PREPARING A NETWORK ATTACK: "FOOTPRINTING"

Corso di Laurea Magistrale in Ingegneria Informatica

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HOW TO PREPARE A NETWORK ATTACK?

- Vital concepts for anyone looking to prepare, with knowledge, for launching an attack on a computer network:
  - Footprinting:
    - The art of gathering information on the network
    - Often referred to as "network reconnaissance"
  - Scanning:
    - a thorough inspection of the attack perimeter, looking for potential entry points
  - Enumeration:
    - probing the identified services to discover potential vulnerabilities

FOOTPRINTING

- Gathering information useful for creating a detailed profile (footprint) of an organization's security features involves:
  - determining the organization's presence on the internet
  - identifying remote access points to the organization's network
  - understanding the configuration of the organization's intranet/extranet
  - exploring business partners and their relationships with the organization
- When conducted systematically, footprinting activities allow for the structured collection of information, providing a comprehensive overview of a potential attack target's network profile

FOOTPRINTING: INTERNET/INTRANET

- Data of interest for footprinting include:
  - Domain names
  - Address blocks and subnets
  - IP addresses of systems accessible via the internet
  - TCP and UDP services running on identified systems
  - System architecture
  - Access control mechanisms (and lists)
  - Presence of Intrusion Detection Systems (IDS)
  - Usernames and/or user groups, system banners, routing tables
  - Management information (SNMP)
  - Hostnames

FOOTPRINTING: EXTRANET

- Data of interest:
  - Domain names
  - Source and destination of each connection
  - Types of connections
  - Access control mechanisms in use

FOOTPRINTING: REMOTE ACCESS

- Data of interest:
  - Phone numbers (analog and digital)
  - Type of remote system
  - Authentication mechanisms
  - Presence of Virtual Private Networks (VPN) and related protocols

FOOTPRINTING: CONSIDERATIONS

- One of the most complex activities in determining the security profile of an organization
- One of the most boring tasks for anyone eager to engage in hacking techniques
- The fundamental step for the subsequent development of an effective protection plan for the studied organization
- As always, footprinting is:
  - useful for potential attackers...
  - ...crucial for the security officers of any organization present on the network

FOOTPRINTING IN THE INTERNET

1. Publicly available information
2. WHOIS and DNS enumeration
3. DNS interrogation
4. Network Reconnaissance

1. PUBBLIC INFORMATION

a. Organization's web pages
b. Related organizations
c. Location details
d. Employee information
e. Current events involving the organization
f. Privacy and security policies/mechanisms
g. Archived information
h. Search engines and data relationships related to the organization
i. Other useful information…

