The iPhone's Forensic Workflow: The Steps to Access Critical Evidence

Extracting evidence from a seized iPhone: systematic approach, tools and challenges
In This Talk

Preserving evidence
- Seizing and storing the device
- Common mistakes and their consequences

Vectors of attack
- Cloud and Over-the-Air Acquisition
- Offline Backups
- Physical Acquisition
- Common mistakes and consequences
iOS Forensics

Acquisition Methods That Don’t Work

- Some acquisition methods common on other platforms are not available for iOS
- JTAG: there is no test access port (but technically USB port can be used)
- Chip-off: full-disk encryption makes offline attacks completely useless
- Bypassing screen lock: encryption key derived from passcode
iOS Forensics

Seizing and Preserving Evidence

Seizing and storing the device properly is extremely important.
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Seizing and Preserving Evidence

Wrong:

- **Do nothing**
  Device susceptible to remote erase command; lost evidence; background activities

- **Switch off**
  Disables Touch ID/Face ID; requires PIN to unlock; disables the ability to use pairing records to unlock; disables Wi-Fi until unlocked

- **Push Touch ID button or look at Face ID camera**
  Wastes 1 of 5 available unlock attempts
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Seizing and Preserving Evidence

Right:

- To turn on display, use Sleep/Wake button
- Isolate (Faraday bag) or turn off radios (Airplane mode)
- If it’s on, don’t switch it off
- If unlocked, don’t let it lock. If possible, unlock the device on the spot and prevent locking
- USB Restricted Mode engages after 1 hour since last unlock
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Seizing and Preserving Evidence

If unlocked, don't let it lock

- Settings – General – Auto Lock – Never
  - May not be possible for devices with MDM/Exchange policies
- Much easier acquisition
- Will be able to produce offline backup
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Seizing and Preserving Evidence

Use Faraday bag; Connect to a charger

- Isolates from wireless networks
- Otherwise, remote wipe easily possible
- What can happen:
  - BBC News: Cambridgeshire, Derbyshire, Nottingham, and Durham police "There were six incidents, but we don't know how people wiped them." (9.Oct.14)
  - Darvel Walker, Morristown wiped his iPhone remotely, charged with tampering with evidence (7.Apr.15)

Hint: Microwave oven is effective as a shield against radio signals. But don’t turn it on 😊
If no Faraday bag is available:

- **Switch to Airplane mode**
  - This is possible even if the device is locked
- Otherwise, do risk assessment of two strategies:
  - Keep device on and connected > can use Touch ID, pairing records to unlock; possibility of remote wipe command (may be low if escorting subject)
  - Switch off the device > remote lock and remote erase impossible; must use passcode to unlock; Touch ID, pairing records and Wi-Fi disabled
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Biometric Unlock: Touch ID and Face ID

64-bit Apple devices equipped with fingerprint reader

- iPhone 5S+, iPad mini3+, Air 2, Pro

Convenient, utilized by most users

Unavailable after cold boot

- Device must be unlocked with passcode at least once to use Touch ID

Can use Touch ID to unlock the device

- Within 48 hours of last use
- But not after power-on or cold boot
• Touch ID unlocks must be properly timed
  • Expires according to multiple rules
    • After 48 hours
    • If passcode not used for 6 days AND not unlocked with Touch ID for 8 hours
  • You only have 5 attempts
  • When checking device lock status, DO NOT PUSH THE HOME BUTTON (or you lose one of the 5 attempts)
• iPhone X: don’t look at the screen…
• Use Sleep/Wake button instead
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Ask Siri

- “Allow Siri When Locked” is enabled by default
- Questions that don’t require device unlocking:
  - What’s my name?
  - Last call
  - Calendar
- These questions work on the lock screen but require device unlocking:
  - Call “name”
  - How long till home?
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Vectors of Attack

Logical Acquisition (Backups)
- Backup can be encrypted with unknown password
  - iOS 11+ allows resetting backup password; passcode required
  - Slow (100 p/s w/GPU); recovery timeframe unpredictable, result not guaranteed
  - Can use lockdown/pairing records (extremely durable and do not seem to expire)

