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Change Requests Analysis Internal Document

Introduction

This document describe the analysis of a three change requests (CRs) analysis conducted for the Lennard Jones simulation system, as proposed by our clients. The change requests are:

CR1:

Due to a new government law on quality assurance of simulation software, any software release should be tested with a dataset containing 100,000 data samples to verify the accuracy of simulation. The samples and reports should be provided to the government IT office to get the approval for release, the approval time is 15 days.

CR2:

The client wants to increase the number of users for the software, therefore, the client requests to include the following simulation methods:

- Molecular dynamics
- Montecarlo methods
- A module to simulate solids
- A module to simulate liquids
- A module to simulate plasma

CR 3:

Due to compatibility reasons, the client desires that the simulation should be developed using an open-source numerical package. This numerical package is new for you, and the learning curve is at least one week.

In the following sections of this document, we analyze the change request (CR) from several fundamental perspectives that are essential for the overall development of the project.

Description of the Document

In the following sections of this document, we analyze each of these CRs from several fundamental perspectives that are essential for the overall development of the project.

Criteria for Identifying Configuration items

The first step in every configuration management (CM) process is to analyze the configuration items (CIs). In this document, we will use the following definition for CIs:

"A configuration item is a module, or part of a system that needs to be modified in order to meet the needs of a change request (CR)"

We consider three modules for our original system:

- GUI
- Simulation module
- Output module

For assessing the impact of a CR on a given module we consider the following criteria:

1. Functionality: to evaluate if implementing a CR would require to add, remove or modify the existing functionality of a module.
2. Data: to assess if the type of data that the module receives, outputs or processes is compatible with the needs of the CR.
3. Performance: to assess if the predefined computational resources of the system will suffice the CR's computational intensity.
4. Dependencies: to check if the module depend on other modules or components that may be affected by the change request.
5. Documentation: to check if the request requires modifications to the existing documentation or the addition of new documentation to reflect the changes made to the module.

Metrics: criteria and scales

The following tables present some of the metrics used for the analysis of each CR.

Technical analysis

Metric name	Low	Medium	High
Code coverage risk	Below 20%	20%-50%	Above 50%
Technical Debt	Below 10% of available time	10%-20% of available time	Above 20% of available time

Financial analysis

Metric name	Low	Medium	High
Net revenue risk	Below 20%	20%-50%	Above 50%
Return time risk	Before 12 months	12-18 months	After 18 months
Return of investment	Below 10%	10% -20%	20%

PR analysis

Metric name	Low	Medium	High

Referral rate (with respect to current number of clients)	Below 10%	10%-20%	Above 20%
Probability of repeat	Below 30%	30-60%	Above 60%

CR1 Analysis

Statement analysis

After an initial review of the change request (CR), it becomes clear that there is ambiguity regarding the definition of a "dataset containing 100,000 samples." Based on this observation, we have identified two potential scenarios for satisfying the government's new regulation:

- **Scenario A**: The government IT office requires a set of 100,000 data points to assess the accuracy of the system. In this case, the company can generate a simulation with a number of timesteps equal to or greater than the required quantity and save the system measurements for each timestep into a file. This functionality is already present in the proposed software system.
- **Scenario B**: The company is required to provide data from 100,000 independent simulations to comply with the regulation. However, given the high computational and time-intensive nature of these simulations, Scenario B requires further consideration and can be further divided into two sub-scenarios:
    - **B.1**: If the legislation does not specify the characteristics each simulation must possess to be accepted in the dataset, the company could perform simulations with small timesteps and a low upper bound on the number of timesteps to generate the required dataset.
    - **B.2**: If there are specific parameters for the simulations in the dataset, the output of this scenario would be similar to that of B.1 if the simulations are not time-intensive. However, if the simulations are lengthy due to their characteristics, this scenario could be risky for the whole project development.

It is important to note that additional clarification from the government IT office is necessary to determine the most appropriate course of action for complying with the new regulation.

To analyze accuracy compliance in the context of the system, you could start by defining what accuracy means in this particular case. Since the system is chaotic, it is important to consider the thermodynamical properties of the system in the accuracy analysis.

One approach to testing for accuracy could be to compare the results obtained from the velocity Verlet integration with a reference solution. We could use various error metrics, such as the mean absolute error, root mean square error, or relative error, to quantify the accuracy of the numerical solution.

