EDITH — Complete Technical Architecture Report

> **EDITH** — *Elite Digital Intelligence & Task Handler* A Chrome Extension-based AI agent with autonomous browser automation, multi-tab parallel research, and intelligent document processing.

Table of Contents

---

1. Technology Stack

1.1 Chrome Extension — Core Agent

Technology	Version	Purpose
WXT	0.20.17	Chrome extension framework (Manifest V3)
TypeScript	5.7.3	Type-safe logic across all modules

Technology	Version	Purpose
React	18.3.1	Sidepanel & New Tab UI
React DOM	18.3.1	DOM rendering for extension pages
OpenAI SDK	4.86.2	LLM API calls directly from browser context
TailwindCSS	3.4.17	Utility-first styling for extension UI
PostCSS	8.5.3	CSS processing pipeline
Chrome Debugger API	CDP	DOM automation via Chrome DevTools Protocol

Chrome Extension Permissions: `debugger` · `sidePanel` · `storage` · `tabs` · `activeTab` · `scripting` · `alarms` · `notifications` · `<all_urls>`

1.2 Document Intelligence Module

Technology	Purpose
FastAPI + Uvicorn	REST API server
Sentence-Transformers (`intfloat/e5-large-v2`)	Text embedding model
FAISS (CPU)	Vector similarity search
PyMuPDF (fitz)	PDF parsing with hyperlink extraction
python-docx	Word document parsing
python-pptx	PowerPoint parsing + embedded image OCR
OpenPyXL + Pandas	Excel/CSV parsing & analysis
Pillow + Pytesseract	OCR for images and embedded visuals
Google GenAI (`gemini-2.5-flash`)	Primary LLM for Q&A
OpenAI (`gpt-5-nano`)	Fallback LLM
LangChain + LangGraph	Interactive reasoning agent orchestration
BeautifulSoup4	Web scraping for linked documents

1.3 External AI Services

Service	Model	Role
OpenAI	`gpt-5-nano` (configurable)	Primary agent LLM — reasoning, tool-calling, intent
OpenAI	`gpt-4`	Interactive reasoning agent (Document Intelligence)
Google Gemini	`gemini-2.5-flash`	Primary LLM for document Q&A (with key rotation)

---

2. High-Level System Architecture

EDITH is composed of **two independent systems** that together form the project:

```
graph TB
    subgraph "Core Agent — Chrome Extension"
        SP["Sidepanel UI<br/>(React + TailwindCSS)"]
        NT["New Tab Page"]
        BG["Background Service Worker<br/>(Message Router + Agent
Loops)"]
        AM["Automation Layer<br/>(CDP Protocol)"]
        LLM_EXT["LLM Client<br/>(OpenAI SDK)"]
        RES["Research Orchestrator<br/>(Multi-Tab Parallel)"]
        STR["Storage Layer<br/>(chrome.storage.local)"]
        TABS["Browser Tabs<br/>(Real Chrome)"]

        SP -->|"chrome.runtime.sendMessage"| BG
        NT --> BG
        BG -->|"callLLM()"| LLM_EXT
        BG -->|"agent loop"| AM
        BG -->|"research plan"| RES
        RES -->|"parallel tabs"| AM
        AM -->|"chrome.debugger<br/>CDP commands"| TABS
        BG --> STR
    end

    subgraph "Document Intelligence — FastAPI Microservice"
```

```
        API["FastAPI Server<br/>POST /api/v1/hackrx/run"]
        DP["Document Parser<br/>(PDF/DOCX/PPTX/XLSX/IMG)"]
        EMB["Embedding Engine<br/>(e5-large-v2)"]
        FAISS["FAISS Vector Index"]
        RAG["RAG Pipeline<br/>(Gemini / OpenAI)"]
        AGENT["Interactive Agent<br/>(LangGraph + GPT-4)"]

        API --> DP --> EMB --> FAISS
        API --> RAG
        FAISS --> RAG
        RAG -->|"if interactive"| AGENT
    end

    LLM_EXT -->|"OpenAI API"| OAI["OpenAI<br/>gpt-5-nano"]

    style SP fill:#6C5CE7,color:#fff
    style BG fill:#FDCB6E,color:#000
    style AM fill:#00B894,color:#fff
    style RES fill:#74B9FF,color:#fff
    style API fill:#E17055,color:#fff
    style RAG fill:#A29BFE,color:#fff
```

