Digital Forensics using Linux and Open Source Tools

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Overview/Goals of Seminar

Provide a high level overview of forensic and investigative tools available for Linux

Present advantages and disadvantages
  - Show advantages for teaching, learning and research
  - Show advantages for Corporate and Law Enforcement forensic labs
  - Outline the disadvantages of Linux & OSS

Target audience both forensics techies and forensics managers
Unix, Linux and Open Source Software

OSS Licensing and Freedoms
- designed to protect the user, not the vendor
- freedom to modify, use, distribute
- freedom to learn, understand, and improve
  [GPL, LGPL, BSD License, GNU, FSF]

Unix Philosophy
- book: "The UNIX Philosophy"
- many small tools which do one job very well
- piping, redirecting
- scripting, automating
  [shell, tee, >> | << & > <]
The Linux Environment

What exactly is Linux?
"Linux" is just an OS kernel
the rest is additional Open Source Software
together they are a "Linux Distribution"
[Knoppix, Ubuntu, Redhat, Novell/SuSe]

Large choice of GUI and/or commandline environments
most popular are KDE and Gnome
Unix-like, Mac-like, MSWindows-like, NeXT-like
advanced shell environments
web front-ends, GUI front-ends
[KDE, Gnome, Windowmaker, bash, zsh, emacs, mc]
The Linux Environment (cont.)

Forensic boot CDs
- fully installed Linux environment on bootable CD or DVD
- non-mount booting
- large pre-installed forensic toolset
- Knoppix based

Most up to date (at the moment)
- FCCU GNU/Linux Forensic Boot CD (Belgian Federal Computer Crime Unit)
- Helix (US e-fense Inc.)

Full installation:
- learning Linux -> Ubuntu, doing forensics -> Debian
- must strip down automount services
Imaging and Evidence Acquisition

Wide range of supported technologies and media
ATA, SATA, SCSI, USB, Firewire
CD, DVD, USB sticks, tapes, floppies, etc

Forensically sound acquisition
typically any sector-based storage medium accessible as a device can be safely imaged
can acquire an image without mounting drive
hardware write-blocker not needed for unmounted devices
support for handling errors, bad blocks
[dd, dcfldd, dd_rescue, sdd, AIR, sleuthkit, adepto, grab]
Imaging and Evidence Acquisition (cont.)

Image handling (with piping, redirection, file desc.)
- compression - possible to acquire devices which are larger than the size of the investigator workstation
- splitting - possible to acquire an image in usable chunks
- secure imaging - possible to encrypt, sign, and hash while imaging
  - [gzip, openssl, dcf1dd, gnupgp, split, md5sum]

Embedded and other small devices
- toolkits for accessing many embedded devices (but often not in the same way as disks)
- PDAs, iPods, digital cameras, cellphones, smartcards
  - [pilot-link, gnupod, gnokii, opensc]
Imaging and Evidence Acquisition (cont.)

Evidence file formats

- currently raw images such as dd are the open standard
- Simpson Garfinkel has recently developed the Advanced Forensic Format (AFF), as an open source equivalent of the Encase .E0* files.

[dd,afflib]
Managing Acquired Data/Evidence

Preservation
- cryptographic hashing (MD5, SHA-1)
- investigator signing (pgp/gpg, smime)
- timestamping/TSA (RFC 3161)
  [md5sum, openssl, dcfldd, gnupg, openTSA]

Packaging
- archive multiple files/directories
- vendor-independent format
- compressed, possibly encrypted
  [tar, zip, gzip, bzip, openssl, gnupg]
Managing Acquired Data/Evidence (cont.)

Storage
  long-term storage of evidence data
  different storage media supported (CD, DVD, Tape)
  backup systems
  [dump, tar, amanda, cdrecord]

Transfer
  secure transfer of data/evidence
  inter-divisional, inter-organizational
  encrypted and authenticated
  [scp, apache-ssl, smime, pgp]
Recovery/Normalization

Partitions
   deleted partition detection, restoration
   [gpart, disktype, testdisk, hexedit --sector]

Files/filesystems
   deleted file recovery (many fs supported)
   slackspace recovery
   data carving
   [gpart, sleuthkit, formost, fatback, e2salvage, formost, disktype, testdisk, scrounge-ntfs, scapel, magicrescue]
Recovery/Normalization (cont.)

Cryptographically protected/hidden data
- password recovery
- steganography detection
  - [fcrackzip, crack, lcrack, nasty, john the ripper, stegdetect, stegbreak, cmospwd, pwl, madussa]
Analysis

Searching/filtering
   known-good, contraband files, NSRL/Hash databases
   support for powerful regular-expressions
   antivirus and rootkit searches
   [clamAV, F-PROT, chkrootkit, grep, autopsy, find, swish-e,
   glimpse, ftimes, md5deep, hashdig]

International language support, Unicode

Timelining/correlation/sorting
   Sleuthkit produces excellent filesystem timelines
   [pyflag, autopsy, zeitline, sleuthkit]
Analysis (cont.)

Converters, editors, data dumping

- wide variety of hexeditors
- email analysis, attachments
- many data and log file analysis tools (cookie files, browser cache, history, etc.)
  
