

The AI Agent Communication Dilemma

Current Natural Language Communication Key Problems:

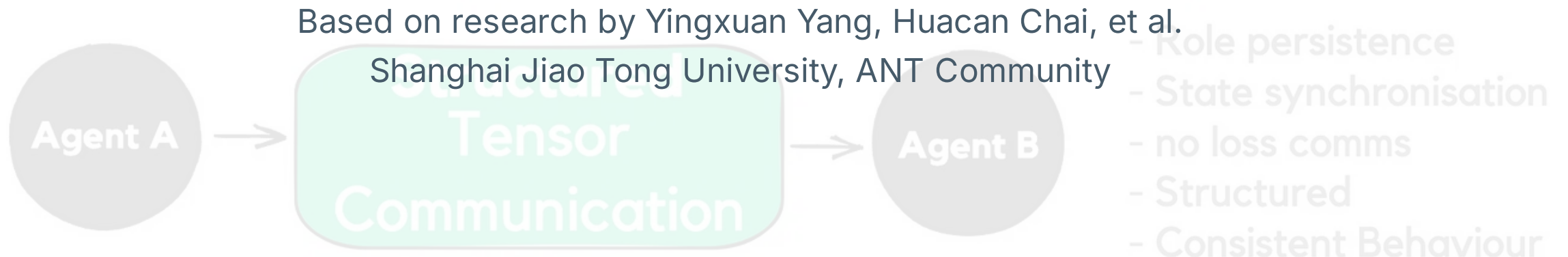
A Survey of AI Agent Protocols



- Semantic Compression
- Information Loss
- Role confusion
- Drift
- Tasks coordination failure

Understanding Communication Standards for LLM Agents

Native Multi-AI Agent Architecture Key Benefits:



Based on research by Yingxuan Yang, Huacan Chai, et al.
Shanghai Jiao Tong University, ANT Community

- Role persistence
- State synchronisation
- no loss comms
- Structured
- Consistent Behaviour

The Challenge of Agent Communication

Rapid Deployment

LLM agents are increasingly deployed across industries: customer service, content generation, data analysis, and healthcare.

Lack of Standardization

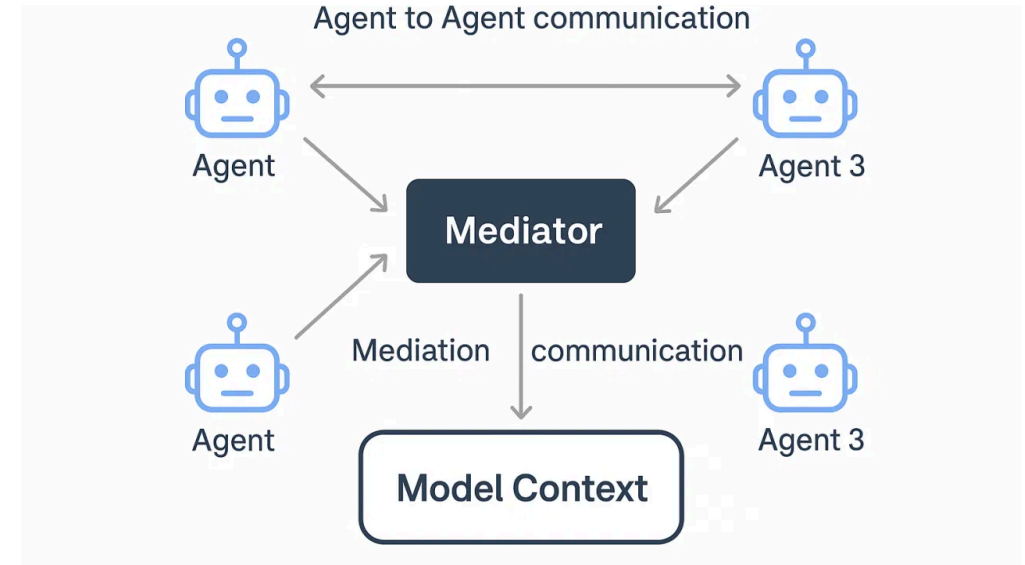
No standard way for agents to communicate with external tools or data sources.