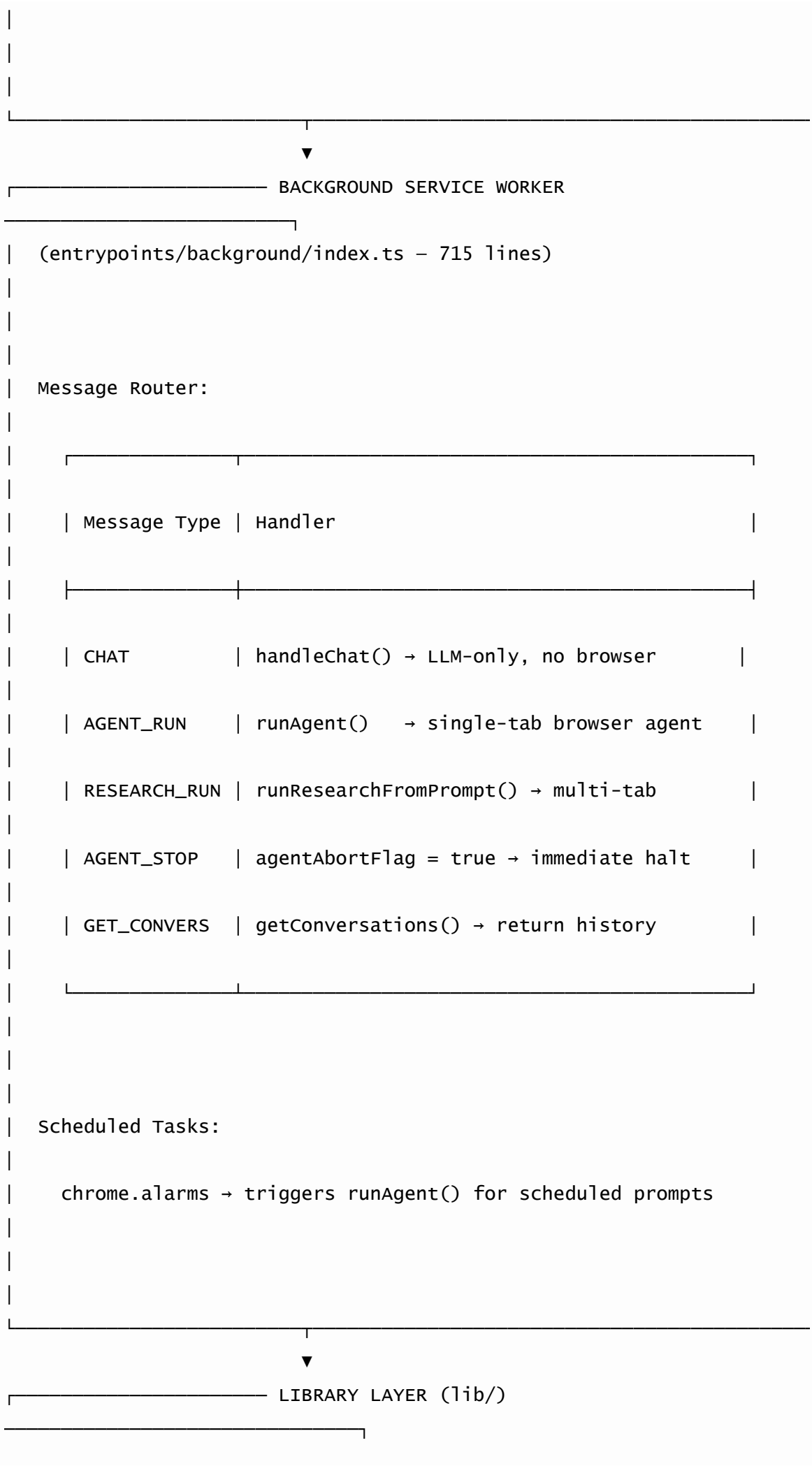
---

3. Extension Architecture — The Core Agent

The extension follows a **3-layer architecture**: UI → Background Service Worker → Automation Layer.

3.1 Layer Breakdown

```
┌──────────────────────── ENTRYPOINTS
──────────────────────────────────────────┐
|
|
|  Sidepanel (entrypoints/sidepanel/)      New Tab
(entrypoints/newtab/)  |
|  ├── main.tsx  → React mount             ├── main.tsx
|
|  └── App.tsx   → Chat UI, settings       └── index.html
|
|
|
|  ── Communicates via chrome.runtime.sendMessage() ──
```


BACKGROUND SERVICE WORKER
(entrypoints/background/index.ts — 715 lines)
Message Router:
Message Type | Handler
CHAT | handleChat() → LLM-only, no browser
AGENT_RUN | runAgent() → single-tab browser agent
RESEARCH_RUN | runResearchFromPrompt() → multi-tab
AGENT_STOP | agentAbortFlag = true → immediate halt
GET_CONVERS | getConversations() → return history
Scheduled Tasks:
chrome.alarms → triggers runAgent() for scheduled prompts
LIBRARY LAYER (lib/)

```
|
|
|  agent.ts        → System prompt, browser tool definitions, snapshot
fmt |
|  automation.ts   → CDP-based DOM automation (1186 lines)
|
|  research.ts     → Multi-tab research decompose/execute/aggregate
|
|  llm.ts          → OpenAI SDK wrapper (callLLM, message formatting)
|
|  storage.ts      → chrome.storage.local CRUD for
settings/conversations  |
|  tab_manager.ts  → Tab lifecycle: create, detach, track active tabs
|
|
|
└──────────────────────────────────────────────────────────────────────┘
```