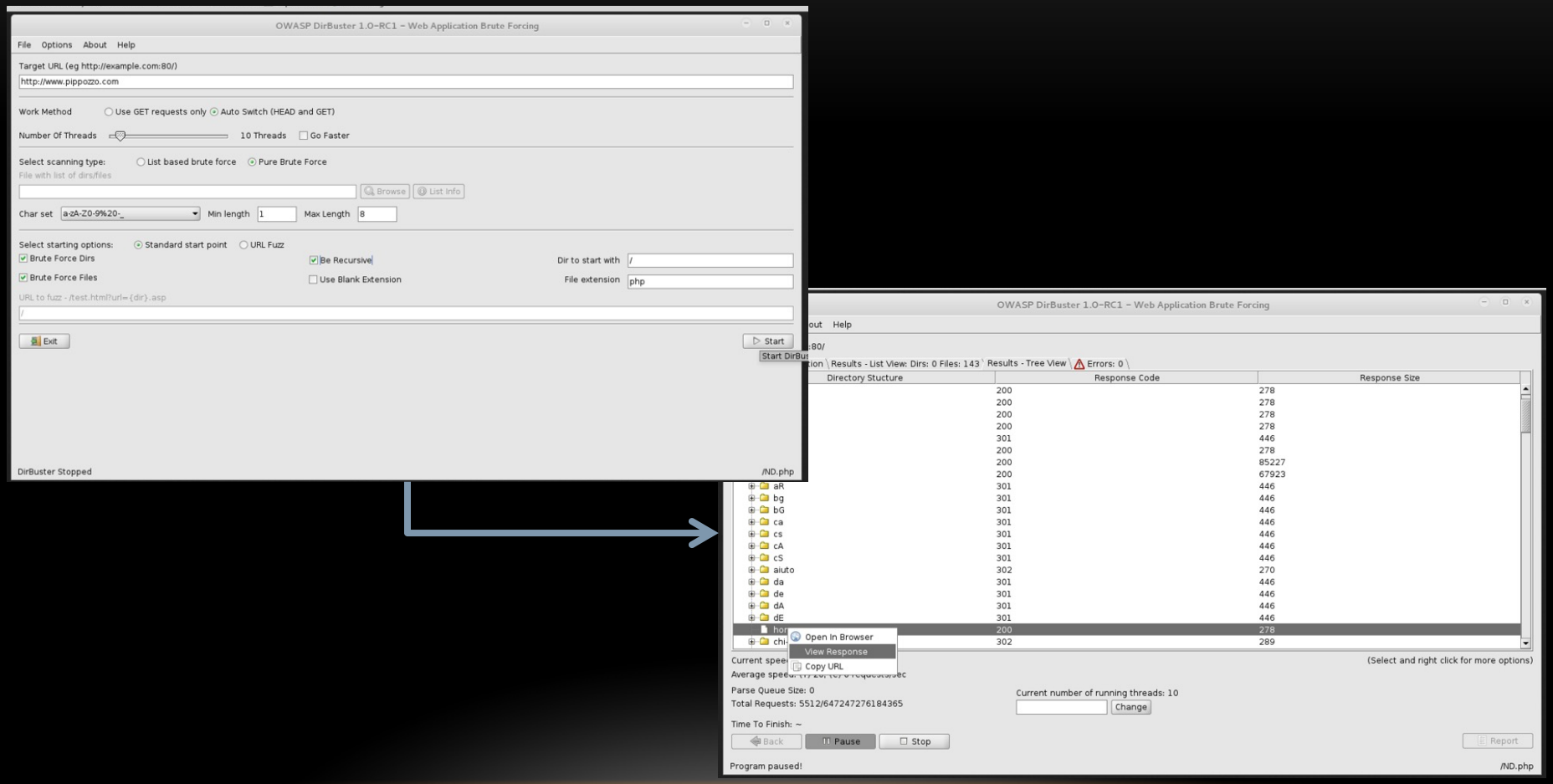
1.a ORGANIZZATION'S WEB SITE

- Many useful (and often sensitive) pieces of information are publicly available on organization websites:
  - details about security configurations
  - complete inventories of the organization's assets ...
- A thorough analysis of HTML code can reveal many surprises:
  - information contained within comments:
    - <!-- Sensitive data contained in a comment... -->
- Many websites often act as proxies to internal organization services:
  - webmail, access to Microsoft Exchange servers, remote access to mainframes (e.g., WebConnect), access to the corporate VPN, etc.

OFF-LINE WEB SITE ANALYSIS

- For a more thorough analysis of an organization's web resources, the following techniques are often used:
  1. Locally downloading a clone of the website for analysis:
     - Using tools like "Wget" (http://www.gnu.org/software/wget/)
  2. Searching for "hidden" information within the local clone of the website:
     - Hidden files and directories
     - This can be automated using brute force approaches
       - Recursively searching within the website for hidden directories and files, with a focus on extensions deemed more interesting (e.g., ".php," ".jsp," ".cgi," ".asp," etc.)

DirBuster: an example of the “Brute Force” technique



1.b RELATED ORGANIZATIONS

- References or links to organizations connected in various ways to the target organization:
  - for example, many companies outsource their websites, both for the design phase and for development and graphic consulting
- Information about partner organizations often leaks from the analysis of the target organization's website
  - e.g., comments on web pages containing the author(s) and affiliation of the code and/or graphics portion
    - JavaScript libraries, style sheets, etc.

1.c DETAILS ABOUT THE LOCATION

- The physical address of an organization can be very useful for launching 'non-technical' attacks:
  - Dumpster diving:
    - Yes, looking for 'information treasures' in the trash!
  - Surveillance
  - Social engineering

Dumpster diving is looking for treasure in someone else's trash. (A dumpster is a large trash container.) In the world of information technology, dumpster diving is a technique used to retrieve information that could be used to carry out an attack on a computer network. Dumpster diving isn't limited to searching through the trash for obvious treasures like access codes or passwords written down on sticky notes. Seemingly innocent information like a phone list, calendar, or organizational chart can be used to assist an attacker using social engineering techniques to gain access to the network. To prevent dumpster divers from learning anything valuable from your trash, experts recommend that your company establish a disposal policy where all paper, including print-outs, is shredded in a cross-cut shredder before being recycled, all storage media is erased, and all staff is educated about the danger of untracked trash.

Social engineering is a non-technical method of intrusion hackers use that relies heavily on human interaction and often involves tricking people into breaking normal security procedures. It is one of the greatest threats that organizations today encounter.

