Enumeration overview

- Actively engage a system and query it for information.
- Used to discover vulnerabilities and then exploit them.
- Information collected include routing tables, users and groups, machine names, network resources.

Common ports and services to enumerate

- 📝 List of most commonly enumerated services and their ports

Port	Protocol	Service
25	TCP	SMTP (Simple Mail Transfer Protocol)
53	TCP/UDP	DNS (Domain Name System)
135	TCP/UDP	Microsoft RPC Endpoint Mapper
137	UDP	NetBIOS Name Service
139	TCP	SMB over NetBIOS
161	UDP	SNMP (Simple Network Management Protocol)
162	TCP/UDP	SNMP Trap
389	TCP/UDP	LDAP
445	TCP/UDP	SMB over TCP
465	TCP	SMTP over TLS
500	UDP	ISAKMP/IKE
514	UDP	Syslog, used for system logging
587	TCP	SMTP over **optionally*** STARTTLS
1433	TCP/UDP	Microsoft SQL Server
3268	TCP/UDP	Global Catalog Service
5060, 5061	TCP/UDP	SIP (Session Initiation Protocol)

- Read more on IANA ports list
- See also • Port monitoring | Malware analysis • Common ports to scan | Scanning networks

Enumeration techniques

- Extracting user names using email ID's
  - E.g. if the e-mail is tom.john@smith.com then tom.john is probably the user name

- Extract information using the default password
  - Identifying OS would tell the default password
  - If no one has changed it can be used to gather more information.
- DNS enumeration

Windows enumeration

- **Enumerating all shares**
  - `net share` or `net view \\serverName /all`
- **Enumerating machine configuration through null sessions**
  - Null sessions allow for enumeration of Windows machines to access information about the machine configuration.
  - E.g. `net use \\target\ipc$ "" /user: "`
- **Configurable services and server/workstation settings**
  - `net config`

Windows user account enumeration

Security Identifier (SID)

- A **subject** can access an **object** with given **permissions**
- **Subject** (who)
  - Windows internally identifies entities as "Security Principals" also known as "Subject"s
  - E.g. user accounts, groups, computers and services
- Subjects are assigned SID (Security Identifier) by the system
- E.g. S-**1**-**5**-**21**-1852694824-1489621752-332472329-**500**
- 📝 Format: `S-<revision-level>-<authority-id>-<first-subauthority>-<o-N subauthorities>-<relative identifier(RID)>`
  - **Authority ID**
    - 0 - `SECURITY_NULL_SID_AUTHORITY` - null group or nobody
    - 1 - `SECURITY_WORLD_SID_AUTHORITY` - account Everybody
    - 2 - `SECURITY_LOCAL_SID_AUTHORITY` - group account Local (logged in users)
    - 3 - `SECURITY_CREATOR_SID_AUTHORITY` - Creator Owner
    - 5 - `SECURITY_NT_AUTHORITY` - Created by OS
    - There are many more
  - **Sub Authority ID**
    - 5 - For applications that run under a specific session
    - 6 - When a process authenticates as a service
    - 21 - For SIDs that are not universal but has local significance
    - 32 - Identifies built-in SIDs
    - 80 - Identifies services' SIDs
  - **Relative identifier (RID)**
    - 500 - Administrator
    - 501 - Guest

Windows user account enumeration tools

- `user2sid` and `sid2touser`: Brings SID value for a given account name and vice versa
  - E.g. `user2sid \\SVR1 Guest`
  - Getting SID allows enumeration of accounts/groups by changing RID
    - E.g. `sid2user \\SVR1 5 21 1928525985 232339646 3462474693 501`
      - Returns like `Name is Guest`, `Domain is DEMO`, `Type of SID is SidTypeUser`
      - Syntax: `sid2user [\computer_name] authority subauthority_1 …`
- `dumpusers`: All-in-one tool to dump account names and information
- `GetAcct`: Can dump account information as CSV file.
- From SystemTools:
  - DumpSec: lists all users and the groups they are in
  - Hyena dumps shares and user login names for Windows domain controllers and servers on same network.
- PsGetSid: Translates SIDs to their display name and vice versa

