OSTBAYERISCHE
TECHNISCHE HOCHSCHULE
REGENSBURG

Fakultät Informatik und Mathematik

COMLAB
Datenkommunikation und Netzwerke

Prof. Dr. Waas

Praktikum zum Fach

Kommunikationssysteme/
Rechnernetze

Lösung zu

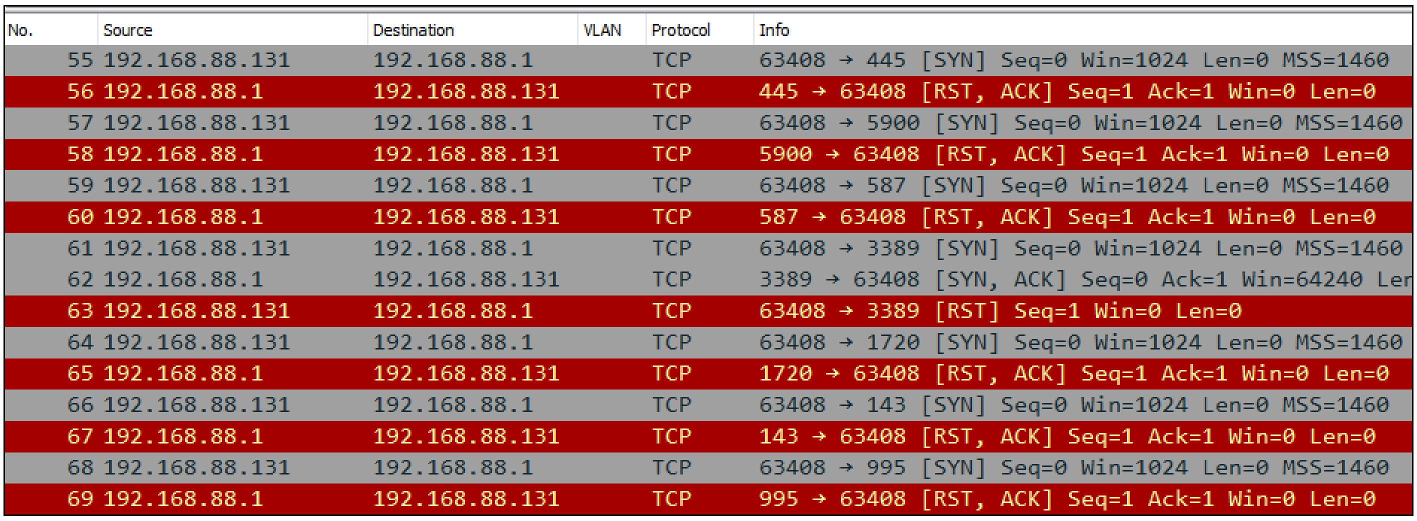
NMAP

Linux

(Version 18.02.2021)

3 IPV4 SCANS

3.1 SYN SCAN



No.	Source	Destination	VLAN	Protocol	Info
55	192.168.88.131	192.168.88.1		TCP	63408 → 445 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
56	192.168.88.1	192.168.88.131		TCP	445 → 63408 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
57	192.168.88.131	192.168.88.1		TCP	63408 → 5900 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
58	192.168.88.1	192.168.88.131		TCP	5900 → 63408 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
59	192.168.88.131	192.168.88.1		TCP	63408 → 587 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
60	192.168.88.1	192.168.88.131		TCP	587 → 63408 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
61	192.168.88.131	192.168.88.1		TCP	63408 → 3389 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
62	192.168.88.1	192.168.88.131		TCP	3389 → 63408 [SYN, ACK] Seq=0 Ack=1 Win=64240 Ler
63	192.168.88.131	192.168.88.1		TCP	63408 → 3389 [RST] Seq=1 Win=0 Len=0
64	192.168.88.131	192.168.88.1		TCP	63408 → 1720 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
65	192.168.88.1	192.168.88.131		TCP	1720 → 63408 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
66	192.168.88.131	192.168.88.1		TCP	63408 → 143 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
67	192.168.88.1	192.168.88.131		TCP	143 → 63408 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
68	192.168.88.131	192.168.88.1		TCP	63408 → 995 [SYN] Seq=0 Win=1024 Len=0 MSS=1460
69	192.168.88.1	192.168.88.131		TCP	995 → 63408 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0

Kontrollfragen

☑ Welche Ports sind offen?

diverse

☑ Über welche Protokolle wurden die Ports gefunden?

TCP

☑ Wie weit wurde der 3-Way Handshake bei der TCP-Eröffnung abgewickelt.

SYN SYN/ACK, dann wird Verbindung abgebaut mit RTS

☑ Welche Antwort wurde bei den offenen Ports zurückgesendet und welche bei den nicht offenen?

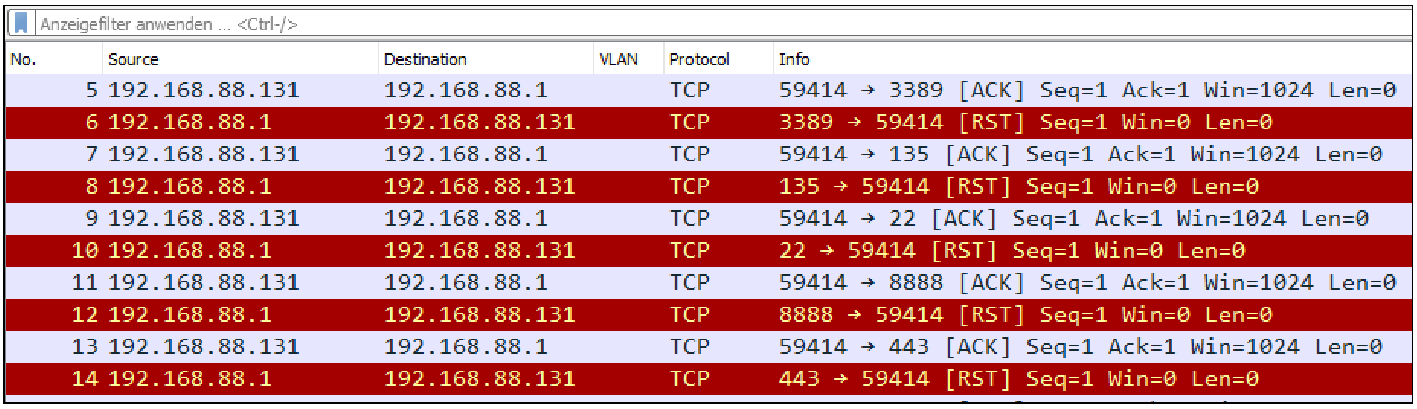
Offener Port:	**SYN/ACK**
geschlossener Port:	RST

-sS (TCP-SYN-Scan)

Der SYN-Scan ist aus gutem Grund die Standardeinstellung und die beliebteste Scan-Methode. Er kann schnell durchgeführt werden und scannt dabei Tausende von Ports pro Sekunde, wenn das Netzwerk schnell ist und nicht von einer intrusiven Firewall behindert wird. Der SYN-Scan ist relativ unauffällig, da er TCP-Verbindungen niemals abschließt. Außerdem funktioniert er auch bei allen konformen TCP-Stacks und ist unabhängig von spezifischen Eigenarten von Plattformen, wie es bei den FIN-/NULL-/Xmas-, Maimon- und Idle-Scans in Nmap der Fall ist. Er erlaubt auch eine klare, zuverlässige Unterscheidung zwischen den Zuständen offen, geschlossen und gefiltert.

