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# Assessment of KQML Improved

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----------**ABSTRACT**----------
**KQML (Knowledge Query Manipulation Language) is both a language and a protocol for establishing communication among multiagent systems. Researchers have been putting efforts to improve the existing structure of KQML. The latest version of KQML i.e. the KQML Improved not only supports existing features but it also extends the list of performatives and parameters along with a novel KQML based communication protocol. It also uniquely contributes security related performatives and hence limits the agents going destructive in a system. A comprehensive evaluation of KQML Improved with respect to available metrics as well as its comparison with its predecessor is being presented in the paper.**

Keywords-**Agent Communication Language, Knowledge Query Manipulation Language (KQML), Multiagent Systems, Metrics of Evaluation**

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## 1. INTRODUCTION

A multiagent system [1,2] allows inter agent communication which in turn facilitates decision making among interacting agents. KQML [3,4] is one of the agent communication languages supporting agent communication which represents the message in three layered format. Layer 1 represents the knowledge and expression of the message to be transferred. Layer 2 depicts the attributes of message itself and identity of sender and recipient and the type of message is represented by third layer. Also, technically a KQML message is known as a performative and it actually performs an action. In fact, like any other language, KQML also contains a set of performatives i.e. the keywords that make the communication meaningful amongst KQML agents. From the basic KQML which contained 36 performatives initially, many new performatives have been proposed with very few being actually added to the list in practice. Further, very few works are available reflecting the evaluation of communication languages and KQML in particular [5]. The paper explores the possible metrics for evaluating KQML and applies for analyzing the extended version of KQML.

The paper is structured into four sections. Section 2 discusses the related work. Section 3 begins by discussing the parameters thus explored from the literature and later analyses the extended version of KQML on the same. Section 4 concludes with the scope of future work.

## II. THE LITERATURE REVIEW

KQML has emerged as the efforts of many researchers. In fact, its developers has been putting efforts to improve the same. Available literature [6,7] suggests that during initial years of development, KQML only had an informal and partial semantic description and still not many commercial applications using KQML are available. A communication language demands committed agents so that they can achieve the target or complete the delegated task. However, language has diverted from fulfilling the requirements of researchers and developers working in the domain of Internet technologies. Further, to the best of our knowledge and literature grilling advocates that development in agent communication language and KQML in particular, has not been the prime agenda of organizations.

For instance, Huhns, Bridgeland and Arni [8] specify that coordination is a property of a system of agents performing some activity in a shared environment and to achieve coordination, agents communicate to avoid sharing the resources. Vaniya et al. [9] addresses the issuesof KQML in particular. Covington [10] examined the encoding of speech acts in KQML and suggested ways of improving KQML. It is a well not fact that agents in different MAS are usually incompatible and a communication protocol make them exchange messages. However, KQML do not offer semantically enhanced approach for expressing the meaning of messages being exchanged. Wu & Sun [11] highlights the research and design of anintelligent Multi-Agent System (MAS) using KQML as agent communication language. Yu, Li and Deng in 2010 reviewed the features and problems of a multiagent cooperative information system (MACIS) [12]. The work has also analyzed the structure of KQML and has verified the rational use of KQML in MACIS. Work by Chen and Lien [13] highlights the technological challenges pertaining in the field of machine to machine world. An indepth survey comparing the pros and cons of various ACLs and protocols is given in [14]. Researchers [15,16] have been continuously putting efforts to improve existing ACL according to FIPA standards and also carrying out the task cooperatively to achieve the shared

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goals. Authors in [17,18] have addressed the issue of semantics for KQML, in particular. They described protocol by which intelligent software agents can communicate to share information and knowledge. They believed that KQML, or something very much like it, will be important in building the distributed agent-oriented information systems of the future.

Mayfield and his coworkers [5] have discussed the desirable features of an agent communication language and suggested that content, semantics, implementation, networking, environment and reliability are some of the most prominent desirable features of any communication language. The authors have further evaluated the KQML. Improvements in the structure of KQML and set of performatives and parameters are also available in KQML as a language and an associated [14,19,20,21]. On the basis of above, the current structure KQML is being evaluated in the upcoming section.

## III. THE EXPLORED METRICS

Literature suggests that an agent communication language is desired to be evaluated on the basis of metrics shown in figure 1. As we are already aware that KQML is both a message handling and a communication protocol, therefore the focus of this work is to evaluate the same as a language as well as a protocol. The basic understanding of the listed semantics has been drawn from work by Mayfield [5]. Each of these metrics and its implication on the same is being discussed as follows.

