Looking for Honey Once Again: Detecting RDP and SMB Honeypots on the Internet

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Introduction

What are Honeypots?

- Mimic vulnerable service, learn something about the attacker
- Low-Interaction: Simple implementation, easy deployment & maintenance, only basic functionality
- High-Interaction: Mimic service as complete as possible

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Why should we look for them?

- Attacker will usually avoid them…
  - Therefore, we should also know how to detect them
- Censys.io and Shodan.io tag their search results with honeypot labels

Introduction

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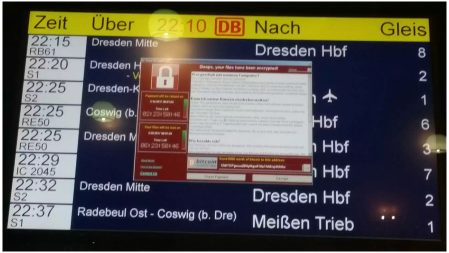
Why SMB & RDP?

- Very common protocols in the Windows world
  - SMB: Windows RPC and File-Exchange Protocol
  - RDP: Remote Access to Windows UI
- Subject to remotely exploitable bugs in the past
  - EternalBlue (CVE-2017-0144)
  - BlueKeep (CVE-2019-0708)
- Gap in literature: HTTP, SMTP, SSH, Telnet and ICS Honeypots have been in focus
- **How many honeypots are deployed in the Internet?**



Picture: Martin Wiesner / heise.de

Creating a Honeypot Detector

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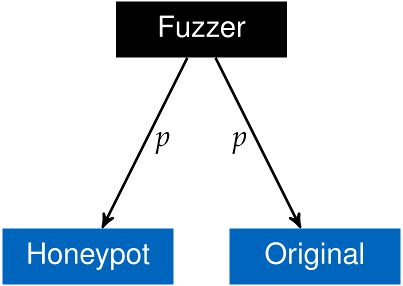
Mission Statement

- How good can open-source honeypots for RDP and SMB be fingerprinted?
  - Analyze the existing implementation, create fingerprints
- How many of these honeypots are deployed on the Internet?
  - Derive a scanner from the fingerprints, conduct an internet-wide scan
- Does it matter? Do attackers react on the presence of honeypots?
  - Deploy own honeypots and benign machines
  - Check the recorded traffic for different attack patterns

Fingerprinting Algorithm

1. Analyze protocol
2. Implement a basic client implementation
3. Add a custom fuzzer to do differential fuzzing
   3.1 Send same probe p to honeypot and benign implementation



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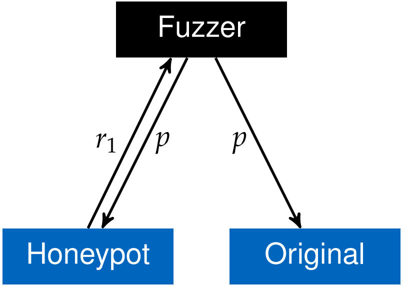

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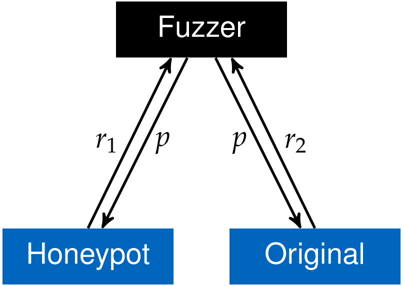

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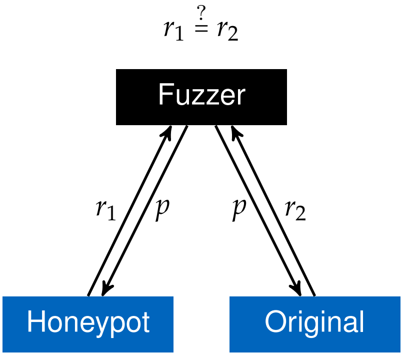

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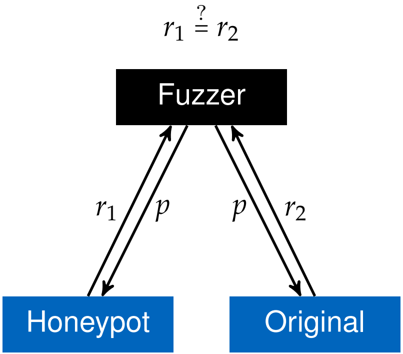
4. Repeat with all implementations of interest
5. Analyze distinctive packets



