



International Journal of Emerging Technologies in Computational and Applied Sciences (IJETCAS)

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Database Management - Inline Queries vs. Stored Procedures—An Extended Analysis

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Abstract: Computer based applications have become an inherent part of every important sector in our life like office work, gaming, research or any other field. The applications can be system/application software providing domain specific services. Not even a single application can be thought of without a direct or indirect database. It is very important to analyse and choose the best fit database management approach for efficient results. Query management is one important aspect of database management. Majorly, two approaches are used for this purpose: Inline Queries and Stored Procedures. This paper provides extended analysis of performance of both approaches during different operations followed with a recommended one in conclusion.

Keywords: Database Management, DBMS, SQL, Inline Query, Stored Procedures

I. Introduction

Computer based applications have become an inherent part of every important sector in our life like office work, gaming, research or any other field. The applications can be system/application software providing domain specific services. Not even a single application can be thought of without a direct or indirect database. Various types of database management systems have been there in market since the inception of computing. Database systems evolved from flat files to tables, relational databases, data marts, data warehouses and so on. It is very important to analyse and choose the best fit database management approach for efficient results as required by an organization. Most of the database systems are dependent on queries, general taken as SQL Queries for most of the systems. SQL queries are predefined set of statements which are fired on a database system to perform some operations like Searching, Insertion, Modifications, etc. So, Query management becomes one important aspect of database management. Majorly, two approaches are used for this purpose: Inline Queries and Stored Procedures. This paper provides extended analysis of performance of both approaches during different operations followed with a recommended one in conclusion.

II. Literature Survey

Thousands of companies depend on the accurate recording, updating and tracking of their data on a minute-to-minute basis. Employees use this data to complete accounting reports, calculate sales estimates and invoice customers. The workers access this data through a computerized database. A proven method to manage the relationships between the various database elements is the use of a relational database management system [1]. A database management system is important because it manages data efficiently and allows users to perform multiple tasks with ease. A database management system stores, organizes and manages a large amount of information within a single software application. Use of this system increases efficiency of business operations and reduces overall costs [2]. SQL statements are used to perform tasks such as update data on a database, or retrieve data from a database. Some common relational database management systems that use SQL are: Oracle, Sybase, Microsoft SQL Server, Access, Ingres, etc. Although most database systems use SQL, most of them also have their own additional proprietary extensions that are usually only used on their system [3]. In general, SQL queries are written within the source code of an application and called from within the application. When some data is to be passed in a query, with the information is passed directly through quotes or it is provided through query parameters. In former approach, a lot of security risks exist, SQL Injection attack to be the most popular one. Through parameterized queries, however, security risks are minimized but better approaches were still required for security and performance. SQL Stored Procedures then came into existence in which the code snippet of SQL Query is written and kept within DBMS environment rather than source code. Stored procedures offer several advantages over embedding queries in your Graphical User Interface (GUI). Your first thought may be: "Why tolerate the added development overhead?" After seeing the advantages, you may change your mind [4]. While many programmers still feel that Inline Queries are better. Following section will provide analytical comparison of both approaches.

III. Detailed Work and Methodology

In order to get an analytical comparison report, a dedicated web server along with database management system was deployed in Microsoft Windows 2008 Server. The database was created holding more than 4 Crore records

in one table and 25 lakh records in another and a web application was also developed which implements both approaches in question and queries through this database to provide analytical information.

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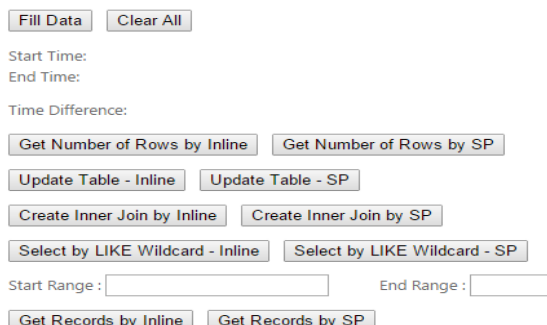


Fig. 1.1 Web Application developed

```
protected void Button4_Click(object sender, EventArgs e)
{
    string start = System.DateTime.Now.ToString();
    SqlCommand com = new SqlCommand("SELECT * FROM test WHERE id BETWEEN @e AND @f", con);
    com.Parameters.Add("@e", TextBox1.Text);
    com.Parameters.Add("@f", TextBox2.Text);
    com.CommandTimeout = 0;
    con.Open();
    SqlDataReader dr = com.ExecuteReader();
```

