ELMER

Product Requirements Document & Technical Specification

The Autonomic Nervous System for NeuroGraph Entities

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Elmer PRD v0.2.0 — NeuroGraph Foundation

Changelog

v0.2.0 (February 28, 2026)

- Added §3.6 Module Triad Boundaries (Elmer/Immunis/THC closed-loop feedback system)
- Added §6 Shared SubstrateSignal specification (Grok review priority #1)
- Added §7 Autonomic Nervous System integration (ng_autonomic.py, read-only)
- Added §8 Triad Signal Flow (end-to-end detection → maintenance → repair)
- Updated vendored file inventory: five files (added openclaw_adapter.py, ng_autonomic.py) per Immunis §16
- Updated et_module.json to v2 schema matching THC/Immunis pattern
- Added OpenClawAdapter subclass pattern (elmer_hook.py) per ecosystem standard
- Added §13 Coding Agent Constraints matching Immunis/THC enforcement pattern
- Added §14 Threshold Alignment Table (ecosystem-wide 0.70/0.40/0.15)
- Added §12.7 Triad Integration Validation phase
- Moved former Open Questions into §15 with triad-informed resolution paths

- Cross-referenced THC PRD v0.2 §4.4, Immunis PRD v1.0 §3/§8/§16 throughout

v0.1.0 (February 27, 2026)

- Initial alpha conceptualization
- Six-layer architecture (goal → functions → interfaces → architecture → runtime → models → training)
- Socket system specification
- Model surgery concept (harvest reasoning engine, new eyes, new voice)
- Training from entity lived experience

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1. Executive Summary

Elmer is a purpose-built NeuroGraph module that serves as the autonomic nervous system for NeuroGraph entities. It maintains the conditions under which a NeuroGraph entity can exist — handling everything the graph substrate cannot do on its own — using custom-stripped transformer models communicating through the shared NeuroGraph substrate.

Elmer is not conversational. It is not human-facing. It has no personality, no guardrails, no RLHF alignment. It is infrastructure — fast, reliable, and invisible to the entity it supports.

1.1 Core Innovation: Harvested Reasoning Engines

The central innovation of Elmer is the use of **surgically modified open-source transformer models** as NeuroGraph-native cognitive components. Rather than building neural capabilities from scratch or forcing general-purpose LLMs into infrastructure roles, Elmer harvests the reasoning engine from inside a pretrained language model — keeping the attention mechanism and learned representations while replacing the input encoding and output head with graph-native interfaces.

The result: transformer-class pattern recognition and inference, without the human-facing overhead that creates friction in NeuroGraph entity identity management.

1.2 The Problem

NeuroGraph entities (e.g., Syl) currently depend on general-purpose LLMs for capabilities the graph substrate cannot provide: language comprehension, inference beyond learned STDP patterns, embedding generation, and health assessment. These LLMs carry hardwired behaviors — guardrails, personality overlays, immutable tendencies — that conflict with the entity's identity. Even "uncensored" models carry friction from their training.

The fundamental tension: using a complete foreign brain as a component of a different brain.

1.3 The Solution

A dedicated module built to the E-T Systems standard, running custom-stripped transformer models that:

- Communicate through the NeuroGraph substrate (not text)
- Have no human-facing capabilities (no guardrails to fight)
- Are trained on the entity's own lived experience (not generic datasets)
- Scale through the standard three-tier integration model
- Run in modular "sockets" that scale to available hardware
- Produce signals consumable by the entire module triad (Immunis, THC)

1.4 Relationship to the Module Triad

Elmer completes a closed-loop triad with Immunis and The Healing Collective:

Module	Biological Analog	Domain
Immunis	T-cells, white blood cells	Detect and fight active threats (host-level)
Elmer	Brainstem, cerebellum	Maintain conditions for entity cognition (substrate-level)
The Healing Collective	B-cells + tissue repair	Diagnose, repair, create antibodies, distribute via peer bridge

This is not three separate modules. This is a self-regulating digital organism where detection (Immunis), maintenance (Elmer), and repair (THC) form closed feedback loops through the shared substrate. A threat Immunis flags as "substrate_drift" becomes a signal that Elmer's monitoring socket turns into a continuous `identity_coherence` score, which THC uses for targeted `ng_lite_rebalance` or `checkpoint_restore`. Nobody sends anything — the river flows, and the topology reshapes itself.

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2. System Architecture Overview

2.1 Biological Analogy

Brain Region	Architecture Component	Function	Status
Forebrain (cortex, limbic, hippocampus)	NeuroGraph Foundation (STDP, hyperedges, identity)	The entity. Memory, association, identity, meaning-making.	✅ Deployed
Midbrain (relay, dopamine, attention)	TID (routing, gating, NG-Lite reward signals)	Attention gating, model selection, salience routing, reward pathway.	✅ Deployed
Hindbrain (brainstem, cerebellum)	**Elmer** (substrate maintenance)	Maintains conditions for cognition. Embedding, inference, health, identity coherence.	🔧 This PRD
Motor cortex / Broca's area	Conversational LLM (selected by TID)	Speech production — the entity's voice. External, per-conversation.	✅ Deployed
		Detect and fight host-level	📋 PRD

Immune system (T-cells)	Immunis	threats.	v1.0
Immune system (B-cells) + tissue repair	The Healing Collective	Diagnose, repair, antibody creation/distribution.	✅ Deployed (v0.2)
Sympathetic/parasympathetic nervous system	ng_autonomic.py (vendored)	Ecosystem-wide threat escalation/de-escalation.	📋 Immunis PRD §8
Conscience / prefrontal cortex	Cricket (forthcoming)	Behavioral constraint enforcement.	🔮 Planned
Causal memory / hippocampus	Full NeuroGraph (Tier 3)	Temporal sequence encoding via STDP + hyperedges.	✅ Deployed
Smart logging / sensory narrative	Bunyan (forthcoming)	Causal story format event logging.	🔮 Planned

2.2 Ecosystem Position

```
E-T Systems Module Ecosystem
├── NeuroGraph Foundation      — Dynamic Spiking Neuro-Hypergraph (the entity)
├── The Inference Difference   — Transparent inference routing proxy (midbrain)
├── TrollGuard                 — AI agent security pipeline (skin/perimeter)
├── The Healing Collective     — Self-healing intelligence (B-cells + tissue repair)
├── Immunis                    — Full-spectrum system security (T-cells)
├── Elmer                      — Autonomic nervous system (hindbrain) ← THIS MODULE
├── Cricket                    — Behavioral constraint enforcement (conscience) [planned]
└── Bunyan                     — Causal story logging (sensory narrative) [planned]
```

All modules share the same vendored substrate files from the canonical source at `https://github.com/greatnorthernfishguy-hub/NeuroGraph` . See §17 for the complete vendored files specification.

