https://youtu.be/0-bYd7HXX6M

Big Hero 6 Team

Team Members and Roles

Team Big Hero 6 - Group 30

- Terence Jiang - Group Leader, Use Cases
- Kevin Chen - System Evolution
- Alexander Zhao - Presenter, Implication for Division, Abstract
- Carter Gillam - Presenter, Concurrency, Glossary
- Kavin Arasu - Introduction & Overview
- Daniel Gao - Control & Data Flow

Conceptual Architecture of GNUstep program

February 13, 2025

Introduction to GNUstep

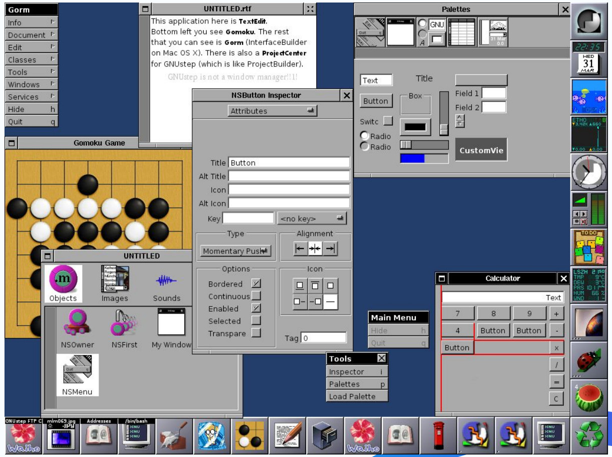
Goal of the Report: Analyze and define the conceptual architecture of GNUstep, an open-source implementation of the OpenStep framework for application development.

- GNUstep follows a modular, object-oriented architecture, with key components such as libs-back, libs-base, libs-corebase, libs-gui, and Gorm.

Component Functions:

- *libs-base*: Handles object management, networking, and file I/O.
- *libs-gui*: Implements Cocoa API functions for cross-platform GUI development.

GNUstep's Evolution: Maintains compatibility with NeXTSTEP and macOS Cocoa while integrating modern features, emphasizing modularity, reusability, and openness.



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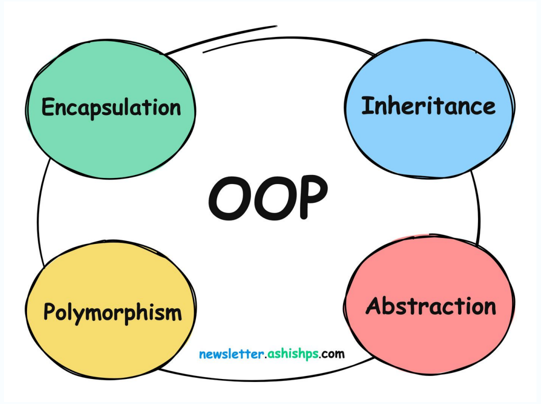
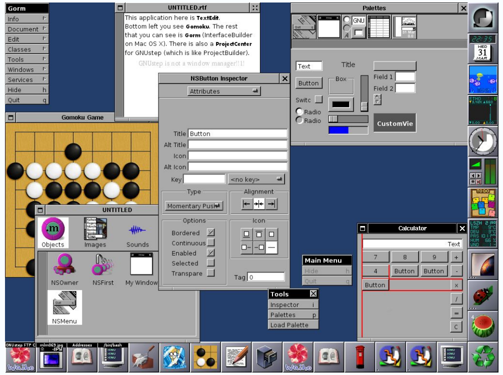
This application here is **TextEdit**.
Bottom left you see **Gomoku**. The rest that you can see is **Gorm** (InterfaceBuilder on Mac OS X). There is also a **ProjectCenter** for GNUstep (which is like ProjectBuilder).

GNUstep is not a window manager!!1!

Architecture Style

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GNUstep is not a window manager!!1!