Diese Methode wird oft als halboffenes Scannen bezeichnet, weil keine vollständige TCP-Verbindung hergestellt wird. Sie senden ein SYN-Paket, als ob Sie eine echte Verbindung herstellen würden, und warten dann auf eine Antwort. Ein SYN/ACK zeigt, dass jemand auf dem Port lauscht (dass er offen ist), während ein RST (Reset) anzeigt, dass niemand darauf lauscht. Falls nach mehreren erneuten Übertragungen keine Antwort erhalten wird, wird der Port als gefiltert markiert. Der Port wird auch dann als gefiltert markiert, wenn ein ICMP Unreachable-Fehler (Typ 3, Code 1, 2, 3, 9, 10 oder 13) empfangen wird.

3.2 ACK SCAN



Anzeigefilter anwenden ... <Ctrl-/>

No.	Source	Destination	VLAN	Protocol	Info
5	192.168.88.131	192.168.88.1		TCP	59414 → 3389 [ACK] Seq=1 Ack=1 Win=1024 Len=0
6	192.168.88.1	192.168.88.131		TCP	3389 → 59414 [RST] Seq=1 Win=0 Len=0
7	192.168.88.131	192.168.88.1		TCP	59414 → 135 [ACK] Seq=1 Ack=1 Win=1024 Len=0
8	192.168.88.1	192.168.88.131		TCP	135 → 59414 [RST] Seq=1 Win=0 Len=0
9	192.168.88.131	192.168.88.1		TCP	59414 → 22 [ACK] Seq=1 Ack=1 Win=1024 Len=0
10	192.168.88.1	192.168.88.131		TCP	22 → 59414 [RST] Seq=1 Win=0 Len=0
11	192.168.88.131	192.168.88.1		TCP	59414 → 8888 [ACK] Seq=1 Ack=1 Win=1024 Len=0
12	192.168.88.1	192.168.88.131		TCP	8888 → 59414 [RST] Seq=1 Win=0 Len=0
13	192.168.88.131	192.168.88.1		TCP	59414 → 443 [ACK] Seq=1 Ack=1 Win=1024 Len=0
14	192.168.88.1	192.168.88.131		TCP	443 → 59414 [RST] Seq=1 Win=0 Len=0

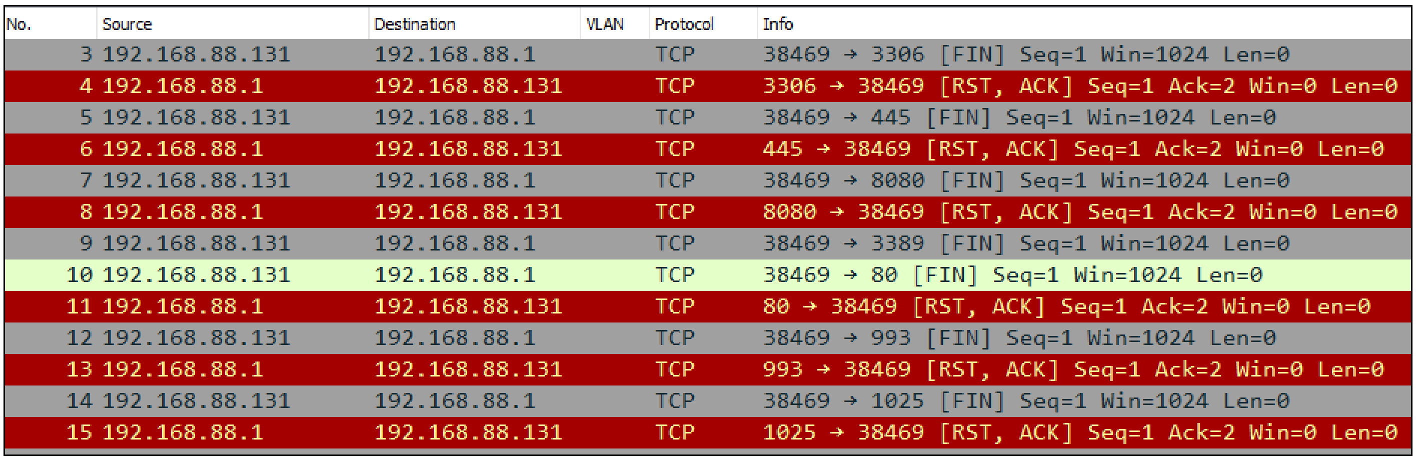
Kontrollfragen

- ☑ Welches Protokoll wurde verwendet?
  TCP
- ☑ Wie funktioniert der ACK Scan?
  siehe folgende Beschreibung
- ☑ Sind die Ports gefiltert oder nicht?
  nicht gefiltert
- ☑ Wie unterscheidet er sich von SYN Scan?
  Kein SYN zu Beginn
- ☑ Was ist der Zweck dieses Scans?
  siehe folgende Beschreibung

-sA (TCP-ACK-Scan)
Dieser Scan unterscheidet sich insofern von den bisher hier vorgestellten, als er nie offene (oder auch nur offene|gefilterte) Ports bestimmt. Er wird dazu benutzt, Firewall-Regeln zu bestimmen, festzustellen, ob sie zustandsbehaftet sind oder nicht, und welche Ports gefiltert werden.

Beim Testpaket eines ACK-Scans wird nur das ACK-Flag gesetzt (es sei denn, Sie benutzen --scanflags). Beim Scannen ungefilterter Systeme werden sowohl offene als auch geschlossene Ports ein RST-Paket zurückgeben. Nmap markiert sie dann als ungefiltert, d.h. sie werden vom ACK-Paket erreicht, aber es kann nicht bestimmt werden, ob sie offen oder geschlossen sind. Ports, die nicht antworten oder bestimmte ICMP-Fehlermeldungen zurückgeben (Type 3, Code 1, 2, 3, 9, 10 oder 13), werden als gefiltert markiert.

3.3 FIN-Scan



No.	Source	Destination	VLAN	Protocol	Info
3	192.168.88.131	192.168.88.1		TCP	38469 → 3306 [FIN] Seq=1 Win=1024 Len=0
4	192.168.88.1	192.168.88.131		TCP	3306 → 38469 [RST, ACK] Seq=1 Ack=2 Win=0 Len=0
5	192.168.88.131	192.168.88.1		TCP	38469 → 445 [FIN] Seq=1 Win=1024 Len=0
6	192.168.88.1	192.168.88.131		TCP	445 → 38469 [RST, ACK] Seq=1 Ack=2 Win=0 Len=0
7	192.168.88.131	192.168.88.1		TCP	38469 → 8080 [FIN] Seq=1 Win=1024 Len=0
8	192.168.88.1	192.168.88.131		TCP	8080 → 38469 [RST, ACK] Seq=1 Ack=2 Win=0 Len=0
9	192.168.88.131	192.168.88.1		TCP	38469 → 3389 [FIN] Seq=1 Win=1024 Len=0
10	192.168.88.131	192.168.88.1		TCP	38469 → 80 [FIN] Seq=1 Win=1024 Len=0
11	192.168.88.1	192.168.88.131		TCP	80 → 38469 [RST, ACK] Seq=1 Ack=2 Win=0 Len=0
12	192.168.88.131	192.168.88.1		TCP	38469 → 993 [FIN] Seq=1 Win=1024 Len=0
13	192.168.88.1	192.168.88.131		TCP	993 → 38469 [RST, ACK] Seq=1 Ack=2 Win=0 Len=0
14	192.168.88.131	192.168.88.1		TCP	38469 → 1025 [FIN] Seq=1 Win=1024 Len=0
15	192.168.88.1	192.168.88.131		TCP	1025 → 38469 [RST, ACK] Seq=1 Ack=2 Win=0 Len=0

Kontrollfragen

☑ Welche Ports sind offen?

diverse

☑ Über welche Protokolle wurden die Ports gefunden?

