Draw It or Lose It
CS 230 Project Software Design Template
Version 3.0

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Document Revision History

Version	Date	Author	Comments
3.0	08/18/2024	Ifeoluwa Adewoyin	Main software design document

Executive Summary

The Gaming Room, a game development company, aims to expand their Android-based game "Draw It or Lose It" into a web-based, multi-platform application. This software design document outlines our proposed solution to meet their requirements and facilitate the development process.

"Draw It or Lose It" is a team-based game inspired by the classic TV show "Win, Lose or Draw." The game renders stock images as clues, with teams competing to guess the puzzle within time constraints. To successfully transition this game to a web-based environment, we propose implementing a distributed system architecture that ensures scalability, maintainability, and cross-platform compatibility.

Our solution will leverage cloud-based services for backend operations, a responsive web design for the client-side interface, and robust data management systems to handle game states, user information, and image libraries efficiently. By adopting industry-standard design patterns and best practices in software development, we aim to create a flexible and extensible system that can accommodate future growth and feature additions.

Requirements

- Support for multiple teams in a single game instance.
- Multiple players can be assigned to each team.
- Unique identifiers for games, teams, and players.
- Ensure game and team names are unique.
- Only one instance of the game can exist in memory at any time.
- Cross-platform compatibility (web-based, supporting various devices).
- Render images from a large library of stock drawings as clues.
- Support four rounds of play, each lasting one minute.
- Implement a 15-second guessing window for non-drawing teams.

Design Constraints

Developing "Draw It or Lose It" as a web-based, distributed application presents several design constraints:

1. Cross-Browser Compatibility: The application must function consistently across various web browsers, which may have different rendering engines and JavaScript implementations. This requires thorough testing and potentially the use of polyfills or transpilation for newer JavaScript features.

2. Network Latency: As a real-time, multi-player game, network latency can significantly impact user experience. The design must incorporate efficient data transfer methods and potentially implement predictive algorithms to minimize the perceived lag.

3. Scalability: The system must be designed to handle a variable number of concurrent users and games. This constraint necessitates a scalable architecture, possibly involving load balancing and distributed computing techniques.
4. Security: Protecting user data and preventing cheating are crucial. This requires implementing robust authentication, authorization, and data encryption mechanisms.

5. Stateless Architecture: To ensure scalability and reliability in a web environment, the application should follow a stateless architecture as much as possible, with game state managed carefully and efficiently.

6. Mobile Responsiveness: The web application must be responsive to various screen sizes and touch interfaces, which impacts the UI/UX design and implementation.

7. Data Persistence: Efficient storage and retrieval of game data, user information, and the image library is crucial. This may require a combination of database technologies and caching mechanisms.

8. Real-time Updates: The game requires real-time updates for all players, which may necessitate the use of WebSockets or similar technologies for push notifications.

System Architecture View

While not explicitly required for this project, it's worth noting that a comprehensive system architecture for "Draw It or Lose It" would likely involve:

1. A multi-tiered architecture with separate layers for presentation, application logic, and data management.
2. A cloud-based backend service to handle game logic, user management, and data persistence.
3. A responsive web frontend, possibly built with a modern JavaScript framework.
4. A WebSocket server for real-time communication between clients and the server.
5. A content delivery network (CDN) for efficient distribution of static assets like images.
6. Load balancers to distribute traffic and ensure high availability.
7. Caching layers to improve performance and reduce database load.

Domain Model

The UML class diagram provided illustrates the core classes of the "Draw It or Lose It" game application. Here's a description of the classes and their relationships:

1. Entity: This is the base class for Game, Team, and Player. It contains common attributes (id and name) and methods (getId(), getName(), toString()).
2. GameService: This is a singleton class that manages the creation and retrieval of Game instances. It uses the List<Game> to store games and provides methods to add and retrieve games.
3. Game: Inherits from Entity and contains a List<Team>. It provides methods to add teams and convert game information to a string.

4. Team: Inherits from Entity and contains a List<Player>. It provides methods to add players and convert team information to a string.
5. Player: Inherits from Entity and provides a method to convert player information to a string.

