

Data Access Technologies in Comparison Regarding Energy Consumption

Impact of Software Design Decisions Compared

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Introduction: In the context of growing concerns about climate change and energy consumption, the field of software engineering has received relatively little attention in discussions about sustainability, compared to other industries. Despite research on measuring energy consumption in projects existing, the topic remains underrepresented in software engineering practice and literature.

Approach: The objective of this project is to investigate the energy consumption of a specific element in software engineering, namely data access. A prototype of a game distribution platform was developed. This prototype encompasses users, game-related elements such as video, audio, and images, and statistics regarding the past and current distribution of these components. The software was constructed using Spring Boot with Java and Gradle, with mocked data generated using Python, requests, and Faker. The corresponding data was stored in PostgreSQL tables and MinIO object storage. A comparative analysis was conducted on three data access technologies—JPA, jOOQ, and JDBC—in order to assess their performance in managing the central game page entity and its associated media. This analysis also encompassed the entity's interactions with numerous other entities. The execution time and energy consumption of these technologies were measured using the commandline tool powermetrics.

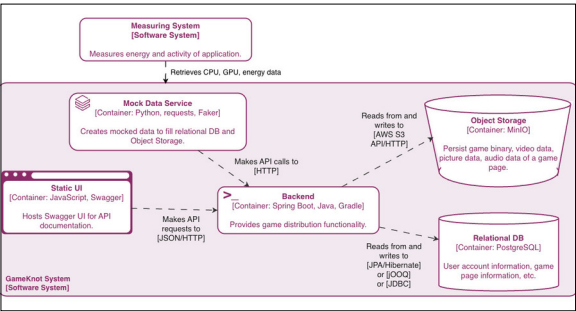
Result: The three data access technologies demonstrate varying trade-offs across abstraction levels, performance, and energy efficiency. JPA offers the greatest developer convenience through annotations and object abstractions. However, it demands the longest execution time and highest energy consumption. jOOQ, in contrast, provides a middle ground, delivering near-JDBC performance with reasonable type safety and moderate energy overhead compared to JDBC. JDBC has been demonstrated to be the fastest and most energy-efficient option due to its minimal abstraction. However, it requires significantly more development effort. The substantial energy disparity between JPA and the other two technologies raises concerns about its suitability for applications where energy efficiency is a priority. Therefore, being aware of alternatives such as JDBC and jOOQ enables developers to make informed decisions that balance productivity with energy efficiency.

Advisor

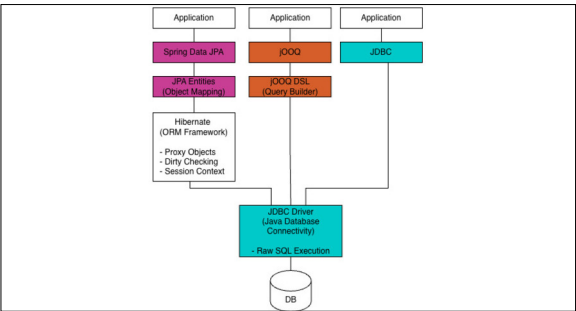
Prof. Mirko Stocker

Subject Area
Computer Science,
Energy and
Environment,
Computer Science,
Software and Systems

Simplified Container Diagram of GameKnot System
Own presentation



Abstraction Stack of all Technologies
Own presentation



Mean Energy Consumption Across All Scenarios: Seeding, Repository Functions, and Resetting
Own presentation