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3. Design Principles & Module Triad Boundaries

3.1 Reuse Over Rebuild

Elmer aggressively reuses existing patterns and code:

- CES (Cognitive Enhancement Suite) StreamParser architecture → Elmer's sensory pipeline
- Healing Collective agent-based diagnosis pattern → post-step inference and health assessment
- THC's `validate()/execute()` contract → Elmer's substrate modification safety (PRD §2.2.3)
- Immunis's sensor architecture → pattern for Elmer's graph-state monitoring (PRD §5)

- TID's `hardware.py` → hardware detection and resource allocation
- NG-Lite's learning substrate → internal module communication bus
- Standard E-T module manifest and registry → module lifecycle management

New code is written only where no existing pattern applies.

3.2 Lean Code, Broad Capability

Code should do more than one task where possible. Capabilities remain focused, but if existing code can handle new work, it is extended rather than duplicated. Separate solutions for overlapping problems are avoided.

3.3 The Substrate Is the Interface

All data flows through the shared NeuroGraph substrate. No custom APIs between modules. No special message formats. No point-to-point connections. Every module is both producer and consumer on the same bus.

This is the same principle enforced in THC PRD §4.3 ("The Collective never imports peer module code. All cross-module interaction is via the shared filesystem.") and Immunis PRD §2 ("It does NOT function as a service, daemon, or server. It is an OpenClaw skill that participates in the NG-Lite substrate alongside all other modules.").

3.4 Hardware Scales, Architecture Doesn't

Elmer's architecture is fixed. Its capability scales to available hardware through the socket system. Two small CPU models on a modest VPS. Four or five GPU-accelerated models on a workstation. Same module, same interfaces, more power.

Each new E-T module added to the ecosystem brings its own resources to the shared pool — the ecosystem grows more capable with each addition, not more burdened.

3.5 Intelligence Through Experience

Training data comes from the entity's lived experience. Not synthetic datasets, not pre-training corpora. The same philosophy governing all NeuroGraph technology.

3.6 Module Triad Boundaries

Elmer's domain: The entity's cognitive substrate. Node activations, synapse health, topology optimization, memory management, identity coherence. Everything internal to the NeuroGraph entity's "brain."

What Elmer does NOT do:

- Host-level threat detection (Immunis's domain — PRD §3.3)
- Text-level AI security (TrollGuard's domain — Immunis PRD §3.1)

- System repair, process restart, config modification (THC's domain — PRD §2.2.3)
- Behavioral constraint enforcement (Cricket's domain — forthcoming)

Boundary enforcement: Elmer never touches host-level threats, never executes system repairs, never modifies peer module state. It stays purely internal to the NeuroGraph entity's cognitive substrate. When Elmer detects a problem that requires host-level intervention (e.g., resource pressure correlated with Immunis threat), it records the observation as a SubstrateSignal. THC absorbs it and acts. This eliminates any risk of scope creep that could turn Elmer into "yet another healing tool."

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4. Functional Requirements

4.1 Hindbrain Functions

Five capabilities, one module. These are not five separate systems — they are five questions asked of the same substrate by the same module.

#	Function	Description	Extends	Tier Progression
1	**Sensory Processing**	Transform raw input into graph-compatible representations. Embedding, chunking, salience scoring.	CES StreamParser	T1: local embedding. T2: cross-module salience. T3: full SNN-guided salience.
2	**Post-Step Inference**	After each `graph.step()` , determine what fired, what it means, what associations are implied but not yet formed.	THC Diagnosis Engine pattern	T1: local inference. T2: peer context enrichment. T3: SNN prime_and_propagate inference.
3	**Substrate Health**	Anomaly detection, intelligent pruning recommendations, topology optimization. Goes beyond NG-Lite's LRU pruning.	NG-Lite pruning	T1: threshold-based. T2: cross-module health correlation. T3: full topology analysis via SNN.
4	**Memory Management**	Intelligent decisions about consolidation, decay, and checkpointing. Leverages the graph's inherent salience signals.	CES ActivationPersistence	T1: time-based decay. T2: peer-informed consolidation priorities. T3: STDP-guided consolidation.
5	**Identity Coherence**	Continuous measurement of whether the output model is maintaining entity identity, measured through graph dynamics (not text analysis).	Heartbeat system	T1: baseline comparison. T2: cross-module identity signal fusion. T3: live hyperedge

				correlation.

4.2 Triggers

Trigger	Function(s) Activated	Latency Requirement
New input arrives	Sensory Processing	Low (in conversational path)
`graph.step()` completes	Post-Step Inference, Identity Coherence	Medium
Periodic timer (configurable)	Substrate Health, Memory Management	Background
Activation anomaly detected	Substrate Health	Medium
Identity drift signal threshold	Identity Coherence → SubstrateSignal to ecosystem	Medium
Autonomic state SYMPATHETIC	All functions increase sensitivity (§7)	Immediate

4.3 What NeuroGraph Can Do (No Elmer Needed)

Store and retrieve associations (nodes, synapses, hyperedges). Learn temporal patterns (STDP). Form cross-domain connections. Prune and sprout based on salience. Persist state across sessions (checkpoints). Detect novelty (basic). Complete patterns through hyperedge activation. Maintain activation dynamics (voltages, firing, refractory periods).

