Android Vulnerabilities

Lecture 11

Security of Mobile Devices

2019

General concepts

Remote attack surfaces

Local attack surfaces

Physical attack surfaces

Application security

Side channel attacks

Gaining root access

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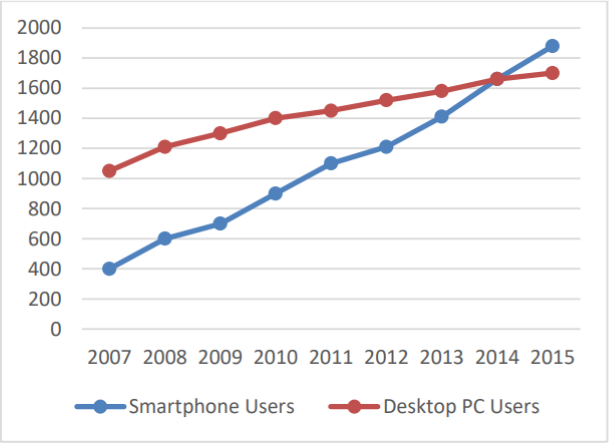
Bibliography

- Vulnerabilities
- What can you gain?
- Causes

Mobile vs Desktop

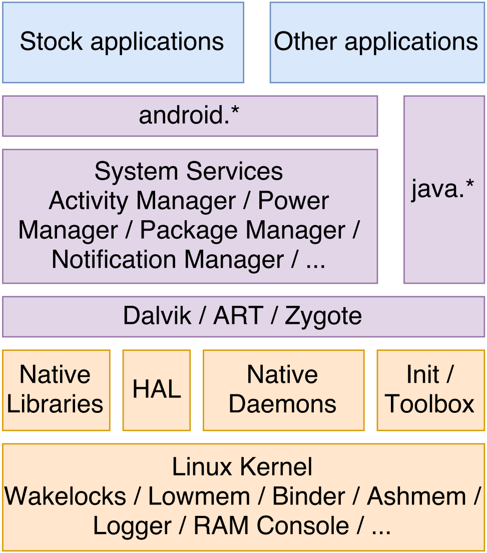


Number of internet users (millions)

Attack surface

- Attack vector
- Attack surface
- Castle analogy

Android system attack surface



Stock applications

Other applications

android.*

java.*

System Services
Activity Manager / Power Manager / Package Manager / Notification Manager / ...

Dalvik / ART / Zygote

Native Libraries

HAL

Native Daemons

Init / Toolbox

Linux Kernel
Wakelocks / Lowmem / Binder / Ashmem / Logger / RAM Console / ...

Android application attack surface

- Activities
- Services (exposed and bound services)
- Broadcast receivers
- Content providers

Attack surface classification

- Remote
- Local
- Physical

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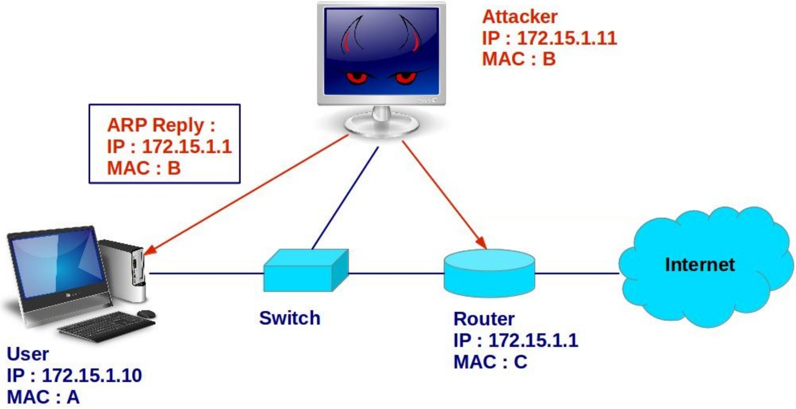
Network attacks

- No network services available
- Susceptible to common network attacks
  - Spoofing attacks (ARP, DNS, DHCP)
  - Man in the middle attacks
  - TCP attacks (SYN flooding, RST attack, sequence prediction attack)
  - DoS attacks

ARP Spoofing



- Cellular communications - an addtional remote surface attack
- SMS, MMS
- WAP (Wireless Application Protocol)

- Dialer attack
  - tel://URI received through SMS, Twitter post
  - USSD code for factory reset
  - USSD code for reseting PUK - after 10 times, SIM card is destroyed

- Stagefright attack
  - Android native multimedia library
  - exploited through MMS, Hangouts, web browsers
  - integer overflow leads to heap overflow
  - shellcode with a reverse TCP connection callback

Client-side attack surface

- Client applications
- Browser attacks
  - Plethora of technologies: HTTP(S)/FTP, HTML, JavaScript
  - rogue URL
  - cross-site scripting (XSS)
  - cross-site request forgery (CSRF)

Client-side attack surface

- Web-Powered mobile applications - Twitter, Dropbox
- Authentication - SSL/TLS certificates
- Apps do not adequately validate the certificates
- 8% of the apps on Google Play Store exposed to MitM attacks

Google Infrastructure

- Google Single Sign On (SSO)
- Google Play Store
- Malicious applications
- Third-party applications

Google Infrastructure

- Google Single Sign On (SSO)
- Google Play Store
- Malicious applications
- Third-party applications
  - Top 100 Android Paid App list
  - hacked, modified, available on 3rd party distribution sites
  - over 500k downloads
  - Android.troj.mdk Trojan infected over 1 million Chinese Android devices - Temple Run, Fishing Joy

Google Infrastructure

- Verify Apps feature queries a Google database
- Bouncer
  - QEMU machine that runs the application in an isolated environment
  - dynamic runtime analysis tool
  - populates the environment dummy data (contacts, photos)

Bouncer

- Why do we still have malicious apps with the Bouncer check?

