TCP Stealth

Port Knocking Advanced

Udo Seidel

Agenda

- Who & Why
- A Bit of History
- The Idea
- Implementation
- Show
- And?

Who & Why

Me :-)

- Teacher of mathematics and physics
- PhD in experimental physics
- Started with Linux in 1996
- Linux/UNIX trainer
- s+c: 2002-2005
- @Amadeus:
  - Linux Admin, Strategy, Automation
  - Architecture & Technical Governance

My 'notebook' :-D

- Raspberry Pi2
- Fedora 21 with custom kernel
- HDMI2VGA
- Mini Bluetooth keyboard
- 10 Ah battery

Why not?

- Security by obscurity
- Port knocking daemon – SPOF
- IP address spoofing
- … and more

Why?

- Brute force login attacks
- Technical evolution
- Snowden disclosures
  - Computer power
  - Country-wide port-scans

A Bit of History

Looking back and around

- Not new
- Several implementations
- Normally 3 parties
- 'Knocking' differences
- E.g. http://www.portknocking.org/

Traditional Port Knocking Procedure

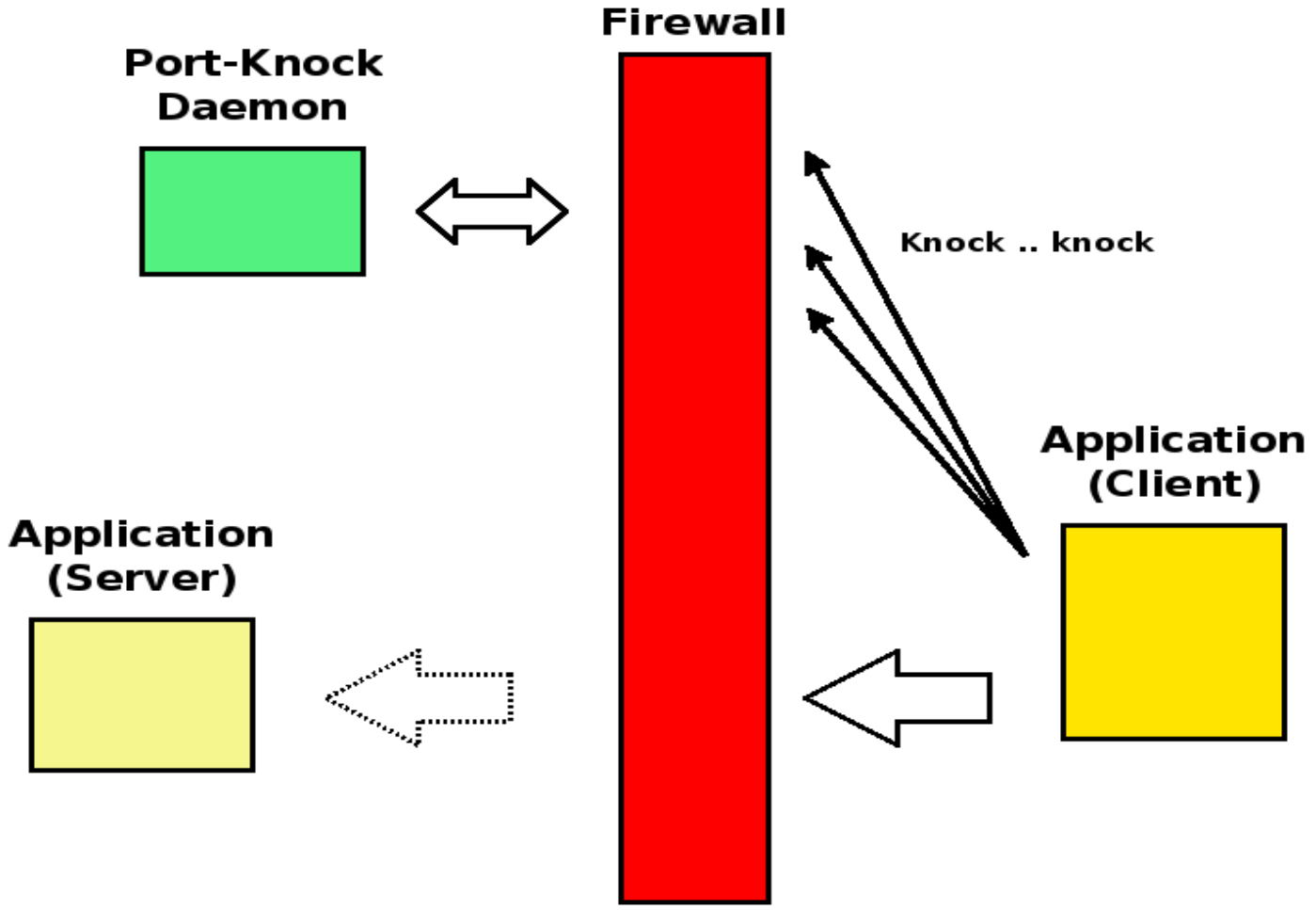
I. Connection attempt by client to server
   => blocked by firewall