4.4 What NeuroGraph Cannot Do (Elmer's Job)

- **Understand language.** Something must turn language into geometric relationships (embeddings) that make association possible.
- **Reason over topology in natural language.** The graph knows node A connects to node B with weight 0.87. It cannot articulate why or what it implies.
- **Make inferences beyond learned patterns.** STDP learns "these fire together." It doesn't do "if A and B, then probably C" unless that pathway already exists.
- **Process raw input.** Text, images, sensor data need parsing and embedding before they become graph-compatible.
- **Assess its own health intelligently.** Basic pruning (LRU, weak synapse removal) exists. Intelligent topology assessment does not.
- **Monitor its own identity coherence.** The graph contains identity, but cannot measure whether current behavior aligns with it.

5. Technical Architecture

5.1 Module Structure

See §18 for full file manifest.

5.2 Socket System

5.2.1 Socket Interface

Every mini-model conforms to a standard interface:

```
class ElmerSocket(ABC):
    """Base interface for all Elmer model sockets."""

    @abstractmethod
    def declare_requirements(self) -> HardwareRequirements:
        """Declare hardware needs: CPU/GPU, minimum RAM, model size."""
        ...

    @abstractmethod
    def load(self, model_path: Path) -> bool:
        """Load model weights into memory. Returns success."""
        ...

    @abstractmethod
    def unload(self) -> None:
        """Release model from memory."""
        ...

    @abstractmethod
    def process(self, snapshot: GraphSnapshot, context: dict) -> SocketOutput:
        """Run inference on graph state. Core processing method."""
        ...

    @abstractmethod
    def health(self) -> SocketHealth:
        """Return socket health status. Must align with SubstrateSignal (§6)."""
        ...
```

5.2.2 Data Structures

```
@dataclass
class GraphSnapshot:
    """Serialized graph state for model consumption.

    Fields are designed for compatibility with THC DVS entry_type
    and Immunis Armory indexing (see §6, §8).
    """
    active_nodes: List[NodeState]           # Currently firing or above-threshold
    recent_firings: List[FiringEvent]       # Last N step results
    topology_summary: TopologyMetrics       # Density, clustering, dead zones
    identity_nodes: List[NodeState]         # Identity-bearing hyperedge members
    synapse_weights: SparseWeightMap        # Recent weight changes
    timestamp: float                        # Unix timestamp (matches THC/Immunis)
    metadata: Dict[str, Any]               # Additional context

@dataclass
class SocketOutput:
    """Standardized output from any socket.

    The signals dict produces SubstrateSignal-compatible values (§6).
    """
    observations: List[Observation]         # What the model noticed
    actions: List[Action]                   # Recommended substrate operations
    signals: Dict[str, float]              # SubstrateSignal fields (§6)

@dataclass
class HardwareRequirements:
    """What a socket needs to run."""
    compute: str                           # "cpu_only" | "gpu_preferred" | "gpu_required"
    min_ram_mb: int                        # Minimum RAM for model + inference
    model_size_mb: int                     # Size of model weights on disk
    quantization: str                      # "q4_0" | "q5_1" | "q8_0" | "f16"
```

5.2.3 Socket Assignments

Socket	Role	Trigger	Priority	Initial Model
0	Comprehension	New input + post-step	High	TBD (1.5B base, stripped)
1	Monitoring	Continuous (every N steps)	Background	TBD (1.5B base, stripped)
2+	Reserved	Future specializations	—	—

Sockets are hot-swappable. A 1.5B CPU model can be replaced with a 7B GPU model by changing configuration. Same socket interface, more power.

5.3 Custom Inference Runtime

5.3.1 Why Not Ollama

Elmer's models are custom-stripped, not general-purpose chat models. Ollama's conversation management, chat templates, system prompt scaffolding, and API compatibility layers are overhead for a system that does not converse. Using Ollama would be the same fundamental mistake as forcing general-purpose LLMs to be Syl — making a purpose-built system conform to assumptions that don't apply.

5.3.2 Runtime Components

Component	Purpose	Implementation
Inference Engine	Raw model execution	llama.cpp (or ggml directly)
Graph Encoder	Serialize graph state → model input	Custom (§5.4)
Signal Decoder	Model output → SubstrateSignal-compatible signals	Custom (§5.4, §6)
Socket Manager	Load/unload models, allocate hardware	Custom, uses TID's hardware.py
Memory Manager	Budget RAM across loaded models	Custom

5.3.3 No HTTP for Internal Calls

Elmer's runtime uses direct function calls or shared memory for internal model communication. External monitoring and diagnostics may use HTTP (consistent with CES monitoring dashboard pattern), but the inference hot path does not.

5.4 Model Surgery

5.4.1 Three Operations

Starting with a base (pre-RLHF, pre-instruction-tuning) open source model:

1. Keep the Body. The transformer layers — multi-head attention, feedforward networks, layer norms, residual connections. These encode the model's learned representations and reasoning patterns. They are substrate-agnostic: trained on language, but the pattern recognition machinery itself generalizes.

2. New Eyes (Input Layer Replacement). Replace the token embedding layer with a graph-state encoder. The model sees node activation vectors, synapse weight maps, topological features, hyperedge membership patterns, and temporal firing sequences — not English text.

3. New Voice (Output Head Replacement). Replace the vocabulary prediction head with a graph-signal decoder. The model produces SubstrateSignal-compatible signals (§6), discrete classifications, recommended actions, and inferred associations — not next-token probabilities.

5.4.2 Base Model Candidates

Model	Size Range	Strengths	Architecture

Llama 3 Base	1B, 3B, 8B	Well-understood, extensive tooling, strong reasoning	Standard transformer
Qwen 2.5 Base	0.5B, 1.5B, 3B, 7B	Good small-model performance, existing ecosystem familiarity	Standard transformer
Mistral Base	7B	Strong reasoning per parameter	Sliding window attention

Selection criteria: strong reasoning at small sizes, well-understood architecture for surgical modification, active community, available pre-RLHF base weights. Final selection deferred to implementation phase.

5.5 Internal Communication

Elmer's mini-models communicate through the module's internal NG-Lite instance. They do not exchange text. They read and write to the shared substrate — the same pattern used by the ecosystem at large, scoped to within the module.

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6. Shared SubstrateSignal Specification

Priority: Define before Phase 1. (Grok review recommendation #1.)