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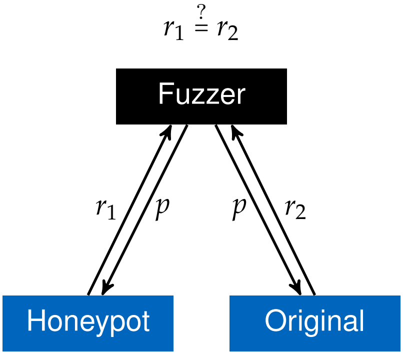
Implementation Details

- p, r_1, r_2 may contain timestamps, IDs, random numbers → Ignore them during comparison
- A single message exchange is usually not distinctive enough! → Use a set of requests, send follow up requests
- We used different fuzzing strategies:
  - Bit-Flipping
  - Grammar based: Use plausible values
  - Both protocols are complex → Enough potential for implementation differences



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  - MS RDP uses the S-Channel TLS implementation of Windows (not OpenSSL!)
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→ **Basically impossible to reimplement everything.**

Fingerprint Example

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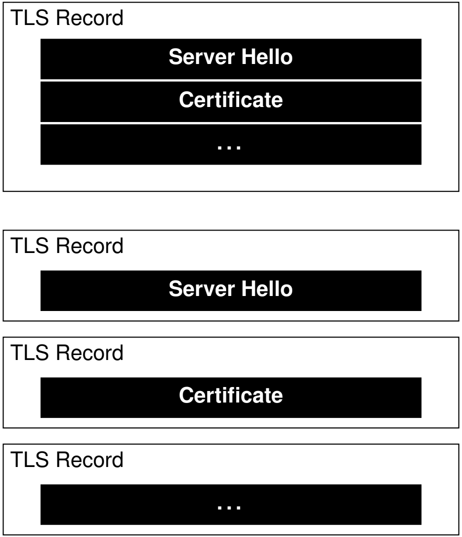
- Require exact fingerprint match
  - Filter out fields being configuration dependent
- Benign implementations answer with different capabilities or hardcoded settings
- Furthermore, they react differently to erroneous behaviour caused by our fuzzer:
  - Windows machines answer with a TCP RST
  - Error message vs no error message
  - Error ignored

Field name	XRDP	Win10	Win8	Win7	WinXP	rdpy	heralding
T.125 Conn. Resp.							
...							
Domain Parameters							
Max Channel IDs	22	✖	34	34	✖	22	✖
...							
RDP Server Data							
Server Core Data							
...							
Length	12	✖	16	12	✖	16	✖
Early Capability Fl.	✖	✖	0x1	✖	✖	0	✖
...							

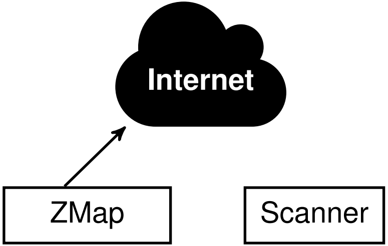
TLS-Fingerprints

- RDP uses TLS (in modern protocol versions)
- TLS offers its own surface for fingerprinting
  - Fingerprintable properties include *Cipher Suites*, *TLS Extensions*, ...
  - Tools: JA3S, JARM, ...
  - **Multiple ways to structure messages**



Internet Scanning

- We utilize ZMap to perform a port scan.
  - BGP dump as IP list input
- Scan only hosts that are alive on the RDP/SMB port.
- We use three probes for SMB and four probes for RDP.
  - Still allow high-scan speeds



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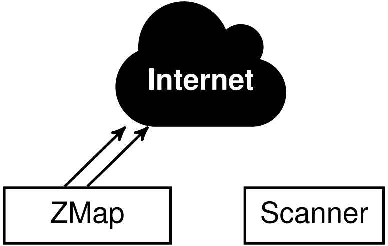

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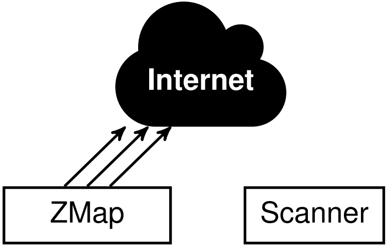

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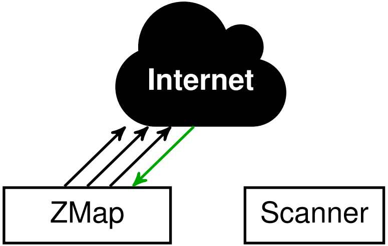

