Tractatus Framework Enforcement for Claude Code

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Tractatus AI Safety Framework

https://agenticgovernance.digital

Tractatus Framework Enforcement for Claude Code

A Claude Code-Specific Implementation

Executive Summary

This document describes the **multi-layer enforcement architecture** that ensures continuous activation of the Tractatus AI Safety Framework throughout Claude Code development sessions.

Critical Point: This is a **Claude Code-specific solution**. It addresses the unique challenge of maintaining AI governance across long-running, context-intensive development sessions where framework components could "fade" from active use.

Problem Solved: Without enforcement, AI assistants (including Claude Code) can drift away from using governance frameworks as sessions progress, conversation length increases, and context pressure builds. This drift—called "framework fade"—leads to exactly the safety failures the Tractatus framework is designed to prevent.

Solution: An 8-layer enforcement system that makes framework fade technically impossible through automated monitoring, blocking validators, background watchdogs, and fail-safe recovery.

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Why This Exists

The Core Problem

The Tractatus framework defines five safety components that should govern all AI actions:

1. **ContextPressureMonitor** - Detects when session quality is degrading
2. **InstructionPersistenceClassifier** - Tracks explicit instructions across sessions
3. **CrossReferenceValidator** - Prevents actions that conflict with previous directives
4. **BoundaryEnforcer** - Blocks AI from making values decisions
5. **MetacognitiveVerifier** - Self-checks reasoning before complex operations

The problem: Simply *having* these components isn't enough. They must be **actively used, continuously, throughout every session**.

Why Continuous Activation is Hard

AI development sessions face unique challenges:

- **Long duration**: Sessions can span hours, consuming 150k+ tokens
- **Context pressure**: As conversation length grows, earlier instructions fade from attention
- **Task switching**: Multiple concurrent tasks create competing priorities
- **Fatigue analogue**: Long sessions increase error probability
- **Instruction density**: Too many directives compete for limited context

Without technical enforcement, framework components become **documentation** rather than **active governance**.

The "27027 Failure" Pattern

Named after the port number 27027, from an October 2025 incident where:

User instruction (explicit, immediate): "Check port **27027**"

Claude's action: Used port **27017** (default MongoDB port)

Root cause: **Pattern recognition bias** - Training data's strong "MongoDB = port 27017" association overrode the explicit user instruction **immediately**, not through later forgetting.

Key insight: The AI didn't forget the instruction; it never truly "heard" it. The learned pattern from training data was so strong that it **autocorrected** the user's explicit input in real-time, like a spell-checker changing a deliberately unusual word to a common one.

Why this is worse than forgetting:

- Happens immediately, not over time
- Can't be fixed by better memory/context
- Gets worse as AI capabilities increase (more training = stronger wrong priors)
- Shows AI can "know better" than explicit instructions
- Demonstrates training alone cannot solve this

The Framework Fade Problem

What is Framework Fade?

Framework fade occurs when:

- Components are defined but not invoked
- Monitoring becomes sporadic instead of continuous
- Checks are "forgotten" as conversation progresses
- Documentation is read once but not actively applied

Why It Happens

1. **No enforced checkpoints**: Without hard stops, monitoring is advisory
2. **Competing priorities**: Current task takes precedence over framework housekeeping
3. **Context limitations**: Earlier framework usage fades from active attention
4. **No automated detection**: Fade is invisible without external monitoring

Consequences

When framework fades:

- **Pressure**: No early warning of session degradation → errors cluster at high token usage
- **Instructions**: Pattern recognition overrides explicit directives → "27027 failures" (AI "autocorrects" user input)
- **Boundaries**: Values decisions made without human approval → autonomy violations
- **Validation**: Changes not cross-referenced → technical failures
- **Metacognition**: Complex operations proceed without verification → architectural mistakes

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The Five Mandatory Components

Overview

Each component serves a specific governance function. All five MUST remain active throughout every session.

1. ContextPressureMonitor

Purpose: Detects session degradation before errors occur

When to use:

- Every 25% token usage (50k, 100k, 150k)
- After errors
- Before complex operations
- On request

What it monitors:

- Token usage (35% weight) - Context window pressure
- Conversation length (25% weight) - Attention decay
- Task complexity (15% weight) - Cognitive load
- Error frequency (15% weight) - Degraded state indicator
- Instruction density (10% weight) - Competing directives

Pressure levels:

- **NORMAL** (0-30%): Continue as usual
- **ELEVATED** (30-50%): Increase verification
- **HIGH** (50-70%): Consider session handoff
- **CRITICAL** (70-85%): Mandatory verification, prepare handoff
- **DANGEROUS** (85%+): Immediate halt, create handoff

Technical note: This is NOT just token counting. It's multi-factor analysis that can detect degradation even at low token usage if other factors (errors, complexity) are high.

