Implementing Fog-Cloud based Architecture for Master Data Management

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Abstract

To efficiently handle organizational transactions, master data is used as context for transactional data. Master data is a critical component of organizational data and master data management techniques are used to handle this. Commercial MDM solutions are of high cost and designed for large organizations. Due to high costs, Small and Medium-size Enterprises (SMEs) are unable to adopt Commercial MDM solutions. As an alternative to commercial solutions and to improve the response time of cloud-based MDM solutions, this paper provides a fog-cloud-based architecture to handle the master data. Presented architecture provides distributed access and handles the issues associated with the cloud-based MDM solution of SME. iFogSim simulator has been used to validate the proposed architecture Performance of the presented architecture was evaluated and compared with the cloud-based solution using simulation.

Keywords

Transactions, data processing, data sharing, response time, cloud.

1. Introduction

For enterprise activities related to quality assessment, updating, and enhancement are dependent on master data. Master data is operational data of the organization which requires minimal updates. Changes in master data are very difficult to implement and to perform changes in master data, special provision is required. Master data is a kind of operational data that has high worth, characterizes center data that helps in a basic dynamic and taking care of business forms over the venture. Master data management (MDM) is a process used to handle the master data. MDM is responsible for the creation, updating, and deletion of the master data [8, 9,12, 14]. Master Data Management is used for customer relationship management, client integration, employee relationship management, quality management, and other management activities. Master data provides information about business perspectives. It gives the base to the transactional data. Master is always non-transactional data and it provide basic attributes of the business. It includes person, place, price, item, and other enterprise-specific data [11,13-15].

MDM is a process, which is used to provide atomicity for master data, enhance the quality of data and process flow in an organization. Due to cost constraints SME's use simple MDM solutions based on either cloud architecture or a stand-alone approach. Cloud-based architecture generates high delay and faces network issues. In this study, we proposed a Fog-cloud architecture-based MDM solution. The proposed architecture uses fog computing approach to handle the response time and data access for MDM. According to this approach a copy of master data will be present in the fog layer that is near to the user. A complete description of this approach is given in third section. Section 2 provides a brief history of MDM. The fourth section provides results and discussion followed by the future scope and conclusion in the last section.

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2. Brief history

As per the studied literature, Siebel described the different categories of data used in organizations and defined the master data [14,15]. Many commercial MDM solutions were provided by big ventures like SAP, IBM, Oracle, Infosys, IBM, Google, Informatics, and TCS, etc. Apart from these big ventures, the research community also participated in this field. According to studied literature, it is observed that big ventures like IBM, SAP, etc. provided the solution of MDM for the large enterprises whereas after decade MDM solutions were also provided for the medium and small size enterprises using hybrid techniques, semantic frameworks, graph structures, and cloud-based solutions [2-6, 11, 14, 15]. MDM framework, maturity model, case studies were designed by the research community to understand the challenges, issues, and requirements associated with MDM [17,19-21]. A recent study highlighted the impact of COVID-19 on MDM [8]. To highlight the research journey in the field of master data, we provided an analysis of major publication from the year 1995 to till data in Figure 1.

