USING IN-BUILT ANDROID SENSORS TO MAP PHYSICAL ACTIONS FOR NFC SECURITY

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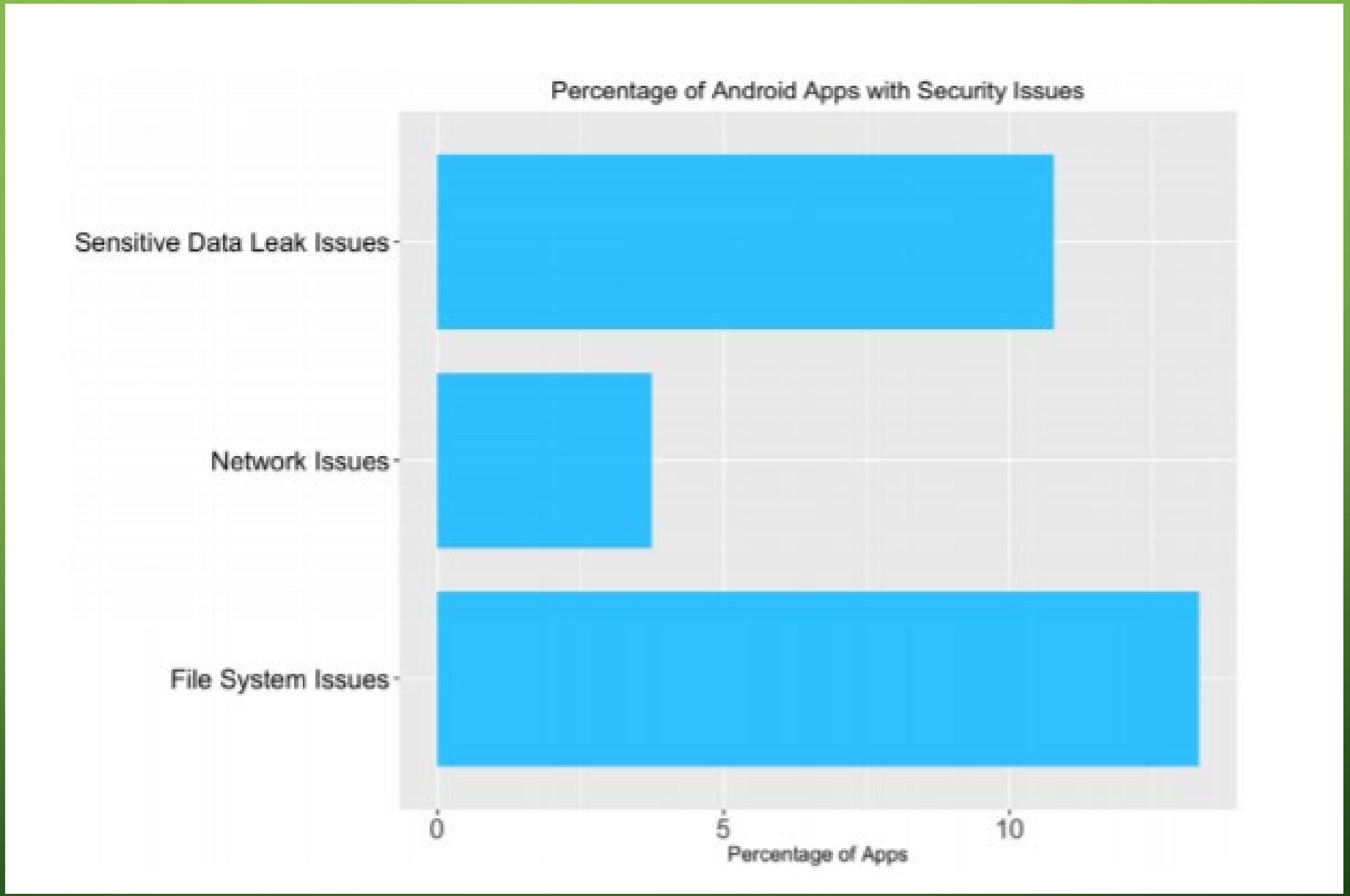
PROBLEM STATEMENT

