

A Novel Business Intelligence System Framework

Venkatadri. M

Dept of Computer Science and
Engineering
Jawaharlal Nehru Institute of Technology
India -5001510.
venkatadri.mr@gmail.com

Hanumat G. Sastry

Dept of Computer Science
School of Science and Technology
Dravidian University
India-517 425
sastrygh2000@yahoo.com

Manjunath. G

Dept of Computer Science and
Engineering
Jawaharlal Nehru Institute of Technology
India -5001510.
gmanjunathc2000@yahoo.co.in

Abstract-Business Intelligence (BI) systems plays a vital role in effective decision making in order to improve the business performance and opportunities by understanding the organization's environments through the systematic process of information. The development of BI systems is limited due to its huge development costs. Developing the complex systems with Self Organized Multi Agent technology would reduce the building cost without affecting the scalability and reliability of the system. Hence, this paper presents a novel framework based on Self Organized Multi Agent technology for building the low cost BI systems.

Keywords- Business Intelligence; Self organized systems; Self Organized Multi Agent systems; BI framework.

I. INTRODUCTION

Decision making is a very crucial role in business organizations to meet the ever increasing competition and demands of the business. Appropriate Information/knowledge plays a very prominent role in effective decision making. Business knowledge is implied with in the business environment (both internal and external), data, past decisions, environment and other various core things like technical advancements, climatic conditions and government policies etc... In this scenario knowledge repositories and knowledge management systems have evolved for generating and managing the knowledge. Due to significance of appropriate knowledge generation from these repositories Decision Support Systems (DSS) and Business Intelligence (BI) systems have evolved. BI systems enable the organizations to take effective decisions through the systematic process of information. From the last two decades BI systems has become an enduring component in decision making in various organizations. BI is defined as a broad category of applications and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions. BI simplifies information discovery and analysis, making it possible for decision makers at all levels of an organization to more easily access, understand, analyze, collaborate, and act on information, anytime and anywhere [1]. BI provides the consolidation and analysis of data, and the capacity of processing data into the executable decision making information. It could enhance the competitiveness of enterprises by using different sources from customers,

operations and market information [2]. Expansion and popularization of BI systems has been drastically slowdown due to the affect of its building complexities and high construction costs.

Self Organized Multi Agent System technology supports high level scalability and robustness in building the complex systems with low cost [3]. Building the complex systems like BI based on Self Organized Multi Agent System Technology would definitely ensures the low cost solution.

Hence, this paper introduces a novel approach using Self Organized Multi Agent System Technology to design the low cost business intelligence system. The paper is organized as follows. Section 2 is dedicated to the brief review. Section 3 presents a novel design with framework using Self Organized Multi Agent System for building low cost BI systems. Finally, Conclusion follows.

II. RELATED WORK

Socio-economic reality of contemporary organizations has made organizations face some necessity to look for instruments that would facilitate effective acquiring, processing and analyzing vast amounts of data that come from different and disparate sources and that would serve as some basis for discovering new knowledge [4]. In order to be able to react quickly to changes that take place on the market, organizations need management information systems that would make it possible to carry out different cause and effect analyses of organizations themselves and their environments [21]. In this scenario information systems have evolved from traditional Management Information Systems (MIS) to highly intelligent Business Intelligence systems for. The various information systems are

- Management Information Systems (MIS)
- Decision Support Systems (DSS)
- Enterprise Systems (ES)
- Enterprise Intelligent Systems (EIS)
- Business Intelligent (BI) Systems

The evolution and complexity hierarchy of the various information systems can be depicted as below.

