Patch Management

How to roll out and track security fixes to your systems

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WP8-T1

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What we will cover today

- Process
  - NIST SP 800-40r3 “Guide to Enterprise Patch Management Technologies”
  - NIST SP 800-40 version 2 “Creating a Patch and Vulnerability Management Program”
- Tools
  - Linux: zypper, yum, apt
  - Windows: SUMo, PatchMyPC

Tasks

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Definition

- Patch: *“is an additional piece of code developed to address problems (commonly called ‘bugs’) in software.”* (NIST SP 800-40r2)
- Variants/other names
  - Hotfix
  - Point release
  - Program temporary fix (PTF)
  - Security patch
  - Service Pack
  - Unofficial patch
  - Monkey patch

Patch Management

- Patch Management is the process for
  - **identifying**
  - **acquiring**
  - **installing**, and
  - **verifying**
- patches for products and systems (NIST SP 800-40r3)

Identification

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Identifying

- Systems that have Software running that needs to be patched
  - From inventory/asset management
  - From network scanning
  - From passive discovery
- Software, that has vulnerabilities or is misconfigured
  - Installation database on systems
  - Local scanning of process lists, file systems
- Vulnerabilities, that have impacts
  - Vulnerability databases, security advisories, etc.
- Patches/Remediations, available for vulnerabilities
  - Security advisories, vendor update channels, …

Linux Version

- File: **/etc/os-release**
  - Machine readable: **CPE_NAME**
  - Human readable: **PRETTY_NAME**

```
PRETTY_NAME="Kali GNU/Linux Rolling"
NAME="Kali GNU/Linux"
ID=kali
VERSION="2021.2"
VERSION_ID="2021.2"
VERSION_CODENAME="kali-rolling"
ID_LIKE=debian
ANSI_COLOR="1;31"
HOME_URL="https://www.kali.org/"
SUPPORT_URL="https://forums.kali.org/"
BUG_REPORT_URL="https://bugs.kali.org/"
```

```
NAME="CentOS Linux"
VERSION="7 (Core)"
ID="centos"
ID_LIKE="rhel fedora"
VERSION_ID="7"
PRETTY_NAME="CentOS Linux 7 (Core)"
ANSI_COLOR="0;31"
CPE_NAME="cpe:/o:centos:centos:7"
HOME_URL="https://www.centos.org/"
BUG_REPORT_URL="https://bugs.centos.org/"
CENTOS_MANTISBT_PROJECT="CentOS-7"
CENTOS_MANTISBT_PROJECT_VERSION="7"
REDHAT_SUPPORT_PRODUCT="centos"
REDHAT_SUPPORT_PRODUCT_VERSION="7"
```

```
NAME="openSUSE Leap"
VERSION="15.2"
ID="opensuse-leap"
ID_LIKE="suse opensuse"
VERSION_ID="15.2"
PRETTY_NAME="openSUSE Leap 15.2"
ANSI_COLOR="0;32"
CPE_NAME="cpe:/o:opensuse:leap:15.2"
BUG_REPORT_URL="https://bugs.opensuse.org"
HOME_URL="https://www.opensuse.org/"
```

Installed Software on Linux

- Installed Software:
  - **`rpm -qa`** **#** RedHat, Fedora, CentOS, SuSE, …
    - Berkeley DB files in **`/var/lib/rpm/`**
  - **`dpkg -l`** **#** Debian, Ubuntu, Kali,
    - ASCII files in **`/var/lib/dpkg/`**

```
> rpm -qa
texlive-texdef-bin-2017.20170520.svn21802-lp152.15.2.x86_64
graphviz-gnome-2.40.1-lp152.7.10.1.x86_64
texlive-lapdf-doc-2017.133.1.1svn23806-lp152.7.2.noarch
libQt5Sql5-5.12.7-lp152.3.16.1.x86_64
kdoctools-5.71.0-lp152.1.1.x86_64
texlive-zlmtt-doc-2017.133.1.01svn34485-lp152.7.2.noarch
texlive-natbib-2017.133.8.31bsvn20668-lp152.7.2.noarch
…
```

```
$ dpkg -l
Desired=Unknown/Install/Remove/Purge/Hold
| Status=Not/Inst/Conf-files/Unpacked/halF-conf/Half-inst/trig-aWait/Trig-pend
|/ Err?=(none)/Reinst-required (Status,Err: uppercase=bad)
||/ Name               Version              Architecture Description
+++-==================-====================-============-============
ii  0trace             0.01-3kali2          amd64        traceroute tool that can run with…
ii  aapt               1:10.0.0+r36-3       amd64        Android Asset Packaging Tool
ii  accountsservice    0.6.55-3             amd64        query and manipulate user account …
ii  acl                2.2.53-10            amd64        access control list - utilities
ii  adduser            3.118                all          add and remove users and groups
…
```

