

TP3: Benchmarking Blockchain frameworks.

This assignment focuses on the subject of Software Architectures for Big Data and more specifically on Blockchain. As discussed in class, Blockchain can be perceived as a secure distributed database. There are several implementations of Blockchain following different architectural and implementation configurations. In this assignment, you are tasked with writing an academic and technical paper to present a comprehensive comparison between 2 Blockchain platforms, namely Hyperledger Fabric and Ethereum (Clique), using a special benchmarking tool. Depending on the tool assigned to your team, you will use either BlockBench (<https://github.com/ooibc88/blockbench>) or BlockCompass (<https://github.com/polytechnique-ease/blockcompass>). More specifically, you have the following tasks:

1. Present the two platforms and their specifications. Compare the two with respect to their documented properties and the general attributes of Blockchain architectures, e.g., what consensus protocol they use, how a block is created and so on.
2. Use the benchmarking tool. Deploy an instance of each of your selected implementations and test their performance using the workloads provided by the benchmark. Provide a comprehensive comparative evaluation for all three implementations and discuss the differences in the performance.
3. Use at least three workloads in your experiments. One “small”, one “medium”, one “large”. The three experiments would differ with respect to how much load they produce for the tested platform, in other words, how much data is sent to the platform. Limit each of your experiments to 10 minutes or to how much time is needed to process the workload (depending on the benchmark tool you use).
4. Strong recommendation: Use VMWare (installed in lab computers) or VirtualBox to prepare and configure your experiments. This will help you deal with any errors locally. Use the provided Amazon EC2 infrastructure for your final experiment. Remember you have \$100 budget so you cannot exceed that. The benefit of using Amazon EC2 is that it will give you enough resources to run the entirety of your experiments efficiently and effectively. However, if you are still able to run experiments locally, exactly as requested, and produce results, they will still be acceptable for the final paper.
5. Use the data produced by the benchmark tool to generate tables and charts for your paper. If the benchmarking tool you use also produces charts, you can use those.

To further help you with the assignment, here are some questions that you may want to answer in your paper:

- What are the basic functions and properties of Blockchain? What makes Blockchain more secure than other data systems?
- For each of the two Blockchain platforms: What are the nominal and documented properties of the platform? How do they implement the functionality of Blockchain in general? What are their benefits and what are their weaknesses?

- How do the two platforms compare based on their documented properties? What use cases are benefited the most by each platform?
- For each of the three implementations: What are the nominal and documented properties of the implementation? How do they implement the basic properties of the respective data model? What are their benefits and weaknesses?
- How does the performance of the three implementations compare against similar workloads? Which one is best in read latency, write latency, throughput? How do the three implementations compare against different workloads? What kind of workloads are more suitable for each implementation?

Article structure

Also, here is an expected structure for the article:

1. Abstract: Summarize your work in 150 words max.
2. Introduction
 - a. What is the principal motivation behind using Blockchain?
 - b. What are the main principles and functionalities of these architectures?
 - c. What are the objectives and contributions of your work?
3. Context – Background
 - a. Present a brief description of Hyperledger Fabric and its principal characteristics and everything that is relevant for your article.
 - b. Present a brief description of Ethereum and its principal characteristics and everything that is relevant for your article.
 - c. Compare the two platforms based on their documentation and their basic properties.
4. Experiments
 - a. Describe the setup of your experiments
 - i. Deployment of Hyperledger Fabric (infrastructure, configuration, etc.)
 - ii. Deployment of Ethereum Clique (infrastructure, configuration, etc.)
 - iii. Description of the selected tasks and workloads.
 - iv. Setup for the benchmarking tool.
 - b. Results
 - i. Present tables and figures for the performance of the two platforms.
 - ii. Describe the results.
5. Discussion

- a. Compare the results of the two systems and explain the differences.
 - b. Does your work have threats to validity and limitations? How did you mitigate them?
6. Conclusions
 - a. Summarize the conclusions of the study and present future work, if relevant.
7. References
 - a. Provide a complete list of references according to the template. Cite every external source you use, including documentations and tools.

Presentation structure

Also, here is a recommended structure for your presentation:

1. A short background with respect to the context.
 - a. Some details about Blockchain, Hyperledger Fabric and Ethereum.
 - b. Some details about the benchmarking tool you used.
2. Experiments
 - a. Describe the setup of your experiments
 - i. Deployment infrastructure for Hyperledger Fabric and Ethereum in the context of the benchmarking tool.
 - ii. Description of the selected workloads.
3. Results.
 - a. Comment on the results with the help of charts and other elements to discuss the performance of the two platforms.
4. Discussion
 - a. Compare the results of the two platforms and explain the differences.
5. Conclusion
 - a. Summarize the results and your experience.

Remember, you only have 12 minutes to present the core of your work, the experiments and the results.

