The A2A Protocol

Powering the Next Generation of Multi-Agent Systems

An open protocol by Google for seamless agent-to-agent communication

The Emerging Protocol Ecosystem

Three Major Protocols

- **MCP (Model Context Protocol)**
  - Developed by Anthropic
  - Standardizes how AI models connect with tools and data sources
- **A2A (Agent-to-Agent Protocol)**
  - Google's contribution
  - Enables direct communication between different AI agents
- **ACP (Agent Communication Protocol)**
  - Open source protocol under the Linux Foundation
  - Addresses agent communication between AI systems

Simple Analogy

Think of these protocols in terms of enterprise architecture patterns:

- **MCP parallels JCA or EJB:**
  Both provide standardized interfaces for accessing resources and services within a system
- **A2A resembles Enterprise Service Bus (ESB):**
  ESBs enable different services to discover, route, and communicate without direct coupling

In enterprise systems, you need both: connectors for resource access (vertical integration) and service buses for inter-service communication (horizontal integration).

The Problem: Limitations of Current Agent Communication

Before A2A, multi-agent systems faced significant challenges:

🔒 Siloed Agents

Agents operate in isolation, unaware of each other's capabilities

🚧 Communication Bottlenecks

Intermediaries required to facilitate agent interactions

📄 Message Format Restrictions

Limited support for rich content types

⏱️ Stateless Interactions

Difficulty tracking long-running tasks

🔗 Framework Lock-in

Agents built with different frameworks struggle to interact

Traditional approaches like MCP work well for tool calling within a single agent but face limitations in multi-agent architectures

Enter A2A: Key Features

🔍 Dynamic Agent Discovery

- Agents advertise capabilities through standardized AgentCards
- `.well-known/agent.json`

🔄 Direct Communication

- Agents communicate directly without intermediaries
- `agent1 → agent2`

📊 Rich Content Types

- Support for various content formats through the Part system
- `text, images, structured data`

📝 Task Management

- Built-in task lifecycle with well-defined states
- `submitted → working → completed`

📡 Streaming & Push

- Real-time updates for long-running tasks
- `WebSockets for live updates`

📦 Formalized Artifacts

- Structured output beyond simple text responses
- `documents, data, visualizations`

Key Goals of A2A

- **Interoperability**: Bridge the communication gap between different agentic systems
- **Collaboration**: Enable agents to delegate tasks and exchange context
- **Discovery**: Allow agents to find and understand capabilities of other agents
- **Flexibility**: Support various interaction modes (sync, streaming, async)
- **Security**: Facilitate secure communication suitable for enterprise environments
- **Asynchronicity**: Support long-running tasks and human-in-the-loop scenarios