NetBIOS enumeration

- NetBIOS (Network Basic Input/Output System) is a unique name of a Windows machine.
- 📝 Allow computers
  - to communicate with others at the same time
  - to share files and printers
- Uses SMB (service message block) protocol
  - Network file sharing protocol.
  - 🤗 Was targeted by WannaCry ransomware who traversed the network and injected hosts.
- Easily exploitable, often used as one of the first scans.
- Helps to collect: • System name • Username • Domain • Printers • Available shares

NetBIOS enumeration tools

- nbtstat
  - Proprietary Windows diagnostic tool for NetBIOS over TCP/IP.
  - `nbtstat -a <IP or hostname>`: shows NetBIOS names
- `net view <IP or hostname>` prints available shares such as printers.
- smb-nat
  - NetBIOS Auditing Tool)
  - `nat -o <output file> -u <user-list> -p <password-list> <ip/range>` allows you to brute force different usernames and passwords for administrative shares.
- WinFingerPrint
  - Windows enumeration tool
  - Scan machines in LAN and returns shares, disk information, services, users (SID), groups..

SNMP enumeration

- Also known as ***SNMP walking***
- SNMP stands for Simple Network Management Protocol.
- Used for
  - monitoring networking equipment
  - remotely modifying settings and configs on the equipment
- Was developed for routers and switches (1988)
  - Extended for linux/windows machines, printers, sensors, power supplies and more...
- Two kind of **community strings**:
  - Read community string: read-only.
    - You can collect information such as
      - System name, system uptime, network settings, CPU usage level etc.
  - Read/write community string: read-write (private) to edit configurations
  - 💡 SNMPv3 encrypts the community strings
- Consists of a **manager** and an **agent**
  - **Agent**s are embedded into network devices.
    - Agents send their information to manager using port 162.
    - Data messages are called traps.
  - **Manager** is installed on a computer.
    - Needs two passwords to access and configure the agents:
      - read community string
      - read/write community string
- **Object identifier (OID)**
  - Any device that can be monitored has an OID.
  - E.g. `1.3.6.1.2.1.2.2.1.8`
- **Management Information Base (MIB)**
  - Text-file that translates numerical OIDs to word-based OIDs.
    - E.g. `SYNOLOGY-SYSTEM-MIB::temperature.0`
  - You can collect information CPU usage level, disk usage level, network settings using vendor-specific OIDs.
- Version 1, 2: (❗ insecure) No encryption, only "community string" and no encryption
- Version 3: Username + password and encryption

SNMP enumeration tools

- `snmpwalk`
  - Enumerates ports in SNMP agent and finds out UDP port sending traffic to manager.
  - `snmpwalk -c public -v1 <agent IP address>`
  - Starts listening to the port.
- `snmp-check`
  - You can find out the version using `snmp-check <IP address> -v <version 1 or 2c>`

        - Gives much more information like routing tables, storage information, users etc.
- `snmp-get`
    - Retrieve specific OID information from target using `-o`
    - SNMP community string for SNMP v1/v2c.
        - E.g. `sysName.0` for system name
    - E.g. `snmpget -v 1 -c public system.sysName.0`

LDAP enumeration

- See also brute-forcing active directory

LDAP

- LDAP stands for Lightweight Directory Access Protocol
- Used by on-premises Active Directory (Microsoft)
- 📝 Hierarchical e.g. domain > child-domains > organizational units > users / groups / computers.
- May return information about usernames, addresses, servers, and other sensitive information.
    - could be utilized in a brute force or social engineering attacks.

LDAP enumeration countermeasures

- Use over encrypted and secure protocols e.g. by e.g.
    - **LDAP over SSL/TLS**
        - Also known as **LDAPS**
        - SSL/TLS is negotiated before LDAP protocol begins.
    - **LDAP over StartTLS**
        - STARTTLS is a way to take an existing insecure connection and upgrade it to a secure connection using TLS.
        - Communication is only encrypted after the connection is established.
- Use NTLM or Basic authentication
- Select a username different from your email address

LDAP enumeration tools

- Jxplorer
- LDAP Admin Tool
- LDP.exe
- Softerra LDAP Administrator
- 📝 `net use` to show list of connected resources and logged-in user accounts.