Useful links for the assignment tools

1. Documentation for Hyperledger Fabric.
 - a. <https://hyperledger-fabric.readthedocs.io/en/release-2.2/>
2. Documentation for Ethereum.
 - a. <https://eips.ethereum.org/EIPS/eip-225>

- b. <https://ethereum.org/en/developers/docs/>
- 3. Manual for BlockBench
 - a. <https://drive.google.com/file/d/1Vr9p25q3sVV7xMLoaXcCn0LIJpjuq3lg/view>
 - b. <https://github.com/polytechnique-ease/blockbench>
- 4. Manual for BlockCompass
 - a. https://drive.google.com/file/d/1Sm7jr_9CxWp0hCta8Bw-plyMOVZHxziF/view?usp=drivesdk
 - b. <https://github.com/polytechnique-ease/blockcompass>
- 5. Video of a demo for BlockBench

<https://youtube.com/watch?v=arFfhtueiO4>
- 6. Video of a demo for BlockCompass

<http://youtube.com/watch?v=R91RybpXbVA>
- 7. Useful papers:
 - a. <https://dl.acm.org/doi/abs/10.1145/3035918.3064033>
 - b. <https://ieeexplore.ieee.org/abstract/document/9210358>
 - c. <https://dl.acm.org/doi/abs/10.1145/3184407.3184441>
 - d. <https://ieeexplore.ieee.org/abstract/document/8946222>

Usability data to retain (optional)

Your experience contacting the experiments with the benchmarking tools can help us in our research. Should you agree to participate, you will give us your consent and be asked to gather some data with respect to your experience using the benchmarking tools. This data will not affect your experiments asked here or your performance in any way. Consent and data will be collected by a member of the research team that is not involved in the project. The instructor or the lab assistant will not be informed of your voluntary participation and the usability data will not be studied until the end of the course. You will be informed of all the details of the study during the first lab session for this assignment.

Here, we will provide a few important details about the data you will need to collect about the study during your experiments. We are interested in knowing whether the benchmarking tools make the evaluation of Blockchain platforms easier and faster, especially compared against a manual, unaided effort. In this sense, we are interested to know how much time it takes you to prepare an experiment (i.e., prepare the prerequisites), configure and setup the experiment, execute the experiment, and prepare a report with the results. It is also expected that the experiments will more or less a process of trial and error. You will most probably encounter errors that will stop an experiment short and you will need to change some configuration and restart the process. We are also interested in the frequency and

the nature of these errors. In this case, we define the concept of an *attempt* as every attempt you make to run a complete experiment until you encounter an error or until you succeed in completing the experiment. Finally, for each attempt we need the following data:

1. Index of attempt (1, 2, 3 etc.)
2. Duration of the attempt (in minutes)
 - a. This includes the time it took you to prepare, setup, configure, execute the experiment and produce the results. It includes manual effort, not only computer time.
3. Phase where the error occurred.
 - a. The phases are prerequisites, setup and configuration, execution and final report.
 - b. If the experiment was completed, you specify “success” as the phase.
4. What was the error you encountered?
 - a. Provide the exception as it appeared in the console or a small description of the error if an exception message was not available.

After you submit your final article for the assignment you will report this data, along with answers to some other relevant questions in an online questionnaire that will be provided to you after you submit your consent to participate. The questionnaires will be anonymous and they will be studied after the final grade for the assignment has been released to you.

Submission Guidelines

- Submit a paper in IEEE format (<https://www.ieee.org/conferences/publishing/templates.html>) of at least 8 pages (maximum 10 pages).
- Your paper should definitely have an abstract, keywords, an Introduction and conclusions. You can organize the rest of the content as you see fit.
- Provide a meaningful title (not just “Assignment 3”) and give the author names and affiliations as specified by the template.
- This is an academic paper and you will need to consult numerous sources (other papers, documentation, possibly online posts). Make sure you properly cite your sources and give credit. Anything that does not have a citation will be considered your contribution and will be subjected to judgement. So, try to support as many of your arguments as possible with proper sources. DO NOT CITE WIKIPEDIA! Instead you can consult the references that a Wikipedia page already cites. They usually contain the information you are looking for. If you provide online documentation or blog posts (as a last resort), also provide the date you last accessed the source.

- Allocate enough time to set up and run the benchmark experiments with BlockBench or with BlockCompass. If you use Amazon EC2, make sure you follow the instructions and you are prudent with the use of resources so that you do not surpass the \$100 limit.
- Along with the paper, you will need to prepare and submit a presentation on your paper. The presentation will be given on the 1st of December during regular class time by all team members. Each team will be allocated 12 minutes for the presentation and 2-3 minutes for questions.
- After the presentation you will have another week to submit the final version of your paper on the 9th of December. You may have to take into account feedback from the presentations to finish your paper.
- You will receive 70% for the paper and 30% for the presentation.
- **Presentation submission deadline: December 1st 23:59**
- **Paper submission deadline: December 9th 23:59**