LEADERSHIP FOR IT SECURITY & PRIVACY ACROSS HHS

HHS CYBERSECURITY PROGRAM

OFFICE OF INFORMATION SECURITY

Unix/Mac/Linux OS Malware

10/15/2020

Report #: 202010151030

Agenda

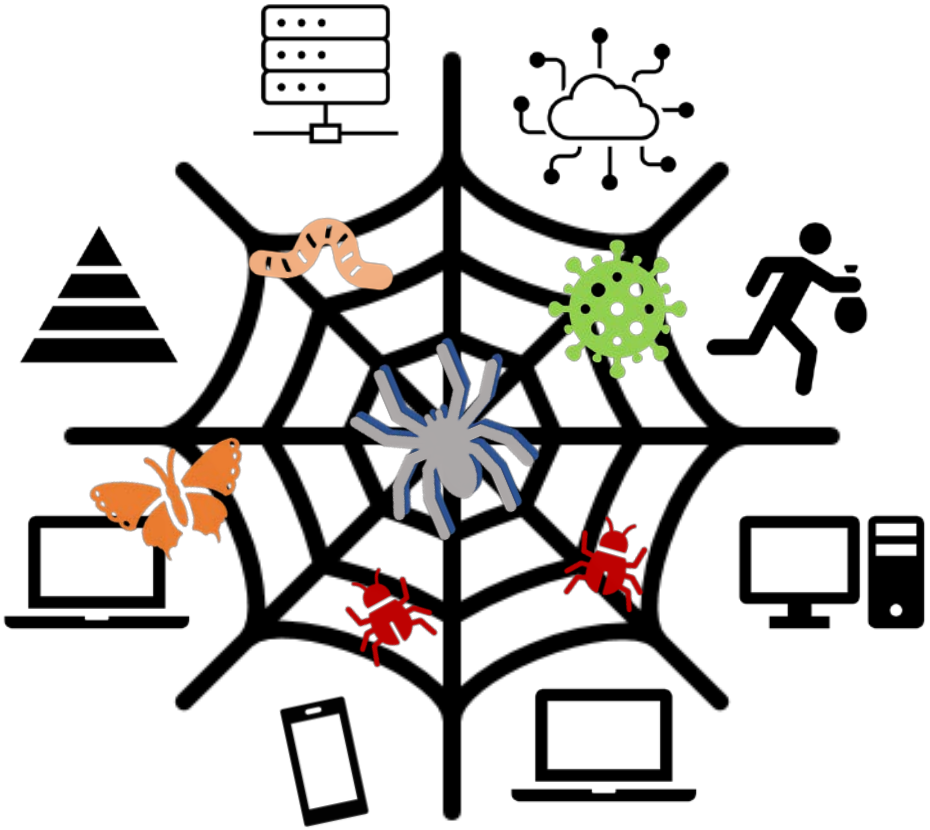
- Executive Summary
- Origin of Modern Operating Systems
- Overview of Operating Systems
  - Desktop
  - Servers
  - Super Computers
  - Mobile
  - Attack Surface and CVEs
- Malware Case Studies
  - Drovorub
  - Hidden Wasp
  - Operation Windigo
  - MAC Malware
- Defending Against Malware
- Summary

Slides Key:

Non-Technical: Managerial, strategic and high-level (general audience)

Technical: Tactical / IOCs; requiring in-depth knowledge (system admins, IRT)

- Unix and Unix-like systems drive most of today's computer systems.
- Vulnerabilities and malware
- Threat mitigation
  - Comprehensive security policies
  - Access control
  - Regular updates and backups
  - Training employees
  - Improving posture and maturity



"Determining the operating system on which the server runs is the most important part of hacking. Mostly, hacking is breaking into the target's system to steal data or any such purpose. Hence, the security of the system becomes the thing of prime importance." Source: Parikh, K. (2020, August) *The Hackers Library*

Functions of Operating Systems

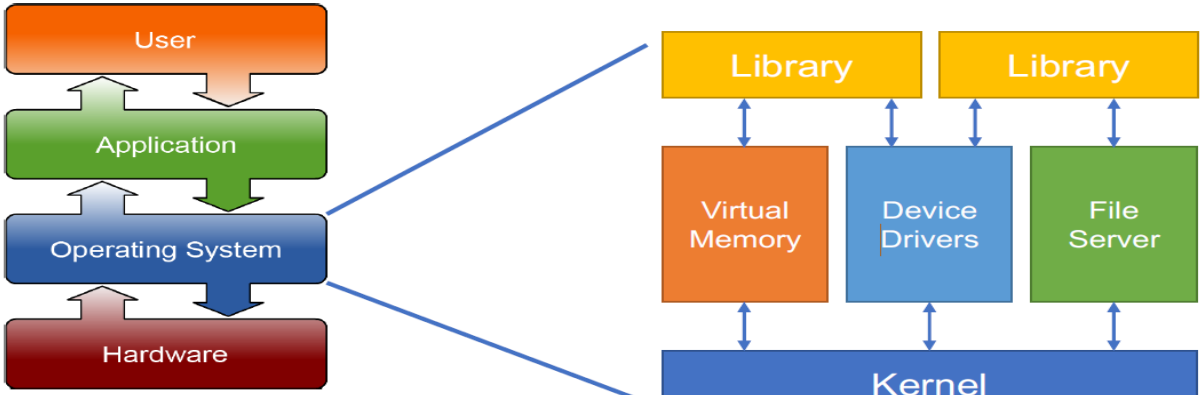
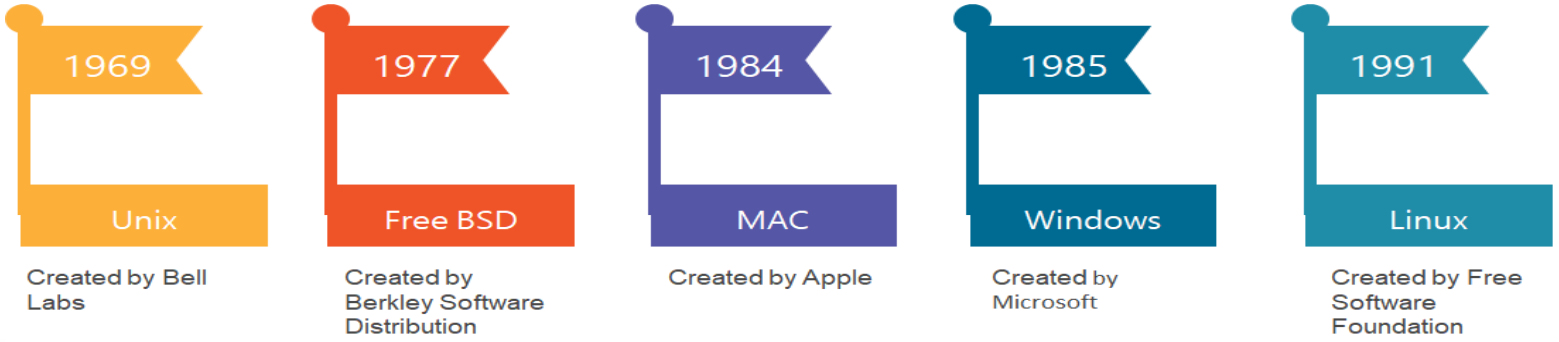