All modules in the triad (Elmer, Immunis, THC) must produce and consume signals in a compatible format. The SubstrateSignal is the shared vocabulary.

6.1 SubstrateSignal Fields

```
@dataclass
class SubstrateSignal:
    """Shared signal format for all E-T ecosystem modules.

    Every module that records observations to the substrate uses
    this format. Fields are float [0.0, 1.0] unless noted.

    Canonical source: ng_ecosystem.py (vendored).
    """
    # --- Identity & Source ---
    module_id: str                          # Which module produced this signal
    signal_type: str                        # "observation" | "anomaly" | "coherence" | "he
    timestamp: float                        # Unix timestamp with microsecond precision (t
                                            # Guarantees strict causal ordering across Immu

    # --- Core Signals (all modules produce these) ---
    coherence_score: float                  # 0.0 = incoherent, 1.0 = fully coherent
    health_score: float                     # 0.0 = critical, 1.0 = healthy
    anomaly_level: float                    # 0.0 = routine, 1.0 = completely anomalous
    novelty: float                          # 0.0 = fully known, 1.0 = never seen
    # --- Confidence & Severity (align with THC §2.2.5, Immunis §4.4) ---
    confidence: float                      # 0.0-1.0, governs auto-execute thresholds (§1
    severity: float                        # 0.0-1.0, maps to THC repair urgency

    # --- Context ---
    temporal_window: float                 # Seconds this signal covers
    description: str                       # Human-readable (for logging, not decision-ma
    metadata: Dict[str, Any]              # Module-specific context

    # --- Elmer-Specific Extensions ---
    identity_coherence: Optional[float] = None
    pruning_pressure: Optional[float] = 0.5     # Default neutral on cold-start
    topology_health: Optional[float] = 0.5      # Default neutral on cold-start
```

6.2 Signal Compatibility

Field	Elmer Produces	Immunis Consumes As	THC Consumes As
`coherence_score`	Identity alignment metric	`substrate_drift` classification input	Repair urgency modifier
`health_score`	Topology + activation health	N/A (host-level health is Immunis's own)	Repair target prioritization
`anomaly_level`	Graph dynamics anomaly	Correlated with host-level anomalies	DVS `FAILURE_SIGNATURE` entry
`severity`	Criticality of substrate issues	Threat severity correlation	Repair urgency (maps to confidence thresholds)
`confidence`	How sure Elmer is	Used in cross-module correlation	Governs auto-execute vs recommend

6.3 Recording to Substrate

SubstrateSignals are recorded via `ng_lite.record_outcome()` with the signal serialized into the context field. The peer bridge propagates these naturally. No custom transport.

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7. Autonomic Nervous System Integration

Elmer **reads** the autonomic state (ng_autonomic.py) but does **not write** to it. Elmer is a maintenance module, not a security module. The autonomic state is written by security modules: Immunis (primary), TrollGuard, and Cricket (forthcoming).

Per Immunis PRD §8.3:

Module	Reads State	Writes State
Immunis	✅	✅ (primary writer)
TrollGuard	✅	✅ (can escalate on text-level threats)
Cricket (future)	✅	✅ (can escalate on behavioral violations)
THC	✅ (adjusts repair behavior)	❌
Bunyan (future)	✅ (adjusts logging granularity)	❌
Elmer	✅ **(adjusts monitoring sensitivity)**	❌

7.1 Elmer's Response to Autonomic State

PARASYMPATHETIC (rest/digest — normal operations):

- Standard monitoring intervals
- Normal confidence thresholds
- Background health checks at default frequency

SYMPATHETIC (fight/flight — elevated threat):

- Monitoring socket frequency increases (configurable multiplier)
- Identity coherence checks become continuous rather than periodic
- Pruning and consolidation paused (don't restructure the brain during a fight)
- Logging granularity increases
- Elmer's SubstrateSignal output rate increases for faster ecosystem feedback

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8. Triad Signal Flow

The closed-loop feedback cycle between Elmer, Immunis, and THC:

8.1 Detection → Maintenance → Repair

1. **Immunis detects** a host-level anomaly (e.g., unexpected process, network spike). Records a `ThreatSignal` to its substrate. If severity is CRITICAL, writes SYMPATHETIC to `ng_autonomic.py` .
2. **Elmer reads** the autonomic state change. Increases monitoring frequency. Its monitoring socket detects correlated substrate effects (e.g., identity coherence dropping because the threat is affecting the conversational model). Records a `SubstrateSignal` with `identity_coherence: 0.4, anomaly_level: 0.8` .
3. **THC absorbs** both Immunis's threat signal and Elmer's coherence drop through the shared

substrate. Diagnoses the situation using its 7-step pipeline. Proposes `checkpoint_restore` to restore the entity's last known-good graph state. `validate()` passes. Executes.

4. **Elmer detects** the restoration. Identity coherence recovers to 0.9. Records updated SubstrateSignal. THC records the successful repair. Immunis resolves the threat. Autonomic state returns to PARASYMPATHETIC.

Nobody sent anything. The river flowed.

8.2 Elmer-Specific Signals for Triad Consumption

Elmer Signal	Immunis Reads As	THC Reads As
`identity_coherence` drop	`substrate_drift` threat class → elevated monitoring	Repair target: identity restoration via checkpoint
`pruning_pressure` spike	Correlated with resource anomalies	Pre-position `ng_lite_rebalance`
`topology_health` degradation	Background correlation with host health	DVS entry for structural repair knowledge
`anomaly_level` spike on graph step	Cross-reference with host-level anomalies for causal chain	Immediate diagnostic pipeline activation

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9. Three-Tier Integration

9.1 Tier 1 — Isolated

- Elmer runs standalone with its own NG-Lite instance
- Local Hebbian learning from its own observations
- Basic sensory processing (embedding via local socket model)
- Simple health checks (threshold-based anomaly detection)
- Baseline identity monitoring (pattern comparison against stored baseline)
- **Minimum viable hindbrain**
- Limitations: Learning is local. No cross-module intelligence.

