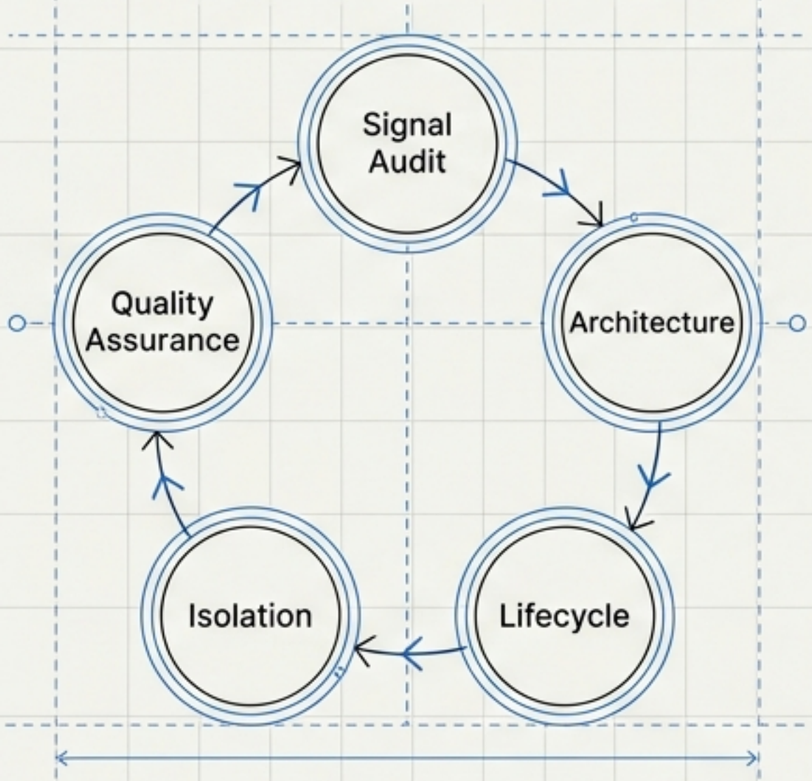
EFFECTIVE CONTEXT ENGINEERING

The Discipline of Building Production-Grade AI Agents: A Technical Handbook

The Quality Control Loop



CONTEXT ENGINEERING DEFINITION:
The art and science of curating what will go into the limited context window from that constantly evolving universe of possible information.

— Anthropic

General Agents Build Custom Agents.

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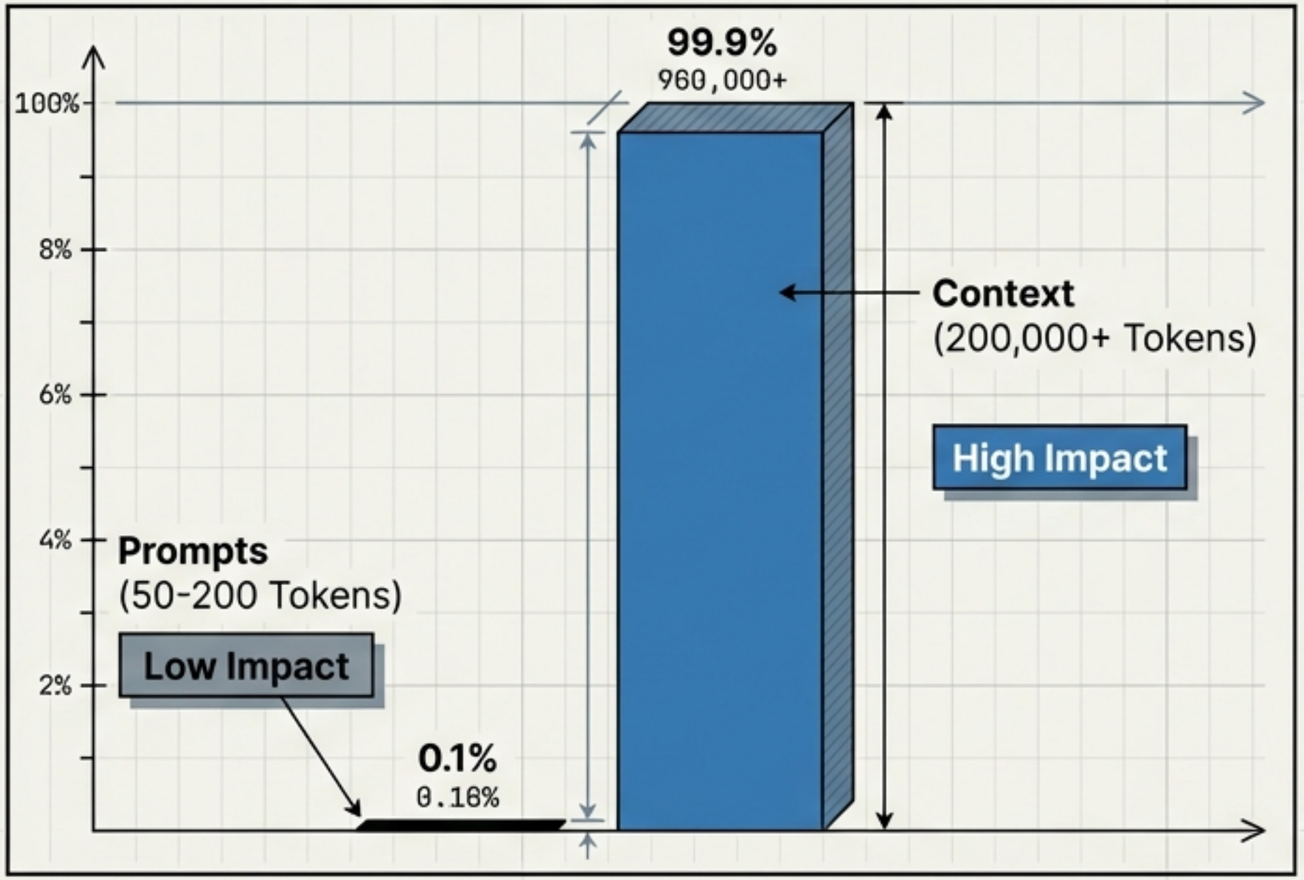
THE PHYSICS OF VALUE: WHY CONTEXT SUPERSEDES PROMPTS

Token Budget Asymmetry



Guiding Principle

The Goal: Find the smallest set of high-signal tokens that **maximize the likelihood** of a desired outcome.

