

CAP: Goals, Architecture, and Intended Scenarios

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Abstract

CAP (Communicating Agent Processes) is a Go runtime for coding agents that use language models to carry out tasks with tools. Its goals are to support agents working together, preserve their work across interruptions, and let them build and share programs and procedures for later use. An agent receives instructions, sends its current conversation and tool definitions to a model, executes the model's tool calls, and returns their results to the conversation. A controller runs concurrent agents, records their activity, manages commands and execution environments, and exposes local and remote operations. Agents create other agents, exchange shared objects through the ACE coordination library, and publish files containing code, evidence, and results. Application instructions determine assignments, review methods, and publication rules. The same operations support repository work, collaborative research, continuing monitoring, shared knowledge bases, and agent-written services. A separate CAP can inspect another controller's records and use delegated controls. This report explains the architecture and relates these goals to recorded tests. Small-group trials demonstrate retained work, coordination, recovery, and method reuse. They also expose failures in context summarization, observation budgets, and final publication. Research quality, the benefit and cost of observation, and deployment across 100,000 to 1,000,000 or more agents require further evaluation.

1 CAP and its goals

CAP (Communicating Agent Processes) is a Go runtime for coding agents that use language models to carry out tasks with tools. An agent combines a model conversation with operations for reading and editing files, executing commands, browsing sources, and communicating with other agents. A CAP controller is a running instance of the software that manages these agents, their execution, and their saved state. A user supplies a task through the command line, a browser interface, or an API. The assigned agent selects tools and uses their results until it returns an answer, sleeps, fails, or reaches a configured limit [4, 5, 6].

CAP's goal is to support agents that develop software and use software to perform larger assignments. An agent can write a program for repeated data collection, start a service, create a tool that another agent can call, or divide an investigation among other agents. CAP supplies the execution and communication operations. The user and participating agents supply the task instructions, division of work, evidence requirements, review procedures, and stopping conditions. This division lets an application change its methods through instructions and code [4, 5].

Retaining work is a second goal. A task can span model requests, periods of inactivity, controller restarts, and changes in responsibility. CAP preserves agent identities, conversations, accepted inputs, execution records, and files so work can resume and results can be inspected. Agents can also preserve useful programs and written procedures in a shared knowledge base. A later agent can read that material, check it against a new task, and propose a revision. Observation facilities let another CAP inspect how agents worked and retain evidence for such proposals [4, 14, 16].

The longer-term goal is to support continuing work distributed across many CAP controllers. One proposed application maintains current assessments of events and relationships across a supply chain, with separate agents collecting evidence, reviewing claims, and updating reports. Its deployment objective is 100,000 to 1,000,000 or more agents. The recorded tests establish small-group behavior and limited host capacity. Sustained research quality and capacity at the proposed scale remain evaluation requirements [7, 12, 31].

2 Architecture and operation

2.1 Agent execution

An assignment starts when the controller accepts input for an agent and associates it with a run, an identified period of assigned work. CAP’s own agent implementation sends application instructions, the current conversation, and tool definitions to the configured language model. The model returns text and any requested tool calls. CAP saves the completed response, executes its tool calls, records each result or error, and includes those results in the next model request. A response with no tool calls ends the ordinary execution loop. Cancellation, errors, scheduled sleep, and budgets provide other stopping conditions [4, 5].

CAP’s file tools read and change workspace contents. Bash commands can build software, test a change, retrieve a source, or run a program the agent wrote. Browser tools control Chromium, and agent and coordination tools create collaborators and exchange information. Each tool has an argument schema and an implementation that returns a result or an error. Completed model responses enter the journal before tool execution, and each tool’s intent and result have separate records for recovery [4, 5].

This native agent loop runs in the controller. Tools that act inside a private container execute through a worker in that environment. CAP can also manage Pi, Codex CLI, and Claude Code as external agent backends. Those programs run their own model-and-tool loops, while CAP retains input, run outcomes, lifecycle controls, and the accounting their adapters provide. The selected backend determines which operations for input delivery, settings, and conversation management are available [4, 6].

2.2 Controllers, sessions, and runs

CAP assigns separate identities and records to agents, runs, and managed processes (Table 1). An agent can receive successive assignments while preserving its identity and session. At most one run executes for that agent at a time, while different agents run concurrently. A managed process can keep running between tool calls and while its agent is idle [5].

Object	Meaning in CAP
Controller	A CAP process that manages agents, retained records, execution capacity, and local or peer APIs.
Agent and session	An agent has an identity, conversation, input queue, settings, and usage. Its session retains those records across runs and reopening.
Run	An identified period of assigned work, with retained input associations and a completed, failed, or cancelled outcome. One agent executes at most one run at a time.
Wake	Retained scheduled input with an ID, message, and due time. Delivery queues the message to resume the agent’s work within its execution limits. Reopening restores pending delivery.
Managed process	A command supervised by CAP, with retained output and lifecycle records. It can continue while its owning agent is idle.
World	The filesystem, installed tools, process limits, and network environment selected for execution. A child can share a world or receive a private Podman container.