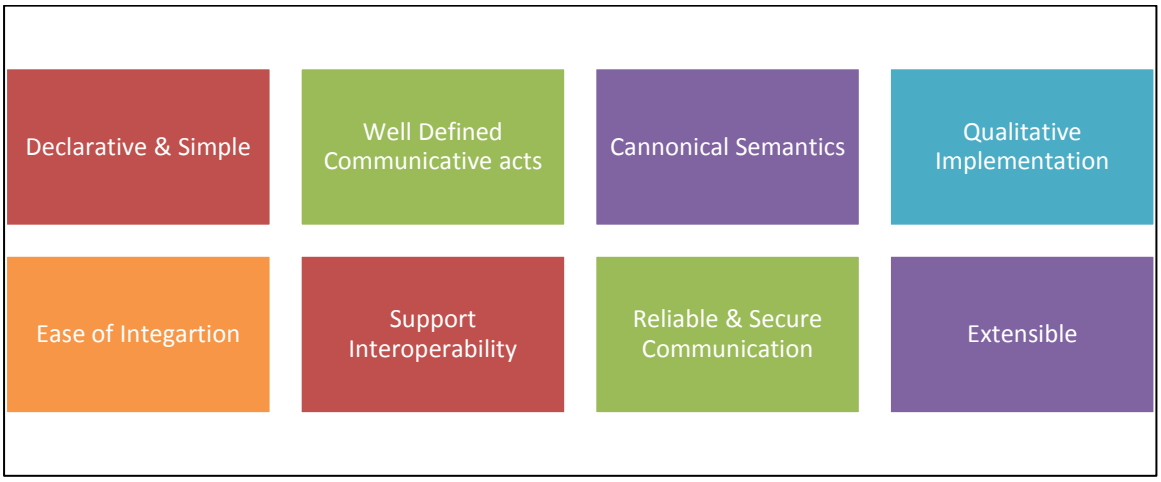


Figure 1: Metrics for Evaluating an Agent Communication Language

- ***Declarative and Simple***
  A communication language should be declarative and simple so that it can be easily understood by its users. It should be to parse the syntax. Further, a language should be platform independent so that it can be used cross-platform.

- ***Well Defined Performatives***
  Since the language should be inter-operational, the performatives should be clear and concise. The perfromatives should be able to convey the intended semantics and further, the set should have the ample scope to improve the same. The performatives should such that these are able to express not only the action associated with the message but also the content of the message should reflect domain of focus.

- ***Canonical Semantics***
  In general, the semantics of any communication language should be canonical i.e. these should obey certain rules such that the associated meaning is obvious to any user. However, developing such semantics has always been a challenge for language developers as the words in a common language are almost indefinite and designing a language with unlimited performatives conveying the correct semantics is out of scope.

- ***Qualitative Implementation***
  A language should be designed so that once its implemented in practice, it offers faster execution, utilizes less resources and since KQML is a language to be used in a networked environment , minimum bandwidth utilization is also one of the evaluating factors. Not only the existing version but also the improved version should be able to integrate with the other high level languages such as Java, C++ and such integration should be at ease.

- ***Ease of Integration***
  Since, now a days all executions and implementations are being carried out in a networked environment, therefore the language should support networking concepts including connection less, connection oriented, synchronous and asynchronous connection modes.

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- ***Support Interoperability***
  The agents in a multiagent system are both homogenous and heterogeneous and usually operate in a networked and distributed environment. In order to support interoperability amongst agents active on different platforms , the communicating agents must understand the semantics of messages being exchanged a language which offers encryption and decryption of messages. Further, a mechanism for authenticating and authorization of the agents moving in the system is highly desired especially in case of mobile agents which can migrate from one hop to another. In such cases, there is high probability of agents getting distracted from the original track.

- ***Extensible & Scalable***
  The language should be extensible in terms of addition of both new performatives and parameters. It is empirical that any language shall continue to improve as the new agents developed would offer new features and thus would demand for new ontology, new parameters and performatives for establishing communication with other agents. Therefore, an agent communication language should be extensible and scalable as well i.e. it should allow integration of new agents easily.

## IV. THE ASSESSMENT OF KQML IMPROVED

Although thirty six performatives including various parameters form the basic KQML and the basic structure is good enough to address the need of a moderately complex multiagent system. However, today's multiagent systems are highly complex and distributed and on the other hand the user of the same demands for early and well in time response. Moreover, the requirements pertaining to prioritizing the tasks with quality of response within the time constraints has been another challenge. The KQML independent of the language in which these are implemented.