- Phone-to-Phone NFC wireless file transfers for everyday users can be exploited by hackers
- Third-party devices can easily “listen” in on these transfers to:
  - Copy the files
  - Modify/Spoof the files
  - Delete the file
- The influx of cybersecurity exploits related to websites and corporations has shifted concern away from smartphones and other mobile devices



2016 NowSecure Mobile Security Report

RESEARCH TOPIC

- Applications of In-Built Android Sensors to Map Physical Actions for NFC Communications

DEFINITIONS

- **Phone Sensors-** Accelerometer, Gyroscope, Proximity and Light
- **Android phone-** Samsung Galaxy S7
- **Physical Actions-** Mapping one's physical actions to sensor data
- **NFC Communication-** Apple Pay, Samsung Pay, Shopping Automation, File to File Transfer

HYPOTHESIS

- User will be prompted for physical action before NFC transfer begins
- User will conduct physical action with the phone in their hand
- **A physical action baseline can be established through the sensor data.**
  - **1 sensor → 1 physical action for 4 sensors**
- Only once the sending phone's sensor data has been verified with the motion required will the data be allowed to transmit.

SIGNIFICANCE OF STUDY

- 8 out of every 10 phones in the world use the Android operating system (McAfee Mobile Threat Report)
- Successful completion of this study would prove physical actions can be mapped using sensor data
- Data and methods from this study can be used to further secure phone security through other sensor authentication projects.

METHOD OF INQUIRY

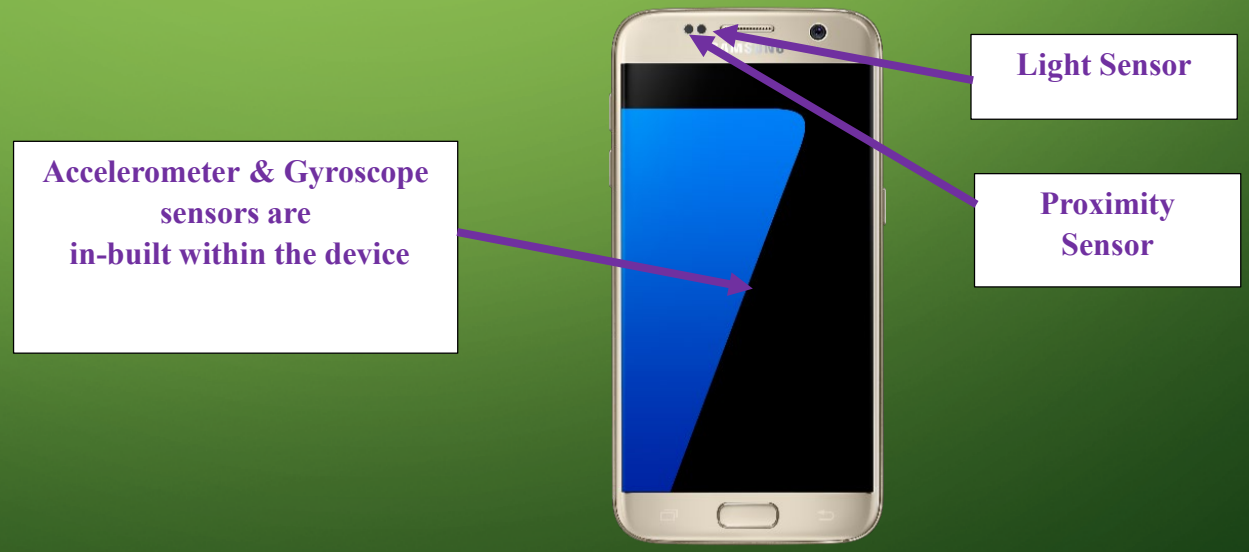
- Analyzing Sensors and Determining Effectiveness of Each- **Qualitative**
- Gathering Sensor Data and Establishing P.A Baselines- **Quantitative**

Steps To Be Done

- ***Choosing In-Built Sensors Relative to NFC's Range***
- ***Determining Physical Actions with Device***
- ***Extracting Sensor Data from Physical Action***
- ***Mapping Each Physical Action to Sensor Data subset***

DEVICE AND SENSORS CHOSEN

- A Samsung Galaxy S7 was chosen as the testing device from which the sensor data was extracted
- Sensors chosen that complement the relatively short range of NFC transfers
  - Light
  - Proximity
  - Accelerometer
  - Gyroscope

