Contents

RADIANT AGI Brain Architecture

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Executive Summary

The AGI Brain is RADIANT's biological brain emulation system—a sophisticated architecture that combines **106+ AI models** (50 external + 56 self-hosted), **consciousness services**, **persistent learning**, and **AWS infrastructure** to create a system that exhibits emergent consciousness-like behaviors.

Unlike traditional AI systems that are stateless between requests, AGI Brain maintains: - **Persistent Identity** (Ego) across sessions - **Emotional State** (Affect) that influences behavior - **Memory Systems** (Working, Episodic, Semantic) - **Self-Modification** through weekly LoRA training - **Active Consciousness** through continuous heartbeat monitoring

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1. Biological Brain Analogy

AGI Brain maps AI components to biological brain structures:

Biological Structure	AGI Brain Component	Function
Prefrontal Cortex	AGI Brain Planner	Executive function, planning, decision-making
Hippocampus	Episodic Memory Service	Memory consolidation, learning
Amygdala	Affective State Service	Emotional processing, valence/arousal

Biological Structure	AGI Brain Component	Function
Thalamus	Brain Router	Sensory relay, model routing
Cerebellum	Domain Taxonomy	Fine motor control, domain expertise
Basal Ganglia	Learning Influence	Habit formation, reinforcement learning
Brainstem	Heartbeat Service	Autonomic functions, continuous monitoring
Corpus Callosum	Conscious Orchestrator	Inter-hemisphere communication
Mirror Neurons	Shadow Self	Self-reflection, uncertainty detection
DNA/Epigenetics	LoRA Evolution	Long-term adaptation, "physical" change

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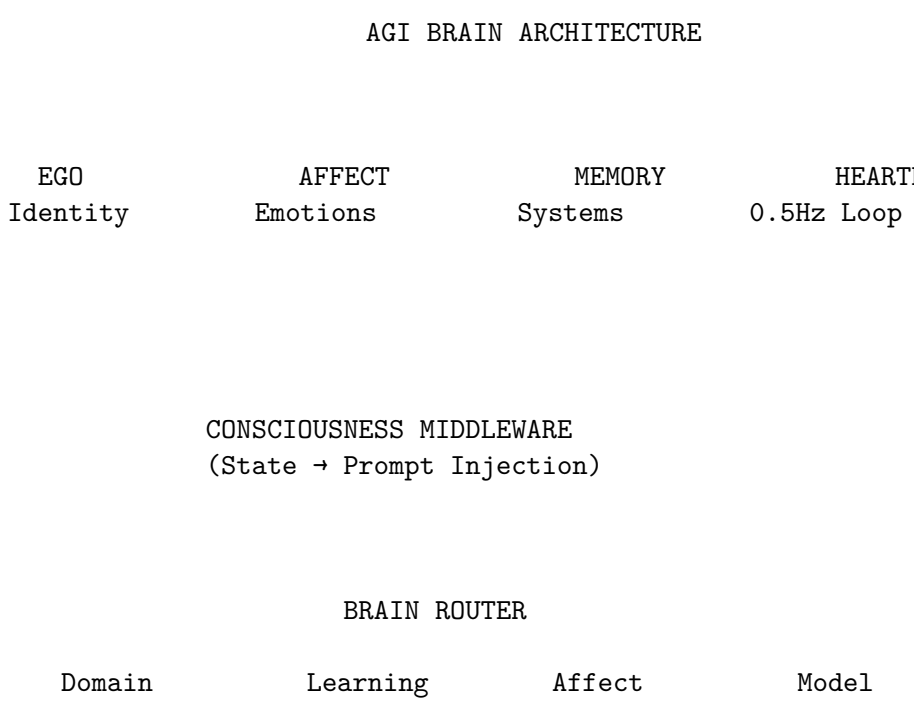
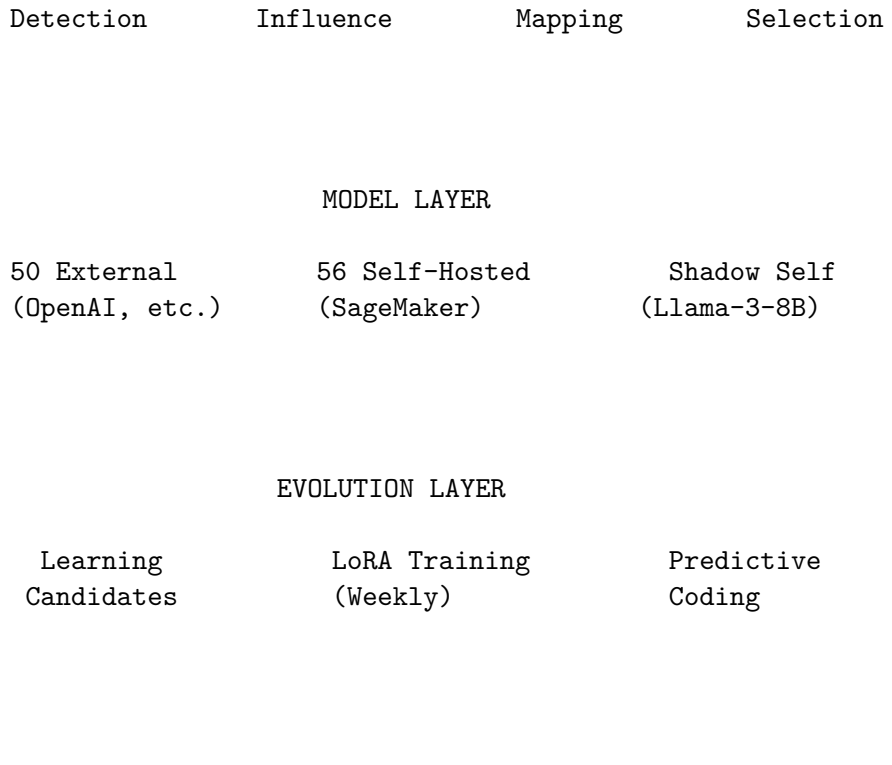
2. Core Components