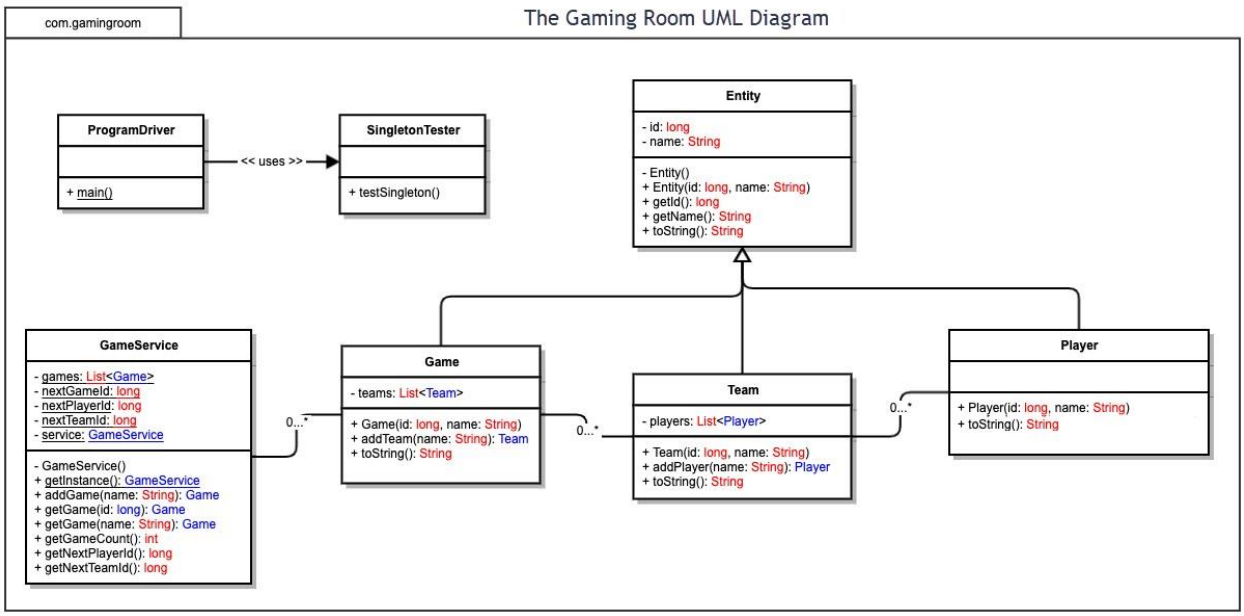
The relationships between these classes are as follows:

- GameService has a one-to-many relationship with Game (composition).
- Game has a one-to-many relationship with Team (composition).
- Team has a one-to-many relationship with Player (composition).
- Game, Team, and Player all inherit from Entity (generalization).

This design demonstrates several object-oriented principles:

1. Inheritance: Game, Team, and Player inherit from Entity, promoting code reuse.
2. Encapsulation: Each class encapsulates its data and provides methods to interact with it.
3. Composition: GameService, Game, and Team use composition to manage their respective collections.
4. Singleton: GameService is implemented as a singleton to ensure only one instance exists.

These principles help fulfill the software requirements efficiently by providing a clear structure for managing games, teams, and players, while ensuring unique identifiers and names as required.



Evaluation

Development Requirements	Mac	Linux	Windows	Mobile Devices

Server Side	Mac servers can run popular web servers like Apache or Nginx, and support various backend technologies. They offer good performance and stability but may have higher hardware costs. The Unix-based system provides robust security features.	Linux is a popular choice for servers due to its stability, security, and low cost. It supports a wide range of web technologies and can be highly customized. Its open-source nature allows for extensive community support and frequent updates.	Windows servers offer seamless integration with other Microsoft technologies. They provide a user-friendly interface for management but may have higher licensing costs. Windows servers are widely used and have good support for various web technologies.	Mobile devices are typically not used for hosting web applications due to power and performance limitations. They are more suited as clients for accessing the web application.
Client Side	Mac provides a consistent environment for testing and development. Safari, the default browser, may require specific considerations. Development for Mac ensures compatibility with a significant user base.	Linux offers a variety of desktop environments and browsers for testing. It's less common as a client OS for average users but important for ensuring compatibility with open-source browsers.	Windows is the most widely used desktop OS, making it crucial for client-side compatibility. It supports all major browsers and development tools, ensuring broad reach.	Mobile devices require specific considerations for touch interfaces, varied screen sizes, and potential bandwidth limitations. Testing on both iOS and Android devices is crucial for ensuring broad mobile compatibility.

