Bytelocker: A Comprehensive File Encryption Plugin for Neovim

Technical Analysis Report

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1 Overview

Bytelocker is a sophisticated Neovim plugin designed for encrypting and decrypting files using multiple cipher algorithms. The plugin provides seamless integration with Neovim's workflow, offering automatic encryption detection, toggle functionality, and robust data integrity preservation.

2 Architecture

The plugin follows a modular Lua-based architecture:

Core Components:

- `lua/bytelocker/init.lua` – Main implementation (1148 lines)
- `plugin/bytelocker.lua` – Plugin entry point and auto-setup
- Magic header system for encrypted content detection
- Persistent password and cipher storage

3 Encryption Mechanisms

3.1 Cipher Algorithms

The plugin implements three distinct cipher methods:

1. Shift Cipher (Default): Uses bitwise rotation operations

```
-- 8-bit rotation with overflow protection
byte_val = rol8(byte_val, shift_amount)
```

2. XOR Cipher: XOR-based encryption with null-byte protection

```
-- Prevents password leakage on null bytes
safe_byte = (byte_val + 1) % 256
encrypted_byte = bxor(safe_byte, key_byte)
```

3. Caesar Cipher: Character shifting with XOR preprocessing

```
-- Combined XOR and shift for enhanced security
intermediate = bxor(byte_val, key_byte)
encrypted_byte = (intermediate + shift + 1) % 256
```

3.2 Block Processing

All ciphers operate on 16-byte blocks with automatic

4 File Detection & Safety

4.1 Two-Layer Safety Architecture

The plugin employs a sophisticated two-layer approach to handle non-ASCII encrypted bytes:

Layer 1 - Binary Encryption with Magic Header:

- Encrypted data begins with "BYTELOCKR" magic header (9 bytes)
- Followed by original file length (4 bytes, big-endian)
- Then encrypted 16-byte blocks (potentially non-ASCII)

Layer 2 - ASCII-Safe File Storage:

- Entire binary encrypted data -> Base64 encoded
- Wrapped with ASCII markers: "—BYTELOCKER-ENCRYPTED-FILE—"
- Guarantees file system compatibility and safe text handling

4.2 Encryption Detection

File detection uses the ASCII wrapper markers, not magic header:

```
-- File detection looks for ASCII markers
local header = "---BYTELOCKER-ENCRYPTED-FILE---"
return content:sub(1, #header) == header
```

4.3 Data Integrity Features

Critical improvements over basic encryption:

- **Length Preservation:** Original file length stored in 4-byte header
- **Perfect Reversibility:** All cipher operations are mathematically reversible
- **Overflow Protection:** Bit operations bounded to prevent corruption

5 User Interface

5.1 Commands

- `:BytelockerToggle` – Auto-detect and toggle encryption
- `:BytelockerEncrypt` – Explicit encryption
- `:BytelockerDecrypt` – Explicit decryption
- `:BytelockerChangeCipher` – Switch cipher method
- `:BytelockerClearPassword` – Clear stored credentials

5.2 Visual Selection Support

The plugin supports both full-buffer and visual selection operations, maintaining the same encryption format for consistency.

6 Password Management

6.1 Security Features

- Password persistence across sessions
- Basic obfuscation using character shifting
- Memory and disk storage with automatic cleanup
- Secure input using `inputsecret()` function

6.2 Password Preparation

```
-- Generate deterministic key from password
for i = 1, CIPHER_BLOCK_SIZE do
    local char_code = string.byte(password,
        ((i - 1) % #password) + 1)
    table.insert(prepared, char_code % 256)
end
```

7 Technical Implementation

7.1 File Format Structure

The complete encrypted file structure demonstrates the two-layer approach:

Final File Format (ASCII-safe):

```
---BYTELOCKER-ENCRYPTED-FILE---
[Base64-encoded binary data]
---END-BYTELOCKER-ENCRYPTED-FILE---
```

Inner Binary Format (before Base64):

1. Magic header "BYTELOCKR" (9 bytes)
2. Original file length (4 bytes, big-endian)
3. Encrypted content blocks (16-byte aligned)

ASCII Safety Transformation:

```
-- Non-ASCII binary -> Base64 -> ASCII file
local binary_encrypted = encrypt_text_only(content, password)
local base64_encrypted = base64_encode(binary_encrypted)
local file_content = header .. base64_encrypted .. footer
```

7.2 Error Handling

Robust error handling includes:

- `pcall()` wrapper for decryption operations
- Validation of file format and header integrity
- Graceful handling of corrupted or invalid files
- User feedback through Neovim's notification system

8 Advanced Features

8.1 Base64 Encoding Layer

To solve the non-ASCII problem, the plugin implements a custom Base64 encoder:

```
-- Custom Base64 implementation ensures ASCII safety
local base64_chars =
  'ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz0123456789+/'

-- Processes 3-byte groups -> 4 ASCII characters
local combined = lshift(b1, 16) + lshift(b2, 8) + b3
local c1 = band(rshift(combined, 18), 0x3F) + 1
-- ... continues for c2, c3, c4
```

This elegant solution transforms any binary data (including cipher-generated non-ASCII bytes) into guaranteed ASCII text safe for file systems, editors, and transmission.

8.2 Cipher Persistence

User cipher choice is automatically saved to disk and restored across sessions, providing consistent encryption behavior.

8.3 Configuration Options

```
require('bytelocker').setup({
    setup_keymaps = true,  -- Enable 'E' keybind
    cipher = "shift"       -- Pre-select cipher
})
```

9 Conclusion

Bytelocker demonstrates sophisticated cryptographic implementation within Neovim's ecosystem. Its multi-cipher approach, robust error handling, and data integrity features make it a reliable tool for file encryption workflows. The plugin's modular architecture and comprehensive test coverage ensure maintainability and extensibility for future enhancements.