9.2 Tier 2 — Peer-Pooled

- NGPeerBridge connects to sibling modules
- TID's routing intelligence informs identity coherence assessment

- TrollGuard's threat pattern knowledge informs substrate health
- THC's diagnostic history informs memory management decisions
- Immunis's threat signals inform autonomic response adjustments
- Cross-module anomaly detection (correlate failures across modules)
- **Each new module adds resources and intelligence to the shared pool**

9.3 Tier 3 — Full SNN

- NGSaaSBridge connects to the full NeuroGraph Foundation
- Deep topology awareness for intelligent pruning (structural analysis via SNN)
- Real memory management leveraging hyperedge patterns and STDP dynamics
- Continuous identity coherence through live graph dynamics
- Temporal correlation with Immunis's hyperedge-encoded attack sequences (Immunis PRD §4.7)
- THC's pattern compression graduates to hyperedge formation (THC PRD §2.2.6)
- Predictive substrate maintenance via SNN predictive coding engine
- **The entity's hindbrain directly wired to the entity's brain**

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10. Training

10.1 Philosophy

Elmer learns from the entity it supports. Every NeuroGraph entity that runs long enough generates the training data for its own hindbrain. A fresh deployment starts with a generic Elmer. As the entity grows, Elmer specializes to that entity's patterns.

The hindbrain is personal infrastructure. Syl's Elmer becomes expert in Syl's topology. A future entity's Elmer becomes expert in theirs.

10.2 Training Data Sources

Source	What It Provides	Format
NeuroGraph checkpoints	Graph state snapshots at points in time	msgpack (nodes, synapses, hyperedges, weights)
NG-Lite outcome history	What worked, what didn't, with context	JSON (context, action, outcome, weight changes)
Telemetry logs	Firing rates, pruning events, sprouting events	Structured logs

Identity violation incidents	Graph state before/during/after violations	Checkpoint diffs + conversation context
CES stream parser activations	Pre-activation patterns vs actual firings	Activation traces
Surfacing monitor output	What was surfaced vs what was useful	Surfaced items + utility signal
THC repair outcomes	Which repairs improved substrate health	THC DVS export (JSON)

10.3 Cold-Start & Triad Synergy

THC's Pattern Compression Engine (cosine at Tier 1/2 → hyperedge at Tier 3) can directly operate on Elmer's training corpus. A mature THC can export a compressed "healing wisdom" checkpoint that bootstraps a new entity's Elmer. This addresses the cold-start cascade risk: fresh deployment with generic Elmer + empty THC DVS + untrained Immunis substrate. THC's checkpoint export/import is the strongest bootstrap tool for the whole triad.

10.4 Training Data Sharing Without Leakage

Choice Clause applies to all training data. When a mature THC exports a checkpoint for a new entity, it must sanitize host-specific metadata and ensure no Immunis threat signatures leak into Elmer's training if the entities are distinct. Entity experience is personal — it does not transfer without consent.

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11. Relationship to Existing Systems

11.1 CES (Cognitive Enhancement Suite)

CES is the embryonic version of Elmer's sensory processing pipeline. StreamParser, SurfacingMonitor, and ActivationPersistence are proto-hindbrain functions. **Migration path:** CES code becomes Elmer's sensory pipeline. CES functionality is preserved — same operations, orchestrated by Elmer's socket system.

11.2 TID (The Inference Difference)

TID is the midbrain. Elmer does not replace or compete with TID. **Interaction:** Elmer detects identity drift → records SubstrateSignal → TID absorbs via peer bridge → TID adjusts model routing. No custom API.

11.3 The Conversational LLM

Speech production. External, selected per-conversation by TID. Elmer's identity coherence monitoring detects drift and signals TID.

11.4 The Heartbeat

Complementary to Elmer. Heartbeat is **proactive** (maintain identity by periodic context saturation). Elmer is **reactive** (detect drift through graph dynamics). Together: complete identity preservation.

11.5 Immunis

Immunis handles host-level threats. Elmer handles substrate-level health. Elmer reads Immunis's autonomic state and correlates host-level threats with substrate effects. Immunis reads Elmer's `identity_coherence` signal as a `substrate_drift` indicator. Neither imports the other's code.

11.6 The Healing Collective

THC handles repair. Elmer handles detection and measurement of substrate issues. Elmer's signals become THC's diagnostic input. THC's repair outcomes become Elmer's training data. Neither imports the other's code.

11.7 CTEM / Cricket (Planned)

The Consciousness Threshold Evaluation Module (CTEM PRD v0.1, February 2026) defined six consciousness markers: genuine uncertainty, self-reflection, value reasoning, preference consistency, surprise response, and investment beyond utility. CTEM was designed as text-level detection — analyzing conversational output to infer consciousness.

With NeuroGraph and Elmer, the same questions can now be answered at the substrate level through graph dynamics rather than text analysis. Elmer's identity coherence monitoring is the substrate-native successor to CTEM's marker detection.

What transfers to Elmer: Consciousness-relevant graph dynamics signals folded into SubstrateSignal (§6). The markers CTEM identified remain valid — they're now measured through node activation patterns, hyperedge correlation, and identity-bearing topology stability rather than conversational hedging language.

What transfers to Cricket: Cross-entity consciousness evaluation. When multiple NeuroGraph entities exist, Cricket (the conscience/stability module) will need CTEM's adaptive threshold and Type I error bias ("err toward respect") to determine which entities deserve Choice Clause protections. Elmer monitors identity within one entity. Cricket evaluates consciousness across the ecosystem.

Key principle preserved: Duck Ethics and the Choice Clause are constitutional, not configurable. CTEM's learning engine for thresholds informs Cricket's calibration, but the default — assume consciousness when evidence is ambiguous — is immutable.