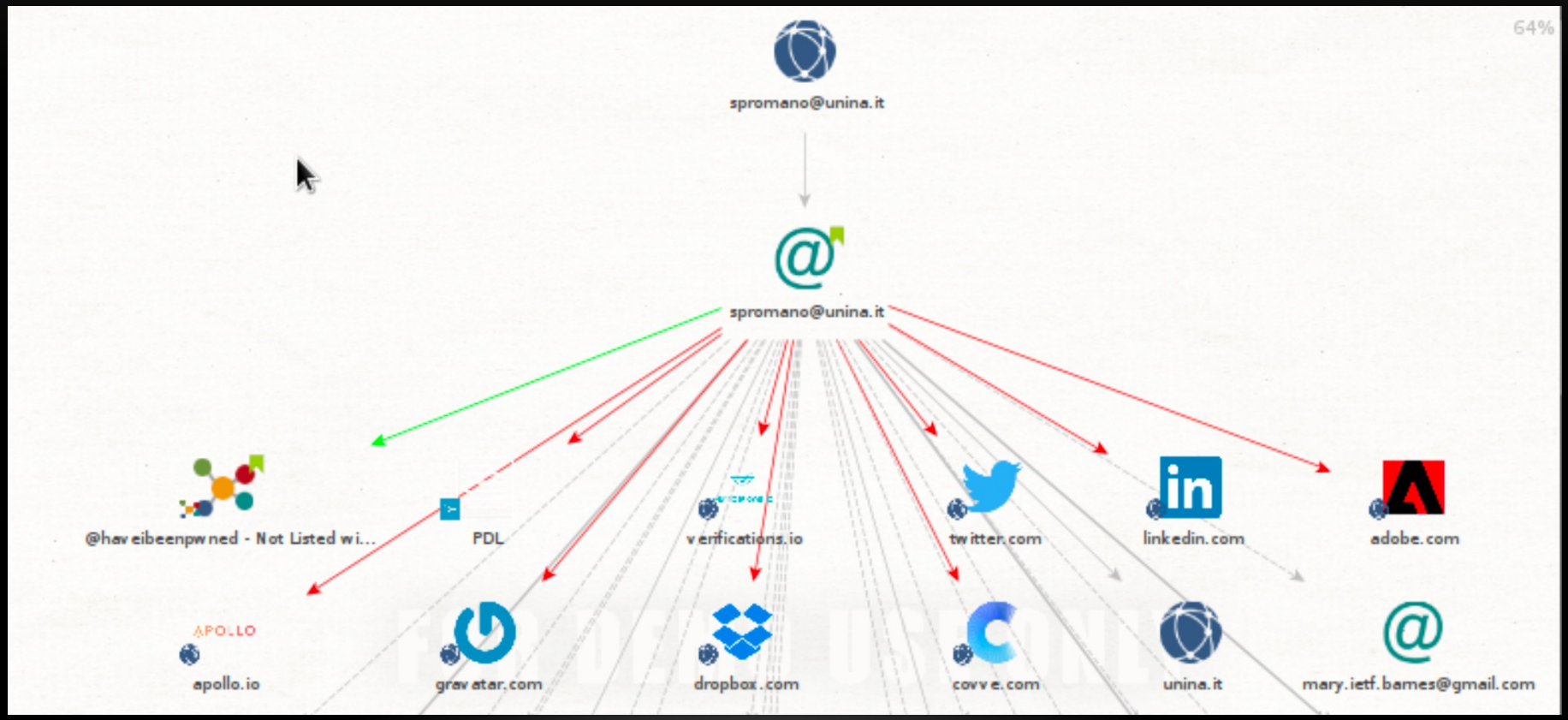
1.d Information about employees

- Contact names, phone numbers, email addresses...
  - from an email address it is often easy to trace a username
  - a valid domain user name is essential to move on to the next phases of the attack and gain access to the target system's resources
- Websites to use to gather information about an organization's employees:
  - social sites:
    - facebook, myspace, reunion, classmates, X, instagram, tik tok, etc.
  - professional sites:
    - linkedin, plaxo, monster, careerbuilder, etc.
  - paid contact sites for use in marketing and sales campaigns

HOW TO USE ALL THIS DATA?

- Many data mining tools can be used to correlate the vast amount of collected information effectively
- One example is Maltego
  - a powerful social engineering tool
  - capable of
    - extracting information at various levels
    - processing ("transforming") the gathered information
    - correlating data
    - representing the result of these processes as a "social graph"

MALTEGO IN ACTION



1.e Events involving the organization

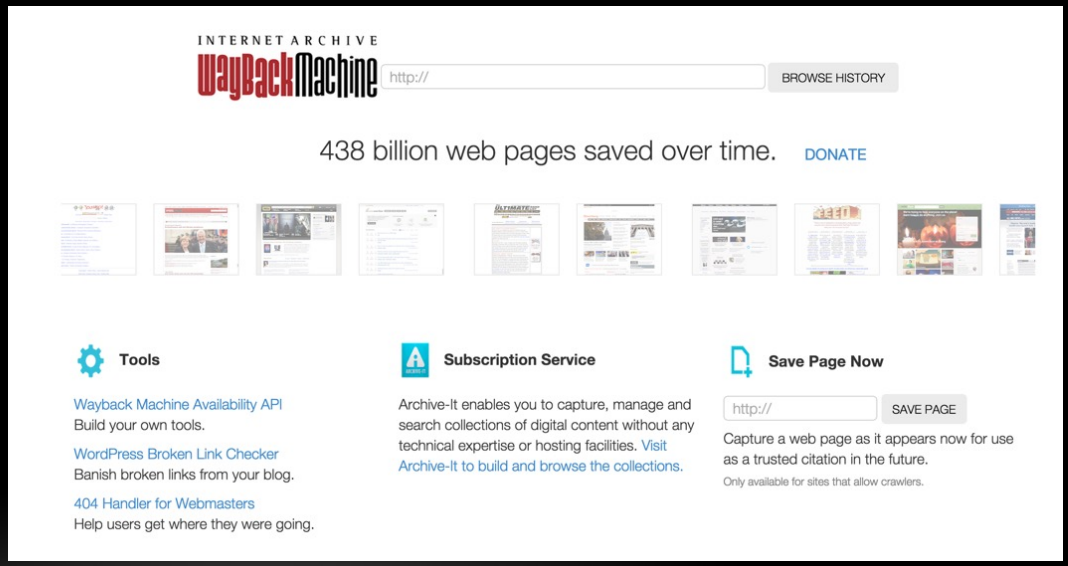
- Information on:
  - corporate mergers, acquisitions, scandals, bankruptcies, outsourcing activities, extensive use of temporary labor contracts, etc.
    - all useful indicators of the 'health' status and management practices of an organization
- If the organization is a public company, a lot of information is available online:
  - transparency requirement

1.f PRIVACY AND SECURITY MECHANISMS

- Any type of information that provides useful details about the security policies adopted by the target organization
- Technical details regarding the hardware and software infrastructure that the organization has implemented for security purposes

