CAPTCHAs as an Operating System Service

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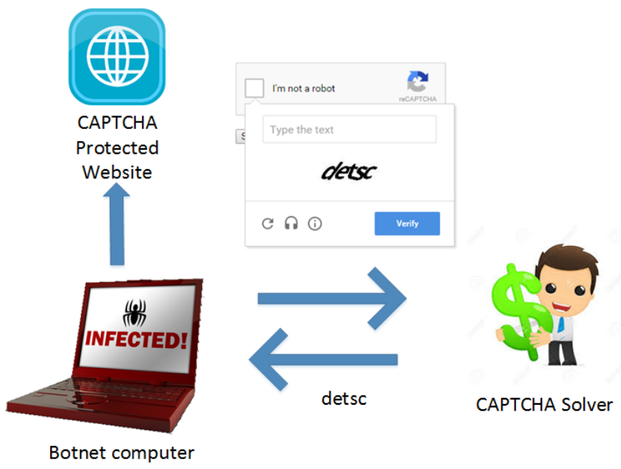
CAPTCHAs fail to stop automated attacks



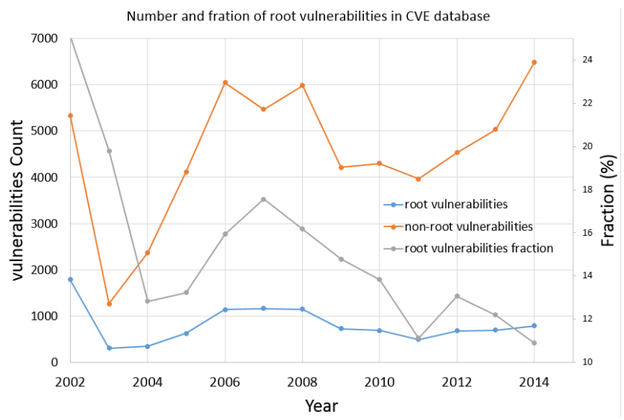
- CAPTCHA solvers employ human workers to solve CAPTCHAs.
- A botnet computer submits a CAPTCHA challenge using a program.
- Average latency: 11.80s; Accuracy: 90% (outsourcing to Antigate.com)

Observation: majority of exploits do not escalate to root

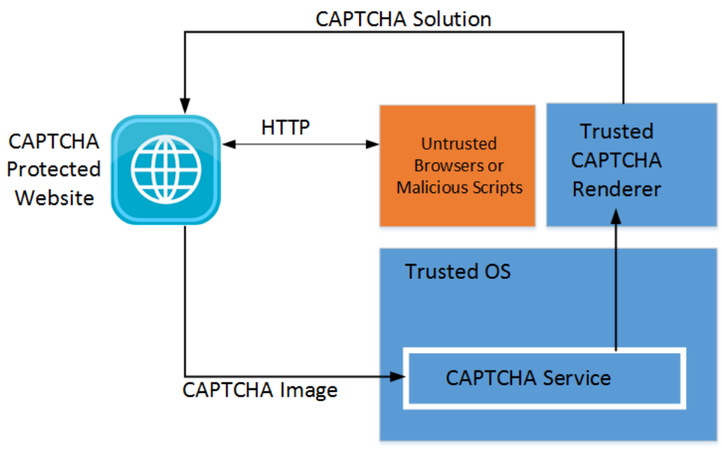
Compromising OS requires root (privileged) access

Observation:

- Only around 1/3 Android malware uses root exploits [1].
- Less than 50% of the botnets with top malicious values [2] may compromise trusted system programs.
- The fraction of vulnerabilities in CVE database containing root privilege escalation is decreasing.



CAPTCHAs as an operating system service



Overview

1. An OS CAPTCHA service listens on a specific port of client machine.
2. Web server sends a CAPTCHA image to the port rather than browser.
3. The CAPTCHA service launches a trusted app to display the CAPTCHA.

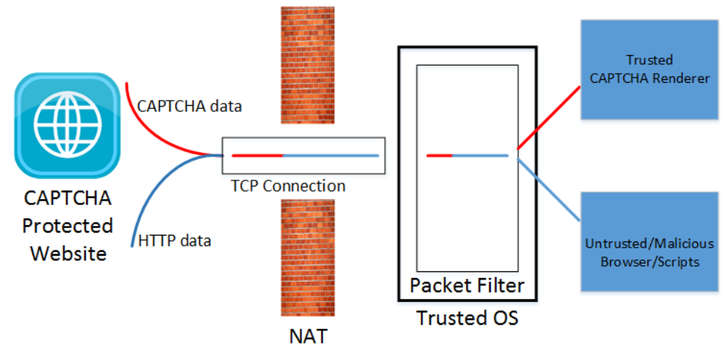
Challenges

- How to reach a client behind a NAT?
- Prevent malicious programs from taking screenshots of a CAPTCHA image.
- Be compatible with legacy clients without OS CAPTCHA service.

Connecting clients behind NAT

Multiplex an existing TCP connection

1. Web server inserts special tags around CAPTCHA data and sends it.
2. A kernel packet filter on the client side strips the CAPTCHA data and passes it to a trusted CAPTCHA renderer.



Compatibility with legacy clients without kernel packet filter

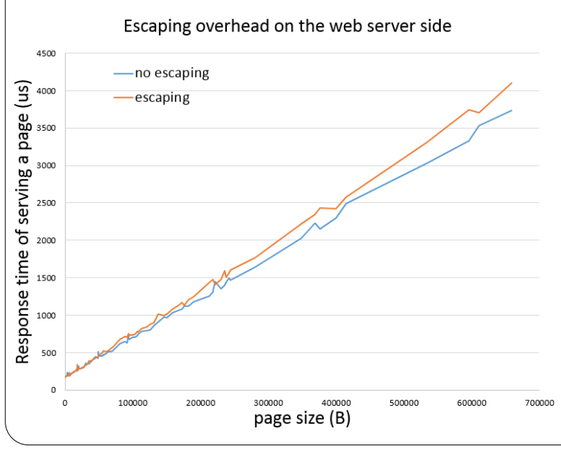
1. Place CAPTCHA data as a JS string variable inside an HTML file. The string will be empty is packet filter is installed.
2. Use JS code to display the a CAPTCHA image inside the browser.

```
var captchaData = "tag captcha-image tag";
if (captchaData === "") {
    /**
     * packet filter is installed
     * notify user to solve CAPTCHA
     */
} else {
    /**
     * packet filter not installed
     * parse captcha image to display it
     */
}
```

Performance

- Server side needs to escape special CAPTCHA tags.
- Client side needs to strip the CAPTCHA data

Experiments on a machine with core i7-860, 8GB RAM



Preventing screenshots of a CAPTCHA

- A **Compositor** (e.g. X11server) is a program that allocates screen buffer, organizes windows of applications and provides screenshot API.
- The CAPTCHA renderer notifies the compositor to disable the screenshot API when a CAPTCHA is being shown on the screen.

Preserving traditional CAPTCHA interface

- A traditional CAPTCHA is shown on the browser and submits the solution with HTML form.
- Compositor places the renderer window inside the browser window to make the CAPTCHA appeared to be rendered inside the browser.

References

1. Yajin Zhou and Xuxian Jiang. Dissecting android malware: Characterization and evolution. In Security and Privacy (SP), 2012 IEEE Symposium on, pages 95-109. IEEE, 2012.
2. Christian Nordlohne. Measuring botnet prevalence: Malice value. 2015, ACDC Project https://www.acdc-project.eu/?page_id=568