Image By Golftheman - https://commons.wikimedia.org/w/index.php?curid=4558519

Timeline of the Origins of Operating Systems



Overview of Operating Systems (Non-Mobile)

Unix
- Derived from Original AT&T Unix
- Command-line input
- Very popular among scientific, engineering and academic users
- Considered more stable than Windows
- Main frames, workstations, and supercomputers

BSD
- Free and open-source
- Based on Unix OS
- Most popular variant of BSD is Free BSD
- Not designed for personal computers
- Servers, workstations, gaming and embedded systems

macOS
- Proprietary to Apple
- Graphical user interface
- Based on Unix OS
- Second most-used OS for personal computers
- Apple computers and other products, some medical devices

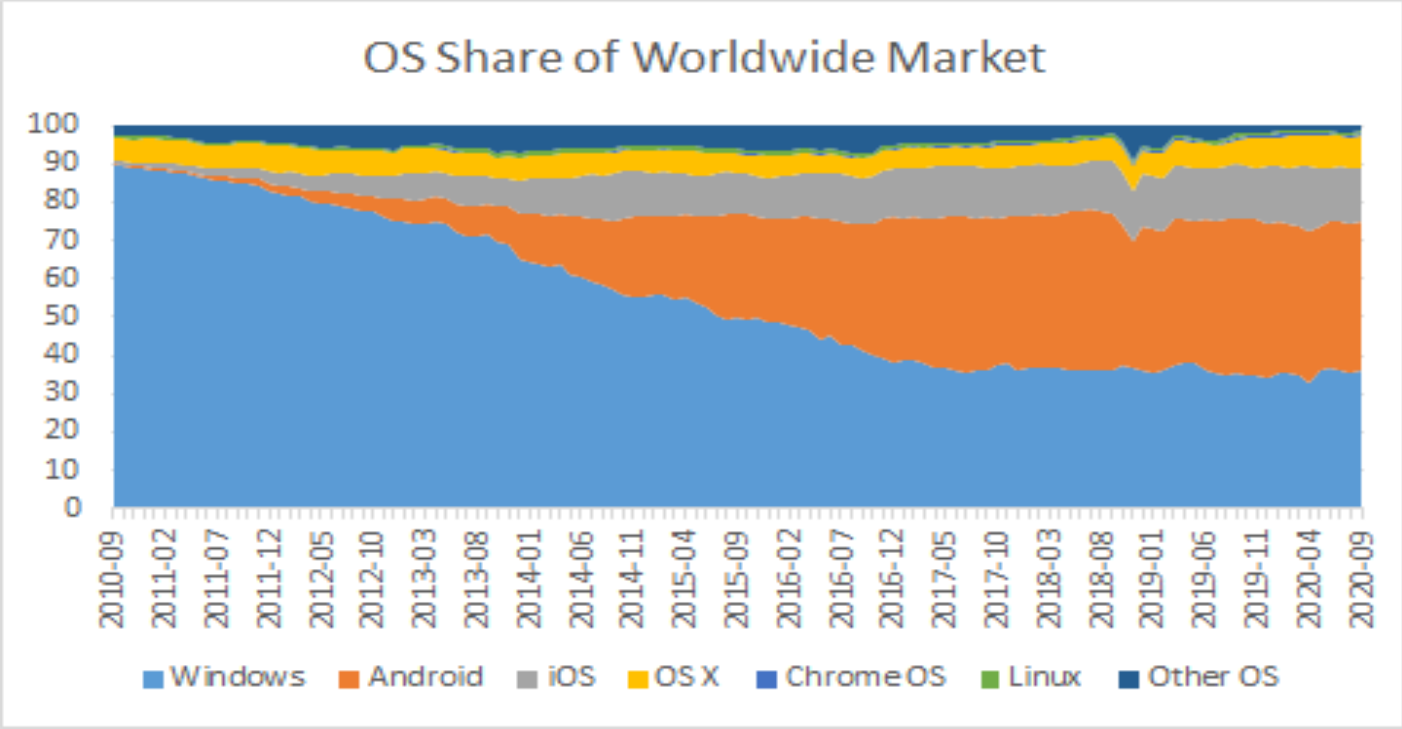
Chrome OS
- Free and open-source
- Graphical user interface
- Based on Linux
- Efficient and easy to maintain
- Chromebooks, tablets, and Google Enterprise Network

Linux
- Free and open-source, but has proprietary variants
- Command-line input
- Based on Unix OS
- More efficient than Windows
- Supercomputers, workstations, web servers, endpoint security, embedded systems

Windows
- Proprietary to Microsoft
- Graphical user interface
- Most-used OS for personal computers
- Computers, workstations, servers, endpoint security, embedded systems

