



Mobile Forensics and Challenges

Saurabh Kumar
Senior Research Scholar
IIT Kanpur
Date: 08/03/2022



<https://github.com/skmtr1/Workshop-Mobile-Forensics-And-Security>

DIGITAL FORENSICS & INVESTIGATION

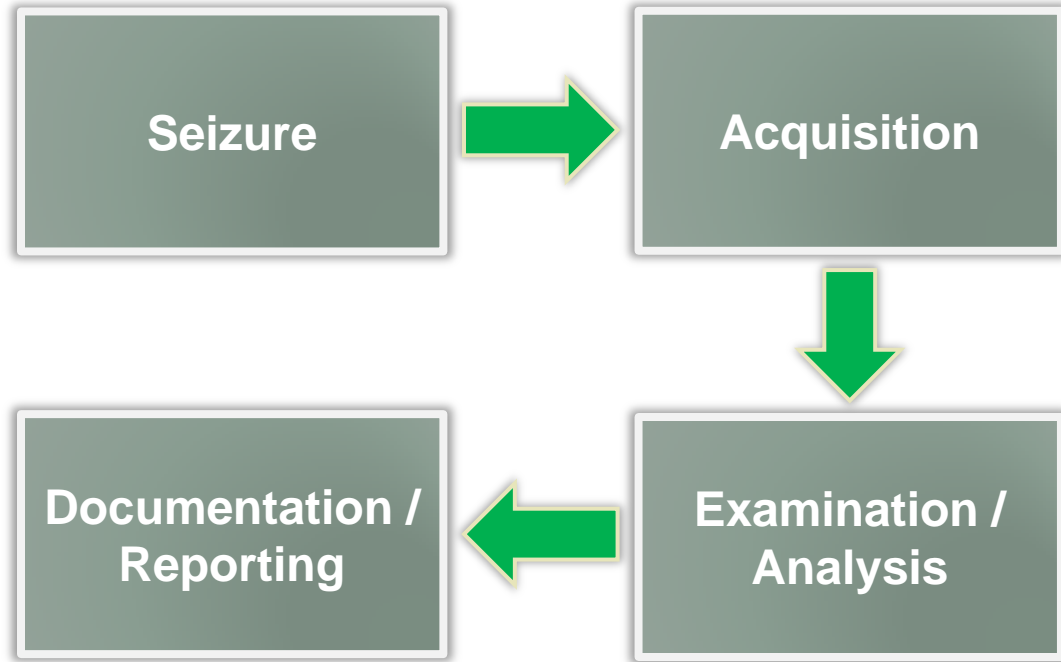
Terms and Definitions

- ❑ **Mobile Forensics:** The science of recovering digital evidence from mobile phone under forensically sound conditions using accepted methods. (NIST)
- ❑ **Penetration Test:** A method of evaluating the security of a computer system or network by simulating an attack from malicious **outsider/insider**. (Wikipedia)
- ❑ **Vulnerability Assessment:** A process of identifying, quantifying and prioritizing the vulnerabilities in a system.

Forensics Overview

- ❑ Potential scenarios, not specific to Mobile
- ❑ Evidence gathering for legal proceedings
- ❑ Corporate investigations
 - Intellectual property or data theft
 - Employment-related investigations including discrimination, sexual harassment
 - Security audit
- ❑ Family matters
 - Property disputes
 - Divorce
- ❑ Government security and operations
 - Cyber Threats
 - Stopping cyber attacks
 - Intelligence / Counter-intelligence gathering

Investigation Process



Forensics Considerations

- ❑ Important items to consider during investigations
 - Chain of custody
 - Detailed notes and complete report

