Toward an Automated Vulnerability Comparison of Open Source IMAP Servers

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December 7, 2005

Overview

- Motivation
- Attack surfaces
- IMAP server design
- Automated attack surface measurement
- Results

Why automated vulnerability comparison

- Goal is to minimize vulnerability of installed software
- But how do we measure future vulnerability?
  - Past bugs?
  - Reputation?
  - Look at the code?
- Useful metric must:
  - Be easy to apply
  - Give simple and usable results

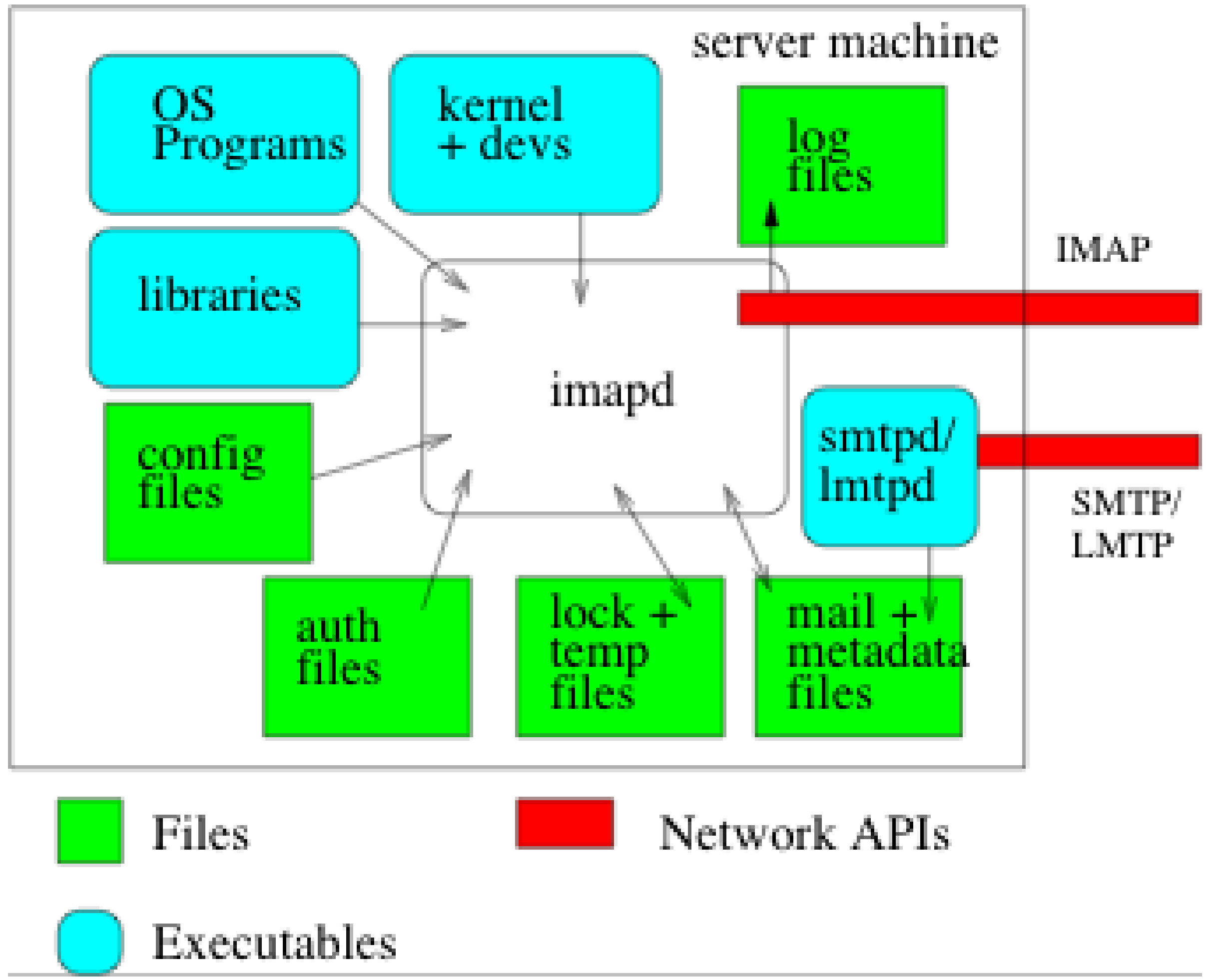
Why analyse IMAP servers

- Protocol for remote authenticated e-mail access
- Three popular servers: UW, Cyrus, Courier
- Prior vulnerability data is inconclusive:
  - Approximately 30 IMAP server vulnerabilities recorded
  - Almost all are remote API buffer overflows allowing arbitrary code execution

Analysis methodology: attack surfaces

- Methodology for generating metrics
- Two prerequisites for an attack on a system:
  - Before attack, attacker must be able to affect the system in some way
  - Attack must increase attacker's access to the system
- Measure system attackability by counting ways to affect the system
- What do attack surface elements look like?

The attack surface of an IMAP server



IMAP design choices which affect attackability

- Permissions and authentication:
  - Imapd account (Cyrus) vs. root/user (UW, Courier)
- Subset of functionality which is built in:
  - Needs external network listener (UW)
  - Custom tcpwrappers workalike (Courier)
  - Custom procmail workalike (Cyrus)
- How do we rigorously measure the effects of all these choices?

Measuring attackability: using the source

- Metric used: a weighted count of the code functions available through the IMAP network interface
- Weighting: not all functions are equally accessible
- Access rights:
  - Authorization needed to execute the code
  - Unauthenticated, anonymous, user, administrator
- Privileges:
  - Power the operating system gives to the running code
  - nobody, user, imapd, root

How to automatically count and classify functions

- Use a code analysis tool to find all reachable functions
- Starting from `main()`, manually divide code by privilege/access
- Finding privilege/access boundaries:
  - Privilege: look for `setuid()/setgid()` calls
  - Access rights: password checks? internal variables?
- Output: set of functions accessible at each privilege/access level

From sets of functions to an attackability value

- Assign a weight to each privilege and access level:
  - More privileged functions have higher weight:
    * weight(`root`) > weight(`nobody`)
  - Functions with more access restrictions have higher weight:
    * weight(authenticated) > weight(unauthenticated)
- Choose a simple attackability function satisfying:
  - Higher privilege leads to higher attackability
  - Higher access restriction leads to lower attackability

$$\text{Attackability}(\text{codebase}) = \sum_{f \in \text{functions}} \frac{\text{weight}(\text{priv}(f))}{\text{weight}(\text{access}(f))}$$

Results and Discussion

Courier outperformed others significantly, while UW and Cyrus tied

- Metric rewards privilege separation heavily:
  - Courier designed to have good privilege separation
  - Cyrus contains more code than UW, but scored similarly
- Results can depend on specific numerical weights chosen:
  - Cyrus imapd account vs. UW root/unprivileged user
  - Imapd almost as privileged as root? UW wins
  - Imapd barely more privileged than user? Cyrus wins
- Still needed: better automation, comprehensiveness
- As implemented, attackability metric gives some sensible results

Questions?

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