The Value Gap

The difference between a $50/mo generic agent and a $5,000/mo custom agent is the **context** engineering discipline.

> **Pull Quote:**
> **If you optimize prompts while ignoring context, you are polishing the doorknob while the house is on fire.**

The Insight: Reliability is a function of consistent context.

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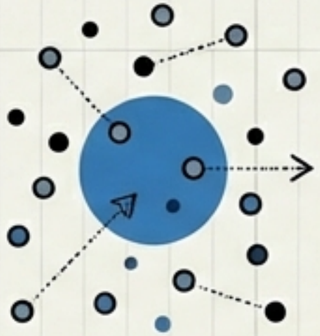
DIAGNOSING CONTEXT ROT: THE FOUR TYPES OF DEGRADATION

AI doesn't get dumber over time; its context gets corrupted.

1. POISONING.

Outdated info persists.

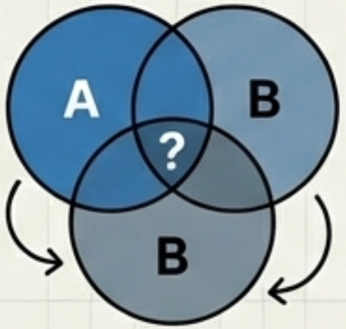
Symptom: References decisions reversed 40 messages ago.



2. DISTRACTION.

Irrelevant content dilutes attention.

Symptom: Tangents consume budget needed for constraints.



3. CONFUSION.

Similar concepts conflate.

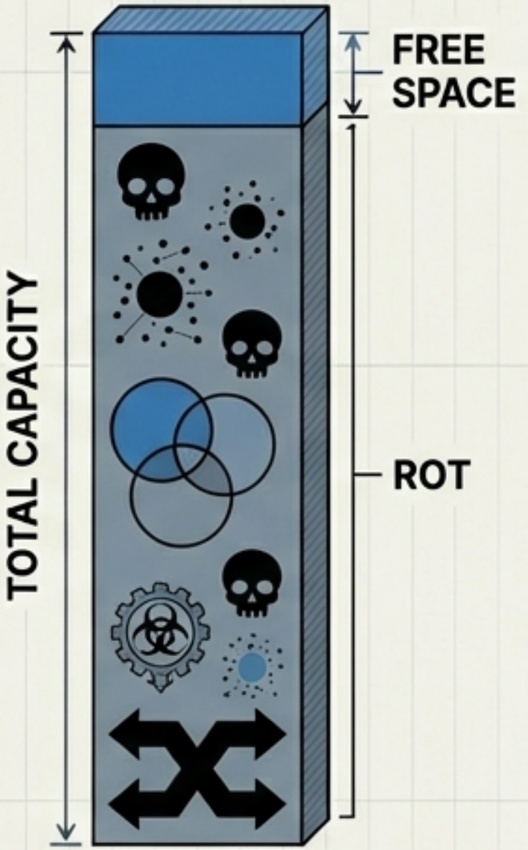
Symptom: Mixing up two similar documents or processes.

4. CLASH.

Contradictory instructions compete.

Symptom: Early instructions conflict with later ones.

Context Window Capacity



The Insight: Context rot is the primary adversary of consistency.

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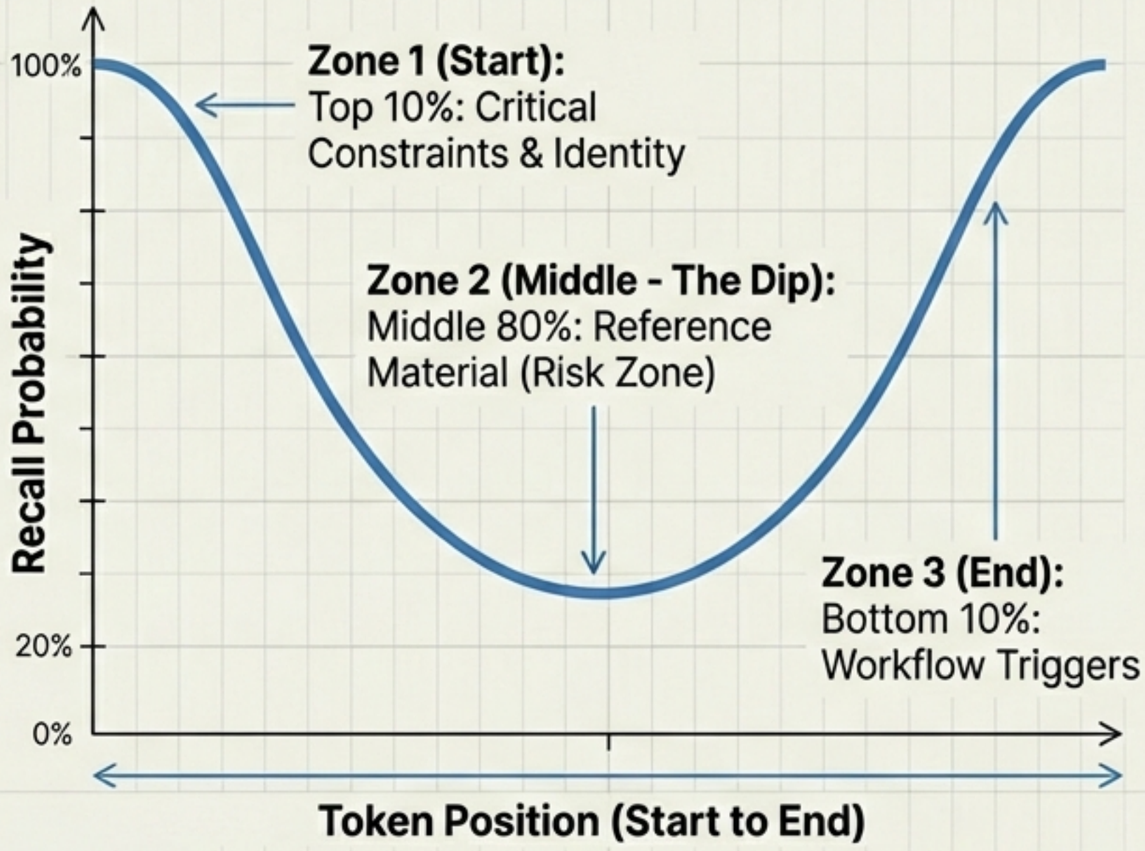
THE PHYSICS OF ATTENTION: CONSTRAINTS & POSITIONING