Limited Collaboration

Difficult for agents to work together or scale effectively, limiting their ability to tackle complex real-world tasks.

Need for Unified Framework

A unified communication protocol could enable agents to interact more smoothly, encourage collaboration, and trigger collective intelligence.



Defining AI Agent Protocols

LLM Agents

AI systems powered by large language models that can perform tasks, make decisions, and interact with their environment.

- ✓ Capable of reasoning, planning, and learning
- ✓ Can use tools and access external resources

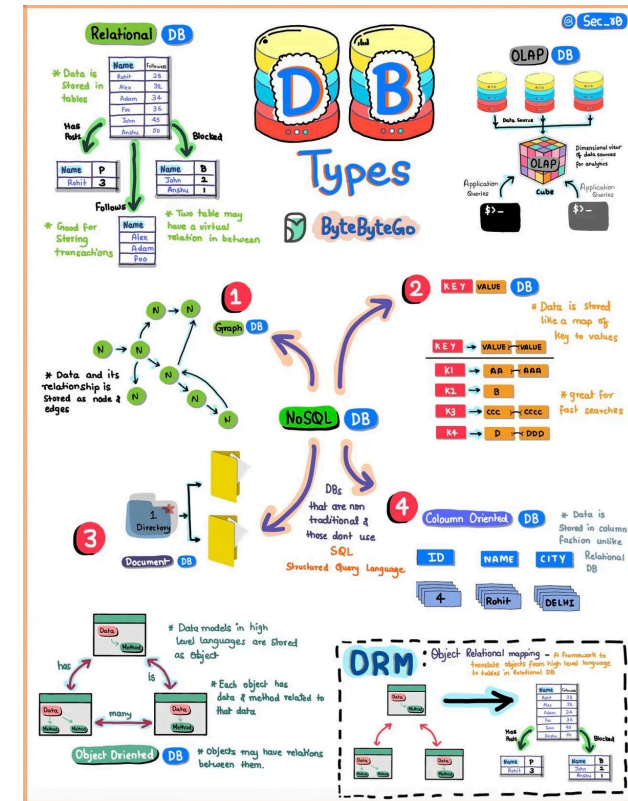
Agent Protocols

Standardized communication frameworks that define how agents interact with external tools, data sources, and other agents.

- ✓ Enable consistent message formats and workflows
- ✓ Support interoperability between different systems

Why Protocols Matter

They facilitate collaboration, enable scaling, and create the foundation for collective intelligence in multi-agent systems.



Classification Framework

Two-Dimensional Classification

The paper proposes a systematic classification framework that differentiates agent protocols along two main dimensions:

Context-Oriented Protocols

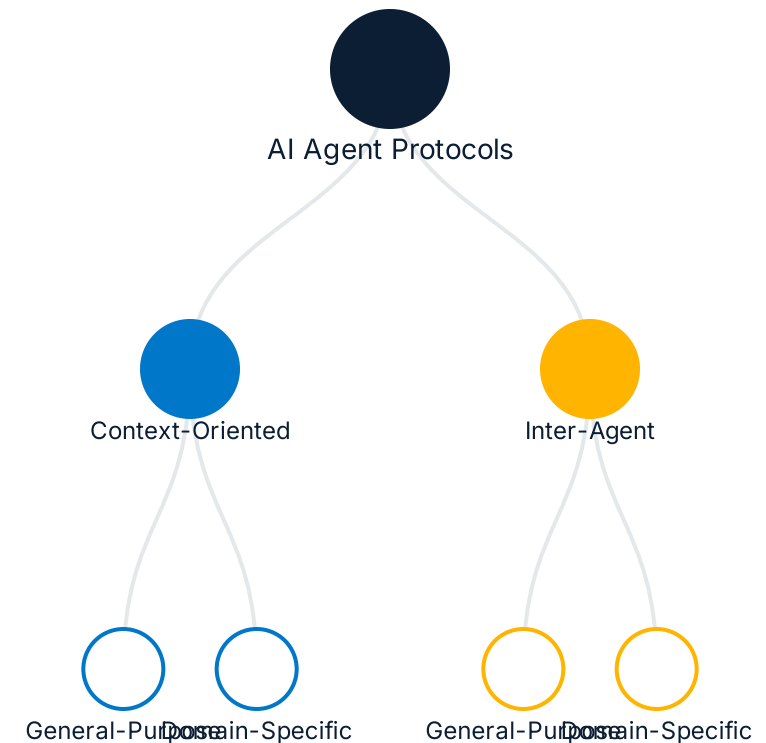
Focus on agent interaction with **external tools and data sources**