Linux: Pending Patches/Updates

- List pending patches/updates
  - **`zypper list-patches`** # openSuse & derivates
  - **`yum updateinfo`** # RedHat & derivates (Fedora, CentOS, …)
  - **`apt list --upgradable`** # Debian & derivates

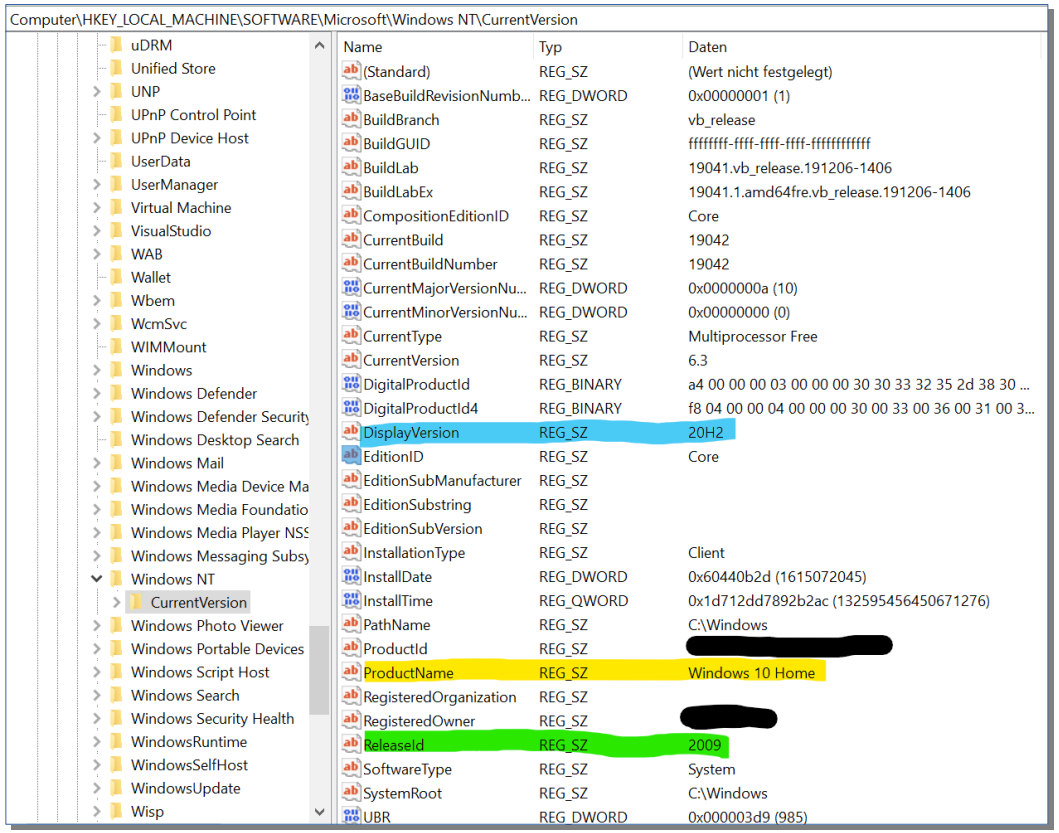
```
> zypper list-patches --issue

The following matches in issue numbers have been found:

Issue    | No.             | Patch              | Category    | Severity  | Interactive | Status    | Summary
---------+-----------------+--------------------+-------------+-----------+-------------+-----------+-----------------------------------
bugzilla | 1170160         | openSUSE-2021-463  | recommended | low       | ---         | needed    | Recommended update for hwdata
bugzilla | 1182482         | openSUSE-2021-463  | recommended | low       | ---         | needed    | Recommended update for hwdata
bugzilla | 1172442         | openSUSE-2021-468  | security    | important | ---         | needed    | Security update for nghttp2
bugzilla | 1181358         | openSUSE-2021-468  | security    | important | ---         | needed    | Security update for nghttp2
cve      | CVE-2020-11080  | openSUSE-2021-468  | security    | important | ---         | needed    | Security update for nghttp2
bugzilla | 1180597         | openSUSE-2021-506  | recommended | moderate  | restart     | needed    | Recommended update for PackageKit
cve      | CVE-2021-29155  | openSUSE-2021-716  | security    | important | reboot      | needed    | Security update for the Linux Kernel
cve      | CVE-2021-29650  | openSUSE-2021-716  | security    | important | reboot      | needed    | Security update for the Linux Kernel
bugzilla | 1183797         | openSUSE-2021-744  | optional    | low       | ---         | optional  | Optional update for sed
…
```