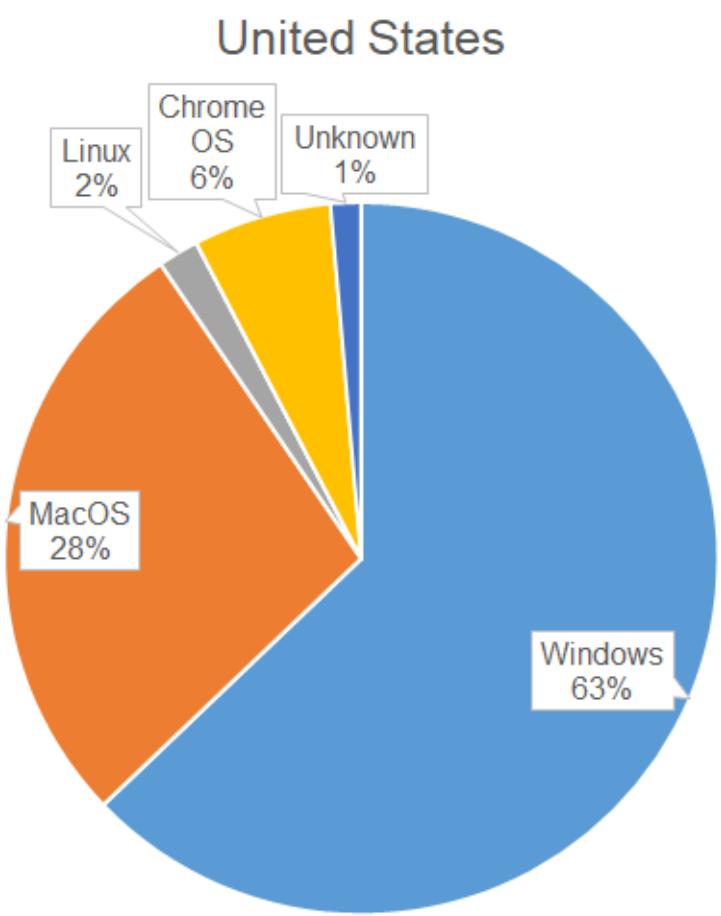
Non-Windows Attack Surfaces Have Grown

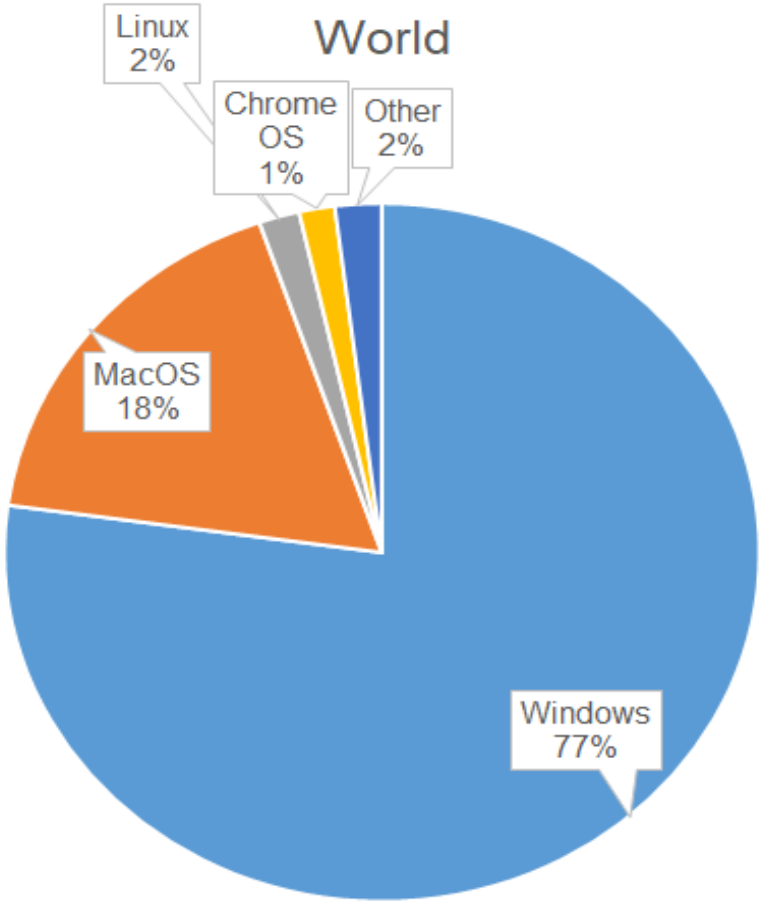
- Linux attack surfaces are growing with Linux/Unix, and BSD variants are used in about 66% of Internet web servers.
- Sales of Chromebooks, which run the Linux-based Chrome OS, grew in the U.S. by 127% between March and June 2020 compared to just 40% for Windows and Mac laptops.
- The Mobile Operating System market share is growing rapidly, as 76% of Internet users are expected to access the web solely via smartphone by 2025.



(Statcounter GlobalStats, 2020)

Operating Systems Used in Desktops/Laptops

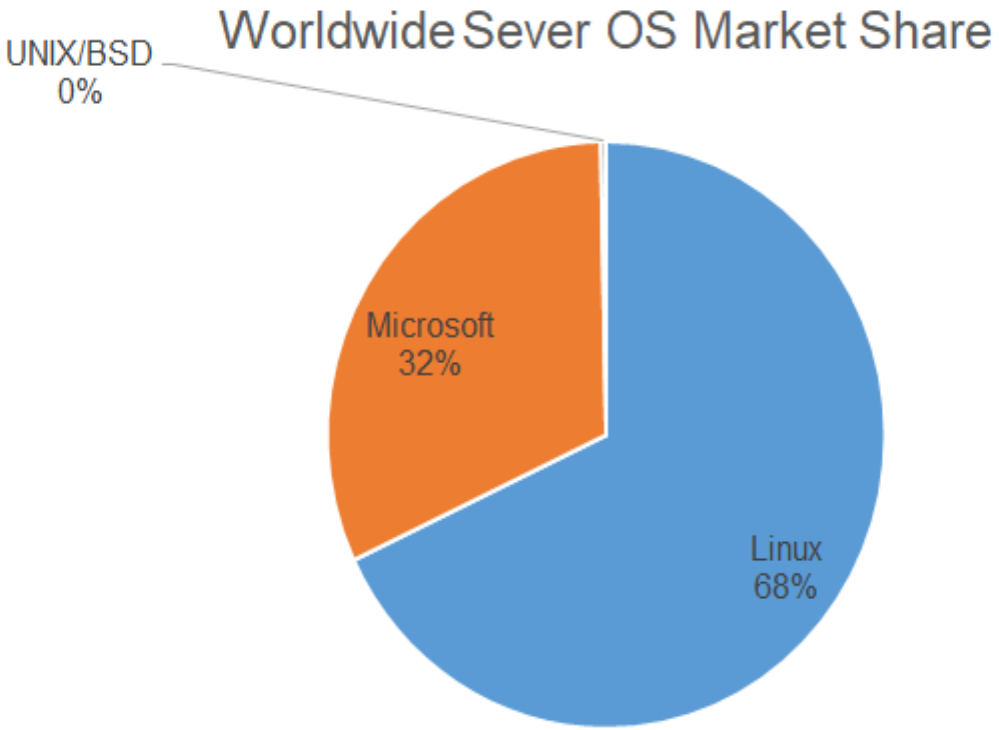




(Statcounter GlobalStats, 2020)

