Introduction to MCP

Brandon Walton

Who are you?

I'm Brandon Walton!

Where are you from?

Tuscaloosa, Alabama

College Education

Louisiana State University – BS in Computer Science, May 2025

What do you do?

Machine Learning Software Developer ~ *LSU*

70%: Leading the development of MikeGPT.

30%: Conducting Cyber Security Research w/ LLMs

Who is this guy?

What is your research?

Enhancing Malware Analysis with LLMs

Publications:
- *"Exploring Large Language Models for Semantic Analysis and Categorization of Android Malware"*, Annual Computer Science Applications Conference, ACSAC (Hawaii!) https://arxiv.org/abs/2501.04848

Fun Facts!

I'm a 5th degree black belt in Taekwondo at Tiger Rock Martial Arts.

I was the Sousaphone (Tuba) section leader in Tiger Band during the 2024-2025 season

What is the MCP?

(You’re not alone)

r/mcp • 3mo ago
Jaydgaitin

Can someone explain to me what an MCP is?

r/devsecops · 5mo ago

what is an MCP and why should I care

r/ClaudeAI • 1y ago
[deleted]

I don't understand what MCP does, and at this point i'm too afraid to ask

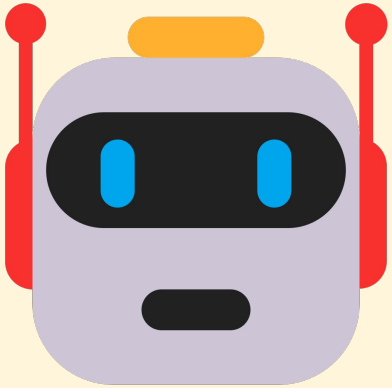
r/programming • 7mo ago
Party-Tower-5475

What the heck is MCP? And why is everybody talking about it?

r/LangChain • 6mo ago
teenfoilhat

Why is MCP so hard to understand?

Model Context Protocol (MCP)



Model

The specific LLM used in the main application.

Examples: OpenAI model, Llama model, Gemini model, etc.

Context

Any additional information the LLM uses to understand or perform tasks.

Examples: documents, summaries, notes, or other supplemental materials.

Protocol

Standard rules that define how the client, server, and data sources send and receive information.

Other Protocols: HTTPS, REST, TCP

What is the MCP?

- **MCP**: Model Context Protocol
- An open-source standard protocol for connecting AI applications to external systems.
- USB-C port for AI applications.

What can the MCP do?

- Connect to data sources, tools, and workflows, which allow LLMs to perform actions and gather needed information.
- ***Examples:*** Local Files, Databases, Search Engines (Google), APIs, etc.

Why do we need the MCP?

- **Standardization:** Provides a common framework for AI applications to connect to tools and data sources consistently.
- You can choose not to use MCP; however, any future integrations will require a **manual** solution.

MCP Host

The main AI application that manages one or more MCP clients.