3.2 Key Source Files & Responsibilities

File	Lines	Role
background/index.ts	715	Service worker: message routing, agent loop, research runner, alarm handler
agent.ts	398	System prompt (140 lines), `BROWSER_TOOLS` definitions (15 tools), formatSnapshot(), pruneHistory()
automation.ts	1186	CDP automation: `takeSnapshot()` (JS injection), `clickElement()`, `typeText()`, `pressKey()`, `scrollPage()`, `selectOption()`, `hoverElement()`, `setValue()`

File	Lines	Role
research.ts	523	decomposeTask(), runSubTask(), aggregateResults() — MapReduce-style parallel research
llm.ts	99	OpenAI SDK client, message format conversion, tool schema mapping
storage.ts	134	Typed CRUD for settings, conversations (100 max), MCP servers, scheduled tasks
tab_manager.ts	~100	`createTab()`, `detachAll()`, multi-tab lifecycle for research

4. Modes of Operation

Every user message enters the background service worker and is routed to one of **four execution modes**:

4.1 CHAT Mode — Simple Conversation

```
sequenceDiagram
    participant U as User (Sidepanel)
    participant BG as Background Worker
    participant LLM as OpenAI API

    U->>BG: { type: "CHAT", prompt: "Hello!" }
    BG->>BG: Load settings + conversation
    BG->>LLM: callLLM(prompt, history, tools=[])
    Note over BG,LLM: No browser tools provided<br/>Pure text
conversation
    LLM-->>BG: "Hi! I can help you browse..."
    BG->>BG: Save to chrome.storage.local
    BG-->>U: sendResponse({ ok: true })
```

Characteristics: - **No browser tools** are passed to the LLM (empty tools array) - Synchronous response — sidepanel waits for `sendResponse` - Conversation persisted to `chrome.storage.local` - Used for: greetings, questions about capabilities, general chat

---

4.2 AGENT_RUN Mode — Single-Tab Browser Automation

```
sequenceDiagram
    participant U as User (Sidepanel)
    participant BG as Background Worker
    participant LLM as OpenAI API
    participant CDP as Chrome Debugger
    participant TAB as Browser Tab

    U->>BG: { type: "AGENT_RUN", prompt: "Search Amazon for laptop" }
    BG-->>U: { ok: true } (immediate ack)
    Note over U: Sidepanel now listens<br/>for broadcastEvent()

    loop Agent Loop (max 30 steps)
        BG->>LLM: callLLM(SYSTEM_PROMPT, history, BROWSER_TOOLS)
        alt LLM returns tool_calls
            LLM-->>BG: [{ name: "open_browser", args: {url:
"amazon.com"} }]
            BG->>BG: progress("🔧 open_browser: ...")
            BG->>CDP: openBrowser("https://amazon.com")
            CDP->>TAB: chrome.debugger.attach + Page.navigate
            CDP-->>BG: tabId
            BG->>BG: sleep(1500ms)
            Note over BG: Next iteration...
        else LLM returns tool: take_snapshot
            BG->>CDP: takeSnapshot(tabId)
            CDP->>TAB: Runtime.evaluate(SNAPSHOT_JS)
            TAB-->>CDP: { url, title, elements[], rawText }
            CDP-->>BG: PageSnapshot
            BG->>BG: formatSnapshot(snapshot)
            Note over BG: Elements formatted with
UIDs<br/>Prioritized: inputs → buttons → links
        else LLM returns tool: click(uid)
            BG->>CDP: clickElement(uid, snapshot, tabId)
            CDP->>TAB: Input.dispatchMouseEvent(x, y)
            BG->>BG: sleep(1200ms)
            BG->>CDP: auto-takeSnapshot()
```

```
            Note over BG: Auto-snapshot after every action
        else LLM returns task_complete
            LLM-->>BG: { name: "task_complete", args: {summary:
"Done!"} }
            BG->>BG: Save final message
            BG->>CDP: detachDebugger(tabId)
            BG->>U: broadcastEvent({ type: "agent_done" })
            Note over BG: EXIT agent loop
        else LLM returns text (no tools)
            LLM-->>BG: "Task completed."
            BG->>U: broadcastEvent({ type: "agent_done" })
            Note over BG: EXIT agent loop
        end
    end
```

Characteristics: - **Asynchronous** — sends immediate ack, then broadcasts progress events - **Max 30 steps** per run - **15 browser tools** provided via `BROWSER_TOOLS` from agent.ts - **Auto-snapshot** after every mutating action (click, type_text, press_key, hover, select_option, set_value) - **Snapshot loop detection** — warns after 3 consecutive snapshots without action - **New tab detection** — automatically switches `activeTabId` when clicks open new tabs - **Abort support** — `agentAbortFlag` checked before each iteration and each tool execution