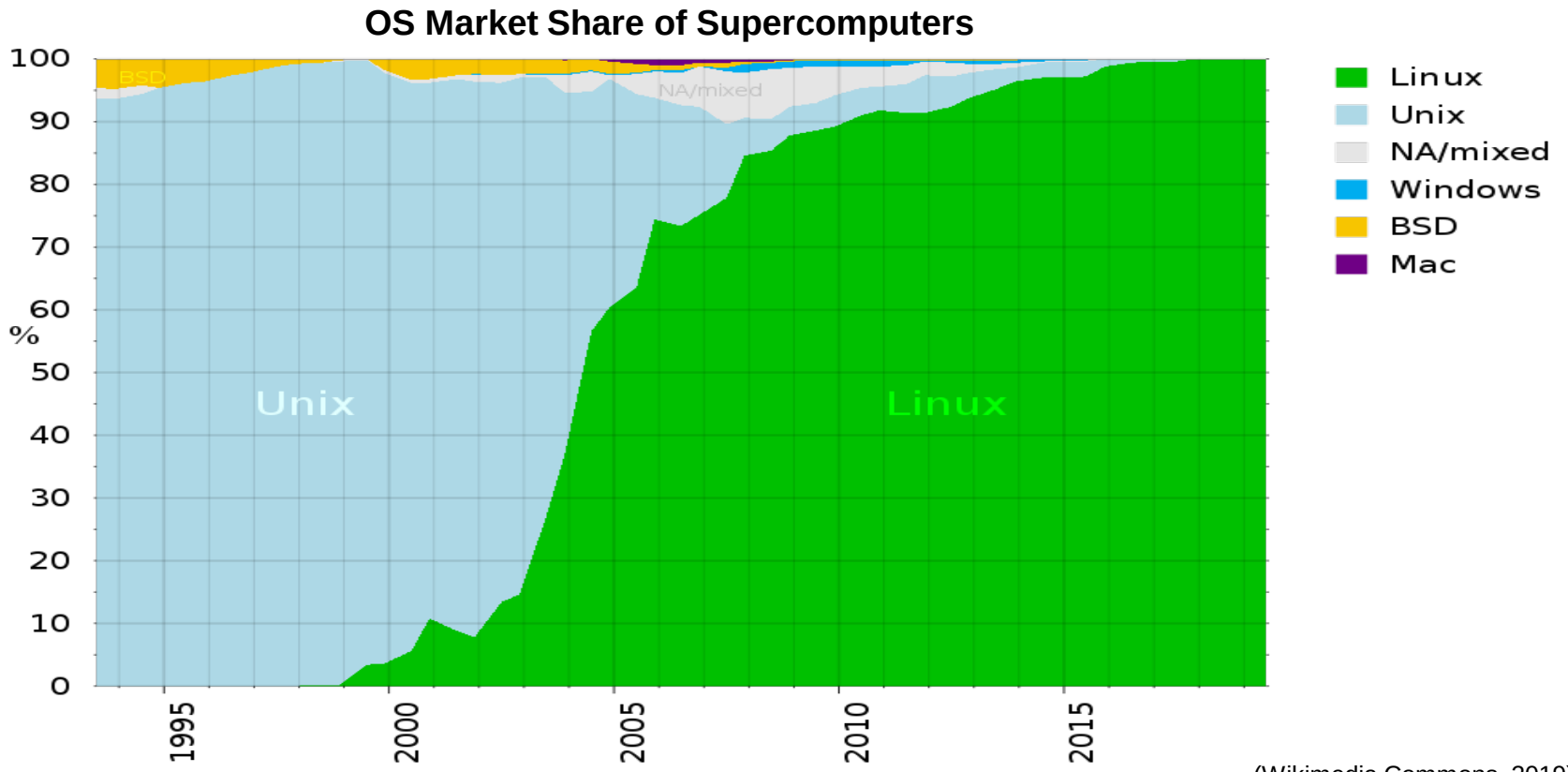
Operating Systems used in Servers

- Linux dominates the server market.
- Many web servers like Unix/BSD, Google Enterprise and Microsoft Azure Cloud use a Linux OS.
- Although Linux is free and open source, many Linux-based variants are not.
- Some paid-for variants include: Red Hat, CentOS and Gentoo. The variants Ubuntu and Fedora are free. Debian has a free version and a paid-for version.



(Team, 2018) Source: Worldwide Operating Systems and Subsystems Market Shares, 2017, IDC, 2018 #U44150918

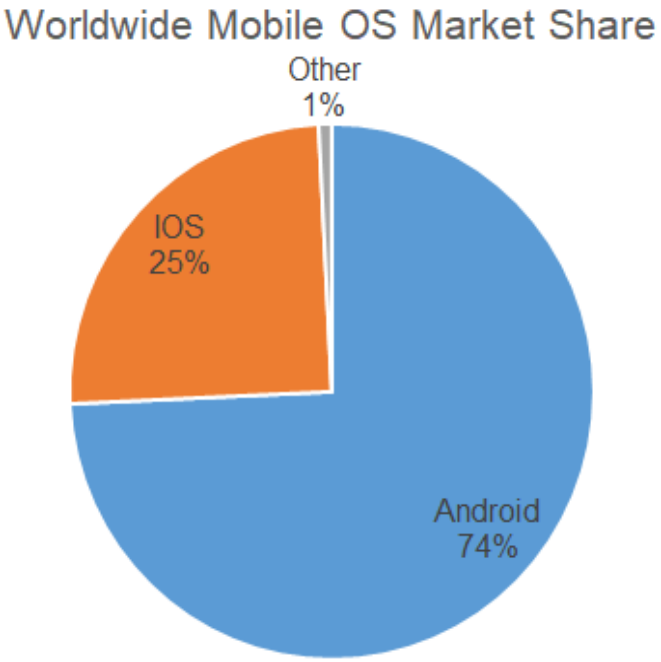
- Linux-based operating systems account for almost 100% of the supercomputer market; a market formerly dominated by Unix operating systems.