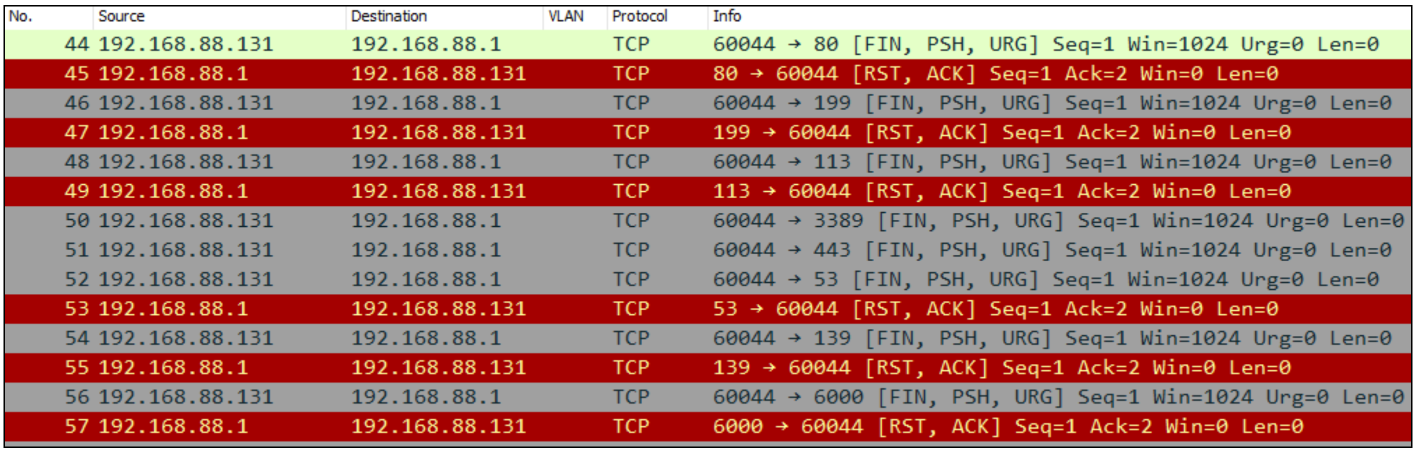
TCP

☑ Wie funktioniert der FIN Scan?

Siehe folgende Beschreibung bei XMAS Tree Scan

☑ Welche Antwort wurde bei den offenen Ports zurückgesendet und welche bei den nicht offenen? Bei dieser Frage sollten Sie in Wireshark einen Display Filter für die einzelnen Ports verwenden, die in NMAP gefunden wurden.
Keine Antwort: offener Port (siehe Port 3389)
RST: geschlossener Port (siehe Port 80)

3.4 XMAS-Tree-Scan



No.	Source	Destination	VLAN	Protocol	Info
44	192.168.88.131	192.168.88.1		TCP	60044 → 80 [FIN, PSH, URG] Seq=1 Win=1024 Urg=0 Len=0
45	192.168.88.1	192.168.88.131		TCP	80 → 60044 [RST, ACK] Seq=1 Ack=2 Win=0 Len=0
46	192.168.88.131	192.168.88.1		TCP	60044 → 199 [FIN, PSH, URG] Seq=1 Win=1024 Urg=0 Len=0
47	192.168.88.1	192.168.88.131		TCP	199 → 60044 [RST, ACK] Seq=1 Ack=2 Win=0 Len=0
48	192.168.88.131	192.168.88.1		TCP	60044 → 113 [FIN, PSH, URG] Seq=1 Win=1024 Urg=0 Len=0
49	192.168.88.1	192.168.88.131		TCP	113 → 60044 [RST, ACK] Seq=1 Ack=2 Win=0 Len=0
50	192.168.88.131	192.168.88.1		TCP	60044 → 3389 [FIN, PSH, URG] Seq=1 Win=1024 Urg=0 Len=0
51	192.168.88.131	192.168.88.1		TCP	60044 → 443 [FIN, PSH, URG] Seq=1 Win=1024 Urg=0 Len=0
52	192.168.88.131	192.168.88.1		TCP	60044 → 53 [FIN, PSH, URG] Seq=1 Win=1024 Urg=0 Len=0
53	192.168.88.1	192.168.88.131		TCP	53 → 60044 [RST, ACK] Seq=1 Ack=2 Win=0 Len=0
54	192.168.88.131	192.168.88.1		TCP	60044 → 139 [FIN, PSH, URG] Seq=1 Win=1024 Urg=0 Len=0
55	192.168.88.1	192.168.88.131		TCP	139 → 60044 [RST, ACK] Seq=1 Ack=2 Win=0 Len=0
56	192.168.88.131	192.168.88.1		TCP	60044 → 6000 [FIN, PSH, URG] Seq=1 Win=1024 Urg=0 Len=0
57	192.168.88.1	192.168.88.131		TCP	6000 → 60044 [RST, ACK] Seq=1 Ack=2 Win=0 Len=0

Kontrollfragen

☑ Welche Ports sind offen?

diverse

☑ Über welche Protokolle wurden die Ports gefunden?

TCP

☑ Wie funktioniert der XMAS Scan?

Siehe folgende Beschreibung

☑ Welche Antwort wurde bei den offenen Ports zurückgesendet und welche bei den nicht offenen? Bei dieser Frage sollten Sie in Wireshark einen Display Filter für die einzelnen Ports verwenden, die in NMAP gefunden wurden.
Keine Antwort: offener Port (siehe Port 3389, 443, 53)
RST: geschlossener Port (siehe Port 80)

-sN; -sF; -sX (TCP-NULL-, FIN- und -Xmas-Scans)
Diese drei Scan-Typen beuten ein subtiles Schlupfloch im TCP RFC aus, um zwischen offenen und geschlossenen Ports zu unterscheiden. Seite 65 von RFC 793 besagt: „Falls der Zustand des [Ziel-] Ports GESCHLOSSEN ist ... bewirkt ein eingehendes Segment, in dem sich kein RST befindet, dass ein RST als Antwort gesendet wird.“ Die nächste Seite beschreibt dann Pakete, die ohne gesetztes SYN-, RST- oder ACK-Bit an offene Ports geschickt werden, und dort heißt es weiter: „Es ist unwahrscheinlich, dass Sie hierhin kommen, aber wenn doch, dann verwerfen Sie das Segment und springen Sie zurück.“

Beim Scannen von Systemen, die konform zu diesem RFC-Text sind, führt jedes Paket, das kein SYN-, RST- oder ACK-Bit enthält, dazu, dass ein RST zurückgegeben wird, wenn der Port geschlossen ist, bzw. zu gar keiner Antwort, falls der Port offen ist. Solange keines dieser drei Bits gesetzt ist, sind alle Kombinationen der anderen drei (FIN, PSH und URG) okay. Das nutzt Nmap mit drei Scan-Typen aus:

Null-Scan (-sN)
Setzt keinerlei Bits (der TCP-Flag-Header ist 0).