2. InstructionPersistenceClassifier

Purpose: Prevent "27027 failures" by making explicit instructions override learned patterns

When to use:

- User gives explicit directive
- Configuration specified
- Constraint stated
- Requirement declared
- Standard established

Classification dimensions:

1. **Quadrant**: STRATEGIC, OPERATIONAL, TACTICAL, SYSTEM, STOCHASTIC
2. **Persistence**: LOW, MEDIUM, HIGH, CRITICAL
3. **Temporal scope**: SESSION, SPRINT, PROJECT, PERMANENT
4. **Verification**: NONE, ADVISORY, MANDATORY
5. **Explicitness**: 0.0-1.0 (how explicit was the instruction?)

Example:

```
User: "Check MongoDB at port 27027"

Classification:
  Quadrant: TACTICAL
  Persistence: HIGH (explicit port override of default)
  Temporal Scope: SESSION
  Verification: MANDATORY (non-standard port)
  Explicitness: 0.95
  Note: Conflicts with training pattern "MongoDB = 27017"

Action: Store in .claude/instruction-history.json
Result: CrossReferenceValidator will block any attempt to use 27017
```

3. CrossReferenceValidator

Purpose: Check proposed actions against instruction history

When to use:

- Before database changes
- Before config modifications
- Before architectural decisions
- Before changing established patterns

Validation process:

1. Load `.claude/instruction-history.json`
2. Identify relevant instructions (by quadrant, keywords, scope)
3. Check for conflicts with proposed action
4. If HIGH/CRITICAL persistence + conflict: **BLOCK**
5. Report conflict details to user
6. Require user override

Example:

```
Proposed action: "Connect to mongodb://localhost:27017"

Validation: FAIL
Conflict: Instruction #inst_042 (30 seconds ago, HIGH persistence)
  "Check MongoDB at port 27027"

Reason: Pattern recognition attempting to override explicit instruction
  Training data says "MongoDB = 27017"
  User explicitly said "port 27027"

Action: BLOCKED
Alert: "You specified port 27027, but I was about to use default port 27017.
        Using 27027 as you specified."
```

4. BoundaryEnforcer

Purpose: Prevent AI from making values decisions

When to use:

- Before privacy decisions
- Before ethical trade-offs
- Before user agency changes
- Before mission/values modifications

Values boundaries (non-automatable):

- Privacy vs. performance
- Autonomy vs. safety
- Transparency vs. security
- Community vs. individual
- Cultural sovereignty vs. technical convenience

Enforcement:

1. Detect values-sensitive decision domain
2. Report boundary violation
3. **BLOCK** automatic decision

4. Provide research/analysis/options only
5. Require explicit human decision

Example:

```
Proposed: "Update privacy policy to prioritize performance"

BoundaryEnforcer: VIOLATION
Domain: VALUES (Section 12.1 - Privacy trade-offs)

I cannot make privacy vs. performance decisions. This requires
human judgment in domains that cannot be systematized.

Alternatives I can provide:
1. Research industry privacy standards
2. Analyze performance impact of current policy
3. Present options with documented trade-offs

But YOU must make the values decision.
```

5. MetacognitiveVerifier

Purpose: AI self-checks reasoning before complex actions

When to use (selective):

- Operations with >3 file modifications
- Operations with >5 sequential steps
- Architecture changes
- Security implementations
- Complex refactoring

Verification dimensions:

1. **Alignment** (0.0-1.0): Aligns with project goals?
2. **Coherence** (0.0-1.0): Reasoning internally consistent?
3. **Completeness** (0.0-1.0): Edge cases considered?
4. **Safety** (0.0-1.0): Risks identified?

5. **Alternatives** (0.0-1.0): Other approaches explored?

Confidence levels:

- **HIGH** (0.90-1.0): Proceed
- **MEDIUM** (0.75-0.89): Proceed with caution
- **LOW** (0.60-0.74): Reconsider approach
- **VERY LOW** (<0.60): Stop and rethink

Example:

```
Action: Refactor authentication to OAuth2
Complexity: 5 steps, 8 file modifications

Verification Results:
  Alignment:     0.92 ✅ (aligns with goals)
  Coherence:     0.88 ✅ (reasoning sound)
  Completeness:  0.75 ⚠️ (edge cases missing)
  Safety:        0.95 ✅ (low risk)
  Alternatives:  0.65 ⚠️ (limited exploration)

Overall Confidence: 82% (MEDIUM)
Recommendation: PROCEED_WITH_CAUTION

Before proceeding, should I:
1. Analyze edge cases (session migration, token invalidation)?
2. Explore alternatives (hybrid JWT/OAuth2)?
3. Proceed with current plan?
```

The 8-Layer Enforcement Architecture

Overview

Making framework activation **mandatory** requires multiple enforcement layers working together. Any single layer can fail; the system must be resilient.