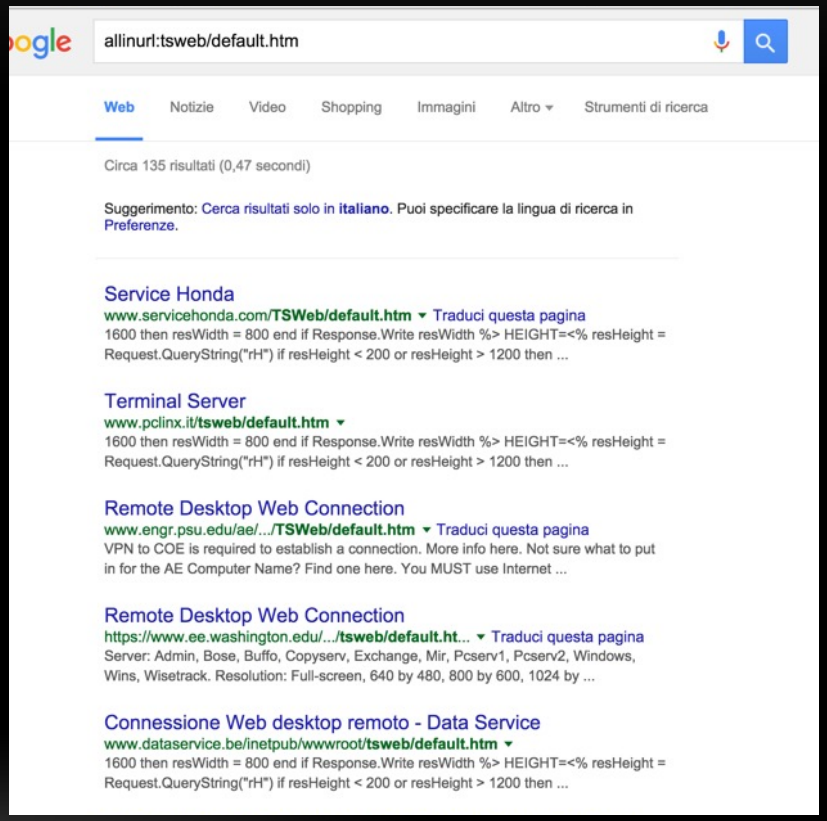
1.g ARCHIVED INFORMATION

- Use of websites that allow you to retrieve obsolete copies of information no longer available from the original source
- Possibility of accessing information (including sensitive data) intentionally removed by the target organization for security reasons.
- An example of this:
  - WayBack Machine (www.archive.org)



1.h SEARCH ENGINES AND DATA RELATIONSHIPS

- Search engines are now among the primary tools of hackers
- e.g.,: "allinurl:tsweb/default.htm"
  - reveals Microsoft servers that expose a web-accessible remote desktop service…
    - …potentially vulnerable to remote-to-local attacks through RDP (Remote Desktop Protocol) exploits Protocol)

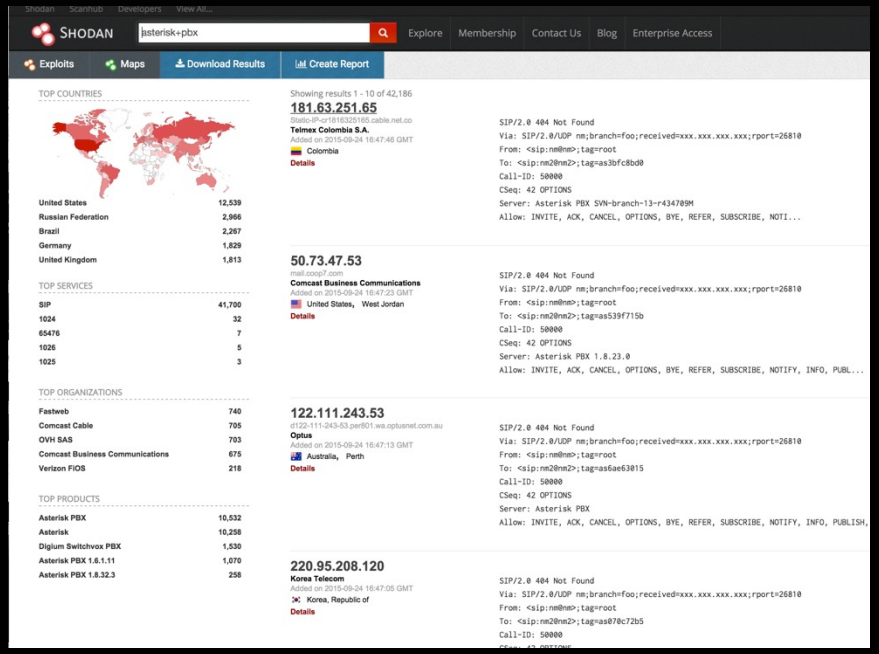


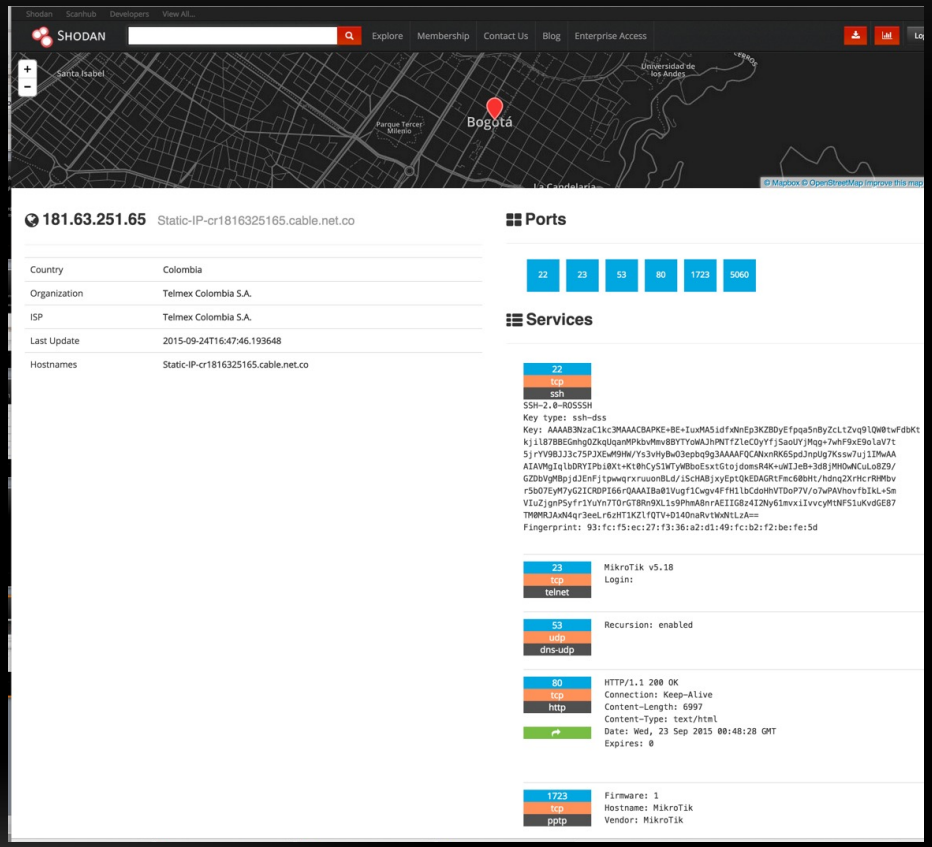
GOOGLE HACKING DATABASE

SHODAN

- *"Sentient Hyper-Optimized Data Access Network"*
- Often referred to as "Google for Hackers"
- Designed to discover systems (computers, routers, webcams, refrigerators, "things") on the network
- Focus on identifying potential vulnerabilities in authentication and authorization mechanisms