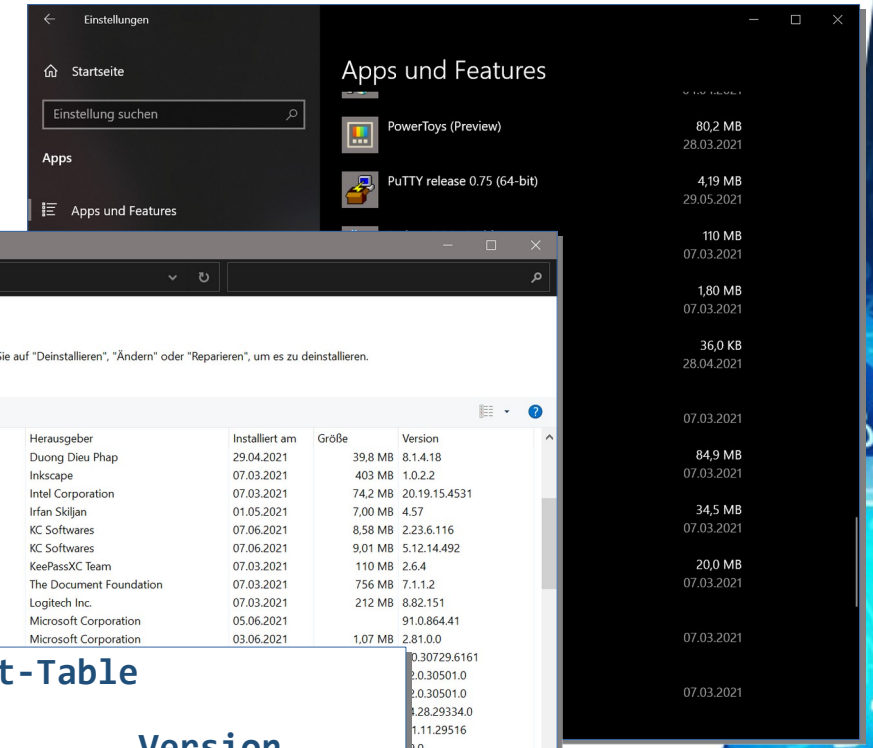
Windows Version

- Workstation & Server
  - (NT 4, 2000, … , 10)
- Keys
  - **DisplayVersion**
  - **ProductName**
  - **ReleaseID**
- Scripting
  - CLI
    - **reg**
  - PowerShell (WMI)
    - **(Get-CimInstance Win32_OperatingSystem)**
    - **Get-ComputerInfo** (PS ≥ version 5)



Installed Software on Windows

- Two GUIs
  - Windows 10: Settings → Apps → Apps and Features
  - System → Programs → Programs & Features



- Scripting
  - PowerShell

```
PS > get-WmiObject -Class Win32_product | Select Name, … | Format-Table

Name                                    Vendor                          Version
----                                    ------                          -------
Python 3.9.2 Add to Path (64-bit)       Python Software Foundation      3.9.2150.0
Python 3.9.2 Utility Scripts (64-bit)   Python Software Foundation      3.9.2150.0
Python 3.9.2 Core Interpreter (64-bit)  Python Software Foundation      3.9.2150.0
KeePassXC                               KeePassXC Team                  2.6.4
…
```

Acquisition

Acquiring Patches: Sources

- Vendor update server
  - Directly from the source without delay
  - Saves effort for deploying and maintaining local infrastructure
- Local (own) update server
  - Less traffic on the uplink
  - A means to include your own patches
  - Works when internet is down
  - Nobody can see what is actually being deployed/patched
  - More work, however
- Manually deploying patch media?
  - Do you have air-gapped systems?
  - You will, after a major breakdown!
  - What about applying patches to installation media (slipstreaming)?