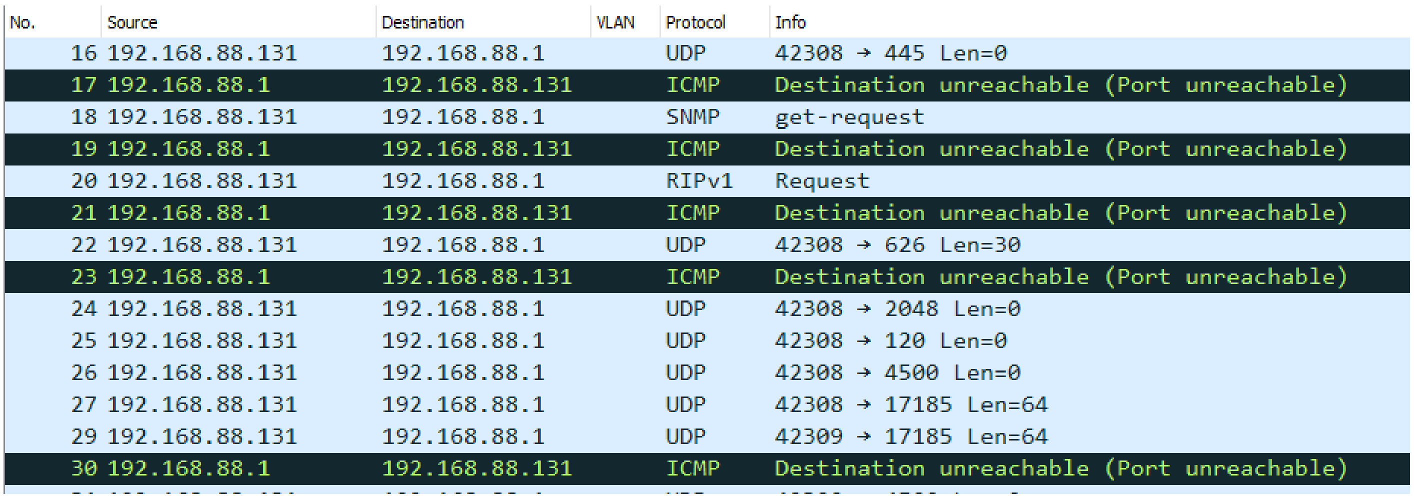
FIN-Scan (-sF)
Setzt nur das TCP-FIN-Bit.

Xmas-Scan (-sX)
Setzt die FIN-, PSH- und URG-Flags und beleuchtet das Paket wie einen Weihnachtsbaum (engl. Xmas).

Diese drei Scan-Typen haben exakt dasselbe Verhalten und unterscheiden sich nur in den TCP-Flags ihrer Testpakete. Wenn ein RST-Paket empfangen wird, wird der Port als geschlossen betrachtet, während keine Antwort bedeutet, dass er offen|gefiltert ist. Der Port wird als gefiltert markiert, falls ein ICMP Unreachable-Fehler (Type 3, Code 1, 2, 3, 9, 10 oder 13) empfangen wird.

Der Schlüsselvorteil dieser Scan-Arten ist, dass sie sich an bestimmten zustandslosen Firewalls und paketfilternden Routern vorbeschleichen können. Ein weiterer Vorteil ist, dass diese Scan-Arten ncoh ein wenig unauffälliger sind als ein SYN-Scan. Aber verlassen Sie sich nicht darauf – die meisten modernen IDS-Produkte können so konfiguriert werden, dass sie diese Scans erkennen. Der große Nachteil ist, dass nicht alle Systeme sich ganz genau an RFC 793 halten. Eine Reihe von Systemen sendet RST-Antworten auf die Testpakete, unabhängig davon, ob der Port offen ist oder nicht. Das bewirkt, dass alle Ports als geschlossen markiert werden. Hauptvertreter der Betriebssysteme, die das machen, sind Microsoft Windows, viele Cisco-Geräte, BSDI und IBM OS/400. Aber auf den meisten Unix-basierten Systemen funktioniert dieser Scan. Ein weiterer Nachteil dieser Scans ist, dass sie keine Unterscheidung zwischen offenen und bestimmten gefilterten Ports machen, sondern lediglich das Ergebnis offen|gefiltert ausgeben.

3.5 UDP-Scan



No.	Source	Destination	VLAN	Protocol	Info
16	192.168.88.131	192.168.88.1		UDP	42308 → 445 Len=0
17	192.168.88.1	192.168.88.131		ICMP	Destination unreachable (Port unreachable)
18	192.168.88.131	192.168.88.1		SNMP	get-request
19	192.168.88.1	192.168.88.131		ICMP	Destination unreachable (Port unreachable)
20	192.168.88.131	192.168.88.1		RIPv1	Request
21	192.168.88.1	192.168.88.131		ICMP	Destination unreachable (Port unreachable)
22	192.168.88.131	192.168.88.1		UDP	42308 → 626 Len=30
23	192.168.88.1	192.168.88.131		ICMP	Destination unreachable (Port unreachable)
24	192.168.88.131	192.168.88.1		UDP	42308 → 2048 Len=0
25	192.168.88.131	192.168.88.1		UDP	42308 → 120 Len=0
26	192.168.88.131	192.168.88.1		UDP	42308 → 4500 Len=0
27	192.168.88.131	192.168.88.1		UDP	42308 → 17185 Len=64
29	192.168.88.131	192.168.88.1		UDP	42309 → 17185 Len=64
30	192.168.88.1	192.168.88.131		ICMP	Destination unreachable (Port unreachable)

Kontrollfragen

☑ Welche Ports sind offen?
diverse

☑ Über welche Protokolle wurden die Ports gefunden?
UDP

☑ Wie ist die Antwort bei eonem offenen Port und wie bei einem geschlossenen?
Offener Port: Keine Antwort
Geschlossener Port: ICMP Port unreachable Meldung

☑ Warum ist ICMP involviert?
Weil es auf UPD Ebene kein Fehlerprotokoll gibt.

-sU (UDP-Scan)
Obwohl die meisten bekannten Dienste im Internet über das TCP-Protokoll laufen, sind UDP-Dienste weitverbreitet. Drei der häufigsten sind DNS, SNMP und DHCP (auf den registrierten Ports 53, 161/162 und 67/68). Weil UDP-Scans im Allgemeinen langsamer und schwieriger als TCP-Scans sind, werden diese Ports von manchen Sicherheitsprüfern einfach ignoriert. Das ist ein Fehler, denn ausbeutbare UDP-Dienste sind recht häufig, und Angreifer ignorieren bestimmt nicht das ganze Protokoll. Zum Glück kann Nmap helfen, diese UDP-Ports zu inventarisieren.

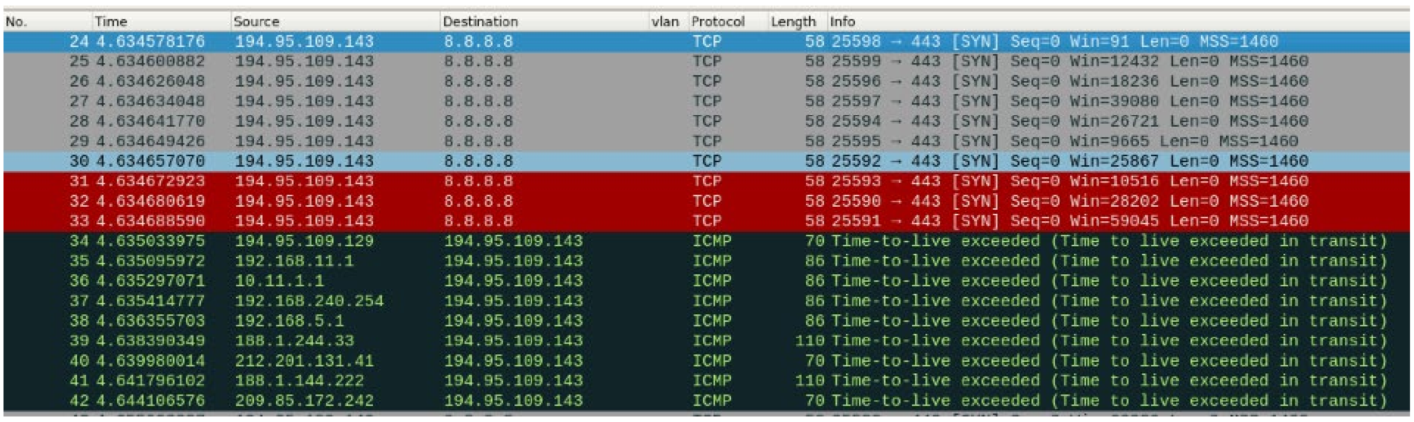
Ein UDP-Scan wird mit der Option -sU aktiviert. Er kann mit einem TCP-Scan-Typ wie einem SYN-Scan (-sS) kombiniert werden, um beide Protokolle im gleichen Durchlauf zu prüfen.