Guiding Principles

Simple

- Reuse existing standards
- HTTP, JSON-RPC 2.0, Server-Sent Events

Enterprise Ready

- Addresses auth, security, privacy
- Aligns with established practices

Async First

- Designed for long-running tasks
- Supports human-in-the-loop scenarios

Modality Agnostic

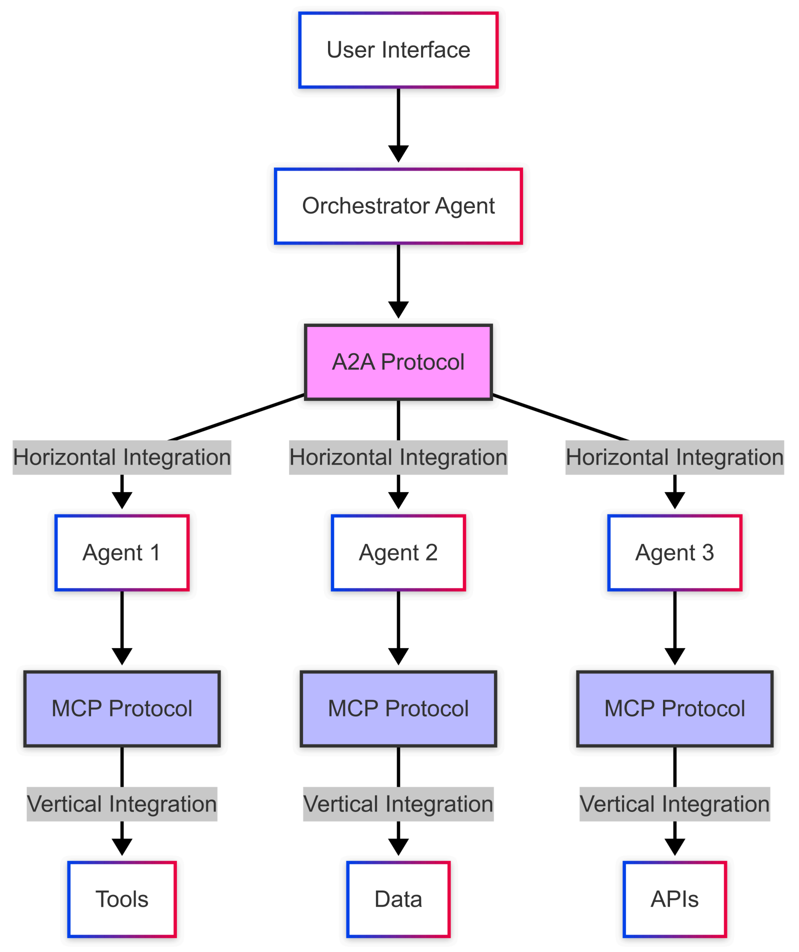
- Text, audio/video, structured data
- Potential embedded UI components

Opaque Execution

- Collaboration based on declared capabilities
- No need to share internal implementation

The "Protocol Bus" Architecture

Modern AI systems use a "dual-bus architecture":