II. Knock sequence performed by client
   => verified by Port Knocking daemon

III. Port-Knocking daemon instructs firewall

IV. 2nd Connection attempt by client
   => granted by firewall

Traditional Port Knocking Setup



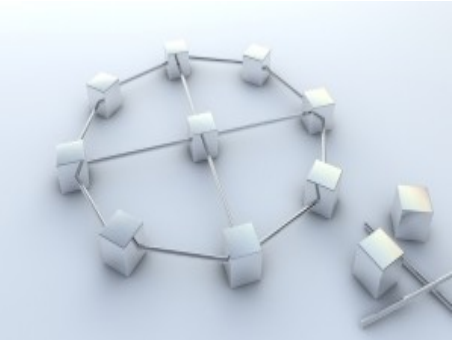
Further downsides of Traditional Port Knocking

- Additional network packets
- Man-in-the-Middle attacks
- Protocol-dependent port behaviour

The Idea

TCP only!?!

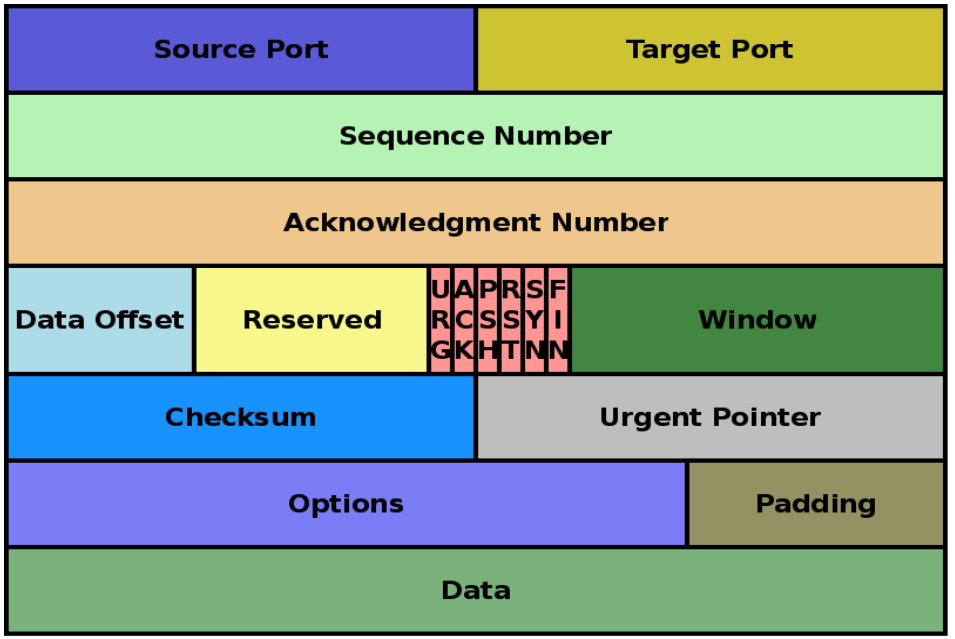
- Well-used
- UDP limitations, e.g syslog, DNS
- Widely used for TLS/SSL



First Thoughts

- Avoid additional packets
- Hide information in protocol header
  - 'Steganography'
  - Limitations per design
  - RFC 793 (and successors)
- Shared Secret
- Not new => Silentknock (1997)

TCP Header – potential candidates



- Initial Sequence Number (ISN)
- Acknowledgement Number (ACK)?
- Timestamps?

