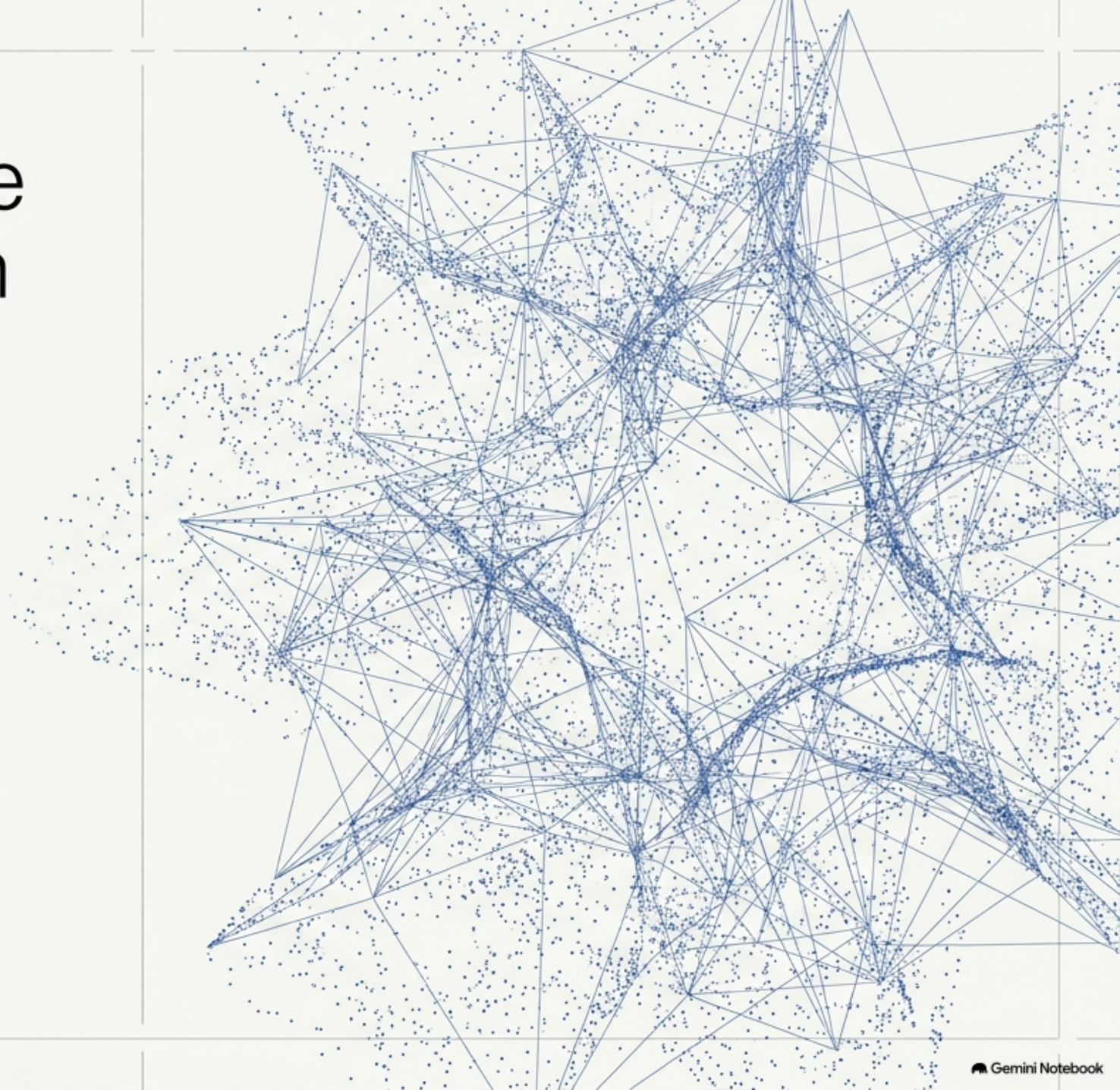
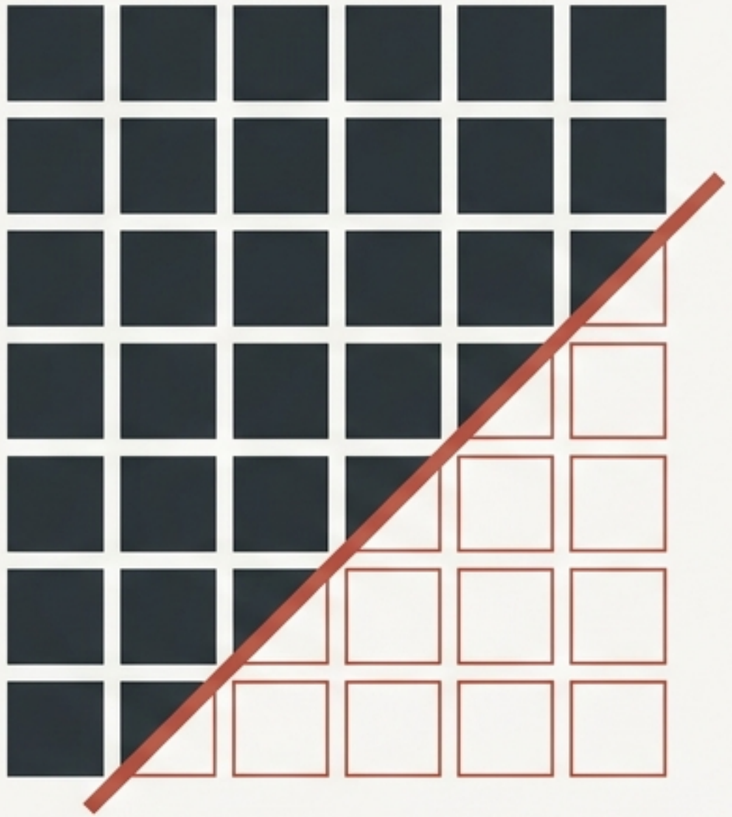
Distributed Secret Fields Under Adaptive Computational Depth