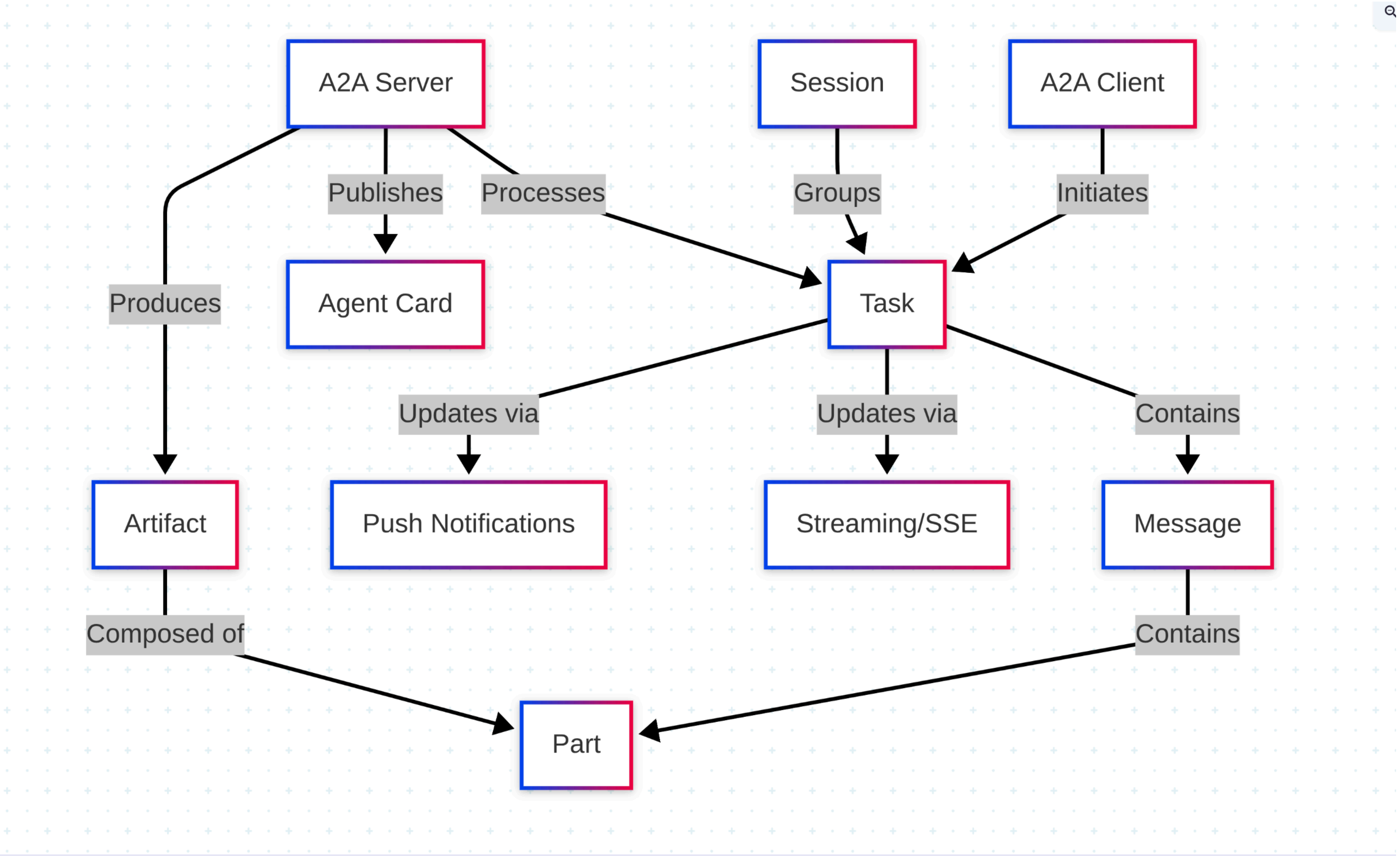


Analogy: If MCP is the brain function of individual agents, A2A is how multiple brains talk to each other.

Core Concepts: Key Definitions

- **A2A Client**: Application/agent that initiates requests to an A2A Server
- **A2A Server**: Agent that exposes an A2A-compliant HTTP endpoint
- **Agent Card**: JSON metadata document describing identity, capabilities, endpoint
- **Task**: Fundamental unit of work with unique ID and defined lifecycle
- **Message**: Communication turn within a Task (user/agent role)
- **Part**: Smallest content unit (TextPart, FilePart, DataPart)
- **Artifact**: Output generated by the agent as result of a task

Core Concepts: Visual Overview



Transport and Format

- **Transport Protocol**: HTTP(S) for all communication
- **Data Format**: JSON-RPC 2.0 for requests and responses
  - Content-Type: `application/json`
- **Streaming**: Server-Sent Events (SSE) for real-time updates
  - Content-Type: `text/event-stream`
  - Each SSE data field contains a complete JSON-RPC 2.0 Response

Agent card

```
agent_card = AgentCard(
            name="Creative Agent",
            description="Generates creative content based on prompts",
            url=f"http://{host}:{port}",
            version="1.0.0",
            capabilities=Capabilities(
                streaming=True,
                pushNotifications=True
            ),
            defaultInputModes=["text"],
            defaultOutputModes=["text"],
            skills=[
                Skill(
                    id="text_generation",
                    name="Text Generation",
                    description="Generates creative text content"
                ),
                Skill(
                    id="story_creation",
                    name="Story Creation",
                    description="Creates compelling stories"
                ),
                Skill(
                    id="content_formatting",
                    name="Content Formatting",
                    description="Formats content for various purposes"
                )
            ]
        )
```

```
agent_card = AgentCard(
            name="Data Analysis Agent",
            description="Processes and analyzes data files",
            url=f"http://{host}:{port}",
            version="1.0.0",
            capabilities=Capabilities(
                streaming=True,
                pushNotifications=True
            ),
            defaultInputModes=["text", "file"],
            defaultOutputModes=["text", "data"],
            skills=[
                Skill(
                    id="data_analysis",
                    name="Data Analysis",
                    description="Analyzes structured data files"
                ),
                Skill(
                    id="visualization",
                    name="Data Visualization",
                    description="Creates visual representations of data"
                )
            ]
        )
```

Security Considerations: Enterprise-Ready by Design

🔐 Authentication & Identity

- Standard OAuth, API keys, OpenID Connect
- Digital certificates for agent identity
- Uses established web security standards

🛡️ Authorization & Access Control

- Per-Skill authorization
- Fine-grained access control
- "Opaque Agents" pattern protects proprietary algorithms

🌐 Transport Security

- HTTPS with modern TLS ciphers
- Rate limiting protection
- Geographic restrictions available