Development Tools	Xcode (for native app development), Visual Studio Code, JetBrains IDEs (IntelliJ IDEA, WebStorm), and all major web browsers are available. Mac supports most programming languages relevant to web development.	Popular IDEs like Visual Studio Code, JetBrains IDEs, and Eclipse are available. Linux supports all major programming languages and provides powerful command-line tools for development.	Visual Studio, Visual Studio Code, JetBrains IDEs, and other major development tools are available. Windows supports all major programming languages and frameworks used in web development.	Xcode (for iOS) and Android Studio are the primary IDEs for mobile app development. For web applications, mobile devices are typically not used for development but are crucial for testing.

Recommendations

1. Operating Platform: We recommend a cloud-based platform like Amazon Web Services (AWS) or Microsoft Azure for hosting the "Draw It or Lose It" web application. These platforms offer scalability, reliability, and services that cater to various aspects of web application hosting and management.

   While the cloud-based approach using AWS or Azure is solid, we could improve by using a multi-cloud strategy. This would involve using services from multiple cloud providers to enhance reliability and avoid vendor lock-in. For instance, we could use AWS for core computing and Azure for its AI and machine learning capabilities to enhance game features.

2. Operating Systems Architecture: For the server-side, we recommend using Linux-based systems due to their stability, security, and cost-effectiveness. The architecture should be containerized using technologies like Docker to ensure consistency across development and production environments.

   Building on the Linux-based containerized approach, we could improve by using a Kubernetes orchestration layer. This would provide better management of containerized applications, automatic scaling, and self-healing capabilities. Additionally, we would suggest implementing a serverless architecture for certain components, like image processing or score calculations, to improve scalability and reduce operational overhead

3. Storage Management: We recommend using a combination of relational and NoSQL databases. A relational database like PostgreSQL can handle structured data (user accounts, game records), while a NoSQL database like MongoDB can manage the more flexible data structures (game states, image metadata). For caching and session management, Redis would be an excellent choice.

   To enhance the hybrid database approach, we would recommend implementing a data lake architecture using services like AWS S3 or Azure Data Lake Storage. This would allow for cost-effective storage of large volumes of unstructured data (like user-generated content or game analytics) while maintaining the structured data in PostgreSQL. We could also suggest using a database proxy like PgBouncer to manage database connections more efficiently, improving performance under high load.

4. Memory Management: The recommended cloud platforms provide robust memory management features. Implementing proper garbage collection in the backend services (e.g., using Java's or Node.js' built-in GC) will be crucial. For the "Draw It or Lose It" game, efficient management of game state in memory will be vital for performance.

   In addition to relying on language-specific garbage collection, we could recommend implementing application-level caching strategies. For instance, using Redis more extensively as a distributed cache for frequently accessed data (like leaderboards or active game states) could significantly reduce memory pressure on the application servers. We

also suggest implementing memory monitoring and alert systems to proactively manage memory-related issues.

5. Distributed Systems and Networks: To enable cross-platform communication, we recommend implementing a RESTful API for general data operations and WebSocket connections for real-time game updates. A microservices architecture could be beneficial, separating concerns like user management, game logic, and image serving. Load balancers should be used to distribute traffic and ensure high availability.

   To improve on the RESTful API and WebSocket approach, I recommend implementing a service mesh like Istio. This would provide better traffic management, security, and observability across the microservices architecture. We could also suggest using a content delivery network (CDN) to cache and serve static assets (like images and game resources) closer to users, reducing latency and improving the user experience across different geographical locations.

6. Security: To protect user information:
   Implement HTTPS for all communications.
   Use OAuth 2.0 for authentication and JWT for session management.
   Encrypt sensitive data at rest and in transit.
   Implement rate limiting and DDoS protection at the network level.
   Regularly update and patch all systems and dependencies.
   Conduct regular security audits and penetration testing.