Another approach could be to perform simulations at different time and number of particles resolutions and compare the thermodynamical properties of the system, such as temperature, pressure, and energy, with the expected values. The expected values could be obtained from analytical calculations or reference simulations with higher accuracy.

It is important to note that the new regulation might specify the accuracy requirements for the system, or provide guidelines on how to test for accuracy. If this information is available, it should be taken into consideration when designing the accuracy tests.

Finally, it is crucial to ensure that the accuracy tests are performed in a consistent and reproducible manner. This implies maintaining the traceability for the initial conditions, parameters, and numerical methods for all simulations.

Analyzing the quantity of data that must be provided to the government IT office

Affected configuration items by CR1

After checking the criteria for identifying the affected configuration items, we conclude that none of the main modules of the system, namely the GUI, Simulation or Output modules; are affected by the data volume needs of complying with the new regulation. The reason for this is that the regulation requires the provision of a dataset containing 100,000 samples, but the existing functionality of the system already includes the ability to generate and save simulation data. Therefore, it is not necessary to modify any of the main modules to comply with the CR.

Although, the CR's computational intensity must be considered in terms of the system's performance. The system must have sufficient computational resources to generate the required dataset within a reasonable amount of time. Whether that is possible or not depends on the specific details of the regulation. Finally, it is important to evaluate the impact of the CR on the system's documentation. **It is also important to ensure that the documentation accurately reflects the requirements of the CR and how they are being met by the system.**

Technical analysis

After carefully examining the requirements of the CR, we have concluded that it does not necessitate any modifications to the existing code modules of the system. Therefore, **the code coverage risk associated with the new regulation is 0%,** as there is no need to perform any code changes.

In addition, we have found that there is no technical debt associated with complying with the new regulation. Technical debt refers to the cost of maintaining software in the future when shortcuts or suboptimal solutions were made during the initial development. As the new regulation does not require any changes to the existing code, we do not anticipate any additional costs or difficulties in maintaining the system in the future.

To assess the impact of the new regulation on the system, we have evaluated the criteria for identifying the affected configuration items, including functionality, data, performance, dependencies, and documentation. Our analysis indicates that none of the main modules of the system, such as the GUI, Simulation, or Output modules, are affected by the new regulation. Therefore, we can conclude that there is no need to modify any of the existing code modules to comply with the new regulation.

In conclusion, our analysis has determined that the new regulation does not pose a need for modifying any of the existing code modules, and therefore the code coverage risk and technical debt associated with complying with the new regulation are both minimal. We recommend to take the necessary actions to comply with the new regulation, but no code changes are necessary.

Financial analysis

For scenario A, there is no financial risk as the simulations with 100,000 timesteps or more were already programmed for the testing phase of the system. Therefore, no additional cost is required to comply with the new regulation.

However, for scenario B, complying with the new regulation could be financially challenging. The regulation requires the company to provide data from 100,000 independent simulations, which is a considerable amount of data. This scenario branches further into two possibilities: B.1 and B.2.

Scenario B.1: This scenario would require a moderate amount of computational resources, which should be factored into the budget. **However, the financial risk associated with this scenario is relatively low.**

Scenario B.2, on the other hand, **has a moderate to high financial risk**, especially if the simulations characteristics make them lengthy. **To define a threshold between B.1 and B.2, we assume that a simulation's acceptable duration is 25 minutes. If the simulation takes longer than this threshold, it will fall into scenario B.2. According to a quick overview of cloud computing prices, to perform 100,000 simulations with a maximum duration of 25 minutes each, it would require around 1500 USD to complete them in a month.**

Therefore, to comply with scenario B.2, the company would need to allocate additional financial resources to cover the cost of running the simulations. This additional cost should be factored into the budget and considered when assessing the financial risk associated with complying with the new regulation.

For scenario A, no additional expenditure is required for human resources as the testing phase of the system already includes simulations with 100,000 timesteps. **However, for scenario B, due to the need of configuring 100,000 independent simulations, a budget of 500 USD is estimated to be required for human resources to oversee and manage the simulation process.**

While the financial risks associated with the proposed CR have been evaluated, **if such costs are incurred, financial resources could be drawn from the unexpected costs reservoirs. However, it is advisable to perform further analysis when other CRs are financially evaluated, as this may affect the availability of resources in the unexpected costs reservoirs.**

In conclusion, complying with scenario A does not pose any financial risk since the simulations required were already programmed. However, complying with scenario B could be financially challenging, especially for scenario B.2, which requires a considerable amount of computational resources. Allocating additional financial resources to cover the cost of running the simulations should be considered when assessing the financial risk associated with complying with the new regulation.