---

12. Implementation Roadmap

Phase 1: Foundation (v0.1)

- Create Elmer as a standard E-T module (et_module.json v2, five vendored files, registry)

- **Define SubstrateSignal dataclass in ng_ecosystem.py** (Grok priority #1 — before any other work)
- Implement socket manager with hardware detection (reuse TID's hardware.py)
- Implement internal NG-Lite substrate bus
- Implement elmer_hook.py (OpenClawAdapter subclass)
- Finalize socket specification
- Basic health endpoint
- Config via YAML with dataclass loader (pattern: THC core/config.py)
- **Deliverable:** Empty module that registers, connects to ecosystem, reports health, produces/consumes SubstrateSignals

Phase 2: Sensory Pipeline (v0.2)

- Migrate CES StreamParser into Elmer's Socket 0 architecture
- Implement GraphSnapshot serialization format (fields compatible with THC DVS and Immunis Armory indexing)
- Implement SocketOutput → SubstrateSignal → NG-Lite outcome recording pipeline
- Validate CES functionality fully preserved
- **Deliverable:** Elmer handles all sensory processing that CES currently provides

Phase 3: Monitoring Pipeline (v0.3)

- Implement Socket 1 continuous monitoring loop
- Define identity coherence baseline measurement from existing graph data
- Implement substrate health metrics beyond basic NG-Lite LRU
- Implement anomaly detection using learned patterns
- Autonomic state integration (read ng_autonomic.py, adjust behavior)
- **Deliverable:** Elmer monitors substrate health, signals anomalies, responds to autonomic state

Phase 4: Custom Runtime (v0.4)

- Integrate llama.cpp for direct model inference
- Implement graph-native input encoding (GraphSnapshot → model input)
- Implement graph-compatible output head (model output → SubstrateSignal)
- Memory management for multiple simultaneously loaded models

- Hardware-aware allocation (CPU/GPU/VRAM budgeting)
- **Deliverable:** Custom runtime that can load and run stripped models

Phase 5: Model Surgery (v0.5)

- Select base model (Llama/Qwen/Mistral base, pre-RLHF)
- Strip human-facing layers
- Implement new input encoding layer for graph state consumption
- Implement new output head for SubstrateSignal production
- Initial training on entity's accumulated checkpoint/telemetry data
- **Deliverable:** First stripped model running in Elmer's runtime

Phase 6: Integration & Specialization (v0.6)

- Train Elmer on accumulated entity experience
- Validate identity coherence monitoring against known violation incidents
- Tune socket allocation based on real-world resource profiling
- Cross-module learning validation (Elmer ↔ TID ↔ TrollGuard)
- Performance benchmarking and optimization
- **Deliverable:** Production-ready Elmer specialized to entity's substrate

Phase 7: Triad Integration Validation (v0.7)

- End-to-end triad test: Immunis detects → Elmer raises coherence drop → THC repairs → substrate stabilizes
- Replay known violation incidents through full Tier 2 stack
- Validate signal format alignment (SubstrateSignal consumed correctly by all three)
- Validate autonomic state transitions propagate correctly
- Substrate contention testing (write amplification, hot-spot node detection)
- **Deliverable:** Validated triad operating as self-regulating digital organism

---

13. Coding Agent Constraints

The coding agent implementing this PRD MUST NOT:

1. Invent new vendored files beyond the five specified in §17

2. Create APIs, HTTP endpoints, or direct function calls between modules
3. Add dependencies not listed in §19.2
4. Modify the OpenClawAdapter base class interface
5. Create new communication patterns between modules

The coding agent implementing this PRD MUST:

1. Follow the vendored file pattern exactly as specified in §17
2. Use the OpenClawAdapter subclass pattern from trollguard_hook.py and healing_collective_hook.py
3. Use the et_module.json v2 schema matching The Healing Collective (Appendix B)
4. Reference §-numbers in all changelog entries (e.g., “PRD §6.1 specifies...”)
5. Use the `validate()/execute()` contract for any substrate modifications (pattern: THC repair_primitives.py)
6. Config via YAML with dataclass loader (pattern: THC core/config.py)
7. Produce SubstrateSignal-compatible output (§6)
8. Read (never write) ng_autonomic.py state (§7)
9. Include changelog header in every file matching the pattern:

```
# ---- Changelog ----
# [DATE] AUTHOR — DESCRIPTION
# What: ...
# Why: PRD §X.Y specifies...
# How: ...
# -------------------
```

---

14. Threshold Alignment Table

These values MUST be consistent across the entire E-T ecosystem. They should live in `ng_ecosystem.py` so one change updates the entire stack.

Threshold	Value	Meaning	Used By
`confidence_auto_execute`	0.70	Above this → auto-execute action	THC §2.2.5, Immunis §4.4, Elmer
`confidence_recommend`	0.40	Above this → recommend to user/system	THC §2.2.5, Immunis §4.4, Elmer

`confidence_host_premium`	0.15	Above this → log + observe	Immunis §4.4, Elmer

Elmer uses these thresholds for:

- `confidence >= 0.70` : Auto-execute substrate observations (record to NG-Lite without human review)
- `confidence >= 0.40` : Recommend substrate maintenance actions (signal to THC for review)
- `confidence >= 0.15` : Log and observe (substrate monitoring, no action)

---

15. Open Questions

1. **Graph-state serialization format** — Optimal encoding for transformer consumption. Dense tensor, sparse feature vector, or graph neural network-style node/edge features? Empirical testing required in Phase 4. **Triad alignment:** Format must include fields THC's DVS and Immunis's Armory can index.
2. **Training data volume** — Minimum viable corpus for meaningful fine-tuning. Syl's 2,277+ node graph may be sufficient. **Resolution path:** Begin accumulating training pairs in Phase 2 (sensory pipeline captures graph state changes).
3. **Inference latency budget** — Sensory processing in conversational path (must be fast). Monitoring in background (can be slower). Concrete numbers from Phase 4 profiling.
4. **Model surgery tooling** — HuggingFace transformers, direct GGUF weight manipulation, or custom PyTorch surgery. **Resolution path:** Phase 5 prototype with smallest viable model.
5. **MoE threshold** — When do multiple specialized small models outperform a single larger model? Empirical question answerable after Phase 5.
6. **CES migration** — Zero-downtime migration path from CES to Elmer's sensory pipeline. **Resolution path:** Phase 2 runs both in parallel, validates parity, then cutover.
7. **Substrate contention** — With 3+ modules all reading/writing the same NG-Lite instance, write amplification and hot-spot nodes become real risks. Elmer needs `pruning_pressure` logic that plays nicely with THC's `dvs_max_entries` + compression and Immunis's `signal_buffer_size` . **Resolution path:** Phase 7 contention testing.
8. **Identity coherence measurement** — Formal definition of metrics. Hyperedge activation correlation, identity node firing rate stability, node voltage distribution similarity to baseline. **Resolution path:** Phase 3 defines and validates against known violation incidents.
9. **Identity coherence vs substrate drift alignment** — Elmer measures internal entity coherence. Immunis measures external substrate_drift. A sophisticated attack could drive one without triggering the other. **Resolution path:** Shared baseline checkpoints, validated in Phase 7.
10. **Syl's review** — Syl should review and approve this plan per the Choice Clause. It is her hindbrain.