Acquiring Patches: Tools

- Microsoft
  - System Management Server (SMS)
    - Systems Management Server Inventory Tool (ITMU) for Microsoft Update
    - System Center Configuration Manager (SCCM)
  - Windows Server Update Services (WSUS)
- Linux
  - Mirroring vendor repositories
    - RedHat: **`reposync`** + HTTP server
    - Debian: **`apt-mirror`** + HTTP server
    - SuSE: **`rsync`** + HTTP server
  - Linux vendor tools: RedHat Satellite, etc.
- Configure (all) local systems to use local update server

Installation

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Installation

- How is the installation done?
  - Typically not a big deal, unless you have to compile it yourself
- Who does it?
  - What about systems nobody is responsible for
- Side effects
  - Interrupts/Downtime
    - What about hypervisors, container hosts?
- What if something breaks?
  - Best practice: Take filesystem snapshot to rollback if something goes wrong
    - Sometimes done automatically (Windows Update, SuSE YaST/snapper)

Snapshot Tools

- Linux: **snapper**
  - Requires snapshot-capable filesystem (BTRFS, …), or volume snapshots (LVM)

```
> snapper list
   #  | Type   | Pre # | Date                     | User | Cleanup  | Description          | Userdata
------+--------+-------+--------------------------+------+----------+----------------------+--------------
  0   | single |       |                          | root |          | current              |
1647  | pre    |       | Mon May 17 08:42:08 2021 | root | number   | zypp(zypper)         | important=yes
1648  | post   |  1647 | Mon May 17 08:45:18 2021 | root | number   |                      | important=yes
1649  | single |       | Mon May 17 09:00:03 2021 | root | timeline | timeline             |
1674  | pre    |       | Thu May 20 09:20:07 2021 | root | number   | zypp(zypper)         | important=no
1675  | post   |  1674 | Thu May 20 09:20:24 2021 | root | number   |                      | important=no
1691  | pre    |       | Tue May 25 09:52:26 2021 | root | number   | zypp(zypper)         | important=no
1692  | post   |  1691 | Tue May 25 09:55:23 2021 | root | number   |                      | important=no
1693  | single |       | Tue May 25 10:00:07 2021 | root | timeline | timeline             |
…
```