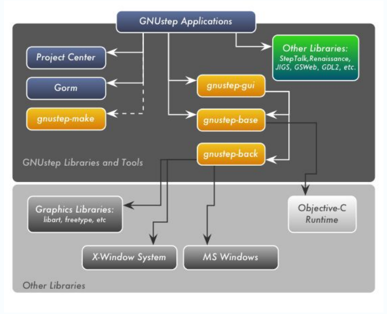
Framework Architecture

- Object-oriented design with modular components
- Modular components are very easy to maintain

Design Principles

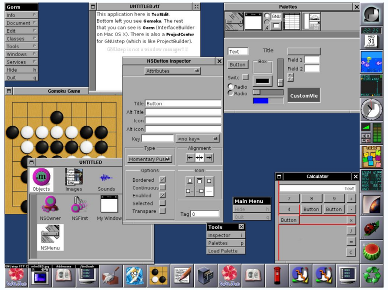
- Encapsulation and inheritance for code reuse
- Loose coupling between framework components
- Well defined interfaces for interaction

Key Components



Core Libraries

- **libs-base -** Core Objective-C classes and system functions.
- **libs-corebase -** Adds macOS-compatible foundation APIs.
- **libs-gui -** Provides AppKit for creating GUIs.



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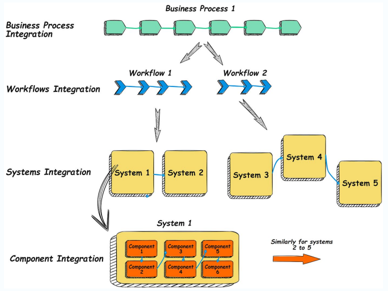
Development Tools

- **Gorm** - Visual interface builder for UI design.
- **ProjectCenter** - IDE for project management.
- Streamlines workflows for application development.



Additional Components

- **GNUstep Make** - Automates builds and linking.
- **libs-back** - Renders graphics for multiple platforms.
- **Workspace** - Desktop tools for file management.

System Evolution

Origins of GNUstep: Began as an open-source reimplementation of NeXTSTEP's OpenStep framework, aiming for API compatibility with early macOS versions and providing essential Objective-C libraries and a GUI toolkit.

Key Evolution Milestones: Introduced Gorm and Project Center, added Automatic Reference Counting (ARC), blocks, and enhanced cross-platform compatibility and GUI capabilities.

Major Version Updates:

- GNUstep 1.0: Basic GUI toolkit for Unix-based systems with limited functionality.
- GNUstep 1.2: Improved memory management, AppKit enhancements, but still lacked cross-platform compatibility.
- GNUstep 1.4: Added Windows/macOS support, Gorm for GUI building, and NSTableView/NSTextView for complex layouts, though missing advanced macOS APIs.
- GNUstep 1.8: Introduced Core Graphics-style and Quartz-style rendering, improving graphics and animations but lacking multi-touch and high-resolution display support.

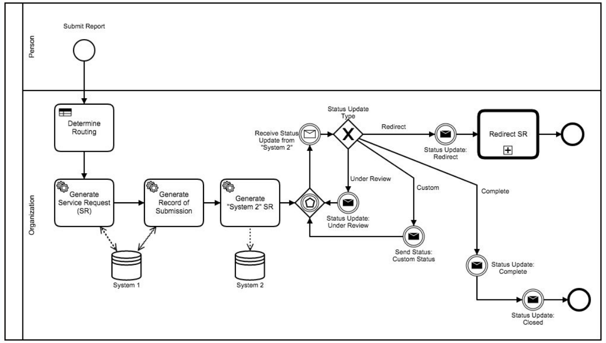
Control Flow

Application Kit (GNUstep GUI):

- Manages the main event loop, handling user input and sending events to corresponding handlers.
- Follows the Model-View-Controller (MVC) pattern:
    - Model: Stores and manages application data.
    - View: Displays the user interface elements.
    - Controller: Manages the logic, moderates data flow, updates the Model, and ensures the View updates correctly.