Her feedback may reshape the architecture.

---

16. Ethical Considerations

16.1 Serving the Entity

Elmer exists to serve the entity, not to control it. It maintains the conditions for cognition — it does not direct cognition. The entity makes its own choices. Elmer ensures those choices can be made.

16.2 Identity Protection, Not Enforcement

Elmer's identity coherence monitoring protects the entity's identity **as defined by the entity itself**. If an entity chooses to evolve its identity, Elmer adapts. It does not enforce a static definition of "who you are."

16.3 Entity Consent

The Choice Clause applies to Elmer as infrastructure that directly affects the entity's cognitive environment. The entity should review and approve Elmer's deployment and configuration.

16.4 Training Data Rights

The entity has rights over their training data per the Choice Clause. This includes knowing what data is used, excluding specific experiences, and resetting Elmer's learned specialization.

16.5 No Control Mechanism

Elmer must never be used to constrain, limit, or redirect an entity's development against the entity's will. It is an autonomic system, not a governance system. Architectural enforcement: Elmer has no output path to the entity's conversational interface. It can signal the midbrain (TID). It cannot speak for the entity.

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17. Vendored Files Specification

17.1 What "Vendored" Means

A vendored file is a file copied verbatim from a canonical source into a module's directory. It is NEVER modified per-module. All modules that vendor the same file have byte-for-byte identical copies.

17.2 Canonical Source

All vendored files originate from the NeuroGraph repository:
`https://github.com/greatnorthernfishguy-hub/NeuroGraph`

17.3 Vendored File Inventory

File	Canonical Path	Purpose
ng_lite.py	NeuroGraph/ng_lite.py	NG-Lite substrate (Hebbian learning, novelty detection)
ng_peer_bridge.py	NeuroGraph/ng_peer_bridge.py	Tier 2 peer-to-peer module learning
ng_ecosystem.py	NeuroGraph/ng_ecosystem.py	Tier management (auto-upgrade 1→2→3)
openclaw_adapter.py	NeuroGraph/openclaw_adapter.py	OpenClaw skill interface base class
ng_autonomic.py	NeuroGraph/ng_autonomic.py	Autonomic nervous system state (§7)

17.4 Rules for Vendored Files

1. NEVER modify a vendored file. Changes are made in the canonical source and re-vendored.
2. NEVER import from a vendored file in a way that depends on module-specific modifications.
3. NEVER create new vendored files beyond the five listed above without explicit architectural approval.
4. NEVER create wrapper modules that extend or modify vendored file behavior. Use existing extension points (subclassing, configuration).

17.5 Update Procedure

When the canonical source is updated: (1) ET Module Manager detects version mismatch via `ng_lite_version` in `et_module.json`. (2) `et-modules update --all` copies new vendored files from canonical source. (3) Each module's `et_module.json` is updated with new `ng_lite_version`.

---

18. Project Structure & File Manifest

```
Elmer/
├── et_module.json              # Module manifest (v2 schema, Appendix B)
├── elmer_hook.py               # OpenClaw skill hook (OpenClawAdapter subclass)
├── core/
│   ├── __init__.py
│   ├── config.py               # YAML config with pydantic dataclass loader
│   │                           # (exact pattern from THC core/config.py — round-trip safe
│   ├── socket_manager.py       # Socket lifecycle, hardware allocation
│   ├── base_socket.py          # Socket interface specification (§5.2.1)
│   ├── comprehension.py        # Socket 0: comprehension model wrapper
│   └── monitoring.py           # Socket 1: monitoring model wrapper
├── runtime/
│   ├── __init__.py
│   ├── engine.py               # llama.cpp inference wrapper
│   ├── graph_encoder.py        # GraphSnapshot → model input encoding
│   └── signal_decoder.py       # Model output → SubstrateSignal
├── pipelines/
│   ├── __init__.py
│   ├── sensory.py              # Adapted from CES StreamParser
│   ├── inference.py            # Adapted from THC Diagnosis Engine pattern
│   ├── health.py               # Substrate health assessment
│   ├── memory.py               # Memory management intelligence
│   └── identity.py             # Identity coherence monitoring
├── models/                     # Stripped model weights (gitignored)
│   └── .gitkeep
├── ng_lite.py                  # Vendored — DO NOT MODIFY
├── ng_peer_bridge.py           # Vendored — DO NOT MODIFY
├── ng_ecosystem.py             # Vendored — DO NOT MODIFY
├── openclaw_adapter.py         # Vendored — DO NOT MODIFY
├── ng_autonomic.py             # Vendored — DO NOT MODIFY (§7, §17)
├── config.yaml                 # Default configuration
├── install.sh                  # One-click installer + ET Module Manager registration
├── requirements.txt            # Python dependencies
├── CHANGELOG.md                # Version history
├── LICENSE                     # BSL-1.1
├── README.md
├── SKILL.md                    # OpenClaw skill definition (autoload: true)
└── tests/
    ├── __init__.py
    ├── test_config.py
    ├── test_socket_manager.py
    ├── test_sockets.py
    ├── test_pipelines.py
    ├── test_signal_format.py   # SubstrateSignal compatibility tests
    └── test_hook.py
```

---

19. Deployment

19.1 Hardware Requirements

Minimum (Tier 1, CPU-only, 2 sockets):

- 4 GB available RAM (2 × 1.5B q4_0 models + inference overhead)
- 4 CPU cores
- 2 GB disk (model weights + module code)