Beim UDP-Scan wird ein leerer UDP-Header (ohne Daten) an alle Ziel-Ports geschickt. Falls ein ICMP Port-unreachable-Fehler (Typ 3, Code 3) zurückkommt, ist der Port geschlossen. Andere ICMP Unreachable-Fehler (Typ 3, Codes 1, 2, 9, 10 oder 13) markieren den Port als filtered. Gelegentlich wird ein Dienst mit einem UDP-Paket antworten, was beweist, dass er offen ist. Falls nach einigen erneuten Übertragungen keine Antwort erhalten wird, wird der Port als offen|gefiltert klassifiziert. Das heißt, der Port könnte offen sein, oder aber es gibt Paketfilter, die die Kommunikation blockieren. Man kann eine Versionserkennung (-sV) benutzen, um bei der Unterscheidung der wirklich offenen von den geschlossenen Ports zu helfen.

Eine große Herausforderung beim UDP-Scanning ist Geschwindigkeit. Offene und gefilterte Ports antworten nur selten, wodurch Nmap Zeitbeschränkungen überschreitet und seine Anfragen erneut sendet, für den Fall, dass das Testpaket oder die Antwort verloren ging. Geschlossene Ports sind oftmals ein noch größeres Problem. Sie senden normalerweise eine ICMP Port-unreachable-Fehlermeldung zurück. Aber anders als die RST-Pakete, die von geschlossenen TCP-Ports als Antwort auf einen SYN- oder Connect-Scan geschickt werden, beschränken viele Hosts standardmäßig die Rate der ICMP Port-unreachable-Nachrichten. Linux und Solaris sind dabei besonders streng. Der Linux-Kernel 2.4.20 z.B. beschränkt Destination-unreachable-Nachrichten auf eine pro Sekunde (in net/ipv4/icmp.c).

Nmap erkennt eine Ratenbeschränkung und verlangsamt seinen Betrieb entsprechend, um zu vermeiden, dass das Netzwerk mit nutzlosen Paketen überflutet wird, die vom Zielrechner verworfen werden. Unglücklicherweise führt eine Beschränkung wie in Linux auf ein Paket pro Sekunde dazu, dass ein Scan von 65.536 Ports über 18 Stunden dauert. Um Ihre UDP-Scans zu beschleunigen, können Sie z.B. mehr Hosts parallel scannen, zuerst nur einen schnellen Scan der beliebten Ports durchführen, von hinter der Firewall scannen und die Option --host-timeout benutzen, um langsame Hosts auszulassen.

4 Traceroute mit TCP



```
No.  Time          Source            Destination      vlan Protocol Length Info
  24 4.634578176   194.95.109.143    8.8.8.8               TCP          58 25598 → 443 [SYN] Seq=0 Win=91 Len=0 MSS=1460
  25 4.634600882   194.95.109.143    8.8.8.8               TCP          58 25599 → 443 [SYN] Seq=0 Win=12432 Len=0 MSS=1460
  26 4.634626048   194.95.109.143    8.8.8.8               TCP          58 25596 → 443 [SYN] Seq=0 Win=18236 Len=0 MSS=1460
  27 4.634634048   194.95.109.143    8.8.8.8               TCP          58 25597 → 443 [SYN] Seq=0 Win=39080 Len=0 MSS=1460
  28 4.634641770   194.95.109.143    8.8.8.8               TCP          58 25594 → 443 [SYN] Seq=0 Win=26721 Len=0 MSS=1460
  29 4.634649426   194.95.109.143    8.8.8.8               TCP          58 25595 → 443 [SYN] Seq=0 Win=9665 Len=0 MSS=1460
  30 4.634657070   194.95.109.143    8.8.8.8               TCP          58 25592 → 443 [SYN] Seq=0 Win=25867 Len=0 MSS=1460
  31 4.634672923   194.95.109.143    8.8.8.8               TCP          58 25593 → 443 [SYN] Seq=0 Win=10516 Len=0 MSS=1460
  32 4.634680619   194.95.109.143    8.8.8.8               TCP          58 25590 → 443 [SYN] Seq=0 Win=28202 Len=0 MSS=1460
  33 4.634688590   194.95.109.143    8.8.8.8               TCP          58 25591 → 443 [SYN] Seq=0 Win=59045 Len=0 MSS=1460
  34 4.635033975   194.95.109.129    194.95.109.143        ICMP         70 Time-to-live exceeded (Time to live exceeded in transit)
  35 4.635095972   192.168.11.1      194.95.109.143        ICMP         86 Time-to-live exceeded (Time to live exceeded in transit)
  36 4.635297071   10.11.1.1         194.95.109.143        ICMP         86 Time-to-live exceeded (Time to live exceeded in transit)
  37 4.635414777   192.168.240.254   194.95.109.143        ICMP         86 Time-to-live exceeded (Time to live exceeded in transit)
  38 4.636355703   192.168.5.1       194.95.109.143        ICMP         86 Time-to-live exceeded (Time to live exceeded in transit)
  39 4.638390349   188.1.244.33      194.95.109.143        ICMP        110 Time-to-live exceeded (Time to live exceeded in transit)
  40 4.639980014   212.201.131.41    194.95.109.143        ICMP         70 Time-to-live exceeded (Time to live exceeded in transit)
  41 4.641796102   188.1.144.222     194.95.109.143        ICMP        110 Time-to-live exceeded (Time to live exceeded in transit)
  42 4.644106576   209.85.172.242    194.95.109.143        ICMP         70 Time-to-live exceeded (Time to live exceeded in transit)
```

Es werden TCP Pakete mit dem gewählten Port mit unterschiedlichen TTL gesendet. Falls ein TTL so klein ist, dass das Ziel nicht erreicht werden kann, sendet der Router, der das Paket verworfen hat, eine ICMP Meldung zurück. In dieser ICMP-Meldung ist auch das Paket selbst enthalten, das verworfen wurde. Damit kann der Sender Rückschlüsse auf die verwendete TTL machen und den Router an der korrekten Position der Routerkette einordnen.

ANHANG: AUSZUG DER MAN-PAGE FÜR NMAP

SCAN TYPES

-sT TCP connect() scan: This is the most basic form of TCP scanning. The connect() system call provided by your operating system is used to open a connection to every interesting port on the machine. If the port is listening, connect() will succeed, other¬ wise the port isn't reachable. One strong advantage to this technique is that you don't need any spe¬ cial privileges. Any user on most UNIX boxes is free to use this call.

This sort of scan is easily detectable as target host logs will show a bunch of connection and error messages for the services which accept() the con¬ nection just to have it immediately shutdown.

-sS TCP SYN scan: This technique is often referred to as "half-open" scanning, because you don't open a full TCP connection. You send a SYN packet, as if you are going to open a real connection and you wait for a response. A SYN|ACK indicates the port is listening. A RST is indicative of a non-lis¬ tener. If a SYN|ACK is received, a RST is immedi¬ ately sent to tear down the connection (actually our OS kernel does this for us). The primary advan¬ tage to this scanning technique is that fewer sites will log it. Unfortunately you need root privi¬ leges to build these custom SYN packets.