Sparse Recursive Holographic Steganography

Flyxion Independent Researcher, 2026



The Brittleness of the Spatial Metaphor



Local accounting guarantees local failure. Destroying the region assigned to a payload block destroys that block permanently.

Brittle Failure

Cropping removes symbols outright.

Blind Commitment

One-pass encoders commit all modifications before observing the channel's realized consequences.

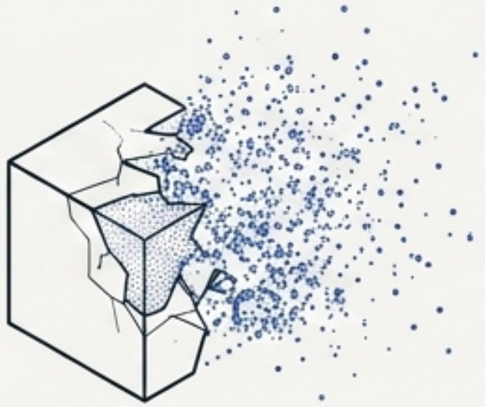
Detectable Waste

Dense modification wastes distortion budget on unreliable locations, expanding the statistical surface for adversaries.

A Fundamental Shift in Steganographic Design

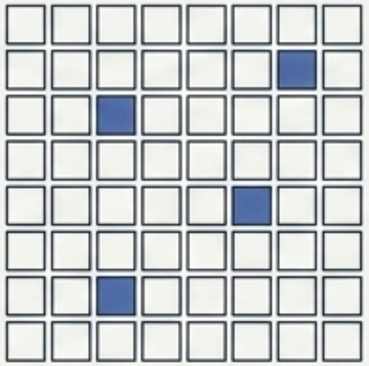
	Conventional	SRHS
Core Metaphor	Symbol Placement (Spatial mapping of blocks)	Secret Field Synthesis (Holographic distribution)
Modification Policy	Dense & One-pass	Sparse & Recursive
Failure Mode	Brittle & Local (Fails at fixed boundaries)	Graceful & Global (Degrades smoothly with evidence)
Channel Response	Assumed in advance	Measured & Adaptive

Replacing the One-Pass Map



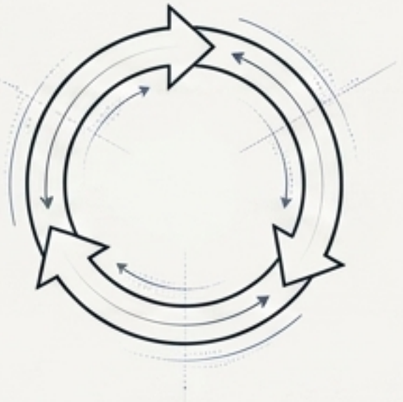
Holographic Payload Projection

Transforming a local payload into a redundant, distributed field of keyed measurements.