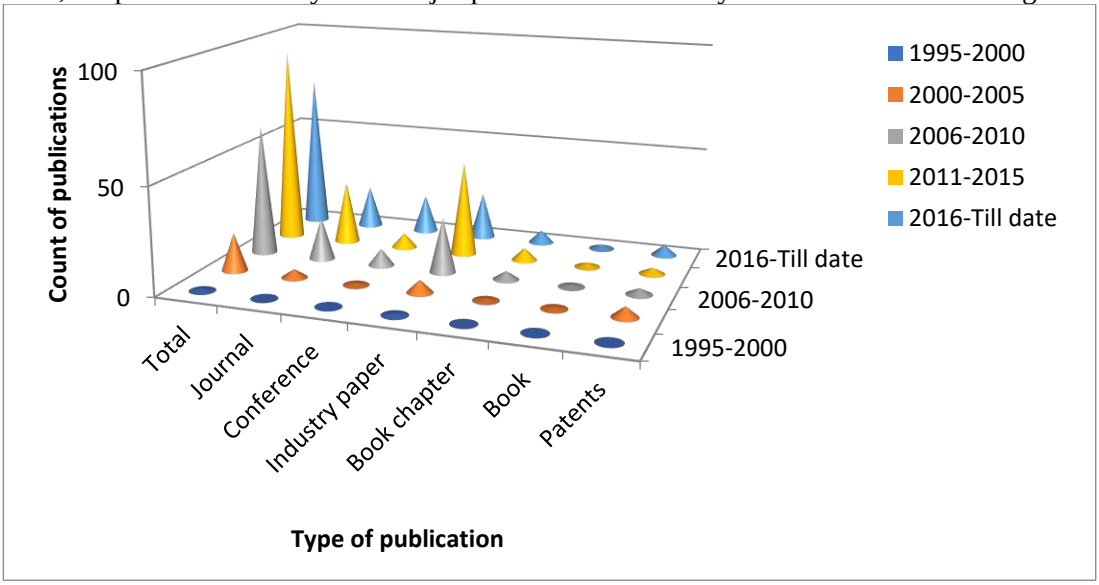

Figure 1: Master data and MDM publication trends and count

2.1 Identified Issues

Cloud based solutions are frequently used for SME having multiple operational sites. As per the studied literature, following are the key issues associated with SME based MDM solutions [1,7,9,13,18]:

- Presence of high cost MDM solution
- Lack of unstructured solution for SME
- Presence of cloud based or stand-alone MDM solution for SME
- Delay in processing the data of SME due to limitations associated with cloud architecture for cloud-based MDM

2.2 Problem Statement

For Small and Medium size enterprises, maintaining data integrity and consistency in existing MDM solutions is very expensive. Present standardize solutions for MDM are expensive for SME to adopt. Alternate to these solutions they use simple, cost-effective solutions. Most of these solutions are based on cloud computing approach and lack of strong internet may cause delay in data processing and slow system response. This paper focuses on the master data handling fog computing approach Ac-cording to this approach a copy of master data will be present in the fog layer that is near to the user. A complete description of this approach is given in the next section.

3. Proposed Architecture

Cloud computing is frequently used for business applications and organizations. Cloud computing-based applications are facing issues like reduced speed, poor spectral performance, high latency, low connectivity, and security concerns [16]. SME's create their own MDM solutions and these solutions are based on cloud or stand-alone system architecture. Cloud-based architecture generates high delay and faces network issues. The delay in processing is due to internet connection and traffic at the cloud channel [10,13,16,18].

Master data is very frequently used as reference data by users for daily operations but requires very fewer changes so considering this feature a Fog-cloud based architecture for the MDM process is proposed in this paper.