MCP Client

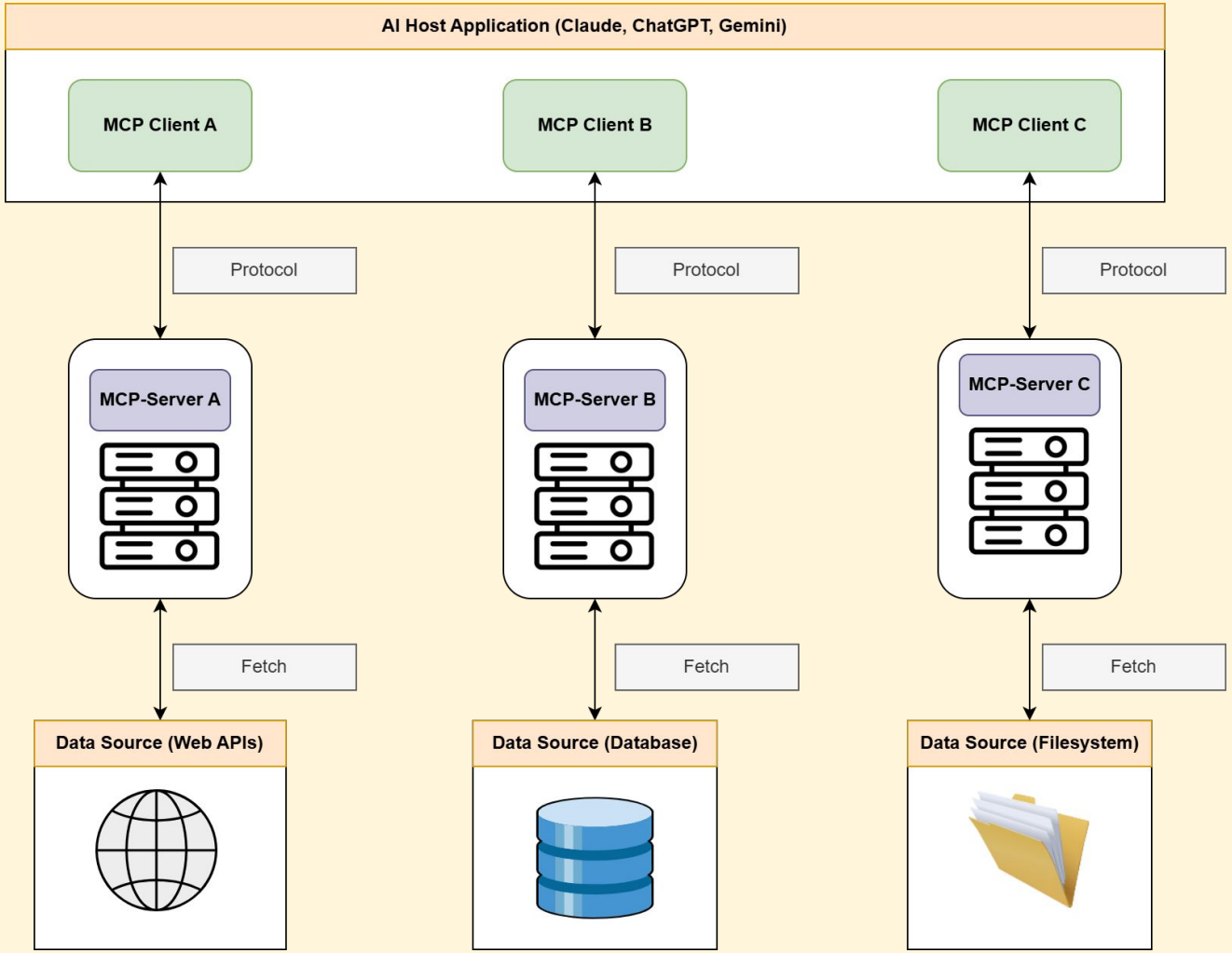
Maintains a connection to the MCP server and retrieves information for the host.

MCP Server

A server that provides data, tools, and capabilities to the MCP Client.

Data Source

The system that stores information for the server to access and pass to the client.



MCP Primitives

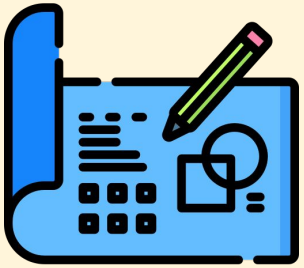
- Most important concept within the MCP
- Define what clients and servers offer each other
- Three core primmativies: Tools, Resources, and Prompts

Tools

Executable functions that AI applications can invoke to perform actions **(Perform)**

Resources

Data sources that provide contextual information to AI Applications **(Provide)**



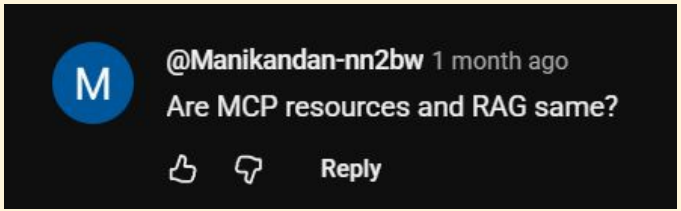
Prompts

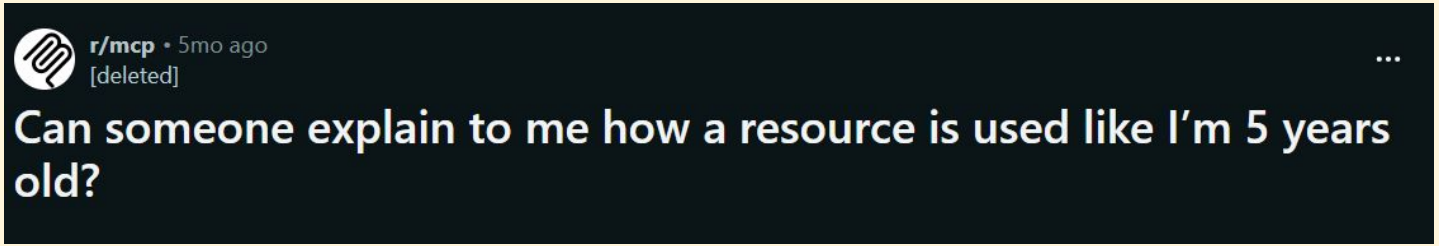
Reusable templates that help structure interactions with language models **(Plan)**