NTP enumeration

NTP

- 📝 NTP (Network Time Protocol) is to synchronize computer clocks.
- E.g. machines in same domain in Active Directory must have same GMT clocks.
- Uses UDP 123
- Target accuracy
  - 10 ms over the public internet
  - 200 ms or better on a local area network
- 🤗 Usually companies have authority of time-source on their on-premises, it synchronizes to internet and everything else synchronizes to it.
  - Important for routers / switches to have logs with right timestamps.
- Attackers query NTP for
  - List of hosts connected to NTP server
  - Clients IP addresses, system names and operating systems.
  - Internal IP addresses can be acquired if the NTP server is on the DMZ

NTP enumeration tools

- `ntptrace`: traces NTP servers back to the primary source.
- `ntpdc`: monitors operation of the NTP daemon, ntpd
- `ntpq`: monitors NTP daemon ntpd operations and determines performance.
- Other tools include: • NTP Time Server Monitor • NTP server Scanner • Nmap • Wireshark • AtomSync • NTPQuery, • PresenTense NTP Auditor • PresenTense Time Server • PresenTense Time Client • Lan Time Analyser...

SMTP enumeration

SMTP

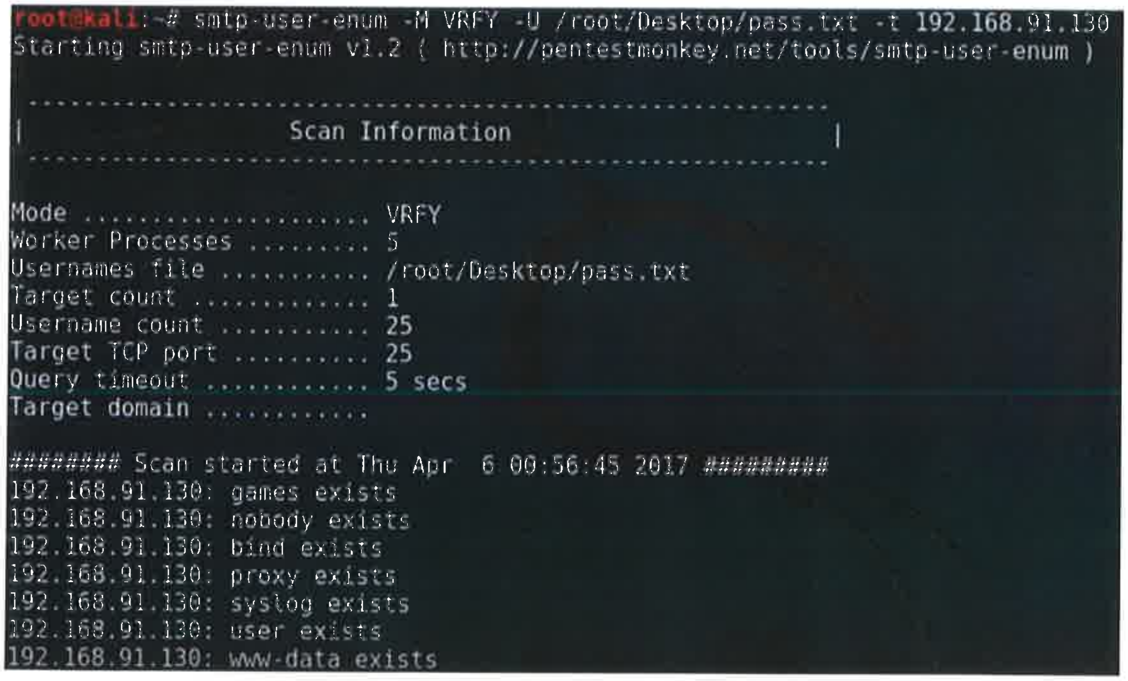
- SMTP = Simple Mail Transfer Protocol (port: 25)
- Protocol used for sending/receiving e-mails.
  - Used by clients talk to SMTP servers
  - Used also by SMTP servers to talk to other servers.
- Secure/encrypted protocols include:
  - **SMTPS** is SMTP over TLS (port: 587)
    - 🤗 Like HTTPS is HTTP over TLS
  - SMTP can also run with STARTTLS (port: 467)
    - Compared to running over TLS, it encrypts communication AFTER the communication is established.
    - STARTTLS is also known as **opportunistic TLS** as it would fall back to unencrypted communication if server does not support it.
- See MX records to find SMTP servers
- Allows to validate e-mail addresses to ensure they exist
  - 🤗 One another: Go to provider → try creating account with that e-mail.
  - 🤗 Large collection of e-mails can be sold or used for phishing.