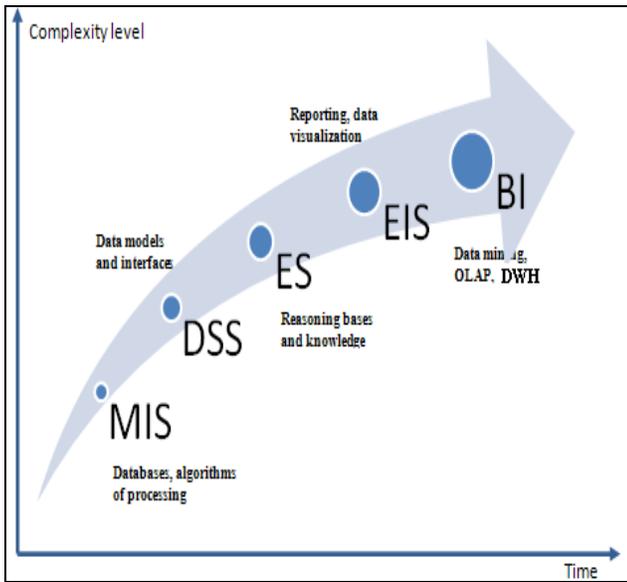


Figure 1: Evolution of Information Systems

BI is a business management term used to describe applications and technologies which are used to gather, provide access to and analyze data and information about an enterprise, in order to make better business decisions [5] [6] [7]. Efficient BI systems provides the well sophisticated functions and facilities for effectively analyzing the business information in order to support and to improve management decision making across a broad range of business activities. BI systems build upon the integration of Databases, Data warehousing technologies, Data Mining technologies, Web Services and Advanced Visualized Interfaces. The following diagram depicts the basic architecture of typical BI system

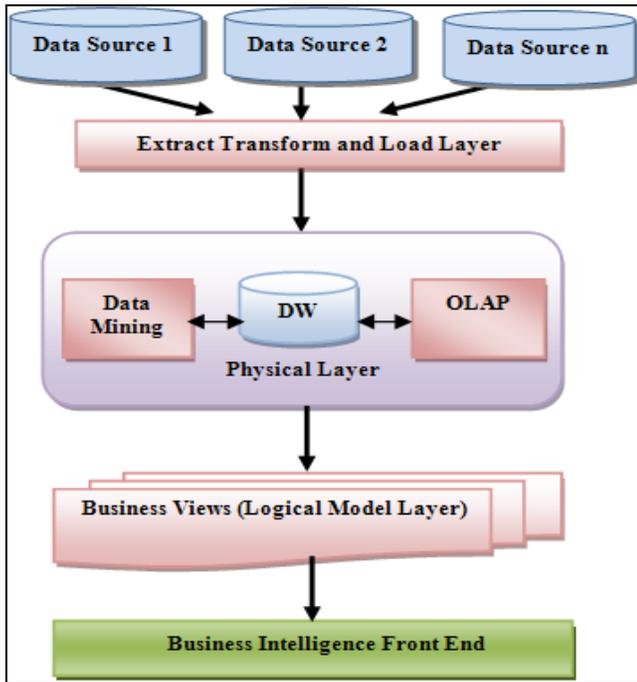


Figure 2: Architecture of typical BI System

In the traditional implementation of BI systems require high speed networks to transfer the data from the distributed data sources to the centralized data warehouse. The centralized data warehouse should have the high volumes of storage devices to store the transferred data. Traditional implementation of BI systems requires high speed networks and high volumes of storage devices, which are very costly. Hence, small and medium level enterprises found difficulty to build and maintain the BI systems due to the cost complexity in establishing and maintaining the high speed networks and high level storage devices. Various frameworks and architectures [8] [9] [10] have been evolved to minimize the cost of BI systems. We found, designing the BI systems based on Self Organized Multi Agent technology would minimize the building cost and enable the affordability by small and medium enterprises.

An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors [11]. Intelligent agents continuously perform the following three functions [12].

- Perception of dynamic conditions in the environment
- Action to affect conditions in the environment
- Reasoning to interpret perceptions, solve problems, draw inferences, and determine actions

Multi-Agent Systems (MAS) have attracted a great attention in developing the complex systems due to its scalability and reliability with low building cost. Multi-agent system is composed of a number of agents and completes the task through the communication between agents and the coordination with each other [13]. MAS reduces the development time and the complexity of implementing the software agents [14]. The following is the MAS framework.