---

4.3 RESEARCH_RUN Mode — Multi-Tab Parallel Research

```
sequenceDiagram
    participant U as User (Sidepanel)
    participant BG as Background Worker
    participant LLM as OpenAI API
    participant TM as Tab Manager
    participant T1 as Tab 1
    participant T2 as Tab 2
    participant T3 as Tab 3

    U->>BG: { type: "RESEARCH_RUN", prompt: "Compare iPhone 16 prices"
}
    BG-->>U: { ok: true } (immediate ack)

    rect rgb(240, 248, 255)
        Note over BG,LLM: Phase 1: Task Decomposition
        BG->>LLM: decomposeTask(prompt)
        LLM-->>BG: { isResearch: true, subTasks: [<br/>  {url:
```

```
"amazon.com", goal: "iPhone 16 price"},<br/>  {url: "flipkart.com",
goal: "iPhone 16 price"},<br/>  {url: "apple.com", goal: "official
price"}<br/>] }
    end

    rect rgb(255, 248, 240)
        Note over BG,T3: Phase 2: Parallel Execution
        BG->>TM: createTab(amazon.com) → tabId1
        BG->>TM: createTab(flipkart.com) → tabId2
        BG->>TM: createTab(apple.com) → tabId3
        BG->>BG: sleep(2000ms)

        par Run all tabs simultaneously
            BG->>T1: runSubTask(settings, subTask1, tabId1)
            Note over T1: Agent loop: snapshot → type → search →
extract
        and
            BG->>T2: runSubTask(settings, subTask2, tabId2)
            Note over T2: Agent loop: snapshot → type → search →
extract
        and
            BG->>T3: runSubTask(settings, subTask3, tabId3)
            Note over T3: Agent loop: snapshot → type → search →
extract
        end
    end

    rect rgb(240, 255, 240)
        Note over BG,LLM: Phase 3: Result Aggregation
        BG->>LLM: aggregateResults(prompt, subTaskResults[])
        LLM-->>BG: "iPhone 16 prices:\n• Amazon: ₹79,900\n• Flipkart:
₹78,999\n• Apple: ₹79,900"
    end

    BG->>TM: detachAll()
    BG->>U: broadcastEvent({ type: "agent_done" })
```

Characteristics: - **MapReduce pattern** — decompose → parallel execute → synthesize - **Max 5 concurrent tabs** (configurable via `MAX_RESEARCH_TABS`) - Each sub-task tab runs its own independent agent loop with `extract_data` as the terminal tool (instead of `task_complete`) - **Minimum 2 sub-tasks** required — otherwise falls back to Agent mode - Uses `Promise.allSettled()` — partial failures don't kill the entire research - Tabs remain open after research so the user can manually review sources

4.4 AGENT_STOP Mode — Emergency Halt

```
sequenceDiagram
    participant U as User
    participant BG as Background Worker
    participant LOOP as Agent/Research Loop

    U->>BG: { type: "AGENT_STOP" }
    BG->>BG: agentAbortFlag = true
    BG-->>U: { ok: true }

    Note over LOOP: Next iteration checks flag
    LOOP->>LOOP: if (agentAbortFlag) break
    LOOP->>BG: detachDebugger()
    LOOP->>U: broadcastEvent("agent_done")
```

Characteristics: - Sets a global `agentAbortFlag` boolean - Checked at the **top of each agent iteration** and **before each tool execution** - Gracefully saves conversation state before stopping - Detaches CDP debugger to free browser resources

---

5. Data Flow

5.1 End-to-End Agent Flow

```
flowchart TD
    A["👤 User types in Sidepanel"] -->
B["chrome.runtime.sendMessage()"]
    B --> C{"Message Router<br/>(background/index.ts)"}

    C -->|"type: CHAT"| D["handleChat()"]
    C -->|"type: AGENT_RUN"| E["runAgent()"]
    C -->|"type: RESEARCH_RUN"| F["runResearchFromPrompt()"]
    C -->|"type: AGENT_STOP"| G["Set abort flag"]

    D --> H["callLLM(prompt, [], no tools)"]
    H --> I["Save response → chrome.storage"]
    I --> J["sendResponse to sidepanel"]

    E --> K["callLLM(SYSTEM_PROMPT,<br/>pruneHistory(messages),
<br/>BROWSER_TOOLS)"]
```

```
    K --> L{"LLM Response"}
    L -->|"tool_calls"| M["Execute via CDP"]
    M --> N["Auto-snapshot"]
    N --> O["Append result to history"]
    O --> K
    L -->|"task_complete"| P["Save + broadcast done"]
    L -->|"text only"| P

    F --> Q["decomposeTask(prompt)"]
    Q --> R["tabManager.createTab() × N"]
    R --> S["Promise.allSettled(<br/>runSubTask per tab)"]
    S --> T["aggregateResults(results)"]
    T --> P

    style C fill:#FDCB6E,color:#000
    style M fill:#00B894,color:#fff
    style K fill:#6C5CE7,color:#fff
    style Q fill:#74B9FF,color:#fff
```