Human resource analysis

In the current project, we have a development team consisting of three experienced programmers who are also responsible for testing. **Given that the team is already fully loaded for the duration of the project, it is essential to evaluate the impact of the new CRs on human resources.**

Scenario A does not require any extra human time, which is excellent news for the development team. Since they are already fully loaded, the team can focus on other aspects of the project without worrying about allocating additional time or resources. **This means that there will be no extra costs associated with hiring or training new team members, and the project can proceed as planned.**

However**, both instances of scenario B require about 20 hours of extra human labor time. The time is required to configure a set of parameters for each simulation**. To ensure that this work is completed on time, it is essential to have a dedicated resource to manage the task.

To address this issue, we propose hiring an intern to perform the required work. Since the hiring process can be completed in the early stages of the project, the intern's work can be scheduled to take place during the late intermediate stage of the project. This will ensure that the development team is not disrupted and can continue to focus on other critical tasks.

The company will pay the intern about 500 USD for the 20 hours of work, which will be distributed over two months. This payment is reasonable and should not put undue financial pressure on the project. Moreover, it is essential to note that the intern will have a positive impact on the project. Since he will be working on a task that is not part of the development team's core responsibilities.

Infrastructure analysis

The infrastructure analysis for the new regulation compliance project reveals that Scenario A has no infrastructural needs as the existing computing equipment of the company is already capable of performing the required simulations. **Any personal computer within the company can run the simulations, and the processing time is not significant. Therefore, the current infrastructure is sufficient for Scenario A.**

However, for Scenario B, the company's infrastructure cannot meet the requirements. **Performing 100,000 independent simulations on personal computers would take several months, making it impractical for the project's timeline**. **Moreover, purchasing enough computing equipment to handle the workload would cost at least $4000, which is not a viable option for a one-time project. The purchased equipment would be useless after the completion of the project and would require a significant amount of space and specialized power infrastructure.**

The infrastructure analysis committee has decided that renting cloud services is the best option for handling Scenario B. By utilizing cloud computing, we can reduce the time required for performing simulations by half, while keeping the budget around $1500. An overview of cloud computing prices has shown that performing 100,000 simulations with the an estimated average computing time length of 25 minutes would require approximately $1500 for completion in one month. Therefore, renting cloud services is a cost-effective solution for Scenario B.

Timeline impact analysis

The timeline impact analysis is an important aspect to consider for the project's viability. For Scenario A, the timeline impact is expected to be negligible since the dataset could be obtained way before the project's deadline. Furthermore, the company can provide the dataset to the government IT office in such a date that even considering the 15 day time of approval, it won't impact the project's deadline.

Similarly, for Scenario B.1, the timeline impact is expected to be null. The company has enough time to carry out the simulations, given that the infrastructure requirements are met. **However, for Scenario B.2, there is a lot of uncertainty regarding the timeline impact since it depends on the specific needs of the regulation. The first-time estimation suggests a possible delay of about 15 days until approval. Still, this depends on the particular regulations' considerations.**

It is crucial to consult the existing contract for analyzing what such a delay would signify to the project's viability. The delay could impact the project's completion date, leading to additional costs and delaying the project's delivery. Therefore, it is essential to evaluate the specific needs of the regulation in advance and consider possible delays in the timeline impact analysis.

Analyzing the accuracy perspective

Identifying affected configuration items

For delimiting the affected configuration items we will consider two scenarios: one where the system's accuracy is already compliant (scenario C) and another where the system's accuracy is not compliant (scenario D). By examining these scenarios, we can identify potential challenges that organizations may face when implementing the new regulations.

Scenario C: Program capabilities are already Compliant with new regulations. In this scenario, the system is already in compliance with the new regulations regarding accuracy. This means that the system has been tested and verified to meet the accuracy requirements set forth by the new regulations. **The implementation of the velocity verlet integration for numerical integration is already sufficient to meet the accuracy requirements.**

In this scenario, the system can continue to operate as it currently does, with no need for any additional modifications. The system can undergo routine testing to ensure that it continues to meet the accuracy requirements set by the new regulations.