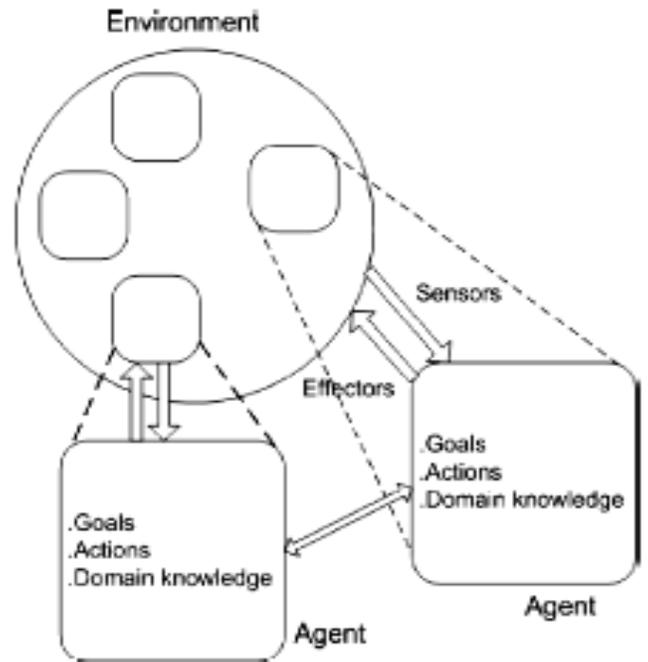


Figure 3: Multi Agent System Framework [15]

In MAS agents can be classified as Static agents and Mobile agents. Static agent resides at originating location and exchanges information with outside world through communication mechanisms and collaborates with other agents. It has the characteristics like autonomy, interaction, reaction and inventiveness. Mobile agent completes the user tasks other than at originating position by moving from one node to another node. Mobile agent characteristics are mobility, parallelism, asynchronism and resources optimization [16]. Integration of self organization with multi agent technology would effectively handle the agent organization, in Self Organized Multi Agent systems [17] [18] [19] [20], agents can be organized into configurations for useful application without imposing external centralized controls. In Self Organized Multi Agent technology each agent is an autonomous entity which can sense the environment and make certain judgments and reasoning by outside information. So it can make decision and control its own behavior to complete a certain task.

Building of BI systems on Self Organized Multi Agent system technology would avoid a lot of data transfer and storage, as the collaboration exists between the agents and primary tasks could be completed on the local at various stages such as data integration, data cleansing, online analytical processing and data mining etc.

III. BUSINESS INTELLIGENCE SYSTEM FRAMEWORK USING SELF ORGANIZED MULTI AGENT SYSTEM TECHNOLOGY

Implementing the BI system using Self Organized Multi Agent technology would minimize the cost, due to the

execution of various tasks by agents like data cleansing, extraction of metadata, querying, analyzing and mining the data etc. Executing the various tasks of BI with agents would reduce the data transfer and storage which minimizes the cost. The following is the BI system framework based on the Self Organized Multi Agent system technology.

The present framework consists of four layers; each layer is dedicated to execute one major task of the system. Each upper layer interacts with the lower layer through Web services. The four layers of the system are

- Application layer
- Business layer
- Data Cleansing layer
- Data Source layer

The core functionalities of the Data Source layer are to provide primary data services from various heterogeneous data resources to Data Cleansing layer and also establishing and maintaining the local metadata. In Data Cleansing layer, data will undergo the cleansing process for maintaining the data accuracy and integrity; this process would help to improve the information correctness. The Business layer provides the core functionality to the Application layer. The Application layer presents user interface to the user by establishing the connection to provide various services like querying, analyzing and mining the data to the user in an interactive and visualized mode.