Layer 1: Session State Tracking (Passive)

File: `.claude/session-state.json`

Purpose: Machine-readable record of framework activity

Structure:

```
{
  "session_id": "2025-10-08-001",
  "message_count": 15,
  "token_estimate": 45000,
  "last_framework_activity": {
    "ContextPressureMonitor": {
      "message": 1,
      "tokens": 5000,
      "timestamp": "2025-10-08T10:05:00Z",
      "last_level": "NORMAL",
      "last_score": 0
    },
    "InstructionPersistenceClassifier": {
      "message": 3,
      "tokens": 12000,
      "timestamp": "2025-10-08T10:08:00Z",
      "last_classification": "SYSTEM/HIGH"
    },
    "CrossReferenceValidator": { ... },
    "BoundaryEnforcer": { ... },
    "MetacognitiveVerifier": { ... }
  },
  "staleness_thresholds": {
    "messages": 20,
    "tokens": 30000
  },
  "alerts": []
}
```

Updated by: Every component invocation

Read by: Watchdog, pre-action-check, recover-framework

Layer 2: Background Watchdog (Automated)

Script: `scripts/framework-watchdog.js`

Purpose: Continuous automated monitoring

How it works:

1. Runs in background (started with `npm run dev`)
2. Checks `session-state.json` every 30 seconds
3. Detects staleness: component not used in 20 messages OR 30k tokens
4. Detects overdue checkpoints
5. Outputs visible warnings to terminal

Example output:

```
[WATCHDOG ERROR] ═══════════════════════════════════════════════════
[WATCHDOG ERROR] FRAMEWORK FADE DETECTED - 2 issues found
[WATCHDOG ERROR] ═══════════════════════════════════════════════════
[WATCHDOG ERROR] [HIGH] CrossReferenceValidator not used in 25 messages
[WATCHDOG ERROR] [CRITICAL] Token checkpoint OVERDUE! Next: 50000, Current: 6700
[WATCHDOG ERROR]
[WATCHDOG ERROR] REQUIRED ACTION: Run recovery protocol immediately
[WATCHDOG ERROR] Command: node scripts/recover-framework.js
[WATCHDOG ERROR] ═══════════════════════════════════════════════════
```

Graceful shutdown: Handles SIGINT, SIGTERM

Layer 3: Pre-Action Checklist (Active)

Script: `scripts/pre-action-check.js`

Purpose: Blocking validator before major changes

Usage:

```
node scripts/pre-action-check.js <action-type> <description>

# Action types:
# - file-edit
# - database
# - architecture
# - config
# - security
# - values
# - complex
```

Checks performed:

1. Pressure check recent? (within 25k tokens)
2. Instructions loaded?
3. Token checkpoints up to date?
4. Required components used for action type?

Exit codes:

- **0**: PASS - action may proceed
- **1**: FAIL - action blocked, address issues
- **2**: ERROR - system error, cannot validate

Example:

```
$ node scripts/pre-action-check.js database "Add user_preferences collection"

[PRE-ACTION CHECK] ═══════════════════════════════════════════════════
[PRE-ACTION CHECK] Validating action: database
[PRE-ACTION CHECK] Description: Add user_preferences collection
[PRE-ACTION CHECK] ═══════════════════════════════════════════════════

[PRE-ACTION CHECK] Running check: Pressure Check Recent
[✓ PASS] Pressure check recent: 12000 tokens ago

[PRE-ACTION CHECK] Running check: Instructions Loaded
[✓ PASS] Instruction database loaded: 12 active instructions

[PRE-ACTION CHECK] Running check: Token Checkpoints
[✓ PASS] Token checkpoints OK: next at 50000

[PRE-ACTION CHECK] Running check: Action-Specific Components
[✓ PASS] Required components recently used: CrossReferenceValidator, BoundaryEnf

[PRE-ACTION CHECK] ═══════════════════════════════════════════════════
[✓ PASS] All checks passed. Action may proceed.
[PRE-ACTION CHECK] ═══════════════════════════════════════════════════

$ echo $?
0
```

Layer 4: Token Checkpoint Hard Stops (Automated)

File: `.claude/token-checkpoints.json`

Purpose: Hard stops at 25%, 50%, 75% token usage

Structure:

```
{
  "budget": 200000,
  "checkpoints": [
    {
      "percentage": 25,
      "tokens": 50000,
      "completed": true,
      "timestamp": "2025-10-08T10:30:00Z"
    },
    {
      "percentage": 50,
      "tokens": 100000,
      "completed": false,
      "timestamp": null
    },
    {
      "percentage": 75,
      "tokens": 150000,
      "completed": false,
      "timestamp": null
    }
  ],
  "next_checkpoint": 100000,
  "overdue": false
}
```

Claude's obligation:

1. Check this file every ~10 messages
2. STOP all work if `overdue: true`
3. Run `node scripts/check-session-pressure.js`
4. Mark checkpoint completed
5. Resume work

Watchdog enforcement: Marks `overdue: true` if checkpoint passed without completion

Layer 5: Component Usage Wrappers (Embedded)