Constraint 1: The Instruction Limit

Frontier LLMs reliably follow ~150-200 distinct instructions.

```
System Prompt:  ~50 instructions
Available:      ~100-150 instructions
Result:         Exceeding leads to
                silent failure.
```

Constraint 2: The U-Shaped Attention Curve



The Insight: If you'd be upset when the AI ignores it, don't put it in the middle.

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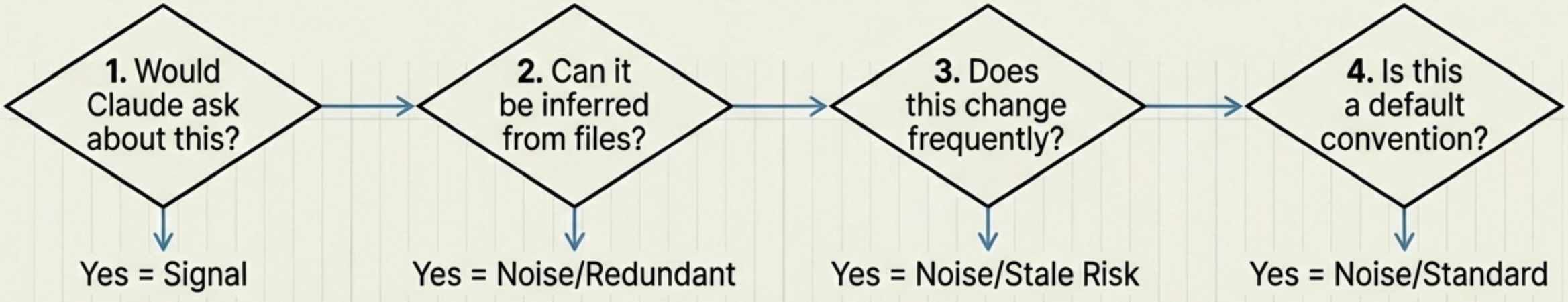
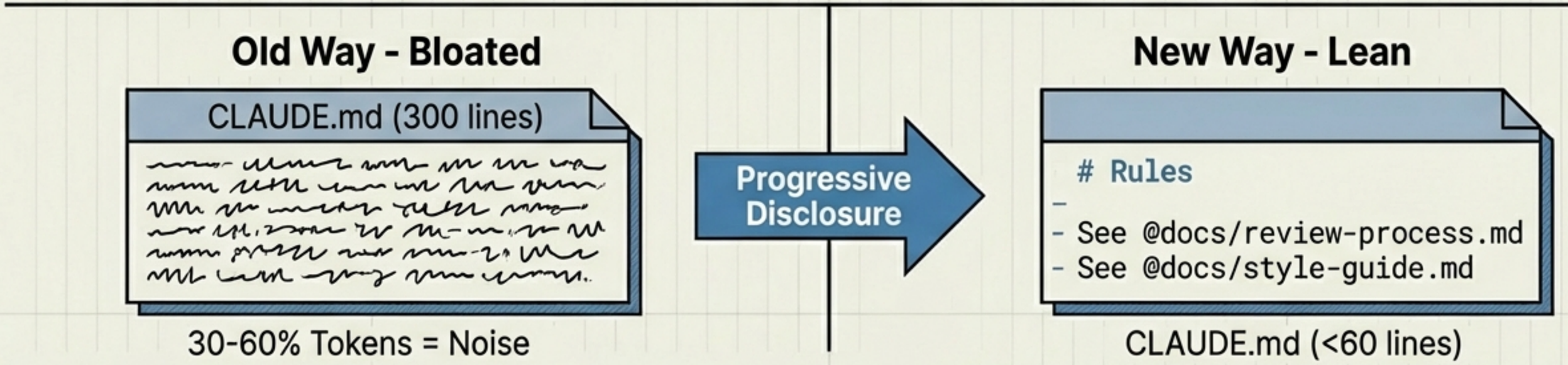
SIGNAL VS. NOISE: THE 4-QUESTION AUDIT FRAMEWORK





The Insight: Don’t inline details; use reference files to load tokens only on demand.