ISN as a Carrier Medium

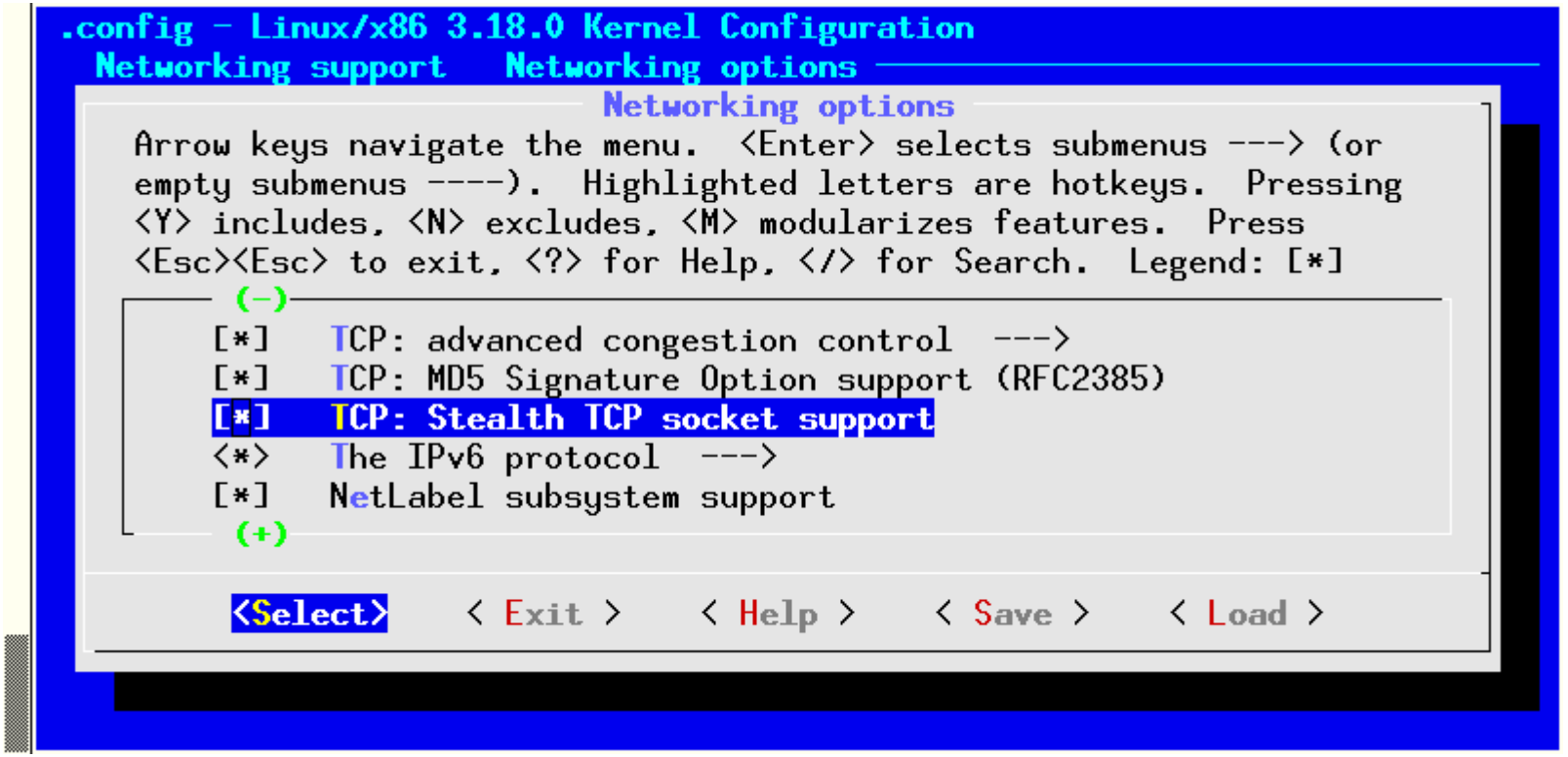
- 32 Bit
- Input data
  - Shared Secret
  - Target IP
  - Target Port
  - Time
- Generation via MD5

Implementation

About Sockets

- Change of TCP implementation
- Client AND Server
- Linux/BSD
  - Kernel
    - `tcp_v4/6_connect()`
    - `tcp_v4/6_do_rcv()`
  - Application
    - `setsockopt()`