- ❑ Validation of investigations results using tools or other investigators

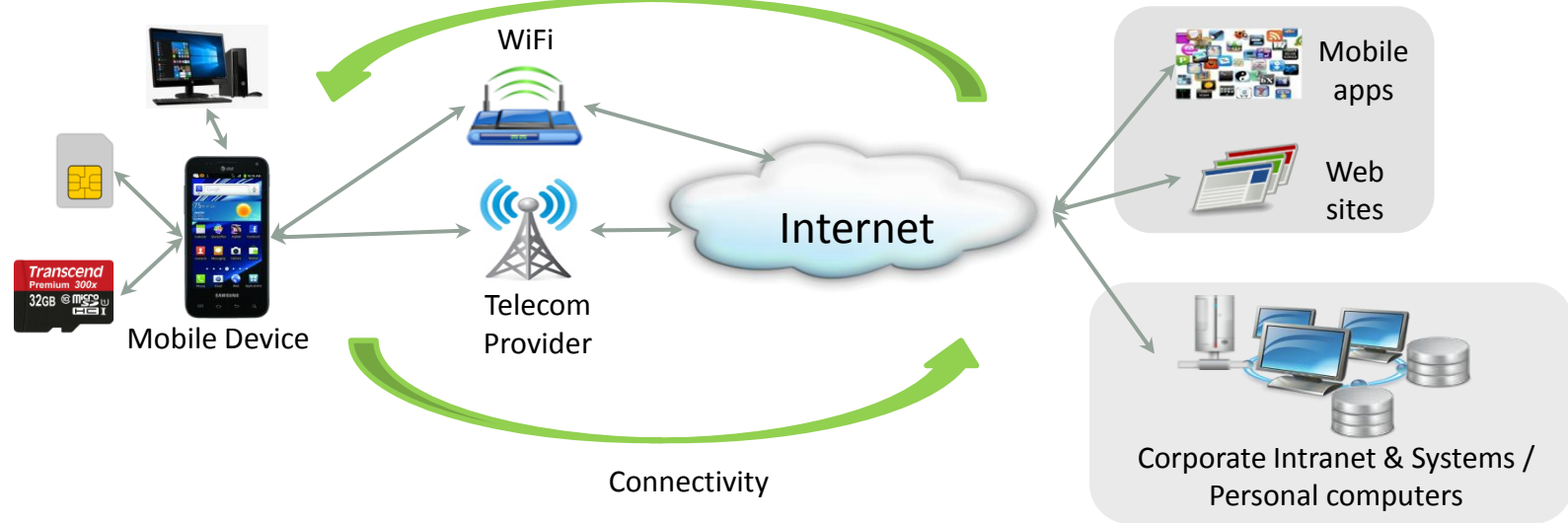
Legalities

- ❑ Possibility of a mobile device being involved in crimes
- ❑ Easily cross geographical boundaries; multi-jurisdiction issues
- ❑ Investigator should be well aware of regional laws
- ❑ Data may be altered during collections, causing legal challenges

MOBILE FORENSICS

Why Mobile Forensics?

- ❑ Technology improvements
- ❑ User activities
- ❑ Valuable data
- ❑ Always powered on
- ❑ Multiple Communication Entity



Types of Evidence from Mobile

- ❑ Physical
- ❑ Electronic

Physical Evidence from Mobile

□ DNA

□ Fingerprints

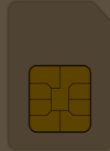
Electronic Evidence

- ❑ Can be use to establish **LAB**
- ❑ **L**ocation
- ❑ **A**ssociation
- ❑ **B**ehavior
- ❑ Some Information
 - Call history
 - Contacts
 - SMSs
 - Calendar
 - Location
 - Images
 - Audio/Video
 - Many more...

Sources of Information



Call history
Location
Tracking



IMSI
ICCID
Contacts
SMSs



Audio
Video
Backup



IMEI
Contacts
SMSs
Call History
Location



Behavior
Emails
Photos
Location

Network Service Provider

❑ Can provide

- Subscriber details
- Call History – Call Details Record (CDR)
- List of accessed web services – IP Details Record (IPDR)
- Geographic location – Tower locations through which a phone is connected for communication
- Cell Tower Logs (Tower Dump)

Call Details Record (CDR)

☐ Looks like

Info about associated
Mobile Device

Info about
user location

Calling No.	Called No.	REC TYPE	TRANS_DT	Duration	IMEI	CELL ID
94XXXXX093	94XXXXX032	MOC	20130101113117	63	35789004232353	405-54-902-2
94XXXXX534	94XXXXX093	MTC	20130101132532	40	35789004232353	405-54-576-1
94XXXXX997	94XXXXX093	SMT	20130101165754	1	35789004232353	405-54-576-3
94XXXXX093	94XXXXX109	MOC	20130101165937	247	35789004232353	405-54-576-2