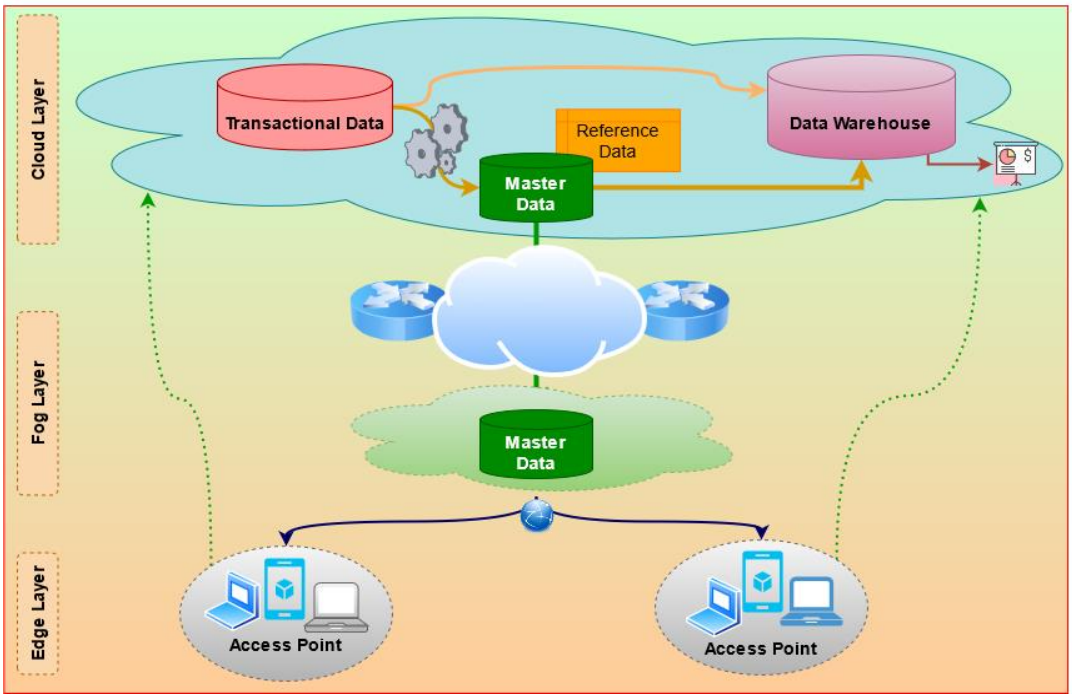

Figure 2: Fog-cloud based architecture for MDM to handle SME master data

This architecture uses fog computing approach to handle the MDM as shown in Figure 2. According to this architecture, the cloud layer handles all the data that includes transactional, master, reference, and data warehousing. Business intelligence is also part of the cloud layer. As master data requires very few updates so master creation process is executed at the cloud layer. This creation process includes operations like profiling, cleansing, consolidation and orchestration. After all the operations, a copy of master data is saved at the fog layer, which is near to users and users can use enterprise intranet to access that. Master data at fog layer registered as an observer with master data solution at cloud layer. Cloud layer automatically send a message for the update to fog layer.

A complete description of master data usage is shown in Figure 3. Following are the steps to access master data in Fog-cloud based architecture for the MDM:

1. Fog layer linked with cloud layer as observer, User ask for the data using User Interface
2. User system generate data query as per the user request
3. Query is executed at fog layer for Master data
4. Fog Layer respond to user
5. As per the update massage from cloud layer, fog layer holds the transaction and update the master data
6. Now fog layer process user queries using updated data