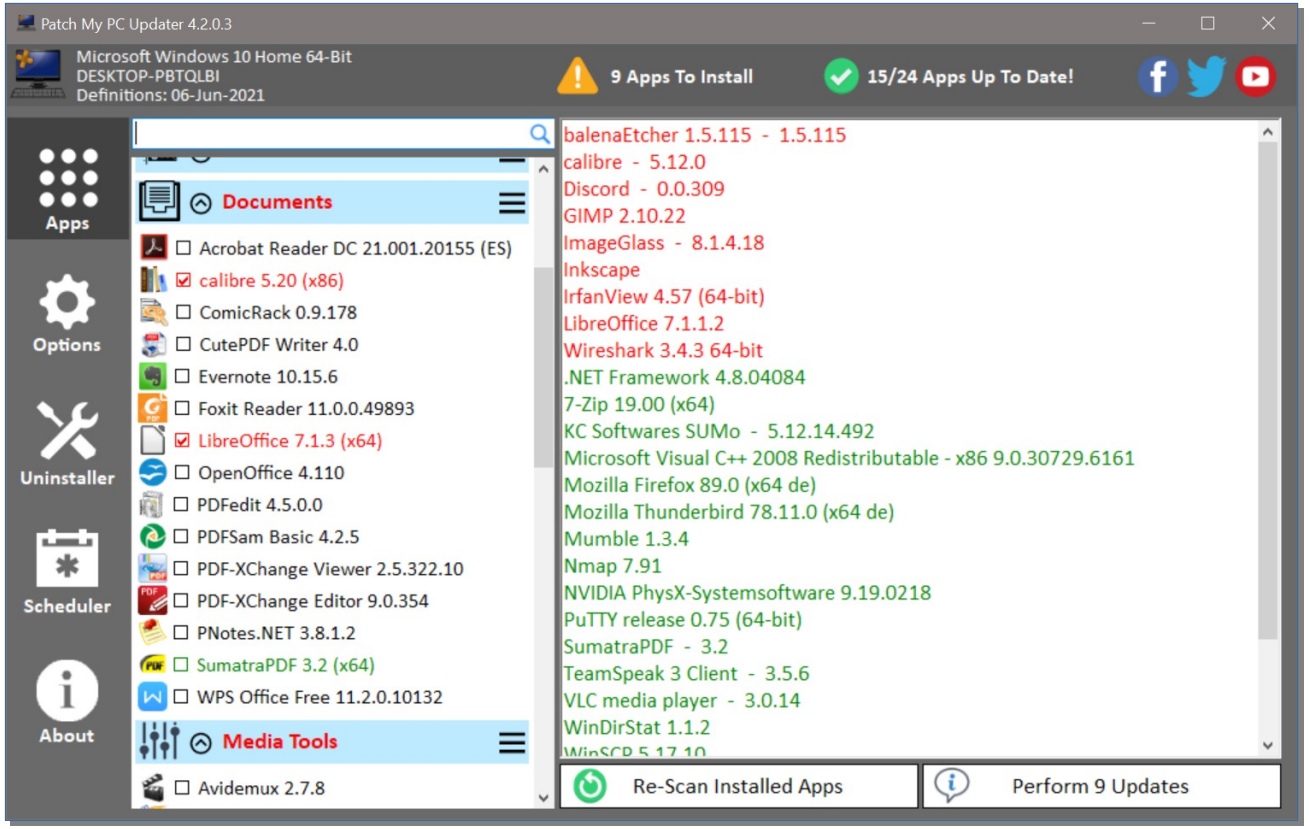
- Windows Volume Shadow Copy Service: **VSSVC.exe**
  - Requires NTFS filesystem
  - Must be enabled/configured first

Update Mechanisms

- Software automatically updates itself
  - Browsers (Chrome), Mail Clients (Thunderbird), etc.
- OS management tool initiates patching
  - Windows Update, Linux PackageKit, …
- User manually directs software to update itself
  - Sometimes by being notified by the software
- Third-party patch management application initiates patching
  - ManageEngine Patch Manager Plus, Atera, Syxsense, OPSI, …
- Other tool initiates patching
  - Network access control, health check technologies, etc.
- Patch or new version is installed manually

3rd Party Tools: Patch My PC

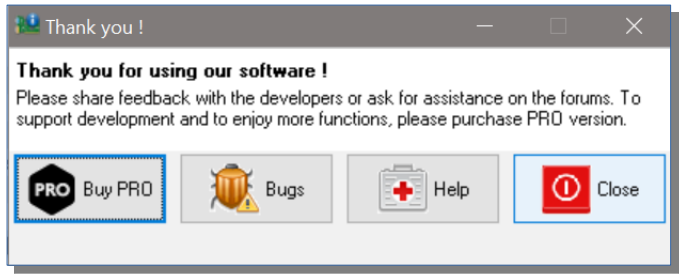
- Freeware: Patch My PC Home Updater
  - Full list of supported 3rd party software directly visible