Calling No.	Called No.	REC TYPE	Date	Time	Duration	IMEI	FIRST_CELL ID (Origin)
94XXXXX093	94XXXXX032	OUT	01/01/2013	11:31:17	63	35789004232353	405-54-902-2
94XXXXX534	94XXXXX093	IN	01/01/2013	13:25:32	40	35789004232353	405-54-576-1
94XXXXX997	94XXXXX093	S_IN	01/01/2013	16:57:54	1	35789004232353	405-54-576-3
94XXXXX093	94XXXXX109	OUT	01/01/2013	16:59:37	247	35789004232353	405-54-576-2

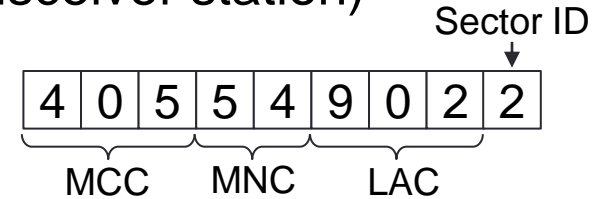
Cell ID

❑ Cell ID is used to uniquely identify BTS (base transceiver station)

❑ Comprises of four components

- Mobile Country Code (MCC): first 2-3 digit
- Mobile Network Code (MNC): next 2-3 digit
- Location Area Code (LAC): variable length
- Sector ID (SID): last digit

❑ Device is always associated with a BTS



Tower Dump

SUBS NO	OTHER PRTY NO	Date	TIME	Dur	CELLID FIRST	CELLID LAST	REC TYPE	SUBS IMEI	SUBS IMSI	SUBSCRIPTION TYPE	SMS CENTER NO	MSCID
9197XXXXX772	9177XXXXX344	8/20/2013	05:01:51	25	11971-20/8	11971-20/8	MOC	359326022655600	405804191782627	PRE	?	919762099002
9181XXXXX996	9183XXXXX714	8/20/2013	05:10:29	1	13311-20/8	13311-20/8	SMMT	358650031107530	405804191482793	PRE	919823000040	919762099002
9197XXXXX131	9198XXXXX217	8/20/2013	05:38:48	94	13311-20/8	13311-20/8	MTC	359351043644880	405804170433460	POST	?	919762099002
9187XXXXX730	9187XXXXX108	8/20/2013	05:53:03	1	13311-20/8	13311-20/8	SMMO	355672050976690	405804181584703	PRE	919716099155	919762099002

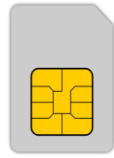
Challenges with Mobile Networks

- ❑ No uniformity between CDR format
- ❑ Correlation among multiple CDR
- ❑ Difficulty in analyzing tower dump
 - Huge amount of data
 - Difficulty in extraction of useful information
- ❑ Non availability of live tower data

Sources of Information



Call history
Location
Tracking



IMSI
ICCID
Contacts
SMSs



Audio
Video
Backup



IMEI
Contacts
SMSs
Call History
Location



Behavior
Emails
Photos
Location

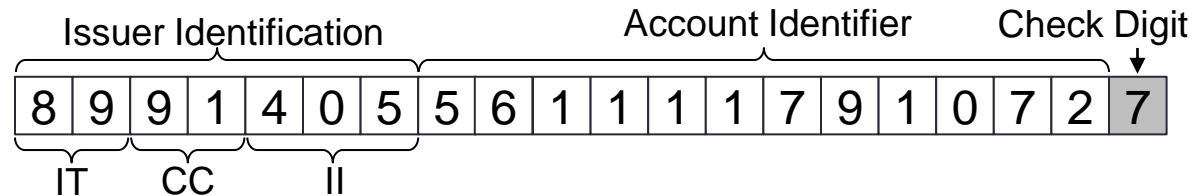
Subscriber Identity Module (SIM)

- ❑ Identifies/authenticates a subscriber to the network
- ❑ Two Unique Identities
 - ICCID
 - IMSI – (Programmable)
- ❑ Storage for contacts, SMSs, etc...

