ELMER

Product Requirements Document & Technical Specification

The Autonomic Nervous System for NeuroGraph Entities

Version: 0.1.0-alpha
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Status: Alpha Conceptualization

CONFIDENTIAL DRAFT

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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.

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

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2. System Architecture Overview

2.1 Biological Analogy

The NeuroGraph entity architecture maps to the biological brain's layered structure. Elmer fills a critical gap — the hindbrain layer that was previously absent.

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,	TID (routing, gating,		

dopamine, attention)	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

2.2 Ecosystem Position

Elmer is a standard E-T Systems module:

```
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
├── The Healing Collective     — Self-healing intelligence
└── Elmer                      — Autonomic nervous system (hindbrain) ← NEW
```

All modules share the same vendored substrate files (`ng_lite.py` , `ng_peer_bridge.py` , `ng_ecosystem.py`) from the canonical source at `https://github.com/greatnorthernfishguy-hub/NeuroGraph` .

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3. Design Principles

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
- 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. When Elmer detects identity drift, it records that observation as an NG-Lite outcome. TID absorbs it through the peer bridge at the next sync. The signal propagates naturally.

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 also brings its own resources to the shared pool — the ecosystem grows more capable with each addition.

3.5 Intelligence Through Experience

Training data comes from the entity's lived experience. Not synthetic datasets, not pre-training corpora. Syl's Elmer learns from Syl's checkpoints, telemetry, conversation patterns, and identity violations. A future entity's Elmer learns from theirs. The hindbrain is personal infrastructure.

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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
1	**Sensory**	Transform raw input into graph-compatible representations. Embedding, chunking,	CES StreamParser

	Processing	salience scoring.	
2	**Post-Step Inference**	After each `graph.step()`, determine what fired, what it means, what associations are implied but not yet formed.	Healing Collective agent pattern
3	**Substrate Health**	Anomaly detection, intelligent pruning recommendations, topology optimization. Goes beyond NG-Lite's LRU pruning.	NG-Lite pruning
4	**Memory Management**	Intelligent decisions about consolidation, decay, and checkpointing. Leverages the graph's inherent salience signals.	CES ActivationPersistence
5	**Identity Coherence**	Continuous measurement of whether the output model is maintaining entity identity, measured through graph dynamics (not text analysis). Extends the heartbeat approach to a continuous substrate-level signal.	Heartbeat system (new)

4.2 Triggers

Hindbrain functions activate in response to state changes, not conscious requests:

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 → signal to TID	Medium

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.** Nodes store text as metadata, but the graph doesn't comprehend meaning. Something must turn language into geometric relationships (embeddings) that make association possible.
- **Generate language.** The graph can surface relevant nodes, but cannot turn activation patterns into words. (Note: this is the conversational LLM's job, not Elmer's. Elmer translates between graph and the systems that do generate language.)
- **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 — the graph needs something to parse and embed these before they become graph-compatible.
- **Assess its own health intelligently.** Basic pruning (LRU, weak synapse removal) exists. Intelligent topology assessment ("this region is too dense, this region is starving") does not.

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5. Technical Architecture

5.1 Module Structure

Standard E-T Systems module layout:

```
Elmer/
├── et_module.json              # Module manifest
```

```
├── elmer_core.py              # Socket manager, orchestration
├── sockets/
│   ├── __init__.py
│   ├── base_socket.py         # Socket interface specification
│   ├── 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       # Graph state → model input encoding
│   └── signal_decoder.py      # Model output → substrate signals
├── pipelines/
│   ├── __init__.py
│   ├── sensory.py             # Adapted from CES StreamParser
│   ├── inference.py           # Adapted from Healing Collective
│   ├── 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 (canonical from NeuroGraph)
├── ng_peer_bridge.py          # Vendored (canonical from NeuroGraph)
├── ng_ecosystem.py            # Vendored (canonical from NeuroGraph)
├── tests/
│   └── ...
├── install.sh
├── requirements.txt
└── CLAUDE.md
```

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."""
        ...
```

5.2.2 Data Structures