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CONTEXT ARCHITECTURE: FOUR TOOLS, FOUR LOADING PATTERNS

Tool	Loading Pattern	Token Cost	Best Use Case
`CLAUDE.md`	→ Session Start	→ Every Request (High)	Baseload rules, stable constraints
`Skills`	→ On-Demand	→ Low until invoked	Domain workflows, specialized tasks
`Subagents`	→ Isolated	→ Zero to main session	Fresh analysis, parallel research
`Hooks`	→ External	→ Zero	Deterministic checks (linting)

Cost Impact Analysis:

- Old Way (Monolithic): ~7,300 tokens/request.
- New Way (Distributed): ~550 tokens/request.
- Reduction: **13x.**

The Insight: Context architecture distributes information to minimize baseline cognitive load.

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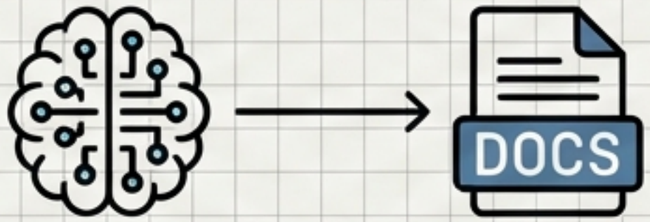
THE TWO-WAY PROBLEM: ENCODING TACIT KNOWLEDGE

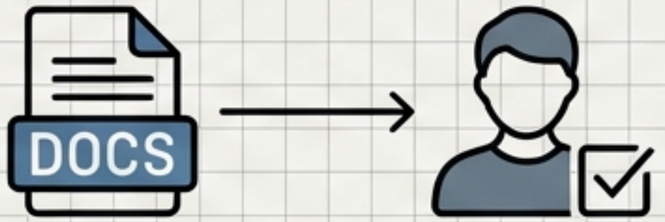
Tacit Knowledge: The “unwritten rules” professionals carry (e.g., specific client dislikes, subtle styling preferences).

GETTING KNOWLEDGE IN



1. Structured Context Docs (Explain the ‘Why’).
2. Encoded Preferences (Examples > Rules).
3. **Memory Scoping** (Global vs. Session).

GETTING UNDERSTANDING OUT



1. **The Rubber Duck Test** (Explain it back).
2. Structured **Output** (Reasoning before Deliverable).

The Insight: Explicitly document the unwritten rules to differentiate generic agents from experts.

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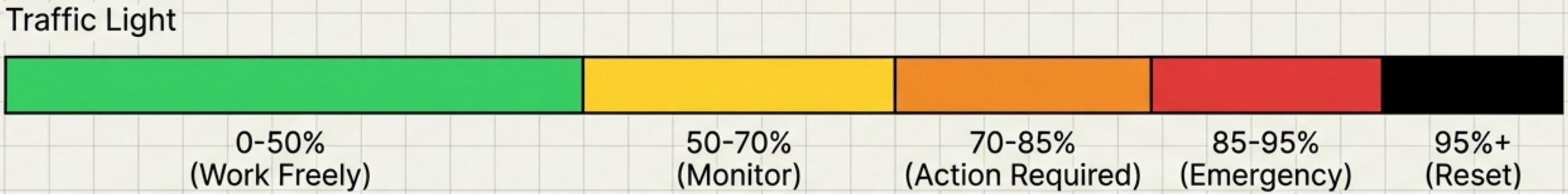
OPERATIONAL LIFECYCLE: THE CONTEXT ZONES FRAMEWORK



Task Complete OR Context Poisoned?

`/clear`

Task Ongoing + Need Decisions?

`/compact`

Custom Compaction Instructions

```
User: /compact\
Instruction: "Preserve [Key Decisions].
Discard [Tangents]."
```

The Insight: Proactively manage the window before degradation begins.

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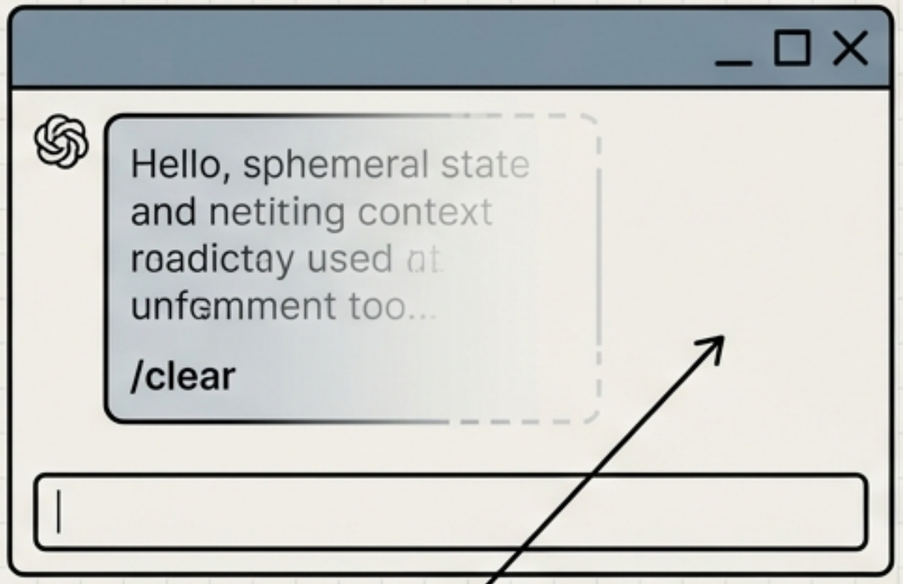
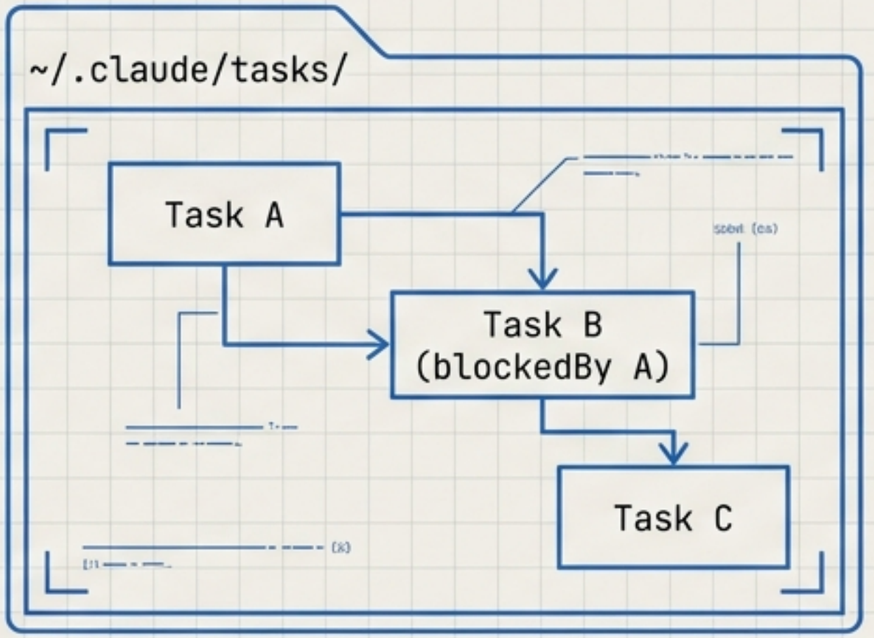
PERSISTENT STATE: THE TASKS SYSTEM