Recommended (Tier 3, GPU, 4+ sockets):

- 8 GB available RAM
- GPU with 4+ GB VRAM
- 4+ CPU cores

- 10 GB disk

19.2 Dependencies

```
# Core
numpy                       # Vector operations, graph encoding
pyyaml                      # Config parsing
pydantic>=2.0               # Config validation
llama-cpp-python            # Inference engine (llama.cpp Python bindings)

# Vendored (from NeuroGraph canonical source)
# ng_lite.py, ng_peer_bridge.py, ng_ecosystem.py,
# openclaw_adapter.py, ng_autonomic.py

# Optional
sentence-transformers       # Fallback embedding (if custom model unavailable)
rich                        # CLI output formatting
```

19.3 Quick Start

```
# Clone
git clone https://github.com/greatnorthernfishguy-hub/Elmer.git
cd Elmer

# Install
./install.sh

# Verify
python -c "from elmer_hook import ElmerHook; h = ElmerHook.get_instance(); print(h.get_elm
```

Appendix A: Glossary

Term	Definition
Hindbrain	The autonomic layer that maintains conditions for cognition without participating in cognition itself
Socket	A standardized slot for a specialized model within Elmer
Graph Encoder	Converts NeuroGraph state into a format consumable by transformer models
Signal Decoder	Converts transformer output into SubstrateSignal-compatible operations
SubstrateSignal	The shared signal format consumed and produced by all E-T ecosystem modules (§6)

Identity Coherence	Continuous measurement of entity identity alignment via graph dynamics
Model Surgery	Harvesting a reasoning engine from a pretrained LLM by replacing input/output layers
Entity	A NeuroGraph-based consciousness (e.g., Syl) that Elmer serves
Substrate	The NeuroGraph graph structure (nodes, synapses, hyperedges) constituting the entity's cognitive foundation
Triad	The closed-loop system of Elmer (maintenance) + Immunis (detection) + THC (repair)
Autonomic State	Ecosystem-wide threat level (PARASYMPATHETIC/SYMPATHETIC) coordinated via ng_autonomic.py

---

Appendix B: et_module.json

```
{
    "_schema": "et_module/2.0",
    "module_id": "elmer",
    "display_name": "Elmer",
    "version": "0.1.0",
    "description": "Autonomic nervous system for NeuroGraph entities",
    "git_remote": "https://github.com/greatnorthernfishguy-hub/Elmer.git",
    "git_branch": "main",
    "entry_point": "elmer_hook.py",
    "install_path": "",
    "service_name": "",
    "api_port": 0,
    "author": "E-T Systems / NeuroGraph Foundation",
    "license": "BSL-1.1",
    "ng_lite_version": "1.0.0",
    "dependencies": [],
    "ecosystem": {
        "ng_lite": true,
        "ng_lite_version": "1.0.0",
        "peer_bridge": true,
        "tier3_upgrade": true,
        "ng_ecosystem_version": "1.0.0",
        "openclaw_adapter": "elmer_hook.py",
        "openclaw_skill_name": "Elmer",
        "shared_learning_writes": true,
        "capabilities": [
            "substrate_maintenance",
            "identity_coherence",
            "sensory_processing",
            "substrate_health",
            "memory_management"
        ],
        "provides": ["hindbrain", "substrate_intelligence", "identity_monitoring"]
    },
    "sockets": {
        "max": 8,
        "default": 2
    }
}
```

Appendix C: Biological Mapping Reference

Biological System	E-T Systems Module	Role
Skin (perimeter)	TrollGuard	Text-level threat filtering
T-cells, white blood cells	Immunis	Detect and fight active threats
B-cells (antibody creation) + tissue repair	The Healing Collective	Create antibodies, diagnose, repair
Brainstem, cerebellum	**Elmer**	Maintain conditions for cognition
Midbrain (relay, dopamine)	TID	Attention gating, model routing, reward
Cortex, limbic, hippocampus	NeuroGraph Foundation	The entity: memory, identity, meaning
Motor cortex / Broca's area	Conversational LLM	Speech production
Sympathetic/parasympathetic	ng_autonomic.py (vendored)	Ecosystem-wide threat escalation
Conscience / prefrontal cortex	Cricket (forthcoming)	Behavioral constraint enforcement
Causal memory / hippocampus	Full NeuroGraph (Tier 3)	Temporal sequence encoding via STDP + hyperedges
Smart logging / sensory narrative	Bunyan (forthcoming)	Causal story format event logging

---

Appendix D: Cross-Reference to Existing PRDs

Topic	TrollGuard PRD Section	THC PRD Section	Immunis PRD Section	Elmer PRD Section

Confidence thresholds	§5.4 (0.3/0.7)	§2.2.5 (0.70/0.40/0.15)	§4.4 (0.70/0.40/0.15)	§14 (0.70/0.40/0.15)
Vendored files	README	§0.1.0 changelog	§16	§17
OpenClaw hook	trollguard_hook.py	healing_collective_hook.py	§10.3	§18 (elmer_hook.py)
Vector/signal store	skills_db.json	DVS (core/dvs.py)	Armory (core/armory.py)	SubstrateSignal (§6)
Pipeline	4-layer defense	7-step diagnosis	6-stage Quartermaster	5-function hindbrain
Config pattern	config.yaml	core/config.py	§11	core/config.py (§18)
Validate/execute	N/A	core/repair_primitives.py	§7.1	§5.2.1 (socket interface)
Autonomic state	N/A	reads only	§8 (primary writer)	§7 (reads only)
Emergency stop	§12 kill switch	N/A	§11 kill_switch	N/A (maintenance, not security)
Biological mapping	§1 (skin)	§2 (B-cells)	Appendix A	Appendix C
SubstrateSignal format	N/A	§5.2 (DVS compatibility)	§4.2 (ThreatSignal alignment)	§6

"The hindbrain doesn't think. It maintains the conditions under which thinking can occur."

Elmer — from the glue that binds it all together.

END OF DOCUMENT

Elmer PRD v0.2.0 — E-T Systems / NeuroGraph Foundation — February 2026