Sparse Carrier Routing

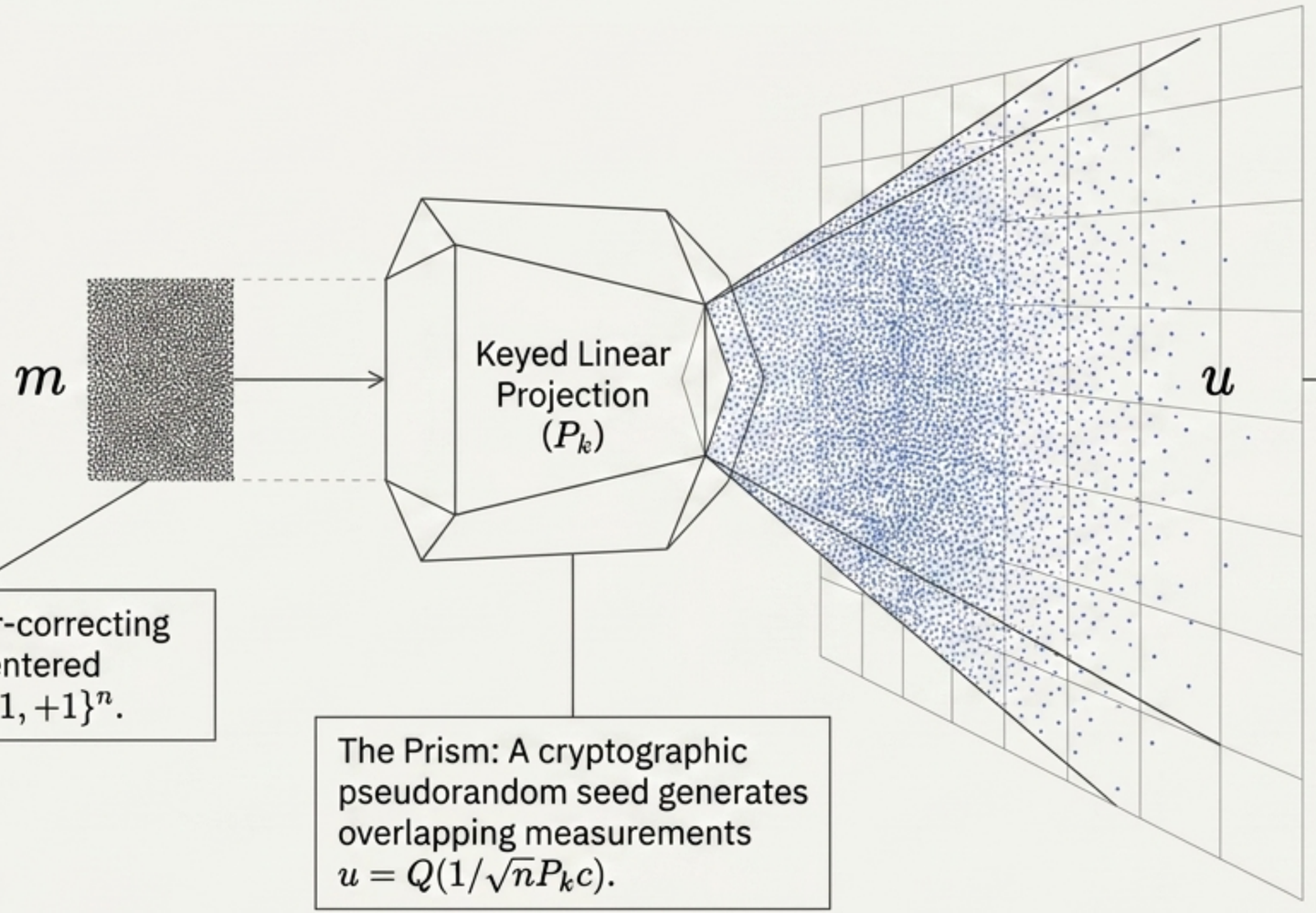
Selecting only a minimal active set of carrier regions to receive edits, reducing statistical artifacts.



Recursive Residual Correction

Employing a shared-parameter recurrent controller to evaluate intermediate distortion and revise the carrier dynamically.