Integrated Circuit Card ID (ICCID)

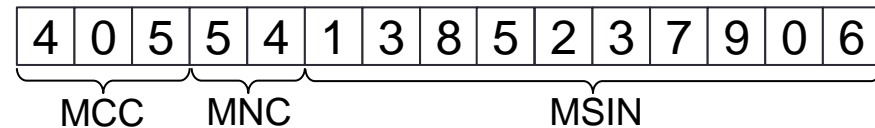
- ❑ It is a SIM serial number
- ❑ 19 or 20 digit length
- ❑ Service provider can identify phone number from ICCID
- ❑ Reveals country of origin, Industry Type, and network
 - Issuer Identification Number: composed of industry type (first 2 digit), country code (next 2-3 digit), and issuer identifier (next 1-4 digit)
 - Individual account identification: Variable length
 - Check digit – Last digit of ICCID

IT: Industry Type
 CC: Country Code
 II: Issuer Identifier



International Mobile Subscriber Identity (IMSI)

- ❑ Used by the network to identify subscriber
- ❑ 15 digit number
- ❑ Stored on the SIM card (programmed by the network provider)
- ❑ Reveals name and country of issuing service provider
 - Mobile Country Code (MCC): first 2-3 digit
 - Mobile Network Code (MNC): next 2-3 digit
 - Mobile Subscriber Identification Number (MSIN): remaining digits



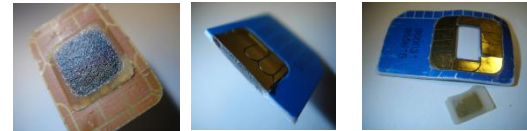
Challenges with SIM

❑ Issue with ICCID

- Partial ID is printed on SIM card
- No printed information about ICCID



❑ Damaged SIM card



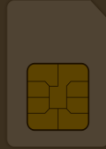
❑ eSIM



Sources of Information



Call history
Location
Tracking



IMSI
ICCID
Contacts
SMSs



Audio
Video
Backup



IMEI
Contacts
SMSs
Call History
Location



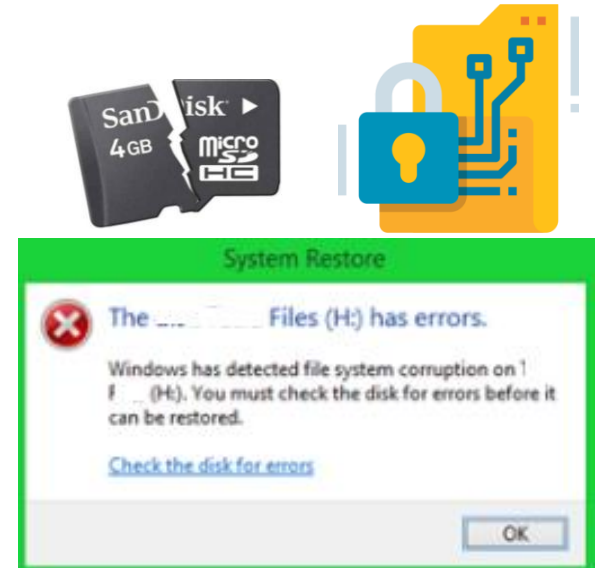
Behavior
Emails
Photos
Location

Memory Card

- ❑ Serves as secondary storage for mobile
- ❑ Use file system to store information mostly FAT
- ❑ Stores Audio, video, photos, backup, etc...

- ❑ Challenge:

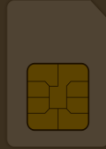
- Damaged memory card
- Corrupted file system
- Encryption



Sources of Information



Call history
Location
Tracking



IMSI
ICCID
Contacts
SMSs



Audio
Video
Backup



IMEI
Contacts
SMSs
Call History
Location



Behavior
Emails
Photos
Location

Mobile Handset

❑ Just Looking

- Make / Model
- Condition
- Age
- Capabilities
- Network type 2G, 3G, 4G, Others

❑ Rich source of information

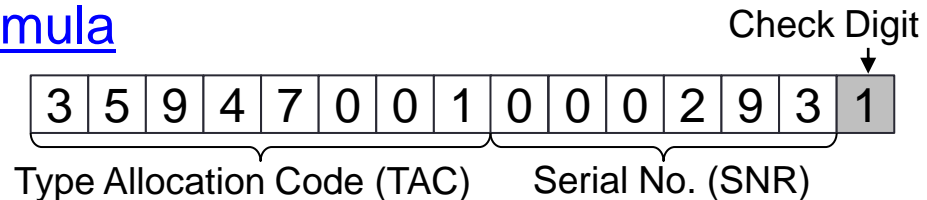
- Contacts, images, videos, call logs, SMSs, etc..