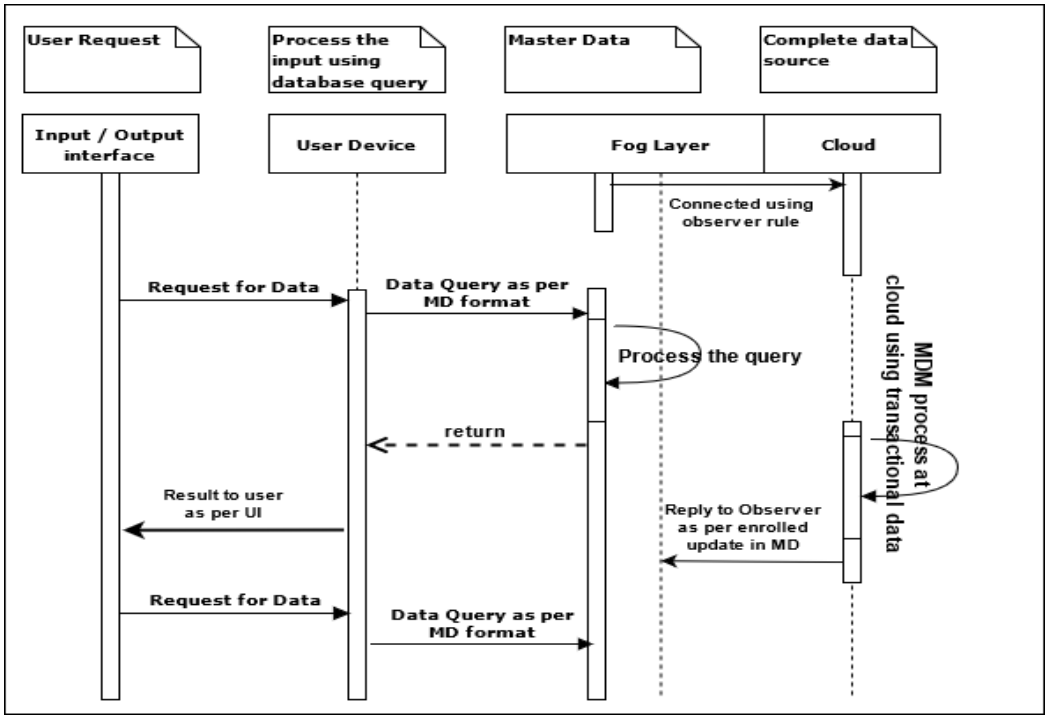

Figure 3. Interaction diagram for handling master data using fog-cloud-based architecture

4. Result and discussion

To validate Fog-cloud-based architecture for the MDM, the iFogSim simulator has been used. Data from food enterprise has been used for this experiment. Two operational sites have been considered in this simulation. Food items, their prize, location of joint, and owner details have been considered as master data. To check the performance, 100 queries have been executed on MDM and without the fog layer. Execution Time-based comparison of Fog-cloud-based architecture for the MDM with cloud-based approach using food joint data is shown in Figure 4. Accuracy-based comparison of Fog-cloud-based architecture for the MDM with cloud-based approach using food joint data 5. As per the Figure 4, Fog-cloud-based architecture for the MDM has less access time in comparison to the cloud-based approach. Figure 6 shows the effect fog architecture on response time with respect to no of query parameter. Though Fog-cloud based architecture for the MDM approach requires additional space for maintaining multiple copies of the master data. According to Figure 5, Fog-cloud based architecture for the MDM and cloud-based MDM have the same accuracy. This study checks query result accuracy based on 100 queries. These bulk queries were implemented using the SQL loader concept. One major challenge with Fog-cloud based architecture for the MDM is maintenance and update handling at the fog layer. An additional mechanism is required to make the consistency at both cloud and fog layers.

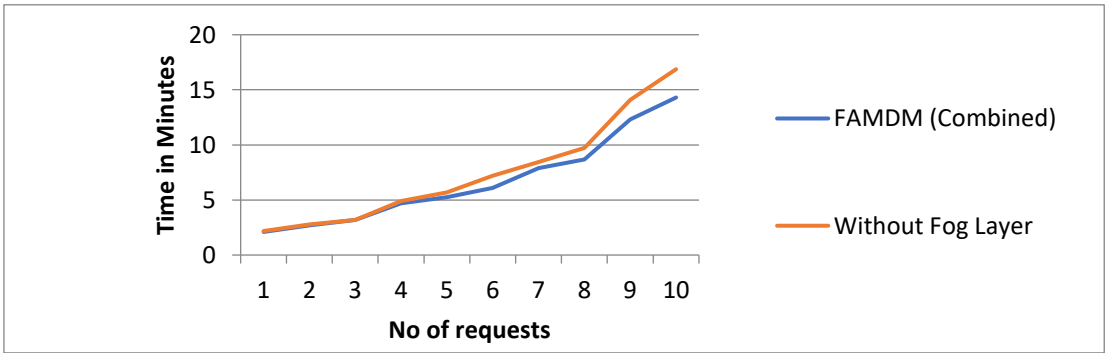

Figure 4: Execution Time based comparison of Fog-cloud based architecture with cloud-based approach using food