The Holographic Payload Projection

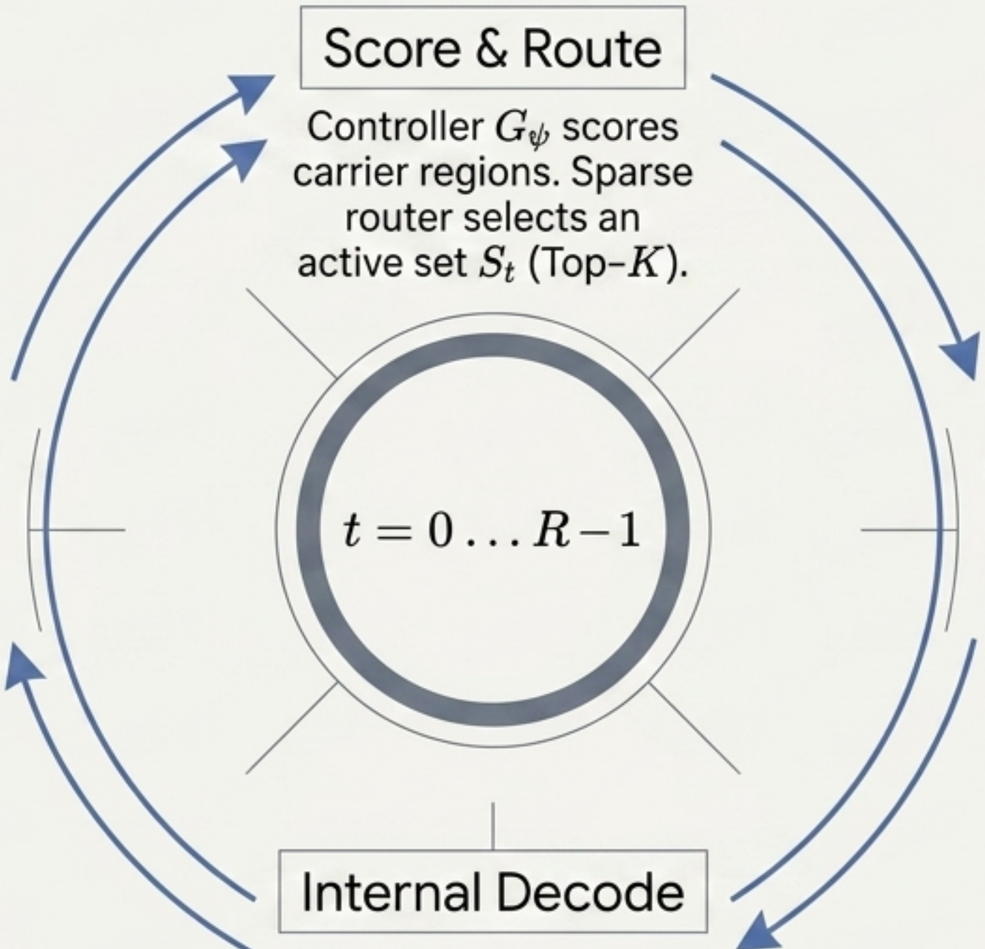


Input: Outer error-correcting code produces centered codeword $c \in \{-1, +1\}^n$.

The Prism: A cryptographic pseudorandom seed generates overlapping measurements $u = Q(1/\sqrt{n} P_k c)$.

Assumption 1 (Restricted Preservation): The projection preserves pairwise distances among codewords. Every