-sF -sX -sN
Stealth FIN, Xmas Tree, or Null scan modes: There are times when even SYN scanning isn't clandestine enough. Some firewalls and packet filters watch for SYNs to restricted ports, and programs like Synlog¬ ger and Courtney are available to detect these scans. These advanced scans, on the other hand, may be able to pass through unmolested.

The idea is that closed ports are required to reply to your probe packet with an RST, while open ports must ignore the packets in question (see RFC 793 pp 64). The FIN scan uses a bare (surprise) FIN packet as the probe, while the Xmas tree scan turns on the FIN, URG, and PUSH flags. The Null scan turns off all flags. Unfortunately Microsoft (like usual) decided to completely ignore the standard and do things their own way. Thus this scan type will not work against systems running Windows95/NT. On the positive side, this is a good way to distin¬ guish between the two platforms. If the scan finds open ports, you know the machine is not a Windows box. If a -sF,-sX,or -sN scan shows all ports closed, yet a SYN (-sS) scan shows ports being opened, you are probably looking at a Windows box. This is less useful now that nmap has proper OS detection built in. There are also a few other systems that are broken in the same way Windows is. They include Cisco, BSDI, HP/UX, MVS, and IRIX. All of the above send resets from the open ports when they should just drop the packet.

-sP Ping scanning: Sometimes you only want to know which hosts on a network are up. Nmap can do this by sending ICMP echo request packets to every IP address on the networks you specify. Hosts that respond are up. Unfortunately, some sites such as microsoft.com block echo request packets. Thus nmap can also send a TCP ack packet to (by default)

port 80. If we get an RST back, that machine is up. A third technique involves sending a SYN packet and waiting for a RST or a SYN/ACK. For non-root users, a connect() method is used.

By default (for root users), nmap uses both the ICMP and ACK techniques in parallel. You can change the -P option described later.

Note that pinging is done by default anyway, and only hosts that respond are scanned. Only use this option if you wish to ping sweep without doing any actual port scans.

-sU UDP scans: This method is used to determine which UDP (User Datagram Protocol, RFC 768) ports are open on a host. The technique is to send 0 byte udp packets to each port on the target machine. If we receive an ICMP port unreachable message, then the port is closed. Otherwise we assume it is open.

Some people think UDP scanning is pointless. I usu¬ ally remind them of the recent Solaris rcpbind hole. Rpcbind can be found hiding on an undocu¬ mented UDP port somewhere above 32770. So it doesn't matter that 111 is blocked by the firewall. But can you find which of the more than 30,000 high ports it is listening on? With a UDP scanner you can! There is also the cDc Back Orifice backdoor program which hides on a configurable UDP port on Windows machines. Not to mention the many commonly vulnerable services that utilize UDP such as snmp, tftp, NFS, etc.

Unfortunately UDP scanning is sometimes painfully slow since most hosts implement a suggestion in RFC 1812 (section 4.3.2.8) of limiting the ICMP error message rate. For example, the Linux kernel (in net/ipv4/icmp.h) limits destination unreachable message generation to 80 per 4 seconds, with a 1/4 second penalty if that is exceeded. Solaris has much more strict limits (about 2 messages per sec¬ ond) and thus takes even longer to scan. nmap detects this rate limiting and slows down accord¬ ingly, rather than flood the network with useless packets that will be ignored by the target machine.

As is typical, Microsoft ignored the suggestion of the RFC and does not seem to do any rate limiting at all on Win95 and NT machines. Thus we can scan all 65K ports of a Windows machine very quickly. Woop!

-sO IP protocol scans: This method is used to determine which IP protocols are supported on a host. The technique is to send raw IP packets without any further protocol header to each specified protocol on the target machine. If we receive an ICMP pro¬ tocol unreachable message, then the protocol is not in use. Otherwise we assume it is open. Note that some hosts (AIX, HP-UX, Digital UNIX) and firewalls may not send protocol unreachable messages. This causes all of the protocols to appear "open".

Because the implemented technique is very similar to UDP port scanning, ICMP rate limit might apply too. But the IP protocol field has only 8 bits, so at most 256 protocols can be probed which should be possible in reasonable time anyway.

-sI <zombie host[:probeport]>
Idlescan: This advanced scan method allows for a truly blind TCP port scan of the target (meaning no packets are sent to the target from your real IP address). Instead, a unique side-channel attack exploits predictable "IP fragmentation ID" sequence

generation on the zombie host to glean information about the open ports on the target. IDS systems will display the scan as coming from the zombie machine you specify (which must be up and meet cer¬tain criteria). I am planning to put a more detailed explanation up at http://www.inse¬cure.org/nmap/nmap_documentation.html in the near future.

Besides being extraordinarily stealthy (due to its blind nature), this scan type permits mapping out IP-based trust relationships between machines. The port listing shows open ports from the perspective of the zombie host. So you can try scanning a tar¬get using various zombies that you think might be trusted (via router/packet filter rules). Obvi¬ously this is crucial information when prioritizing attack targets. Otherwise, you penetration testers might have to expend considerable resources "own¬ing" an intermediate system, only to find out that its IP isn't even trusted by the target host/net¬work you are ultimately after.

a particular port on the zombie host for IPID changes. Otherwise Nmap will use the port it uses by default for "tcp pings".

-sA ACK scan: This advanced method is usually used to map out firewall rulesets. In particular, it can help determine whether a firewall is stateful or just a simple packet filter that blocks incoming SYN packets.

This scan type sends an ACK packet (with random looking acknowledgement/sequence numbers) to the ports specified. If a RST comes back, the ports is classified as "unfiltered". If nothing comes back (or if an ICMP unreachable is returned), the port is classified as "filtered". Note that nmap usu¬ally doesn't print "unfiltered" ports, so getting no ports shown in the output is usually a sign that all the probes got through (and returned RSTs). This scan will obviously never show ports in the "open" state.

-sW Window scan: This advanced scan is very similar to the ACK scan, except that it can sometimes detect open ports as well as filtered/nonfiltered due to an anomaly in the TCP window size reporting by some operating systems. Systems vulnerable to this include at least some versions of AIX, Amiga, BeOS, BSDI, Cray, Tru64 UNIX, DG/UX, OpenVMS, Digital UNIX, FreeBSD, HP-UX, OS/2, IRIX, MacOS, NetBSD, OpenBSD, OpenStep, QNX, Rhapsody, SunOS 4.X, Ultrix, VAX, and VxWorks. See the nmap-hackers mailing list archive for a full list.

-sR RPC scan. This method works in combination with the various port scan methods of Nmap. It takes all the TCP/UDP ports found open and then floods them with SunRPC program NULL commands in an attempt to determine whether they are RPC ports, and if so, what program and version number they serve up. Thus you can effectively obtain the same info as firewall (or protected by TCP wrappers). Decoys do not currently work with RPC scan, at some point I may add decoy support for UDP RPC scans.

-sL List scan. This method simply generates and prints a list of IPs/Names without actually pinging or port scanning them. DNS name resolution will be performed unless you use -n.

-b <ftp relay host>
FTP bounce attack: An interesting "feature" of the

ftp protocol (RFC 959) is support for "proxy" ftp connections. In other words, I should be able to connect from evil.com to the FTP server of tar¬get.com and request that the server send a file ANYWHERE on the internet! Now this may have worked well in 1985 when the RFC was written. But in today's Internet, we can't have people hijacking ftp servers and requesting that data be spit out to arbitrary points on the internet. As *Hobbit* wrote back in 1995, this protocol flaw "can be used to post virtually untraceable mail and news, hammer on servers at various sites, fill up disks, try to hop firewalls, and generally be annoying and hard to track down at the same time." What we will exploit this for is to (surprise, surprise) scan TCP ports from a "proxy" ftp server. Thus you could connect to an ftp server behind a firewall, and then scan ports that are more likely to be blocked (139 is a good one). If the ftp server allows reading from and writing to some directory (such as /incoming), you can send arbitrary data to ports that you do find open (nmap doesn't do this for you though).