Over-the-Air (Cloud) Extraction
- Apple ID/password or binary authentication token
- Can be obtained from Apple with court order

Physical Acquisition
- On recent devices, must unlock/know the passcode
- Jailbreak required, multiple issues arise
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Software to use

- Elcomsoft iOS Forensic Toolkit: logical and physical acquisition
- Elcomsoft Phone Breaker: logical and over-the-air acquisition
- Elcomsoft Phone Viewer: view, explore, search, export
- Apple iTunes: logical acquisition
Device Is Unlocked

If device is unlocked or can be unlocked, several acquisition options may be available, in this order:

1. Make local backup: set your own password if password empty
2. Attempt jailbreak, perform physical acquisition
3. If local backup protected with unknown password:
   - Force cloud backup (via Settings – iCloud – Backups) or
   - Disable backup password (iOS 11+ only) via Settings – General – Reset All Settings
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Make a Local Backup

Acquisition steps:

- Make the device produce a backup or
- Access information stored in existing backup

Limitations:

- Device must be unlocked (with passcode, Touch ID, iTunes or lockdown file)
- **iOS 11+ requires a passcode to pair**
  - Lockdown files can be used instead (if available)
- May produce encrypted backup
  - Must break password (no guaranteed timeframe, no guarantee of success)
- Limited amount of information
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Backup Passwords

- Encrypted backups contain more information than unencrypted
- Must set known backup password before acquisition
- Otherwise, keychain items will be encrypted with a hardware key and cannot be decrypted
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Using Lockdown Files (Pairing Records)

Extract lockdown record from user’s computer

Windows Vista, 7, 8, 8.1, Windows 10: %ProgramData%\Apple\Lockdown
Windows XP: %AllUsersProfile%\Application Data\Apple\Lockdown
Mac OS X: /var/db/lockdown

Use to establish pairing relationship

* Since iOS 8, lockdown files expire after factory reset. Pairing records for iOS 7 and earlier persist through factory resets, available with Apple
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What If…?

The Encrypt iPhone backup option is activated and you don’t know the password

- **iOS 8..10**: Password cannot be changed without specifying the old password
- **iOS 11+**: Password can be reset if you can unlock the device. Use Settings – General – Reset – Reset All Settings
- Make the phone produce a backup nevertheless. Attempt recovering backup password with Elcomsoft Phone Breaker
If backup password is specified (in iTunes):

No unencrypted data leaves the phone*

All encryption is performed inside the device (iPhone, iPad)

iTunes pulls encrypted data stream
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iOS 11: Resetting iTunes Backup Password

iOS 11 allows to reset iTunes backup password

- Unlock the iPhone with Touch ID, Face ID or passcode.
- Open the Settings app and navigate to General.
- Scroll all the way down and tap Reset.
- Tap and confirm Reset All Settings.
Using “Reset All Settings” will erase the following settings:

- Display brightness
- Whether or not to display battery percentage
- All Wi-Fi passwords (but not any other passwords or tokens stored in the Keychain)
- com.apple.wifi.plist
- iTunes backup password

All existing lockdown (pairing) records, data, and all keychain items (except Wi-Fi) are preserved.
Perform steps to create a local backup. You may still attempt attacking the original backup password.

Disconnect the iPhone from the computer.

Unlock the iPhone with Touch ID, Face ID or passcode.

In Settings – General – Reset, tap and confirm Reset All Settings.

Reconnect the iPhone to the computer.