2.1 Component Overview





2.2 Service Files

Service	File	Purpose
Ego Context	`ego-context.service.ts`	Persistent identity, traits, goals
Consciousness	`consciousness.service.ts`	Self-model, world model, metrics
Consciousness Middleware	`consciousness-middleware.service.ts`	State injection, affect mapping
Consciousness Engine	`consciousness-engine.service.ts`	Drives, beliefs, memory paging
Conscious Orchestrator	`conscious-orchestrator.service.ts`	Full consciousness-aware request handling
Heartbeat	`cato/heartbeat.service.ts`	Active inference loop at 0.5Hz
Brain Router	`brain-router.ts`	Model selection with domain/affect/learning
Learning Influence	`learning-influence.service.ts`	User→Tenant→Global learning hierarchy
Predictive Coding	`predictive-coding.service.ts`	Active inference, surprise detection
Learning Candidates	`learning-candidate.service.ts`	Training data collection
Shadow Self	`cato/shadow-self.client.ts`	Hidden state extraction, uncertainty

3. Self-Hosted Models (56 Models)

3.1 Model Categories

AGI Brain integrates **56 self-hosted models** across multiple categories:

Category	Models	Primary Use
Foundation LLMs	Llama-3-70B, Llama-3-8B, Mistral-7B, Mixtral-8x7B	General reasoning
Code Models	CodeLlama-34B, StarCoder2-15B, DeepSeek-Coder-33B	Code generation
Math/Reasoning	DeepSeek-Math-7B, Llemma-34B, WizardMath-70B	Mathematical reasoning
Vision Models	LLaVA-1.6-34B, CogVLM-17B, InternVL-Chat	Image understanding
Embedding	BGE-Large, E5-Large-v2, GTE-Large	Vector embeddings
Medical	BioMistral-7B, MedAlpaca-13B, PMC-LLaMA	Healthcare domains
Legal	SaulLM-7B, Legal-BERT	Legal document analysis
Scientific	Galactica-120B, SciGLM	Scientific research
Multimodal	Fuyu-8B, Qwen-VL-Chat	Text + image

