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Performance Optimization of PLM System

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ABSTRACT / EXECUTIVE SUMMARY

Product Lifecycle Management (PLM) is a software application-based business approach to support the collaborative creation, management, dissemination and use of product definition information. PLM applies to product information from concept to end of life—integrating people, processes, and information. PLM technology has become the backbone of product design and development for many companies across the globe. PLM system involves different layers of deployment such as Database, Web server, Operating system, Network, Storage system, Servers and clients, etc.

System Performance is the "Transaction time as perceived by the end-user - conforming to requirements". Optimized performance of all the IT components of the PLM system will ensure successful product design and development. Optimization will generally focus on improving just one or two aspects of performance: execution time, memory usage, disk space, bandwidth, power consumption or some other resource. This will usually require a trade-off - where one factor is optimized at the expense of others.

An effort is made in this research for analysis of the different deployment components of the PLM system, which greatly influence the optimization of system performance. By analyzing the interview survey based primary research results in detail, the researcher has identified three focus areas, since these are found to be the highly potential areas which influence the system performance. [Ref. 5].

Experimental research methods are used to further validate the findings from the interview based primary research and to determine the best possible approach with recommendations. All the three potential areas are analyzed on different platforms such as Microsoft Windows, UNIX and Linux. [Ref. 6 to 9].

Based on the experimental research results analysis, the researcher has recommended a very comprehensive holistic approach for PLM system performance optimization as "Nine Step Approach to PLM system Performance Optimization". Steps 1 to 3 are the preliminary actions needed before the actual optimization effort. Steps 4 to 9 are shown with increasing effort needed and also increasing cost/time involved for implementation. These steps are recommended to be followed in the same chronological order from 1 to 9 to achieve optimized system performance.

Keywords: **Deployment Architecture, Performance Optimization, PLM System, Product Lifecycle, System Performance.**

1. INTRODUCTION

The core of the company's value remains in its products. The future of a company is dependent on the successful launch of new innovative products and services. Innovation is the leading topic for business executives today. The second topic for business executives is the need for easy access to right information, at right time and with right context.

As the trend to globalization continues to accelerate, the need for effective means of collaboration continues to become more and more important. As organizations embrace Design Anywhere, Build Anywhere, and Service Anywhere (DABASA) objectives, they will need to create the equivalent of the project collaboration room in virtual space.

Globally competitive industry demands PLM—a business strategy that seeks to enable innovation of an enterprise's product and product definition related processes, making sure that the enterprise's people, processes, and technologies are continuously improved in a closed-loop fashion. The importance of PLM is heightened due to the fact that today's industry need to continue to shorten time-to-market while at the same time designing more complex globally-acceptable products and associated manufacturing capabilities.

Product design is the backbone of every industry. Product design IT systems consist of 2D/3D CAD applications, Finite Element Analysis (FEA) systems, Digital Simulation systems, Design Calculation software, Product Data Management (PDM) systems, Tool Design systems, Surface Design Software, etc. which are managed by Product Lifecycle Management (PLM) system. Today's products are filled with an ever-increasing number of complex electromechanical systems that include a significant amount of embedded software.

This Product Lifecycle Management (PLM) system necessarily involves smooth integration with different Databases, Web servers, Project Management systems, Enterprise Resource Planning (ERP) systems, Supply Chain Management (SCM) systems, Customer Resource Management (CRM) systems, Legacy systems, Manufacturing automation systems, etc. [Ref. 3].

PLM today has evolved to an enterprise application at the same level as ERP, CRM and SCM and, unlike these applications which are more transaction and cost reduction focused; PLM is emerging as the application set which underpins a global environment for growth and innovation.

CIMdata defines Product Lifecycle Management (PLM) as a strategic business approach that applies a consistent set of business solutions in support of the collaborative creation, management, dissemination, and use of product definition information across the extended enterprise from concept to end of life—integrating people, processes, and information.

Throughout the history of computers, a primary design goal in all systems has been to achieve maximum performance. Optimized performance of all the sub systems of PLM system will ensure successful product development. Any one system suffering from performance bottleneck will

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hamper the total Product Design and Development cycle. When the application is running into the limits in every dimension, including fully utilized CPU, fully optimized performance is achieved.

In many real-life systems, including PLM systems, the application performance is far from optimal. A lot of improvement can often be achieved by measuring how the system behaves and configuring the system optimally. Optimization will generally focus on improving just one or two aspects of performance: execution time, memory usage, disk space, bandwidth, power consumption or some other resource. This will usually require a trade-off - where one factor is optimized at the expense of others.

