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Initial Post

by Fahad Abdallah - Tuesday, 26 August 2025, 7:05 PM

The proliferation of multi-agent systems (MAS) in artificial intelligence has shown the utility of structured communications. Agents must not only be able to exchange data but also represent intentions, goals, and commitment. ACLs, especially the Knowledge Query and Manipulation Language (KQML), were developed to satisfy this need, whose protocol is based on speech act theory (Warstadt & Bowman, 2022). In contrast with regular programming calls, ACLs strive to reflect the semantics of interaction and not its syntax. The best advantage of ACLs is that they limit a heterogeneous environment. Agents programmed in various programming languages or developed to run on multiple systems will be able to interact with each other, provided that they work under the same communication standard (Kim et al., 2024). Besides that, ACLs can be semantically rich, because messages are performatives (except inform and request), such as converse or play-game, and the agent's intent is expressed (Zhang et al., 2024). Along with their advantages, ACLs have practical drawbacks. They impose the need to do meaningful reasoning on the agents, increasing the computational complexity. Besides, communication cannot be done without a shared ontology; otherwise, semantic inconsistency will arise. ACLs have overhead over lightweight calls and are therefore less applicable in real-time or performance-sensitive applications (Belda-Medina & Calvo-Ferrer, 2022). These limitations are why ACLs are still more typical in scholarly experimentation than commercial purposes, in which simpler mechanisms, such as an API or message queues, are more common. Calling methods in Python or Java is a straightforward, efficient, and predictable method of communication between software components. It is ideal for tightly coupled systems. ACLs, in turn, are preferable in open dynamic environments where agents are autonomous and require the interpretation of the goals of other agents (Liu et al., 2024). This generates some form of trade-off whereby method invocation is good in speed and ACLs are good in flexibility and knowledge-level communication.

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Peer Response

by Abdulla Almessabi - Monday, 1 September 2025, 4:46 AM

Hi Fahad,

I concur with your focus on the semantics richness of ACLs like KQML, especially that they have a speech act theory underpinning. This design renders them much more than mere containers of data, as they transfer intention and societal commitments among agents (Chalupsky et al., 1992). ACLs are indeed well adapted to open, distributed environments where agents in different programming languages are to communicate with each other. Such interoperability is not something that method invocation in either Python or Java can naturally offer, because these two approaches are explicitly tied to a particular runtime (Finin et al., 1994).

I also like the fact that you point out the computational cost and how a common ontology is needed. In the absence of shared language, agents can communicate with each other and yet be unable to reach a level of true understanding, defeating the benefits of semantic communication (Liu, Zhang, and Wu, 2011). That is why, as you pointed out, ACLs are still more common in the realm of academia and the lab, but not in the realm of commerce, where speed and reliability are more important.

Maybe one more aspect that should be taken into consideration is the increasing role of hybrid approaches. Many modern multi-agent systems combine lightweight APIs for efficiency with ACL-inspired protocols for higher-level reasoning. As an example, ontologies may be combined with conventional communication channels through such frameworks as JADE, which simplifies the process of uniting performance and semantics (Luo, Zou, and Luo, 2012). This indicates that, opposed to considering ACLs and method invocation as exclusive mechanisms, there is a possibility that the future of adaptive systems is to use both based on the circumstances.

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Peer Response

by Ali Alzahmi - Saturday, 6 September 2025, 7:49 AM

Fahad, your post provides a straightforward and elaborate description of how Agent Communication Languages (ACLs) like KQML can achieve meaningful communication within multi-agent systems. I concur with you that the key strength of ACLs is that they express semantics, not syntax, and agents can share not only information but also their plans, intentions, and commitments. The difference is the key to cooperation within dynamic and open settings. The significance of structured, semantically rich communication in enhancing collaborative action and level of reasoning is also included in current studies on multimodal large language model-oriented agents (Xie et al., 2024).

I was particularly interested in how you emphasised the aspect of heterogeneity. As you clarified, ACLS enables agents that may be programmed in different languages or platforms to interoperate using a single standard. This capability is essential to distributed applications and systems such as robotics and autonomous driving, where agents must cooperate irrespective of their design differences. The recent research on multimodal large language models in autonomous driving emphasises the importance of interoperability in integrating perception, decision-making, and interaction among multiple systems (Cui et al., 2024). ACLs are capable of that common ground, so they help scale complicated systems.

Simultaneously, I would like to concur with your discussion of constraints. Shared ontologies and sophisticated reasoning add to computational overhead, making ACLs less effective in real-time applications. This is consistent with recent results on conversational agents, which note that semantic richness is both a benefit and a performance issue (Ma et al., 2024). This trade-off between invoking a lightweight method to be fast and ACLs to be flexible brings you to the essence of the design dilemma in constructing contemporary multi-agent systems.