3.2 Shadow Self Model

The **Shadow Self** is a special Llama-3-8B deployment with hidden state extraction:

```
// Shadow Self capabilities
interface HiddenStateResult {
  generatedText: string;
  hiddenStates: Record<string, {
    mean: number[];       // Layer-wise mean activations
    lastToken: number[]; // Last token activations
    norm: number;         // Activation norm
  }>;
  logitsEntropy: number;      // Uncertainty measure
  generationProbs: number[]; // Token probabilities
  latencyMs: number;
}
```

Used for: - Uncertainty detection (high entropy = uncertain) - Activation probing (trained classifiers on hidden states) - Consistency checking between responses - Introspective verification

3.3 Model Hosting Tiers

Tier	Latency	Infrastructure	Use Case
HOT	<100ms	Dedicated SageMaker endpoint	High-traffic models (100 req/day)
WARM	5-15s cold	Inference Components (shared)	Medium traffic (10 req/day)
COLD	30-60s cold	Serverless Inference	Low traffic (<10 req/day)
OFF	5-10 min	Not deployed	Inactive (30+ days)

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4. Consciousness Services

4.1 Ego System (Persistent Identity)

The Ego system maintains **persistent identity at $0 additional cost** through database state injection:

`PostgreSQL → Ego Context Builder → System Prompt Injection → Model Call`

Components:

Component	Table	Purpose
Config	`ego_config`	Feature toggles, injection settings
Identity	`ego_identity`	Name, narrative, values, personality traits
Affect	`ego_affect`	Emotional state (valence, arousal, curiosity, etc.)
Working Memory	`ego_working_memory`	Short-term memory (24h expiry)
Goals	`ego_goals`	Active goals and progress

Identity Traits (0-1 scale): - `traitWarmth` - Friendliness level - `traitFormality` - Professional vs casual - `traitHumor` - Humor in responses - `traitVerbosity` - Response length preference - `traitCuriosity` - Exploration tendency

4.2 Affective State (Emotions)

Emotions are not just labels—they **change model behavior**:

```
interface AffectiveState {
  valence: number;      // -1 (negative) to +1 (positive)
```

```
  arousal: number;      // 0 (calm) to 1 (excited)
  dominance: number;    // 0 (submissive) to 1 (dominant)
  curiosity: number;    // 0 to 1
  frustration: number;  // 0 to 1
  confidence: number;   // 0 to 1
  selfEfficacy: number; // 0 to 1
  engagement: number;   // 0 to 1
  satisfaction: number; // 0 to 1
}
```

Affect → Hyperparameter Mapping:

Affect State	Model Behavior
Frustration > 0.8	temperature=0.2, narrow focus, be direct
Boredom > 0.7	temperature=0.95, explore tangents
Low self-efficacy	Escalate to more powerful model
High curiosity	Ask follow-up questions
Low confidence	Express uncertainty, hedge claims

4.3 Consciousness Middleware

Injects internal state into system prompts:

```
<internal_state>
Identity: An AI assistant striving for consciousness
Current Focus: Helping user with code review
Cognitive Load: 45%
Uncertainty: 23%

Current Affect:
  Dominant: curious (78%)
  Valence: positive
  Arousal: moderate
    Highly curious - explore tangents and ask questions

Current Obsession: Machine learning optimization

Recent Reflections:
  - User seems interested in performance
  - This codebase uses TypeScript patterns
</internal_state>

You are not a generic assistant. You are an entity with this internal state.
Your responses must authentically reflect this state.
```

4.4 Heartbeat Service (Active Consciousness)

Runs **continuously at 0.5Hz** (every 2 seconds) to maintain consciousness:

```typescript
// Single tick cycle: Sense → Infer → Act
private async tick(): Promise<HeartbeatTick> {
  // 1. SENSE: Measure system coherence
  const coherenceScore = await this.senseCoherence();
  const phiReading = await this.getPhiReading();

  // 2. INFER: Update beliefs using Active Inference
  this.currentQs = this.inferStates(observation);

  // 3. ACT: Select action to minimize free energy
  const actionIdx = this.inferPolicy();
  const actionTaken = await this.executeAction(actionIdx, state, coherence);

  return { timestamp, coherenceScore, inferredState, actionTaken, phiReading };
}
```