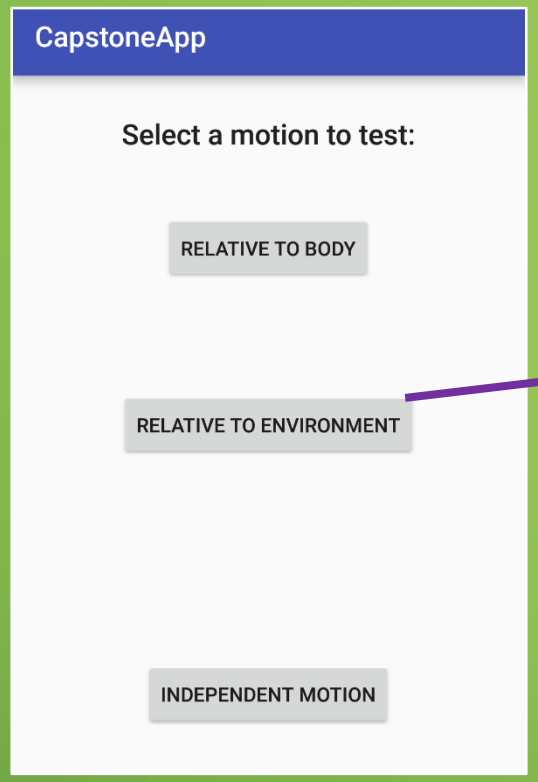


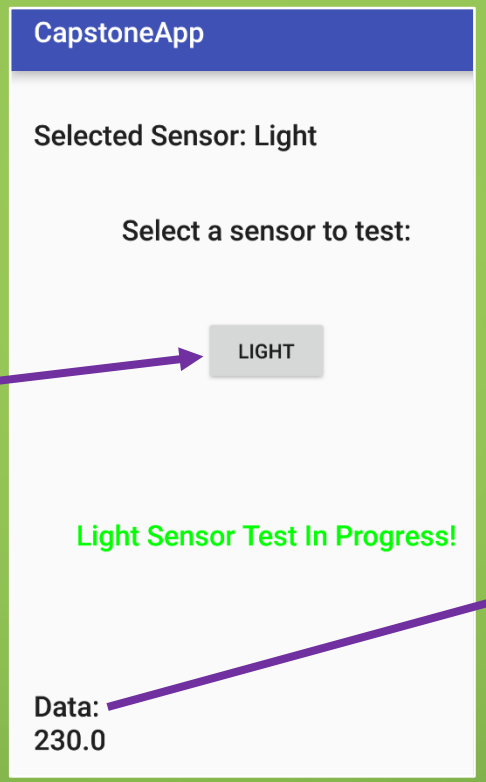
PHYSICAL ACTIONS WITH DEVICE

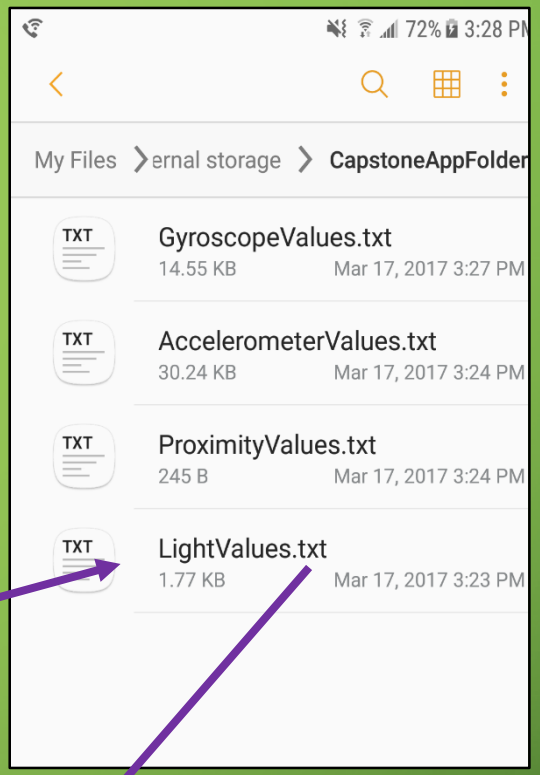
- Physical Actions fall under 3 categories:
  - Movement of Phone Relative to Body- Placing phone near/far object
  - Movement of Phone Relative to Environment- Placing phone relative to light
  - Movement of Phone Independent of External Factors – Flipping, titling, rapid motion
- Each physical movement was designed to have one associated sensor that could be used to distinguish the movement from others

