INDEX

A	В
abrt (automated bug reporting tool),	backdoors, 234–237
107	best practices, 8
activation and on-demand services concept behind, 168	biometric fingerprint authentication, 300
D-Bus activation, 169	BIOS/MBR GRUB booting, 147
device activation, 171	block device type, 19
path-based activation, 170	blocks, 44
scheduled commands and timers,	Bluetooth artifacts, 242–244
172-175	bookmarks, 310–311
socket activation, 168	bootloader analysis, 145-153
addressing, 226–229	BIOS/MBR GRUB booting, 147
advanced persistent threat (APT)	booting overview, 145
malware, 3	GRUB configuration, 150
Anaconda, 190	other bootloaders, 152
analysis hosts, xxix	UEFI GRUB booting, 148
Anonymous, 3	btrfs analysis, 56–65
anti-forensics, 9	buttons, physical, 181
AppImage, 213-215	- ,
application crash data, 107–109	C
application logs, 129-135	anche divectory 90
application metadata, 99	cache directory, 89
application plug-ins, 223	carving tools, 71
APT. See advanced persistent threat	CentOS Stream, 27
(APT) malware	CERT (Computer Emergency
apt command, 203–206	Response Team), 2
Arch Linux, 27, 192	CFTT (Computer Forensics Tool Testing project), 3
Arch pacman packages, 210-212	01 0
at program, 172	character device type, 19 chip-off technique, 32
attached storage devices, 334-337	clipboard data, 307–308
audit logs, 135–143	cloud services, 321–324
authentication and authorization,	code examples
288-303	formatting and presentation, xxix
biometric fingerprint	collaboration, 6
authentication, 300	command line (Linux systems), 21
elevated privileges, 293	commands, scheduled, 172–175
GNOME Keyrings, 296	Comprehensive Perl Archive Network
GNU Privacy Guard (GnuPG), 301	(CPAN), 222
KDE wallet manager, 298	Computer Emergency Response Team
PAM module, 288	(CERT), 2
user, group, and password files, 288	(/, -

Computer Forensics Tool Testing	desktop thumbnail images, 311
project (CFTT), 3	desktop trash cans, 308
configuration artifacts. See also	GNOME desktop searches, 315
desktop settings and	KDE desktop searches, 316
configurations	other search engines, 317
areas covered, 225	screenshots, 315
network configuration analysis, 226–237	well-integrated desktop applications, 313
network security artifacts, 246-253	desktop environments (Linux systems),
wireless network analysis, 237-246	22
configuration directory, 89	desktop logins, 284-287
content analysis, 100	desktop search engines, 315
copy-on-write (CoW) snapshots, 41	desktop settings and configurations,
core dumps, 104–114	303-306
Coroner's Toolkit, 2	GNOME configuration, 303
COVID-19 health crisis, 4	KDE configuration, 306
CPAN (Comprehensive Perl Archive	other desktop configurations, 306
Network), 222	desktop thumbnail images, 311-313
crash dumps, 104–114	desktop trash cans, 308
cron system, 173	device activation, 171
cryptographic hashes, 93	devices (Linux system), 19
cryptsetup tool, 76	DFRWS. See Digital Forensics Research
custom logs, 129–131	Workshop (DFRWS)
cyber insurance, 8	digital forensics
,	analysis trends and challenges, 5–7
D	anti-forensics, 9
	forensic readiness, 9
daemon logs, 129–135	future concerns, 4
daemons, 166–168	history of, 1-4
DARPA (Defense Advanced Research	principles of, 7–8
Projects Agency), 2	Digital Forensics Research Workshop
data flow diagrams, xxx	(DFRWS)
daylight saving time, 259	2001 conference, 2
D-Bus activation, 169	role of, 8
dead disk forensics, xix	Digital Investigation journal, 7
Debian apt command, 203–206	Digital Millennium Copyright Act, 2
Debian binary package format (DEB),	directory files, 45
194-198	directory layout and file analysis
Debian Installer, 188	crash and core dumps, 104–114
Debian Linux, 25	Linux directory layout, 83–95
debugfs tool, 55	Linux file analysis, 99–104
Defense Advanced Research Projects	Linux file types and identification,
Agency (DARPA), 2	95-99
desktop artifacts, 303–317	DISCARD command, 32
desktop bookmarks and recent files,	disktype tool, 35, 46
310	distro installer analysis, 187–193
desktop clipboard data, 307	Arch Linux, 192
desktop search engines, 315	basic questions, 187
desktop settings and configurations, 303	building timelines, 187