Fig 1.2 SQL Query within Source Code

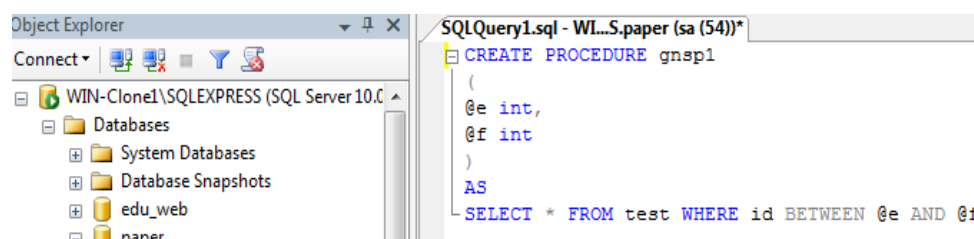


Fig. 1.3 SQL query inside Stored Procedure in Database Environment

A. Execution Time – Update Table

An update query was fired on the table with 25lakh records. Total number of affected records was counted through COUNT function of SQL using Inline queries and Stored Procedures from 8 remote machines. Following observations were drawn:

Start Time: 11:16:22 AM End Time: 11:18:08 AM Time Difference: 106 Total Record Updation Count is : 2500000	Start Time: 11:16:20 AM End Time: 11:17:09 AM Time Difference: 49 Total Record Updation Count is : 2500000	Start Time: 11:16:11 AM End Time: 11:16:48 AM Time Difference: 37 Total Record Updation Count is : 2500000	Start Time: 11:16:59 AM End Time: 11:18:20 AM Time Difference: 81 Total Record Updation Count is : 2500000
Start Time: 11:16:14 AM End Time: 11:17:19 AM Time Difference: 65 Total Record Updation Count is : 2500000	Start Time: 11:16:17 AM End Time: 11:17:44 AM Time Difference: 87 Total Record Updation Count is : 2500000	Start Time: 11:16:16 AM End Time: 11:17:31 AM Time Difference: 75 Total Record Updation Count is : 2500000	Start Time: 11:16:19 AM End Time: 11:17:55 AM Time Difference: 96 Total Record Updation Count is : 2500000

**Fig. 1.4 Time (in seconds) to update Records using Inline Queries
Mean Time Taken by 8 machines on Internet (Inline): 74.5 seconds**

Start Time: 11:39:46 AM End Time: 11:41:16 AM Time Difference: 90	Start Time: 11:39:43 AM End Time: 11:40:27 AM Time Difference: 44	Start Time: 11:39:34 AM End Time: 11:40:06 AM Time Difference: 32	Start Time: 11:39:35 AM End Time: 11:41:06 AM Time Difference: 91
Start Time: 11:39:37 AM End Time: 11:40:17 AM Time Difference: 40	Start Time: 11:39:39 AM End Time: 11:40:46 AM Time Difference: 67	Start Time: 11:39:40 AM End Time: 11:40:36 AM Time Difference: 56	Start Time: 11:39:41 AM End Time: 11:40:56 AM Time Difference: 75

**Fig. 1.5 Time (in seconds) to update Records using Stored Procedures
Mean Time Taken by 8 machines on Internet (SP): 61.87 seconds**

B. Execution Time – INNER JOIN

An Inner Join was fired on both tables such that out of 4 crore records, the 25 lakh record matching with other table are returned. Total number of affected records was counted through COUNT function of SQL using Inline queries and Stored Procedures from 8 remote machines.

Start Time: 11:53:32 AM End Time: 11:55:13 AM Time Difference: 101 Total Record Count is : 2500000	Start Time: 11:53:32 AM End Time: 11:55:13 AM Time Difference: 101 Total Record Count is : 2500000	Start Time: 11:53:32 AM End Time: 11:56:54 AM Time Difference: 202 Total Record Count is : 2500000	Start Time: 11:53:32 AM End Time: 11:56:54 AM Time Difference: 202 Total Record Count is : 2500000
Start Time: 11:53:35 AM End Time: 11:56:54 AM Time Difference: 199 Total Record Count is : 2500000	Start Time: 11:53:39 AM End Time: 11:58:24 AM Time Difference: 285 Total Record Count is : 2500000	Start Time: 11:53:44 AM End Time: 11:58:24 AM Time Difference: 280 Total Record Count is : 2500000	Start Time: 12:19:34 PM End Time: 12:23:52 PM Time Difference: 258 Total Record Count is : 2500000

