are specified. A later observer's compact description is not a counterexample.

2. [SHAPE] **A causal influence is communicable difference at a stated grain.** The identification is a structural vocabulary unification, not a claim that every grain supplies the same recovery or semantic description. For a named receiving frame, boundary, and grain, the construction fails if a realised causal influence requires an element not representable as a carried or changed relation at that boundary, and no finer stated grain renders it a cross-frame difference. An intra-frame change with no carried distinction across the selected boundary is excluded from the communication relation at that grain; it may be communication only under a different, explicitly named frame relation. Mere unavailability of recovery at the chosen grain is not a counterexample.

3. [DETAIL] **Admissibility is layer-relative.** The network mapping fails if a single validity predicate is found to be authoritative across all layers of an actual stack, so that no carrier can be accepted at one grammar while opaque, malformed, or inoperative at another.

4. [DETAIL] **Recovery is graded and can outrun exact token identity.** The account's retrieval mechanism fails if reliable receiver action requires exact carrier identity in every relevant case, or if target-shape access never constrains a local lexical or structural recovery when direct access fails.

5. [DETAIL] **Repair uses a differential condition.** The repair account fails if a system corrects a carrier-dependent error while no mismatch, syndrome, constraint violation, or alternative comparison affects any later state transition. Feedback need not occur, so a forward-error-correcting code is not a counterexample.

6. [SHAPE] **Provenance is not closed by delivery.** The account fails if a receiver can settle from its own delivered carrier alone the ultimate source, truth, or complete intended interpretation of that carrier, rather than accumulating only additional frame-relative evidence. Attachments (signatures, headers, return addresses, contextual cues) are paid evidence toward a source, not proof of it (Remark 4.3); the account also fails if any single attachment is shown to be, by itself, incorrigible proof of provenance rather than forgeable, replayable, or convention-dependent evidence.

7. [SHAPE] **Audit attributions do not project into constituents.** The stratigraphy fails if a licensed communication requires that one of its constituent frames represent a source, sender, receiver, message, purpose, or intent—that is, if some causal influence cannot be a communication at its grain unless an audit-band attribution is already realised as a rule those frames run (Definition 4.1, Remark 4.2). Attributing intent, source, or purpose from an audit frame or self-model is not a counterexample; projecting one of those attributions downward into the run as an operative participant would be.

The evidence plan has corresponding layers. First, a formal audit should show that every term in Definition 1.1 is realised through inherited graph, rule, aperture, residual, and boundary

structure, without a new primitive. Second, executable protocol fixtures can demonstrate framing, encapsulation, corruption, discard, retransmission, and layer-specific parsing; they establish specification and implementation adequacy, not the substrate's truth. Third, standards and independently developed biological, computational, and linguistic cases can test whether the arrangement transfers. Finally, lexical-access experiments can test the narrow claim about partial recovery. None of these evidences should be silently promoted from a case of composition to a proof of the framework.

10 Conclusion

Communication is difference across frames. It need not begin with a human mind, an intention, a word, a signal convention, or a recipient's success. A tap on the shoulder and a punch establish the ordinary case: kinetic influence is communication, differing from language in magnitude, grain, persistence, and recoverable structure rather than in kind. A record can communicate while unread; a network frame can be received while semantically opaque; a word can be held as a shape while its lexical edge cannot be fetched.

What unifies these cases is not a free carrier or a view from nowhere. Each operative change pays where it changes frames. A boundary crossing, a receiver's admission, a retained record, and a repair operation are separately chargeable writes. The carrier is not its own meaning, and a higher frame's description does not make distinctions free to the lower one. Networking makes this especially clear because its frames are literal, bounded, layered, and independently specified: a link-layer frame, a network-layer datagram, and an application message are not interchangeable even when they travel in one physical event.

The proposed grounding therefore earns its place only if it lets the same small substrate vocabulary do work that the local literatures leave distributed: locate the grain of a communication, the frame that pays for it, the grammar that can receive it, the residual that can repair it, and the boundary beyond which provenance cannot be closed. If it cannot make those distinctions without adding a communication primitive, treating causal influence as a different kind, or silently importing an external interpreter, the draft should be narrowed or rejected.

References

Gregory Bateson. *Steps to an Ecology of Mind.* Chandler Publishing Company, San Francisco, 1972.

