Original Manuscript ID: Access-2025-12209

Original Article Title: "EyanaSSDSim: Explore the Inner Workings of Solid-State Drives with Data Visualization"

To: IEEE Access Editor

Re: Response to reviewers

Dear Editor,

Thank you for allowing a resubmission of our manuscript, with an opportunity to address the reviewers' comments.

We are uploading (a) our point-by-point response to the comments (below) (response to reviewers, under "Author's Response Files"), (b) an updated manuscript with yellow highlighting indicating changes (as "Highlighted PDF"), and (c) a clean updated manuscript without highlights ("Main Manuscript").

Best regards,

Habibur Rahman et al.

Reviewer#1, Concern # 1 (please list here):

Author response:

Author action: We updated the manuscript by ….

Reviewer#2, Concern # 1: The abstract is not concise enough to sketch the entire theme, in particular, the results of the manuscript.

Author response: We sincerely thank the reviewer for this valuable feedback. We have revised the abstract to make it more concise while clearly summarizing the theme and key results of the manuscript. The revised abstract now explicitly highlights the main contributions of EyanaSSDSim, including real-time visualization of SSD internals, support for multiple workload patterns, and validation results showing alignment with established simulators (FTLSim and FEMU).

Author action: We updated the abstract to be more concise and to clearly present the theme, contributions, and key results of the study. Changes are highlighted in yellow (additions) and crossed out (deletions) in the revised manuscript.

Reviewer#2, Concern # 2: Furthermore, the introduction section needs considerable effort (concise and brief). The problem being investigated should be described clearly, but before that, the field of research should be made clearer. Furthermore, briefly describe the major contributions in bullet form, just before the organization paragraph. The introduction should lead the way throughout the paper. In addition, the benefits coming from this paper should be made clearer in the introduction and throughout the paper.

Author response: We thank the reviewer for this constructive suggestion. We have significantly revised the Introduction section to make it more concise and focused. The field of research (SSD simulation and visualization) is now clearly established at the beginning, followed by a clear problem statement. We have added the major contributions in bullet-point form just before the organization paragraph, highlighting:

- Full visual tracking of data placement and movement inside SSDs
- Real-time observation of write, invalidation, erase, and GC operations
- Workload characterization revealing sequentiality, randomness, and write locality
- Web-based accessibility with no setup required

Author action: We updated the Introduction (Section I) by restructuring it for clarity, adding bullet-point contributions before the organization paragraph, and ensuring the benefits of EyanaSSDSim are clearly communicated. Changes are highlighted in yellow (additions) and crossed out (deletions) in the revised manuscript.

Reviewer#2, Concern # 3: I suggest summarizing the related works into a table with respect to their characteristics. The authors should put their proposal into this table for easy comparison. Furthermore, I have listed some related works that authors should consider for evaluation of their work. [References 1-6 provided]

Author response: We thank the reviewer for this helpful suggestion. We have added Table 1: "Comparison of SSD Simulators and Related Tools" in Section II (Related Work), which summarizes existing simulators and tools based on their characteristics such as visualization support, real-time analysis, web accessibility, workload support, and GC/wear-leveling analysis. EyanaSSDSim is included in this table for direct comparison, clearly showing its unique features compared to existing solutions.

Regarding the suggested references, we have reviewed them carefully. While these works address important topics in IoT, neural networks, scheduling, and wireless sensor networks, they are not directly related to SSD simulation or flash storage systems, which is the core focus of our manuscript. Therefore, we have not included them in our literature review to maintain relevance and coherence.

Author action: We updated the manuscript by adding Table 1 in Section II (Related Work) to provide a structured comparison of SSD simulators and related tools. Changes are highlighted in yellow in the revised manuscript.

Reviewer#2, Concern # 4: Do the results shown in various figures refer to a single run or multiple runs (average)? In the latter case, I will suggest adding standard deviation bars. The reason behind this is to ensure that the results overlap with the closest rivals or not.

Author response: We thank the reviewer for this important clarification request. EyanaSSDSim is a deterministic simulator, meaning that given the same input workload and configuration parameters, the simulation produces identical results across multiple runs. This is because the simulator follows fixed algorithms for page allocation, garbage collection (Greedy policy), and wear-leveling without any randomized components. Therefore, the results shown in the figures represent deterministic outputs rather than averages, and standard deviation bars are not applicable in this context.

Author action: We updated the manuscript by adding a clarifying note in Section IV (Full System Evaluation) explaining that EyanaSSDSim is a deterministic simulator, and thus the results are reproducible and do not require standard deviation analysis. This clarification is highlighted in yellow in the revised manuscript.

Reviewer#2, Concern # 5: Furthermore, the evaluation metrics should be briefly described in the experimental section. Moreover, add further details on how the experiments were conducted. Which tool was used to implement the algorithms? Similarly, system and resource characteristics should be added for clarity.

Author response: We appreciate the reviewer's suggestion for additional experimental details. We have expanded Section IV (Full System Evaluation) to include:

Brief descriptions of all evaluation metrics (WAF, DoIPD, DoEC, erase count distribution, latency)

Implementation details: EyanaSSDSim is implemented as a web-based application using JavaScript for the frontend visualization and simulation logic

System characteristics: The simulator runs entirely in the browser, making it platform-independent

Configuration parameters are now clearly specified in Table 2

Author action: We updated the manuscript by expanding Section IV with detailed descriptions of evaluation metrics, implementation tools, and system characteristics. Changes are highlighted in yellow in the revised manuscript.