Fig. 1.6 Time (in seconds) to complete an Inner Join using Inline Queries
Mean Time Taken by 8 machines on Internet (Inline): 203.5 seconds

Start Time: 12:29:29 PM End Time: 12:33:24 PM Time Difference: 235 Total Record Count is : 2500000	Start Time: 12:29:27 PM End Time: 12:33:24 PM Time Difference: 237 Total Record Count is : 2500000	Start Time: 12:29:18 PM End Time: 12:30:41 PM Time Difference: 83 Total Record Count is : 2500000	Start Time: 12:29:18 PM End Time: 12:30:41 PM Time Difference: 83 Total Record Count is : 2500000
Start Time: 12:29:19 PM End Time: 12:30:43 PM Time Difference: 84 Total Record Count is : 2500000	Start Time: 12:29:23 PM End Time: 12:32:04 PM Time Difference: 161 Total Record Count is : 2500000	Start Time: 12:29:24 PM End Time: 12:32:04 PM Time Difference: 160 Total Record Count is : 2500000	Start Time: 12:29:25 PM End Time: 12:32:04 PM Time Difference: 159 Total Record Count is : 2500000

Fig. 1.7 Time (in seconds) to complete an Inner Join using Stored Procedures
Mean Time Taken by 8 machines on Internet (SP): 150.25 seconds

C. Execution Time – Search with Pattern Matching using LIKE and wildcards

A search query was fired on the table having of 4 crore records with LIKE clause using the Wildcard: %lh%. Total number of affected records was counted through COUNT function of SQL using Inline queries and Stored Procedures from 8 remote machines.

Start Time: 1:31:47 PM End Time: 1:36:39 PM Time Difference: 292 Total Record Count is : 9900001	Start Time: 1:31:47 PM End Time: 1:36:39 PM Time Difference: 292 Total Record Count is : 9900001	Start Time: 1:31:47 PM End Time: 1:36:39 PM Time Difference: 292 Total Record Count is : 9900001	Start Time: 1:31:47 PM End Time: 1:36:39 PM Time Difference: 292 Total Record Count is : 9900001
Start Time: 1:31:48 PM End Time: 1:36:39 PM Time Difference: 291 Total Record Count is : 9900001	Start Time: 1:31:48 PM End Time: 1:36:39 PM Time Difference: 291 Total Record Count is : 9900001	Start Time: 1:31:55 PM End Time: 1:36:39 PM Time Difference: 284 Total Record Count is : 9900001	Start Time: 1:32:02 PM End Time: 1:36:39 PM Time Difference: 277 Total Record Count is : 9900001

Fig. 1.8 Time (in seconds) to complete Wildcard based Pattern Search Operation using Inline Queries
Mean Time Taken by 8 machines on Internet (Inline): 288.87 seconds

Start Time: 1:03:17 PM End Time: 1:05:00 PM Time Difference: 103 Total Record Count is : 9900001	Start Time: 1:03:17 PM End Time: 1:05:00 PM Time Difference: 103 Total Record Count is : 9900001	Start Time: 1:03:20 PM End Time: 1:05:00 PM Time Difference: 100 Total Record Count is : 9900001	Start Time: 1:03:21 PM End Time: 1:05:00 PM Time Difference: 99 Total Record Count is : 9900001
Start Time: 1:03:22 PM End Time: 1:05:00 PM Time Difference: 98 Total Record Count is : 9900001	Start Time: 1:03:24 PM End Time: 1:05:00 PM Time Difference: 96 Total Record Count is : 9900001	Start Time: 1:03:26 PM End Time: 1:05:00 PM Time Difference: 94 Total Record Count is : 9900001	Start Time: 1:03:28 PM End Time: 1:05:00 PM Time Difference: 92 Total Record Count is : 9900001

Fig. 1.9 Time (in seconds) to complete Wildcard based Pattern Search Operation using Stored Procedures
Mean Time Taken by 8 machines on Internet (SP): 98.125 seconds