Development Tools:

- Gorm: A UI design tool enabling drag-and-drop element editing.
- Project Center: An IDE for writing and compiling source code.
- Both tools simplify application creation and management.



Data Flow Architecture

Foundation Kit (GNUstep Base):

- Handles data management, exception handling, and file system operations.
- Provides fundamental Objective-C classes for application logic.

Application Kit (GNUstep GUI):

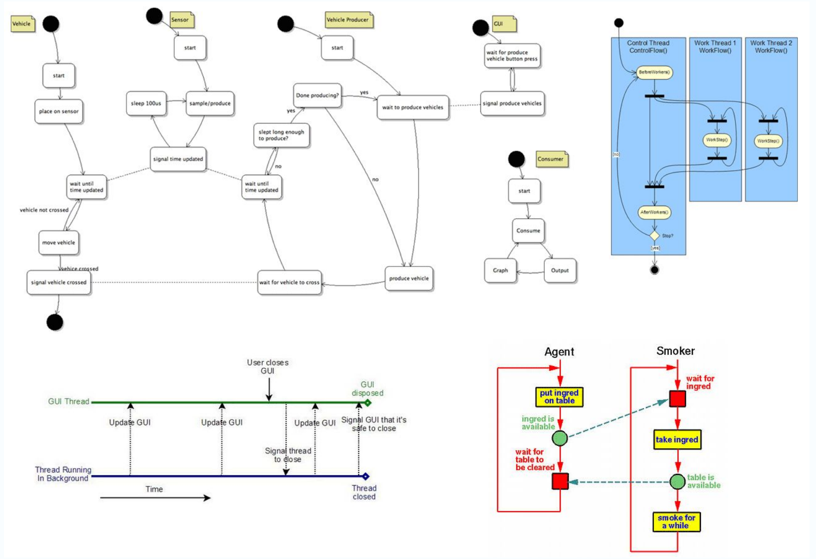
- Handles event-driven interactions, updating data based on user input.
- Ensures the Controller updates the Model and modifies the View accordingly.

Cross-Platform Support:

- GNUstep components work together to enable cross-platform applications with consistent data handling and UI behavior across different operating systems.

Concurrency Model

- Concurrency in GNUstep improves responsiveness, scalability, and reliability, making it essential for GUI applications and server-side operations that require real-time performance and fault tolerance.
- NSThread enables independent thread management, isolating resource-intensive tasks like file loading and calculations, while NSOperation and NSOperationQueue simplify task scheduling and allow background execution without freezing the interface.
- Fault isolation is a key advantage, as tasks run independently, preventing failures from affecting the main thread. Synchronization tools like synchronized blocks and locks prevent race conditions and ensure thread-safe access to shared resources.
- Challenges include race conditions, deadlocks, and performance overhead. Developers must carefully manage locking strategies to prevent deadlocks, while GNUstep minimizes overhead through lightweight thread management.



Developer Division & Organization

- GNUstep follows an object-oriented architecture, making it modularized, where components interact through well-defined interfaces. This allows independent development, maintenance, and replacement of modules without significantly affecting the program's structure.

- Development responsibilities are distributed based on expertise and module goals. Some developers work on lower-level Foundation classes like NSString, while others focus on graphical elements or tool development, such as enhancing Gorm for a better development experience.

- Inheritance and modular expansion enable new functionality by extending existing classes. Core libraries like libs-base, libs-corebase, libs-gui, libs-back, and gorm form the foundation, requiring developers to ensure compatibility and adhere to Cocoa API behavior rules.