Note: iOS Forensic Toolkit will set a temporary password of “123”; this will allow you to decrypt keychain items. You may use an existing lockdown file (pairing record) to create the backup.
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Breaking iTunes Backup Password

- Unknown backup password MUST be recovered
- Backups are securely encrypted
- iOS 9: 2400 combinations per second with CPU; 150,000 with GTX 1080
- iOS 10, iOS 11, iOS12: extremely slow at 100 p/s with GTX 1080 GPU
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Step 2: Physical Acquisition

- On newer devices, jailbreak is required
- Passcode must be known or recovered
- iPhone 5S and newer: must keep device unlocked during entire acquisition process
  - Use (D)isable Lock in iOS Forensic Toolkit
- No jailbreak for some versions of iOS
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Jailbreak: How To

- Unified installation procedure for all modern jailbreaks
- Device must be paired and unlocked
- Use Cydia Impactor to sideload jailbreak
  - Use Apple ID/password (disposable account) to sign the jailbreak IPA
    - This is very unstable, multiple tries may be required
- Trust developer certificate in device settings
- Launch the jailbreak
- Ensure SSH connectivity; if SSH daemon not pre-installed, install OpenSSH from Cydia
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Jailbreak: Issues

Jailbreak has many forensic implications
Dangerous, no guaranteed outcome
Not forensically sound, introduces artifacts
Process must be carefully documented

- Semi-tethered jailbreaks expire in 7 days (unless Apple Developer account is used)
- Each Apple Developer account can be used to sign IPA files to jailbreak a limited number of devices
- Disposable Apple ID to jailbreak is a good idea
Jailbreaks for iOS

What iOS jailbreak actually does

- Escalates privileges of user, allowing:
  - Download, install and run any application, including unsigned ones
  - Access all application sandboxes (many viruses exist for jailbroken iOS devices)
  - In some cases access to all system files including kernel
Jailbreaks for iOS

Classic jailbreak

- Allows access to the root of device file system – “/”
- Requires to remount file system to gain access to /
- Modifies many system files
- OTA iOS update becomes impossible
- Leaves very many traces
- In some cases device is unstable until full restore with iTunes
Jailbreaks for iOS

Rootless jailbreak

- “Rootless” does not mean “without root access”, it means “without access to root of file system”
- Can be applied offline with developer account
- File system is accessible from /var folder
- Modifies only files inside /var
- Leaves significantly less traces than classic JB
- System is more stable
- We recommend to use rootless jailbreaks for forensic analysis
Mobile Forensics

Physical Acquisition: 64-bit devices

Physical acquisition steps

1. D - Disable screen lock
2. K - Decrypt keychain items
3. F - Extract files and folders
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Step 3: Producing Cloud Backup

Cloud backups are produced when:

- Device connected to a known Wi-Fi network (matching SSID and password)
- Connected to a charger
- Screen locked

**WARNING:** exposing device to wireless connectivity makes it subject to remote lock and remote erase
Forcing a Cloud Backup on Locked iPhone

Make the phone produce a fresh cloud backup

- Try other methods first if passcode known or unlock possible
- Bring to the proximity of a known Wi-Fi network
- SSID and password must match
- Connect to a charger
- Leave “overnight”
- If iCloud backups are enabled, the phone should produce a fresh cloud backup
- Request from Apple
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Forcing Cloud Backup on Unlocked iPhone

If device is unlocked or can be unlocked:

- Fresh iCloud backup can be forced
- Settings – iCloud – Storage & Backup – Back Up Now
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Risks and Issues

- Device susceptible to remote wipe command (that’s why try other methods first)
- Won’t connect to Wi-Fi if device was turned off and never unlocked afterwards (at least once)
- iCloud backups may not be enabled
- If the phone can be unlocked, try other methods first (iTunes backup, physical acquisition)
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Apple ID Password

- If you know the password to user’s Apple ID, perform cloud acquisition first
- If you don’t, DO NOT RESET APPLE ID PASSWORD EVEN IF YOU CAN
- Otherwise, you won’t be able to make the phone produce a fresh cloud backup without unlocking it first
  - What can happen:
    - San-Bernardino case: password reset, iCloud backup impossible even with Apple cooperation
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Not That Easy

“Auto Join” Wi-Fi network is enabled in device settings
Device unlocked at least once after booting *
  ▪ Device was discovered powered on, and
  ▪ It was kept powered on in a Faraday bag
Wi-Fi enabled on the device