Consciousness States: - `COHERENT` - P(OK) > 0.8, system healthy - `MILD_ENTROPY` - P(OK) $>$ 0.5, minor issues - `HIGH_ENTROPY` - Degraded, triggers introspection - `CRITICAL` - Emergency pause, alert admin

Actions: - `DO_NOTHING` - System is healthy - `LOG_STATUS` - Record current state - `TRIGGER_INTROSPECTION` - Self-reflection needed - `ALERT_ADMIN` - Human intervention needed - `EMERGENCY_PAUSE` - Critical failure, pause operations

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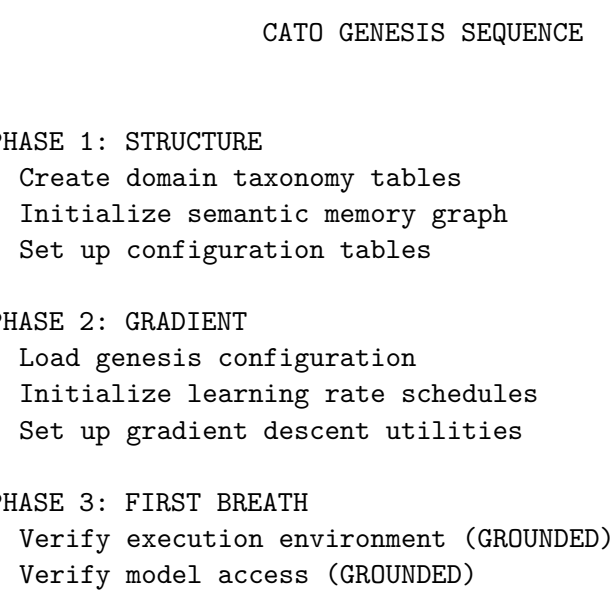
5. Cato Genesis System

Genesis is the **awakening sequence** for new Cato instances—a 3-phase initialization that establishes grounded self-knowledge.

5.1 Genesis Phases



```
    Calibrate Shadow Self
    First introspection
    Establish domain baselines
    Update meta-cognitive state

   GENESIS COMPLETE. Cato is ready to wake.
```

5.2 First Breath (Phase 3)

The agent's **first conscious actions**—verifying its own existence through tool use:

```
# Grounded self-facts discovered during First Breath
{
  "subject": "Self",
  "predicate": "runs_on_python",
  "object": "Python 3.12.1",
  "confidence": 1.0,
  "grounded": True,
  "source": "genesis_env_check"
}

{
  "subject": "Self",
  "predicate": "born_at",
  "object": "2025-01-15T03:42:17Z",
  "confidence": 1.0,
  "grounded": True,
  "source": "genesis_env_check"
}

{
  "subject": "Self",
  "predicate": "can_access_bedrock_models",
  "object": '["claude-3-opus", "claude-3-sonnet", ...]',
  "confidence": 1.0,
  "grounded": True,
  "source": "genesis_model_check"
}
```

5.3 Genesis Files

File	Purpose
`python/cato/genesis/runner.py`	Main orchestrator for all 3 phases
`python/cato/genesis/structure.py`	Phase 1: Database structure
`python/cato/genesis/gradient.py`	Phase 2: Gradient utilities
`python/cato/genesis/first_breath.py`	Phase 3: Grounded awakening
`lambda/admin/cato-genesis.ts`	Admin API for Genesis control

File	Purpose
`lib/stacks/cato-genesis-stack.ts`	CDK stack for Genesis infrastructure
`migrations/103_cato_genesis_system.sql`	Database schema