5.2 Snapshot Lifecycle

The snapshot is the **central data structure** that bridges the LLM and the browser:

```
flowchart LR
    A["Chrome Tab<br/>(real webpage)"] --
>|"chrome.debugger<br/>Runtime.evaluate"| B["SNAPSHOT_JS<br/>(injected
script)"]
    B -->|"Scans DOM"| C["PageSnapshot"]
    C --> D["formatSnapshot()"]
    D --> E["Prioritized Text<br/>for LLM"]
    E -->|"Sent as tool result"| F["LLM"]
    F -->|"Returns: click(uid: 42)"| G["clickElement(42, snapshot)"]
    G -->|"Lookup uid → x,y coords"| H["CDP:
Input.dispatchMouseEvent"]
    H --> A

    subgraph PageSnapshot
        C
        C1["url: string"]
        C2["title: string"]
        C3["elements: SnapshotElement[]"]
        C4["rawText: string (5000 chars)"]
```

```
    end

    subgraph SnapshotElement
        C3
        E1["uid: number"]
        E2["tag, role, name"]
        E3["x, y, width, height"]
        E4["context (parent section)"]
        E5["value, placeholder"]
        E6["checked, disabled, options[]"]
    end
```

Snapshot processing pipeline: 1. **Inject** `SNAPSHOT_JS` into the page via CDP `Runtime.evaluate` 2. **Scan** all DOM elements — filter by clickable tags, actionable ARIA roles, and input elements 3. **Classify** each element's type: `INPUT`, `BUTTON`, `LINK`, `CHECKBOX`, `SELECT`, `RADIO`, etc. 4. **Assign UIDs** — sequential numeric IDs based on position 5. **Extract context** — walk up to 5 parent levels for `aria-label`, id, `class` hints 6. **Prioritize** — Tier 1 (inputs) → Tier 2 (buttons/checkboxes) → Tier 3 (product cards) → Tier 4 (links) 7. **Format** as a flat text string with `uid | TYPE | "label" [in: section-context]` 8. **Append** the page's `rawText` (first 5000 chars) for context

---

6. Browser Automation Engine (CDP)

The automation layer in automation.ts uses the **Chrome DevTools Protocol** via `chrome.debugger`:

6.1 CDP Architecture

```
flowchart TD
    subgraph "Extension Process"
        A["automation.ts"]
        B["ensureAttached(tabId)"]
        C["cdp(tabId, method, params)"]
    end

    subgraph "Chrome Debugger Bridge"
        D["chrome.debugger.attach(tabId, '1.3')"]
        E["chrome.debugger.sendCommand(tabId, method, params)"]
    end

    subgraph "CDP Domains Used"
```

```
        F["Page.navigate"]
        G["Runtime.evaluate"]
        H["Input.dispatchMouseEvent"]
        I["Input.dispatchKeyEvent"]
        J["DOM.getDocument"]
        K["Page.captureScreenshot"]
        L["Network events"]
    end

    A --> B --> D
    A --> C --> E --> F & G & H & I & J & K & L
```

6.2 Key Automation Functions

Function	CDP Method	What It Does
`openBrowser(url)`	`chrome.tabs.create` + ensureAttached	Opens new tab, attaches debugger, navigates
navigateTo(url)	`Page.navigate`	In-tab navigation
`takeSnapshot()`	`Runtime.evaluate(SNAPSHOT_JS)`	Injects 300-line JS scan interactive DC elements
`clickElement(uid)`	`Input.dispatchMouseEvent`	Maps UID → (x,y) from snapshot, dispatches mouse events
`typeText(text, uid)`	`Runtime.evaluate` (focus) + `Input.dispatchKeyEvent`	Character-by-character typing wi 30-80ms delays
`pressKey(key)`	`Input.dispatchKeyEvent` (keyDown + keyUp)	Simulates Enter, Ta Escape, arrows
`scrollPage(dir)`	`Runtime.evaluate` (window.scrollBy)	Scroll up/down/top/botto
`selectOption(uid, value)`	`Runtime.evaluate`	Programmatically sets select value + fires change event
`hoverElement(uid)`	`Input.dispatchMouseEvent` (mouseMoved)	Triggers hover state for dropdown menu
`setValue(uid, value)`	`Runtime.evaluate`	Direct `.value` injection for numer

Function	CDP Method	What It Does
		fields
`takeScreenshot()`	`Page.captureScreenshot`	PNG screenshot of visible viewport
`waitForNetworkIdle()`	Network event monitoring	Waits until no pending network requests
waitForLoad()	`Page.loadEventFired`	Waits for page load completion
`detachDebugger()`	`chrome.debugger.detach`	Releases debugger from tab

6.3 Multi-Tab Support

The automation layer tracks attached tabs via `attachedTabs: Set<number>`: - Multiple debugger sessions can be active simultaneously (for research) - `lastSingleTabId` provides backward compatibility for single-tab agent runs - `detachAllDebuggers()` cleans up all sessions at once

---

7. Multi-Tab Research Orchestrator

Defined in research.ts, the research system uses a **3-phase MapReduce** architecture:

7.1 Phase 1: Task Decomposition (decomposeTask)

An LLM call analyzes the user's prompt and decides: - **Is this a research task?** (`isResearch: boolean`) - **What sub-tasks are needed?** Each with: `description`, url, `extractionGoal`

The LLM is given strict criteria for what counts as research: > Genuine research requiring **2+ different websites** — NOT simple browsing, messaging, or single-site tasks.