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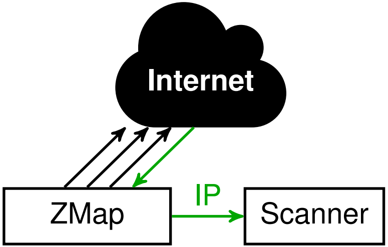

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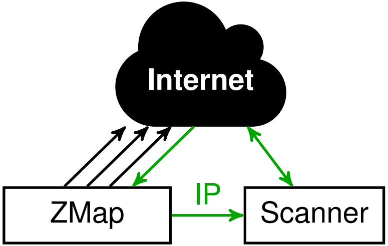

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- 14 RDP hosts match perfectly with our RDP fingerprint except the fingerprint of the TLS stack.
  - MitM-Box? High Interaction Honeypots?

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- More than 50 percent of honeypots are placed in less than 12 ASes!

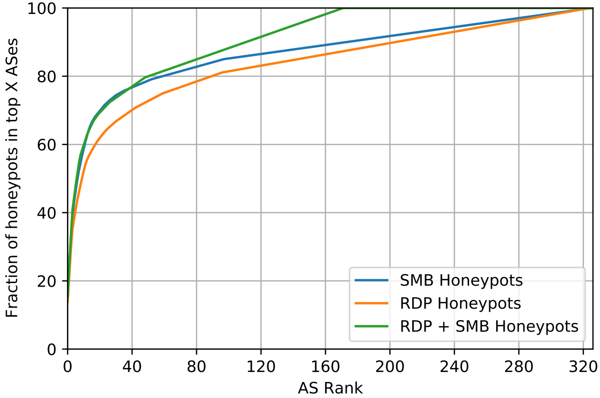

Figure: AS distribution of honeypot addresses

CO	ASN	Organization	SMB	RDP	**Total**
US	16509	AMAZON	232	167	399
US	20473	CHOOPA	126	95	221
US	14061	DIGITALOCEAN	102	90	192
DE	197540	netcup	66	72	138
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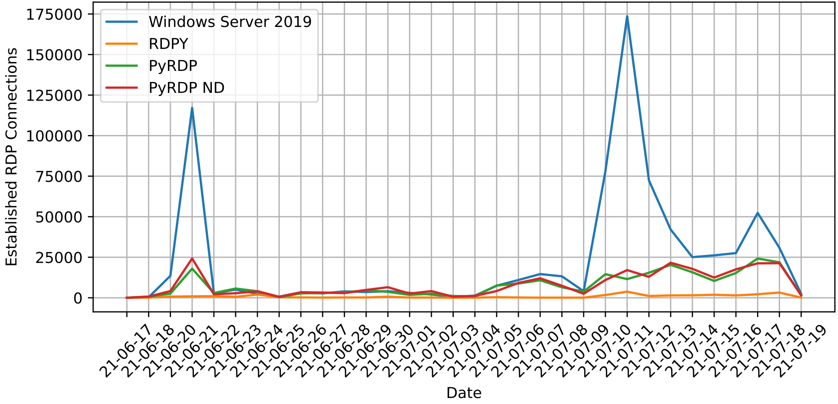
- 1097 hosts have been correctly classified while only 5 have been misclassified!

Attack Analysis

Do attackers react on the presence of honeypots?
We deployed RDP honeypots and benign Windows machines for 34 days to the Internet and analyzed the results…



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Observations

- We received traffic from Shodan.io, Censys.io and other not well known Internet scanning services.
- Benign hosts are preferably connected to.
- Clients connect and disconnect immediately or perform credential stuffing attacks.
- Issue: Hosts communicate! A scan of host A influences behaviour of host B.
  - i.e. Censys.io has dedicated hosts for port scanning and dedicated protocol analysis.
  - Benign hosts are prefered even if the connecting hosts has never connected to others.
  - Scans are done by Autonomous Systems / IPv4 address ranges.

Conclusion

- Low-Interaction honeypots are rarely, but still used!
- It is challenging to build a stealthy honeypot for RDP and SMB.
  - Both protocols offer a giant surface for implementation differences!
  - Differential fuzzing can be used to eliminate differences!
- We demonstrated that attacks are less common on honeypots as on benign machines in the Internet!
- Watch out for differences in your TLS implementation!

We provide code!
Check it out!

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