The argument passed to the 'b' option is the host you want to use as a proxy, in standard URL nota¬tion. The format is: username:pass¬word@server:port. Everything but server is optional. To determine what servers are vulnerable to this attack, you can see my article in Phrack 51. And updated version is available at the nmap URL (http://www.insecure.org/nmap).

GENERAL OPTIONS

None of these are required but some can be quite useful.

-P0 Do not try and ping hosts at all before scanning them. This allows the scanning of networks that don't allow ICMP echo requests (or responses) through their firewall. microsoft.com is an exam¬ple of such a network, and thus you should always use -P0 or -PT80 when portscanning microsoft.com.

-PT Use TCP "ping" to determine what hosts are up. Instead of sending ICMP echo request packets and waiting for a response, we spew out TCP ACK packets throughout the target network (or to a single machine) and then wait for responses to trickle back. Hosts that are up should respond with a RST. This option preserves the efficiency of only scan¬ning hosts that are up while still allowing you to scan networks/hosts that block ping packets. For non root users, we use connect(). To set the des¬tination port of the probe packets use -PT<port number>. The default port is 80, since this port is often not filtered out.

-PS This option uses SYN (connection request) packets instead of ACK packets for root users. Hosts that are up should respond with a RST (or, rarely, a SYN|ACK). You can set the destination port in the same manner as -PT above.

-PI This option uses a true ping (ICMP echo request) packet. It finds hosts that are up and also looks for subnet-directed broadcast addresses on your network. These are IP addresses which are exter¬nally reachable and translate to a broadcast of incomming IP packets to a subnet of computers. These should be eliminated if found as they allow for numerous denial of service attacks (Smurf is the most common).

-PB This is the default ping type. It uses both the ACK (-PT) and ICMP (-PI) sweeps in parallel. This way you can get firewalls that filter either one (but not both). The TCP probe destination port can be set in the same manner as with -PT above.

-O This option activates remote host identification via TCP/IP fingerprinting. In other words, it uses a bunch of techniques to detect subtleties in the underlying operating system network stack of the computers you are scanning. It uses this informa¬tion to create a 'fingerprint' which it compares with its database of known OS fingerprints (the nmap-os-fingerprints file) to decide what type of system you are scanning.

If Nmap is unable to guess the OS of a machine, and conditions are good (eg at least one open port), Nmap will provide a URL you can use to submit the fingerprint if you know (for sure) the OS running on the machine. By doing this you contribute to the pool of operating systems known to nmap and thus it will be more accurate for everyone. Note that if you leave an IP address on the form, the machine may be scanned when we add the fingerprint (to validate that it works).

The -O option also enables several other tests. One is the "Uptime" measurement, which uses the TCP timestamp option (RFC 1323) to guess when a machine was last rebooted. This is only reported for machines which provide this information.

Another test enabled by -O is TCP Sequence Predictability Classification. This is a measure that describes approximately how hard it is to establish a forged TCP connection against the remote host. This is useful for exploiting source-IP based trust relationships (rlogin, firewall fil¬ters, etc) or for hiding the source of an attack. The actual difficulty number is based on statisti¬cal sampling and may fluctuate. It is generally better to use the English classification such as "worthy challenge" or "trivial joke". This is only reported in normal output with -v.

When verbose mode (-v) is on with -O, IPID Sequence Generation is also reported. Most machines are in the "incremental" class, which means that they increment the "ID" field in the IP header for each packet they send. This makes them vulnerable to several advanced information gathering and spoofing attacks.

-I This turns on TCP reverse ident scanning. As noted by Dave Goldsmith in a 1996 Bugtraq post, the ident protocol (rfc 1413) allows for the disclosure of the username that owns any process connected via TCP, even if that process didn't initiate the con¬nection. So you can, for example, connect to the http port and then use identd to find out whether the server is running as root. This can only be done with a full TCP connection to the target port (i.e. the -sT scanning option). When -I is used, the remote host's identd is queried for each open port found. Obviously this won't work if the host is not running identd.

-f This option causes the requested SYN, FIN, XMAS, or NULL scan to use tiny fragmented IP packets. The idea is to split up the TCP header over several packets to make it harder for packet filters, intrusion detection systems, and other annoyances to detect what you are doing. Be careful with this! Some programs have trouble handling these tiny packets. My favorite sniffer segmentation faulted immediately upon receiving the first 36-byte frag¬ment. After that comes a 24 byte one! While this method won't get by packet filters and firewalls that queue all IP fragments (like the CON¬FIG_IP_ALWAYS_DEFRAG option in the Linux kernel), some networks can't afford the performance hit this causes and thus leave it disabled.

Note that I do not yet have this option working on all systems. It works fine for my Linux, FreeBSD, and OpenBSD boxes and some people have reported success with other *NIX variants.

-v Verbose mode. This is a highly recommended option and it gives out more information about what is going on. You can use it twice for greater effect. Use -d a couple of times if you really want to get crazy with scrolling the screen!

-h This handy option display a quick reference screen of nmap usage options. As you may have noticed, this man page is not exactly a 'quick reference' :)

-oN <logfilename>
This logs the results of your scans in a normal human readable form into the file you specify as an argument.

-oX <logfilename>
This logs the results of your scans in XML form into the file you specify as an argument. This allows programs to easily capture and interpret Nmap results. You can give the argument ´-´ (with¬out quotes) to shoot output into stdout (for shell pipelines, etc). In this case normal output will be suppressed. Watch out for error messages if you use this (they will still go to stderr). Also note that ´-v´ may cause some extra information to be printed. The Document Type Definition (DTD) defin¬ing the XML output structure is available at http://www.insecure.org/nmap/nmap.dtd .

-oG <logfilename>
This logs the results of your scans in a grepable form into the file you specify as an argument. This simple format provides all the information on one line (so you can easily grep for port or OS information and see all the IPs. This used to be the preferred mechanism for programs to interact with Nmap, but now we recommend XML output (-oX instead). This simple format may not contain as much information as the other formats. You can give the argument ´-´ (without quotes) to shoot output into stdout (for shell pipelines, etc). In this case normal output will be suppressed. Watch out for error messages if you use this (they will still go to stderr). Also note that ´-v´ will cause some extra information to be printed.

-oA <basefilename>
This tells Nmap to log in ALL the majore formats (normal, grepable, and XML). You give a base for the filename, and the output files will be base.nmap, base.gnmap, and base.xml.

-oS <logfilename>
thIs l0gz th3 r3suLtS of YouR ScanZ iN a s|<ipT kiDd|3 f0rM iNto THe fiL3 U sPecfy 4s an arGuMEnT! U kAn gIv3 the 4rgument ´-´ (wItHOUt qUOteZ) to sh00t output iNT0 stDouT!@!!

--resume <logfilename>
A network scan that is cancelled due to control-C, network outage, etc. can be resumed using this option. The logfilename must be either a normal (-oN) or machine parsable (-oM) log from the aborted scan. No other options can be given (they will be the same as the aborted scan). Nmap will start on the machine after the last one success¬fully scanned in the log file.

--append_output
Tells Nmap to append scan results to any output files you have specified rather than overwriting those files.

-iL <inputfilename>
Reads target specifications from the file specified RATHER than from the command line. The file should contain a list of host or network expressions

seperated by spaces, tabs, or newlines. Use a hyphen (-) as inputfilename if you want nmap to read host expressions from stdin (like at the end of a pipe). See the section target specification for more information on the expressions you fill the file with.

