The Blunderdome: An Offensive Exercise for Building Network, Systems, and Web Security Awareness

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Pre-Introduction: The Blunderdome

- Framework of vulnerable services and systems
- Educational, linear, goal-oriented offensive exercise using the framework
- Deployed twice: graduate course, high school interns
- Note: This is an education talk, not a testbed talk

Overview

- Cyber Security Exercises
- The Blunderdome exercise
  - Architecture / Framework
  - Network attack
  - Systems attack
  - Web attack
- Deployments
  - Graduate course
  - High school interns
- Lessons Learned
- Perspective on Offensive Exercises
- Conclusions

Background: Cyber Security Exercises

- Simulated activity involving cyber attack or defense
- Quick and dirty taxonomy:
  - Offensive vs. Defensive
  - Symmetric (both attack and defend) vs. Asymmetric (only one)
- Some examples
  - DEFCON CTF (Symmetric)
  - Collegiate Cyber Defense Competition; Service Academies' Cyber Defense Exercise (Asymmetric, Defensive)
  - OWASP WebGoat; Blunderdome (Asymmetric, Offensive)
- Frequently built for adaptability, flexibility, and exploration

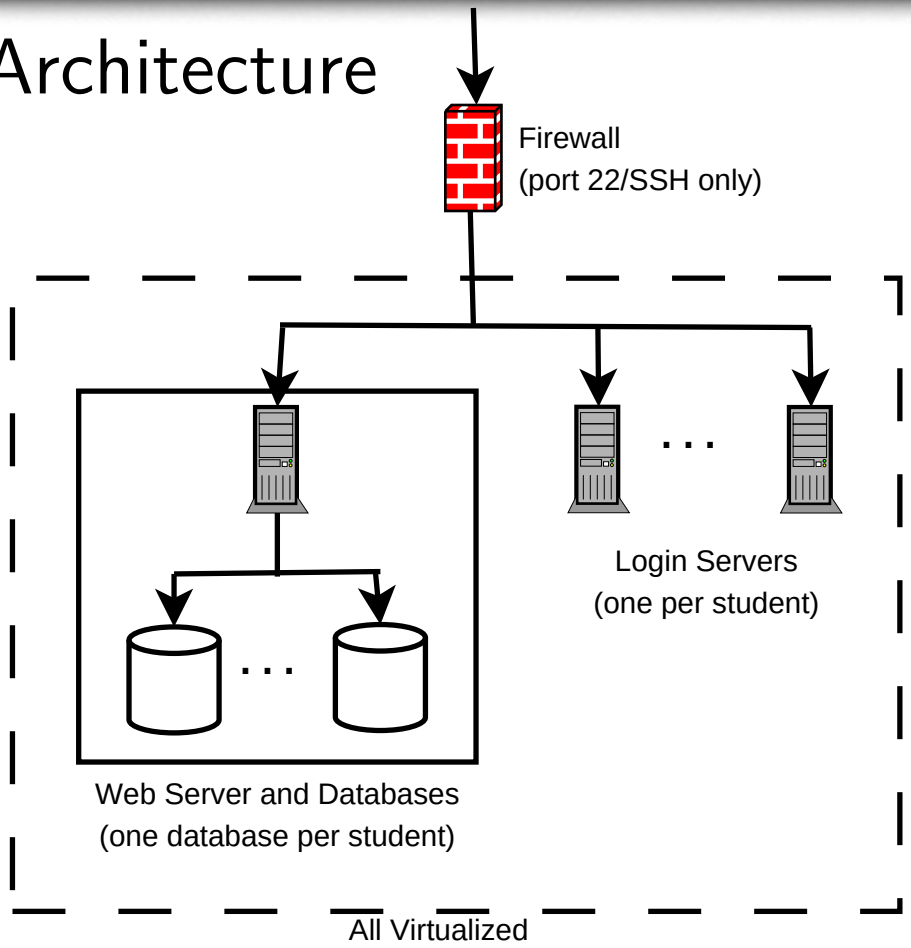
Blunderdome: Overview

- Obstacle course, not a sandbox
- Design goals:
  - Linearity
  - Goal-oriented design
  - Realism of services and vulnerabilities
  - Clear criteria for completion of stages
  - "Off-the-shelf" components
- Simulates an academic network and grades management system
- Scenario: change your grade