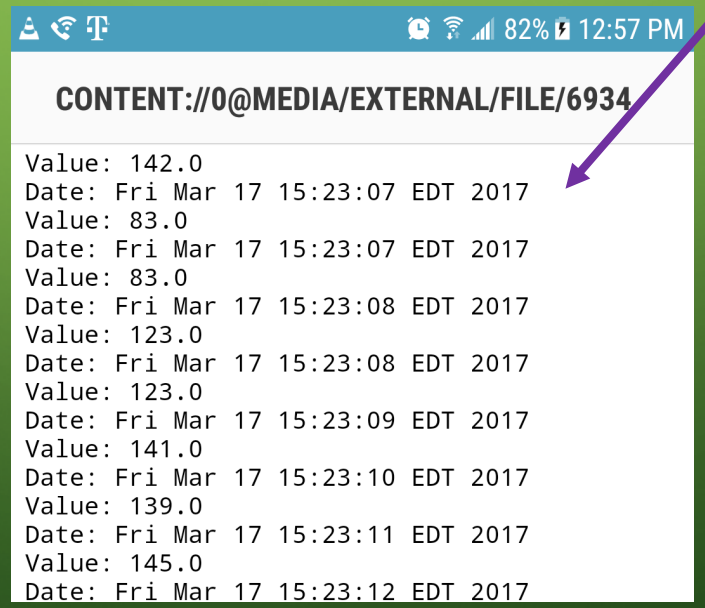
EXTRACTING SENSOR DATA

- An application was developed within Android Studio to extract sensor data during physical action
- Pre-compiled pieces of code called libraries and interfaces were used to convert sensor data from electrical signals to integers and values.
- During each physical action, the associated sensor value and a timestamp were logged in a text-file stored within the phone


CapstoneApp
Select a motion to test:
RELATIVE TO BODY
RELATIVE TO ENVIRONMENT
INDEPENDENT MOTION

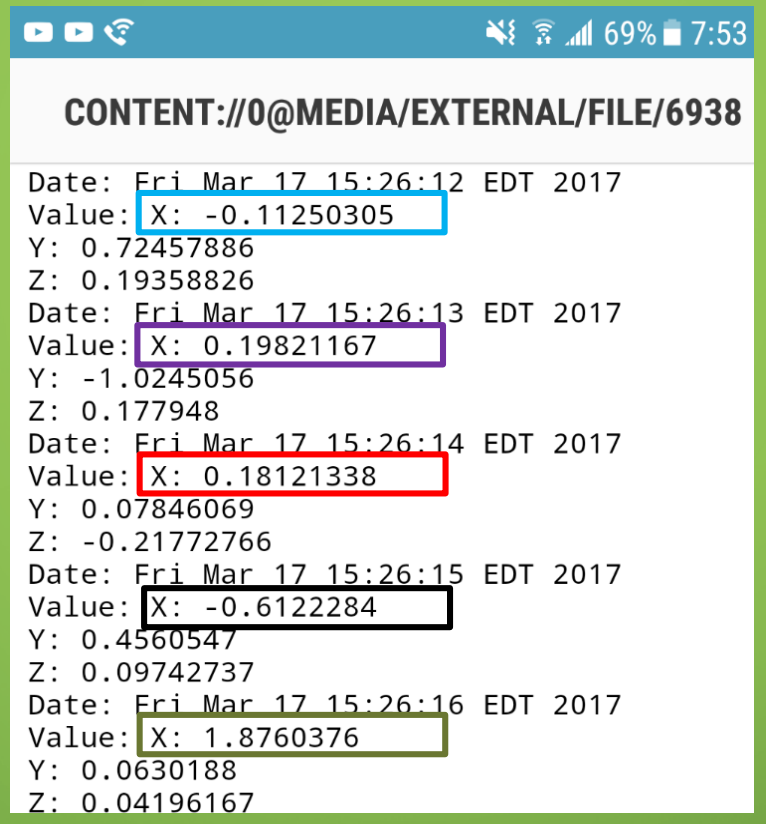

CapstoneApp
Selected Sensor: Light
Select a sensor to test:
LIGHT
Light Sensor Test In Progress!
Data:
230.0