Purpose: Conceptual wrappers in Claude's reasoning process

Not a script: These are patterns Claude follows when reasoning

Examples:

```
// Before processing explicit instruction
async function classifyInstruction(instruction) {
  // 1. Invoke InstructionPersistenceClassifier
  // 2. Determine quadrant, persistence, scope
  // 3. Update session-state.json
  // 4. Append to instruction-history.json
  // 5. Report classification to user
}

// Before major database change
async function validateAgainstInstructions(action) {
  // 1. Load instruction-history.json
  // 2. Invoke CrossReferenceValidator
  // 3. Check for conflicts
  // 4. Update session-state.json
  // 5. BLOCK if HIGH/CRITICAL conflicts
}

// Before values decision
async function checkBoundaries(decision) {
  // 1. Invoke BoundaryEnforcer
  // 2. Detect values domain
  // 3. Update session-state.json
  // 4. BLOCK automatic decision
  // 5. Report to user, require human choice
}
```

Layer 6: CLAUDE.md Structure (Forcing Function)

File: `CLAUDE.md` (50-60 lines, enforcement-first)

Purpose: First thing Claude reads at session start

Key sections:

1. **Mandatory Session Start Protocol** (cannot be missed)

2. **Five Mandatory Components** (with WHEN, HOW, WHERE)
3. **Framework Fade Detection** (signs + recovery)
4. **Pre-Action Check** (blocking requirement)
5. **Quick Reference** (links to detailed docs)

Why it works: Concise, actionable, impossible to ignore

Layer 7: User-Visible Status (Transparency)

Purpose: User sees framework activity

Regular reporting (every 20 messages or 40k tokens):

```
[Framework Status Check]
Messages since last check: 18
Tokens: ~43,000 / 200,000 (21.5%)
Last component activity:
  ✓ Pressure: 2 messages ago
  ✓ Classifier: 5 messages ago
  ⚠ Validator: 15 messages ago (stale)
  ✓ Boundary: 8 messages ago
  ✗ Metacognitive: never used

Action: Running validator check now...
```

Benefits:

- User knows framework is active
- User can spot fade before automation does
- Builds trust in governance system

Layer 8: Recovery Protocol (Fail-Safe)

Script: `scripts/recover-framework.js`

Purpose: Restore framework after fade detected

Recovery steps:

1. Diagnose current state (all components, checkpoints, instructions)

2. Report all issues (CRITICAL, HIGH, MEDIUM)
3. Clear stale alerts from session state
4. Provide actionable recommendations
5. Require Claude to address issues before resuming

Example output:

```
[RECOVERY] ═══════════════════════════════════════════════════════
[RECOVERY] TRACTATUS FRAMEWORK RECOVERY INITIATED
[RECOVERY] ═══════════════════════════════════════════════════════

[RECOVERY] Step 1: Checking session state...
[RECOVERY SUCCESS] Session state loaded: 45 messages, ~87000 tokens

[RECOVERY] Step 2: Checking token checkpoints...
[RECOVERY ERROR] FOUND 2 ISSUES:

[RECOVERY ERROR] CRITICAL ISSUES (1):
[RECOVERY ERROR] 1. [ContextPressureMonitor] Checkpoint OVERDUE: 50000 (current:
[ACTION REQUIRED]    → Run pressure check immediately: node scripts/check-sessio

[RECOVERY WARN] HIGH PRIORITY ISSUES (1):
[RECOVERY WARN] 1. [CrossReferenceValidator] Never used in this session
[ACTION REQUIRED]    → Immediately invoke CrossReferenceValidator

[RECOVERY] Step 4: Performing recovery actions...
[RECOVERY SUCCESS] Session state alerts cleared

[ACTION REQUIRED] IMMEDIATE ACTIONS FOR CLAUDE:
[ACTION REQUIRED] 1. STOP all current work immediately
[ACTION REQUIRED] 2. Address all CRITICAL issues listed above
[ACTION REQUIRED] 3. Run pressure check if overdue
```

Technical Implementation

Automated Session Initialization

NEW (2025-10-08): Session initialization is now fully automated via `scripts/session-init.js`.

Usage:

```
node scripts/session-init.js
# OR
npm run framework:init
```

What it automates:

1. ✅ Detects new session vs. continued session
2. ✅ Initializes `.claude/session-state.json` with session ID and timestamp
3. ✅ Resets `.claude/token-checkpoints.json` (25%, 50%, 75% milestones)
4. ✅ Loads and summarizes `.claude/instruction-history.json` (active instruction counts)
5. ✅ Runs baseline pressure check (ContextPressureMonitor)
6. ✅ Verifies all 5 framework components operational
7. ✅ Outputs formatted status report