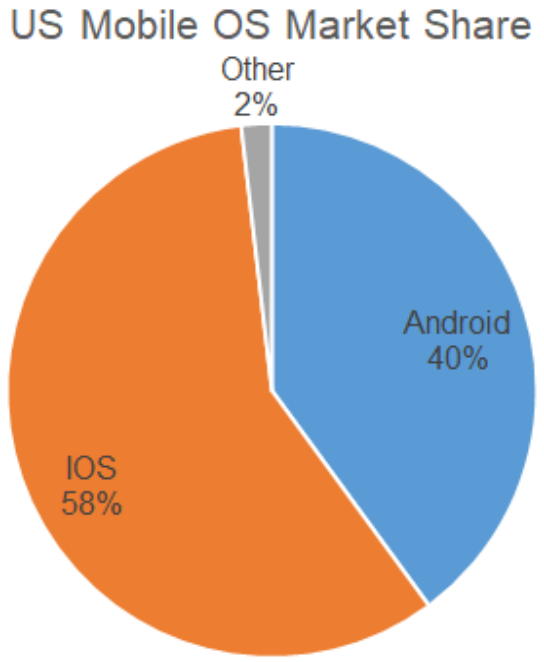


(Wikimedia Commons, 2019)

Mobile Operating Systems

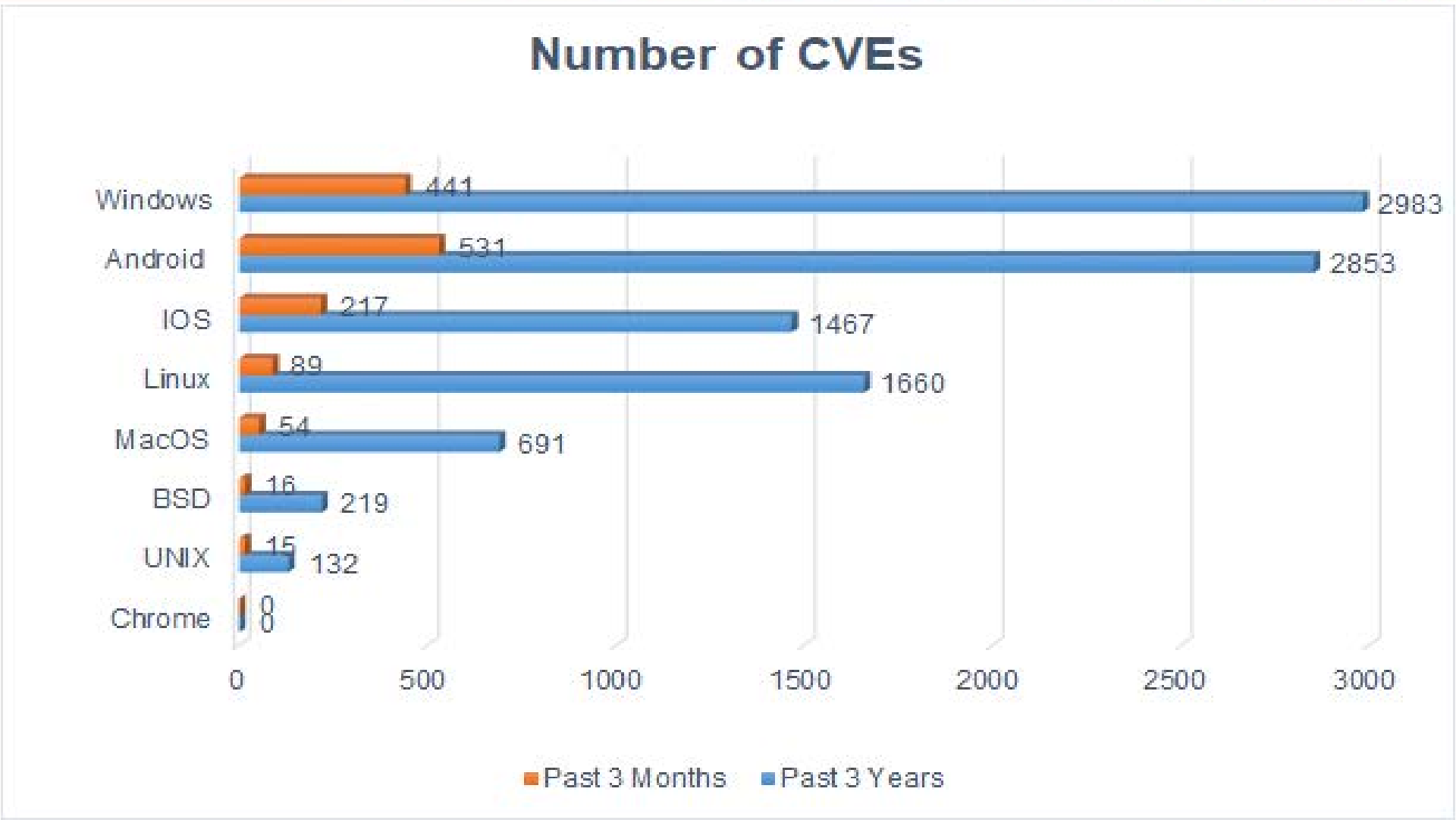
Android	IOS
• Established in 2008 • Google and the Open Handset Alliance • Open source • Based on the Linux kernel	• Established in 2007 • Apple • Proprietary • Based on Apple's Darwin, a Unix and BSD variant