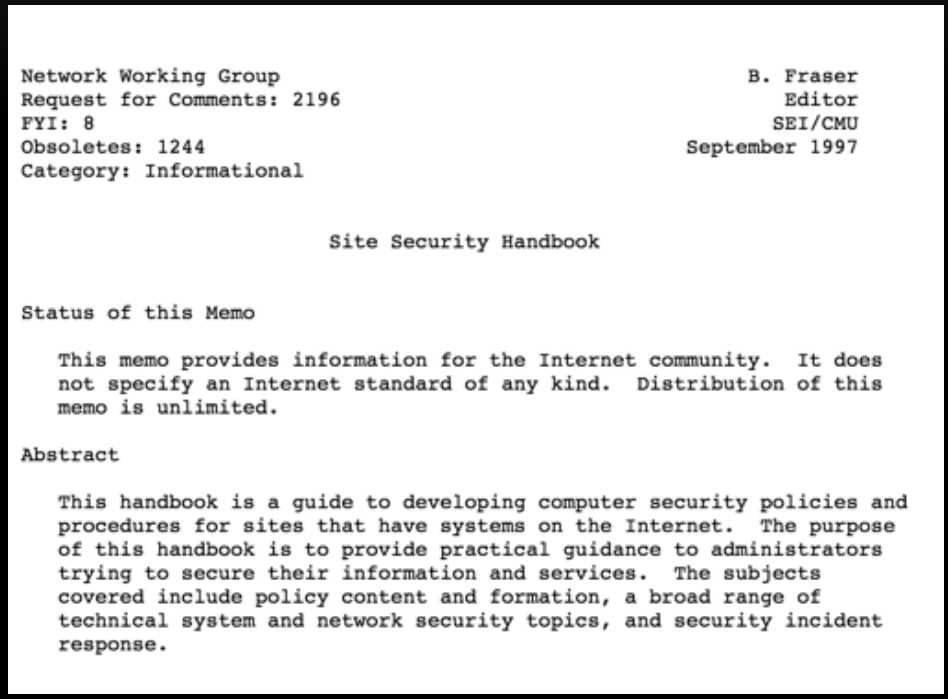
SHODAN: A SAMPLE SEARCH





COUNTERMEASURES?

- RFC 2196: Site Security Handbook:
  - a guide for defining and implementing security policies and procedures for organizations that expose their systems on the Internet



Network Working Group
Request for Comments: 2196
FYI: 8
Obsoletes: 1244
Category: Informational

B. Fraser
Editor
SEI/CMU
September 1997

Site Security Handbook

Status of this Memo

This memo provides information for the Internet community. It does not specify an Internet standard of any kind. Distribution of this memo is unlimited.

Abstract

This handbook is a guide to developing computer security policies and procedures for sites that have systems on the Internet. The purpose of this handbook is to provide practical guidance to administrators trying to secure their information and services. The subjects covered include policy content and formation, a broad range of technical system and network security topics, and security incident response.

2. WHOIS AND DNS ENUMERATION

- ICANN: Internet Corporation for Assigned Names and Numbers
  - an organization responsible for technical coordination of the Internet
  - coordinates the assignment of the following identifiers:
    - Domain names
    - IP addresses
    - Protocol parameters and their port numbers
  - monitors the proper functioning and stability of DNS root name servers
  - has taken over responsibilities once held, under contract from the U.S. government, by the Internet Assigned Numbers Authority (IANA)