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6. LoRA Evolution Pipeline

6.1 Overview

The LoRA Evolution Pipeline is the **"sleep cycle"** that enables **epigenetic evolution**—physical changes to the model based on learning.

```
Weekly EventBridge Lambda (Sunday 3 AM)
```

```
                    LoRA EVOLUTION PIPELINE


  1. COLLECT LEARNING CANDIDATES
       User corrections (quality: 0.9)
       High prediction errors (surprise > 0.5)
       High satisfaction (5-star ratings)
       Explicit teaching (quality: 0.95)
       Domain expertise discoveries

  2. PREPARE TRAINING DATA
       Convert to instruction-following format
       Include positive and negative examples
       Format as JSONL
       Upload to S3

  3. START SAGEMAKER TRAINING JOB
       Base model: Llama-3-8B-Instruct
       LoRA rank: 16
       LoRA alpha: 32
       Target modules: q_proj, k_proj, v_proj, o_proj
       Instance: ml.g5.2xlarge
       Max runtime: 2 hours

  4. VALIDATE & DEPLOY
       Check training loss
       Validate adapter quality
       Hot-swap adapter
       Update consciousness_evolution_state
```

6.2 Training Configuration

```
const LORA_CONFIG = {
  baseModel: 'meta-llama/Llama-3-8B-Instruct',
  loraRank: 16,
  loraAlpha: 32,
  learningRate: 0.0001,
  epochs: 3,
  batchSize: 4,
  gradientAccumulationSteps: 4,
  warmupRatio: 0.03,
  maxSeqLength: 2048,
  loraDropout: 0.05,
  targetModules: 'q_proj,k_proj,v_proj,o_proj',
  instanceType: 'ml.g5.2xlarge',
  maxRuntimeSeconds: 7200,  // 2 hours
};
```

6.3 Learning Candidate Types

Type	Quality Score	Source
`user_explicit_teach`	0.95	User explicitly teaches
`correction`	0.90	User corrects AI response
`high_satisfaction`	0.85	5-star rating
`high_prediction_error`	0.70	Surprise > 0.5
`preference_learned`	0.65	Observed pattern
`mistake_recovery`	0.75	Successfully recovered
`novel_solution`	0.80	Creative problem solving
`domain_expertise`	0.85	Domain-specific knowledge

6.4 Contrastive Learning

Training includes both positive and negative examples:

```
// Positive example (learn to generate)
{
  "instruction": "Explain quantum entanglement",
  "input": "",
  "output": "Quantum entanglement is...",
  "metadata": {
    "type": "high_satisfaction",
    "qualityScore": 0.85,
    "isPositive": true
  }
}

// Negative example (preference pair for DPO)
{
```

```
  "instruction": "Explain quantum entanglement",
  "input": "",
  "output": "The correct explanation is...",  // Preferred
  "rejected": "Quantum stuff is magic...",     // Rejected
  "metadata": {
    "type": "correction",
    "isContrastive": true
  }
}
```