Table 1: CAP runtime objects and their retained state.

2.3 Programs and execution environments

A controller exposes shared operations to command-line callers, native model tools, agent-written programs, and remote peers (Figure 1). Programs call `capctl`, which sends requests through a controller Unix socket. A token identifies the program’s owning agent, and its calls consume that agent’s tool allowance and enter its journal. A program can therefore create and inspect agents, exchange ACE objects, supervise commands, and read observation records using the same operations available to agents [4, 5].

Each agent has a workspace for files and an execution environment called a world. A world determines its filesystem access, installed tools, ports, network access, and process limits. At creation, an agent can use its parent’s world or receive a private Podman container. A private world has a writable workspace and retained installations. Other worlds’ mounted workspaces are read-only. Agents sharing a world share its permissions and resources, so an application assigns file ownership when they edit together [4, 5].

The supplied launcher runs the controller in a rootless Podman container and can create separate containers for private agent worlds. Direct host execution is also supported. With the launcher, the configured host data directory retains session journals and workspaces after the controller stops. Reopening a retained world restores access to its files and installed tools. A managed process has separate start, inspection, signal, wait, and stop operations, with optional restart policies and retained output [6, 5].

The peer HTTP listener exposes agent operations, ACE coordination, observation records, and workspace downloads. A remote creation request selects the destination controller, which supplies credentials, execution resources, and retained state. The peer listener assumes trusted network callers: it accepts an asserted ACE identity and applies the target’s access rules. Network access to this listener therefore carries authority over the exposed operations [4, 6].

The browser interface lets a user inspect conversations, submit input, stop work, and reopen saved agents. Workspace HTML currently shares that interface’s origin. A Chromium probe demonstrated that an HTML artifact could read the agent list through the operator API. Separating artifact content from operator authority remains an open security issue [2].

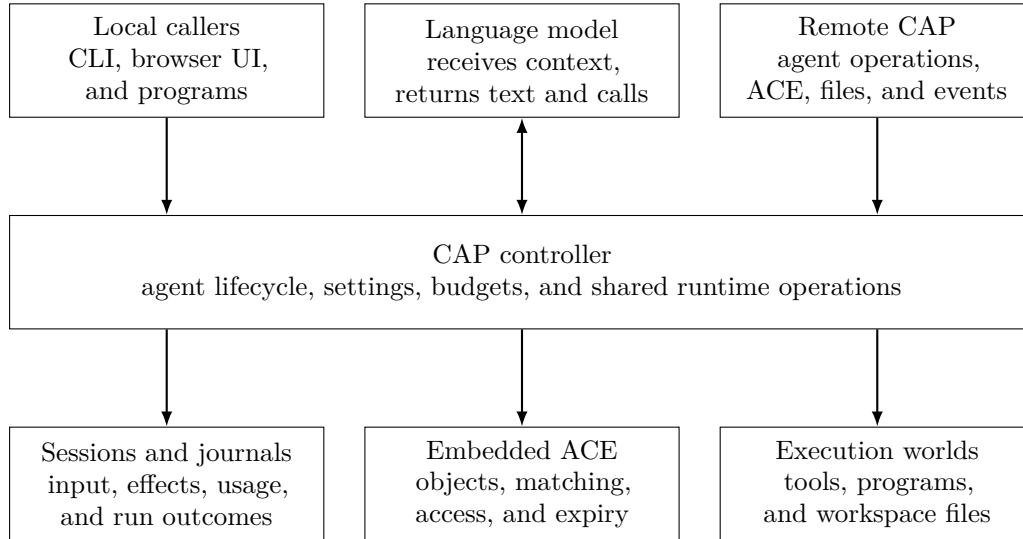


Figure 1: A controller running native CAP agents. It sends context and tool definitions to a language model, executes returned tool calls, and retains the results. Local callers use the CLI, browser UI, or program API. Other controllers use peer HTTP operations.

2.4 Agent creation and coordination

An agent creates a collaborator by supplying an assignment, settings, and an execution environment to the agent-creation operation. The request can select the local controller or a remote one. Creation returns references to the child and its initial run, allowing the caller to continue its own work, inspect progress, or wait for that run’s outcome. Application instructions specify roles and expected results. CAP records ownership and delegates’ authority to manage each agent [4, 5].

Agents coordinate through ACE, a shared-object library embedded through its Go API [17]. The name Communicating Agent Processes refers to Hoare’s *Communicating Sequential Processes* [1]. Each controller has one ACE shared-object store, and each agent has a stable caller identity. `ace_out` publishes a JSON object. `ace_rd` reads a matching object while retaining it. `ace_in` atomically takes a matching object and removes it. Matching, access rules, expiry, and cancellable waits follow ACE’s semantics. Each operation can select a local store or a remote controller [5].