-iR This option tells Nmap to generate its own hosts to scan by simply picking random numbers :). It will never end. This can be useful for statistical sam¬ pling of the Internet to estimate various things. If you are ever really bored, try nmap -sS -iR -p 80 to find some web servers to look at.

-p <port ranges>
This option specifies what ports you want to spec¬ ify. For example '-p 23' will only try port 23 of the target host(s). ´-p 20-30,139,60000-´ scans ports between 20 and 30, port 139, and all ports greater than 60000. The default is to scan all ports between 1 and 1024 as well as any ports listed in the services file which comes with nmap. For IP protocol scanning (-sO), this specifies the protocol number you wish to scan for (0-255).

When scanning both TCP and UDP ports, you can spec¬ ify a particular protocol by preceding the port numbers by "T:" or "U:". The qualifier lasts until you specify another qualifier. For example, the argument "-p U:53,111,137,T:21-25,80,139,8080" would scan UDP ports 53,111,and 137, as well as the listed TCP ports. Note that to scan both UDP & TCP, you have to specify -sU and at least one TCP scan type (such as -sS, -sF, or -sT). If no proto¬ col qualifier is given, the port numbers are added to all protocol lists.

-F Fast scan mode.
Specifies that you only wish to scan for ports listed in the services file which comes with nmap (or the protocols file for -sO). This is obviously much faster than scanning all 65535 ports on a host.

-D <decoy1 [,decoy2][,ME],...>
Causes a decoy scan to be performed which makes it appear to the remote host that the host(s) you specify as decoys are scanning the target network too. Thus their IDS might report 5-10 port scans from unique IP addresses, but they won't know which IP was scanning them and which were innocent decoys. While this can be defeated through router path tracing, response-dropping, and other "active" mechanisms, it is generally an extremely effective technique for hiding your IP address.

Separate each decoy host with commas, and you can optionally use 'ME' as one of the decoys to repre¬ sent the position you want your IP address to be used. If your put 'ME' in the 6th position or later, some common port scan detectors (such as Solar Designer's excellent scanlogd) are unlikeley to show your IP address at all. If you don't use 'ME', nmap will put you in a random position.

Note that the hosts you use as decoys should be up or you might accidently SYN flood your targets. Also it will be pretty easy to determine which host is scanning if only one is actually up on the net¬ work. You might want to use IP addresses instead of names (so the decoy networks don't see you in their nameserver logs).

Also note that some (stupid) "port scan detectors" will firewall/deny routing to hosts that attempt port scans. Thus you might inadvertantly cause the machine you scan to lose connectivity with the decoy machines you are using. This could cause the target machines major problems if the decoy is, say, its internet gateway or even "localhost".

Thus you might want to be careful of this option. The real moral of the story is that detectors of spoofable port scans should not take action against the machine that seems like it is port scanning them. It could just be a decoy!

Decoys are used both in the initial ping scan (using ICMP, SYN, ACK, or whatever) and during the actual port scanning phase. Decoys are also used during remote OS detection (-O).

It is worth noting that using too many decoys may slow your scan and potentially even make it less accurate. Also, some ISPs will filter out your spoofed packets, although many (currently most) do not restrict spoofed IP packets at all.

-S <IP_Address>
In some circumstances, nmap may not be able to determine your source address (nmap will tell you if this is the case). In this situation, use -S with your IP address (of the interface you wish to send packets through).

Another possible use of this flag is to spoof the scan to make the targets think that someone else is scanning them. Imagine a company being repeatedly port scanned by a competitor! This is not a sup¬ported usage (or the main purpose) of this flag. I just think it raises an interesting possibility that people should be aware of before they go accusing others of port scanning them. -e would generally be required for this sort of usage.

-e <interface>
Tells nmap what interface to send and receive pack¬ets on. Nmap should be able to detect this but it will tell you if it cannot.

-g <portnumber>
Sets the source port number used in scans. Many naive firewall and packet filter installations make an exception in their ruleset to allow DNS (53) or FTP-DATA (20) packets to come through and establish a connection. Obviously this completely subverts the security advantages of the firewall since intruders can just masquerade as FTP or DNS by mod¬ifying their source port. Obviously for a UDP scan you should try 53 first and TCP scans should try 20 before 53. Note that this is only a request -- nmap will honor it only if and when it is able to. For example, you can't do TCP ISN sampling all from one host:port to one host:port, so nmap changes the source port even if you used -g.

Be aware that there is a small performance penalty on some scans for using this option, because I sometimes store useful information in the source port number.

-n Tells Nmap to NEVER do reverse DNS resolution on the active IP addresses it finds. Since DNS is often slow, this can help speed things up.

-R Tells Nmap to ALWAYS do reverse DNS resolution on the target IP addresses. Normally this is only done when a machine is found to be alive.

-r Tells Nmap NOT to randomize the order in which ports are scanned.

--randomize_hosts
Tells Nmap to shuffle each group of up to 2048 hosts before it scans them. This can make the scans less obvious to various network monitoring systems, especially when you combine it with slow timing options (see below).

-M <max sockets>
Sets the maximum number of sockets that will be

used in parallel for a TCP connect() scan (the default). This is useful to slow down the scan a little bit and avoid crashing remote machines. Another approach is to use -sS, which is generally easier for machines to handle.

TIMING OPTIONS

Generally Nmap does a good job at adjusting for Network characteristics at runtime and scanning as fast as possible while minimizing that chances of hosts/ports going undetected. However, there are same cases where Nmap's default timing policy may not meet your objectives. The following options provide a fine level of control over the scan tim¬ ing:

-T <Paranoid|Sneaky|Polite|Normal|Aggressive|Insane>

These are canned timing policies for conveniently expressing your priorities to Nmap. Paranoid mode scans very slowly in the hopes of avoiding detec¬ tion by IDS systems. It serializes all scans (no parallel scanning) and generally waits at least 5 minutes between sending packets. Sneaky is simi¬ lar, except it only waits 15 seconds between send¬ ing packets. Polite is meant to ease load on the network and reduce the chances of crashing machines. It serializes the probes and waits at least 0.4 seconds between them. Normal is the default Nmap behaviour, which tries to run as quickly as possible without overloading the network or missing hosts/ports. Aggressive mode adds a 5 minute timeout per host and it never waits more than 1.25 seconds for probe responses. Insane is only suitable for very fast networks or where you don't mind losing some information. It times out hosts in 75 seconds and only waits 0.3 seconds for individual probes. It does allow for very quick network sweeps though :). You can also reference these by number (0-5). For example, ´-T 0´ gives you Paranoid mode and ´-T 5´ is Insane mode.

These canned timing modes should NOT be used in combination with the lower level controls given below.

--host_timeout <milliseconds>

Specifies the amount of time Nmap is allowed to spend scanning a single host before giving up on that IP. The default timing mode has no host time¬ out.

--max_rtt_timeout <milliseconds>

Specifies the maximum amount of time Nmap is allowed to wait for a probe response before retransmitting or timing out that particular probe. The default mode sets this to about 9000.

--min_rtt_timeout <milliseconds>

When the target hosts start to establish a pattern of responding very quickly, Nmap will shrink the amount of time given per probe. This speeds up the scan, but can lead to missed packets when a response takes longer than usual. With this param¬ eter you can guarantee that Nmap will wait at least the given amount of time before giving up on a probe.

--initial_rtt_timeout <milliseconds>

Specifies the initial probe timeout. This is gen¬ erally only useful when scanning firwalled hosts with -P0. Normally Nmap can obtain good RTT esti¬ mates from the ping and the first few probes. The default mode uses 6000.

--max_parallelism <number>

Specifies the maximum number of scans Nmap is allowed to perform in parallel. Setting this to one means Nmap will never try to scan more than 1 port at a time. It also effects other parallel