❑ Uniquely identified by using IMEI



International Mobile Equipment Identifier (IMEI)

- ❑ Kind of serial number of the handset, (15 digit long)
- ❑ Intended to be unique
 - Can be reprogrammed with specialized equipment (illegal)
- ❑ Can reveal (First eight digits, TAC)
 - Make, mode, date and country of origin
- ❑ Serial Number (next six digits)
- ❑ Check digit (last digit)
- ❑ Can be validated by using [Luhn formula](#)



Information of Interest

Basic Information

- IMEI
- H/W and S/W information
- Network Information

Event Logs

- Incoming, outgoing missed call history
- SMS history
- Session logs – Wi-if, GPRS/3G/4G

Calendar Events

- Meetings, reminders
- Last modification

Tasks

- Description
- Deadline, priority
- Completion date & time

Messaging System

- Text and multimedia messages
- BIO messages: vCard, configurations, and others
- Beamed messages: file sent via Bluetooth, IT or USB

Information of Interest cont..

GPS Navigation

- Last fixed GPS coordinates
- Search and Routes history
- Saved maps, favorite places

Location Tagger

- GPS coordinates in camera snapshots
- Cell tower coordinates in camera snapshots
- Cell tower coordinates for SMS, calls

IM Clients

- IP, Login (UID, email) and password*
- Contact list
- Chat and call history

Contact Info

- Caller groups
- Speed dials

Apps

- Multiple Apps with their storage capacity
- Like social media activities, emails, web history, etc..

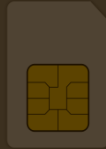
Challenges with Mobile Device

- ❑ Multiple smartphone vendors and OS(es)
- ❑ Mobile platform security features
- ❑ Generic state of the device
- ❑ Anti-forensic techniques
- ❑ Dynamic nature of evidence
- ❑ Accidental reset
- ❑ Device alteration
- ❑ Phone lock
- ❑ Malicious Programs
- ❑ Multiple communication point
- ❑ Legal issues

Sources of Information



Call history
Location
Tracking



IMSI
ICCID
Contacts
SMSs



Audio
Video
Backup



IMEI
Contacts
SMSs
Call History
Location



Behavior
Emails
Photos
Location

Applications (Apps)

- ❑ Can be used to analyze behavior/state of person
 - Social gathering, health condition, etc..
- ❑ App stores local data in SQLite database
- ❑ Application analysis can give type of information and metadata about an App

- ❑ Challenge:
 - Different architecture for different Apps
 - Dynamic nature – behave differently in different environment
 - Use of encryption to store data
 - Correlations between Apps