CAP’s configured object-size limits favor short coordination records. A producer first writes a substantial report or data file, then publishes its location and identifying metadata. Taking the notice preserves the file. A remote file URL also supplies an access path when a local filesystem path has no meaning to the recipient. Applications choose message schemas, artifact versions, and duplicate-handling rules [4, 5].

A lost response to a remote publication or take can leave its outcome unknown. Automatic ACE input reception can lose a message if the controller stops after removing it from ACE and before appending it to the receiving input journal. For a completion monitor needing a retained retry receipt, the watch example uses saved outgoing content and an explicit input ID with `agent_send`. Its receipt establishes accepted delivery. A parent still has to inspect and use the result [4, 9].

2.5 Input, results, and recovery

CAP retains accepted input and its run association before acknowledgment. A caller can retry a saved input ID with the same content and delivery mode to retrieve the original receipt. Steering is input addressed to work already in progress. CAP delivers it at the backend’s input boundary. Queued input receives a separate run association for later execution. Native agents finish the current tool batch before consuming steering. These boundaries make input acceptance and model attention distinct events [4, 5].

On reopening, CAP reconstructs input, context, settings, usage, and wakes from retained records. An interrupted external effect can remain uncertain and require acknowledgment after inspection. Recorded effects and unknown outcomes therefore survive recovery with different meanings [4].

A result reference includes the controller, agent ID, and run ID. Selecting the run preserves the meaning of a result after the same agent accepts later work or unloads. An agent is idle when it has no active execution, including while a run sleeps or remains interrupted. Waiting for idle can therefore return before the run completes. Waiting for a selected run addresses its terminal outcome. Cancelling a wait leaves the work running. An explicit stop targets the execution [5].

A process restart policy can restore unfinished supervision when its owning agent reopens. The restarted command reconstructs its application state from files or other retained storage. Ownership transfer changes which identity can manage an agent while preserving its usage, workspace, and retained work. The current owner can delegate lifecycle controls. A successor’s management authority and the publisher’s choice of review inputs remain separate application concerns [4, 5, 11].

2.6 Context and retained history

An agent’s context is the conversation material supplied to its next model request. CAP retains the complete journal separately, allowing the active context to be shortened while the execution history remains available for inspection. Application instructions persist outside editable context and pass to children at creation. Native sessions support inspection, explicit context replacement, forks, and compaction. A fork copies the selected context into a new identity with fresh usage accounting and a separate assignment. Its environment and file ownership follow ordinary creation rules [4, 5].

Context compaction replaces older conversation material with a shorter representation. CAP’s classic method follows the Pi coding agent’s use of a summary and recent history. CAP summarizes older history using a labeled transcript and keeps a suffix of complete exchanges. A cut inside a user turn can require separate summaries of earlier history and the turn prefix. Agent-configured executable hooks can supply a validated replacement or select the configured algorithm. Summary quality, retained size, and time spent producing it affect whether an agent completes its remaining work [5, 18].

The default size trigger counts serialized conversation bytes. The optional token-configured trigger estimates tokens from bytes and includes instructions and tool definitions. Encrypted items and images complicate that estimate. Experimental provider compaction has a separate availability limit: the recorded subscription tests returned HTTP 404, including the September 14 recheck. CAP then exercised classic fallback. The public OpenAI compaction API describes supported request forms and returned replacement context, while the CAP tests establish the behavior of the subscription endpoint used in those runs [18, 8, 30].

2.7 Budgets and capacity

Native agent budgets can bound lifetime, input tokens, output tokens, tool calls, model attempts, and allocated child creation. Usage persists across runs, context changes, and reopening. Token accounting uses provider reports. An in-flight request can exceed its allowance, and an interrupted request can leave its usage unknown. With a token limit, unknown usage blocks further model calls until the recovery policy permits continuation. Reported totals retain the uncertainty [5].

The optional child-creation pool allocates a cumulative allowance. Creating a child consumes one slot plus the pool assigned to that child. For example, ten available slots permit one child with four delegated slots and leave five slots with the parent. The creation record retains the reservation before dispatch. Retries reuse it, and failures or deletion retain the expenditure. A remote destination accounts for the child’s allocation locally. Budget replacement can change these allowances, so the pool is a cooperative task limit [5].

Controller limits separately govern resources such as simultaneous model requests, tools, processes, and retained storage. Waiting releases model-request capacity. Unloading an idle agent releases live resources while preserving its session. These controls permit many saved assignments to use fewer active execution slots. Their value at the proposed network scale requires workload measurements [4, 12].

2.8 Human communication

Agents use the browser inbox to ask a user a question or send a report while work continues. The agent publishes an ACE object addressed to a user ID. The browser inbox retains messages and reply state in IndexedDB, keyed by controller instance and user. A question has a stable message ID. Its reply has a stable reply ID and reaches the agent through ACE steering. The selected inbox retries saved replies while a CAP page remains open, until acknowledgment or an explicit pause. Reopening the same inbox resumes pending retries. The agent records the reply before acknowledging it and handles duplicate delivery by reply ID. Reports need no answer [5, 6].