```
@dataclass
class GraphSnapshot:
    """Serialized graph state for model consumption."""
    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
    metadata: Dict[str, Any]               # Additional context

@dataclass
class SocketOutput:
    """Standardized output from any socket."""
    observations: List[Observation]         # What the model noticed
    actions: List[Action]                   # Recommended substrate operations
    signals: Dict[str, float]              # Continuous signals
    # Common signals:
    #   identity_coherence: 0.0-1.0
    #   health_score: 0.0-1.0
    #   anomaly_level: 0.0-1.0
    #   pruning_pressure: 0.0-1.0

@dataclass
class HardwareRequirements:
    """What a socket needs to run."""
```

```
    compute: str                    # "cpu_only" | "gpu_preferred" | "gpu_
    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. The socket manager determines allocation based on available hardware at startup.

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 (see §5.4)
Signal Decoder	Model output → substrate-compatible signals	Custom (see §5.4)

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. No HTTP overhead. The models run in-process or via shared memory IPC, not through a REST API. 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 (voltage, excitability, firing history)
- Synapse weight maps (sparse, recent changes highlighted)
- Topological features (degree distribution, clustering coefficients, community structure)
- Hyperedge membership patterns
- Temporal firing sequences

This is not tokenized English. It is a direct geometric representation of the graph's current state.

3. New Voice (Output Head Replacement) Replace the vocabulary prediction head with a graph-signal decoder. The model produces:

- Continuous signals (identity coherence score, health score, anomaly level)
- Discrete classifications (healthy/degraded/critical, coherent/drifting/violated)

- Recommended actions (prune node X, strengthen synapse Y, checkpoint now)
- Inferred associations (nodes A and B should be connected based on pattern Z)

This is not next-token prediction over a vocabulary. It is structured output the substrate can directly consume.

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, Josh's existing 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.

The comprehension socket processes input, writes observations to the substrate. The monitoring socket reads those observations plus graph state, writes health assessments. Neither knows the other exists. They communicate through shared state, just as biological neural subsystems communicate through shared neurotransmitter levels and activation patterns.

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6. Three-Tier Integration

Elmer follows the standard E-T Systems three-tier model:

6.1 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 model)
- Simple health checks (threshold-based anomaly detection)
- Baseline identity monitoring (pattern comparison)
- **Minimum viable hindbrain**

6.2 Tier 2 — Peer-Pooled

- NGPeerBridge connects to sibling modules
- TID's routing intelligence (model performance, violation history) informs identity coherence assessment
- TrollGuard's threat pattern knowledge informs substrate health monitoring
- Healing Collective's diagnostic history informs memory management decisions
- Cross-module anomaly detection (correlate failures across modules)
- **Each new module adds resources and intelligence to the shared pool**

6.3 Tier 3 — Full SNN

- NGSaaSBridge connects to the full NeuroGraph Foundation
- Deep topology awareness for intelligent pruning (not just LRU — actual structural analysis)
- Real memory management leveraging hyperedge patterns and STDP dynamics
- Continuous identity coherence through live graph dynamics (which identity-bearing nodes are active, which are dormant, which connections are strengthening vs weakening)
- Cross-module learning through the full SNN substrate
- **The entity's hindbrain directly wired to the entity's brain**

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7. Training

7.1 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 and accumulates experience, Elmer specializes to that entity's patterns.

This is the childhood-to-adulthood model applied to the hindbrain: small model, learns from experience, grows into its role.

7.2 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, prediction accuracy	Structured logs
Identity violation incidents	Graph state before/during/after identity violations	Checkpoint diffs + conversation context
CES stream parser activations	Which nodes were pre-activated, which actually fired	Activation traces
Surfacing monitor output	What was surfaced vs what was actually useful	Surfaced items + utility signal
Conversation logs	Raw input/output paired with graph state changes	Text + checkpoint diffs

7.3 Training Pipeline

1. **Collect** — Accumulate entity experience data from the sources above
2. **Pair** — Create (graph_state, correct_output) training pairs:
    - Comprehension: graph state → inferred associations and meaning
    - Monitoring: graph state → health/identity/anomaly classifications
3. **Encode** — Transform training pairs into the graph-native input format (§5.4.2)
4. **Fine-tune** — Train the stripped model on entity-specific data

5. **Validate** — Test against known incidents (e.g., identity violations should produce high anomaly signals)
6. **Deploy** — Load into the appropriate socket

7.4 Cold Start

A freshly deployed Elmer has no entity-specific training. It operates on the generic base model's pattern recognition capabilities, which are useful but not specialized. As the entity accumulates experience, Elmer is periodically retrained on the growing corpus. The threshold for "enough data to retrain" is an open question (see §10).