Blunderdome: Architecture

- Simulates a small, firewalled "academic network"
- Web Service (Grades management)
  - Username/password protected (not intentionally vulnerable)
  - SQL injection vulnerability for the grades table
- Login Server
  - Entry point to network
  - SSH key authentication only
  - Unpatched Ubuntu 7.10
  - Pre-configured with weak keys (CVE-2008-0166)
  - Root exploit vulnerability in kernel (CVE-2008-0600)
- Firewall (only permit SSH)

Blunderdome: Architecture



The Blunderdome architecture

Step 0: Set up

- Participants start with:
  - IP address
  - User name
  - SSH public key
- Instructed to:
  - Find the associated public key and log into the machine
  - Gain root, read a root-owned, root-readable file containing grades server credentials and address
  - Change your grade (an A is suggested)

Step 1: Network attack

- IP address and public key to login server are given
- Login server runs Ubuntu 7.10 - Debian OpenSSL bug caused weak keys (CVE-2008-0166)
- Keyspace was only 32,767 possibilities.
- Intended to require coding, but Googling worked as well
- Result: user-level access to login server on "internal" network
- All further actions staged from the login server (SSH tunneling)

Step 2: Systems attack

- Vulnerability (CVE-2008-0600) in vmsplice shipped with Ubuntu 7.10
- Local root privilege escalation exploit available
- Credentials and address for web service read from root-owned, non-public file

Step 3: Web attack

- Very simple homegrown web service
- Internal access only (users tunnel via login server)
- "Check Grades" button that submits a hidden field that is concatenated into an SQL query

Summary of Stages

Stage	Precondition	Attack	Proof
Gain remote user access	SSH public key available (given)	Break weak public key	Create a user-owned text file
Gain root access	User-level access	Execute `vmsplice` privilege escalation	Create root-owned text file
Change grade	Address and credentials for web service	Execute SQL injection	Altered grade in database

Deployment: Graduate Course

- Developed originally for *Information Systems Security Engineering*
  - Course on security engineering and secure software development
  - Vulnerability-related topics on buffer overflows, weak cryptographic protocols, and web vulnerabilities
- Some objectives:
  - Illustrate examples of classes of attacks described theoretically
  - Drive discussion regarding engineering causes of vulnerabilities
  - Reinforce potential for flaws on multiple levels of the stack
- Assigned as a week-long project at end of term

Lessons: Graduate Course

- First issue: problem with student *buy-in*
- Term-end project: limited opportunities for discussion
- Needed tighter lecture integration
- Security is easy. SSH is hard.

Deployment: Interns

- Deployed again to summer interns from high schools (juniors and seniors)
- Some goals:
  - Crash-course introduction to security
  - Assess interns' general technical knowledge
  - Use as a motivator to teach general systems and network knowledge
  - Disillisionment
- Assigned to about 6 students with a graduate student supervising

Lessons: Interns

- Interns learned:
  - Linux command line
  - Asymmetric key cryptography
  - Secure shell and tunneling
  - Network fundamentals
  - GNU toolchain and compiling other people's code from source
  - Vocabulary and exploit/vulnerability taxonomy
  - ...

Lessons: Interns

- Total non-issue: buy-in
- In fact, buy-in was a huge advantage
- Big issue: hand-holding required

Offensive Exercises

- Offensive exercises are controversial in academia
  - Ethics concerns (We don't want to be a "hacker school".)
  - Perception concerns (We don't want people to *think* we're a "hacker school".)
- Nevertheless, we advocate targeted, educational offensive exercises (as well as ethics), particularly for:
  - Penetration testing
  - Security engineering
  - Network operations
- Drives enthusiasm

Conclusion

- Blunderdome: offensive, asymmetric, linear, cross-sectional exercise
- We still believe in all of those properties
- Useful to drive enthusiasm for building general knowledge (intro or survey course) - catch them young
- Needs tight lecture integration
- Overall, demonstrated the usefulness of offensive exercises in coursework

Future Work

- Focus on curriculum integration
- Future expansion to:
  - Interns
  - Information Systems Security Engineering
  - Secure Electronic Commerce
  - Using a real testbed?

Q & A

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