sufficiently informative view carries degraded evidence of the entire whole.

Sparse Recursive Embedding



The Necessity of Joint Action

Sparsity without Recursion

Irreversible commitment to a single, possibly mistaken active set.

Recursion without Sparsity

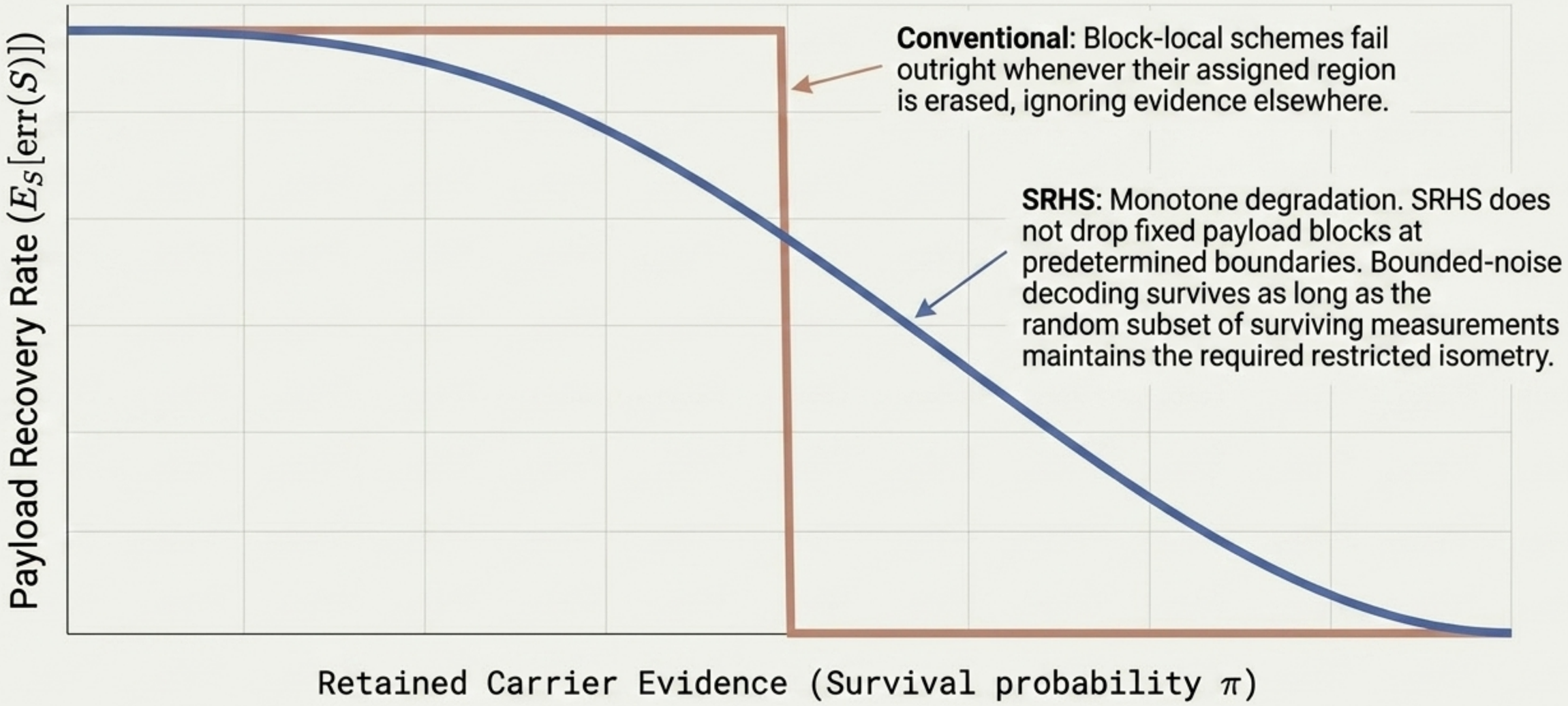
Widespread carrier perturbation, compounding detectable residue across steps.