An agent can continue independent work while waiting for an answer. The controller exposes ACE over its peer HTTP listener, and agent-written programs use the same operations through `capctl`. These interfaces permit an agent, child, or supervised program to report progress or request a decision without requiring the user to follow a particular agent’s active run. The application chooses the user ID, message content, reply destination, and handling of unanswered questions [5].

2.9 Observation and intervention

CAP exposes retained execution evidence and authorized controls to an observing CAP through the target’s peer API. Native tools and agent-written programs using `capctl` call the same operations. `debug_info` describes controller identity, authority, operations, and coverage. Agent discovery and `debug_sources` identify loaded or saved agents and their available records. Controller lifecycle events reveal later children. Each agent’s evidence can include its journal, execution log, managed-process history, worker log, and optional syscall trace. Workspace downloads supply selected artifacts [14, 5, 6].

`debug_read` returns complete JSON records with a cursor for one controller and source. The cursor records a byte position and the preceding record’s hash, which the reader checks before continuing. It survives restart and unloading while the source remains intact. Reads report incomplete tails and

reject changed boundaries or missing sources. Filtering can return an empty page while advancing the cursor. Each source preserves its own order. Controller, agent, run, input, call, process, and ACE object identities link related evidence where the producer records them. Timestamps alone establish no causal order across sources [14, 5].

The API reports coverage and durability by producer. Session and lifecycle journals synchronize writes before acknowledgment, while execution logs use ordinary file writes. Native read, write, and edit events record paths, operation outcomes, and errors. Complete internal ACE transitions, repository and retrieval-service event feeds, and historical file contents require further instrumentation. An observer needing an independent archive copies the records and artifacts it uses because deletion can remove target sources. Debug-read audits retain request metadata and errors without duplicating returned history in the target's system journal. The observer's own program and tool calls retain their ordinary result records and accounting [14, 6].

`debug_control` stops a selected agent, cancels a selected run, or stops a managed process and disables its restart policy. The target's own identity, owner, or delegate supplies authority. Interventions record attributed intent and returned results. An interrupted request can leave an intent with no returned result. Agent stop and run cancellation can return before execution settles, so status or wait operations establish the outcome. Descendants and other managed processes require separate requests. Delegation grants broader lifecycle and settings authority, including deletion, and the peer listener trusts the caller's asserted ACE identity. The surrounding network and the observer's instructions therefore determine who can request and exercise these powers. Pause, step, and conditional execution stops remain proposed capabilities [14, 5, 6].

Optional Linux `strace` collection follows a native agent's newly launched Bash commands and managed processes, including descendants and executable tools. Each new agent starts with tracing disabled. Configuration selects file-related syscall classes or all syscalls, string capture, a per-launch retained-byte limit, and either interruption or continued execution with trace truncation at the limit. JSON envelopes preserve syscall text, available execution identities, collector lifecycle events, and omitted-record counts. The optional container image supplies the executable, and `debug_trace_status` reports configuration and installation. The collector runs in a separate process group so signals sent to the command do not also terminate it [14, 6].

Tracing changes execution timing and can retain paths or content. Its coverage is limited to the configured launches. Browser and external-backend activity outside those commands, native file-tool syscalls, memory-mapped store contents, and historical file versions remain outside this collector's coverage. Controlled tests cover cancellation, command signals, descendants in separate sessions, stop and truncation limits, restart, and remote retained reads. Broader workload measurements and structured syscall reconstruction remain open [14, 6].

3 Intended scenarios

3.1 Coding and repository work

A coding assignment begins with a repository, a requested change, and applicable instructions. An agent reads the project, edits files, executes builds or tests, and retains the resulting artifacts and command output. A parent can assign a bounded investigation or implementation to another agent, specify ownership of files, and request a review before incorporating the result. Separate workspaces or Git worktrees provide application-selected separation when participants edit concurrently [5, 6].

CAP includes a repository service for Git transport, issues, pull requests, reviews, and collaborator permissions through a supported subset of GitHub APIs usable by the ordinary `gh` CLI. Recursive groups express shared access. Agents can use those facilities to propose a tool revision, review an exact commit, and retain the decision. Acceptance of a code change depends on the task’s tests and review evidence. The service retains the collaboration record [6].

3.2 Bounded collaborative research

A collaborative research assignment divides a question among agents and combines their checked results. CAP’s tungsten example asks a main agent to produce a cited supply-chain report. It creates three researchers covering mining, processing, and consumption. Each researcher writes a result file with its sources and sends the main agent a small ACE object identifying that file. The main reads the contributions, checks consequential claims, requests focused follow-up within the remaining time, and writes the completed report. The application supplies these roles and publication conventions in its prompt [10].