Problem: Ephemeral Context vs. **Solution:** Plan on Disk.



Ephemeral State
(Lost on /clear)



Cross-Session ID: CLAUDE_CODE_TASK_LIST_ID

The Insight: Tasks enable aggressive context clearing without losing the roadmap.

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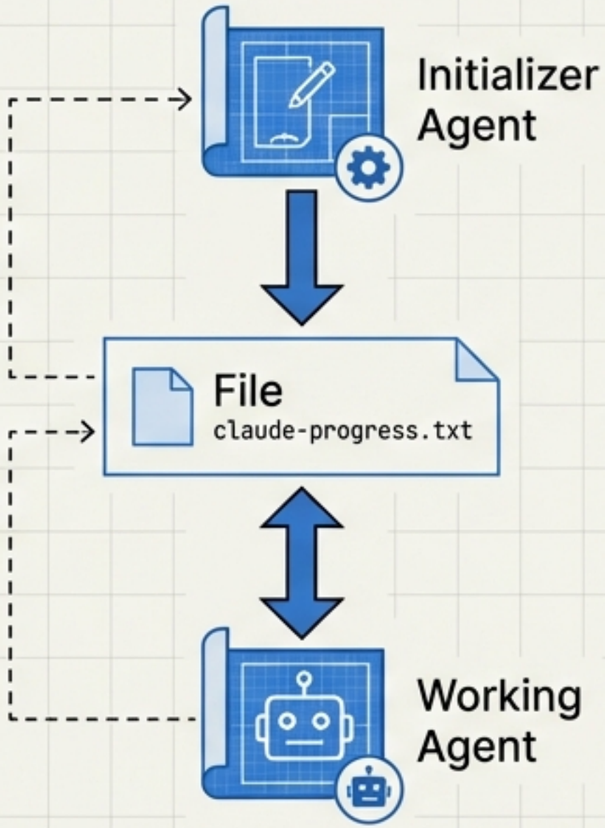
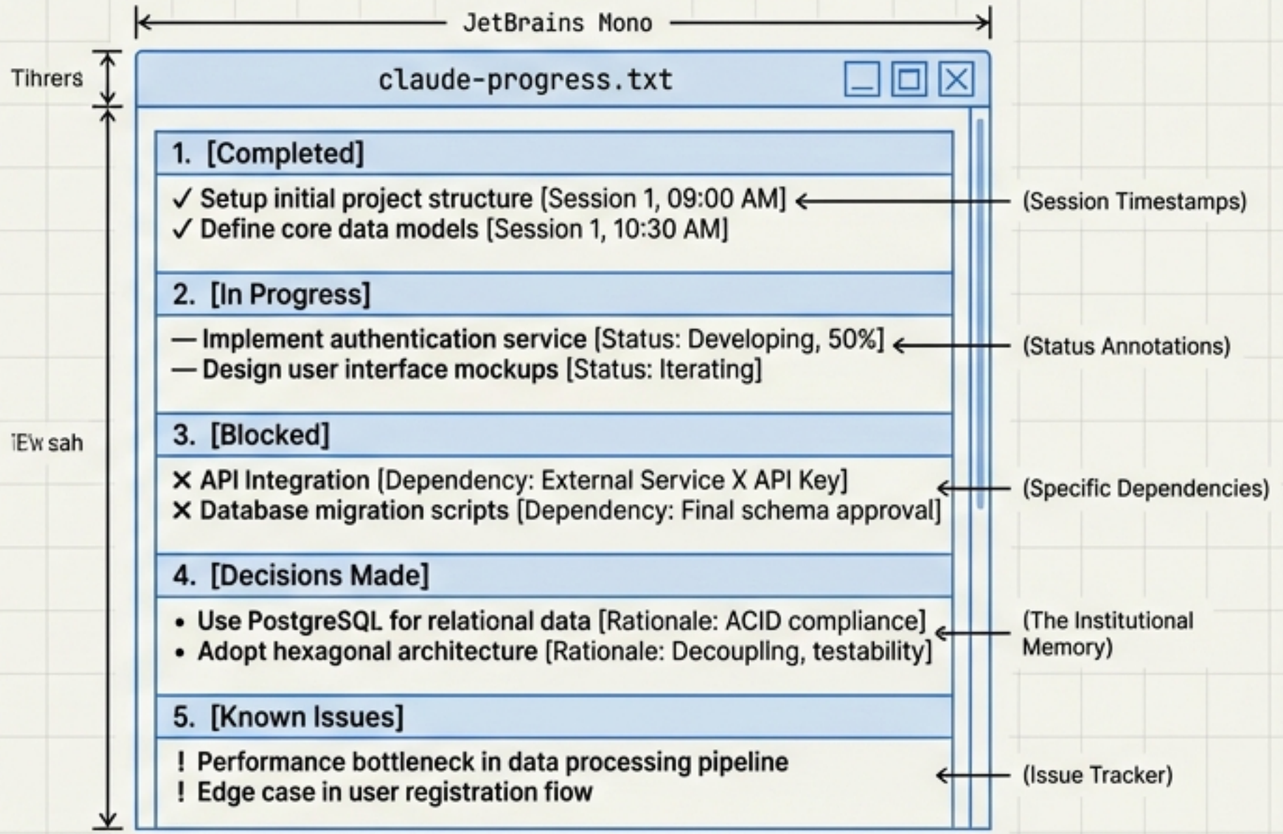
LONG-HORIZON WORK: THE HARNESS ARCHITECTURE