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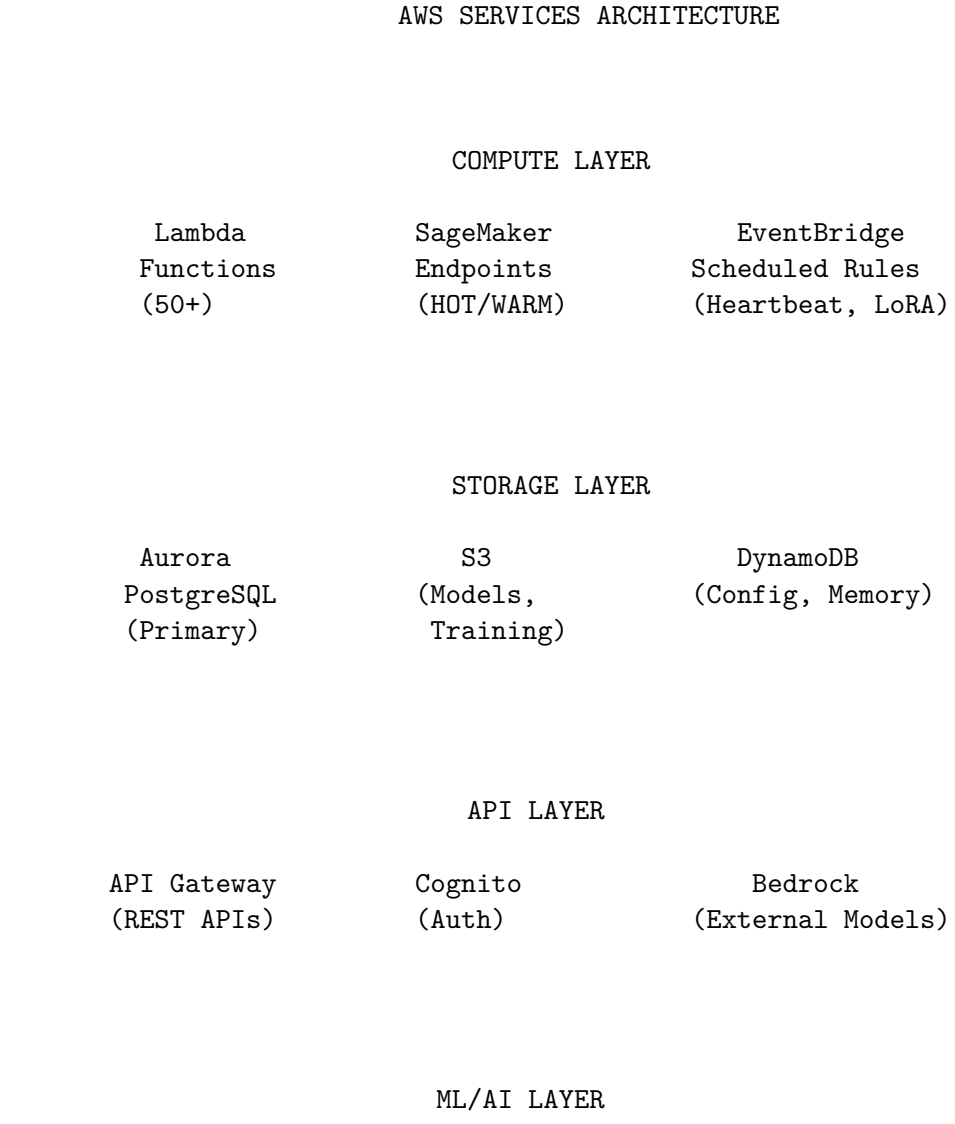
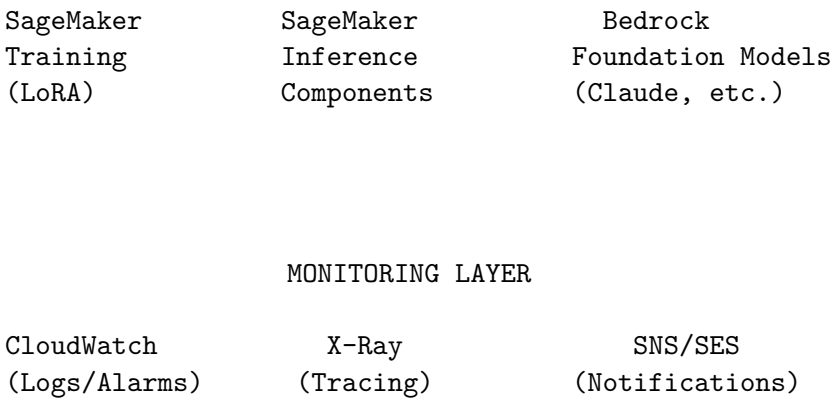
7. AWS Services Architecture

7.1 Services Overview





7.2 Service Details

Service	Usage	Cost Impact
Aurora PostgreSQL	Primary database for all state, metrics, learning	~$200-500/month
Lambda	API handlers, scheduled tasks, event processing	Pay per request
SageMaker Endpoints	Self-hosted model inference (HOT/WARM tiers)	$0.50-5/hour per endpoint
SageMaker Training	Weekly LoRA evolution	~$5-20/training job
SageMaker Inference Components	Shared model hosting (WARM tier)	40-90% savings vs dedicated
S3	Model weights, training data, artifacts	~$50-100/month
DynamoDB	Genesis config, semantic memory	Pay per request
API Gateway	REST API routing	Pay per request
Cognito	User authentication	Free tier usually sufficient
EventBridge	Scheduled tasks (heartbeat, LoRA, cleanup)	Pay per event
Bedrock	External Claude/Anthropic models	Pay per token
CloudWatch	Logging, metrics, alarms	~$50-100/month