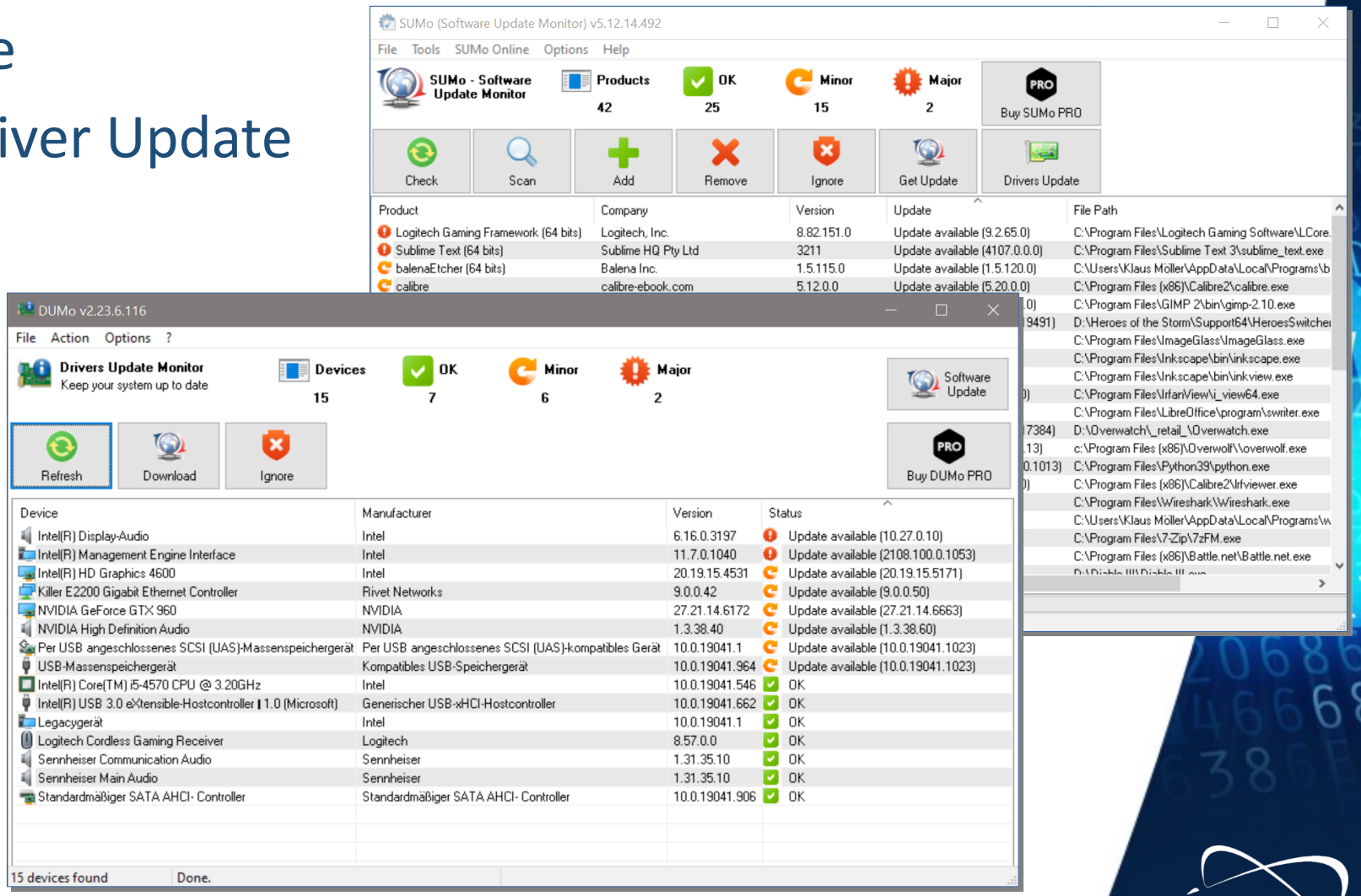


3rd Party Tools: Software Update Monitor (SUMo)

- Freeware: SUMo lite
- Companion tool: Driver Update Monitor (DUMo)

☹ Nag screen/icons





Challenges

- Timing (after the vulnerability is published, exploits happen)
  - When will the patch be released?
    - Risk of exploitation increases as time passes
    - Vendors follow their own schedule - sometimes weeks or months until patch is published
  - What to do in the meantime?
    - Workarounds, hotfixes, disabling services, etc.
- Prioritisation
  - Which patches to install when and where?
  - Side effects of patches
  - Time & resources for testing of patches
- Multiple Update Mechanisms
  - Blacklisting of patches becomes a challenge
  - Assuming that some other tool/admin might already be doing the update

Verification

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Verifying

- Why?
  - Things may break during patching: power outage, shutdown, connection loss, etc.
  - Rollback of partly-applied patches?
- Even if the patch was successful, did it fix the vulnerability?
  - Does the system need to reboot? (Kernel patches, system libraries, …)
  - Does the service need to restart?
  - What if we see further exploits happening?
- What else could be affected?
  - Performance, memory consumption, disk space
  - Incompatibilities, configuration changes
  - Patch itself might be broken, etc.