Debian Installer, 188	Fedora Anaconda, 190
Fedora Anaconda, 190	Fedora dnf, 206-208
initial steps, 187	file analysis. See directory layout and
Raspberry Pi Raspian, 190	file analysis
SUSE YaST, 191	file extensions, 97
timestamps, 188	file managers, 308, 314
distro release information, 185	filesystems and storage devices,
distro-specific configurations, 229-231	334-337
distro-specific crash data, 107–109	btrfs analysis, 56–65
dnf (Dandified Yum), 206-208	erasing files versus trashing files,
DNS (domain name system), 231	308
DNS resolution, 231-234	ext4 analysis, 50-56
domain name system (DNS), 231	extracting evidence from, 31
dot files, 88, 98	filesystem encryption analysis,
dumpe2fs tool, 52	72-81
dumping core, 104	filesystem forensic analysis, 44-50
1 0	filesystem hierarchy, 84–88
E	Linux swap analysis, 69
	storage layout and volume
eCryptfs encrypted directories, 77–80	management, 33–44
elevated privileges, 293–295	xfs analysis, 65–69
ELF (Executable and Linkable	file types, POSIX standard, 95
Format), 101	financial technologies (FinTech), 5
encryption analysis, 72–81	firewalls, 249-251
eCryptfs encrypted directories,	Flatpak, 215-218
77-80	fls tool, 48
ext4 directory encryption, 80–81	forensic readiness, 9
fscrypt directory encryption, 80–81	Forensic Science International
LUKS full-disk encryption, 74–77	(FSI), 8
erasing files, versus trashing files, 308	forensics tools and platforms
Ethernet cables, 180	carving tools, 71
evidence collection, trends and	cryptsetup tool, 76
challenges in, 5	debugfs tool, 55
evidence drives, xxix	disktype tool, 35, 46
Ewing, Marc, 27	dump2fs tool, 52
examination hosts, xxix	first open source, 2
Executable and Linkable Format	fls tool, 48
(ELF), 101	fstat tool, $46,52$
executable files, 101–104	istat tool, 54
ext4 analysis, 50–56	lvdisplay tool, 39
ext4 directory encryption, 80–81	mdadm tool, 42
extended filesystem (ext), 50	mmls tool, 35
external attached storage, 334–337	pvdisplay tool, 39
-	requirements for, xxii
F	The Sleuth Kit (TSK), 2, 32
Farmer, Dan, 2	undelete-btrfs tool, 64
fast user switching, 287	fscrypt directory encryption, 80-81
favorites, 310–311	FSI (Forensic Science International), 8
Fedora, 27	fstat tool, 46, 52
•	

G	INTERPOL Forensic Science
GeoClue geolocation service, 271 geographic location, 268–272 location history, 269	Symposium, 3 IOCE (International Organization of Computer Evidence), 2
overview of, 268	IoT. See Internet of Things (IoT) devices
GNOME configuration, 303–305	IP access control, 249–251
GNOME Kowings, 206–207	IP geolocation, 269
GNOME Keyrings, 296–297 GNU Privacy Guard (GnuPG), 301	IPsec, 248
GNU software packages, 221	istat tool, 54
group files, 288-293	
GRUB configuration, 150	K
GRUB MBR booting, 147	KDE configuration, 306
GRUB UEFI booting, 148	KDE desktop searches, 316
GUI frontends, 219–221	KDE wallet manager, 298–300
Н	kernel architecture (Linux systems), 18
	kernel crashes, 109 kernel initialization analysis, 153–161
hardware (Linux systems), 17	analyzing initrd and initramfs, 158
hash databases, 93–95	initialization overview, 153
hashsets, 93–95 hibernation, 71	kernel command line and runtime
hidden files/directories, 88, 98	parameters, 154
hostname, 186	kernel modules, 155
human proximity indicators, 179-182	kernel parameters, 157
	kernel logs, 135–143 kernel ring buffer, 136–139
I	keyboard layout, 266–268
i18n. See internationalization	keyrings, 296–297
independent server application logs,	
	L
independent user application logs, 133–134	language settings, 264-266
industry-specific regulations, 8	laptop lid interactions, 179
initialization. See system boot and	LBA. See logical block access (LBA)
initialization	leap time, 259 Linux. See also Linux forensics; Linux
initrd and initramfs files, 158–161 inodes, 44	logs
installed software packages. See	access points, 241
software packages installed	distributions, 23–28
interfaces, 226-229	filesystem concepts, 44
internationalization, 264	firewalls, 249–251 forensic analysis of, 28
locale and language settings, 264	history of, 12–16
overview of, 264	interfaces, 226–229
physical keyboard layout, 266	system components, 16-23
International Organization of	system components, 10 20
International Organization of Computer Evidence (IOCE), 2	Linux Auditing System, 139-143
International Organization of Computer Evidence (IOCE), 2 Internet of Things (IoT) devices	Linux Auditing System, 139–143 Linux forensics. <i>See also</i> Linux; Linux
Computer Evidence (IOCE), 2	Linux Auditing System, 139-143