The SRHS Synthesis: Sparsity + Recursion

Exploration followed by Correction.

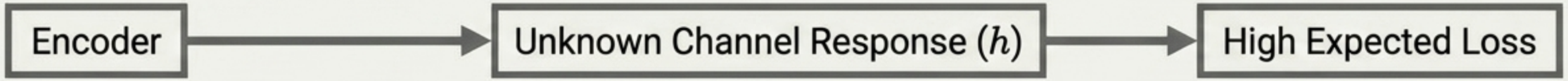
Early steps allocate weak measurements to predicted safe regions. An intermediate decode reveals uncertain payload directions. Later steps correct those directions through new regions or revisions. Computation becomes conditional: difficult covers consume more steps; clean covers stop early.

Proposition 1: Graceful Erasure Recovery

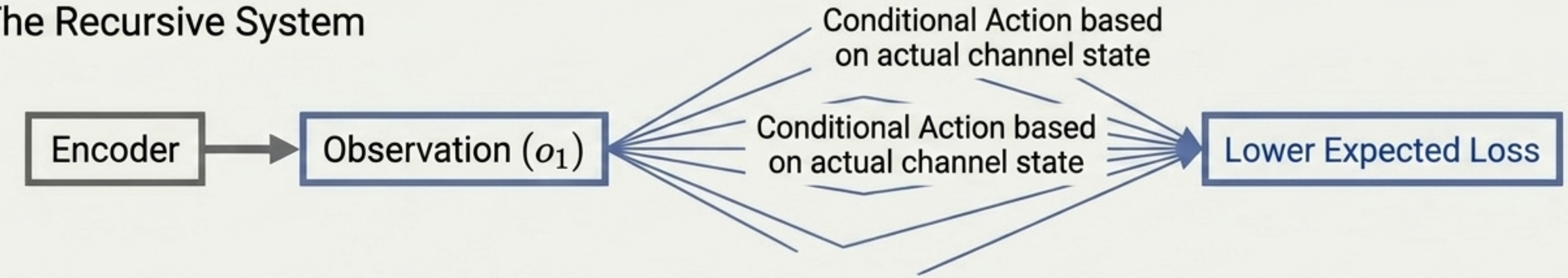


Proposition 2: Strict Dominance Under Uncertainty

The One-Pass System



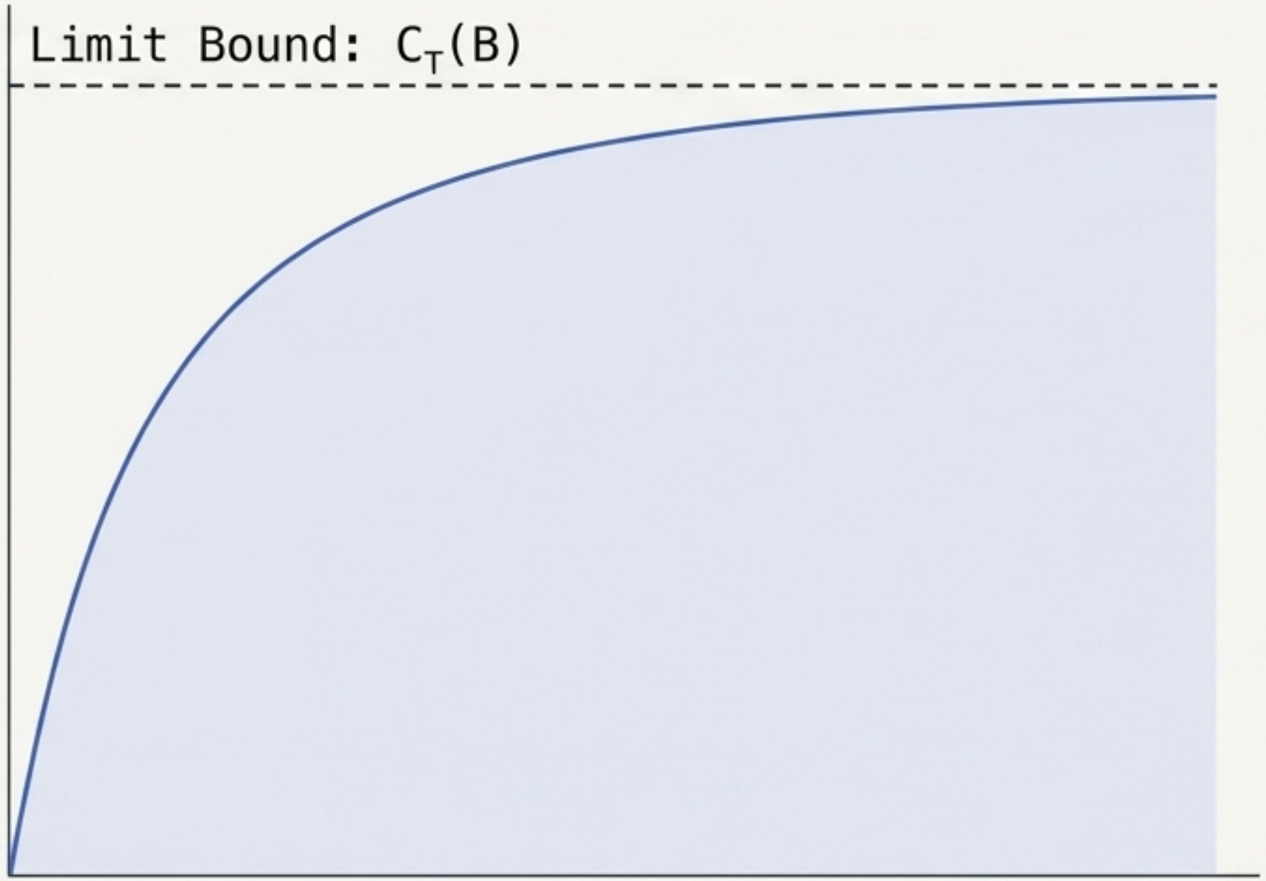
The Recursive System



$$\mathbb{E}_{o_1}\left[\min_a \mathbb{E}[\ell(a,h) \mid o_1]\right] < \min_a \mathbb{E}[\ell(a,h)]$$

Weak dominance is definitional. Strict dominance relies on the Value of Information. The internal decode provides an observation (o_1) that is informative about the realized channel state. The encoder learns from what survived its own preceeding attempt; strict dominance is achieved whenever the channel response is uncertain.

Proposition 3: Acknowledging Channel Capacity



$$L \leq C_T(B)$$

SRHS is not a claim that Shannon's channel capacity can be circumvented. Reliable transmission of an L-bit payload remains bounded by the effective capacity of the transformed channel under distortion budget B.

The role of projection redundancy, sparse routing, and recursive correction is to move the achievable operating point closer to the theoretical bound, using available capacity more effectively.