- ***Reliable and Secure Communication***
  The language of agent communication should offer a reliable communication such that the messages being exchanged are secure. The developer should design

Improved made an attempt addressing the issues mentioned above by introducing: priority and *:capabilities* parameters in ask-one and advertise performatives respectively. While the parameter priority reflects represents execution time, priority of task and quality of response in a more general way, the capability parameters specifies the exact time of execution and quality of response.

Further since KQML is not only an agent communication language, it also acts as communication protocol, the KQML Improved suggested improvements in the communication protocol. In fact, it proposed the new structure of communication protocol with five new performatives reflecting the state of agent extending the basic list of thirty six performatives to forty one performatives (see figure 2). The new performatives are *active, acquire, waiting, busy and sleep.*In order to maintain theintegrity and order of messages, parameters reflecting timestamp on messages have been included. Therefore number of parameters being supported by any performtive have also increased. The KQML Improved allows inclusion of *:priority* parameter, *:capabilities* parameter and *msg_timestamp* in ask-one, advertise and the eight new performatives where five contributes to communication protocol and three limits the autonomy of agents in a multiagent system. Further, basic KQML supports one communication protocol but nothing pertaining to message time stamping and integrity is considered. The novel protocol is an additional feather in the cap as in addition to the basic features that conventional KQML offers, it overcomes the limitation mentioned above.

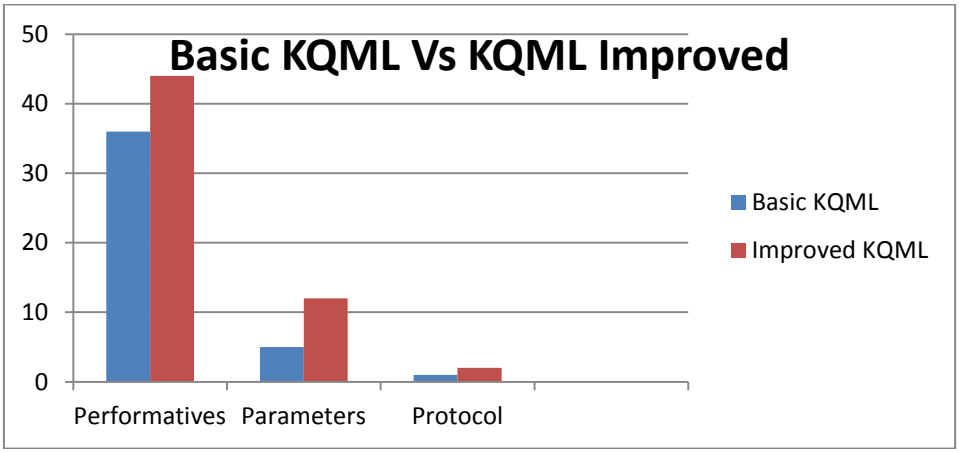


Figure 2: A Comparison of Basic KQML with KQML Improved

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Further, since basic KQML which is based on performatives is declarative and simple, KQML Improved also extends the same. The novel performatives and parameters which contributes towards improvement in KQML are also declarative and simple. The new performatives are well defined and self-explanatory. KQML Improved allows interoperability and is agent implementation independent. The KQML Improved is extensible as it allows addition of new agents at ease. Governing policies for ensuring the authenticity and integrity of agents participating in communication also guarantees that the communicating entities are reliable and secure. Therefore, it can be conveniently concluded that KQML Improved is at par with basic KQML and contains all desirable features of any agent communication language. Table 1 enlists the comparison of basic KQML and KQML Improved.

**Table 1: Comparison of Basic KQML with KQML Improved**

| **Metric** | **Basic KQML** | **KQML Improved** |
|---|---|---|
| Declarative & Simple | Based on Core PErformatives | Based on Core as well as New Performatives and Parameters |
| Well Defined Performatives | 36 Core performatives | 44 Core Performatives |
| Canonical Semantics | Yes but few performatives are ambiguous | Yes (New Parameters are semantically unambiguous) |
| Qualitative Implementation | Supports Cross-Platform Implementation | Supports Cross-Platform Implementation |
| Ease of Integration | Can be integrated with C, C++, Prolog | Can be integrated with C, C++, Prolog, Java, Javabeans |
| Reliable & Secure | Do not ensure authenticity of agents | Ensure the security of message by limiting the agents autonomy |
| Extensible & Scalable | Allows introduction of new agents easily | Allows introduction of new agents easily |

## V. CONCLUSION

The paper began by defining the metrics for evaluating an agent communication language. In fact, to the best of our understanding, literature grilling did not reveal many works suggesting the metrics and further evaluation of agent communication languages. Therefore, a detailed discussion pertaining to the desirable features of agent communication language and thus the metrics of evaluation was presented. Later a comparison of basic KQML with the KQML Improved is being given and it can be concluded that although the basic KQML still forms the backbone of KQML Improved, However; KQML Improved contributes significantly in terms of new performatives, parameters as well as a communication protocol.