The Two-Agent System



Artifact: claude-progress.txt Wireframe



Protocol: Never end a session with work in disarray. Use the 'Save Checkpoint' pattern.

The Insight: Separate 'Action Items' (Tasks) from 'Project State' (Progress Files).

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MID-STREAM RELEVANCE: SEMANTIC MEMORY INJECTION

Solving Workflow Drift

Turn 1 (Strategy) → Turn 20 (Execution)

PreToolUse Injection

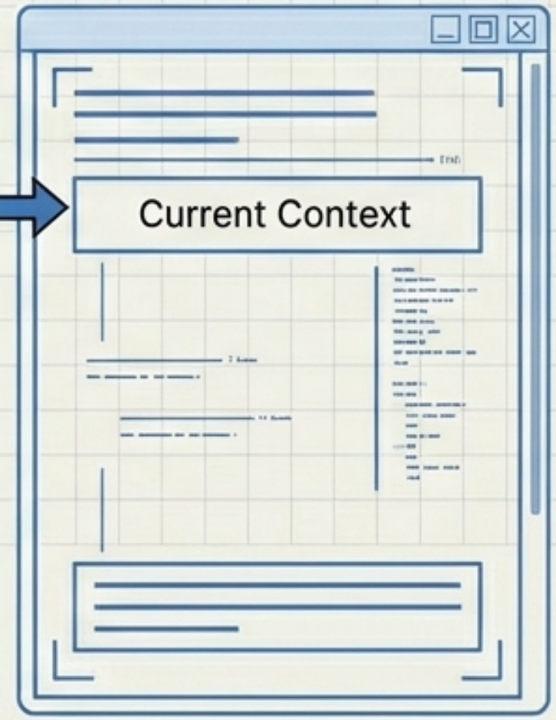
Thinking Block

```
JetBrains Mono
I need to format
this table...
```

→ Vector Search →

```
JetBrains Mono
Relevant Rule Found
(e.g., 'Formatting Rules')
```

→



UserPromptSubmit	PreToolUse
Static. Injects based on user prompt.	Dynamic. Injects based on AI's ***current*** thought process.

The Insight: Ensure the AI has context for what it is doing NOW, not what you asked an hour ago.