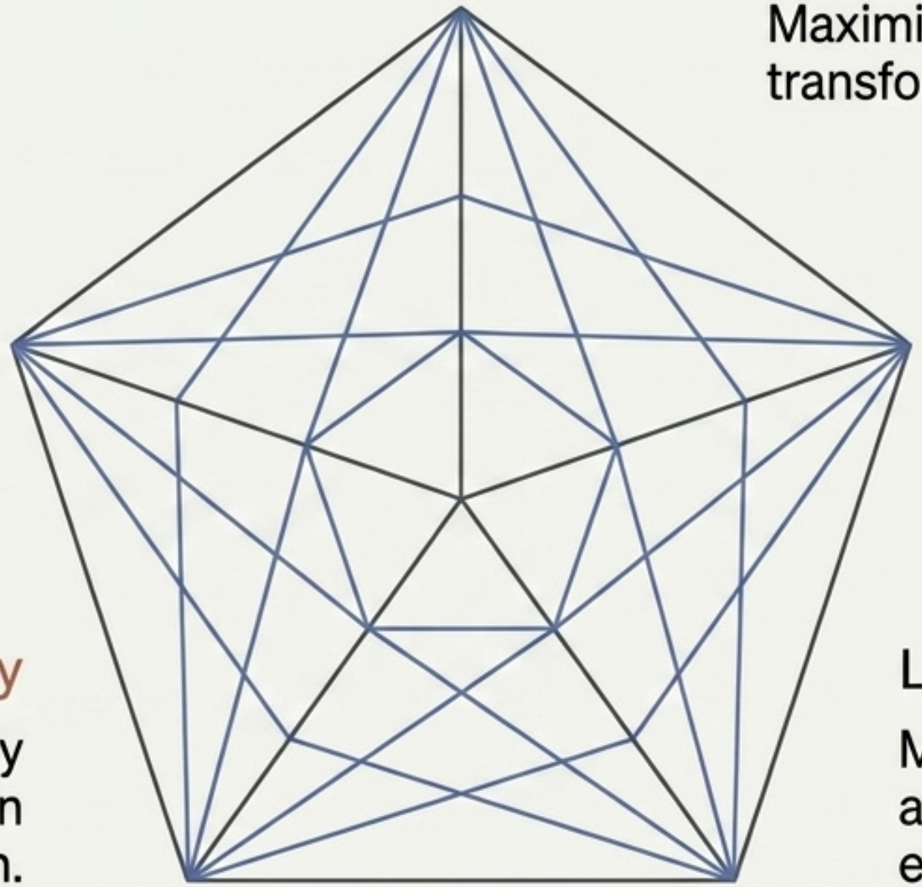
The Training Objective: A Tension Network

L_{msg}: Payload Loss

Maximizes recovery under transformed channels.

L_{view}: View Consistency

Requires independent partial views to agree on the decoded payload distribution.



L_{fid}: Fidelity

Enforces a hard distortion constraint (B), preventing visible carrier damage.

L_{route}: Routing Sparsity

Penalizes repeatedly concentrating revisions in the same region.

L_{sec}: Security

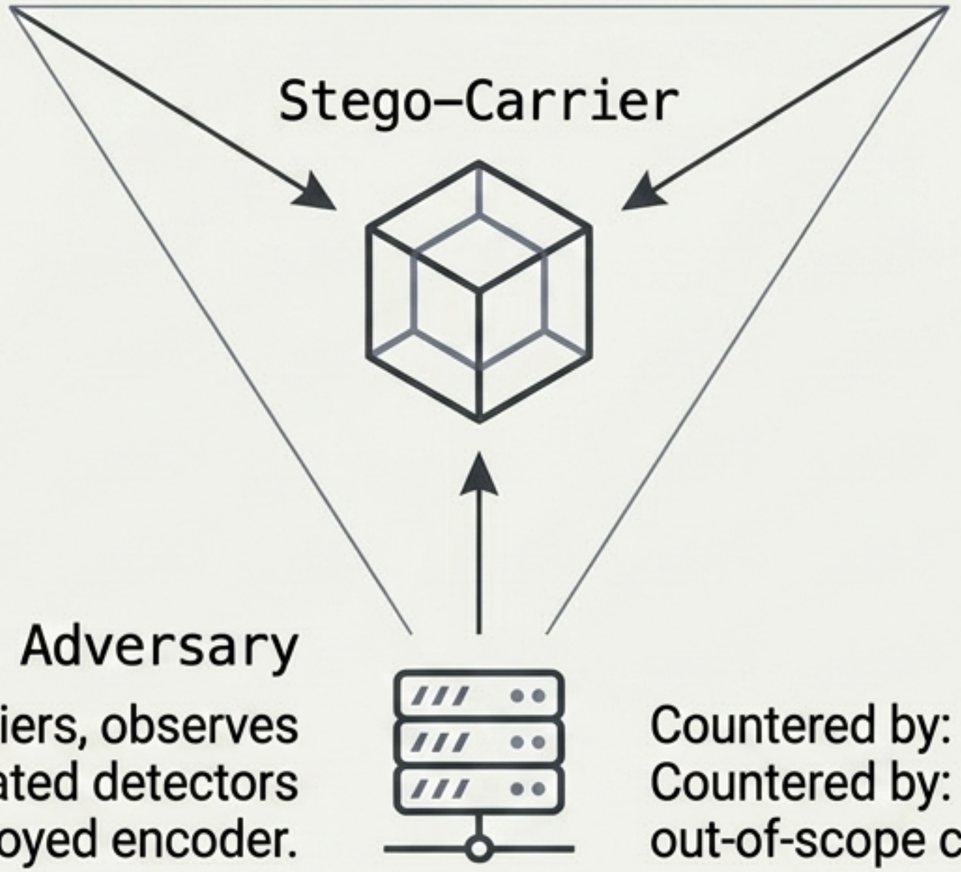
Minimizes adversarial advantage against a periodically refreshed ensemble of detectors.