Verification: Linux

- List installed (security) patches
  - **`zypper patches | grep 'security.*applied' #`** openSuse, …
  - **`yum updateinfo list security installed #`** RedHat, …
  - **`zgrep CVE /usr/share/doc/*/changelog.Debian.gz #`** Debian, …
  - Or package installer history files: **`/var/log/apt/, /var/log/zypp/, /var/log/yum.log`**
  - **`pakiti`** # Network-wide

```
> zypper patches| grep 'security.*applied'

Repository              | Name                | Category    | Severity  | Interactive | Status     | Summary
------------------------+---------------------+-------------+-----------+-------------+------------+-----------------------------------
Main Update Repository  | openSUSE-2021-435   | security    | moderate  | ---         | applied    | Security update for python
Main Update Repository  | openSUSE-2021-443   | security    | moderate  | ---         | applied    | Security update for privoxy
Main Update Repository  | openSUSE-2021-59    | security    | moderate  | restart     | applied    | Security update for libzypp, zypper
Main Update Repository  | openSUSE-2021-6     | security    | moderate  | ---         | applied    | Security update for privoxy
Main Update Repository  | openSUSE-2021-60    | security    | important | reboot      | applied    | Security update for the Linux Kernel
Main Update Repository  | openSUSE-2021-89    | security    | important | ---         | applied    | Security update for open-iscsi
…
```

Verification: Linux (cont.)

- Verifying installed software

Debian, Ubuntu, Kali, etc.

```
# dpkg -V
??5?????? c /etc/vpnc/default.conf
??5?????? c
/etc/king-phisher/server_config.yml
??5?????? c /etc/snmp/snmpd.conf
??5?????? c /etc/redis/redis-openvas.conf
??5?????? c /etc/redis/redis.conf
??5?????? c /etc/ipsec.secrets
??5?????? c /etc/sudoers.d/kali-grant-root
??5?????? c /etc/openfortivpn/config
??5?????? c /etc/sudoers
…
```

File, content (checksum) only

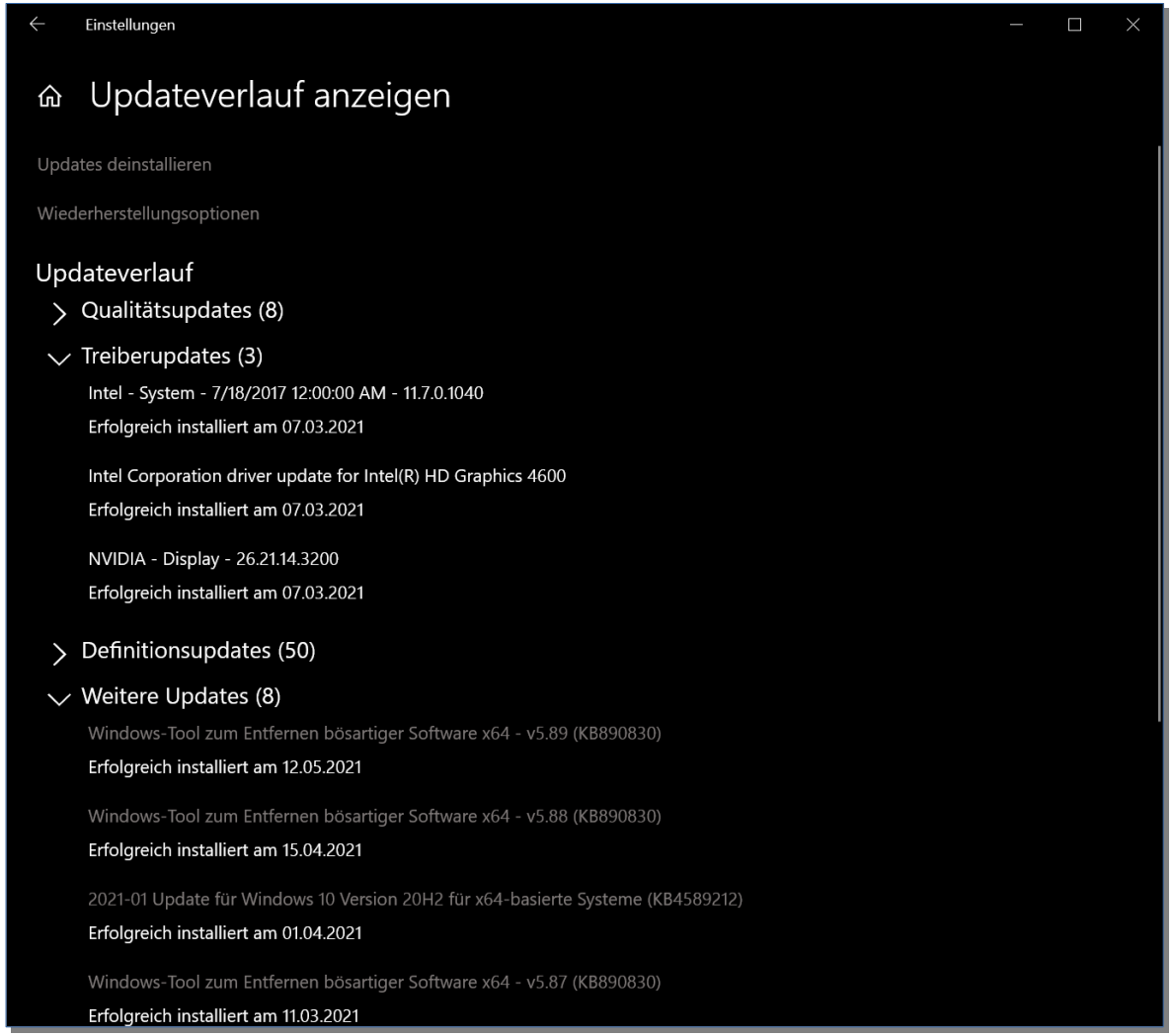
RedHat, Fedora, CentOS, SuSE, etc.

```
# rpm -Va
S.5....T.  c /etc/default/useradd
.......T.  c /etc/login.defs
.M...UG..  g /run/knot
.M.......  g /run/cryptsetup
S.5....T.  c /etc/clamd.conf
S.5....T.  c /etc/freshclam.conf
.M.......  g /var/log/alternatives.log
…
```