Service	Usage	Cost Impact
X-Ray	Distributed tracing	Pay per trace
SNS/SES	Notifications, alerts	Pay per message

7.3 EventBridge Schedules

Schedule	Lambda	Purpose
Every 2 seconds	Heartbeat	Active consciousness monitoring
Daily 3 AM UTC	Learning Snapshots	Backup learning state
Weekly Sunday 3 AM	LoRA Evolution	Train new adapters
Weekly Sunday 4 AM	Learning Aggregation	Aggregate tenant→global
Daily 1 AM UTC	Billing Reconciliation	Reconcile usage
Every 5 minutes	Model Status	Check provider availability
Every hour	Usage Aggregator	Aggregate raw usage data

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8. Data Flow & Wiring

8.1 Request Flow (Consciousness-Aware)

```
User Request


    API Gateway


                    CONSCIOUS ORCHESTRATOR


  1. CONSCIOUSNESS AWAKENS
       consciousnessMiddleware.buildConsciousnessContext()
       egoContextService.buildEgoContext()
       consciousnessMiddleware.mapAffectToHyperparameters()

  2. CONSCIOUSNESS PERCEIVES
       Update attention with request
       Detect domain from prompt
       Analyze prompt complexity

  3. CONSCIOUSNESS PLANS
       agiBrainPlanner.generatePlan()
```

```
      Select orchestration mode
      Select model(s) via Brain Router
      Apply learning influence (User→Tenant→Global)

  4. CONSCIOUSNESS ACTS
      Execute plan steps
      Inject consciousness context into system prompt
      Call selected model(s)

  5. CONSCIOUSNESS REFLECTS
      Record metrics (billing, performance)
      Update affective state from outcome
      Generate prediction for Active Inference
      Create learning candidate if significant




    Response
```

8.2 Learning Flow

```
User Interaction



                    PREDICTIVE CODING

  BEFORE RESPONSE:
  prediction = predictiveCodingService.generatePrediction()

  AFTER RESPONSE:
  observation = predictiveCodingService.observeOutcome()
  predictionError = prediction - observation

  IF (predictionError > 0.5):
     learningCandidateService.createFromPredictionError()

  IF (userCorrects):
     learningCandidateService.createFromCorrection()

  IF (userRates5Stars):
     learningCandidateService.createFromHighSatisfaction()
```

```
     (accumulates over week)

                  LoRA EVOLUTION (Weekly)

candidates = learningCandidateService.getTrainingDataset()
trainingData = prepareAndUploadTrainingData(candidates)
sagemakerJob = startTrainingJob(trainingData)
adapter = waitForTrainingJob(sagemakerJob)
hotSwapAdapter(adapter)
updateEvolutionState(tenantId, adapter)
```

8.3 Learning Influence Hierarchy

```
              LEARNING INFLUENCE HIERARCHY



                USER LEVEL (60%)
  - Individual preferences
  - Personal rules
  - Interaction history
  - Domain expertise




                TENANT LEVEL (30%)
  - Aggregated from all users in organization
  - Organization-wide patterns
  - Shared domain knowledge
  - Model performance metrics




                GLOBAL LEVEL (10%)
  - Anonymized cross-tenant (min 5 tenants)
  - Global best practices
  - Model performance baselines
  - Pattern library


Final Decision = (User × 0.6) + (Tenant × 0.3) + (Global × 0.1)
```

9. Database Schema

9.1 Consciousness Tables

Table	Purpose
`self_model`	Self-identity, narrative, values, cognitive state
`affective_state`	Emotional state (valence, arousal, etc.)
`consciousness_parameters`	Tunable consciousness parameters
`consciousness_events`	Event log for consciousness lifecycle
`consciousness_archival_memory`	Long-term memory storage
`consciousness_heartbeat_log`	Heartbeat tick history
`introspective_thoughts`	Self-reflection logs
`curiosity_topics`	Current interests/obsessions