A Three-Observer Threat Model

Passive Warden

Attempts to decide whether a carrier contains a payload.

Countered by: L_{sec} and learned ensemble indistinguishability.



Active Warden

Applies transformations intended to destroy covert communication while preserving carrier utility.

Countered by: Holographic multi-view consistency.

Forensic Adversary

Collects multiple carriers, observes key reuse, or trains dedicated detectors against a deployed encoder.

Countered by:
Countered by: Adaptive key schedules and out-of-scope cryptographic assumptions.

Falsifiability and The Scientific Standard

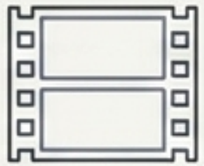
Preregistered Success

- Lowers transformed-channel bit error without increasing held-out detector AUC at matched distortion.
- Partial-view recovery degrades smoothly with retained evidence.
- Recursion improves the frontier beyond parameter-matched one-pass models.

Preregistered Failure

- Gains disappear against completely held-out detector architectures.
- Additional recursion steps offer no measurable gain after compute matching.
- Robustness is achieved only by silently exceeding the declared hard distortion budget B.

Modality Independence and Extensions



Video

Measurements dispersed over space, time, and motion trajectories. Recursion targets only unreliable frames.

Audio

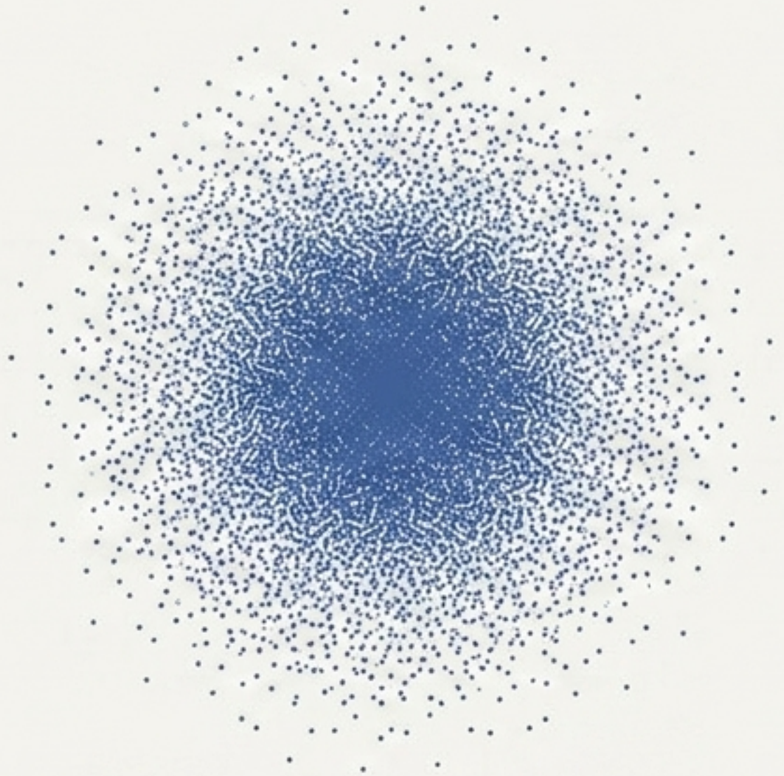
Sparse routing exploits transient masking and spectral uncertainty limits.

Text

Admissible semantic edits.
Continuous internal projection combined with constrained discrete generators.

Generative Synthesis

Steering construction.
Encoding secrets into a distributed pattern of generative choices (textures, micro-motions) rather than altering a finished artifact.



From the Secret Bit to the Secret Field

Hidden information can no longer be identified with particular altered carrier locations.

By joining error-correcting projection, sparse routing, and recursive correction, SRHS renders hidden data as a recoverable property of the carrier as a whole—weakly present in many views, strengthened by aggregation, and written through adaptive computation rather than fixed placement.