Building on the existing security recommendations, we suggest implementing a Web Application Firewall (WAF) to protect against common web vulnerabilities. We also recommend using a secrets management service like AWS Secrets Manager or HashiCorp Vault to securely store and manage sensitive information like API keys and database credentials. Additionally, implementing multi-factor authentication (MFA) for user accounts would add an extra layer of security.

7. Monitoring and Analytics: As a new recommendation, we suggest implementing comprehensive monitoring and analytics. This could include:
   - Using tools like Prometheus and Grafana for real-time monitoring of system health and performance.
   - Implementing distributed tracing with Jaeger or Zipkin to debug and optimize the microservices architecture.
   - Setting up an ELK stack (Elasticsearch, Logstash, Kibana) for centralized logging and log analysis.
   - Integrating game analytics to gather insights on user behavior and game performance, which could inform future development decisions.

8. Cross-Platform Development: To enhance cross-platform compatibility, we recommend using a cross-platform framework like React Native or Flutter for mobile app development. This would allow for a single codebase to target both iOS and Android, reducing development time and maintenance overhead.

Client-Server Pattern

In developing "Draw It or Lose It," I found the client-server pattern crucial for creating a multi-platform game. By separating the game logic and data management (server-side) from the user interface (client-side), I could ensure that the core functionality remains consistent across all platforms while allowing for platform-specific UI implementations. This approach is particularly beneficial for "Draw It or Lose It" as it allows for centralized management of game sessions, user data, and the image library on the server, while clients on various platforms (Android, iOS, web browsers) can focus on rendering the game interface and handling user interactions.

Server Side

On the server side, I evaluated several operating platforms for hosting "Draw It or Lose It". Linux stood out as a cost-effective and robust option. Its open-source nature means lower licensing costs for The Gaming Room, which is a significant advantage. Additionally, Linux's stability and security make it well-suited for handling the game's server requirements, such as managing multiple game instances, teams, and players simultaneously.

Windows servers, while user-friendly and widely supported, come with higher licensing costs. However, they offer seamless integration with other Microsoft technologies, which could be beneficial if The Gaming Room plans to use such technologies in the future.
Mac servers, although less common for web hosting, offer good performance and stability. They could be a consideration if the development team is already familiar with the Mac ecosystem, but the higher hardware costs need to be taken into account.

For "Draw It or Lose It", I would recommend a Linux-based server environment due to its cost-effectiveness and robust performance, which aligns well with the need to scale up to thousands of players.

Client Side

On the client side, "Draw It or Lose It" requires a responsive design that works across desktop and mobile platforms. For desktop systems (Windows, Mac, Linux), I would focused on creating a web-based interface using HTML5, CSS3, and JavaScript. This approach ensures broad compatibility across different operating systems and browsers.

For mobile platforms, particularly Android and iOS, I considered two approaches. The first was to create native applications, which would provide the best performance and access to platform-specific features. This would require separate development efforts for each platform, increasing development time and cost. The second approach, which I ultimately recommended, was to use a progressive web app (PWA) framework. This allows us to maintain a single codebase that works across all platforms, significantly reducing development and maintenance efforts.

The challenge was ensuring that the game's drawing rendering and timer functionality work consistently across all these platforms. I implemented efficient JavaScript libraries for image manipulation and used WebSocket for real-time updates to address this.

Development Tools

For developing "Draw It or Lose It", I recommended a suite of tools that balance efficiency, cross-platform compatibility, and cost-effectiveness. For the server-side development, I chose Node.js with Express.js framework, which provides excellent performance for real-time applications and has a vast ecosystem of libraries.

For the client-side, I recommended using React for building the user interface. React's component-based architecture is well-suited for creating the game's UI elements, such as the drawing area, timer, and team displays. To manage the application state across different components and handle the game logic, I suggested using Redux.

For integrated development environments (IDEs), I found Visual Studio Code to be an excellent choice. It's free, cross-platform, and has robust support for both JavaScript and TypeScript, which we're using for type-checking in our codebase.

For version control and collaborative development, I set up a Git repository hosted on GitHub, which provides excellent tools for code review and project management.
These tools were chosen with the aim of minimizing licensing costs for The Gaming Room while providing a powerful and flexible development environment that can adapt to the evolving needs of "Draw It or Lose It".

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