Reviewer#2, Concern # 6: Some sections have repeated text or the discussion is too detailed and should be reduced. In fact, the paper is quite wordy, and the authors should make significant efforts to make it concise and short.

Author response: We sincerely thank the reviewer for this feedback. We have made significant efforts to reduce wordiness throughout the manuscript. Specifically, we have:

- Removed redundant phrases and repetitive explanations in the Related Work section
- Condensed verbose descriptions in Section III (Navigating Our SSD Simulator)
- Streamlined explanations in Section IV (Full System Evaluation)
- Reduced repetitive analytical text in Section V (Analysis of Simulation Results)
- Trimmed verbose validation explanations in Section VI (Performance Validation)
- Condensed the Discussion, Survey, and Conclusion sections

Author action: We updated the manuscript by removing redundant text and condensing overly detailed discussions throughout all sections. Deleted content is shown as crossed out text in the revised manuscript.

Reviewer#2, Concern # 7: Add further details on how simulations were conducted. Perhaps add a flowchart that clearly identifies how the entire system works.

Author response: We thank the reviewer for this suggestion. We have enhanced the manuscript by:

- Adding Figure 1, which presents a high-level architecture diagram showing the complete data flow from host interface through the Flash Translation Layer (FTL) to NAND flash blocks
- Expanding the simulation methodology description in Section III
- Clearly explaining how users can configure parameters, upload workloads, and observe real-time visualization

Author action: We updated the manuscript by enhancing Figure 1 with a detailed architecture diagram and adding simulation workflow details in Section III. Changes are highlighted in yellow in the revised manuscript.

Reviewer#2, Concern # 8: The conclusion section also needs significant revisions. It should briefly describe the findings of the study and some more directions for further research.

Author response: We appreciate the reviewer's feedback on the Conclusion section. We have revised it to:

- Briefly summarize the key findings, including the effectiveness of visualization for understanding SSD behavior
- Highlight validation results showing alignment with FTLSim and FEMU
- Add future research directions such as support for emerging technologies (ZNS, FDP), integration with machine learning for predictive analysis, and extension to multi-SSD configurations

Author action: We updated the Conclusion section to provide a concise summary of findings and expanded future research directions. Changes are highlighted in yellow (additions) and crossed out (deletions) in the revised manuscript.

Reviewer#2, Concern # 9: Proofread the article to ensure appropriate use of English grammar, tenses, and punctuation. Longer sentences should be broken out into smaller ones. There are also some linguistic issues that should be corrected. The use of article "the" is redundant and somewhere missing.

Author response: We thank the reviewer for this observation. We have carefully proofread the entire manuscript to:

- Correct grammatical errors and improve sentence structure
- Break longer sentences into shorter, clearer ones
- Address redundant or missing articles ("the", "a", "an")
- Ensure consistent tense usage throughout the paper

Fix punctuation issues

Author action: We proofread and revised the entire manuscript for grammar, punctuation, and linguistic clarity. Corrections are reflected throughout the revised manuscript.

Reviewer#2, Concern # 10: I suggest adding a brief description of each figure in its caption.

Author response: We appreciate this helpful suggestion. We have updated all figure captions to include brief descriptions that explain what each figure shows and its significance. For example:

- Figure 1 now describes the high-level architecture and data flow
- WAF comparison figures now explain the workload conditions and OPS configurations

- SSD layout visualization figures now describe the visual representation of block states

Author action: We updated all figure captions with brief descriptions explaining the content and significance of each figure. Changes are highlighted in yellow in the revised manuscript.

Reviewer#2, Concern # 11: Authors should describe the scalability of the proposed algorithms. Is the system scalable? If yes, under what assumptions and conditions?

Author response: We thank the reviewer for raising this important point. We have added a discussion on scalability in Section VII (Discussion and Implication). EyanaSSDSim is designed with scalability in mind:

- The web-based architecture allows easy deployment and access without installation
- Configuration parameters (number of blocks, pages per block, OPS) can be adjusted to simulate SSDs of varying capacities
- The modular design allows extension to support additional allocation schemes and GC policies
- For very large-scale simulations, the visualization can be adjusted to show aggregated views rather than individual page-level details

The current implementation is optimized for educational and research purposes with moderate-scale configurations. For enterprise-scale simulations with thousands of blocks, performance may be affected by browser limitations.

Author action: We updated the manuscript by adding a scalability discussion in Section VII (Discussion and Implication), describing the conditions and assumptions under which the system scales effectively. Changes are highlighted in yellow in the revised manuscript.

Reviewer#2, Concern # 12: Furthermore, each and every mathematical notation should be explained. I suggest adding a table that describes all the mathematical notations with brief definitions.

Author response: We sincerely thank the reviewer for this excellent suggestion. We have added Table 3: "Summary of Mathematical Notations Used in This Paper" in Section IV. This comprehensive table includes all mathematical symbols organized by category:

- General SSD Parameters: n (total blocks), m (pages per block), p (page size), b (block size), WAF
- DoIPD Variables: Invalid page distribution metrics

- DoEC Variables: Erase count distribution metrics
- Fourier Transform Variables: Frequency analysis parameters for wear-leveling comparison
- Allocation Scheme Variables: Parameters for different page allocation strategies

Author action: We updated the manuscript by adding Table 3 (Summary of Mathematical Notations) in Section IV, providing clear definitions for all mathematical symbols used throughout the paper. The entire table is highlighted in yellow in the revised manuscript.

Note: References suggested by reviewers should only be added if it is relevant to the article and makes it more complete. Excessive cases of recommending non-relevant articles should be reported to ieeeaccesseic@ieee.org