Chapter 4

AIM AND OBJECTIVES

4.1 Introduction
The details presented in the previous chapters unveiled contributions and limitations of existing works and this research study aims to pay attention to some of the untouched challenges which are still the focus of researchers. The chapter highlights the research issues in KQML and thus draws attention to the aims of research work being carried out during the study and also illustrates the objectives.

4.2 Research Issues
One of the primary issues towards the practical implementation of KQML as a popular ACL is the gap between the semantic theory and theory of agency where the former is primarily based on speech acts and later considers belief, desire and intention (BDI) architecture as foundation (31,38,76,106). In fact, in contrast to FIPA-ACL which assumes BDI architecture for communication, KQML is based on assertions derived from virtual knowledge base. Initial presumptions about the behavior of KQML were weak but with the introduction of preconditions, postconditions and completion conditions, KQML has proved to be semantically comparable with FIPA ACL. However, conditions related to failure and ensuring the sincerity are missing. It is presumed that an agent would never assert anything that it believes that it can’t achieve but according to the mental agency, it is highly impractical as agents might deceive the other agents and pose a behavior which semantically it is not expected to behave.

It is clear from the literature that some work has been done to improve the semantics of communication languages but since the semantics of KQML are based on mental agency and agents are programmable entities, therefore verification of how an agent is interpreting the message is hard challenge and leads to gaps between theory and practice. There exists only one work of Wooldridge (75) that addresses the issue of verification of
semantics. Further, semantics defined so far are neither unique nor unambiguous. Therefore the desire to put in efforts in this direction is highly apparent. Further, mechanisms related to finding the state of agents are also lacking.

Turning our attention to the available set of communicative acts defined for ACL, it is obviously understood that the set contains very limited number of acts for communication. At the time of listing, the available communicative acts are insufficient and the important acts reflecting the commitments, sincerity, security etc. shall be included with properly defined semantics.

In short, we can summarize that there is an ample scope to improve the existing KQML. It can be improved either by adding new performatives, adding new parameters, and defining basic ontologies, their query answering capabilities and requirements and policies for communication and so on. We aim to improve the same in future.

4.3 Aim of the Work

Considering the above stated issues, following is the aim of current research work:

- To study and compare KQML with other popular agent communication languages.
- To study the existing agent interactions protocols and explore the feasibility of improvement or requirement of new protocol.
- To propose a novel KQML based agent communication protocol having new set of performatives.
- To improve the existing structure of KQML by involving new set of performatives and also introducing new parameters making existing performatives more functional and capable.
- To compare and to evaluate the Improved KQML as well as the proposed protocol.
4.4 Objectives of Thesis

As shown in figure 4.1, the proposed work is being accomplished in five phases delineated as follows.

Figure 4.1 : Research Objectives
• *Comparison of Knowledge Query Manipulation Language with existing ACL*

KQML has been one of the early agent communication languages put forward by DARPA and later FIPA-ACL, proposed by Foundation of Intelligent Physical Agents had evolved in competition to KQML. The two languages while different are also similar in many aspects. For example, KQML primarily depends on performatives whereas FIPA-ACL is based on speech-act theory. Further, development of Extensible Markup Language (XML) has outperformed both KQML and FIPA-ACL. However; many MASs are still making use of KQML for agent communication and the need to bridge the gap between system using other communication languages such FIPA-ACL, XML, SQL and so on is highly apparent.

This objective recaps the principles behind origin and development of Knowledge Query Manipulation Language and also compares and contrast KQML with FIPA-ACL. It also unfolds various issues in applying KQML as an agent communication language and efforts that are required to improve the existing structure so that it can continue to dominate as a primary communication language. The study summarizes the developments in terms of syntax, performatives, semantics and the working architecture of KQML.

• *A Comparative Study of Popular Agent Interaction Protocols*

Although agent communication languages have played a vital role in facilitating the communication amongst agents operating in a multiagent system; However, the agent interaction protocols also contributes significantly as these allow performatives to be used in systematic manner.

The study presents various agent interaction protocols justifying the use of communicative acts as well as performatives during a conversation. An effort has
been put to understand the contribution of existing protocols and the limitations therein with the intention to find the scope of new protocol.

- **Novel Design of KQML-based Communication Protocol for Multiagent Systems**
  The premise of this objective is to design a communication protocol for the agents operating in different multiagent systems. The protocol thus proposed offers full autonomy to agents for deciding if they are interested in communicating and collaborating with peer agents. It emphasizes that an agent in communication can be in any of the five states i.e. active, acquire, busy, waiting, sleep.

  Further, the work proposes six iterative rules for establishing the communication and five new performatives in KQML to support the working of protocol in multiagent systems using KQML as communication language.

- **Updates in Knowledge Query Manipulation Language**
  Knowledge Query Manipulation Language (KQML) is a language that facilitates communication and interoperability among coordinating software agents. The existing specifications of KQML focus on perspective, meaning, syntax, semantics, coverage and context of communication to lead to the final result derived from the communication. It is desired that the new extension should support the abstract interaction among software agents coordinating in multi-agent systems.

  Further, literature reveals that standards that are implementation independent are also lacking. Therefore, the language which is normative and can make communication between heterogeneous agents operating cross-platforms compatible has always been the area of interest to scientific community. In
particular, this premise of this work is to extend pragmatic component of KQML which would shore up the use of language as a protocol. Also, the implementation prototype of the proposal is being presented.

- **Assessment of Improved KQML**
  During the study it is well understood that KQML 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 proposed improvements and the novel protocol 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.

  Moreover, 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 achieved in this objective.

**4.4 Conclusion**

The chapter presented aims and objectives pertaining to the thesis. It discussed the research issues prevailing in the basic version of KQML and stated the discrete objectives to be attained during the course of this study.

The upcoming chapter presents a detailed discussion about various simulation tools that supports agent development and communication and also the research methodology adopted to realize this research work.