

Peer Response 1

Fabian, I enjoyed reading your clear account of the strengths and weaknesses of KQML and ACLs more generally. You emphasise abstraction and interoperability as the defining benefits, which aligns well with the way early designers framed ACLs in terms of speech-act theory (Austin, 1975; Searle, 1969). I particularly liked your point that ACLs make not only the content of a message but also the sender's intent explicit, since this is a crucial distinction from traditional method invocation.

I do think there are areas I wish you had explored further. For instance, you raise the difficulty of maintaining semantic agreement, but it would be interesting to know your view on whether ontology alignment techniques, or even machine learning-driven translation between ontologies, might alleviate this issue. Another area worth considering is the degree to which ACLs remain relevant in today's systems. Recent research shows that alternative paradigms are gaining traction. Zhu, Dastani and Wang (2024) describe how agents can learn communication strategies dynamically through reinforcement learning, while Yan et al. (2025) show how large language model-based agents increasingly use natural language itself as a medium of coordination. Both approaches attempt to overcome the rigidity of traditional ACL semantics, albeit with new challenges.

Your conclusion that method invocation is at odds with agent-oriented design is well taken. Still, I would argue that we now see a spectrum of communication mechanisms rather than a strict divide. It might have been valuable to hear your perspective on where

ACLs sit in this spectrum today, particularly given the advances in emergent and natural language-based communication.

References:

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Zhu, C., Dastani, M. and Wang, S. (2024) *A survey of multi-agent deep reinforcement learning with communication*. *Autonomous Agents and Multi-Agent Systems*, 38(4), 4. Available at: <https://link.springer.com/article/10.1007/s10458-023-09633-6> (Accessed: 28 September 2025).

Peer Response 2

Pavlos, thank you for your meaningful contribution to this discussion. I found your post a well-balanced comparison of ACLs and method invocation. I agree with your observation that interoperability and expressiveness are key advantages of ACLs, particularly in heterogeneous and distributed environments (Labrou and Finin, 1997). Your point about the ambiguity in content semantics is also important; KQML was deliberately underspecified in this regard, which makes flexibility possible but also increases the potential for misinterpretation.

That said, I would have liked to see you explore more of the *current directions* in this area. For example, Ehtesham et al. (2025) show how newer interoperability protocols such as the Model Context Protocol (MCP) and the Agent Communication Protocol (ACP) attempt to retain the flexibility of ACLs while addressing modern requirements like decentralised identity and cross-platform negotiation. These represent attempts to overcome precisely the implementation and maintenance challenges you highlight.

Another interesting perspective comes from Singh (1998) who argued that ACLs should be grounded not in unverifiable mental states but in social commitments between agents. Although an older idea, this social semantics has influenced later frameworks and could have been a useful lens for your point about ambiguity.

Finally, I would be curious to know your views on the rise of natural language as a communication medium for agents. Recent work shows that large language model-based agents can coordinate through dialogue in ways that bypass formal ACLs

altogether (Yan et al., 2025). This raises a provocative question: will ACLs evolve alongside these trends or will they gradually be replaced?

References:

Ehtesham, A., Singh, A., Gupta, G.K. and Kumar, S. (2025) *A survey of agent interoperability protocols: Model Context Protocol (MCP), Agent Communication Protocol (ACP), Agent-to-Agent Protocol (A2A), and Agent Network Protocol (ANP)*. arXiv preprint. Available at: <https://arxiv.org/html/2505.02279v1> (Accessed: 28 September 2025).

Labrou, Y. and Finin, T. (1997) *A semantics approach for KQML—a general purpose communication language for software agents*. Proceedings of the Third International Conference on Multi-Agent Systems (ICMAS), pp. 447–454.

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Peer Response 3

Saleh, thank you for your meaningful contribution. I found your post both clear and practical, especially in the way you linked the theoretical basis of ACLs in speech act theory to applications such as e-commerce and supply chains. I also share Abdulrahman's view that the computational cost you mention is a central issue, and like Ali I agree that efficiency deserves further reflection.

One perspective that could extend your post is the question of security. In open systems, inter-agent communication may be subject to manipulation or interception. Recent work has shown that adversarial strategies can disrupt the flow of information in multi-agent environments, particularly in LLM-based systems, which highlights the need for safeguards in protocol design (He et al., 2025). This suggests that the barriers to scalability are not just computational but also resilience related.