Example: Authentication in AgentCard

```
agent_card = AgentCard(
  # ... other fields ...
  authentication_requirements={
    "type": "oauth2",
    "flows": {
      "authorizationCode": {
        "authorizationUrl": "https://auth.example.com/authorize",
        "tokenUrl": "https://auth.example.com/token",
        "scopes": {
          "agent.read": "Read-only access to agent capabilities",
          "agent.write": "Full access to agent capabilities"
        }
      }
    }
  }
)
```

Authentication and Authorization

Transport Security

- Production MUST use HTTPS
- Modern TLS (1.2+) recommended

Server Identity Verification

- Clients verify server via TLS certificate

Client Authentication Process

1. Discover requirements from Agent Card
2. Obtain credentials out-of-band
3. Transmit in HTTP headers

Server Responsibilities

- Authenticate every request
- Use standard HTTP status codes
- Include relevant headers for challenges

In-Task Authentication

- Request via `input-required` state
- Client provides secondary credentials

Authorization

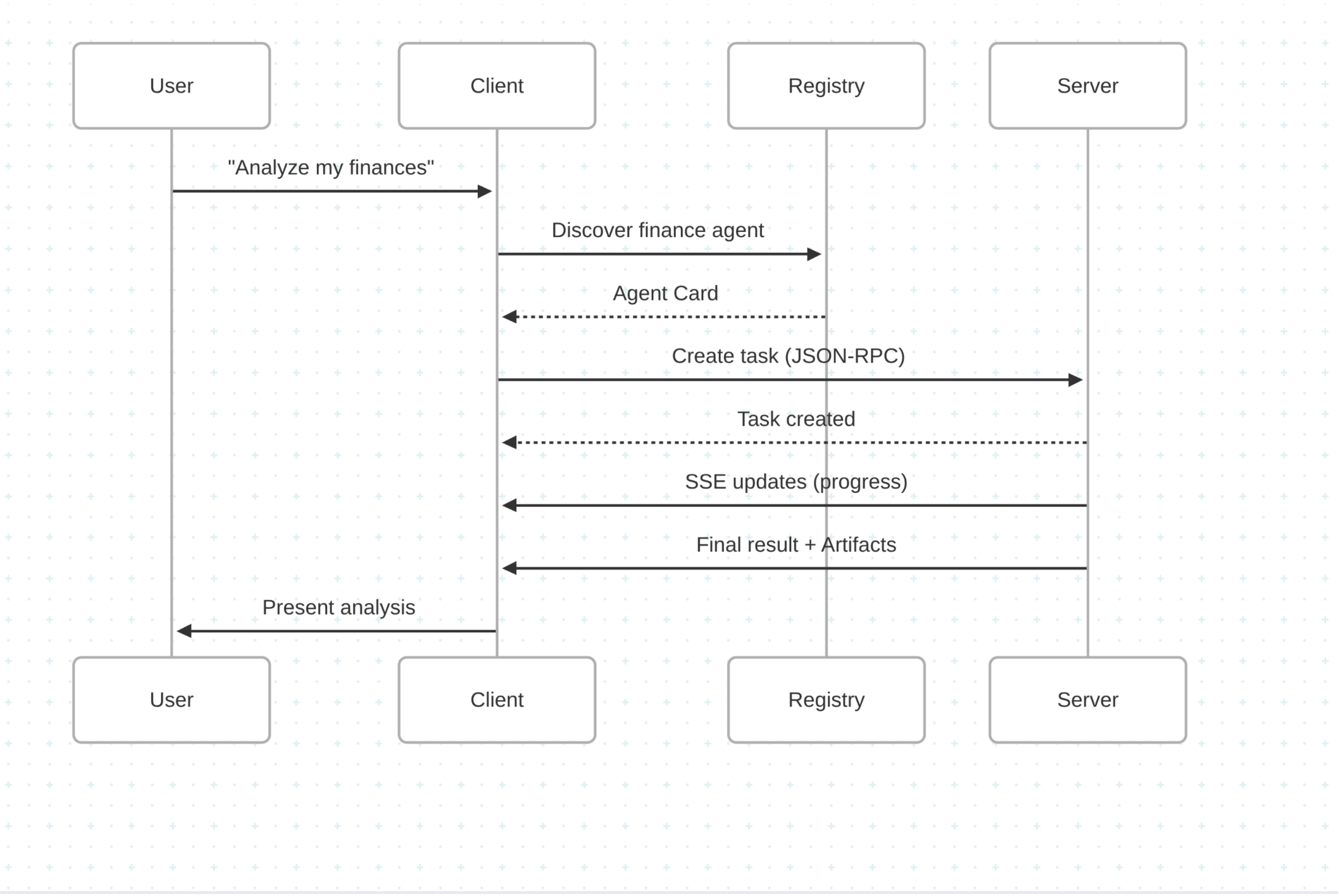
- Based on authenticated identity
- Implementation-specific policies