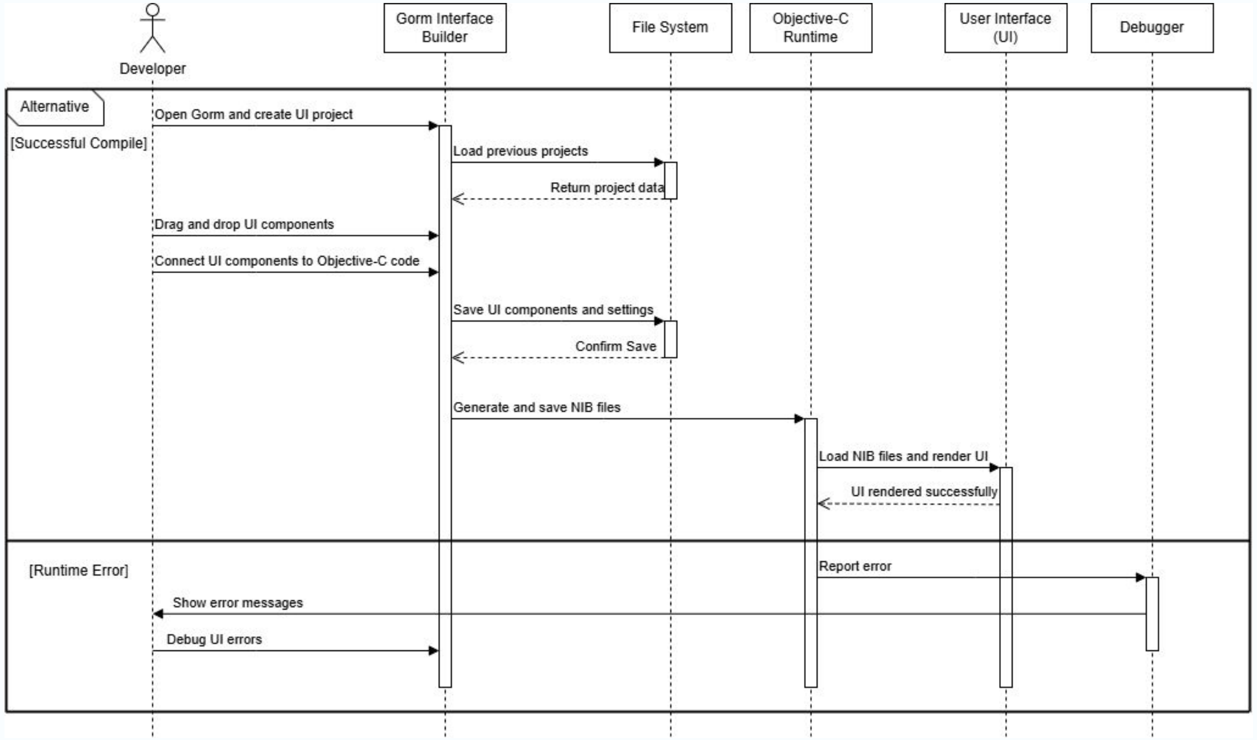
Developer Division & Organization

- Polymorphism within GNUstep demands careful maintenance, ensuring different classes interact seamlessly while preserving core functionalities. Documentation is crucial for helping contributors understand modules and their usage.