It is important to note here that bottlenecks occur at various points in a PLM system. Determining the bottlenecks is a step-by-step procedure of narrowing down the root causes. Root-Cause analysis involves analysis diagrams such as fish bone diagram, including "Cause Elimination Algorithms". Performance optimization is relatively a complex process that requires correlating many types of information, to locate and analyze performance problem bottlenecks.

All the possible causes for the performance issue are entered into a fish bone diagram format showing clearly which particular cause effects at specific level and the correlation between these candidate causes. Each of these causes is eliminated by conducting specific controlled experiment and performance tests. This is an iterative process and has to be conducted with properly controlled boundary conditions.

2. ANALYSIS

This research focus is on the need to optimize PLM system performance and the areas that need to be focused for achieving optimized performance of PLM system. After finding out the specific gaps in the area of research from the secondary literature survey, the researcher has formulated the research design to find answers to the identified gaps. Methodology used for this research is as below:

a. Secondary research literature survey is conducted to study the current status in the performance optimization area of Product design IT systems and the gaps are identified specific to this research focus.

b. Interview based primary research survey is conducted to identify potential areas to optimize product design system performance by Interviewing many practicing managers/engineers from Indian and global companies. A structured questionnaire was administered with the purpose of collecting necessary information regarding potential areas to be focused for optimization of the PLM system performance. Following three areas having maximum potential for performance optimization are selected as focus areas for this research based on the analysis and interpretation of responses. [Ref. 5].

- Software Parameters Tuning
- Deployment Architecture
- Hardware Infrastructure Sizing

c. Experimental research methods are used to analyze the three potential areas and determine the optimization methods in these areas. All the three potential areas are analyzed on different platforms such as Microsoft Windows, UNIX, and Linux. [Ref. 6 to 9].

Based on the exhaustive literature survey thro' this research work and experimental research results, the researcher has identified that an integrated comprehensive methodology for PLM system optimization is not available. As PLM system involves different layers of deployment such as database, Web server, Operating system, Network, Storage system, Servers and clients, etc., a holistic optimization method involving all these layers of PLM system is missing.

This need of a pragmatic wholesome methodology is analyzed by the researcher and a new systematic "Nine Step Approach" method is suggested.

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3. RESULTS AND DISCUSSION

The system performance optimization process basically consists of the following steps:

a) Define the performance problem and identify the key transactions facing performance issues.
b) Identify the bottlenecks and possible causes.
c) Carryout "root cause analysis" using fish bone diagram.
d) Eliminate the root causes one by one using "cause elimination approach" to narrow down to specific root causes.
e) Remove the root cause bottlenecks by appropriate performance optimization methodologies.
f) Repeat steps b to e, until we have a satisfactory optimum performance.

Based on the experimental research results analysis, the researcher has recommended a "Nine Step Approach to PLM system Performance Optimization". Steps 1 to 3 are the preliminary actions needed before the actual optimization effort. Steps 4 to 9 are shown with increasing effort needed and also increasing cost/time involved for implementation. These steps are recommended to be followed in the same chronological order from 1 to 9 to achieve optimized system performance.

1. As-Is System Testing and identification of slower transactions
2. Baseline Parameters Tuning
3. Baseline System Testing to arrive at baseline system performance values
4. Specific Parameters Tuning for performance optimization with iterative testing
5. Deployment Architecture changes implementation for performance optimization with iterative testing
6. Hardware Infrastructure changes implementation for optimized system performance and also for maximizing the usage of available hardware
7. Software Version updates to resolve compatibility issues and for better performance
8. Software Code Optimization and de-customization
9. Other practically feasible optimization efforts such as:
    - Network Infrastructure improvement
    - Hierarchical Storage Management (HSM)
    - Business Process Re-engineering (BPR)
    - Virtualization of hardware system
    - Cloud Computing approach, etc.

This approach is used by the researcher for PLM system performance optimization at various companies across the globe and it is found to be the best possible method to achieve optimized PLM system performance within the practical constraints faced by the specific industry. The recommended "Nine Step Approach" to PLM system performance optimization is shown diagrammatically in Figure1.