CASE STUDY

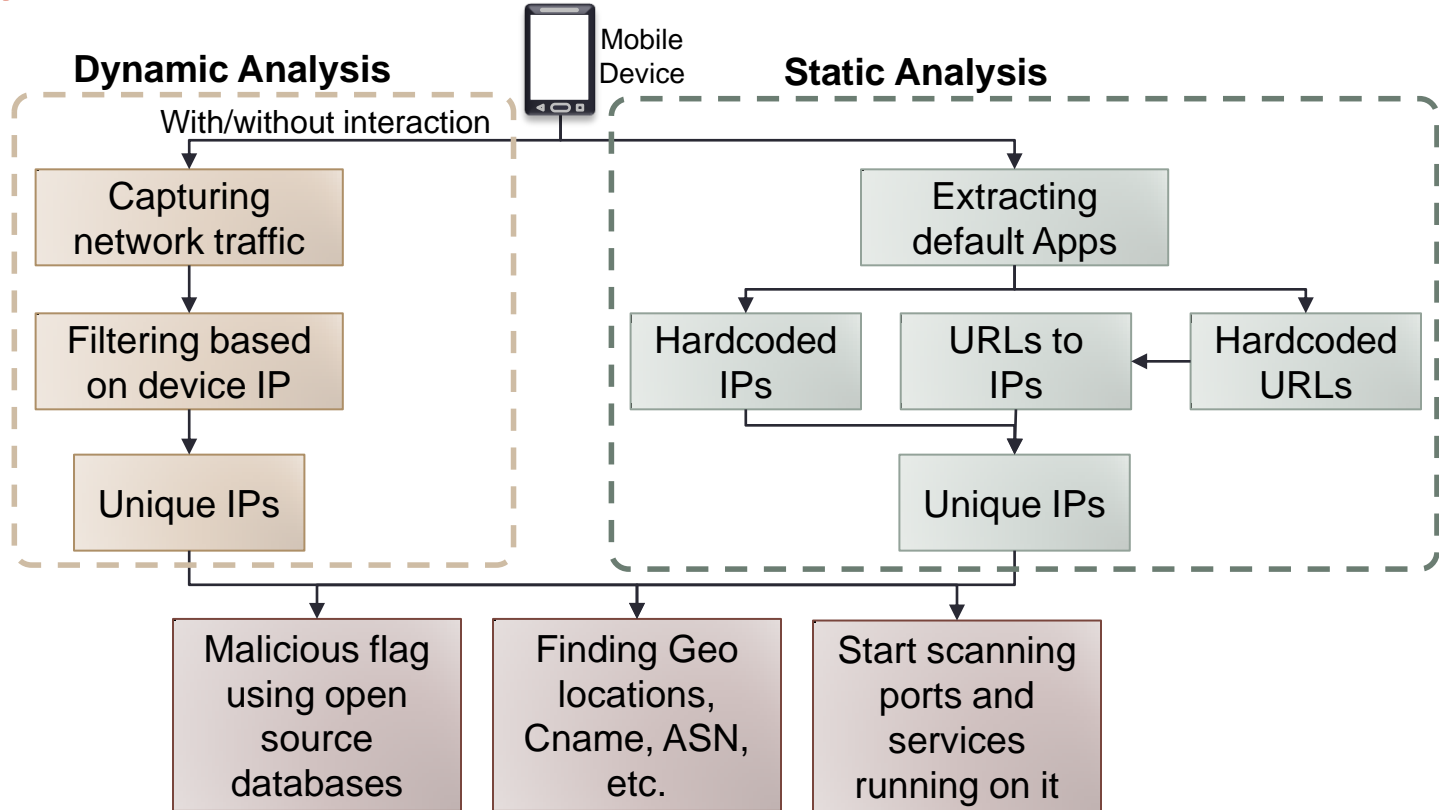
VAPT of Mobile Devices

Why VAPT of Mobile Devices?

- ❑ In September 2021 (Lithuania Government)
 - Malicious activities by Xiaomi Mi 10T mobile
 - Communication to outside server
 - Censoring certain terms and phrases