- Evading Bouncer
  - identifying the unique dummy data
  - identifying the unique fingerprint of the QEMU instance
  - use a command and control server that sends to the application malicious code

Wireless communication attacks

- GPS
  - no known attacks to compromise a device
  - GPS spoofing
- Baseband (GSM, HSPA, LTE)
  - emulate a base station (cell tower) - specialized equipment
  - RIL (Radio Interface Layer) - AT commands through USB

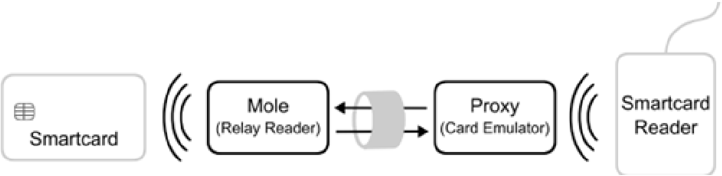
Wireless communication attacks

- Bluetooth
  - weaknesses related to pairing and encryption in the Android Bluetooth stack (BlueDroid)
  - Bluejacking, BlueBorne (heap overflow)
- WiFi
  - WEP, WPA, WPA2, WPA3
  - rogue AP (access point)
  - Krack - Key Reinstallation Attack

Wireless communication attacks

- NFC
  - lack of encryption and authentication
  - browser attack
  - NFC relay attack

Wireless communication attacks



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- file system - files, pipes, character and block devices
  - F2FS (Flash Friendly File System) vulnerabilities
  - boundary checks, integer overflows
- sockets
  - PF_INET
  - PF_UNIX
  - PF_NETLINK - Gingerbreak jailbreak
- binder
  - Use-After-Free issue caused by race conditions
- shared memory - KillingInTheNameOf jailbreak

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Physical attack surfaces

- dismantling the device
- USB
  - send AT commands to the RIL - issue calls, alter the pin
  - vold vulnerability - allows to overwrite filesystems through USB

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Application security

- application permission issues
  - Android documentation related to permissions does not correspond with what the Android middleware actually requires
  - undergranting or overgranting permissions
- insecure transmission of sensitive data
- insecure data storage
  - plaintext storage
  - no encryption
  - Skype - world-readable, world-writable permissions, no encryption

Application security

- information leakage through logs
  - excessive, very verbose logging
  - Firefox - browsing activity, session identifiers
- insecure transmission of sensitive data
- Unsecured IPC endpoints
  - who can access whom?
  - activities - UI redressing attacks (clickjacking) - Cloak and Dagger
  - bounded services - expose functionality
  - content providers - expose data, susceptible to SQLite injection
  - broadcast receivers - implicit intents

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Side channel attacks

- What are they?
- Classification
  - Active vs Passive
  - Physical properties vs Logical properties
  - Local attackers vs Vicinity attackers vs Remote attackers

Local pasive side channel attacks

- power analysis attack - attacks on DES
- electromagnetic analysis attack - attacks on AES, RSA, ECC, ECDSA
- smudge attack
- shoulder surfing and reflections
- hand and device movements

Local active side channel attacks

- clock and power glitching
  - underclocking, overclocking
- electromagnetic fault injection
  - EM pulses affect state of memory cells
- laser and optical faults
  - laser beams can flip bits in memory cells
- temperature variation
  - heat up can lead to faults in memory cells
  - cooling down can lead to remanence effect of RAM

Vicinity pasive side channel attacks

- network traffic analysis
- USB power analysis
    - USB charging stations can detect power traces
- WiFi signal monitoring
    - keystrokes can affect the WiFi signal

Remote pasive side channel attacks

- Linux inherited procfs leaks
  - /proc/[pid]/status
  - infer browsing behavior using the memory footprint
  - shared memory size increase to detect activity transitions
  - number of context switches and interrupts to detect keystrokes pattern
- data-usage statistics
  - infer browsing behavior
- page deduplication
  - identical physical pages merged into one across differente processes
  - copy-on-write
  - infer browsing behavior

Remote pasive side channel attacks

- microarchitectural attacks
  - timing behavior of cryptographic system components
  - branch prediction units, CPU caches
  - cache-timing attacks against AES
- location inference
  - accelerometer, gyroscope
  - speaker status information offered by Android API
  - infer speech length (Turn right onto East Main Street)
- speech recognition
  - acoustic signals can influence gyroscope measurements

Remote active side channel attacks

- Rowhammer
  - high cell density in DRAM
  - cells leak their electrical charge to other cells
  - bypass isolation between DRAM memory cells
  - RAMpage attack - gain root privileges

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- Goto Don't root robots presentation
- The don't root robots presentation is not required for the exam

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- Android Hacker's Handbook, Joshua J. Drake, 2014

Keywords

- Attack vector
- Attack surface
- Application security
- Side channel attacks
- Root access
- Cellular communications
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- Bluetooth
- NFC

- Activities
- Services
- Content providers
- Broadcast receivers
- Bouncer