Yoshua Bengio, Réjean Ducharme, Pascal Vincent, and Christian Jauvin. A neural probabilistic language model. *Journal of Machine Learning Research*, 3:1137–1155, 2003.

Roger Brown and David McNeill. The "tip of the tongue" phenomenon. *Journal of Verbal Learning and Verbal Behavior*, 5:325–337, 1966.

Tom B. Brown, Benjamin Mann, Nick Ryder, Melanie Subbiah, Jared Kaplan, et al. Language models are few-shot learners. In *Advances in Neural Information Processing Systems 33 (NeurIPS 2020)*, pages 1877–1901, 2020.

Herbert H. Clark. *Using Language.* Cambridge University Press, Cambridge, 1996.

Herbert H. Clark and Deanna Wilkes-Gibbs. Referring as a collaborative process. *Cognition*, 22(1):1–39, 1986.

Thomas M. Cover and Joy A. Thomas. *Elements of Information Theory.* Second edition, Wiley, Hoboken, 2006.

Wesley Eddy, editor. *Transmission Control Protocol*. RFC 9293, Internet Engineering Task Force, August 2022.

Institute of Electrical and Electronics Engineers. *IEEE Standard for Ethernet*. IEEE Std 802.3-2022, New York, 2022.

Urvashi Khandelwal, Omer Levy, Dan Jurafsky, Luke Zettlemoyer, and Mike Lewis. Generalization through memorization: Nearest neighbor language models. In *International Conference on Learning Representations (ICLR 2020)*, 2020.

Taku Kudo and John Richardson. SentencePiece: A simple and language independent subword tokenizer and detokenizer for neural text processing. In *Proceedings of the 2018 Conference on Empirical Methods in Natural Language Processing: System Demonstrations*, pages 66–71, 2018.

Eyal Kushilevitz and Noam Nisan. *Communication Complexity*. Cambridge University Press, Cambridge, 1997.

Willem J. M. Levelt, Ardi Roelofs, and Antje S. Meyer. A theory of lexical access in speech production. *Behavioral and Brain Sciences*, 22(1):1–75, 1999.

Minh-Thang Luong, Ilya Sutskever, Quoc V. Le, Oriol Vinyals, and Wojciech Zaremba. Addressing the rare word problem in neural machine translation. In *Proceedings of the 53rd Annual Meeting of the Association for Computational Linguistics*, pages 11–19, 2015.

John Maynard Smith and David Harper. *Animal Signals*. Oxford University Press, Oxford, 2003.

Ruth Garrett Millikan. *Language, Thought, and Other Biological Categories*. MIT Press, Cambridge, Massachusetts, 1984.

Vern Paxson, Mark Allman, Jerry Chu, and Matt Sargent. *Computing TCP's Retransmission Timer*. RFC 6298, Internet Engineering Task Force, June 2011.

Charles Sanders Peirce. *Collected Papers of Charles Sanders Peirce, Volume 2: Elements of Logic*. Harvard University Press, Cambridge, Massachusetts, 1931.

Jon Postel, editor. *Internet Protocol*. RFC 791, Internet Engineering Task Force, September 1981.

Alec Radford, Jeffrey Wu, Rewon Child, David Luan, Dario Amodei, and Ilya Sutskever. Language models are unsupervised multitask learners. Technical report, OpenAI, 2019.

Jerome H. Saltzer, David P. Reed, and David D. Clark. End-to-end arguments in system design. *ACM Transactions on Computer Systems*, 2(4):277–288, 1984.

Thomas C. Scott-Phillips. Defining biological communication. *Journal of Evolutionary Biology*, 21(2):387–395, 2008.

Rico Sennrich, Barry Haddow, and Alexandra Birch. Neural machine translation of rare words with subword units. In *Proceedings of the 54th Annual Meeting of the Association for Computational Linguistics*, pages 1715–1725, 2016.

Claude E. Shannon. A mathematical theory of communication. *Bell System Technical Journal*, 27:379–423 and 623–656, 1948.

William A. Simpson, editor. *PPP in HDLC-like Framing*. RFC 1662, Internet Engineering Task Force, July 1994.

Andrew C.-C. Yao. Some complexity questions related to distributive computing. In *Proceedings of the Eleventh Annual ACM Symposium on Theory of Computing*, pages 209–213. ACM, 1979.

Table 2: Frame-relation band: a difference carried, exposed, or held across a boundary, relative to a receiver.