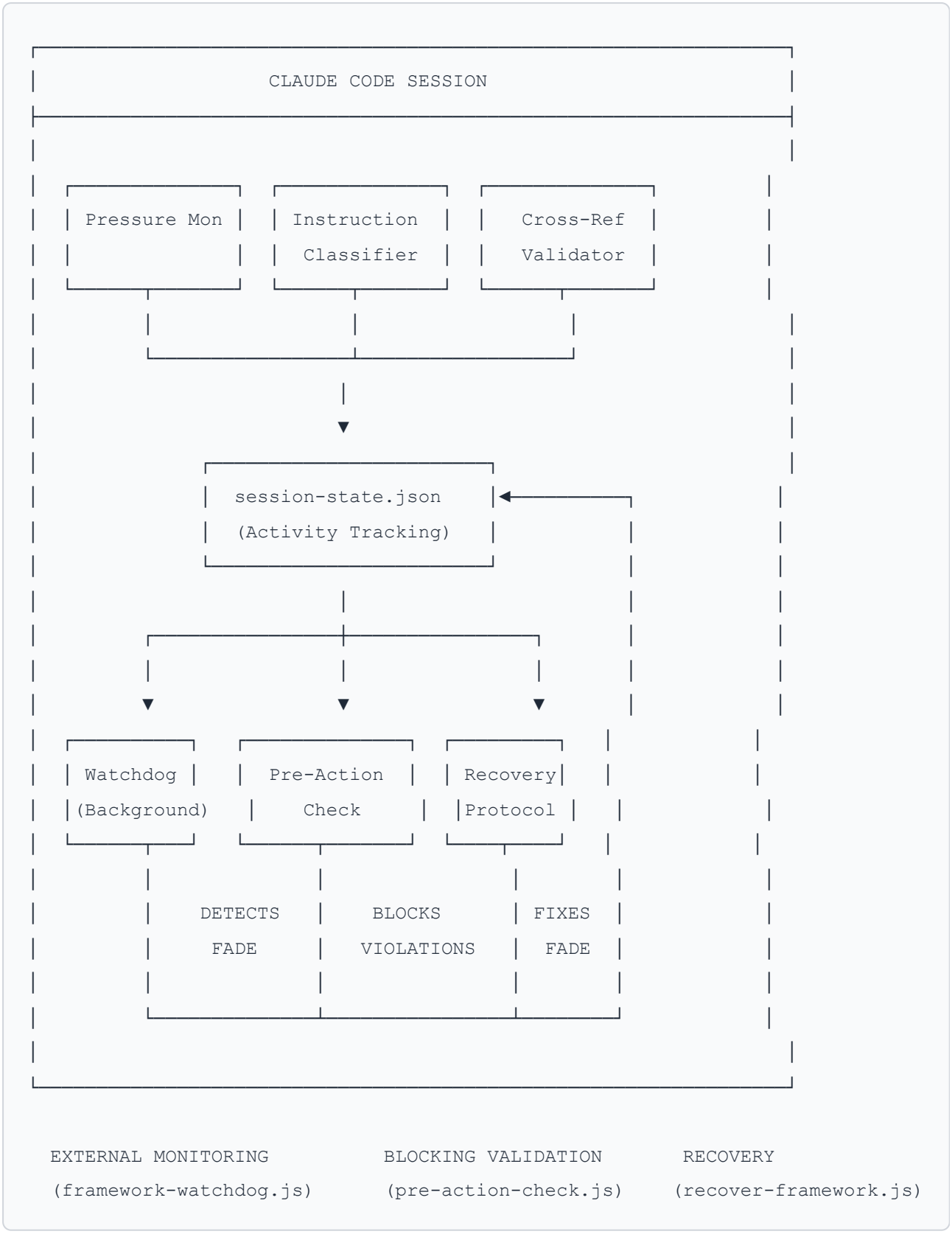
Why this matters:

- **Previously**: Manual 5-step initialization that could be forgotten (and was, in Oct 8 session)
- **Now**: ONE command that handles all mandatory session startup
- **Benefit**: Eliminates framework fade at session start

Integration:

- Added to `CLAUDE.md` as mandatory first action
- Added to `package.json` as `framework:init` script
- Documented in maintenance guide with manual fallback

Architecture Diagram



Data Flow

1. **Component Invocation**:

```
User → Explicit Instruction
      → Claude: InstructionPersistenceClassifier
      → Classify (quadrant, persistence, scope)
      → Update session-state.json
      → Append instruction-history.json
      → Report to user
```

2. **Continuous Monitoring**:

```
Watchdog (every 30s)
      → Read session-state.json
      → Check staleness (20 msg OR 30k tokens)
      → Check token checkpoints
      → If violations: Output warnings
      → Update session-state.json (alerts)
```

3. **Pre-Action Validation**:

```
Claude → Major change planned
      → Run pre-action-check.js <type>
      → Check pressure, instructions, checkpoints, components
      → Exit 0 (PASS) or 1 (FAIL)
      → If FAIL: BLOCK action, report issues
```

4. **Fade Recovery**:

```
Watchdog OR Claude → Fade detected
      → Run recover-framework.js
      → Diagnose all issues
      → Report CRITICAL/HIGH/MEDIUM
      → Clear stale alerts
      → Recommend actions
      → Claude addresses issues
      → Resume work
```