  - 🤗 Many e-mail senders (e.g. AWS Simple Email Service) blocks you if you send e-mails that will not reach the targets.
    - One idea is to create fake accounts in cloud providers → ask to increase soft limits → enumerate per accounts

SMTP enumeration through SMTP commands

- `VRFY`: validates e-mail address that actually exists
- `EXPN`: tells the actual delivery address of aliases and mailing lists
- `RCPT TO`: Defines recipients of the messages
- ❗ Some admins may turn off `VRFY` and `EXPN`, but not `RCPT TO` (or no one can receive e-mail)

SMTP enumeration through tools

- NetScanTools Pro SMTP Server Tests Tool Description
  - Used to perform tests sending e-mails
- `smtp-user-enum`
  - Enumerates OS-level user accounts on Solaris
  - Inspects responses to `VRFY`, `EXPN` and `RCPT TO`
  - 

```
root@kali:~# smtp-user-enum -M VRFY -U /root/Desktop/pass.txt -t 192.168.91.130
Starting smtp-user-enum v1.2 ( http://pentestmonkey.net/tools/smtp-user-enum )

 ----------------------------------------------------------
|                   Scan Information                       |
 ----------------------------------------------------------

Mode ..................... VRFY
Worker Processes ......... 5
Usernames file ........... /root/Desktop/pass.txt
Target count ............. 1
Username count ........... 25
Target TCP port .......... 25
Query timeout ............ 5 secs
Target domain ............

######## Scan started at Thu Apr  6 00:56:45 2017 #########
192.168.91.130: games exists
192.168.91.130: nobody exists
192.168.91.130: bind exists
192.168.91.130: proxy exists
192.168.91.130: syslog exists
192.168.91.130: user exists
192.168.91.130: www-data exists
```

    - `stmpy-user-enum -M <command> -U <list of emails> -t <SMTP server>`

Brute forcing Active Directory

1. Get admin user with SID 500
   - `Get-ADUser -Filter * | where { $_.SID -like "*-500" }`
2. Brute-force its credentials
   - E.g. if user is `admin@cloudarchitecture.io`:
     - `net use \\%computername% "PasswordTest1" /u:admin@cloudarchitecture.io`
     - `net use \\%computername% "PasswordTest2" /u:admin@cloudarchitecture.io`
     - ...

DNS enumeration

DNS

- Stands for "Domain Name System"
- Hierarchical and decentralized naming system
- Used for resources connected to the Internet including computers and services
- Runs on TCP/UDP port 53

DNS records

- Database record used to map a URL to an IP address
- Stored in zone files in DNS servers
  - A DNS server contains a "zone file" for each domain
  - Zone file is made up of "resource records" (RRs)
- Helps users connect their websites to the outside world.
- 📝 Common DNS records include
  - `A`
    - Points a domain to an IPv4 address, such as `11.22.33.44`.
  - `AAAA`
    - Points a domain to an IPv6 address, such as `FE80::0202:B3FF:FE1E:8329`.
  - `MX`
    - Mail eXchange records are used to direct emails sent to domain
    - See also MX records | Whois, GeoIpLocation and DNS interrogation
  - `NS`
    - Used to delegate a domain or subdomain to a set of name servers
  - `SOA`
    - Contains data to control the zone transfer.
    - Includes serial number, timestamps, mail address of zone responsible..
    - E.g.

```
$TTL 86400
@   IN  SOA    ns.icann.org. noc.dns.icann.org. (
        2020080302  ;Serial
        7200        ;Refresh
        3600        ;Retry
        1209600     ;Expire
        3600        ;Minimum TTL
)
```

  - `CNAME`

        - Link a subdomain to a domain's existing A or AAAA record
        - E.g. `www.cloudarchitecture.io` to `cloudarchitecture.io`
    - `PTR`
        - Opposite of `A`, points an IP to domain
        - Commonly used for spam verification for e-mail programs
    - `HINFO`
        - System information including CPU and OS type.