Concept	**Minimum factual frame**	**What it licenses**	**What it does not license**
Boundary / crossing	A relation between two frames whose condition is known by crossing.	That a difference can traverse.	That the crossing was intended or attributed to a source.
Carrier / trace / record	Realised transition or held structure exposing a distinction.	That a difference is available to be recovered.	That its origin or meaning travels with it.
Holding / exposure	Structure persisting or offered at a boundary.	Communication without uptake.	That any receiver has acted.
Aperture	Receiver-relative restriction on intake and action.	Bounding what can enter this receiver.	A claim about other receivers or a total intake.
Grammar / admissibility	The receiver's rules for what it can admit.	Deciding what is admissible at this grain.	Semantic truth or provenance.
Availability	A distinction the receiver can retain or discriminate.	Conditioning a later rule on the carrier.	That the distinction is operative or acted upon.
Uptake / operative reception / action	Availability that participates in a rule, state, or action.	That a difference did work in this receiver.	Crediting a receiver from an external description alone.
Encoding / decoding	A grammar mapping distinctions to and from a carrier form.	Recovery under a shared or installed scheme.	An intrinsic or universal code in the carrier.
Token / label / polarity	Carrier features a grammar reads as discrete values.	Cheap selection of a held shape.	That the label is self-interpreting.
Lexical edge	An installed selector to a held shape at a grain.	Fast retrieval when the edge is present.	That the shape equals the edge, or that absence erases the shape.
Meaning / content / interpretation	A receiver-side distinction made under a grammar.	Receiver-relative content at a grain.	A meaning intrinsic to the carrier or shared by fiat.
Error / residual / integrity	A mismatch or non-admissible remainder under a rule.	Detecting a scoped failure.	Global storage of all that was discarded, or source truth.
Repair / correction / feedback	A differential condition altering a later transition.	Discard, retransmit, correct, or degrade.	That two-way interaction is required for communication.
Common grammar / codebook	A grammar realised across both frames.	Coordinated recovery where it is held.	A free or universal precondition of communication.
Addressing / routing	Carrier features a relation uses to select a next frame.	Delivery toward a frame at a grain.	Proof that the addressee is the true or intended receiver.
Time / order	A partial order induced by a receiver's rules over crossings.	Sequencing relative to a receiver.	A total order given free by the medium.

Table 3: Audit and self-model band: attributions about a run, held in a frame that represents the relation.

Concept	**Minimum factual frame**	**What it licenses**	**What it does not license**
Source / receiver attribution	An audit frame that directly perceives a crossing or reads an attachment.	Naming ends of a relation for a purpose.	That the run itself contains a source or receiver participant.
Direct perception	An audit frame that itself holds the crossing relation.	First-hand attribution of an end.	Attribution where the relation is not held.
Explicit attachment	A paid carrier asserting an origin (signature, header, label).	Evidence toward a source.	Proof of provenance; it can be forged or copied.
Implicit attachment	Context or convention a frame reads as origin evidence.	Weaker evidence toward a source.	Certainty, or a fact independent of the reading frame.
Provenance	An audit chain of attachments and perceptions.	Accumulating frame-relative evidence of origin.	Closure of ultimate source from a delivered carrier alone.
Identity / authentication	Rules testing an attachment against held keys or records.	A scoped predicate on claimed identity.	That the predicate settles truth or intent.
Sender / receiver	Roles an audit frame assigns to attributed ends.	Talking about the relation's asymmetry.	Intrinsic participants inside the run.
Purpose / function	An audit or selection ascription over a run.	Explaining or selecting for an effect.	An inner aim operative in the substrate step.
Intent	A self-model or audit inference about a run's disposition.	Predicting or judging a frame from its course.	An inner operator, or a precondition of communication.
Truth	An audit relation between a claim and a held relation.	Assessing a correspondence where the relation is held.	A view from nowhere or a carrier-intrinsic fact.
Audit frame	A specified frame that can represent the relations.	Making any attribution above.	A privileged observer (Axiom -1).
Self-model	A frame's incomplete model of its own run.	Calibrated attribution of one's own intent or reception.	Completeness, or transparency to the run it models.
Social convention	A grammar and attachment scheme held across many frames.	Shared, cheaper attribution and codebooks.	Intrinsic meaning or a universal precondition.