- General-Purpose Protocols
- Domain-Specific Protocols

Inter-Agent Protocols

Enable **communication between multiple agents**

- General-Purpose Protocols
- Domain-Specific Protocols



Context-Oriented Protocols

General-Purpose Protocols

Designed for broad applicability across different domains and use cases.

Examples: OpenAI Function Calling, LangChain Tools, AutoGPT

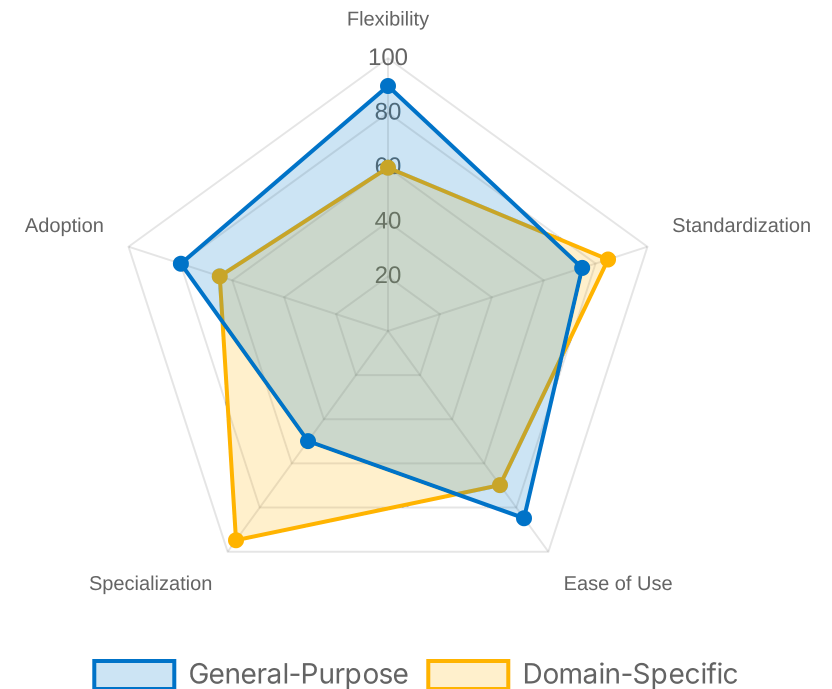
Domain-Specific Protocols

Tailored for specialized applications with domain-specific requirements and optimizations.

Examples: Healthcare data exchange, Financial transaction protocols, Scientific research collaboration

Context-oriented protocols focus on how agents interact with their environment, tools, and data sources. They define the structure and format of these interactions.

Protocol Type Comparison



Inter-Agent Protocols

Agent-to-Agent Communication

Standards that enable direct communication between multiple AI agents, allowing them to collaborate, coordinate, and share information.