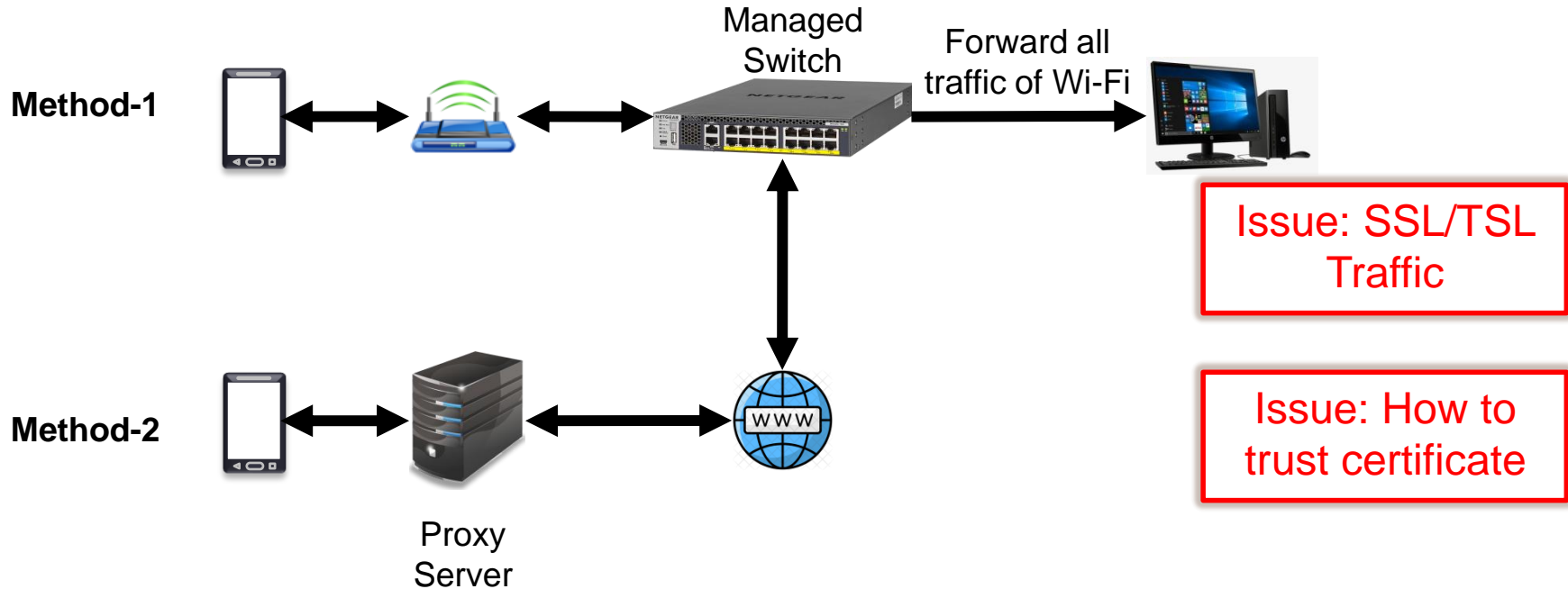
- ❑ C3i Hub at IIT Kanpur decided to test new Xiaomi Mi 10T device available in the Indian market

Analysis Workflow



How to Monitor Network traffic

❑ Two ways.



VAPT OF XIAOMI MI 10T

Analysis of Device

- ❑ Three scenarios
- ❑ First, Network traffic analysis without interaction
- ❑ Second, Traffic analysis with interaction
- ❑ Third, Static analysis of default applications (Apps)

Traffic Analysis Without Interaction

Configuration

- Did not configured Google account
- No third-party app installed
- No alteration to device such as rooting
- Connected with Wi-Fi router
- Wi-Fi router is connected with managed switch
- Port mirroring to get network traffic on a system

Results and Observation

- 188 unique IPs
- Active SSH connection to the device from IP 165.XXX.189.245. IP is not present in IP Abuse database.
- Communication with custom port (5222 seems web based SSH) with two IPs (13.XXX.155.113, 13.XXX.235.56). IP 13.XXX.235.56 was flagged malicious by VirusTotal.com

Traffic Analysis With Interaction

Configuration and conditions

- Connected with Wi-Fi router
- Wi-Fi router is connected with a managed switch
- Port mirroring to get network traffic on a system and started capturing
- Creating an Mi account and start interacting with the phone
- Storing sensitive data such as photos, videos. Text files etc., with file name such as password, username ..

Static Analysis: Default Apps

Procedure

- 89 default Apps
- Extracted using ADB
- From each application extracted hardcoded:
 - IPs
 - URLs
- Obtained unique IPs/URLs
- Search of IPs/URLs in publicly known databases to flag malicious IP/URLs

Results: Traffic Analysis with Interaction and Static Analysis of Default Apps

Results and Observation

- 1533 Unique IPs associated with Apps
- Two IP (129.226.107.102, 129.226.106.5) belongs to Tenecent Cloud Computing (Beijing) Co.
- 15 malicious IP flagged by different services of Virustotal
 - Services: Webroot, Comodo Valkyrie Verdict, EST security-Threat inside
 - Malicious IPs: 163.XXX.208.212, 185.XXX.111.153, 185.XXX.108.153, 185.XXX.110.153, 185.XXX.109.153, 157.XXX.158.198, 157.XXX.163.158, 221.XXX.79.225, 104.XXX.20.226, 104.XXX.21.226, 151.XXX.128.14, 157.XXX.163.158, 157.XXX.158.198

hands ON



<https://github.com/skmtr1/Workshop-Mobile-Forensics-And-Security>

Thank You