Communication Flow Analogy

Think of A2A communication like a professional work request:

1. **Finding an expert** (Agent Card): Looking up a specialist in a directory
2. **Making a request** (Task creation): Submitting a work order
3. **Conversations** (Messages): Back-and-forth clarifications
4. **Deliverables** (Artifacts): Final products of the work
5. **Status updates** (Streaming/Push): Progress notifications

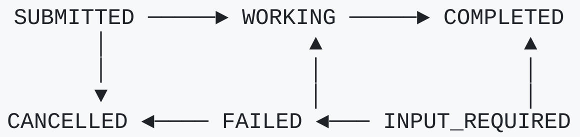
A2A in Action: Example Scenario



Task Lifecycle Management

A2A introduces a formalized task lifecycle with well-defined states:

```python
class TaskState(str, Enum):
    """States for A2A tasks."""
    SUBMITTED = "submitted"
    WORKING = "working"
    INPUT_REQUIRED = "input-required"
    COMPLETED = "completed"
    FAILED = "failed"
    CANCELLED = "cancelled"
```



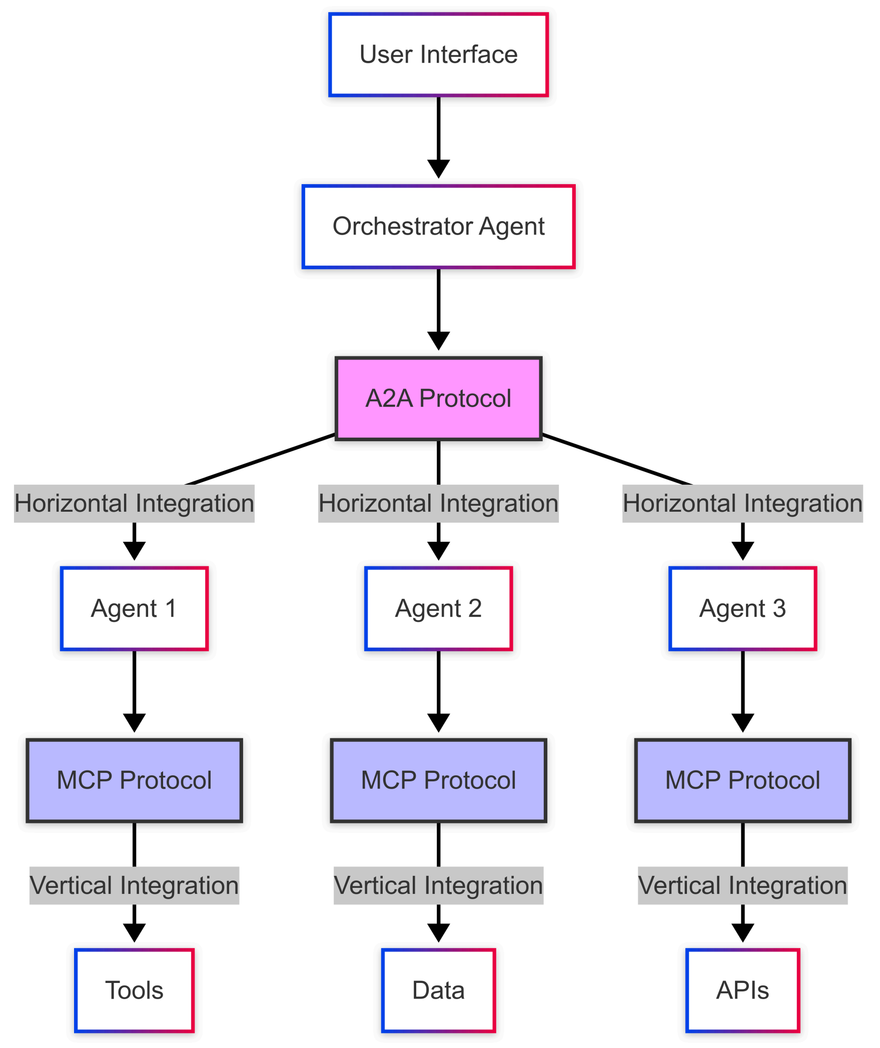
Benefits of Task Lifecycle

- Long-running task management
- Stateful multi-turn conversations
- Proper error handling and recovery
- Cancellation support
- Progress tracking for complex workflows

Example: "Write an email" request

1. Task created in **SUBMITTED** state
2. Creative Agent transitions to **WORKING**
3. Agent may ask for more info (**INPUT_REQUIRED**)
4. When email is ready, task moves to **COMPLETED**
5. Results returned with structured artifact

System Architecture Example



A2A + MCP: The Best of Both Worlds

How They Work Together

```python
class DataAnalysisAgent(A2ABaseServer):
    """Data Analysis Agent that uses MCP for tool calling."""

    # A2A for agent communication
    async def handle_task(self, task: Task) -> Task:
        # Process A2A task
        # ...

        # Call MCP for tool usage
        result = await self._process_with_mcp(task_data)

        # Create response and artifacts for A2A
        # ...
        return task

    # MCP for tool calling
    def _create_tools(self) -> List[Tool]:
        """Create tools for data analysis."""
        tools = [
            Tool.from_function(
                func=self._load_csv,
                name="load_csv",
                description="Load a CSV file for analysis"
            ),
            # More tools...
        ]
        return tools
```