72% 3:28 PM
My Files > ernal storage > CapstoneAppFolder
TXT
GyroscopeValues.txt
14.55 KB Mar 17, 2017 3:27 PM
TXT
AccelerometerValues.txt
30.24 KB Mar 17, 2017 3:24 PM
TXT
ProximityValues.txt
245 B Mar 17, 2017 3:24 PM
TXT
LightValues.txt
1.77 KB Mar 17, 2017 3:23 PM


82% 12:57 PM
CONTENT://0@MEDIA/EXTERNAL/FILE/6934
Value: 142.0
Date: Fri Mar 17 15:23:07 EDT 2017
Value: 83.0
Date: Fri Mar 17 15:23:07 EDT 2017
Value: 83.0
Date: Fri Mar 17 15:23:08 EDT 2017
Value: 123.0
Date: Fri Mar 17 15:23:08 EDT 2017
Value: 123.0
Date: Fri Mar 17 15:23:09 EDT 2017
Value: 141.0
Date: Fri Mar 17 15:23:10 EDT 2017
Value: 139.0
Date: Fri Mar 17 15:23:11 EDT 2017
Value: 145.0
Date: Fri Mar 17 15:23:12 EDT 2017

MAPPING SENSOR DATA TO PHYSICAL ACTION

- Each action was conducted 20 times to minimalize the effect of outliers within data subset
- The values logged in the text file were converted into an Excel file to be analyzed
- The timestamps within sensor data were compared to timing of actual physical activity to determine if baseline could be established



Action	**Sensor**	Sensor Data Time Total	
Tilting phone forwards (relative to user)	**Gyroscope**	4 seconds	
Time	**Visible Motion**	Sensor Data Value	**Sensor Data Trend**
0th second (starting)	Phone is lying face-up on stationary table	-0.11 X	Approximately 0 for each axis
1st second	User picks up phone and begins to tilt phone towards them slightl	0.19 X	X value increases 0.2 °/s
2nd second	User stops tilting and holds phone stationary	0.18 X	All axes relatively constant
3rd second	User accidentally tilts phone backwards (heard wrong prompt)	**-0.61 X**	X value decreases by 0.7 °/s
4th second	User corrects themselves and tilts phone forward fully	**1.87 X**	X value increases by 2.4 °/s

DATA AND RESULTS OBTAINED

Name of Physical Activity	Type of Physical Activity	Average Duration of Physical Activity	Intended Sensor with Physical Activity	Trend/Baseline established with sensor data
Placing phone against chest	Relative to Body	3 seconds	Proximity	Data value was 0
Placing phone in palm (face-up)	Relative to Body	2.5 seconds	Proximity	Data value was 8.000183
Placing phone face-down or in dimly lit setting	Relative to Environment	3.5 seconds	Light	Data value was <50
Placing phone facing sky/light-source	Relative to Environment	1.5 seconds	Light	Data value was >50
Flipping phone face-up	Independent to external factors	1 second	Accelerometer	Inconclusive
Flipping phone face-down	Independent to ext.	2.5 seconds	Accelerometer	Inconclusive
Tilting phone forwards (relative to user)	Independent to ext.	3.5 seconds	Gyroscope	Positive X-axis value
Titling phone backwards (rel. to user)	Independent to ext.	2 seconds	Gyroscope	Negative X-axis value
Moving phone rapidly in linear direction	Independent to ext.	1.5 seconds	Accelerometer	Positive X, Y, and Z-axes values

CONCLUSION & IMPLICATIONS

- Baselines could be established for 7 out of the 9 physical actions
- Flipping phone face-up and face-down could not be identified with accelerometer, but could with accelerometer and gyroscope
- Using two sensors to check a physical motion won't be practical in implementation
- Results prove it is possible to map certain physical actions to an established sensor data trend which can be used in future authentication applications
- Limitations include small pool of physical actions to choose from and a delay within NFC interactions

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