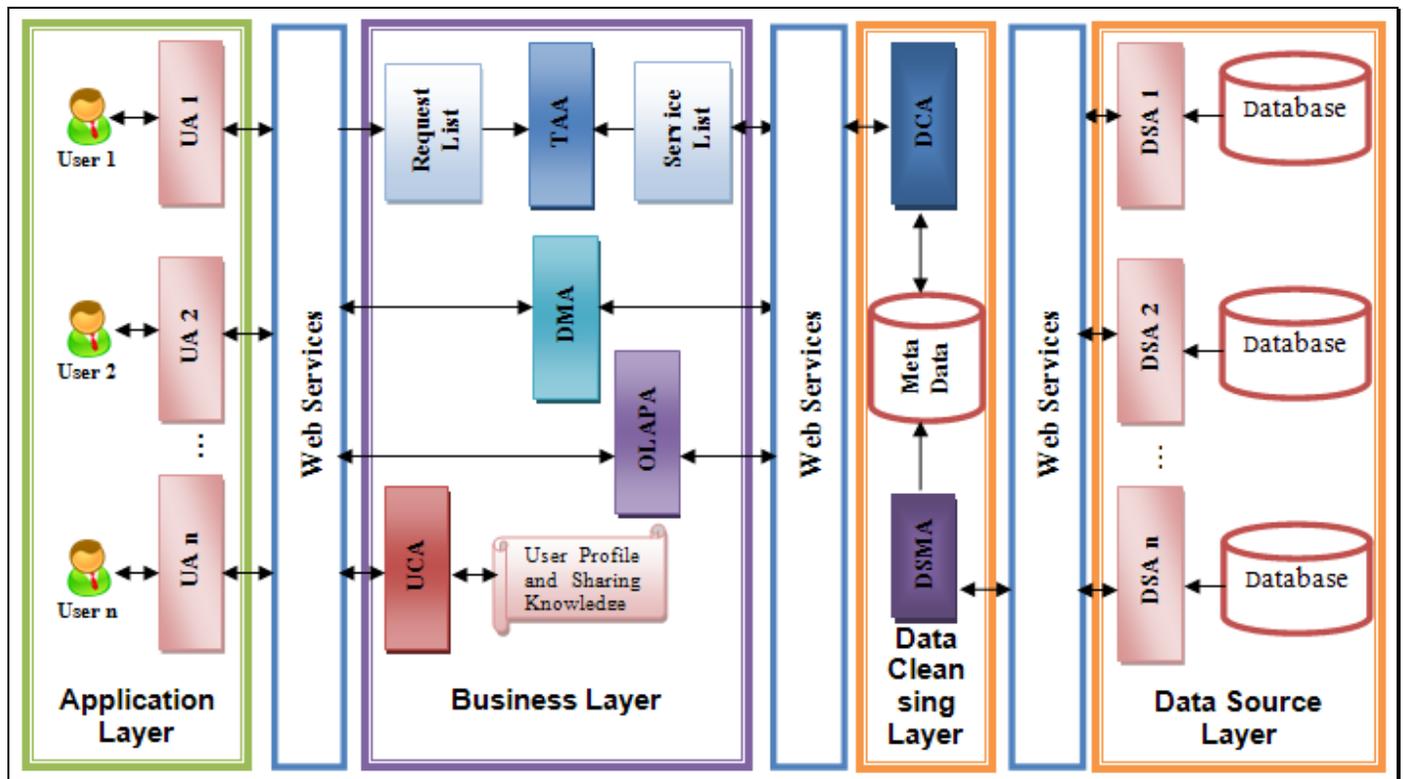


Figure 4: Self Organized Multi Agent technology based BI Framework

The above presented framework consists of multiple agents, among them the following are the core agents, which plays a vital role in implementation of the system.