Linux Kernel with TCP Stealth



Socket changes for closed source

- Helper library
  - *libknockify*
  - *LD_PRELOAD*
  - Overlay of system calls
    - `listen()`
    - `connect()`
- A bit flaky
- Not recommended => 'just a hack'

Stealth Socket Example

```
$ cat tcp_stealth_server.c
...
#define TCP_STEALTH                    26
...
  char secret[64] = "This is my magic ID.";
...
  if (setsockopt(sock, IPPROTO_TCP, TCP_STEALTH, secret,
sizeof(secret))) {
                printf("setsockopt() failed, %s\n", strerror(errno));
                return 1;
  }
...
$
```

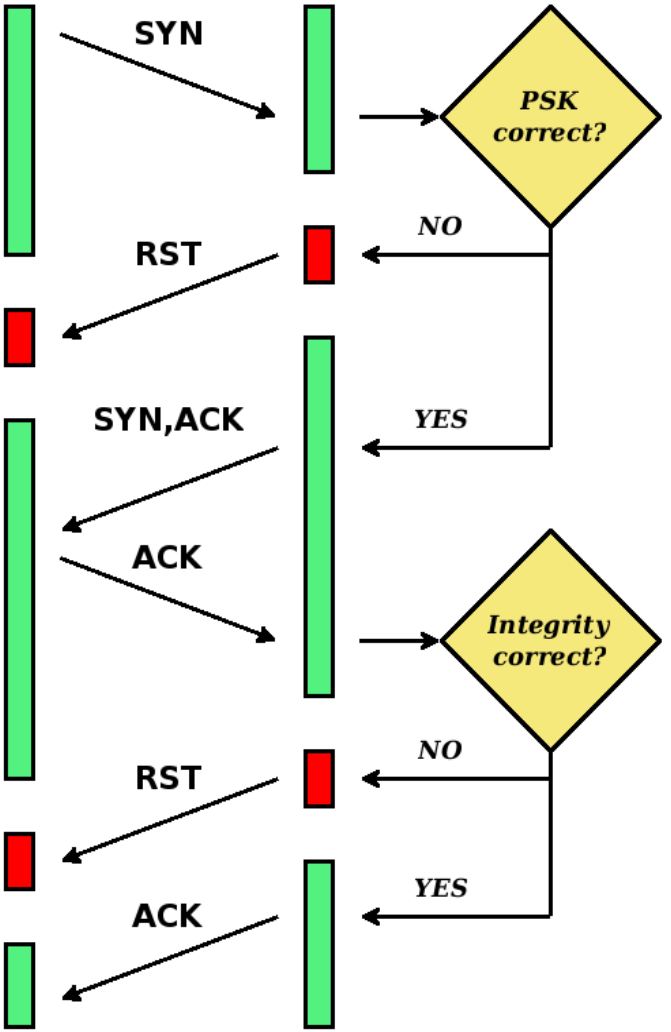
Man in the Middle .. Still possible!?!

- Duty of application .. yes .. but ..
- Small but real attack vector
- Data integrity check!!

TCP Stealth – Data Integrity Check I

- Input data
  - PSK
  - Additional information
- MD5
- Split and XOR => 16 Bit
- 2nd part of ISN :-)

TCP Stealth - Data Integrity Check II



TCP Stealth – Retransmissions

- Traditional TCP => new timestamp
- TCP Stealth
  - Timestamp => ISN calculation
  - Use same/old timestamp

Show

Example – The Scene

- Patched Linux kernel 3.19rc1
- Patched SSHD with TCP Stealth enabled
- Configured as service using port 10022