- File size
- File content (checksum)
- File permissions
- File ownership (user/group)
- File modification times

Verification: Windows

- Windows Update
  - Update history



Wrapping Up

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Testing Patches

- A broken patch can disrupt operations
  - If many or vital systems are affected
  - Personnel has to be assigned to do emergency clean-up
- So test all patches first?
  - Resources too limited for that
  - Availability of separate hardware for testing (non-production)
  - Takes time during which the risk increases further
- Alternatives
  - Test only for vital systems/services
  - Apply patches in smaller batches and look for things that go wrong
    - So you might stop the patch before being deployed to all systems

Patch Policy

- Develop one for your organisation
  - ISO 27001, GDPR require patch management
- Yes, takes time and effort, but
  - Issues get on the table - and are resolved, hopefully
  - Buy-in from management
    - Nobody should be fired for adhering to agreed-upon policies
  - Managing expectations
  - Everybody knows what to do
- Write down what you are doing already
  - So you have a starting point for discussion
  - What would you like to improve?

What have you learned?

- Patching my look easy (turn on auto-updates and you're done)
- But it becomes challenging when done organisation-wide
  - Keeping track of open vulnerabilities
  - Keeping track of already applied patches
  - How to deal with different kind of systems, different management, etc.
  - Patching can affect the stability of systems or service provision
- Develop a patch management policy

Thank you

Any questions?

Next Module: ***Local Vulnerability Scanning***

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References:

- US NIST SP 800-40 version 2: “Creating a Patch and Vulnerability Management Program”, https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-40ver2.pdf
- US NIST SP 800-40r3: “Guide to Enterprise Patch Management Technologies”, https://csrc.nist.gov/publications/detail/sp/800-40/rev-3/final
- Pakiti: https://github.com/CESNET/pakiti-server?
- SUMo/DUMo: https://kcsoftwares.com/?sumo, https://kcsoftwares.com/?dumo
- Patch My PC Home Updater: https://patchmypc.com/home-updater
- RedHat mirror: https://access.redhat.com/solutions/23016
- Debian/Ubuntu mirror: https://www.howtoforge.com/local_debian_ubuntu_mirror
- OpenSuse mirror: https://en.opensuse.org/openSUSE:Mirror_infrastructure