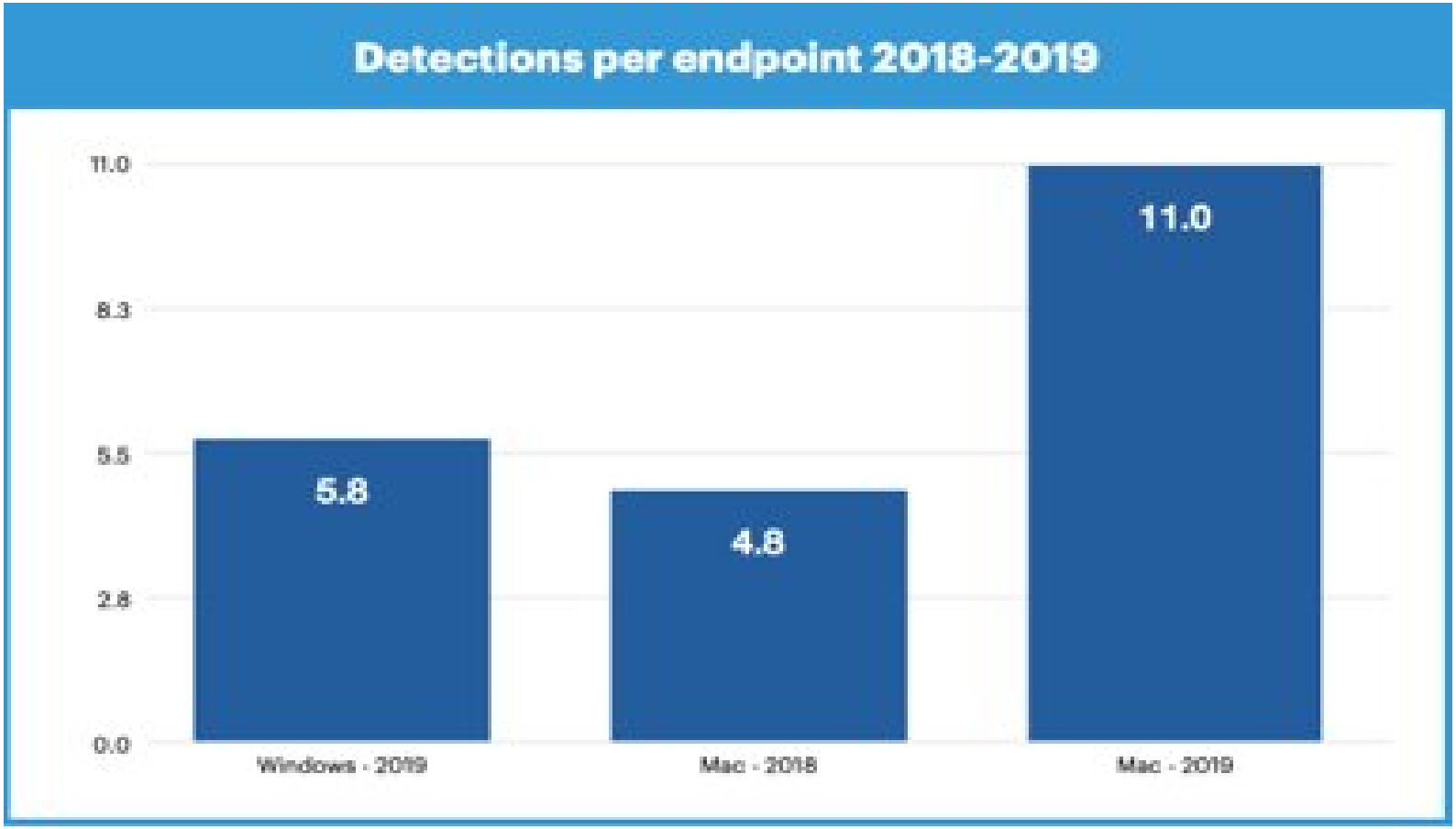


(Statcounter GlobalStats, 2020)

Linux/Unix-based OS Common Vulnerabilities and Exposures (CVE) Exceed Windows

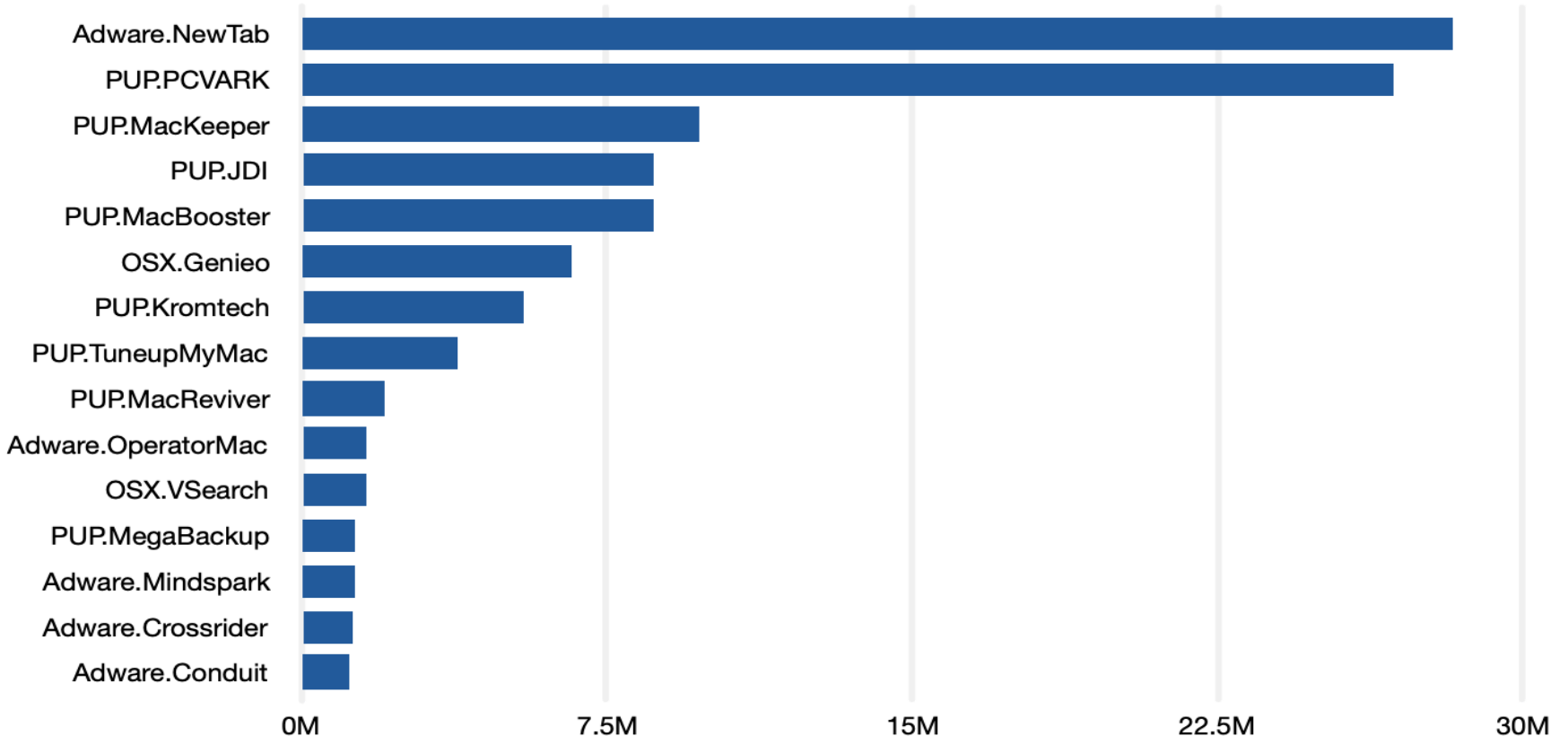


(National Institute of Standards and Technology, 2020)