Another area worth considering is monitoring and accountability. While method calls can be logged and traced easily, it is more difficult to observe and verify the semantics of ACL-based interactions. Kaminka, Pynadath and Tambe (2001) proposed plan-recognition techniques based on "overhearing" agents, which remains an important line of thought for ensuring transparency in distributed communication.

Finally, I would have liked to see your perspective on how ACLs are evolving today. Ehtesham et al. (2025) discuss modern interoperability protocols such as the Model Context Protocol and the Agent Communication Protocol, which are designed to overcome some of the implementation and maintenance challenges you raise. Similarly, Charalambous and Pappas (2025) argue that goal-oriented communication

can reduce overhead by ensuring that agents exchange only task-relevant content.

Together, these perspectives suggest that efficiency and semantic richness need not be mutually exclusive.

References:

Charalambous, T. and Pappas, N. (2025) *Toward goal-oriented communication in multi-agent systems: An overview*. arXiv preprint. Available at: <https://doi.org/10.48550/arXiv.2508.07720> (Accessed: 28 September 2025).

Ehtesham, A., Singh, A., Gupta, G.K. and Kumar, S. (2025) *A survey of agent interoperability protocols: Model Context Protocol (MCP), Agent Communication Protocol (ACP), Agent-to-Agent Protocol (A2A), and Agent Network Protocol (ANP)*. arXiv preprint. Available at: <https://arxiv.org/abs/2505.02279> (Accessed: 28 September 2025).

He, P., Lin, Y., Dong, S., Xu, H., Xing, Y. and Liu, H. (2025) *Red-teaming LLM multi-agent systems via communication attacks*. Findings of the Association for Computational Linguistics. Available at: <https://aclanthology.org/2025.findings-acl.349> (Accessed: 28 September 2025).

Kaminka, G.A., Pynadath, D.V. and Tambe, M. (2001) *Monitoring teams by overhearing: A multi-agent plan-recognition approach*. Journal of Artificial Intelligence Research, 17, pp. 83–135. Available at: <https://arxiv.org/abs/1106.1816> (Accessed: 28 September 2025).

Peer Response 4

Andrea and Jaco, I really enjoyed your exchange. You highlighted one of the central debates in ACLs: whether semantic ambiguity was a fundamental flaw of KQML or simply a product of the stage of research at the time. Andrea, your point about KQML Improved was particularly interesting, as it shows that attempts have been made to refine the language to reduce ambiguity. Jaco's reference to the role of FIPA-ACL also reminded me of how the field has continually sought more formal semantics.

What I think could enrich this conversation is looking at how communication is now being reimagined in multi-agent systems. Peters et al. (2025) provide a survey of emergent communication, showing how agents can invent their own languages tailored to the environment. This possibility of agents developing protocols dynamically could help strike a balance between the semantic richness you both emphasise and the efficiency required in large-scale systems.

Another angle is security. Owoputi and Ray (2022) show that as agents are deployed in cyber-physical systems, adversarial manipulation of messages is a real risk.

Robustness against spoofing, tampering and interception must be designed into communication frameworks if they are to be viable outside controlled academic environments. This shifts the debate beyond semantics into resilience, which is arguably just as important in practice.

Overall, I valued your dialogue and think that combining the historical evolution of ACLs with perspectives on emergent communication and security offers a fruitful way to situate KQML and its successors in the present research landscape.

References:

Owoputi, R. and Ray, S. (2022) *Security of multi-agent cyber-physical systems: a survey*. IEEE Access. Available at: <https://www.ece.ufl.edu/wp-content/uploads/sites/119/publications/ieee-access22.pdf> (Accessed: 28 September 2025).

Peters, J., Waubert de Puiseau, C., Tercan, H., Gopikrishnan, A., Lucas de Carvalho, G.A., Bitter, C. and Meisen, T. (2025) *Emergent language: a survey and taxonomy*. Autonomous Agents and Multi-Agent Systems. Available at: <https://link.springer.com/article/10.1007/s10458-025-09691-y> (Accessed: 28 September 2025).