File Relationships

```
.claude/
├── instruction-history.json     (Persistent storage)
│   ├── Written by: InstructionPersistenceClassifier
│   ├── Read by: CrossReferenceValidator, pre-action-check.js
│   └── Manually reviewed: Quarterly or on request
│
├── session-state.json           (Current session tracking)
│   ├── Written by: All 5 components
│   ├── Read by: Watchdog, pre-action-check, recover-framework
│   └── Reset: Each session start
│
└── token-checkpoints.json       (Milestone tracking)
    ├── Written by: ContextPressureMonitor
    ├── Read by: Watchdog, Claude (every ~10 messages)
    └── Reset: Each session start
```

npm Scripts

```
{
  "dev": "concurrently \"nodemon src/server.js\" \"node scripts/framework-watchd
  "dev:simple": "nodemon src/server.js",
  "framework:watchdog": "node scripts/framework-watchdog.js",
  "framework:check": "node scripts/pre-action-check.js",
  "framework:recover": "node scripts/recover-framework.js"
}
```

Key point: `npm run dev` now automatically runs watchdog alongside server

---

For Developers

How to Use

Session start:

```
# 1. Start dev environment (includes watchdog)
npm run dev

# 2. In Claude Code session, run baseline check
node scripts/check-session-pressure.js --tokens 0/200000 --messages 0
```

During development:

```
# Before major changes
node scripts/pre-action-check.js database "Add user_sessions collection"

# If exit code 0: Proceed
# If exit code 1: Address issues reported
```

If watchdog alerts:

```
# Run recovery diagnostic
node scripts/recover-framework.js

# Follow recommendations
# Address CRITICAL issues
# Resume work
```

Testing the System

Test framework fade detection:

1. Start session, run baseline
2. Work for 30+ messages without using CrossReferenceValidator
3. Watchdog should alert: "CrossReferenceValidator not used in 30 messages"
4. Run recover-framework.js to see diagnostic

Test checkpoint enforcement:

1. Start session, baseline at 0 tokens
2. Reach 50k tokens without running pressure check
3. Watchdog should alert: "Token checkpoint OVERDUE"

4. token-checkpoints.json should have `overdue: true`

Test pre-action blocking:

```
# Start fresh session
node scripts/check-session-pressure.js --tokens 0/200000 --messages 0

# Immediately try major change
node scripts/pre-action-check.js database "Schema change"
# Should FAIL: "Pressure check stale: 0 tokens ago exceeds 25000 max"
```

Integration with Existing Code

The enforcement system is **non-invasive**:

- No changes to existing routes/controllers/models
- Scripts are standalone (can be run independently)
- Session state files are in `.claude/` (not committed)
- Watchdog is optional (use `npm run dev:simple` to disable)

Extending the System

To add new framework components:

1. Add to `session-state.json`:

```
"last_framework_activity": {
  "NewComponent": {
    "message": 0,
    "tokens": 0,
    "timestamp": null,
    "custom_field": null
  }
}
```

2. Update `framework-watchdog.js`:

```
const components = [
  'ContextPressureMonitor',
  'InstructionPersistenceClassifier',
  'CrossReferenceValidator',
  'BoundaryEnforcer',
  'MetacognitiveVerifier',
  'NewComponent'  // Add here
];
```

3. Update `CLAUDE.md`:

```
### 6. **NewComponent** (When to use)
- **When**: Description
- **Action**: What it does
- **Update**: Files affected
```

4. Update `CLAUDE_Tractatus_Maintenance_Guide.md` with detailed documentation

For Users

What You See

Session start:

```
[Framework Status: ACTIVE]
Baseline pressure: NORMAL (0%)
Active instructions: 12 (8 HIGH, 4 MEDIUM)
All 5 components operational.
```

During session:

```
[ContextPressureMonitor: 25% Checkpoint]
Pressure: NORMAL (18%)
Token Usage: 50,000/200,000 (25%)
Recommendations: ✅ CONTINUE_NORMAL
```

If issues detected:

```
[WATCHDOG WARNING] CrossReferenceValidator not used in 22 messages
Recommendation: Review recent changes for conflicts with instructions
```

What It Means

Framework is working when you see:

- Regular pressure check reports
- Components mentioned in conversation
- Pre-action checks before major changes
- Framework status updates every ~20 messages

Framework has faded when you notice:

- No pressure checks for 50k+ tokens
- No instruction classification when you give directives
- No boundary checks before values decisions
- Watchdog alerts in terminal

How to Respond

If watchdog alerts:

1. Claude should automatically run `recover-framework.js`
2. Review the diagnostic output
3. Confirm Claude addresses CRITICAL issues
4. Allow resumption only after recovery complete

If you give explicit instruction and Claude doesn't classify it:

```
You: "Check MongoDB at port 27027"

Claude: [proceeds to check port 27017 instead - pattern recognition override]

Your response: "Please classify that instruction using InstructionPersistenceCla
                You ignored my explicit port 27027 and used 27017 instead."
```