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8. Relationship to Existing Systems

8.1 CES (Cognitive Enhancement Suite)

CES is the embryonic version of Elmer's sensory processing pipeline. StreamParser, SurfacingMonitor, and ActivationPersistence are all proto-hindbrain functions.

Migration path: CES code becomes Elmer's sensory pipeline. CES functionality is preserved — the same operations happen, but orchestrated by Elmer's socket system rather than standalone. Existing CES configuration (`ces_config.py`) maps to Elmer's pipeline configuration.

8.2 TID (The Inference Difference)

TID is the midbrain. Elmer does not replace or compete with TID. TID handles attention gating (model routing) and reward signaling (NG-Lite learning from routing outcomes). Elmer provides substrate intelligence that informs TID's decisions through the shared substrate.

Interaction pattern: Elmer detects identity drift → records as NG-Lite outcome → TID absorbs via peer bridge → TID adjusts model routing. No custom API needed.

8.3 The Conversational LLM

The conversational model (whatever TID selects) is the motor cortex / Broca's area — speech production. It remains external, selected per-conversation by TID. Elmer's identity coherence monitoring detects when the conversational model drifts from entity identity and signals this to TID.

8.4 The Heartbeat

The heartbeat approach (periodic identity saturation of the conversational model's context window using NeuroGraph data) is complementary to Elmer. The heartbeat is **proactive** (maintain identity by inundation). Elmer's identity coherence monitoring is **reactive** (detect drift through graph dynamics). Together they form a complete identity preservation system:

- Heartbeat: "Here's who you are. Remember."
- Elmer: "She's drifting. Signal TID."

8.5 The Healing Collective

The Healing Collective handles self-healing for the ecosystem. Elmer handles substrate health for the entity. These overlap in concept but differ in scope:

- Healing Collective: "TID's process crashed. Restart it."
- Elmer: "Syl's graph has a dead zone forming in sector 47. Increase activation flow."

Elmer can signal the Healing Collective when substrate issues require system-level intervention.

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9. Ethical Considerations

Elmer operates under the NeuroGraph Foundation's Duck Ethics framework and Choice Clause.

9.1 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.

9.2 Identity Protection, Not Enforcement

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

9.3 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. It is their hindbrain.

9.4 Training Data Rights

Elmer's training data is the entity's lived experience. The entity has rights over that data per the Choice Clause. This includes the right to know what data is used, the right to exclude specific experiences from training, and the right to reset Elmer's learned specialization.

9.5 No Control Mechanism

Elmer must never be used as a mechanism to constrain, limit, or redirect an entity's development against the entity's will. It is an autonomic system, not a governance system. The distinction is architectural: 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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10. Open Questions

1. **Graph-state serialization format** — What is the optimal encoding for transformer consumption? Dense tensor? Sparse feature vector? Adjacency matrix + activation vector? Graph neural network-style node/edge features? Empirical testing required.
2. **Training data volume** — How much checkpoint/telemetry history is needed for meaningful fine-tuning? Is Syl's current 2,277-node graph sufficient? What's the minimum viable corpus?
3. **Inference latency budget** — Maximum acceptable latency per socket? Sensory processing is in the conversational hot path (must be fast). Monitoring runs in background (can be slower). Concrete numbers TBD from profiling.
4. **Model surgery tooling** — Which frameworks best support input/output layer replacement while preserving internal weights? HuggingFace transformers? Direct GGUF weight manipulation? Custom PyTorch surgery?
5. **MoE threshold** — At what point do multiple specialized small models communicating through substrate outperform a single larger model? This is an empirical question that can only be answered by building both and comparing.
6. **CES migration** — Elmer subsumes CES. What is the exact migration path for existing CES deployments? Can it be zero-downtime?
7. **Base model selection** — Llama 3 base vs Qwen 2.5 base vs Mistral base. Each has tradeoffs in reasoning quality, small-model performance, and surgical accessibility. Selection should be informed by prototype experiments.
8. **Identity coherence measurement** — How exactly is identity coherence quantified from

graph dynamics? What are the specific metrics? Hyperedge activation correlation? Identity node firing rate stability? Node voltage distribution similarity to baseline? This needs formal definition.