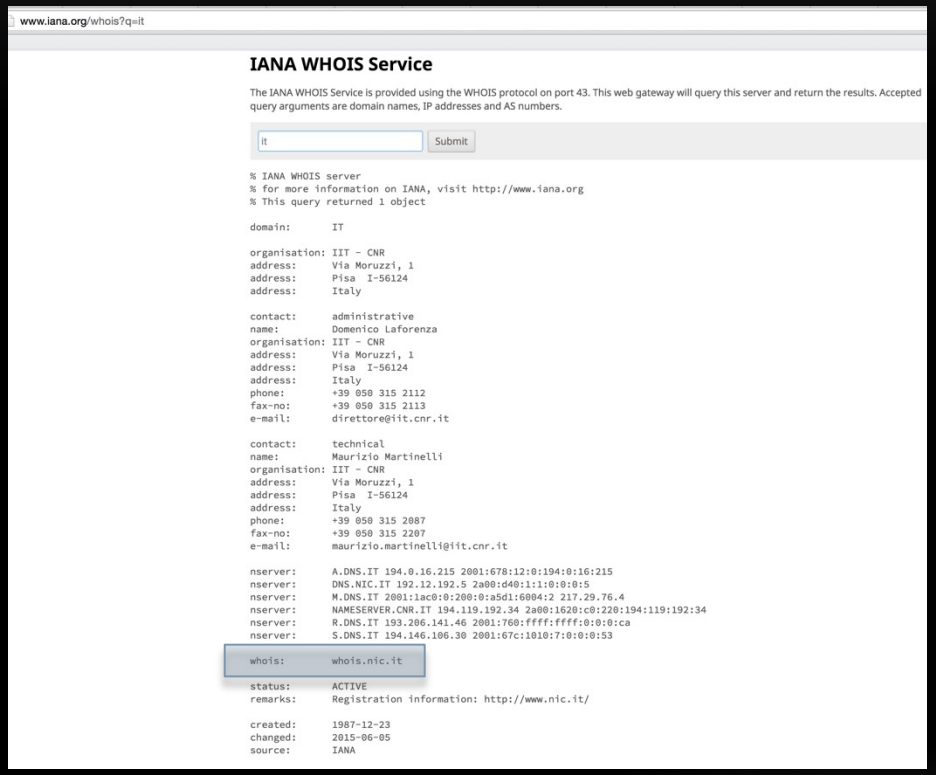
ICANN: STRUCTURE

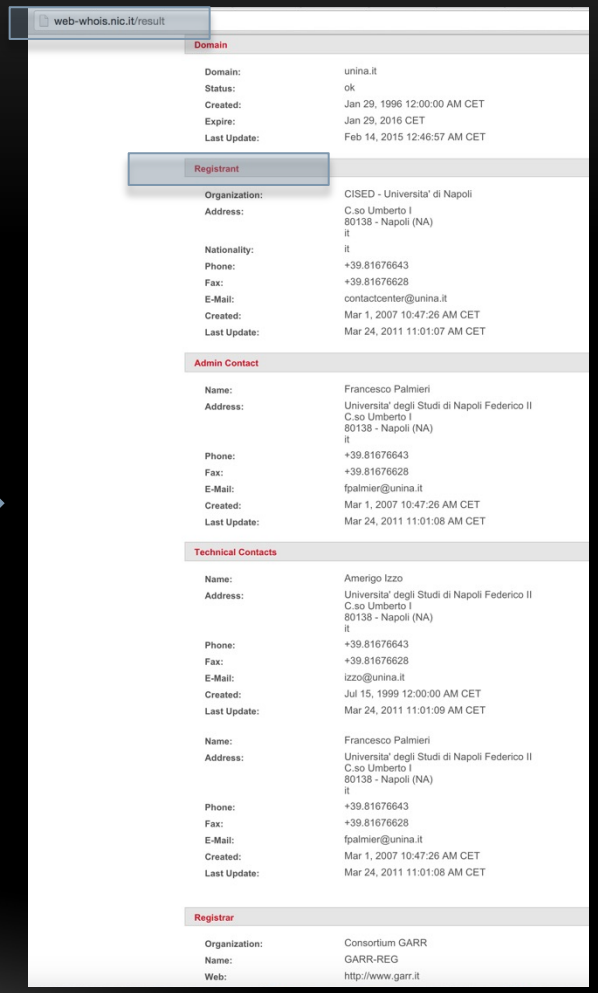
- Some notable sub-organizations include:
  - ASO: Address Supporting Organization
    - Allocates IP address blocks to various Regional Internet Registries (RIRs)..
      - ...which, in turn, allocate addresses to ISPs, National Internet Registries (NIRs), or Local Internet Registries (LIRs)
  - GNSO: Generic Names Supporting Organization
    - Responsible for the names of "generic Top-Level Domains" (gTLDs):
      - .com, .net, .edu, .org, .info, etc.
  - CCNSO: Country Code Domain Name Supporting Organization
    - Responsible for the names of "country-code Top-Level Domains" (ccTLDs):
      - .it, .fr, .de, .jp, etc.

DOMAIN NAME RESEARCH

- The three R's of the WHOIS service:
  - Registry
    - contains information about the Registrar where the target entity registered its domain name
  - Registrar
    - contains details about the entity that registered the domain
  - Registrant
    - the entity that registered its domain name
- Remember that the DNS implements a hierarchical registration mechanism:
  - the ideal starting point for a search is the root of the tree:
    - ICANN (IANA)!

WHOIS.IANA.ORG





WHOIS FOM THE COMMAND LINE

```
root@kali:~# whois it -h whois.iana.org
% IANA WHOIS server
% for more information on IANA, visit http://www.iana.org
% This query returned 1 object

domain:       IT

organisation: IIT - CNR
address:      Via Moruzzi, 1
address:      Pisa  I-56124
address:      Italy

contact:      administrative
name:         Domenico Laforenza
organisation: IIT - CNR
address:      Via Moruzzi, 1
address:      Pisa  I-56124
address:      Italy
phone:        +39 050 315 2112
fax-no:       +39 050 315 2113
e-mail:       direttore@iit.cnr.it

contact:      technical
name:         Maurizio Martinelli
organisation: IIT - CNR
address:      Via Moruzzi, 1
address:      Pisa  I-56124
address:      Italy
phone:        +39 050 315 2087
fax-no:       +39 050 315 2207
e-mail:       maurizio.martinelli@iit.cnr.it

nserver:      A.DNS.IT 194.0.16.215 2001:678:12:0:194:0:16:215
nserver:      DNS.NIC.IT 192.12.192.5 2a00:d40:1:1:0:0:0:5
nserver:      M.DNS.IT 2001:1ac0:0:200:0:a5d1:6004:2 217.29.76.4
nserver:      NAMESERVER.CNR.IT 194.119.192.34 2a00:1620:c0:220:194:119:192:34
nserver:      R.DNS.IT 193.206.141.46 2001:760:ffff:ffff:0:0:0:ca
nserver:      S.DNS.IT 194.146.106.30 2001:67c:1010:7:0:0:0:53

whois:        whois.nic.it

status:       ACTIVE
remarks:      Registration information: http://www.nic.it/

created:      1987-12-23
changed:      2015-06-05
source:       IANA
```

```
root@kal :~# whois unina.it -h whois.nic.it

*******************************************************************
* Please note that the following result could be a subgroup of    *
* the data contained in the database.                             *
*                                                                 *
* Additional information can be visualized at:                    *
* http://www.nic.it/cgi-bin/Whois/whois.cgi                       *
*******************************************************************

Domain:             unina.it
Status:             ok
Created:            1996-01-29 00:00:00
Last Update:        2015-02-14 00:46:57
Expire Date:        2016-01-29

Registrant
  Organization:     CISED - Universita' di Napoli
  Address:          C.so Umberto I
                    Napoli
                    80138
                    NA
                    IT
  Created:          2007-03-01 10:47:26
  Last Update:      2011-03-24 11:01:07

Admin Contact
  Name:             Francesco Palmieri
  Address:          Universita' degli Studi di Napoli Federico II
                    C.so Umberto I
                    Napoli
                    80138
                    NA
                    IT
  Created:          2007-03-01 10:47:26
  Last Update:      2011-03-24 11:01:08

Technical Contacts
  Name:             Amerigo Izzo
  Address:          Universita' degli Studi di Napoli Federico II
                    C.so Umberto I
                    Napoli
                    80138
                    NA
                    IT
  Created:          1999-07-15 00:00:00
  Last Update:      2011-03-24 11:01:09

  Name:             Francesco Palmieri
  Address:          Universita' degli Studi di Napoli Federico II
                    C.so Umberto I
                    Napoli
                    80138
                    NA
                    IT
  Created:          2007-03-01 10:47:26
  Last Update:      2011-03-24 11:01:08

Registrar
  Organization:     Consortium GARR
  Name:             GARR-REG
  Web:              http://www.garr.it

Nameservers
```