Prim. Type	Purpose?	When to Use?	Notes
Tools	Perform	Use when the LLM needs to **act** or **compute** something outside its internal knowledge (e.g., call APIs, perform calculations, generate images).	The LLM can **automatically** decide which tool to use for a user's query, determine the appropriate inputs, and execute the tool.
Resources	Provide	Use when the LLM needs **additional context** or factual information that isn't included in the base model.	Designed to be **application-driven**, with users or the app deciding how to provide and use the context.
Prompt	Plan	Use prompts to **shape** the model's reasoning, and **guide** its response style.	—

What about RAG?

MCP Tools vs Resources: When does data retrieval become a “tool” operation?





Tools

Executable functions that AI applications can invoke to perform actions **(Perform)**

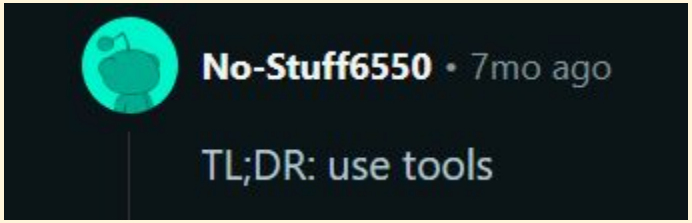
Resources

Data sources that provide contextual information to AI Applications **(Provide)**

Prim. Type	Control	Execute?	Retrieve?	Defined By?
Tools	Model	Yes	Yes	MCP-Provider
Resources	Application	No	Yes	Application

TLDR: Use Tools!

(you'll be using tools 99% percent of the time)



Tool Execution

Tool Structure

1. MCP uses **JSON-RPC 2.0** (JavaScript Object Notation Remote Procedure Call)
    a. A lightweight, standardized protocol that executes functions on a server via JSON.
2. Each Tool has the following
    a. ***Name***: Unique identifier
    b. ***Description***: What it does (Usually is provided to the LLM)
    c. ***Parameters*** *(Input Schema)*: The input it accepts
    d. ***Response*** *(Output Schema)*: The result/output

User Interaction Model

1. LLM can **discover** and **automatically** invoke tools based on the user's prompts and contextual understanding
2. Applications Should:
    a. Provide UI that makes clear which tools are being **exposed** to the LLM
    b. Display clear **visual indicators** when tools are invoked
    c. Present **confirmation prompts** to the user for operations (Human in the loop)

Tool Structure

```
{
  "name": "get_weather_data",
  "title": "Weather Data Retriever",
  "description": "Get current weather data for a location",
  "inputSchema": {
    "type": "object",
    "properties": {
      "location": {
        "type": "string",
        "description": "City name or zip code"
      }
    },
    "required": ["location"]
  },
  "outputSchema": {
    "type": "object",
    "properties": {
      "temperature": {
        "type": "number",
        "description": "Temperature in celsius"
      },
      "conditions": {
        "type": "string",
        "description": "Weather conditions description"
      },
      "humidity": {
        "type": "number",
        "description": "Humidity percentage"
      }
    },
    "required": ["temperature", "conditions", "humidity"]
  }
}
```

Tool Request

```
{
  "jsonrpc": "2.0",
  "id": 2,
  "method": "tools/call",
  "params": {
    "name": "get_weather",
    "arguments": {
      "location": "New York"
    }
  }
}
```

Tool Response

```
{
  "jsonrpc": "2.0",
  "id": 5,
  "result": {
    "content": [
      {
        "type": "text",
        "text": "{\"temperature\": 22.5, \"conditions\": \"Partly cloudy\", \"humidi
      }
    ],
    "structuredContent": {
      "temperature": 22.5,
      "conditions": "Partly cloudy",
      "humidity": 65
    }
  }
}
```

Tool Security

1. Servers **MUST**:
   a. Validate all tool inputs
   b. Implement proper access controls
   c. Rate limit tool invocations
   d. Sanitize tool outputs

2. Clients **SHOULD**:
   a. Validate tool results before passing to LLM
   b. Implement timeouts for tool calls
   c. Log tool usage for audit purposes

3. Do **NOT** trust random MCP servers:
   a. *Malicious Content*: Servers can host or serve malware, scams, or harmful files.
   b. *Prompt Injection*: Servers can include hidden/manipulative instructions in text or metadata.
   c. *Lack of Authentication*: Many unofficial MCP servers don't verify identity
   d. *Context Bloat*: Servers can overload your context window **($$$)**