Benefits of the Hybrid Approach

1️⃣ A2A for macro-level agent orchestration

Handles agent discovery and high-level communication

2️⃣ MCP for micro-level tool calling within agents

Each agent can use specific tools suited to its task

3️⃣ Framework interoperability

A2A works with any agent framework (LangGraph, CrewAI, Google ADK)

4️⃣ Separation of concerns

Clear distinction between inter-agent and intra-agent operations

Why A2A Matters: The Big Picture

1️⃣ Framework Interoperability

Agents built on different frameworks (ADK, LangGraph, CrewAI) can communicate seamlessly, breaking down framework silos

2️⃣ Polyglot Agent Ecosystems

Language-agnostic protocol enables Python agents to communicate with JavaScript or Java agents

3️⃣ Agent Specialization

Encourages specialized agents that excel at specific tasks, leading to better performance and clearer separation of concerns

4️⃣ Autonomous Agent Discovery

Dynamic agent discovery enables more autonomous systems where agents can discover capabilities without explicit programming

5️⃣ Scalable Multi-Agent Architectures

The formal task lifecycle and stateful communication model make A2A well-suited for complex, distributed systems that manage many concurrent tasks and interactions

Conclusion: The Future of Agent Communication

A2A represents a significant step forward in how we design and implement multi-agent systems:

✅ **Standardized communication protocol** with rich features like agent discovery, task lifecycle management, and structured artifacts

✅ **Enables more interoperable, scalable, and capable** agent ecosystems

✅ **Complements MCP** (for tool calling) to provide a comprehensive solution for building next-gen AI systems

As AI systems continue to grow in complexity, protocols like A2A will become increasingly important for building coherent, reliable multi-agent architectures.

Try it yourself: GitHub Repository

A Java SDK for A2A?

Why?

What?

How?

https://github.com/fjuma/a2a-java-sdk

Hijacking the talk

https://codiceartificiale.substack.com

https://artificialcode.substack.com

https://medium.com/@stefano.maestri

The recurrent trends I write about

Vibe Coding

Agentic AI

Robotics

Enterprise adoption & BigTech moves

Society impact