General-Purpose vs Domain-Specific

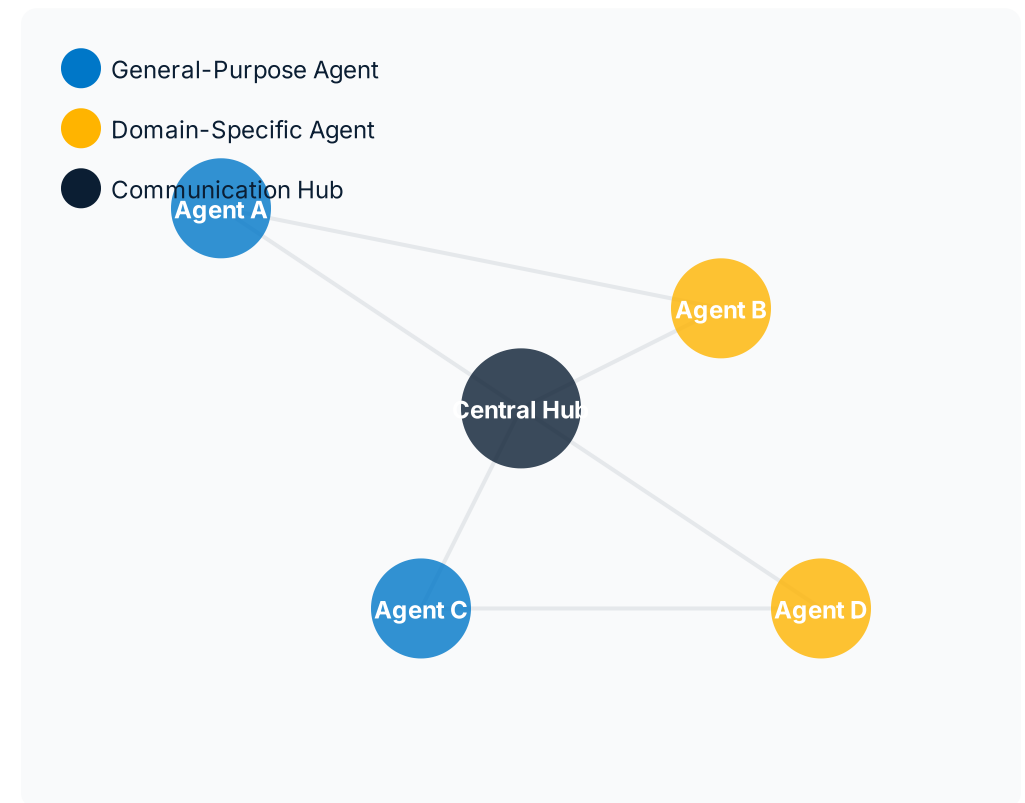
- ✓ **General-Purpose:** Flexible frameworks for diverse agent interactions
- ✓ **Domain-Specific:** Optimized for particular industries or tasks

Collaboration Mechanisms

- ✓ Message passing and event handling
- ✓ Task delegation and result aggregation
- ✓ Shared memory and knowledge bases

Benefits

Enables complex multi-agent systems that can tackle problems beyond the capabilities of individual agents, creating emergent intelligence.



How We Evaluate Protocols

Protocols in Action



MCP

Single Agent Invokes All Tools

Model-Centric Protocol enables a single LLM agent to interact with multiple external tools through standardized interfaces.

- ✓ Simplified tool integration
- ✓ Consistent input/output formats



A2A

Complex Collaboration Within Enterprise

Agent-to-Agent protocols facilitate complex workflows where multiple specialized agents collaborate within an organization.

- ✓ Task delegation and coordination
- ✓ Structured message passing



ANP

Cross-Domain Agent Protocol

Agent Networking Protocol enables communication between agents from different domains, vendors, or ecosystems.

- ✓ Cross-platform interoperability
- ✓ Standardized authentication



Agora

Natural Language to Protocol Generation

Converts natural language instructions into structured protocol messages, bridging human intent with machine execution.

- ✓ Human-friendly interfaces
- ✓ Automatic protocol translation

The Road Ahead

Short-Term Outlook

From Static to Evolvable

Moving from rigid protocol definitions to adaptive frameworks that can evolve with changing requirements.

→ Self-updating protocol specifications

Mid-Term Outlook

From Rules to Ecosystems

Development of comprehensive protocol ecosystems with shared standards, libraries, and tools.

→ Interoperable protocol marketplaces

Long-Term Outlook

From Protocols to Intelligence Infrastructure

Evolution toward a unified intelligence infrastructure where protocols become the foundation for emergent collective intelligence.

→ Self-organizing agent networks



Conclusion & Impact

Standardization is Critical

As LLM agents proliferate, standardized protocols are **essential** for effective communication, collaboration, and scaling.

Dual Classification Framework

The context-oriented vs. inter-agent taxonomy provides a systematic way to understand and evaluate different protocol approaches.

Evolving Landscape

Agent protocols are rapidly developing from static rule-based systems toward dynamic, evolvable ecosystems and intelligence infrastructure.

Join the Conversation

Researchers, engineers, and organizations are encouraged to contribute to protocol development, evaluation, and standardization efforts.