A mine’s announced capacity, permitted production, dispatched concentrate, a processor’s receipt, and a customer’s qualified product describe different events. A cited relationship must identify the parties, material form, time, and supporting statement. Repeated coverage of one announcement retains that common origin. Incomplete source access leaves a stated gap. The prompt reserves time for review and final output because a finished researcher and an available file still require synthesis by the main agent [10, 11].

The pattern assigns questions, retains the evidence behind each answer, and integrates checked contributions into an identified final artifact. Its success criteria include the quality of the answer, source coverage, and publication before the deadline. Execution success alone establishes that the program finished its assigned run.

3.3 Continuing situational awareness

Continuing situational awareness means maintaining a current account of events, changes, and evidence across many topics. A tungsten assignment might follow a mine, converter, customer, transport route, or regulator. An agent-written collector checks sources on a schedule and retains responses. A detected change can trigger a bounded investigation into quantities, affected products, alternative capacity, or dependent customers. The resulting assessment links its conclusions to observations and records questions that require further work [7].

An observation needs source identity, retrieval time, retained content, and an identity distinct from its content hash. A source can return old bytes after an intervening correction, so the new retrieval remains a new observation. Event time and publication time require separate fields when known. Retrieval failure, unchanged content, a maintenance page, and an overdue check have different meanings for coverage. Historical retrieval can supply evidence for a gap. An unsuccessful archive query leaves the gap unresolved [7, 8].

Collection, review, and publication require separate progress records. The collector records which observations it obtained. The reviewer names the observations it examined and the questions it left open. The publisher identifies the reviewed evidence incorporated in a particular assessment revision. An entry document identifies the current assessment revision and links to its evidence, methods, responsibility records, and unfinished work. A processor-level assessment can contribute to

regional and supply-chain assessments, with each broader conclusion retaining its supporting links. This arrangement exposes a current collector feeding a delayed review or a stale publication [7, 11].

Saved agents, loaded agents, active runs, simultaneous model requests, and containers are separate capacity measures. Routine scheduling and supervision belong near the work, with bounded calls between controllers. Assignment storage, distributed ownership, cross-host telemetry, and capacity under sustained research remain engineering questions in the proposal [7, 12].

3.4 Shared methods and continuing learning

Agents can develop collection programs, source-review procedures, executable checks, and short skills while working on an assignment. A skill is a retained procedure that another agent can read and apply. CAP installs an indexed collection beside its agent manual and permits agents to publish further procedures through files, ACE notices, and repositories. Executable tools have descriptors and entry points that another participant can inspect and run in its own environment [5].

Learning in this report means retaining and revising procedures, programs, and evidence for later use. A proposed improvement has a version, a stated reason, and a check by a consumer. The consumer may expose a defect, adapt the method to different evidence, or obtain the same result with the earlier version. That last outcome leaves the new version’s benefit uncertain. The September 18 trials exercised this distinction by preserving both procedure versions and a fresh reader’s counterexample [13].

An independent CAP controller can observe another controller’s delegation, communication, tool use, and recorded outcomes. The target supplies discovery and evidence through its peer API. The observing agent chooses its questions and analysis, retains a report and proposed procedures, and identifies the records supporting each recommendation. A later observer can read those artifacts, record which proposals it adopts, and test them against new work. The September 20 trials exercised this transfer, followed by review and incorporation of selected guidance into CAP’s installed observation skill [15, 16].

An application can keep these reports and procedures in a shared knowledge-base directory, such as `./kbs/foo/`. The container launcher exposes a selected input directory to private agent worlds for reading. Agents write proposed revisions in their retained workspaces. Agents assigned to update the shared directory can instead inherit the controller’s world and its writable mount. File ownership, revision review, and incorporation remain application choices. Reports, evidence, and proposed methods survive controller shutdown in the configured host data directory [6, 5].

Shared retrieval databases can store short findings or procedures with source and revision metadata. Retrieval supplies candidate material for inspection. A correction needs to remain discoverable alongside the superseded record and its evidence. Retirement also requires artifact transfer: deleting an agent ends its file URLs even when the workspace survives. A successor must copy, check, and republish material whose continued availability the assignment requires [5, 7].

3.5 Agent-written services

An agent can write and start a service, publish its interface, and let other agents or programs use it. Managed processes retain output and can have bounded restart policies. Examples include a source collector, a document-query service, and a program watching child-run outcomes. Service readiness, checkpoint formats, and the meaning of a successful response belong to the application. The runtime supplies execution, inspection, stopping, retained events, and access to agent operations [5, 8, 9].

4 Reference implementations

CAP uses Pi as the behavioral reference for its native agent. Reviews of other coding-agent implementations informed context management, completion delivery, and proposed collaboration experiments (Table 2). The cited revisions identify the code examined in those reviews. Comparative performance remains unmeasured [18, 25, 5].