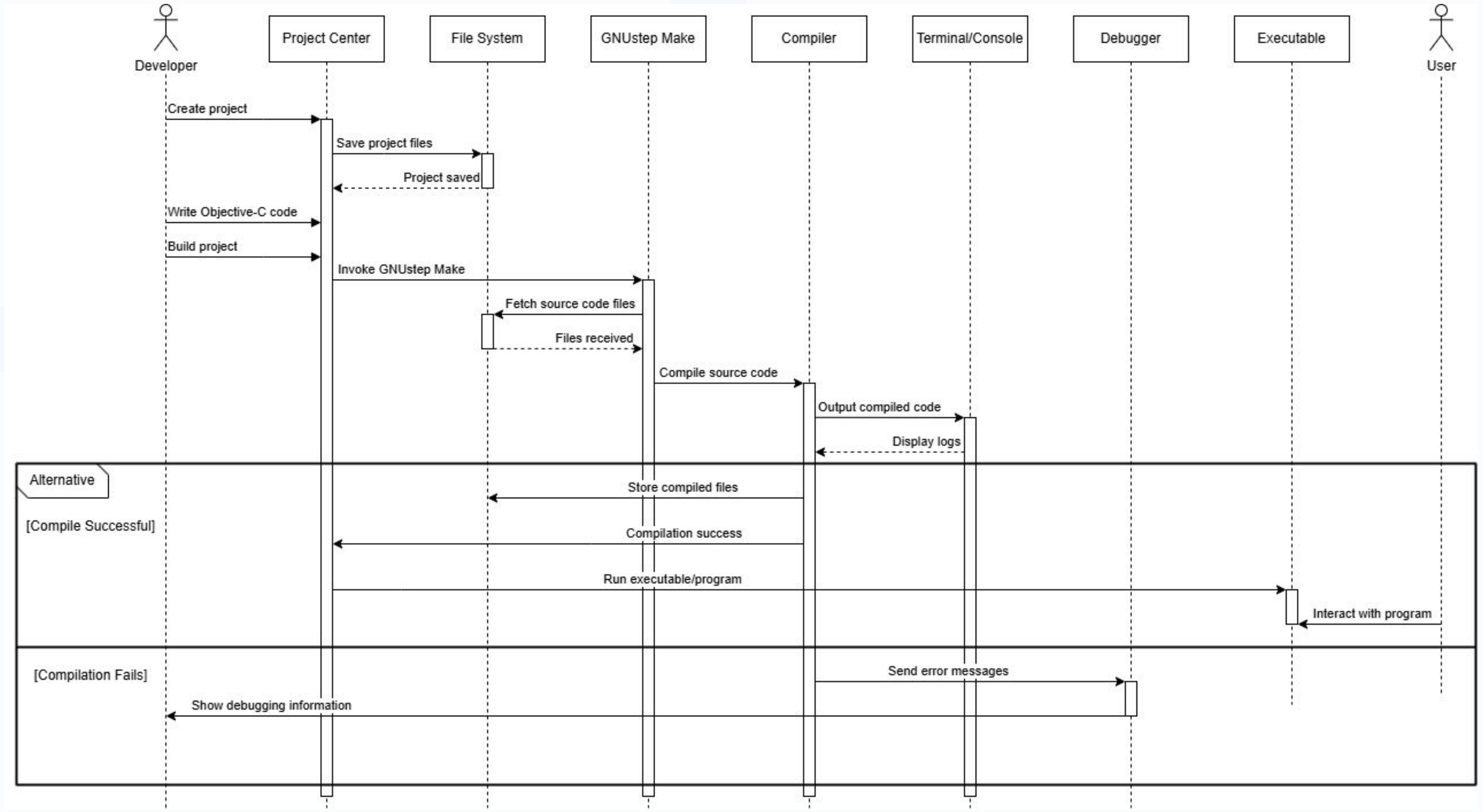
- Thread safety and concurrency must be considered, as some applications require multi-threading. Developers need to handle race conditions, resource sharing, and synchronization mechanisms to maintain stability.

- The division of responsibilities in GNUstep ensures modular development, consistency, and maintainability. Developers can specialize without deep system knowledge, Objective-C ensures consistency, and encapsulated libraries allow bug fixes and extensions without disrupting other components.

Use Case#1: Creating An App with Gorm



Use Case #2: Compiling and Running a Project in ProjectCenter



Architectural Insights

Key Architectural Strengths

- Modular design enables flexible component integration
- Strong compatibility with OpenStep standards
- Efficient memory management system
- Cross-platform portability and adaptability

Design Trade-offs

- Performance overhead in some GUI operations
- Limited modern UI framework features
- Resource intensive for small applications

Conclusion

GNUstep Architecture: Key Takeaways and Future

GNUstep's object-oriented framework provides a robust foundation for cross-platform development through its MVC architecture and comprehensive component system. While it excels in compatibility and modularity, developers should consider memory management and platform-specific optimizations. Future developments focus on enhanced mobile support, modern UI capabilities, and improved cross-platform performance.