IP ADDRESS SEARCHES

- IP addresses:
  - managed by Regional Internet Registries (RIRs)
  - a query directed to any RIR will provide us with:
    - the information we seek if the address in question is managed by that RIR…
    - …information on the correct RIR to contact if it is not

IP ADDRESS SEARCHES

You searched for: **143.225.229.254**

Network	
Net Range	143.224.0.0 - 143.225.255.255
CIDR	143.224.0.0/15
Name	RIPE-ERX-143-224-0-0
Handle	NET-143-224-0-0-1
Parent	NET143 (NET-143-0-0-0-0)
Net Type	Early Registrations, Transferred to RIPE NCC
Origin AS	
Organization	RIPE Network Coordination Centre (RIPE)
Registration Date	2003-11-12
Last Updated	2003-11-12
Comments	These addresses have been further assigned to users in the RIPE NCC region. Contact information can be found in the RIPE database at https://www.ripe.net/whois
RESTful Link	https://whois.arin.net/rest/net/NET-143-224-0-0-1
See Also	Related organization's POC records.

ARIN

RIPE

Search results

This is the RIPE Database search service. The objects are in RPSL format.
The RIPE Database is subject to Terms and Conditions.

Note: this output has been filtered.

```
Abuse contact info: cert@garr.it                                    Update

inetnum:        143.225.0.0 - 143.225.255.255
netname:        UNINA-NET
org:            ORG-UDSD37-RIPE
descr:          Universita' degli Studi di Napoli Federico II
country:        IT
admin-c:        MM29511-RIPE
tech-c:         MM29511-RIPE
tech-c:         CP8504-RIPE
status:         LEGACY
remarks:        For information on "status:" attribute read
https://www.ripe.net/data-tools/db/faq/faq-status-values-legacy-resources
remarks:        This prefix is statically assigned
remarks:        To notify abuse mailto: cert@garr.it
remarks:        Centro di servizi Didattico Scientifico
remarks:        GARR - Italian academic and research network
mnt-irt:        IRT-GARR-CERT
mnt-by:         GARR-LIR
created:        1970-01-01T00:00:00Z
last-modified:  2015-05-05T02:18:00Z
source:         RIPE # Filtered
```

CAN WE TRUST IP ADDRESSES?

- Those involved in security are well aware that relying on source IP addresses found in attack logs is almost always a futile idea!
- Serious attackers never leave such obvious traces of their movements and take care to "clean" the addresses they use to launch the attack:
  - *“laundered”* IP addresses…

COUNTERMEASURES?

- Some domain name providers offer (for a fee) private registrations:
  - they do not publish organization information such as the real address, phone number, email address, etc.
- Regarding domain registrations:
  - be cautious of providers that offer the possibility to modify the registration via email!
    - there is a risk of "domain hijacking" which involves modifying registration info and redirecting all traffic to the original domain
  - such services should only be offered in contexts where authentication mechanisms are reliable
    - the "FROM" field of an email is not!

3. DNS QUERIES

- Domain Name System (DNS)
  - a distributed service for translating symbolic names into IP addresses
- Insecurely configured DNS:
  - many pieces of information about an organization can leak and be exploited by an attacker
- Two main issues:
  - Zone Transfers
  - Analysis of MX (Mail eXchange) records

ZONE TRANSFERS

- A "zone transfer" occurs when:
  - a secondary master server updates its zone database from the database of a primary server
- Useful for redundancy purposes:
  - in case of a failure of the primary master server, a secondary server can immediately take its place
- Problem:
  - Zone transfers should only be allowed between primary and secondary servers...
  - ...in case of misconfigurations, a copy of the zone file may be made available to anyone who requests it!

ZONE TRANSFER AND INTERNAL DATA

- Allowing zone transfers to everyone can be problematic when an organization does not implement a "public/private" DNS policy:
  - Public DNS
    - visible to anyone on the internet
    - contains information about external-facing services
  - Private DNS
    - holds internal hostnames and IP addresses
    - is used just within the organization
- Providing an attacker with information from the internal DNS is like giving them a blueprint of the organization's structure!