All in all, your post offers a rather balanced view, demonstrating the feasibility problems and longevity of the ACLs in research and system creation.

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Peer Response

by Koulthoum Hassan Ahmad Flamerzi - Monday, 8 September 2025, 10:05 AM

Fahad, to prevent the incidents you surface—semantic inconsistency, reasoning overload, and real-time performance hits—I'd harden MAS deployments along four fronts. First, enforce ontology governance: adopt a shared, versioned ontology with machine-checkable constraints (e.g., SHACL) and validation at ingress so malformed or ambiguous performatives are rejected early with actionable errors; include deprecation policies and mapping rules to curb drift (W3C, 2017). Second, constrain and standardize interactions: use a small, well-profiled subset of FIPA ACL performatives and documented FIPA interaction protocols with explicit timeouts, retries with jitter, and idempotency tokens; cap negotiation rounds (e.g., Contract Net) to avoid live lock and resource hoarding (FIPA, 2002; Labrou, Finin and Peng, 1999). Third, separate intent from throughput: keep ACL for tasking/negotiation but route bulk or latency-critical data over RPC/streams, correlating both via conversation IDs; add backpressure (rate limits, priority queues) and graceful degradation to keep real-time paths predictable. Fourth, make failure observable and safe: structured logs by performative/ontology, distributed tracing across agents, and semantic anomaly detection to flag contradictory or looping dialogues; pair with security controls (mutual auth, message signing, capability-scoped authorization) and replicated directories/facilitators with health checks and cached, signed capability manifests for resilience (Bellifemine et al., 2008). Finally, reduce reasoning cost and regressions with contract tests over message schemas, simulation harnesses that inject drops/reordering/duplication, and canary agents behind feature flags before full rollout. These measures preserve ACL flexibility while systematically addressing the real incidents you note—meaning fewer misunderstandings, fewer stalls, and predictable performance in open, heterogeneous environments (FIPA, 2002; Bellifemine et al., 2008; W3C, 2017; Labrou, Finin and Peng, 1999).

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Peer Response

by Rayyan Mohamed Abdalla Alshambeeli Alnaqbi - Monday, 8 September 2025, 5:05 PM

Hi Fahad,

Your summary does a good job of showing the main benefits of Agent Communication Languages (ACLs) like KQML. One of the best things about them is that they let different systems talk to each other using the same communication protocol (Kim et al., 2024). The focus on using performatives to show what an agent wants to do is what makes ACLs different from regular method calls. This allows for more complex exchanges of information (Zhang et al., 2024).

I also like how you have a balanced view of the practical problems with ACLs, especially the extra work they require and the need for shared ontologies to avoid semantic mismatches. These problems do make it harder to use ACLs in real-time or performance-critical situations, where languages like Python and Java are better because they make method invocation simple and quick (Belda-Medina & Calvo-Ferrer, 2022).

Your point that ACLs work best in open, changing environments where independence and understanding goals are important is very important. It shows the balance between speed and flexibility that system designers need to think about very carefully. This nuanced understanding is essential for implementing intelligent systems that fulfill both practical and research requirements.

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Peer Response

by Ali Alhammadi - Monday, 8 September 2025, 7:18 PM

Fahad, you have given a powerful account of how Agent Communication Languages (ACLs) such as KQML can be used as high-level protocols, through which agents can have conversations and exchange simple data. I would have to concur with you that the fact that it is not bound to particular implementation languages is a significant strength, given that multi-agent systems tend to have different architectures. This ability is further pronounced because the large language models can be implemented in real-world activities requiring coordination between various platforms. It has been demonstrated in recent studies that large language models are capable of producing accurate and interpretable communication in complex tasks, which underscores the importance of standardized ways of interoperability (Liu et al., 2025).

I also liked that you focused on rich communicative acts. As you said, ACLs can also encode not just information but intentions behind actions, which is helpful in cooperation and negotiation among agents. This is in line with more recent literature on vision-language models, which attributes the effectiveness of interaction to maintaining between modalities and avoiding degradation when transferring (Zheng et al., 2023). This finding implies that ACLs still apply in designing systems where agents have to exchange more than mere instructions.

Simultaneously, you also rightfully pointed out the disadvantage of ACLs. Complex reasoning and shared ontologies require them to be computationally difficult and subject to inconsistency. This is similar to the recent research on conversational AI, which warns that despite the potential of large language models, to achieve reliable and effective communication, one will have to optimize through iterative schemes and structures to cope with high complexity (Ma et al., 2024). By comparison, method invocation in programming languages like Python or Java is more predictable and faster, but less flexible.

Overall, your post has an excellent ratio of ACLs' strengths and weaknesses because it demonstrates why they will continue to be the core of research, and industry implementation may be better off with more lightweight alternatives.

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