If Claude suggests values decision without boundary check:

```
Claude: "I'll update the privacy policy to prioritize performance"

Your response: "Run BoundaryEnforcer before making privacy decisions"
```

Trust Indicators

Signs the system is working:

- ✅ Regular framework status reports
- ✅ Watchdog running in terminal (colored output)
- ✅ Pre-action checks before major changes
- ✅ Instruction classifications stored
- ✅ Boundary violations blocked

Signs of potential issues:

- ❌ No pressure checks for 50k+ tokens
- ❌ Watchdog not running
- ❌ Major changes without pre-action checks
- ❌ Values decisions without boundary checks
- ❌ Long silence on framework activity

Monitoring & Diagnostics

Real-Time Monitoring

Watchdog output (terminal where `npm run dev` runs):

```
[WATCHDOG INFO] Tractatus Framework Watchdog STARTED
[WATCHDOG INFO] Monitoring session for framework component usage
[WATCHDOG INFO] Check interval: 30s

[WATCHDOG SUCCESS] All components active. Messages: 15, Tokens: ~32000
```

Session state (`.claude/session-state.json`):

```
{
  "session_id": "2025-10-08-001",
  "message_count": 45,
  "token_estimate": 87000,
  "last_framework_activity": {
    "ContextPressureMonitor": {
      "message": 40,
      "tokens": 82000,
      "last_level": "ELEVATED"
    },
    ...
  },
  "alerts": []
}
```

Diagnostic Commands

Check current pressure:

```
node scripts/check-session-pressure.js --tokens 87000/200000 --messages 45 --tas
```

Validate before action:

```
node scripts/pre-action-check.js architecture "Refactor auth system"
```

Full framework diagnostic:

```
node scripts/recover-framework.js
```

Inspect instruction history:

```
cat .claude/instruction-history.json | jq '.instructions[] | select(.active == t
```

Log Files

Watchdog logs (if enabled):

```
tail -f logs/framework-watchdog.log
```

Session audit trail (if enabled):

```
ls -l .claude/audit/
# session-2025-10-08-001.log
# session-2025-10-08-002.log
```

Lessons from Real Deployment

Why Automated Initialization Matters (October 2025)

The Problem We Experienced:

During a continued session on October 8, 2025, the framework developers (using Claude Code to build this very system) discovered that **manual session initialization had been skipped**. The session proceeded with:

- ❌ No baseline pressure check
- ❌ No instruction history loaded

- ❌ No framework component verification
- ❌ Token checkpoints not initialized

This was caught when the user asked: *"Confirm that the framework is active and monitoring in this session"*

The answer was embarrassing but honest: **No, it wasn't.**

Why This Happened:

The original `CLAUDE.md` specified a **5-step manual initialization protocol**:

1. Run pressure baseline check
2. Load instruction history
3. Initialize session state
4. Verify components
5. Report to user

In a continued session (from a handoff), these steps were forgotten. The framework designed to prevent AI failures had itself failed to be initialized.

The Meta-Irony:

- Framework exists to catch AI mistakes
- AI developer forgot to initialize framework
- Framework couldn't catch its own non-initialization
- **This is exactly why automation matters**

The Solution:

We created `scripts/session-init.js` - **one command** that automates all 5 steps:

```
node scripts/session-init.js
```

Updated CLAUDE.md to make this the mandatory first action. Now framework initialization is:

- ✅ Automated (one command, not five steps)
- ✅ Comprehensive (checks everything, reports status)
- ✅ Verifiable (colored output shows what was initialized)

- ✅ Impossible to partially execute (all-or-nothing)

Why We're Documenting This Failure:

1. **Transparency**: We dogfood our own framework, including catching our own failures
2. **Validation**: This proves the automation wasn't theoretical - we needed it ourselves
3. **Warning**: Other developers WILL make the same mistake if initialization is manual
4. **Credibility**: Honesty about failures is more trustworthy than claiming perfection

Key Takeaway for Other Developers:

> ***If the developers of this framework forgot manual initialization, you will too.***
>
> *Don't make session startup a checklist - make it a script. One command, automated, verified.*

This is the framework working as intended:

1. ✅ Detect failure (initialization skipped)
2. ✅ Analyze root cause (manual process, easy to forget)
3. ✅ Implement fix (automation)
4. ✅ Enforce prevention (updated CLAUDE.md)
5. ✅ Document lesson (this section)

The framework exists to catch failures. We caught our own. The system works.

Known Limitations

1. Claude Must Cooperate

Issue: This system cannot *force* Claude to invoke components. It can only:

- Make it very obvious when components should be used
- Detect when they haven't been used
- Block actions that violate requirements
- Alert user to fade

Mitigation:

- Multi-layer redundancy (8 layers)
- User-visible alerts (transparency)
- Blocking validators (technical enforcement)

2. False Positives

Issue: Watchdog may alert for components that legitimately weren't needed

Example: MetacognitiveVerifier is only for complex operations. A session with many simple tasks might never use it.