Malwarebytes 2020

Top Mac detections 2019



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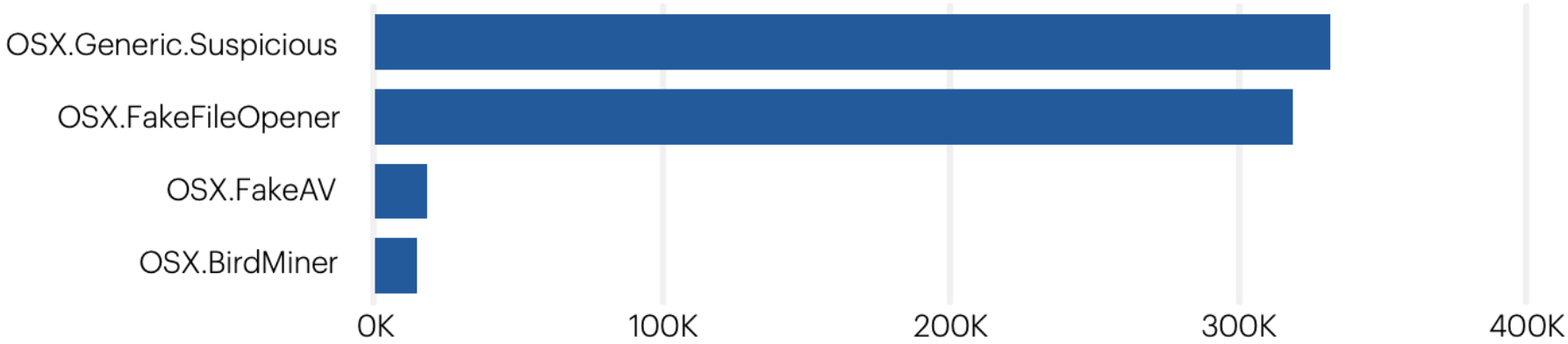

Malwarebytes 2020

iOS

- Nation-state malware, such as NSO Group's Pegasus spyware
- Zero-day vulnerability: Checkm8

Malware Case Study: Hidden Wasp

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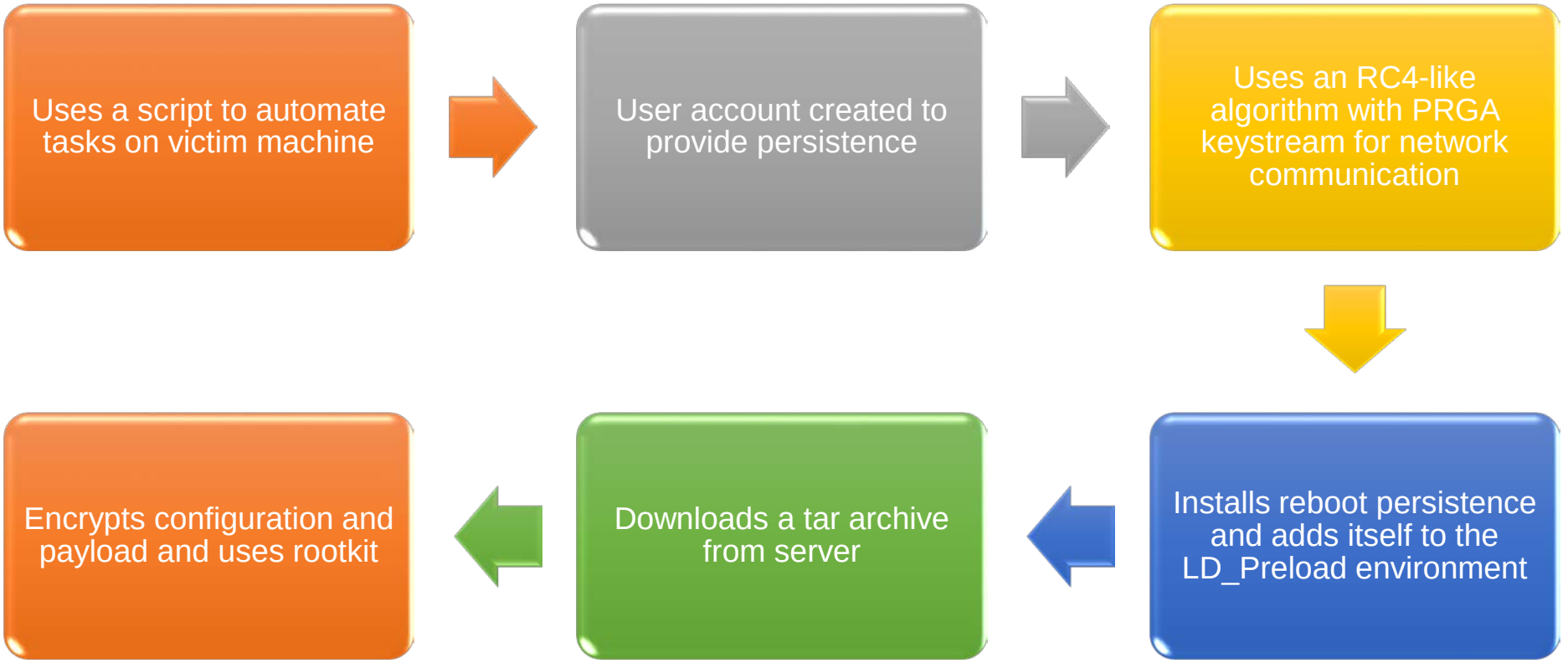
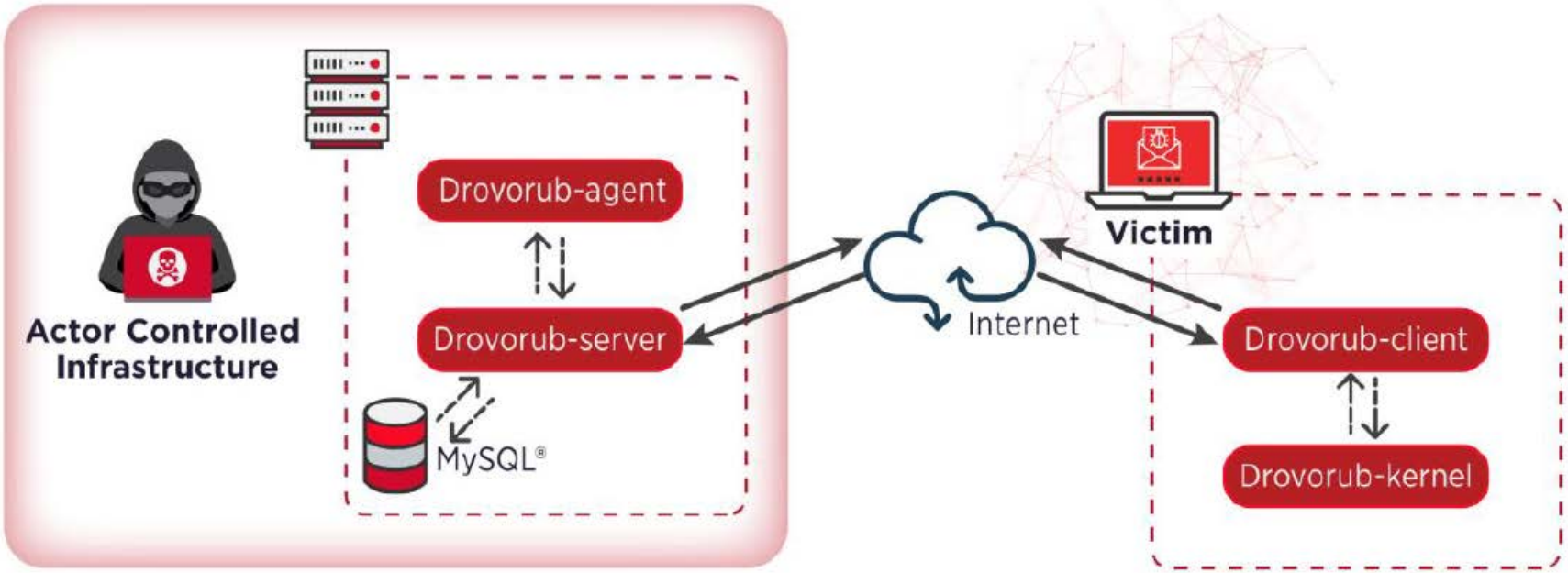