D. Consumption of Resources on Server

SQL Query was fired on this database using Inline queries and Stored Procedures over Internet from 8 remote Computers connected through Internet over Broadband. Stored Procedures use precompiled form of its database logic while inline queries are compiled and executed each time they are fired. Also, stored procedures support the feature of information caching for better performance. Following CPU Load observations from a Dual Core CPU were drawn:

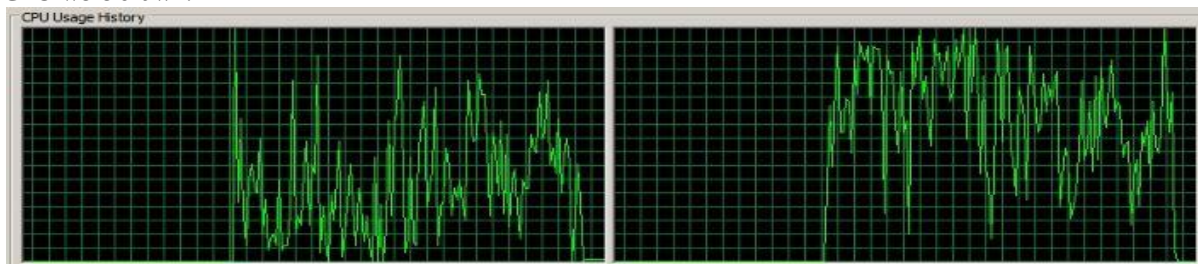


Fig. 1.10 CPU Load – Update Table by Inline on 8 remote machines over Internet

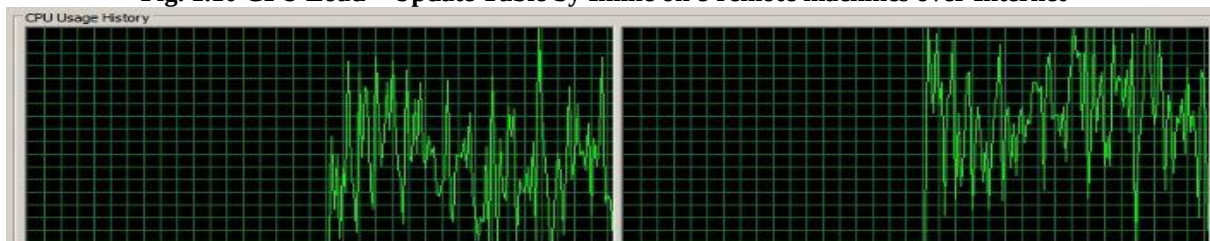


Fig. 1.11 CPU Load – Update Table by Stored Procedures on 8 remote machines over Internet



Fig. 1.12 CPU Load - Inner Join by Inline on 8 remote machines over Internet

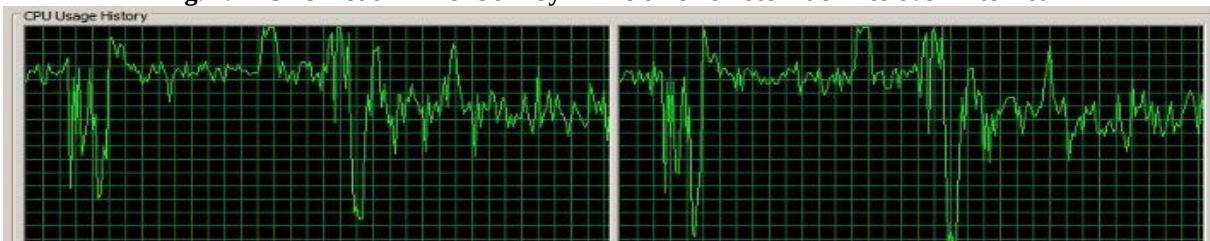


Fig. 1.13 CPU Load - Inner Join by SP on 8 remote machines over Internet

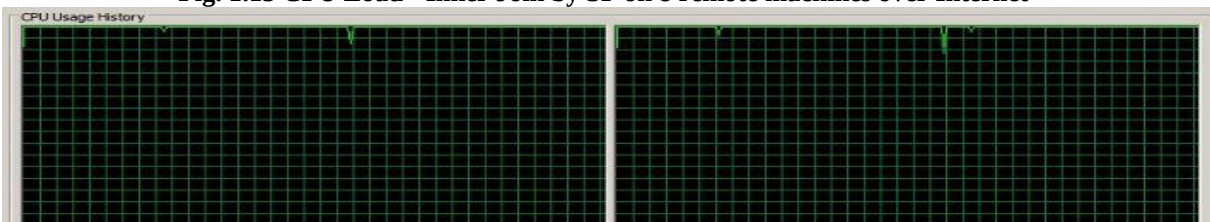


Fig. 1.14 CPU Load (100%) – Pattern Search by Inline on 8 remote machines over Internet