## REFERENCES

[1] Wooldridge, M. (2009). An introduction to multiagent systems. John Wiley & Sons.

[2] Wooldridge, M., & Jennings, N. R. (1995). Agent theories, architectures, and languages: a survey. In Intelligent agents (pp. 1-39). Springer Berlin Heidelberg

[3] Finin, T., Fritzson, R., McKay, D., & McEntire, R. (1994, November). KQML as an agent communication language. In Proceedings of the third international conference on Information and knowledge management (pp. 456-463). ACM.

[4] Labrou, Y., & Finin, T. (1997). A Proposal for a new KQML Specification. Technical Report Technical Report TR-CS-97-03, University of Maryland Baltimore County.

[5] Mayfield, James, YannisLabrou, and Tim Finin."Evaluation of KQML as an agent communication language."Intelligent Agents II Agent Theories, Architectures, and Languages..Springer Berlin Heidelberg, 1995.347-360.

[6] Labrou, Y., amd Finin, T. (1994) 'A semantics approach for KQML—a general purpose communication language for software agents.' In Proceedings of the third international conference on Information and knowledge management, ACM, pp. 447-455.

Volume: 07 Issue: 06 Pages: 2931-2935 (2016) ISSN: 0975-0290

[7] Neches, R., Fikes, R. E., Finin, T., Gruber, T., Patil, R., Senator, T. and Swartout, W. R. (1991) 'Enabling technology for knowledge sharing.' AI magazine, Vol.12, No. 3, pp.36.

[8] Michael N. Huhns, David M. Bridgeland, and Natraj V. Arni," A DAI communication aide". Technical Report ACT-RA-317-90, MCC, Austin TX , October 1990

[9] Sandip Vaniya, Bhavesh Lad and Shreyansh Bhavsar "A Survey on Agent Communication Languages", International Conference on Innovation, Management and Service, IPEDR vol.14(2011) Singapore 2011.

[10] Covington,"Speech Acts, Electronic Commerce, and KQML" 1997, Artificial Intelligence Center The University of Georgia, USA.

[11] Wu, X., & Sun, J. (2010, May). Study on a KQML-based intelligent multi-agent system. In 2010 International Conference on Intelligent Computation Technology and Automation (pp. 466-469). IEEE.

[12] Yu, Y., Li, Y., & Deng, Y. (2010, August). Research and realization of KQML in Multiagent Cooperative Information System. In 2010 5th International Conference on Computer Science & Education.

[13] Chen, Kwang-Cheng, and Shao-Yu Lien. "Machine-to-machine communications: Technologies and challenges." Ad Hoc Networks 18 (2014): 3-23.

[14] Jagga, A., Juneja, D., & Singh, A. Updates in Knowledge Query Manipulation Language for Complex Multiagent Systems.

[15] Kone, M. T., Shimazu, A. and Nakajima, T. (2000) 'The state of the art in agent communication languages.' Knowledge and Information Systems, Vol.2, No. 3, pp. 259-284.

[16] Korzyk, A. (2000) 'Towards XML as a secure intelligent agent communication language.' In the 23rd National Information Systems Security Conference, Baltimore Convention Center, Baltimore, Maryland, SA.

[17] Labrou, Y. (2001) 'Standardizing agent communication.' In Multi-Agent Systems and-Applications, Springer Berlin Heidelberg, pp. 74-97.

[18] Labrou, Y., amd Finin, T. (1994) 'A semantics approach for KQML—a general purpose communication language for software agents.' In Proceedings of the third international conference on Information and knowledge management, ACM, pp. 447-455.

[19] Singh, R., Singh, A., & Mukherjee, S. (2016). Governing the Authenticity and Degree of Autonomy of Agents in Multiagent System. Journal of Network Communications and Emerging Technologies (JNCET) www. jncet. org, 6(3).

[20] Jagga, A., Juneja, D., & Singh, A. ,"KQML Based Communication Protocol for Multi Agent Systems" Published in International Journal of Emerging Technologies in Computational and Applied Sciences (IJETCAS),2015

[21] Juneja, D., Singh, A., & Hooda, R. A Three Tier Secure KQML Interface with Novel Performatives.International Science Index, Vol 8(3),