7.2 Phase 2: Parallel Execution (runSubTask)

Each sub-task gets: - Its own Chrome tab via `tabManager.createTab(url)` - Its own agent loop (similar to runAgent but with `extract_data` as terminal tool) - Its own LLM conversation context - An abort signal connection to the global abort flag

Sub-task tools are the same as `BROWSER_TOOLS` but with `task_complete` replaced by `extract_data` (which captures findings instead of ending the run).

7.3 Phase 3: Aggregation (aggregateResults)

An LLM call receives all extracted data and the original prompt, then synthesizes: - Key findings from each source - Differences and similarities across sources - Source citations for every data point - Tables or bullet points for comparisons

---

8. Tool Ecosystem

8.1 Browser Tools (defined in agent.ts)

Tool	Description	Auto-Snapshots?
`task_complete`	Signals task completion — **stops the agent immediately**	—
`open_browser`	Opens URL in new tab	No (manual snapshot needed)
`take_snapshot`	Gets all interactive elements with UIDs	—
`click`	Clicks element by UID	✅ Auto-snapshot after
`type_text`	Types text char-by-char into field by UID	✅ Auto-snapshot after
`press_key`	Keyboard events (Enter, Tab, Escape, etc.)	✅ Auto-snapshot after
`scroll`	Scrolls page up/down	No
screenshot	Captures visual screenshot	No
`select_option`	Selects dropdown option by value	✅ Auto-snapshot after
`hover`	Triggers hover/mouseover on element	✅ Auto-snapshot after
`set_value`	Direct value injection for inputs	✅ Auto-snapshot after
`wait_for_page_update`	Waits for AJAX/network idle	✅ Auto-snapshot after

Tool	Description	Auto-Snapshots?
navigate	In-tab URL navigation	No

8.2 Research-Only Tools

Tool	Description
`extract_data`	Terminal tool for research sub-tasks — captures extracted information

9. Document Intelligence Module

A standalone FastAPI microservice for intelligent document Q&A, located at `Document Intelligence/doc_intel/`.

9.1 Architecture

```
flowchart TD
    A["POST /api/v1/hackrx/run<br/>{documents: url, questions: [...]}"]
    B["Token Authentication<br/>(Bearer token)"]
    A --> B

    B --> C{"URL Type Detection"}
    C -->|"Has file extension"| D["download_and_parse_document()"]
    C -->|"No extension"| E["HEAD request → detect_file_type_from_response()"]
    C -->|"API/JSON"| F["handle_api_link()"]

    D --> G{"Format?"}
    G -->|PDF| H["parse_pdf()<br/>(PyMuPDF + link extraction)"]
    G -->|DOCX| I["parse_docx()"]
    G -->|PPTX| J["parse_pptx()<br/>(+ OCR for embedded images)"]
    G -->|XLSX| K["parse_excel()<br/>(Pandas → string)"]
    G -->|Image| L["parse_image()<br/>(Pytesseract OCR)"]

    H & I & J & K & L --> M["pages: string[]"]

    M --> N["expand_pages_with_linked_content()<br/>(extract URLs → fetch linked docs)"]
    N --> O["get_embeddings(pages)<br/>(e5-large-v2 model)"]
```

```
    O --> P["build_faiss_index(embeddings)"]
    P --> Q["save_to_cache()<br/>(pickle + FAISS)"]

    Q --> R["ThreadPoolExecutor<br/>(8-16 workers)"]
    R --> S["process_question() × N"]

    S --> T["FAISS search: top-15 chunks"]
    T --> U{"Contains URLs/API links?"}

    U -->|"No"| V["Standard RAG<br/>TEMPLATE.format(clauses, question)
<br/>→ Gemini 2.5 Flash"]
    U -->|"Yes"| W["Interactive Agent<br/>(LangGraph + GPT-4)"]

    V --> X["Gemini fails?"]
    X -->|"Yes"| Y["Fallback: OpenAI gpt-5-nano"]
    X -->|"No"| Z["Return answer"]
    Y --> Z
    W --> Z

    style A fill:#E17055,color:#fff
    style P fill:#00CEC9,color:#fff
    style V fill:#6C5CE7,color:#fff
    style W fill:#FDCB6E,color:#000
```

9.2 Dual-Path Processing

The system dynamically chooses between two processing paths:

Path A: Standard RAG Pipeline

For regular documents without interactive instructions: 1. Parse document → chunks 2. Embed with `e5-large-v2` → FAISS index 3. For each question: semantic search → top-15 chunks → LLM prompt 4. Gemini 2.5 Flash (primary) → OpenAI (fallback)

Path B: Interactive Reasoning Agent

For documents containing URLs, API endpoints, or multi-step instructions: 1. Detects that relevant chunks contain URLs/API references via `contains_api_or_url()` 2. Activates the **LangGraph ReAct agent** with two tools: - `document_retriever` — searches the loaded document via FAISS - `web_scraper_tool` — fetches data from external URLs/APIs 3. The agent reasons through multi-step instructions autonomously

9.3 Key Features

Feature	Implementation
Multi-format support	PDF, DOCX, PPTX, XLSX/XLS, JPG/PNG/GIF (OCR)
Linked document expansion	Auto-extracts URLs from document text, fetches and indexes linked content
Embedding caching	MD5-hashed filenames in `pdf_cache/` — persistent across requests
Concurrent Q&A	`ThreadPoolExecutor` with 8-16 workers for batch question processing
LLM key rotation	3 Gemini API keys cycled via `itertools.cycle()`
OneDrive/SharePoint	Auto-converts sharing URLs to direct download URLs
OCR for images in PPTX	Extracts embedded images from slides and runs Pytesseract
Prompt engineering	Domain-specific template for insurance, legal, HR documents

9.4 Document Intelligence File Structure

```
Document Intelligence/doc_intel/
├── app/
|   ├── main.py               # FastAPI app, token auth, request
logging
|   ├── document_parser.py     # parse_pdf, parse_docx, parse_pptx,
parse_excel, parse_image
|   ├── embeddings.py          # SentenceTransformer (e5-large-v2) +
FAISS index builder
|   ├── retrieval.py           # RAG pipeline, caching, linked doc
expansion, question processing
|   ├── intractive_agent.py    # LangGraph ReAct agent with
document_retriever + web_scraper tools
|   ├── prompt_template.py     # Domain-specific RAG prompt template
|   └── utils.py               # clean_response(),
contains_api_or_url()
├── pdf_cache/                  # Persistent embedding cache (pickle +
FAISS)
├── requirements.txt            # 23 Python dependencies
```

```
├── Dockerfile                  # Docker containerization support
└── .env                        # Gemini keys (×3), OpenAI key, Groq
key
```

---

10. Storage & State Management

10.1 Extension Storage (`chrome.storage.local`)

```
graph LR
    subgraph "chrome.storage.local"
        A["edith_api_key<br/>(OpenAI API key)"]
        B["edith_api_base_url<br/>(default: api.openai.com/v1)"]
        C["edith_model<br/>(default: gpt-4o-mini)"]
        D["edith_conversations<br/>(last 100 conversations)"]
        E["edith_mcp_servers<br/>(MCP server configs)"]
        F["edith_schedules<br/>(scheduled tasks)"]
    end
```

10.2 Data Structures

```
interface Conversation {
    id: string;           // UUID
    title: string;        // First 60 chars of prompt
    messages: Message[];  // Full message history
    createdAt: number;
    updatedAt: number;
}

interface Message {
    id: string;
    role: 'user' | 'assistant' | 'tool';
    content: string;
    toolCalls?: ToolCall[];   // For assistant messages with tool
        calls
    toolCallId?: string;      // For tool response messages
    toolName?: string;
    timestamp: number;
}

interface ScheduledTask {
    id: string;
    name: string;
```

```
    prompt: string;           // Agent prompt to execute
    cronExpression: string;
    enabled: boolean;
    lastRun?: number;
}
```

10.3 Document Intelligence Caching

- **In-memory cache**: `pdf_cache` dict (keyed by document URL)
- **Persistent cache**: `pdf_cache/` directory with pickled pages + embeddings
- **Cache key**: MD5 hash of the document URL
- **FAISS index**: Rebuilt from cached embeddings on load (fast)

---

11. LLM Integration

11.1 Extension LLM Client

The extension calls OpenAI-compatible APIs directly from the browser via the **OpenAI SDK**:

```
const client = new OpenAI({
    apiKey: settings.apiKey,
    baseURL: settings.apiBaseUrl,       // User-configurable
    dangerouslyAllowBrowser: true,      // Required for extension
        context
});

const response = await client.chat.completions.create({
    model: settings.model,              // User-configurable (default:
        gpt-4o-mini)
    messages: [system, ...history],
    tools: browserTools,
    tool_choice: 'auto',
    max_completion_tokens: 4096,
});
```

11.2 System Prompt Architecture

The `SYSTEM_PROMPT` in `agent.ts` (140 lines) contains: - **Workflow instructions**: open → snapshot → interact → verify → complete - **Snapshot reading guide**: How to interpret UIDs, types, and section context - **Site-specific intelligence**: YouTube, WhatsApp, Gmail, Amazon, e-commerce

patterns - **Forbidden actions**: Never re-open sites, never click navigation links when searching - **Completion criteria**: URL-based verification for each task type