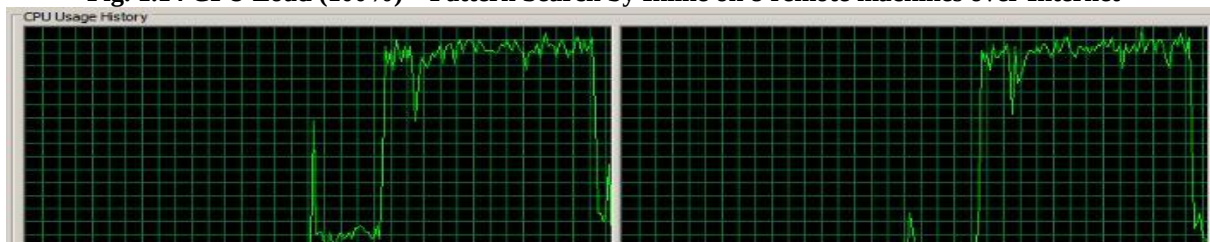


Fig. 1.15 CPU Load – Pattern Search by SP on 8 remote machines over Internet

E. Observations Summary

Sr. No.	Task	Time Taken (in seconds)	
		Inline Queries	Stored Procedures
1	Records counted on local system [5]	89	87
2	1 lakh Records fetched on local system [5]	95	93
3	Records counted on Intranet (Mean of two machines) [5]	91	71
4	1 lakh Records fetched over Intranet (Mean of two machines) [5]	86.5	72.5
5	Records Counted over Internet (Mean of 8 machines) [5]	81.12	64.87
6	1 lakh Records fetched Internet (Mean of 8 machines) [5]	225.87	95.5
7	Update Records over Internet (Mean of 8 machines)	74.5	61.87
8	Inner Join Over Internet (Mean of 8 machines)	203.5	150.25
9	Wildcard based Pattern Searchig over Internet (Mean of 8 machines)	288.87	98.125

Table 1.1: Observation Summary

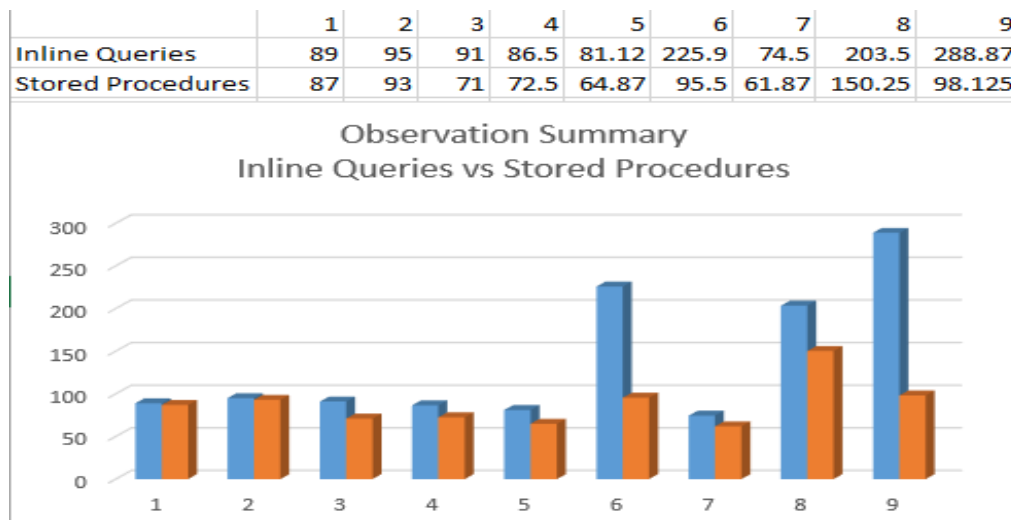


Fig. 1.16 Observations Summary - Graphical

IV. Conclusion

So, from the above details statistics and summary chart, it is easy to draw the conclusion that under all parameters and circumstances, using Stored Procedures are definitely a superior approach, especially when load increases in terms of number of users and amount of information required.

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