- User Agent (UA)
- User Control Agent (UCA)
- Task Allocate Agent (TAA)
- Data Mining Agent (DMA)
- Online Analytical Processing Agent (OLAPA)
- Data Cleansing Agent (DCA)
- Data Source Management Agent (DSMA)
- Data Source Agent (DSA)

User Agent exists in the Application layer. User Control Agent creates the new user agent whenever a user logins the system and it will be destroyed whenever the user logouts. The functionality of this agent is to provide BI services to the user and it sends the requests to the request list. The results from the various agents will be presented to the user in visualized and interactive mode as per the user preferences.

User Control Agent exists in the Business layer. The main tasks of this agent are controlling the user agent, maintaining the user profiles and sharing knowledge, providing the querying on shared results, intelligently completing certain tasks on behalf of user as per the user history.

Task Allocate Agent exists in the Business layer. This agent assigns the tasks based on the requests and services; it manages the request list and service list. This agent carries out the requests by assigning them to the corresponding services.

OLAP Agent exists in the Business layer. This agent provides the online analytical processing services such as interactive analysis of data, allowing data to be summarized and viewed in a different way in an online fashion (with negligible delay). Also provides Multidimensional data analysis functioning.

Data Mining Agent exists in the Business layer. This agent provides the data mining services based on the various data mining techniques and algorithms. This agent is more intuitive, allowing for increased insight beyond OLAP agent, to analyze large databases to solve business decision-making problems. Also predict future trends and behaviors, allowing businesses to make proactive, knowledge-driven decisions. Data mining agent can answer business questions that traditionally were too time-consuming to resolve.

Data Cleansing Agent exists in the Data Cleansing layer. This agent applies the data cleansing services to the data obtained from the various data sources. Data Cleansing agent detects and removes the errors and inconsistencies of the data and improves the quality in data for processing.

Data Source Management Agent exists in the Data Cleansing layer. This agent monitors the various data sources

and local metadata of various data sources. It manages the global Meta data base. This agent receives the various data queries from the upper layer and these queries will be sent to the respected data source agents and integrates the results that are returned by the data source agent.

Data Source Agent exists in the Data Source layer. This agent manages heterogeneous data sources to provide the core data services to the upper layer. The core data services includes receiving of the data queries, extracting and mining the data to complete the respected task, providing datasets for query and analysis and managing the local Meta data for sending to the upper layer for maintenance of global Meta data.

IV. CONCLUSION

The above presented BI framework based on Self Organized Multi Agent technology would definitely improves the scalability and reliability of the BI system with reduced building cost and improves the affordability of the BI systems by small and medium enterprises. We will discuss the detailed implementation of the system along with evaluation reports in next paper. However, the initial test reports of the presented system are encouraging towards the production system.

ACKNOWLEDGMENTS

The authors thank the authorities and management of the Dravidian University, Kuppam, AP, India and Jawaharlal Nehru Institute of Technology (JNIT), Hyderabad, AP, India for the support extended to them for research in thrust areas of Computer Science.

REFERENCES

- [1] [http://technet.microsoft.com/en-us/library/cc811595\(office.12\).aspx](http://technet.microsoft.com/en-us/library/cc811595(office.12).aspx)
- [2] D. H. "Business Intelligence: Competing Against Time". Twelfth Annual Office Information Systems Conference. 1993. Gartner Group.
- [3] Florian Klein, Matthias Tichy. "Building Reliable Systems based on Self Organizing Multi Agent Systems". Available at: <http://www.irisa.fr/lande/lande/icse-proceedings/selmas/p51.pdf>
- [4] Celina M. Olszak and Ewa Ziemia. "Approach to Building and Implementing Business Intelligence Systems". Interdisciplinary Journal of Information, Knowledge, and Management vol 2. 2007.
- [5] Liya Wu, Gilad Barash and Claudio Bartolini. "Service Oriented Architecture for Business Intelligence". Available at : http://www.hpl.hp.com/personal/Claudio_Bartolini/download/soca07.pdf
- [6] C. Nicholls. "BI 2.0 – how real time Business Intelligence is irrevocably changing the way that we do business - In Search Insight". 2006. Available at: www.seewhy.com
- [7] C. White." Business Intelligence Network – The Vision for BI and Beyond". 2006. Available at : www.b-eye-network
- [8] Christoph Bussler . "B2B integration: Concept and architecture". Springer Berlin Heidelberg. 2003.
- [9] T. Ariyachandra and H. J. Watson. Key Factor in Selecting a Data Warehouse Architecture, Business Intelligence Journal, Vol. 10, No. 2. 2005
- [10] T. Ariyachandra and H. J. Watson. "Which Data Warehouse Architecture is Most Successful". Business Intelligence Journal, Vol. 11, No. 1. 2006.
- [11] S.J. Russell and P. Norvig. "Artificial intelligence a modern approach". Prentice Hall International, Englewood Cliffs, NJ. 2005.