book conventions and format, xxviii book organization and structure, xxiv book overview by chapter, xxvi data flow diagrams, xxx defined, xvii formatting and presentation, xxix increased need for, 5 prerequisites to learning, xxii reliable resources, xxviii scope of coverage, xxiii target audience, xxi terminology, xxix tools and platforms required, xxii Linux From Scratch (LFS), 184 Linux logs. See also Linux; Linux forensics kernel and audit logs, 135–143 other application and daemon logs, 129–135 systemd journals, 121–129 traditional syslogs, 116–121 Linux time configuration analysis, 264 live system incident response, xix locale settings, 264–266 location history, 269–271 lock-down technologies, 5 logical block access (LBA), 44 Logical Volume Manager (LVM), 37–41 login activity. See user desktops and login activity reconstruction login and session analysis, 273–287 desktop logins, 284 overview of, 273 seats and sessions, 275 shell logins, 278 X11 and Wayland, 281 logs. See Linux logs LUKS full-disk encryption, 74–77 lvdisplay tool, 39 LVM. See Logical Volume Manager	Mason, Chris, 56 MBR GRUB booting, 147 mdadm tool, 42 media, removable, 181 mmls tool, 35 mounted storage, 336 multi-jurisdictional concerns, 6 Murdock, Ian, 25 N National Institute of Standards and Technology (NIST), 3, 94 National Software Reference Library (NSRL), 94 network access. See user network access; wireless network analysis network addressing, 226–229 network configuration analysis, 226–237 DNS resolution, 231 Linux interfaces and addressing, 226 network managers and distrospecific configuration, 229 network services, 234 network configuration artifacts. See configuration artifacts. See configuration artifacts, 246–253 IPsec, 248 Linux firewalls and IP access control, 249 openvpn program, 249 proxy settings, 251 WireGuard, 246 network services, 234–237 network shares, 321–324 NIST (National Institute of Standards and Technology), 3, 94 NSRL (National Software Reference
(LVM)	Library), 94
machine IDs, 186 magic strings, 46, 97 man pages, xxviii manually compiled software, 221	on-demand services. <i>See</i> activation and on-demand services oops conditions, 109 openvpn program, 249

P	power cables, 179
package file format analysis, 193	prerequisite knowledge, xxii
Arch pacman packages, 200–202	printers, 330-334
Debian binary package format	privileges, 293-295
(DEB), 194	programming language packages, 222
forensic analysis tasks, 193	proxy settings, 251-253
Red Hat Package Manager (RPM),	pvdisplay tool, 39
198	Python Package Installer, 222
PackageKit, 219–221	
package management systems analysis,	R
202-212	RAID. See redundant array of
Arch pacman packages, 210	independent disks (RAID)
Debian apt command, 203	Raspberry Pi clock, 262
Fedora dnf, 206	Raspian, 190
SUSE zypper, 208	reboot evidence, 176–178
typical components, 202	recent files, 310–311
pacman tool, 210-212	Red Hat Linux, 27
PAM module, 288, 301	Red Hat Package Manager (RPM),
panic conditions, 109	198–200
partition tables, 33–37	redundant array of independent disks
password files, 288–293	(RAID), 41, 44
path-based activation, 170	regulations, industry-specific, 8
PCI Express devices, 329	remote desktop access, 320
peer-reviewed research, 7	removable media, 181
peripheral devices	resources, locating accurate and
external attached storage, 334–337	reliable, xxviii
human proximity indicator, 181	rolling-release distributions, 27
identifying attached USB devices,	rolling-release model, 184
327	root directory, 83
identifying PCI and Thunderbolt	Ruby Gems, 222
devices, 329	Ruby Gellis, 222
Linux device management, 326	S
printers and scanners, 330–334	3
perpetrators, xix-xxi	Sarbanes-Oxley Act, 2, 8
physical buttons, 181	scanners, 330–334
physical environment analysis. See	scheduled commands, 172–175
power and physical	Scientific Working Group on Digital
environment analysis	Evidence (SWGDE), 3
physical keyboard layout, 266-268	scope of coverage, xviii
plug-ins, 223	screenshots, 315
Plymouth splash startup logs, 134	seats, 275–278
POSIX file types, 95	secure shell access, 317–320
power and physical environment, 182	September 11, 2001 attack, 2
power and physical environment	sessions, 275–278
analysis, 175	shell logins, 278–281
human proximity indicators, 179	shutdown evidence, 176-178
overview of, 175	signatures, 46
sleep, shutdown, and reboot	slackspace, 47
evidence, 176	sleep evidence, 176-178