  [ghex, khex, hexedit, openssl, uuencode, mimedecode, hexdump, od, strings, antiword]

Document/Image viewers and multimedia players

- wide range of tools for current and obsolete documents
- scriptable thumbnail, image manipulation support
- configurable video playback, variety of formats
  
  [openoffice, gv, xv, imagemagic, mplayer, vlc]
Mounting and Booting Suspect Images

Loopback mounting acquired images in a read-only manner
useful for browsing/searching
Wide range of filesystem support (apple, microsoft, various unix)
[mount, losetup]

Virtually booting an image on a Linux PC
booting a Macintosh image (MacOS9, OSX)
booting Windows images
Any other X86 OS image (Linux)
[pearpc, VMWare]
Simulators for Running Programs

Dos/Windows simulation
Mac simulation
Palm simulation
HP48
Various unix binary support
[dosemu, wine, VMWare, pose, x48, linux-abi]
Support for Analyzing Legacy Technologies

Home computers from the 80s and early 90s
- Sinclair ZX Spectrum, ZX81 [zx, fuse, x81]
- Apple IIGS, early Mac [xgs, prodosemu, vMac, basiliskII]
- Commodore C64, C128, VIC20, PET, and CBM-II [vice, frodo]
- Amiga [uae, hatari, e-uae]
- AtartiST, Atari 800 [stonx, atari800]

Mainframes and minis
- IBM System/370, ESA/390 [hercules]
- Dec PDP- series, Nova, and IBM 1401 [sim, klh10]

Other legacy operating system support
- MS-DOS [doscmd, dosbox, dosemu]
- CPM [cpm]
Case Management, Bookmarking, Reporting

Auto generated pdf reports possible to a certain degree
Integrated bookmarking support is difficult, too many separate tools
Integrated reporting is also difficult when using multiple tools.
Case management is often rudimentary (file/directory based)
[pyFlag, autopsy, sleuthkit, Latex, pdf tools]
Microsoft Specific Tools

MS System tools
  Tools for viewing the registry
  Tools for the event viewer
  Analysis of INFO2 and Recycle bin
cab files, OLE properties
  [ntreg, kregedit, regviewer, grokevt, rifiuti, orange, fccudocprop, ]

Outlook and IE tools
  converting MS Outlook .pst files to plain text
  analyzing cache files and cookies
  [libpst, readpst, pasco, galleta]
Other Forensic Areas (very brief)

Network Forensics
  packet capturing tools
  [tcpdump, etherreal, tcpflow, ssldump, tcptrace, ngrep, driftnet]
  basic tools for Internet investigations
  [nslookup, dig, whois, traceroute]
  various other troubleshooting tools
Other Forensic Areas (very brief)

Live system Forensics
  memory examination
  state of system and configuration
  logs
  host-based intrusion detection systems
  [ps, netstat, ifconfig, lsof, memdump, tripwire]
Other Forensic Areas (very brief)

Software Forensics
   emulators/simulators
   debuggers
   dissassemblers
   reverse-engineering tools
   [gdb, strace, coreography, fenris, truss and dtrace (Solaris)]
Non-forensic Tools for Forensics

Non-forensic tools are often useful
- trouble shooting and debugging tools
- conversion and data migration tools
- repair tools
- log processing, statistics/trend tools

Getting additional data from existing tools
- many programs have additional verbose or debugging flags
- can be configured to do additional logging
Resources for Linux tools

e-evidence.info
opensourceforensics.org
linux-forensics.com
freshmeat.net
sourceforge.net
Disadvantages of Linux in Forensics Labs

Requires some retraining
  it takes time and effort to learn Unix/Linux
  command line is not as intuitive as an all-GUI environment

Support model is different
  often no formal support organization (however, the informal support is sometimes superior)
  support queries are often direct to the community at large, and the quality of the answers varies greatly
Disadvantages of Linux in forensics labs (cont.)

Interoperating with proprietary technology is hard
  proprietary technologies are reverse engineered, not licensed
  sometimes this takes time to implement
  maybe not be a complete implementation

Volunteer development effort
  software maybe in perpetual state of development
  maybe abandoned, dead projects
  "rough around the edges"
  in some cases poorly documented (the source code might be
  the only documentation)
Advantages of Linux/OSS in forensics labs

Software availability and accessibility
  software is freely available on the Internet
  source code is provided
  tools can be closely scrutinized for correctness

Efficiency
  allows for much automation and scripting
  helpful in labs with high volumes of casework

Optimizing and Customizing
  since the source can be freely modified, software can be modified to fit the requirements of a particular lab
Advantages of Linux in Forensics Labs (cont.)

Support
  ad-hoc community support can be excellent
  mailing lists can answer calls for help within minutes
  often quick implementation of patch and feature requests.

Linux/OSS is ideal for an academic/lab settings
  it uses open, published standards, not closed or proprietary
  vendor-neutral
  strives to work together with competing groups, not against them
  building on previous work is encouraged
  interoperable/compatible across technologies, organizations, and over time
Summary

Over 100 open source tools have been listed here which can be used to perform forensic and investigative work. This list is not exhaustive and many more exist, or are in development.

Using Linux for corporate or law enforcement labs is viable. A complete range of functionality exists to deal with typical laboratory casework.

The open, published, and free nature of open source tools lends itself well to the academic community. They are an excellent teaching/learning aid, and are well suited for open research environments.
Concluding Remarks

Thanks for listening
If you have comments or want to contact me:
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Slides will be available at:
   www.digitalforensics.ch
Any questions?