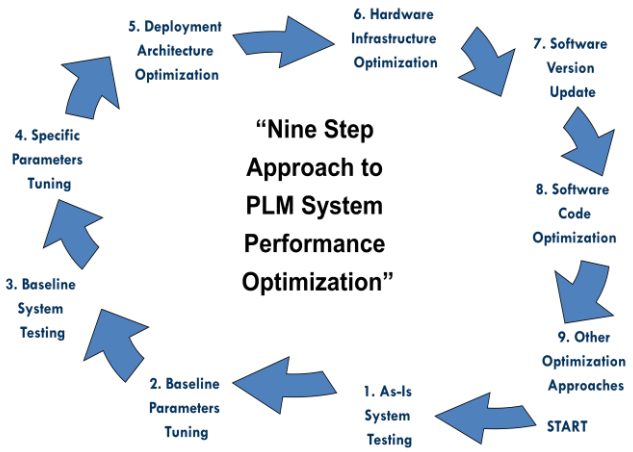

Figure1: Nine step Approach to PLM system Performance Optimization

Preliminary action steps1 to 3 and the step4 on Parameters Tuning for performance optimization are explained in detail in Reference 8. The default installation parameters setting of most of the applications such as PLM, Database, Web application, OS, etc will not be at the optimum performance level for specific installation of the PLM system. The most effective way to tune the system is to have an established performance baseline that can be used for comparison if a performance issue arises. [Ref. 8].

Step5 on Deployment Architecture Optimization is explained in detail in Reference 9. Measurements have shown that deployment of 2-tier clients over WAN results in very unacceptable performance. Any client not on the same LAN as the Web and Enterprise tiers should be deployed as 4-tier. Performance is noticeably slower if the network latency exceeds 5–10 ms between PLM application server process and database server. For optimal performance, it is recommended that the PLM application server reside on the same Gbit LAN as the database server. It is always recommended to configure separate server machines for Database, PLM Application, Web application and Data Volume. This will provide greater flexibility in vertical and horizontal scalability including load balancing at each layer of PLM deployment. [Ref. 9].

Step6 on Hardware infrastructure Optimization is presented with detailed experimental research in Reference 6. Companies need to ensure that the servers used for PLM system deployment meet the sizing requirements as calculated and this calculated size is the minimum needed size for the specific number of concurrent users to achieve desired end user performance.

This sizing calculation result can be used to procure properly sized server machines for new implementations. In case of existing deployment infrastructure, this calculation will help to maximize the usage of existing hardware. Companies can determine the number of concurrent users that can be deployed on the existing

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infrastructure for optimal system performance. When the number of concurrent users deployed on the PLM system equals the calculated value, the PLM system is on "Break-Even". At this point, the PLM system will not have resource bottleneck affecting the end user performance.
If more users are added, the system performance will deteriorate. Any system performance optimization efforts on hardware infrastructure will be futile, unless the infrastructure is upgraded and/or enhanced to the calculated value for the increased number of concurrent users. If less numbers of users are deployed, infrastructure usage will not be maximized, resulting in under utilization of available resources. [Ref. 6].
Steps 7 to 9 are areas reserved for Future Research in this technology field. These areas are identified as the potential root causes for PLM system performance issues by the interview survey respondents, but with lower ranking for their impact on performance optimization.

- Software Version updates to resolve compatibility issues and for better performance
- Software Code Optimization and de-customization
- Other practically feasible optimization efforts such as Network Infrastructure improvement, Hierarchical Storage Management (HSM), Business Process Re-engineering (BPR), Virtualization of hardware system, Cloud Computing approach, etc.

The optimization effort needed for these steps is very high and the costs involved are also expected to be very high compared to the areas of optimization under steps 1 to 6, covered in this research. Any system performance optimization efforts will be futile, unless the costs involved with such optimization effort are reasonably substantiated to achieve the company goals and objectives. Hence the effort on these steps depends on the target organization.
Some of the areas such as Cloud computing, Virtualization, HSM, etc. involve latest/newer technology and are still under development by the technology companies involved.

4. CONCLUSION

The results and conclusions from this research can be used at most of the industry segments such as Aerospace industry, Ship building industry, Automobile industry, Electronics industry, Consumer durables industry, Pharmaceuticals, etc., who have implemented PLM system for their product design function.
System performance optimization of product design IT systems will indirectly result in optimization of the following related areas also:

- Productivity improvements will happen in the product design process and new product development process, thus keeping the overall development cost down.
- Shortening of the development timeline happens; thereby the right product is released to market before the competitor and maximize early market share.
- New improved empirical deployment architecture frameworks will help unlock, practices with which managers can deploy well-coordinated global product development strategies.
- Faster average time required to implement a design change in the current product design will improve the overall reliability of the product.
- Faster average time required for searching available information helps in increased re-use resulting in cost savings on inventory/purchase functions.

This research is focused on the PLM system used in the product design area of the automobile industry. These results are not applicable to other IT systems such as SAP, CRM, SCM, etc., even though these systems are also used in product design area by the industry.

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