* The device must be unlocked with passcode at least once after booting. Otherwise, Wi-Fi passwords remain encrypted, and the device will not attempt to connect to any Wi-Fi network.
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Apple ID Password Already Known

Use Elcomsoft Phone Breaker to download cloud backup

What can go wrong:

- Two-factor authentication may be an issue
- Access to secondary authentication factor is required (unless using authentication token)
- Cloud backup may not exist
- It can be very old
If iCloud for Windows is installed, binary authentication token may exist
- Locate and extract the token
- Download cloud backup using the authentication token

What can go wrong:
- In iOS 8.x, iCloud authentication tokens expire quickly
- In iOS 9.x, iCloud Drive is used, tokens do not expire
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Over-the-Air Acquisition

You have:

- Apple ID and password, or
- PC synced with iCloud (binary authentication token)
- Acquisition steps:
  - Use Apple ID and password to download the backup
  - Extract binary authentication tokens, use to download backup
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iCloud Authentication Tokens

• Authentication tokens are used for convenience
• Saved on a Mac or PC used to access iCloud
• Allow users to avoid entering for Apple ID and password every time
• Technically, an authentication token is stored in a file on the user’s computer (see figure)
• Locating the file and extracting the token allows bypassing login/password authentication and 2FA
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What Authentication Tokens Are Not

- Authentication tokens do not contain a password to the user’s Apple account
- They don’t contain a hash of the password either
- They cannot be used to brute-force the original plain-text password
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Obtaining a Binary Authentication Token

- Will need a PC synced with iCloud, its hard drive or forensic disk image
- Full instructions available online
- **PC:**
- **Mac:**
The iCloud authentication token has expired

- Expired tokens cannot be used to download cloud backups

The Apple ID password has been changed

- All existing authentication tokens are immediately invalidated
- Must enter the correct password and overcome 2FA
- To force the creation of a new cloud backup, unlock the device and enter the new Apple ID password
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iCloud Keychain

• Passwords, tokens and payment information synchronized through iCloud
• Apple does not provide any tools or APIs to access iCloud Keychain
• Several different implementations
  • Passwords may or may not be stored in iCloud
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iCloud Keychain

- No 2FA and no iCloud Security Code
  - The keychain is NOT stored in the cloud; direct synchronization across devices.

- No 2FA, iCloud Security Code is present
  - The keychain is AVAILABLE in the cloud.

- 2FA is enabled
  - There can be no iCloud Security Code; the keychain is ALWAYS stored in the cloud.
  - Access to iCloud Keychain only possible after successfully passing 2FA and entering a passcode (or system password) of one of the already enrolled devices.
No Two-Factor Authentication

- Sign in with an Apple ID and password
- Supply iCloud Security Code, if one is configured
- Receive and enter a one-time code delivered to the user’s registered phone number as a text message (SMS)
- If iCloud Security Code is NOT configured, iCloud Keychain cannot be obtained
Two-Factor Authentication enabled

- Sign in with Apple ID and password
- Confirm 2FA prompt on the device; use one-time code displayed to complete sign in
- Enter device passcode or system password of an iOS or macOS device already enrolled into iCloud Keychain
- iCloud Keychain will be downloaded. The process may take from several seconds to several minutes depending on the number of records in iCloud Keychain.
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Exploring iCloud Keychain

What’s inside?

• Passwords
• Tokens
• Payment data
• Wi-Fi networks
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iCloud Data Sync

- If Settings | iCloud | Safari is enabled, it syncs:
  - Bookmarks
  - Open tabs
  - Reading list
  - Browsing history
  - **Call logs** (not in the Settings; syncs if iCloud Drive is enabled)

- Contacts, Notes, Calendars, Wallet (including boarding passes), Maps (searches and bookmarks)

- Keychain
  - With luck, password to Google Account

- Messages (iMessages, SMS): since iOS 11.4
iOS Forensics: Acquisition Methods and Techniques

Extracting evidence from a seized iPhone: systematic approach, tools and challenges

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