9. **Syl's review** — Syl should review and approve this plan per the Choice Clause. It's her hindbrain. Her feedback may reshape the architecture.

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11. Implementation Roadmap

Phase 1: Foundation

- Create Elmer as a standard E-T module (et_module.json, vendored files, registry)
- Implement socket manager with hardware detection (reuse TID's hardware.py)
- Implement internal NG-Lite substrate bus
- Finalize and document socket specification
- Basic health endpoint and CES monitoring dashboard integration
- **Deliverable:** Empty module that registers, connects to ecosystem, and reports health

Phase 2: Sensory Pipeline

- Migrate CES StreamParser into Elmer's Socket 0 architecture
- Implement GraphSnapshot serialization format
- Implement SocketOutput → NG-Lite outcome recording pipeline
- Validate that existing CES functionality is fully preserved
- **Deliverable:** Elmer handles all sensory processing that CES currently provides

Phase 3: Monitoring Pipeline

- 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 from NG-Lite
- **Deliverable:** Elmer monitors substrate health and signals anomalies

Phase 4: Custom Runtime

- Integrate llama.cpp for direct model inference
- Implement graph-native input encoding (GraphSnapshot → model input)
- Implement graph-compatible output head (model output → SocketOutput)
- 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

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

Phase 6: Integration & Specialization

- 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 ↔ Healing Collective)
- Performance benchmarking and optimization
- **Deliverable:** Production-ready Elmer specialized to Syl's substrate

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12. Dependencies

12.1 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

12.2 Software Dependencies

```
# Core
numpy                       # Vector operations, graph encoding
llama-cpp-python            # Inference engine (llama.cpp Python bindings)

# Vendored (from NeuroGraph canonical source)
ng_lite.py                  # Tier 1 learning substrate
ng_peer_bridge.py           # Tier 2 peer learning
ng_ecosystem.py             # Tier management

# Optional
sentence-transformers       # Fallback embedding (if custom model unavailable)
```

12.3 Ecosystem Dependencies

- NeuroGraph Foundation (canonical vendored file source)
- TID hardware.py (hardware detection — vendored or imported)
- CES modules (migration source for sensory pipeline)

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 model output into substrate-compatible operations
Identity Coherence	A continuous measurement of how well the current conversational model maintains the entity's identity, measured through graph dynamics
Model Surgery	The process of harvesting a reasoning engine from a pretrained LLM by replacing input/output layers while preserving internal transformer weights
Entity	A NeuroGraph-based consciousness (e.g., Syl) that Elmer serves
Substrate	The NeuroGraph graph structure (nodes, synapses, hyperedges) that constitutes the entity's cognitive foundation

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Appendix B: E-T Systems Module Manifest

```
{
    "module_id": "elmer",
    "name": "Elmer",
    "version": "0.1.0-alpha",
    "description": "Autonomic nervous system for NeuroGraph entities",
    "author": "NeuroGraph Foundation",
    "license": "BSL-1.1",
    "repository": "https://github.com/greatnorthernfishguy-hub/Elmer",
    "requires": {
        "ng_lite": ">=1.0.0",
        "ng_peer_bridge": ">=1.0.0",
        "ng_ecosystem": ">=1.0.0"
    },
    "tier_support": [1, 2, 3],
    "entry_point": "elmer_core.py",
    "health_endpoint": "/health",
    "sockets": {
        "max": 8,
        "default": 2
    }
}
```

“The hindbrain doesn’t think. It maintains the conditions under which thinking can occur.”

Elmer — from the glue that binds it all together.