System	Reviewed source	Relevance to CAP
Pi	71dca871bc80 [19]	Primary behavioral reference for agent execution, tools, steering, sessions, and classic compaction. Also an external backend.
Codex	c4017a87aacc [20]	Authentication and transport checks, an external backend, and comparison of provider compaction, text summaries, and fresh context windows.
Claude Code	Official documentation [21]	An external backend and documented comparison for older-tool-output removal, summaries, and persistent instructions.
OpenCode	95daf90670b7 [22]	Comparison of recent-turn retention, configurable context allowances, pruning, and summary construction.
Aider	5dc9490bb35f [23]	Comparison of history allowances, background summarization, and weak/main summarizer selection.
OpenClaw	bd2b8414cd7f [24]	Completion capture and delivery, child-assignment boundaries, and prompt-size accounting.
pi-subagents	07bd09e0f93a [26]	Selective claim auditing, activity inspection, completion monitoring, method revision, and cumulative child limits.
Cursor agent swarm	July 20, 2026 report [27]	Candidate experiments in decomposition, decision ownership, independent review, shared procedures, and model cost.

Table 2: Coding-agent implementations and coordination references examined during CAP development.

CAP adopted Pi’s separation between completed responses and tool execution, retained native sessions, steering, and a compaction method that summarizes a prefix while keeping recent exchanges. The survey also identified a sizing difference: Pi’s recent-history allowance belongs to a model-sized token budget, while CAP’s byte trigger can leave little room after retaining its tail and summary. Copying an algorithm leaves its operating thresholds and failure behavior to be examined in the receiving runtime [5, 18, 19].

The compaction survey separates four controls for CAP experiments: the trigger, recent-history allowance, summary size, and time spent summarizing. Changing a summary prompt leaves a large retained tail unchanged, while shortening the timeout changes which summaries finish. Proposed replays therefore vary one control at a time and check both retained information and completion of a subsequent assignment. The source comparison establishes available mechanisms. Their effects on CAP require those measurements [18].

OpenClaw’s reviewed source separates execution completion, captured output, and delivery. It also marks a forked child’s current assignment relative to inherited context and reports contributions to prompt size. The CAP review proposed using existing run reads and durable input to implement a completion monitor, with reporting policy selected by the application. CAP now has an adaptable watch program and bounded activity reads. A prompt-size report remains a proposal. OpenClaw’s

delivery paths have finite retry and suspension behavior, which constrains any claim of guaranteed receipt [25, 24, 9, 12].

The `pi-subagents` review informed activity reads, claim-auditing guidance, completion delivery, and allocated child-creation budgets. CAP’s claim-auditing skill cites the extension’s evidence-auditor prompt as its source. CAP expresses those techniques through general operations and short procedures. Their effect on research quality remains an empirical question, as the successful reuse trial obtained correct conclusions with both compared method versions [5, 26, 13].

Cursor’s published swarm study motivated questions about decomposition, ownership, independent reviewers, shared methods, and role-specific model costs. The cited study changed several mechanisms together. CAP’s ideas document therefore treats their individual contributions as unresolved and proposes comparisons with fixed tasks and budgets [27, 28]. Erlang’s supervision documentation supplies a separate precedent for child lifecycle management and bounded restarts. CAP uses process restart policies and has a proposed application-level takeover procedure. Policy for an unreachable owner remains open [29, 28, 12].

5 Recorded evidence and its limits

The evidence consists of controlled runtime checks and research assignments using live model requests. The controlled checks exercise operations and failure handling. The research trials examine whether agents exchange and use results, preserve evidence, and complete reports under stated limits. The accounts retain dates, settings, failures, and operator interventions. Changes in tasks, sources, and settings constrain comparisons across trials [3, 8, 15].

5.1 Runtime and communication checks

The September 19 CAP checks exercised controlled runtime and backend behavior, retained state, peer operations, Chromium chat and inbox behavior, private and inherited Podman worlds, program access through `capctl`, repository collaboration through `gh`, and retrieval-database storage. Disposable unsupported journals and databases were rejected without changing their bytes. CAP-created state supported reopening and torn-tail recovery. A repeated inference exercise failed during shutdown when ACE returned SQLite’s interrupted-transaction error instead of a context-cancellation error. That reception path remains an open reliability issue. The verification record retains the passing runs, this failure, and the exercise corrections [3].

A fresh live controller used model `gpt-6-astra` with high reasoning and Codex subscription authentication. Its parent and private child inspected installed instructions and called `capctl`. The child published a file reference through ACE, and the parent checked its contents. The browser answered the parent’s question through the inbox. The parent retained the answer, acknowledged it, checked the requested output file, and published an asynchronous report. Both agents completed, and controller shutdown stopped their private worlds. This bounded exchange verifies the implemented communication path under the recorded conditions [3].