11.3 Conversation History Pruning

`pruneHistory()` keeps only the **last 6 tool exchange rounds** to manage token costs: - User/assistant text messages are always kept - Only the most recent tool call/response pairs are retained

11.4 Document Intelligence LLM Strategy

```
Question → FAISS top-15 chunks → prompt template

Primary: Gemini 2.5 Flash (3 API keys rotated)
    ↓ on failure
Fallback: OpenAI gpt-5-nano
    ↓ on failure
Return: "Unable to process this query"

If interactive (URLs/APIs detected):
    → LangGraph Agent with OpenAI GPT-4
```

---

12. Project File Structure

```
EDITH - Final yr project/
|
├── EDITH-main/EDITH-main/
|   └── extension/                          ★ CORE AGENT
|       ├── wxt.config.ts                   # Manifest V3 config +
permissions
|       ├── package.json                    # Dependencies (OpenAI,
React, WXT, TS)
|       ├── tsconfig.json                   # TypeScript configuration
|       ├── tailwind.config.js              # TailwindCSS theme
|       ├── postcss.config.js               # PostCSS plugins
|       ├── entrypoints/
|       |   ├── background/
|       |   |   └── index.ts                # ★ Service worker (715
lines)
|       |   |                               #   Message router, agent
loop,
```

```
|       |   |                              #   research runner, alarm
handler
|       |   ├── sidepanel/
|       |   |   ├── main.tsx               # React mount
|       |   |   ├── App.tsx                # Chat UI + settings
|       |   |   └── index.html
|       |   └── newtab/
|       |       ├── main.tsx               # New tab page
|       |       └── index.html
|       ├── lib/
|       |   ├── agent.ts                   # ★ System prompt (140
lines) +
|       |   |                              #   BROWSER_TOOLS
definitions +
|       |   |                              #   formatSnapshot() +
pruneHistory()
|       |   ├── automation.ts              # ★ CDP automation (1186
lines)
|       |   |                              #   Snapshot JS, click,
type, scroll,
|       |   |                              #   hover, select, multi-
tab attach
|       |   ├── research.ts                # ★ Research orchestrator
(523 lines)
|       |   |                              #   decomposeTask,
runSubTask,
|       |   |                              #   aggregateResults
|       |   ├── llm.ts                     # OpenAI SDK wrapper (99
lines)
|       |   ├── storage.ts                 # chrome.storage CRUD (134
lines)
|       |   └── tab_manager.ts             # Multi-tab lifecycle
(~100 lines)
|       └── assets/
|           └── global.css
|
└── Document Intelligence/
    └── doc_intel/                         ★ DOCUMENT Q&A MODULE
        ├── app/
        |   ├── main.py                    # FastAPI app + auth
middleware
        |   ├── document_parser.py         # PDF/DOCX/PPTX/XLSX/Image
parsers
```

```
        |   ├── embeddings.py              # e5-large-v2 + FAISS
builder
        |   ├── retrieval.py               # RAG pipeline + caching +
linked docs
        |   ├── intractive_agent.py        # LangGraph ReAct agent
        |   ├── prompt_template.py         # Domain-specific prompt
template
        |   └── utils.py                   # Utilities
        ├── pdf_cache/                     # Persistent embedding
cache
        ├── requirements.txt               # 23 dependencies
        ├── Dockerfile                     # Docker support
        └── .env                           # API keys (Gemini ×3,
OpenAI, Groq)
```

---

13. Security Architecture

Layer	Mechanism	Details
Extension Permissions	Manifest V3	Scoped: `debugger`, `sidePanel`, `storage`, `tabs`, `scripting`, `alarms`
API Key Storage	`chrome.storage.local`	User's OpenAI key stored locally, never transmitted to any server except OpenAI
LLM Calls	Direct browser → OpenAI	No intermediary — extension calls API directly with `dangerouslyAllowBrowser: true`
Agent Safety	Abort flag	User can immediately stop any running agent via `AGENT_STOP`
Snapshot Loop Prevention	Counter + warning	Detects 3+ consecutive snapshots without action
New Tab Tracking	`activeTabId` switch	Automatically follows cross-tab navigation
CDP Cleanup	`finally` block	`detachDebugger()` always called, even on errors

Layer	Mechanism	Details
Doc Intel Auth	Bearer token	Static token validation on all API requests
Gemini Key Rotation	`itertools.cycle()`	3 keys rotated to avoid rate limits
Conversation Limits	100 max conversations	Prevents unbounded storage growth
History Pruning	Last 6 tool rounds	Prevents token overflow on long agent runs

---

> **Report generated from exhaustive source code analysis of every file in the extension and Document Intelligence modules.** All architecture diagrams and data flows are derived directly from the actual implementation.