Tool Selection

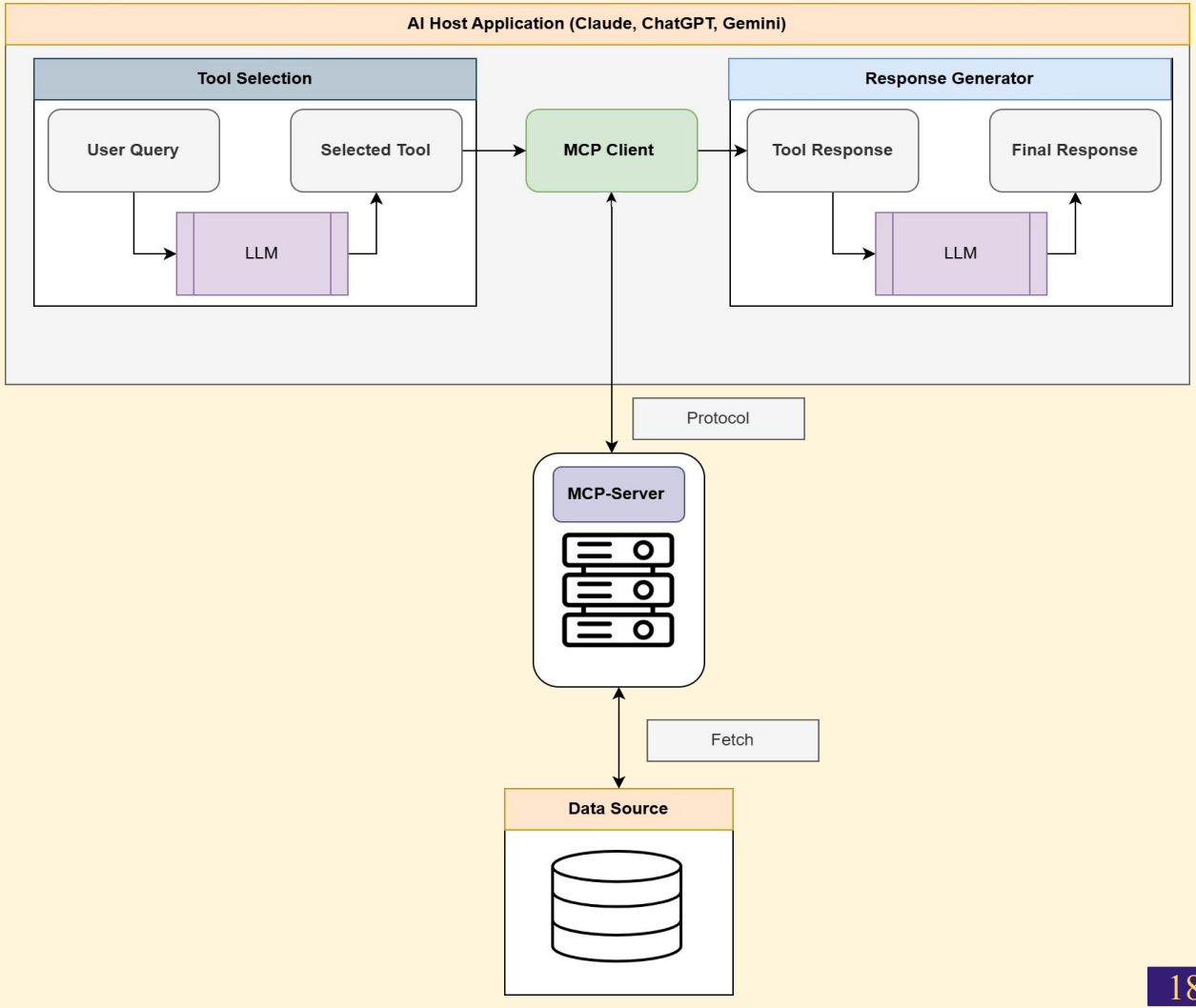
1. Select the best tool(s) for the user's query

2. Manage tools appropriately.
   - Adding more tools without strategy leads to **poor scaling**
   - Index Carefully
   - Allow for **multi-tool** execution
   - Separate tools into **synchronous** and **asynchronous** pools

Response Generator

1. Generates the final response displayed to the user.

2. Sometimes the tool response has the final answer. However, it's **highly recommend** to validate the response and then generate your own.



Code!

(Github: https://github.com/BJW101102/MCP-Template)