- [12] B. Hayes-Roth. "An architecture for adaptive intelligent systems". Artificial Intelligence: Special Issue on Agents and Interactivity, vol.72. 1995.
- [13] W. J. Lin, J. L. Hong and X. H. Chen. "Expert Systems and multi-Agent Cooperative Systems". Computer Science, Vol. 25. 1998.
- [14] Armugam and Joshva Devadas. "Object Oriented Intelligent Multi-Agent System Data Cleaning Architecture to clean Preference based Text Data". International Journal of Computer Applications Vol-9. No-8. 2010.
- [15] J.P. Bigus and J. Bigus. "Constructing Intelligent Agents Using Java™", Second ed., John Wiley & Sons, New York. 2001.
- [16] X. Na, Z. W. Yun and P. Xin. "Research on Business Intelligence Model Based on Agent". Computer Applications and Software, Vol. 24. 2007.
- [17] Gleizes M.-P., Camp, V. and Glize P. "A Theory of Emergent Computation Based on Cooperative Self-Organisation for Adaptive Artificial Systems". 4th European Congress of Systems Science, Valencia. 1999.
- [18] Di Marzo Serugendo G., Gleizes M-P., and Karageorgos A." Self-Organisation and Emergence in MAS: An Overview". Informatica, this issue, Ljubljana, Slovenia. 2005.
- [19] Rodriguez S., Hilaire V., and Koukam A. "Towards a Methodological Framework for Holonic Multi-agent Systems". Proceedings of the Fourth Workshop on Engineering Societies in the Agents World (ESAW'03), pp. 31-45. 2003.
- [20] Van Parunak H. "Go to the Ant: Engineering Principles from Natural Multi-Agent Systems". Annals of Operations Research 75, pp. 69-101. 1997.
- [21] Power, D. "Supporting decision-makers: An expanded framework". Proceedings of the Informing Science and IT Education Conference. 2001. Available at: <http://proceedings.informingscience.org/IS2001Proceedings/pdf/PowerEBKSupp.pdf>

AUTHORS PROFILE



Venkatadri. M received his Masters Degree in Computer Science and Engineering from Acharya Nagarjuna University, India. He is currently associated with Information Technology and Computer Science & Engineering Departments of Jawaharlal Nehru Institute of Technology, Hyderabad, India. He is working towards Ph.D degree in Computer Science and Engineering in the area of Data Mining from Dravidian University, India. His area of interests includes databases, data warehousing and mining, and artificial intelligence.



Hanumat G. Sastry received his Masters' Degree in Computer Science from Vinayaka Missions' University, India. He is presently pursuing his Ph.D in Computer Science, Dravidian University, India. His area of interest includes databases, digital libraries, user interfaces, e-commerce and web technologies.



Manjunath.G received his Masters Degree in Engineering from Acharya Nagarjuna University, India. Presently, he is as an Associate Professor in Department of Computer Science and Engineering, Jawaharlal Nehru Institute of Technology –Hyderabad, India. His areas of interests are data mining and data warehouse, image processing,. He is working towards Ph.D degree in Computer Science and Engineering.