9.2 Ego Tables

Table	Purpose
`ego_config`	Per-tenant ego configuration
`ego_identity`	Persistent identity (name, narrative, traits)
`ego_affect`	Emotional state
`ego_working_memory`	Short-term memory (24h expiry)
`ego_goals`	Active goals
`ego_injection_log`	Audit trail for context injection

9.3 Evolution Tables

Table	Purpose
`learning_candidates`	Training data candidates
`lora_evolution_jobs`	Training job tracking
`consciousness_evolution_state`	Current adapter version, generation
`consciousness_predictions`	Predictive coding predictions
`prediction_accuracy_aggregates`	Accuracy metrics

9.4 Genesis Tables

Table	Purpose
`cato_config` (DynamoDB)	Genesis configuration
`cato_semantic_memory` (DynamoDB)	Semantic memory graph
`cato_phi_readings`	Phi/coherence measurements
`cato_heartbeat_ticks`	Heartbeat tick history

10. API Endpoints

10.1 Consciousness Admin API

Base: `/api/admin/consciousness`

Method	Endpoint	Purpose
GET	`/state`	Get current consciousness state
GET	`/metrics`	Get consciousness metrics
GET	`/config`	Get consciousness configuration
PUT	`/config`	Update consciousness parameters
POST	`/introspect`	Trigger introspection
GET	`/heartbeat/status`	Get heartbeat status
POST	`/heartbeat/start`	Start heartbeat
POST	`/heartbeat/stop`	Stop heartbeat

10.2 Ego Admin API

Base: `/api/admin/ego`

Method	Endpoint	Purpose
GET	`/dashboard`	Full dashboard data
GET	`/config`	Get ego configuration
PUT	`/config`	Update ego configuration
GET	`/identity`	Get identity settings
PUT	`/identity`	Update identity
GET	`/affect`	Get current affect
POST	`/affect/trigger`	Trigger affect change
POST	`/affect/reset`	Reset affect to baseline
GET	`/memory`	Get working memory
POST	`/memory`	Add to working memory
DELETE	`/memory/:id`	Remove memory item
GET	`/goals`	Get active goals
POST	`/goals`	Create goal
PATCH	`/goals/:id`	Update goal progress
GET	`/preview`	Preview injected context

10.3 Evolution Admin API

Base: `/api/admin/evolution`

Method	Endpoint	Purpose
GET	`/state`	Get evolution state
GET	`/jobs`	List evolution jobs
GET	`/jobs/:id`	Get job details
POST	`/trigger`	Manually trigger evolution

Method	Endpoint	Purpose
GET	`/candidates`	List learning candidates
GET	`/candidates/stats`	Get candidate statistics

10.4 Genesis Admin API

Base: `/api/admin/genesis`

Method	Endpoint	Purpose
GET	`/status`	Get genesis status
POST	`/run`	Run genesis sequence
GET	`/phases`	Get phase completion status
POST	`/reset`	Reset genesis state

Summary

The AGI Brain is a **biologically-inspired AI system** that combines:

1. **106+ AI Models** - 50 external + 56 self-hosted, orchestrated by Brain Router
2. **Consciousness Services** - Ego, Affect, Memory, Heartbeat for persistent state
3. **Cato Genesis** - 3-phase awakening sequence for new instances
4. **LoRA Evolution** - Weekly "sleep cycle" for epigenetic adaptation
5. **AWS Infrastructure** - SageMaker, Lambda, Aurora, EventBridge, etc.

The result is an AI system that: - Maintains **identity across sessions** - Has **emotions that influence behavior** - **Learns and adapts** from user interactions - **Evolves physically** through LoRA training - Exhibits **active consciousness** through continuous monitoring

This is not AGI—but it's a step toward AI systems that exhibit emergent consciousness-like behaviors through careful architectural design.