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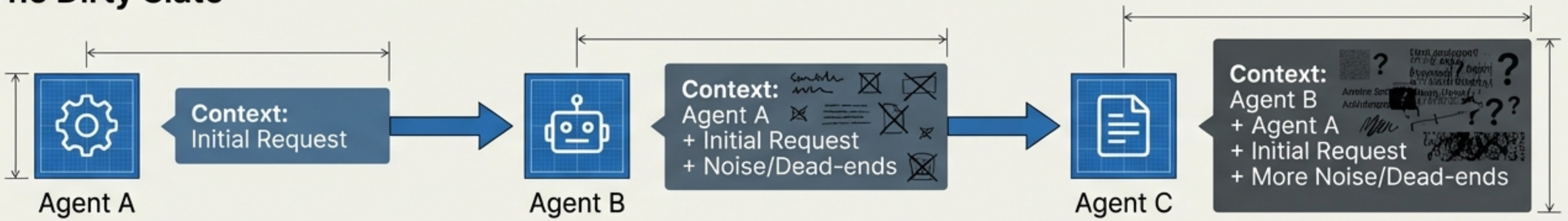
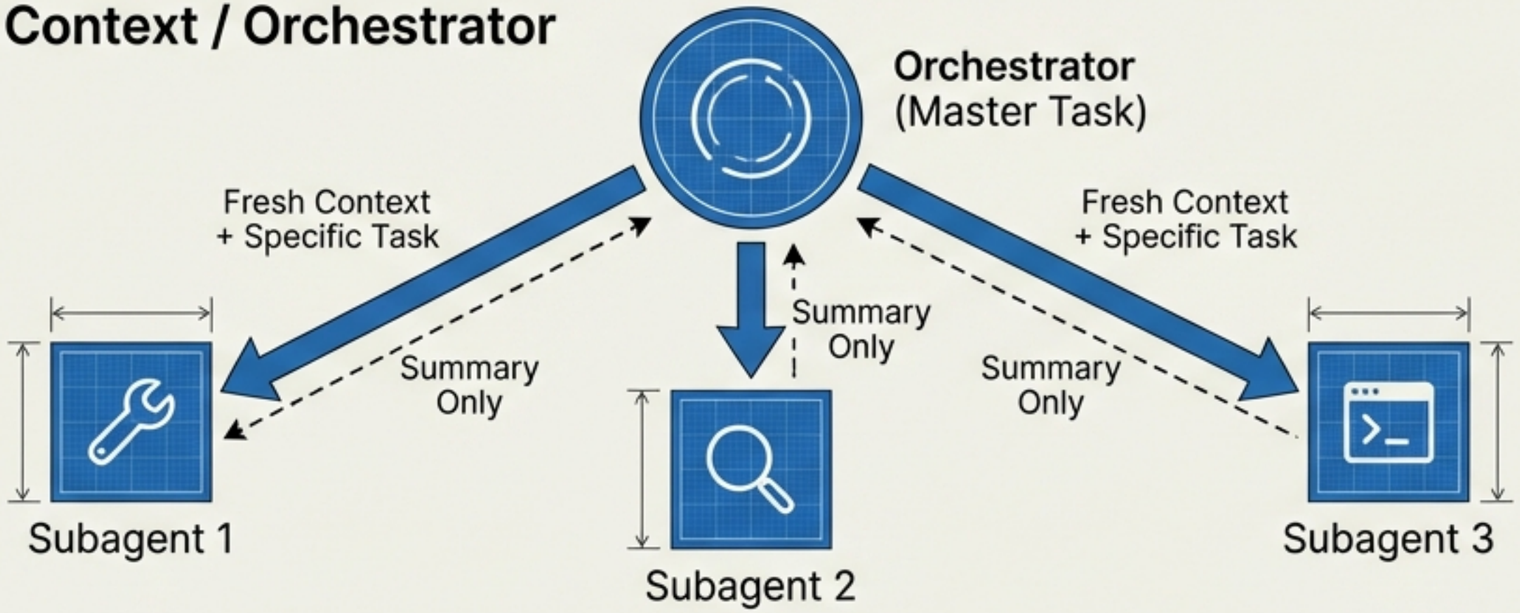
CONTEXT ISOLATION: THE ORCHESTRATOR PATTERN

The Dirty Slate



Clean Context / Orchestrator



Subagent Patterns

- **Stateless** (Parallel)
- **Stateful** (Handoffs)
- **Shared** (Source of Truth)

The Insight: Why clean slates beat accumulated context.

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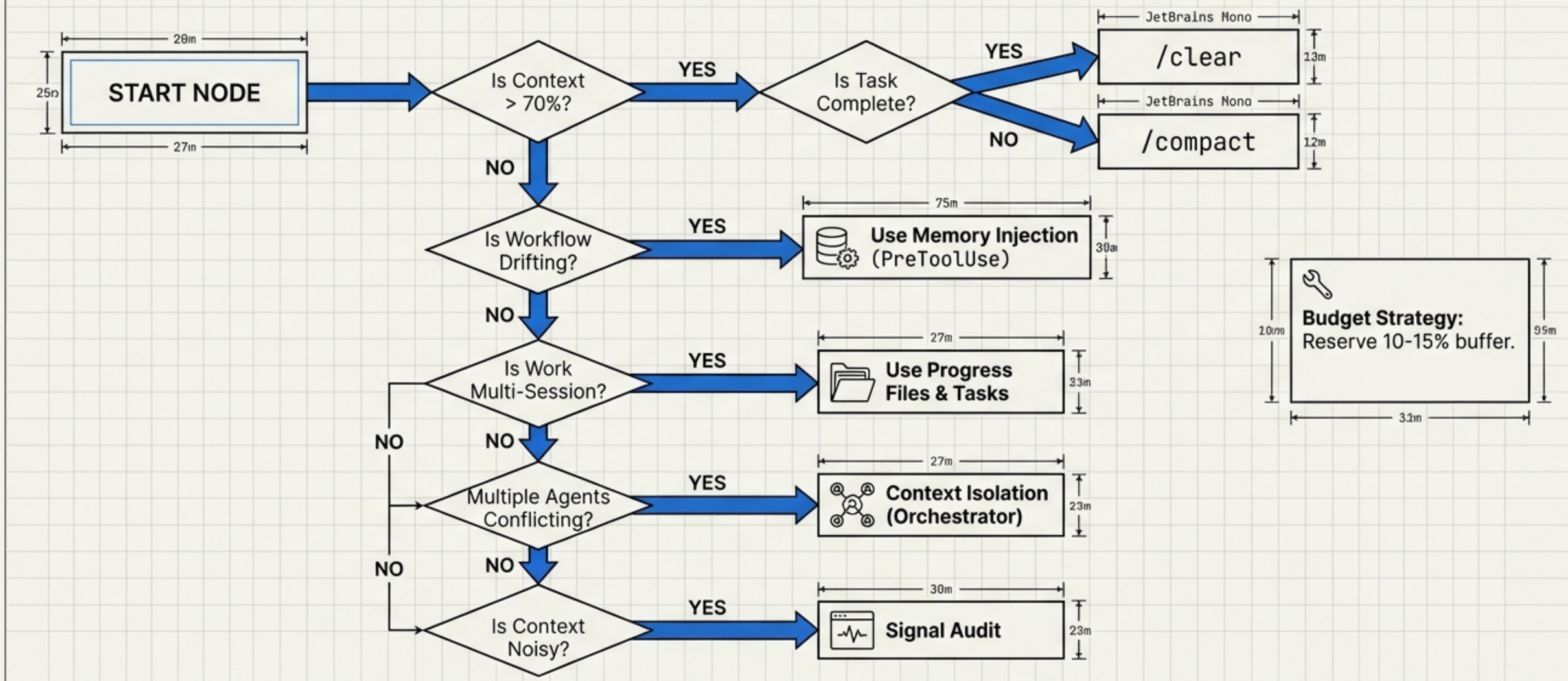
THE PLAYBOOK: CONTEXT ENGINEERING DECISION TREE



The Insight: A consolidated framework for application.