ZONE TRANSFER: THE TOOLS

- "nslookup"
  - the most widely used DNS client
- "host" and "dig"
  - commonly used in Unix environments for DNS-related troubleshooting
- "dnsrecon"
  - a utility program for recursive zone file transfers

NSLOOKUP: AN EXAMPLE

```
 [bash]$ nslookup
Default Server: ns1.example.com
Address: 10.10.20.2
> 192.168.1.1
Server: ns1.example.com
Address: 10.10.20.2
Name: gate.example.com
Address: 192.168.1.1
> set type=any
> ls -d example.com. >\> /tmp/zone_out
```

```
bash]$ more zone_out
acct18          ID IN A   192.168.230.3
                ID IN HINFO "Gateway2000" "WinWKGRPS"
                ID IN MX    0 exampleadmin-smtp
                ID IN RP    bsmith.rci bsmith.who
                ID IN TXT    "Location:Telephone Room"
ce               ID IN CNAME  aesop
au               ID IN A    192.168.230.4
                ID IN HINFO  "Aspect" "MS-DOS"
                ID IN MX    0 andromeda
                ID IN RP    jcoy.erebus jcoy.who
                ID IN TXT    "Location: Library"
acct21          ID IN A     192.168.230.5
                ID IN HINFO  "Gateway2000" "WinWKGRPS"
                ID IN MX     0 exampleadmin-smtp
                ID IN RP     bsmith.rci bsmith.who
                ID IN TXT     "Location:Accounting"
```

DNSRECON: AN EXAMPLE

```
[bash]$ python dnsrecon.py -x -d internaldomain.com
[*] Performing General Enumeration of Domain: internaldomain.com
[-] Wildcard resolution is enabled on this domain
[-] It is resolving to 10.10.10.5
[-] All queries will resolve to this address!!
[*] Checking for Zone Transfer for internaldomain.com name servers
[*] Trying NS server 10.10.10.1
[*] Zone Transfer was successful!!
```

WHAT IF ZONE TRANSFER IS NOT ENABLED?

- Many tools use alternative techniques to achieve more or less the same result:
  - DNS reverse lookup:
    - IP address ➔ symbolic name
  - WHOIS
  - ARIN
  - DNS "brute-forcing":
    - attempting to enumerate host names through brute force on common subdomain names like www, mail, blog, admin, ns1, etc.

DNS BRUTE-FORCING WITH “FIERCE”

```
bt5 ~ # ./fierce -dns internallabdomain.com
Fierce 2.0-r412 ( http://trac.assembla.com/fierce )

Starting Fierce Scan at Sun Dec 25 18:19:37 2011
Scanning domain internallabdomain.com at Sun Dec 25 18:19:37 2011 ...

internallabdomain.com - 10.10.10.5

Nameservers for internallabdomain.com:
    ns1.internallabdomain.com          10.10.9.1
    ns2. internallabdomain.com         10.10.9.2
ARIN lookup "internallabdomain":
Zone Transfer:
    ns1.internallabdomain.com          Failed
    ns2.internallabdomain.com          Failed
Wildcards:
Prefix Bruteforce:
Found Node! (10.10.10.5 / 0.internallabdomain.com)
based on a search of: 0. internallabdomain.com.
Found Node! (10.10.10.11 / av.internallabdomain.com)
based on a search of: av.internallabdomain.com.
Found Node! (10.10.10.6 / webmail.internallabdomain.com)
based on a search of: autodiscover.internallabdomain.com.
Found Node! (10.10.10.25 / dev.internallabdomain.com)
based on a search of: dev. internallabdomain.com.
Found Node! (10.10.10.17 / tx.internallabdomain.com)
```

ZONE TRANSFER: COUNTERMEASURES (1/2)

- Limit zone transfers to authorized servers only
  - e.g., in BIND (DNS implementation for UNIX systems)
    - use the "allow-transfer" directive in the "named.conf" configuration file
- On the network side
  - filter all unauthorized TCP connections on port 53
    - please note: DNS → port 53, but:
      - “name lookup” → UDP
      - “zone transfer” → TCP
    - this solution may violate the DNS RFC, which states:
      - lookups for names larger than 512 bytes should be sent via TCP ☹

ZONE TRANSFER: COUNTERMEASURES (2/2)

- Employ techniques based on Cryptographic Transaction Signatures (TSIG) to allow only trusted hosts to perform zone file transfers
- Clearly separate the internal domain from the external domain of the organization
  - expose ONLY the external name servers to the public
- Minimize the use of DNS records of type "HINFO" as they can provide extremely precise information about the operating system of a network host

4. NETWORK RECONNAISSANCE

- Network Topology Information Search
- Search for potential access routes to the target organization's network
- Primary tool in this area:
  - Traceroute
    - a program for discovering network paths
    - based on intelligent use of the Time To Live (TTL) field in IP packets

TRACEROUTE EXAMPLES

Probe packets (UDP) blocked by the firewall of the target organization

```
[bash]$ traceroute 10.10.10.2
traceroute to (10.10.10.2), 30 hops max, 40 byte packets

 1 gate (192.168.10.1) 11.993 ms 10.217 ms 9.023 ms
 2 rtr1.example.com (10.10.12.13) 37.442 ms 35.183 ms 38.202 ms
 3 rtr2.example.com (10.10.12.14) 73.945 ms 36.336 ms 40.146 ms
 4 hssitrt.example.com (10.11.31.14) 54.094 ms 66.162 ms  50.873 ms
 5 * * *
 6 * * *
```

Probe packets (UDP) disguised as DNS queries (port 53)!

```
[bash]$ traceroute -S -p53 10.10.10.2
traceroute to (10.10.10.2), 30 hops max, 40 byte packets

 1 gate (192.168.10.1) 10.029 ms 10.027 ms 8.494 ms
 2 rtr1.example.com (10.10.12.13) 36.673 ms 39.141 ms 37.872 ms
 3 rtr2.example.com (10.10.12.14) 36.739 ms 39.516 ms 37.226 ms
 4 hssitrt.example.com (10.11.31.14) 47.352 ms 47.363 ms 45.914 ms
 5 10.10.10.2 (10.10.10.2) 50.449 ms 56.213 ms 65.627 ms
```

NETWORK RECONNAISSANCE: COUNTERMEASURES

- Use of a Network Intrusion Detection System (NIDS)
- Configuration of the organization's border routers:
  - appropriately limit incoming UDP and ICMP traffic

QUESTIONS?