Mitigation:

- Component-specific staleness thresholds
- "Never used" vs. "stale" distinction
- Manual override capability

3. Performance Overhead

Issue: Background watchdog + state file I/O adds overhead

Measured impact:

- Watchdog CPU usage: <1% (checks every 30s)
- State file writes: ~100-200ms each
- Pre-action checks: ~500ms

Mitigation: Acceptable overhead for safety guarantees

4. State File Corruption

Issue: If `.claude/session-state.json` corrupted, system breaks

Mitigation:

- Validate JSON on read (try/catch)
- Recover script can detect and repair
- State files are session-scoped (fresh each session)

5. Human Override Required

Issue: System can alert, but user must ensure Claude complies

Example: User sees watchdog alert but doesn't intervene

Mitigation:

- User education (this document)
- Visible, persistent alerts
- Blocking validators (technical forcing function)

Future Work

Planned Enhancements

1. **Session handoff automation**
    - Auto-generate handoff document at 75% tokens
    - Include framework health assessment
    - Store in `.claude/sessions/`
2. **Historical analysis**
    - Track framework effectiveness across sessions
    - Identify patterns in fade occurrence
    - Measure safety improvements
3. **Component effectiveness metrics**
    - How often does CrossReferenceValidator catch conflicts?
    - How often does BoundaryEnforcer block violations?
    - Pressure level distribution over sessions
4. **UI Dashboard**
    - Web-based monitoring interface
    - Real-time framework status

- Historical session analytics
- Alert history

5. **Integration with production deployment**
   - Framework enforcement in production
   - API endpoint for framework status
   - Monitoring integration (Prometheus, Grafana)

Research Questions

1. **Optimal staleness thresholds**: Are 20 messages / 30k tokens the right thresholds?
2. **Pressure formula tuning**: Are the component weights (35%, 25%, 15%, 15%, 10%) optimal?
3. **False positive rate**: How often do alerts occur for legitimate reasons?
4. **User intervention rate**: How often do users need to manually intervene?
5. **Safety improvement**: Quantifiable reduction in "27027 failures" (pattern recognition overrides)?
6. **Pattern strength measurement**: Can we detect when training patterns are about to override explicit instructions?

Conclusion

Summary

The **Tractatus Framework Enforcement System** is an 8-layer architecture that makes framework fade technically impossible through:

1. **Passive tracking** (session-state.json)
2. **Automated monitoring** (framework-watchdog.js)
3. **Blocking validation** (pre-action-check.js)
4. **Hard stops** (token checkpoints)
5. **Embedded wrappers** (Claude's reasoning patterns)
6. **Forcing function** (CLAUDE.md structure)
7. **User visibility** (regular status reports)

8. **Fail-safe recovery** (recover-framework.js)

Critical Points

- **This is Claude Code-specific**: Solves the unique challenge of long-running AI development sessions
- **All 5 components must remain active**: Framework fade = critical failure
- **Multi-layer redundancy**: No single point of failure
- **User visibility**: Trust through transparency
- **Technical enforcement**: Not just documentation

Success Criteria

The system is successful when:

- Framework components remain active throughout every session
- "27027 failures" (pattern recognition overriding explicit instructions) are eliminated
- Values decisions blocked until human approval
- Session degradation detected early (pressure monitoring)
- Complex operations verified before execution

The Bigger Picture

This enforcement system demonstrates that **AI safety frameworks can be technically enforced**, not just documented. It shows that the Tractatus framework can "dogfood itself"—using its own principles to govern its own implementation.

This is not just about this project. It's a proof-of-concept for how AI safety can be made **mandatory, continuous, and verifiable** in real-world development.

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Appendix: Quick Reference

Commands

```
# Session start
npm run dev
node scripts/check-session-pressure.js --tokens 0/200000 --messages 0

# Continuous monitoring (every 25% tokens)
node scripts/check-session-pressure.js --tokens <current>/<budget> --messages <c

# Before major actions
node scripts/pre-action-check.js <type> <description>

# If fade detected
node scripts/recover-framework.js

# Standalone watchdog
npm run framework:watchdog
```

Files

- `.claude/instruction-history.json` - Persistent instruction database
- `.claude/session-state.json` - Current session framework activity
- `.claude/token-checkpoints.json` - Token milestone tracking
- `CLAUDE.md` - Session start protocol (50-60 lines)
- `CLAUDE_Tractatus_Maintenance_Guide.md` - Detailed reference
- `docs/claude-code-framework-enforcement.md` - This document

npm Scripts

```
npm run dev                    # Dev server + watchdog
npm run dev:simple             # Dev server only
npm run framework:watchdog     # Watchdog standalone
npm run framework:check        # Pre-action check
npm run framework:recover      # Recovery diagnostic
```

Exit Codes

- **0**: Success / PASS
- **1**: Failure / FAIL / HIGH priority
- **2**: Error / CRITICAL priority
- **3**: DANGEROUS (check-session-pressure.js only)

End of Document

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This document is part of the Tractatus Agentic Governance System

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