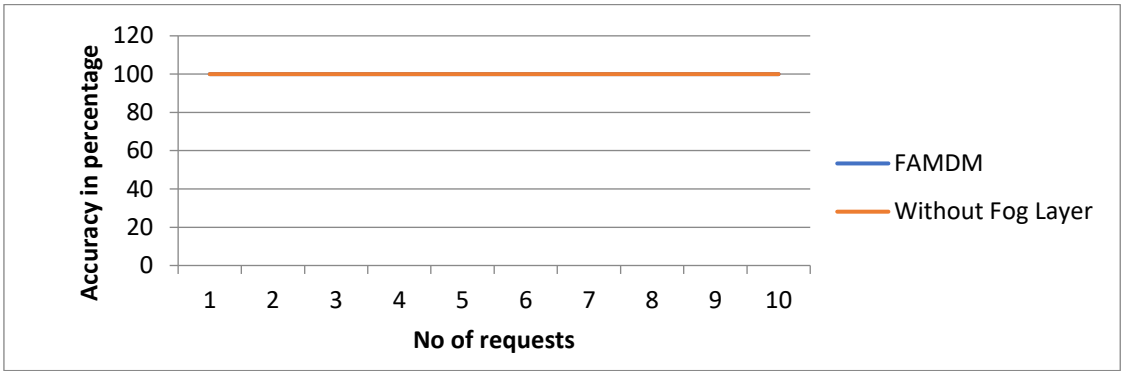

Figure 5: Accuracy based comparison of Fog-cloud based architecture with cloud-based approach.

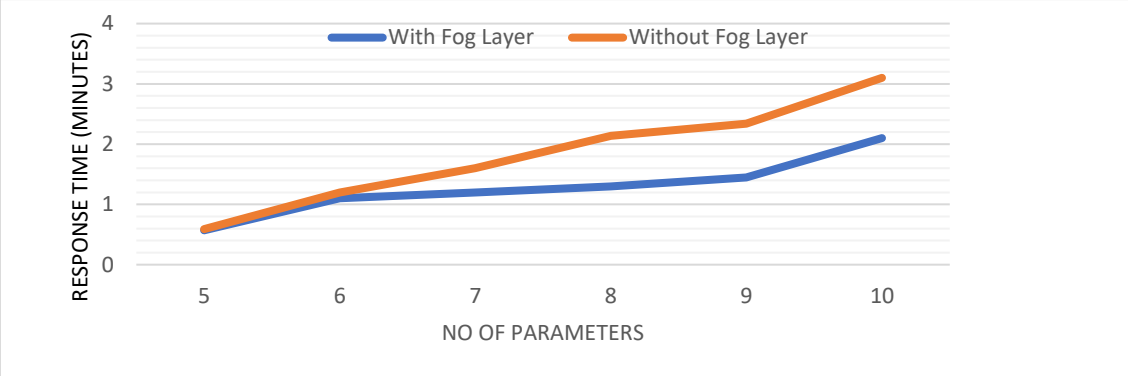

Figure 6: Effect of query parameters on response time

5. Conclusion and Future Scope

Market and economic operations depend heavily on master data. The academic group and the IT industry have produced several MDM technologies and frameworks. Due to high-cost SMEs cannot afford commercial MDM solutions and many cloud-based solutions were presented by the research community. These cloud-based solutions faced the issue of low response time and high processing delay. This paper provided fog-cloud-based architecture for MDM. iFogSim simulator has been used to validate the proposed architecture. Data of food joint with 100 queries have been used to validate Fog-cloud-based architecture. The proposed architecture provided the same accuracy and better performance than normal cloud-based architecture. Additional concurrency algorithm is required to maintain data consistency at both cloud and fog layers. One major challenge associated with the proposed architecture is to handle user queries while performing the update at the fog layer. In future, this approach can be implemented with consistency and concurrency control protocol. Security at the fog layer can also be added in future research.

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