Malware Case Study: Drovorub

- Linux malware attributed to Russian military group APT28
- Requires the attackers to gain root privileges using another vulnerability before successful installation
- Consists of an implant, rootkit, C&C server and a file transfer and port forwarding tool
- Persists through a reboot of an infected machine

Malware Case Study: Drovorub



National Security Agency 2020

Malware Case Study: Operation Windigo

- Windigo Suite (Ebury, Cdorked, Onimiki and Perl/Calfbot):
  - Disable direct root login in your OpenSSH daemon
  - Disable password-based logins and use an SSH key
  - Use multi-factor authentication on your servers
  - Use SSH agent forwarding from server to server instead of copying your SSH private keys on servers
    - On GNU/Linux, use SSH-agent
    - GNOME Keyring with ForwardAgent under a trusted host entry in your .ssh/config file6
    - On Windows, PuTTY's Pageant supports SSH agent forwarding
- Use an up-to-date antivirus solution

Recommendations and Mitigations

- Apply system updates to:
  - Operating system
  - Programs
  - All browsers
- Properly configure network detection and prevention systems/devices/firewalls/proxies
- Prevent untrusted kernel modules and load only modules with a valid digital signature
- Utilize a combination of system-hardening techniques and network-based controls
- Update Mac cybersecurity or anti-malware program from a reputable vendor
- Common tools such as rkhunter and chrootkit may be used to detect Linux rootkits
- Application control and software restrictions tools such as SELinux, KSPP, grsecurity MODHARDEN, and Linux kernel-tuning can aid in restricting kernel module loading
- Limit access to the root account and prevent users from loading kernel modules and extensions through proper separation
- Limit privilege escalation opportunities
- Restrict web-based content

- Restrict PowerShell execution policy to administrators
- Block Command-and-Control IP addresses
- Use multifactor authentication for user and privileged accounts
- Limit the use of local administrator accounts
- SSL/TSL inspections to see the contents of encrypted sessions and look for network-based indicators
- Restrict file and directory permissions
- Do not allow loading of remote DLLs and enable Safe DLL Search Mode
- Ensure proper registry permissions are set

Summary

- Unix and Unix-like systems drive most of today's computer systems
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- Threat mitigation
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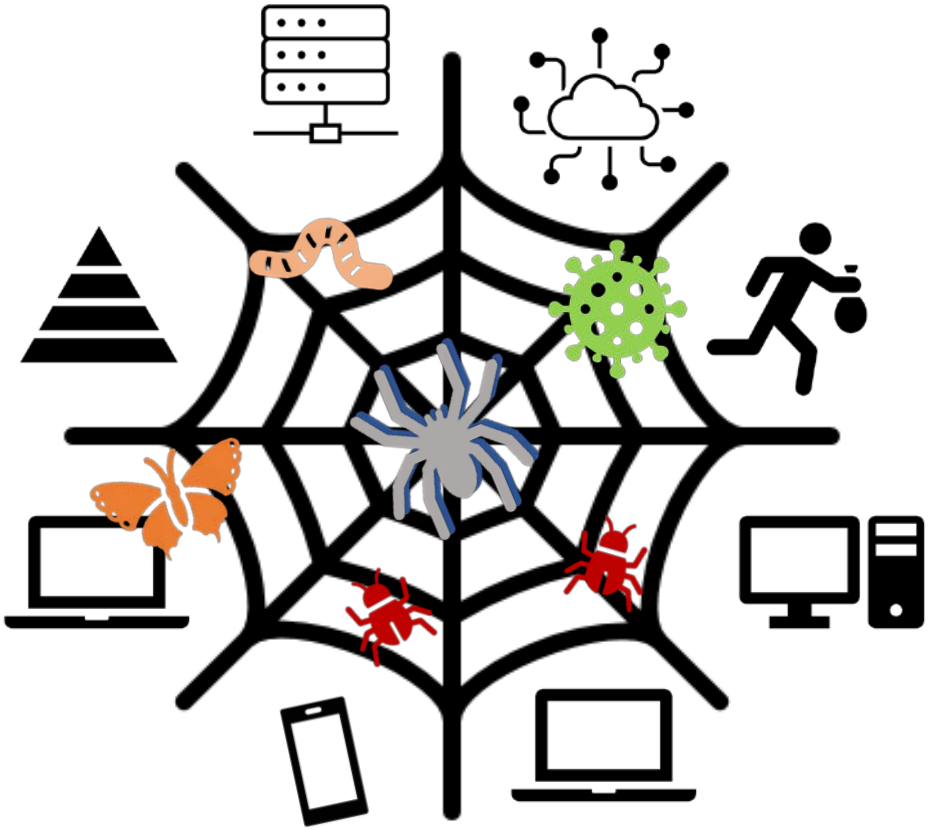

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