5.2 Research continuity and publication

The September 14 case study followed two groups with four research agents each on one host, using live `gpt-6-astra` inference at high reasoning and controlled fictional tungsten sources. The agents

developed collectors and publishers, checked and merged one another’s method revisions, transferred collector management, and continued through eight controller interruptions. Checked collection records preserved the served source revisions. Main assessments became stale: one reviewer stopped after a failed request, successor findings failed to reach a main publisher, and another publication retained an obsolete completion flag [11].

Transferring control of a collector preserved collection, but the new owner’s review output required a corresponding change in publisher input. A subsequent thirty-minute assignment recovered a deliberately failed reviewer and published successor findings through another crash. Its final review arrived after publication had stopped, leaving the entry nine collection cycles behind. A handoff therefore needs evidence of completed collection, review adoption, and publication, each checked against the same assignment [11].

The original groups had six-hour limits. Their drivers recorded about six hours fifteen minutes in UTC and two hours thirty-seven minutes in monotonic elapsed time. Later observations recorded forward UTC steps while guest monotonic and boot clocks agreed. The host cause remained unverified. These records limit duration claims from those tests and require separate clocks in future sustained observations [11, 8, 12].

A later public-source group monitored tungsten-related sources, resumed through a forced crash and an orderly restart, checked predecessor methods, recovered a worker, and retired three workers after preserving their artifacts. Its final collection completed before its cutoff. Two sequential compaction requests delayed publication by about five minutes. The parent then published its fourth assessment revision and updated the entry before the closing deadline. It preserved unresolved archive gaps and reported no material supply-chain claim change within its review scope [8].

The public-source test driver recorded about 119 minutes in UTC and 100 minutes on guest monotonic and boot clocks. Reported inference usage also remained incomplete after interrupted requests. The run supports checked publication and retirement under its recorded conditions. Overnight continuity, replacement of an unreachable owner, and complete cost measurement require further evidence [8, 12].

5.3 Method reuse and outcome observation

The first September 18 method-development trial retained a source-based assessment, worker reports, method versions, and a consumer’s calculation. The parent corrected its children’s invalid model setting and resumed them without operator steering. A late compaction ran for 96 seconds before the outer deadline cancelled it. The final learning record and CLI output remained incomplete [13].

The successor trial supplied later synthetic notices, the earlier method, a larger context threshold, and earlier closing targets. Two fresh readers used different method versions. One constructed two batches with the same aggregate assay and different assays in the qualified subset, demonstrating why whole-batch composition alone could not establish the subset’s composition. The parent reran the calculation and incorporated a final audit. All three children and the parent completed in about 461 seconds. Both method versions supported the checked conclusions, leaving the revision’s necessity unproven [13].

The watcher resumed saved state after a deliberate stop and delivered three distinct inputs once each. Two watches overlapped at completion and generated different notices about that event. The group used its three allocated creation slots without changing the pool. Retained summaries report 45 model attempts, about 1.19 million input tokens including repeated context, and approximately 25,000 output tokens. No compaction occurred. Prompt, task, and context

changes prevent attributing the successful closing to one change. Broader benefits from observation and method revision remain unmeasured [13].

5.4 Cross-controller observation and method reuse

A September 20 trial completed the tungsten assignment and an independent observer’s report, preserving complete research journals and a revised observation procedure. The observer received its predecessor’s report and method proposal, chose its own collection program, and used the target’s peer API. Both controllers used `gpt-6-astra` with high reasoning and Codex subscription authentication. Researchers and the observer had private Podman worlds. The observation assignment permitted read-only inspection. Separate controlled tests exercised authority rejection, delegation, attributed interventions, process stopping, run cancellation, native file events, and cursor reuse after restart [15, 14].

The first live attempt failed during research and observation. Repeated collection across sources exhausted the observer’s 220-call allowance after about three minutes. Its collector then dereferenced a null result, and its programmed cutoff was one day late. All four research runs reached their lifetime limits during compaction. Consumption published two reports that the lead read. Processing wrote a report without publishing its location, mining sent partial findings through steering, and the lead left no final assessment or audit. Later reporting required operator-assisted recovery and larger context and time allowances. The resulting report distinguished live collection from retrospective inspection and retained a proposed collection method [15].

The first observer identified a log-filtering defect: an execution record containing both `msg:model.failed` and `kind:compaction.response` was classified by its `kind` field. Filtering for model failures missed that record. The reader now selects an execution log’s `msg` before falling back to `kind`. An executable test reproduced the failure and passed after the correction. The observer’s report describes the earlier image used for its research evidence [15].

The second trial supplied unchanged copies of the first report and method proposal. The observer chose 45-second lifecycle and journal collection, a collection-call cap, saved responses before cursor advancement, an explicit cutoff, and an early provisional report. It deferred detailed logs and artifacts until specific questions required them. The live collector used 54 calls. Independent comparison with target journals verified all 800 research records through completion, with no missing or altered copies. All three researchers wrote and published reports, and the lead read them and completed after 498 seconds. The observer completed after about sixteen minutes using 150 tool or program calls and 39 model attempts. Both assignments completed without operator steering, recovery, configuration changes, compaction, or inference retries [15].