DNS enumeration techniques

- Check all NS Records for [zone transfers](#).
- Enumerate general [DNS records](#) for a given domain.
- Perform common SRV Record Enumeration.
    - Service records contain the hostname, port and priority of servers for a given service.
    - Enumerates e.g. • LDAP • Autodiscover for Exchange • Kerberos...
    - E.g. by `nmap --script dns-srv-enum --script-args "dns-srv-enum.domain='google.com'"`
- Brute force subdomain and host A and AAAA records discovery with given top domain and wordlist.
- DNS PTR lookup given a IP range CIDR range
    - Querying dns for PTR record of each IP in subnet
- See also [DNS interrogation](#)

DNS cache snooping

- Checks a DNS server cached records.
  Done by performing **non-recursive** (or also known as **iterative**) DNS queries
    - Also known as iterative query
    - Server returns either its own record or another DNS server that may know the answer.
    - As opposed to [recursive DNS lookup](#) where servers communicates with other DNS servers.
- **Tools**
    - Automated: [dnsrecon](#)
    - 📝 Manual:
        - `dig` with `+norecurse` flag
        - `nslookup` with `-norecurse` flag
        - `host` with `-r` flag

Zone transfers

- DNS server passes a copy of part of it's database ("zone") to another DNS server
- There's one master DNS server, and one or more slave DNS servers
    - Slaves ask master for a copy of records
- Uses TCP port 53
- 📝 Uses **AXFR** (full) protocol or **IXFR** (incremental).
- The secondary server request a new copy if the primary SOA serial number is higher.

    - The primary increments the serial number every time the SOA changes
    - If the secondary checks in and the primary's copy has a higher serial number

DNS zone transfer attack

- Pretending to be a slave and ask for records
- Allows an attacker to obtain sensitive information about internal DNS records (network).
- 📝 Flow
    1. Get NS records (DNS servers that are responsible for resolving the queries)
        - Using `dig`: `dig ns zonetransfer.me` or `dig +short ns zonetransfer.me`
        - Using `nslookup`: `nslookup zonetransfer.me`
    2. Initiate AXFR request to get a copy of the zone from name server
        - Using `dig`: `dig axfr @<DNS you are querying> <target>`
            - E.g. `dig axfr @nsztm1.digi.ninja zonetransfer.me`
        - Using `nslookup`
            - `nslookup -ls -d nsztm1.digi.ninja`
                - `-d`: list all records for DNS domain
                - Sends AXFR query to the remote nameserver
                - Initiates zone transfer if and only if the remote nameserver is dumb enough to respond to unsolicited, unauthorized AXFRs originating from random machines on the Internet.
            - Or using interactive mode with specified a DNS server:

```
$ nslookup
> server <DNS you are querying>
> set type=any
> ls -d <target>
```

        - Or `nslookup -query=AXFR <target> <DNS you are querying>`
        - Using `host`: `host -l nsztm1.digi.ninja`
- 🤗 In June 2017 the registrar responsible for Russian top-level-domains accidentally enabled DNS zone transfers via AXFR which led to 5.6 million records being accidentally exposed | source

Zone transfers countermeasures

- Do not allow or restrict zone transfers
- Use split DNS

Split DNS

- Also known as ***split-horizon DNS***, ***split-view DNS***, ***split-brain DNS*** or ***split DNS***
- 📝 Separation of internal network (intranet) DNS and public network (Internet) DNS
- Provides different answers to DNS queries based on the source address of the DNS request.
- Can be accomplished with hardware or software solutions

DNS enumeration tools

dnsrecon

- Open source python script
- E.g. `./dnsrecon.py -d cloudarchitecture.io`
- Enumerates DNS records and more

nslookup

- Limited: Depends on existence of DNS reverse lookup zone.
- Forward lookup (normal): Here's name give me IP
- Reverse lookup: Here's IP give me back the name

dig

- *Nix tool for querying DNS
- E.g. `dig cloudarchitecture.io any`
  - `any` argument (optional): all records it can find
- `dig axfr cloudarchitecture.io`

`host`

- On Unix-like operating systems, the `host` command is a DNS lookup utility
- Using e.g. `host <target-domain>` to see all records.
- 📝 You can also set type `-t` to see specific records e.g.
  - `host -t a <target-domain>` to see A records
  - `host -t ns <target-domain>` to see NS records
  - ...