Sleuth Kit, The (TSK), 2, 32	power and physical environment
Snap, 218-219	analysis, 175–182
Snowden, Edward, 3	systemd analysis, 161–175
social engineering attacks, xix, 4, 73	systemd analysis, 161–175
socket activation, 168	activation and on-demand services,
software centers, 219–221	168
software packages installed	overview of, 161
areas of interest, 183	systemd initialization process, 164
distro installer analysis, 187–193	systemd services and daemons, 166
lack of installation standards, 184	systemd unit files, 161
manual installation process, 183	systemd journals, 121–129
other software installation analysis,	systemd (Linux systems), 20
221-223	systemd timers, 174
package file format analysis, 193-202	system hostname, 186
package management systems	system identification, 184–187
analysis, 202–212	distro release information, 185
software release management, 184	initial steps, 184
system identification, 184–187	system hostname, 186
universal software package analysis,	unique machine IDs, 186
212-221	1
version numbers, 184	T
standards, lack of, 7	
storage devices, external attached. See	target audience, xxi
filesystems and storage devices	thumbnail images, 311–313
storage layout and volume management	Thunderbolt devices, 329
Linux software RAID, 41	time and location analysis
storage layout and volume	internationalization, 264
management analysis	Linux and geographic location,
Linux software RAID, 44	268-272
Logical Volume Manager (LVM),	Linux time configuration analysis,
37-41	255-264
partition tables, 33–37	time configuration analysis, 255
Stuxnet worm, 3	daylight saving time and leap time,
subject drives, xxix	259
superblocks, 46	time formats, 256
SUSE YaST, 191	timestamps and forensic timelines,
SUSE zypper, 208	262
suspect drives, xxix	time synchronization, 260
swap analysis, 69–72	time zones, 257
SWGDE (Scientific Working Group on	time formats, 256–257
Digital Evidence), 3	timers, 172–175
switch user option, 287	timestamps, 188, 256, 262-264
symlinks, 161	time synchronization, 260–262
syslogs, 116–121	time zones, 257–259
system boot and initialization	tools. See forensics tools and platforms
reconstruction	Torvalds, Linus, 12, 14
bootloader analysis, 145–153	trash cans, 308
kernel initialization analysis,	TRIM command, 32
153–161	typographical conventions, xxviii

UEFI GRUB booting, 148 undelete-btrfs tool, 64 unique machine IDs, 186 unit configuration files (systemd), 161 universal package systems, 212	victims, xix-xxi Vinet, Judd, 27 volume management. <i>See</i> storage layout and volume management
universal software package analysis, 212–221	
AppImage, 213	wallet managers, 298–300 Wayland, 281–284
Flatpak, 215	well-integrated applications, 313-315
role of universal packages, 212 Snap, 218	Wi-Fi artifacts, 237–242
software centers and GUI frontends,	Wikileaks, 3 WireGuard, 246–248
219	wireless network analysis, 237–246
Unix, 12–14 user desktops and login activity	areas of interest, 237
reconstruction	Bluetooth artifacts, 242 Wi-Fi artifacts, 237
authentication and authorization,	WWAN artifacts, 244
288–303 Linux desktop artifacts, 303–317	WWAN artifacts, 244–246
Linux login and session analysis, 273–287	X
user network access, 317-324	X11 window system, 281–284
user files, 288–293	XDG base directories, 88 xfs analysis, 65–69
user home directory, 88–93 user network access, 317–324	his tilitaysis, oo oo
network shares and cloud services,	Υ
321	YaST (Yet another Setup Tool), 191
remote desktop access, 320 secure shell access, 317	Young, Bob, 27
V	Z
Venema, Wietse, 2	zypper tool, 208

version numbers, 184