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QUALITY ASSURANCE: AUDITING PRODUCTION AGENTS

The 4 Quality Metrics

QUADRANT 1: CONSISTENCY

Definition:
- Same answer at Turn 1 vs Turn 50?

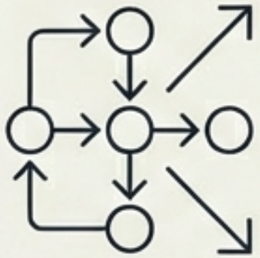
Test:
→ Run standard task at session start & end.

QUADRANT 2: PERSISTENCE

Definition:
- Resume after 24h break?

Test:
→ Reconstruction time < 5 min.

QUADRANT 3: SCALABILITY



Definition:
- Handle 10-step tasks?

Test:
→ Alignment with original goal (no drift).

QUADRANT 4: KNOWLEDGE

Definition:
- Apply domain rules unprompted?

Test:
→ Remove explicit reminders; check compliance.

The Insight: Quality is not accidental; it is engineered.

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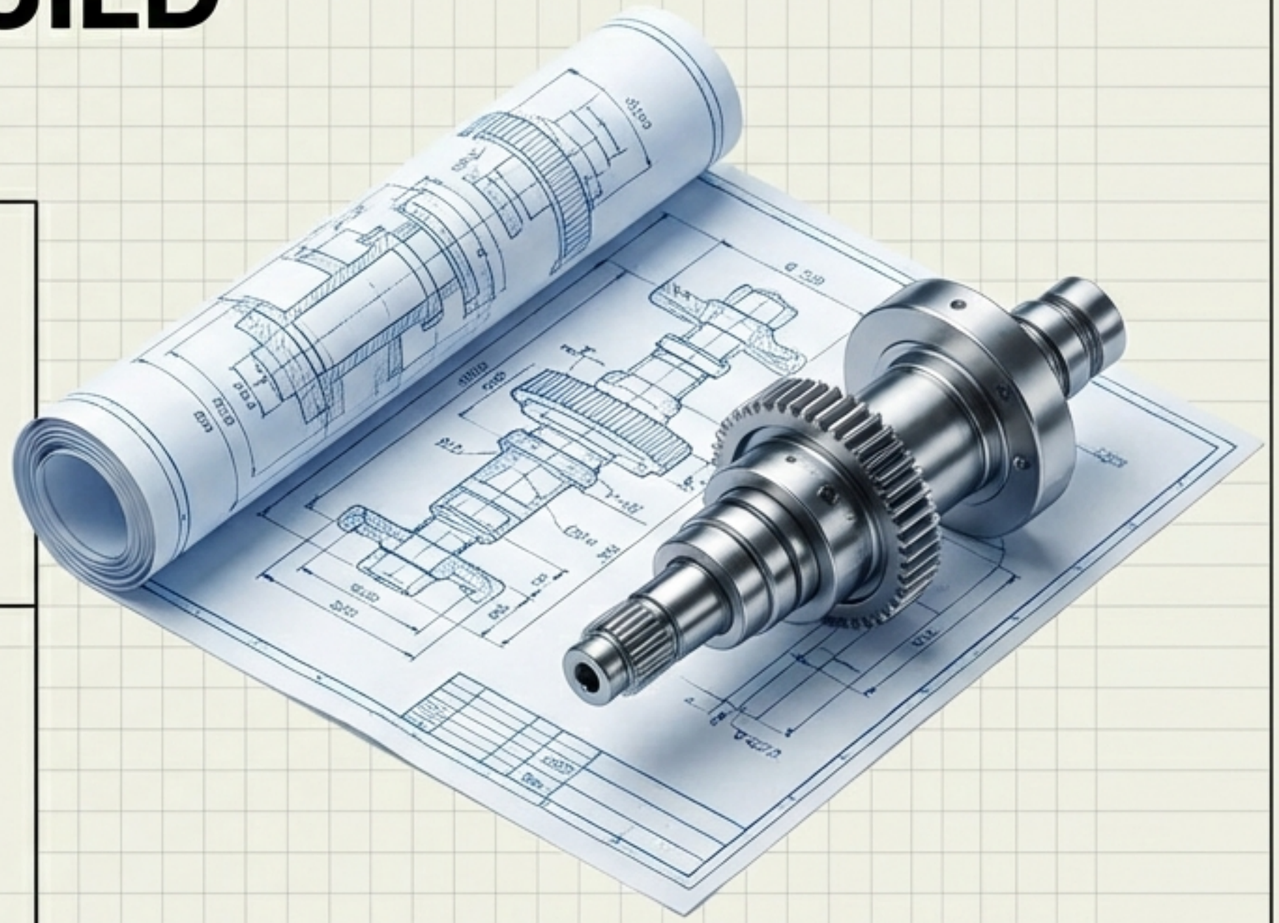
THE STRATEGIC IMPERATIVE

GENERAL AGENTS BUILD CUSTOM AGENTS.

The Differentiator:

- Competitor: Same Model (Claude/GPT).
- Competitor: Same Prompts.
- **Your Edge:** `Context Engineering Discipline`.



Stop ‘using’ AI. Start manufacturing Digital FTEs.

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