Scenario D: System Accuracy is not compliant with the new regulation. In this scenario, the system does not meet the accuracy requirements set by the new regulation. This means that **the implementation of the velocity verlet integration for numerical integration is not sufficient to meet the accuracy requirements.**

Hence, in this scenario, the affected configuration items are described in the following table:

CI-ID	Name	Criteria
CI01	Simulation module, specifically the numerical integrator.	1, 3, 5
CI02	Documentation regarding accuracy testing and the simulation module.	5

Since Scenario's C outcome is straightforward and doesn't imply changes to the system we will focus on Scenario D.

Technical analysis

The compliance with the new regulation regarding accuracy is of paramount importance for the success of the project. In this regard, it is essential to analyze the technical aspects of the system to ensure that it meets the required standards.

One of the significant technical challenges in scenario D is the code coverage risk, as we will have to implement and test at least one new numerical integrator. The uncertainty about which numerical integrators would improve the system's accuracy to the required level poses a moderate level of risk to the system.

To mitigate the risk, the team should conduct a thorough analysis of the numerical integrators' performance and select the one that can achieve the highest level of accuracy with the least number of errors. This analysis will involve evaluating various numerical integrators based on their stability, convergence, and error estimates. Additionally, it will be necessary to conduct a comprehensive set of tests to ensure that the selected numerical integrator performs as expected.

Another critical aspect to consider is the impact of the new regulation on the simulation module's architecture**. Since the implementation of a new numerical integrator will affect approximately 30% of the code, it is important to analyze the potential impact of the changes on the system's overall performance. This analysis will involve assessing the integration of the new numerical integrator into the simulation module and ensuring that the updated code does not introduce any new errors or bugs into the system.**

Finally, it is important to consider the documentation related to accuracy testing and the simulation module. The team must ensure that the updated documentation accurately reflects the changes made to the simulation module and the new numerical integrator. The documentation should also provide clear and concise instructions on how to conduct accuracy testing and interpret the results.

Complying with the new accuracy regulations is essential for the success of the project. Scenario D poses a moderate level of risk due to the uncertainty about which numerical integrators will improve the system's accuracy to the required level. However, by conducting a thorough analysis of the numerical integrators' performance, carefully updating the simulation module's architecture, and accurately documenting the changes made, the team can mitigate the risk and ensure that the system meets the required accuracy standards.

Human resource and timeline analysis

We need to consider the personnel who will be responsible for implementing and testing the new numerical integrators. **The coding personnel consists of three intermediate coders who will also perform the testing.**

It is important to note that they are fully loaded until the end of the project. Therefore, additional resources will be required to complete the implementation and testing of the new numerical algorithms. So the implementation and testing of these algorithms will require more time than originally planned.

A good estimate for the additional time required to complete this work is approximately 1.5 months. This estimate includes the time required to study the new numerical algorithms, implement them into the simulation module, and test the accuracy of the system using the new algorithms.

Additionally, it is important to assess the impact of this delay on the current contract. We need to determine if the delay will result in any penalties or impact the overall timeline of

the project. It may be necessary to renegotiate the contract if the delay is significant enough to impact the delivery of the final product.

It is also important to consider the level of expertise required to implement and test the new numerical algorithms. **We may need to provide additional training or hire personnel with specialized knowledge in this area to ensure the accuracy of the system.**

It is important to acknowledge the risk of uncertainty that comes with the implementation of new numerical algorithms**. Since we are not certain which numerical integrators would best improve the system's accuracy to the required level, there is a medium to high risk of uncertainty in the time and human resources needed. The uncertainty stems from the fact that the implementation of each numerical integrator will require different levels of effort and expertise from the coding personnel. Moreover, as this will be a new area for the personnel, it is difficult to estimate the exact amount of time required to study, implement, and test the new numerical algorithms.** The risk of uncertainty in time and human resources will have to be addressed by closely monitoring the progress of the implementation and testing phase, and by constantly reevaluating the estimated time and resources needed.

Financial analysis

For the financial analysis, it is estimated that paying the coding personnel for an additional 1.5 months to study, implement, and test the new numerical algorithms required for **compliance with the new regulations will cost approximately 6000 USD. This cost can be drawn from the unexpected costs budget for the project. It is important to note that this cost is not insignificant and should be taken into consideration when evaluating the financial impact of the new regulations.** However, it is also important to ensure that the system is compliant with the new regulations, as non-compliance can result in even greater financial consequences. Overall, while the cost of implementing the new numerical algorithms may be a burden on the project budget, **it is necessary to ensure compliance and avoid potential legal and financial consequences.**