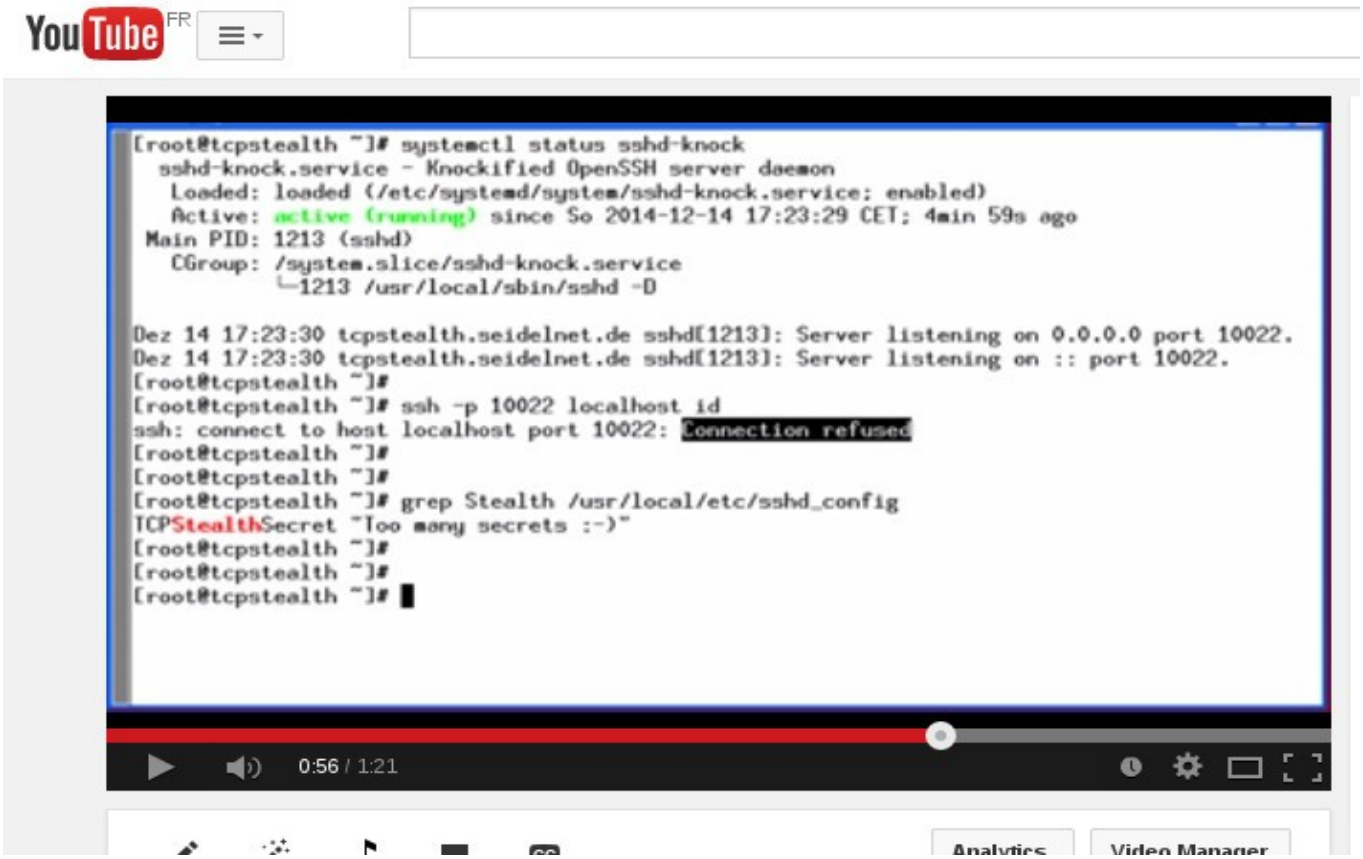
```
#
# uname -r
3.19.0-rc1
#
# cat /etc/systemd/system/sshd-knock.service
[Unit]
Description=Knockified OpenSSH server daemon
After=network.target sshd-keygen.service
Wants=sshd-keygen.service

[Service]
EnvironmentFile=/etc/sysconfig/sshd
ExecStart=/usr/local/sbin/sshd -D $OPTIONS
ExecReload=/bin/kill -HUP $MAINPID
KillMode=process
Restart=on-failure
RestartSec=42s

[Install]
WantedBy=multi-user.target
#
#
#
```

Example – The Show

- http://youtu.be/7CadOVTNxr4 :-)



And?

Bits and Pieces

- Not part of Vanilla kernel
  - First trial in DEC 2013
  - Last one in DEC 2014
- No plans by Linux distributors
  - True for Enterprise
  - Not true for Knoppix :-)
- IETF discussions
  - Not using ISN
  - Using TSval/TSecr

Summary

- Promising project
- Good documentation
- Addresses known challenges
- Upstream integration outstanding

References

- http://gnunet.org/knock
- http://gnunet.org/sites/default/files/ma_kirsch_2014_0.pdf
- http://tools.ietf.org/html/draft-kirsch-ietf-tcp-stealth-00
- http://github.com/useidel/knock

Thank you!

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