Lady Linux – Focus Area Module

Abstraction Layer & System Mediation

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1. Focus Area Overview

Purpose:
The Abstraction Layer role designs and prototypes the controlled interface between the Lady Linux operating system and its integrated Large Language Model (LLM). This layer determines what the LLM can inspect, what actions it can propose, and how those actions are translated into safe, reversible system operations.

Context Within the System:
Without an abstraction layer, the LLM would either be dangerously overpowered or functionally useless. This role defines the boundary where system intelligence meets system authority, ensuring that all interactions are mediated, auditable, and subject to human approval.

Relevance:
Modern AI-enabled systems increasingly fail due to poorly defined interfaces between reasoning engines and real-world actions. This role reflects real-world challenges in API design, safety engineering, and secure system mediation.

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2. Learning Objectives & Goal Setting

Initial Goals:

1. Define a clear interface between the LLM and system resources.
2. Design mediation rules that enforce safety and least privilege.
3. Support explainability and reversibility of system actions.
4. Enable system inspection without unrestricted modification.
5. Provide a reusable abstraction pattern for future extensions.

Required Skills & Knowledge:

- API and interface design
- Systems programming concepts
- Basic security and access control principles
- Structured data representation (e.g., JSON, schemas)
- Technical documentation and architectural reasoning

Success Criteria:

- Clear definition of allowed system interactions
- Well-documented and enforceable boundaries
- Integration with security and UI components
- Conceptual clarity that supports future development

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3. Research & Planning Phase

Background Research:

- API design best practices
- Capability-based security models
- Middleware architectures
- System call mediation and wrappers
- Explainable and auditable system actions

Design Constraints:

- Abstraction must not leak raw system access
- All actions must be inspectable and reversible
- Human approval is required for system changes
- Performance overhead must be reasonable
- Interface must remain understandable to non-experts

Proposed Approach:
Design a layered abstraction that separates system inspection, action proposal, and action execution into distinct stages with explicit approval checkpoints.

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4. Workflow & Implementation

Development Workflow:

1. Identify system capabilities requiring mediation
2. Define inspection vs action interfaces
3. Design structured action proposals
4. Implement approval and execution workflows

5. Integrate logging and rollback hooks
6. Review abstraction boundaries with security and UI teams

Tools & Technologies:

- Python-based middleware frameworks
- API schemas and validation tools
- Configuration and policy files
- Logging and monitoring utilities

Integration Points:

- LLM reasoning and proposal generation
- OS command execution
- Security permission enforcement
- UI approval dialogs and explanations

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5. Deliverables

Primary Deliverables:

- Abstraction layer architecture document
- API/interface definitions
- Action proposal and approval schemas
- Execution and rollback workflow descriptions

Supporting Artifacts:

- Sequence diagrams
- Example request/response payloads
- Policy configuration examples

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6. Validation & Evaluation

Testing & Verification:

- Simulated action proposal scenarios
- Verification of permission enforcement
- Review of rollback functionality

Limitations Identified:

- Partial coverage of system capabilities
- Performance trade-offs
- Simplified execution models

Risk Assessment:

- Overexposing system functionality
- Ambiguous action definitions
- Insufficient user understanding of approvals

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7. Reflection & Critical Analysis

Learning Reflection:
Students reflect on the challenge of designing interfaces that deliberately limit power while enabling meaningful functionality.

Challenges & Resolutions:
Challenges may include defining appropriate abstraction boundaries or reconciling system flexibility with safety. Resolutions are documented with clear rationale.

Impact on the Overall System:
This role enables Lady Linux to function as a safe, explainable, and user-aligned system rather than an uncontrolled autonomous agent.

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8. Future Work & Recommendations

Improvements:

- Expand supported system operations
- Improve formal verification of interfaces
- Refine user-facing explanations of actions

Long-Term Relevance:
The abstraction layer establishes a pattern for safe AI-system integration applicable beyond Lady Linux.

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9. Documentation & Presentation

Documentation Standards:
All interfaces and workflows must be clearly documented and annotated to support reuse and review.

Presentation Component:
The student presents abstraction flows and explains how mediation protects users while enabling intelligent assistance.

Assessment Alignment (Faculty Use)

- Quality of interface design
- Effectiveness of safety mediation
- Integration with security and UI
- Documentation clarity
- Depth of reflection