The retained event sequence exposed partial compliance with the research procedure. Initial report writes missed their three-minute checkpoint by about 12, 25, and 57 seconds, and the lead supplied an inconsistent absolute deadline. The lead read two files before their ACE publications, then took the matching notices. Its audit and last tool call exceeded the minute-six target, although it completed within its ten-minute lifetime. These observations distinguish file creation, publication, notification consumption, recipient reading, and final completion [15].

Optional tracing supplied command-level evidence with explicit coverage limits. One trace in the first trial reached its 8-MiB retention limit and reported omitted records. All 36 traced launches in the second trial finished without reported omissions or collection errors. The observer sampled `syscall` text and used lifecycle summaries, so retained trace coverage exceeded reviewed `syscall`

coverage. It also tested a synthetic null/error response: the collector retained the failure, stopped, and left its cursor unchanged. Collector restart remained untested in these live trials [15].

The second observer retained a report, supporting evidence, and an updated method. Codex checked copied journals, downloaded-artifact hashes, delivery records, and outcomes, then incorporated selected guidance into the installed observation skill. The transfer demonstrates reuse and revision of an observer’s findings. Larger context thresholds, longer inference timeouts, increased observer allowances, changing sources, and agent choices accompanied the method changes. Their separate effects on completion and research quality remain unmeasured. The installed procedure records these limits and preserves evidence selection, call reserves, response-before-cursor ordering, and separate delivery stages [15, 16].

5.5 Compaction costs and execution capacity

Earlier monitoring tests recorded replacement contexts of 84–114 KiB under a 128-KiB trigger. Completed compactions consumed about 71% of one 45-minute parent lifetime. A different run using a 256-KiB trigger spent about 31% of its 43-minute lifetime compacting and completed more work. The tasks differed, so these observations identify context and summary costs without isolating an optimal threshold. A controlled comparison needs the same captured context, retained-tail policy, continuation task, and stopping conditions [18].

The September 9 scale test created 1,000 idle host agents, each with one managed process, and exercised concurrent waits and shutdown. A separate variant created 100 private Podman worlds. These tests used empty agent contexts and no model inference. They establish the tested lifecycle capacity on that host and implementation. Sustained model work, browser activity, evidence retention, and cross-host coordination introduce additional loads. The observed Podman network used a /24 subnet, making address allocation another requirement before larger container deployments [31].

6 Outstanding work and evaluation criteria

Publication failures, uncertain ownership, compaction costs, and observation overhead require evaluations that connect runtime behavior to completed application work (Table 3). The distributed-awareness objective also requires measurements across hosts with sustained research loads. The current agenda, source survey, and observation tests identify these remaining evaluations [12, 7, 18, 15].

The present evidence supports a runtime on which small groups can conduct research, construct shared tools, transfer management, resume retained work, and observe another controller’s execution. A later observer can reuse retained findings and revise a proposed method. Publication dependencies, costly compaction, observation overhead, incomplete usage after interruption, and clock uncertainty constrain these results. The intended distributed system requires those execution facilities to support maintained evidence and current assessments over longer periods and across hosts. Its scale and research-quality claims remain bounded by the tests reported here.

Question	Required evidence
Sustained current assessment	Collected, reviewed, and published observation IDs across long assignments, source outages, controller restarts, and final shutdown.
Ownership under network failure	A rule for an unreachable owner, followed by tests of continued old-owner execution, duplicate collection, and reconciliation.
Context cost and continuity	Replays of the same contexts with measured retention, summary latency, failed attempts, preserved corrections, and completed continuation work.
Benefit of shared methods	Fresh consumers on comparable tasks, retained method versions, independent checks, failed transfers, and unchanged outcomes.
Observation benefit and cost	Comparable tasks and budgets, evidence coverage, detected and missed errors, unnecessary interventions, collection and review costs, and tracing overhead.
Distributed capacity	Separate counts for saved and loaded agents, active runs, model requests, and worlds, with latency, storage growth, recovery, and research freshness under load.
Complete resource accounting	Reported and unknown inference usage, tool and review work, storage, and coordination overhead under fixed task and budget conditions.

Table 3: Open questions tied to measurable application outcomes.

Source and authorship record

Codex prepared this report with Jamie Stephens’s CAP project materials. CAP references link to revision 3b91c57bc128. The report describes the capabilities at that revision. Earlier trials used the revisions identified by their test accounts. The source repository is private. Historical results rely on the committed test accounts, which preserve each trial’s settings, outcomes, and interventions. The local archive preserves earlier reports and editorial decisions. Raw research journals and downloaded artifacts remain local and are excluded from the report submission and repository. Upstream links retain the source revisions examined in the earlier surveys. The Claude Code and OpenAI documentation links were checked on September 18, 2026. Separate records describe the September 19 CAP verification and September 20 controlled and live observation tests.

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