CARLOS III UNIVERSITY OF MADRID

HIGHER TECHNICAL SCHOOL



MASTER IN CYBERSECURITY

MASTER THESIS

TARGETED EXERCISER FOR ANDROID MALWARE AND GRAYWARE

**Author**: Mario Herreros Díaz

**Mentors**: Juan E. Tapiador, Guillermo Suarez-Tangil

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**Abstract**

Nowadays each person has one or more mobile device (smartphones, tablets, wearables, etc) with similar characteristics and performance of a personal computer. Many people use these devices to check their email or make bank transfers. For this, these devices store a lot of sensitive information that it could be very attractive to an attacker.

Mobile devices share same security troubles can be found in a conventional computer as malware hidden inside apps or users that don’t use nor protect their correctly.

Malware has evolved and is able to by pass protection systems and works only under certain circumstances to avoid detection. Some kind of malware is activated depends of network connection, device location, apps installed, calls received or other type of events.

The purpose of this Master Thesis is to study the behavior of malware on mobile devices depending of the device context, focusing on Android operating system. It has developed a system that allows dynamic and automatic generation of many different contexts to study the behavior of Android malware in each of the different scenarios.

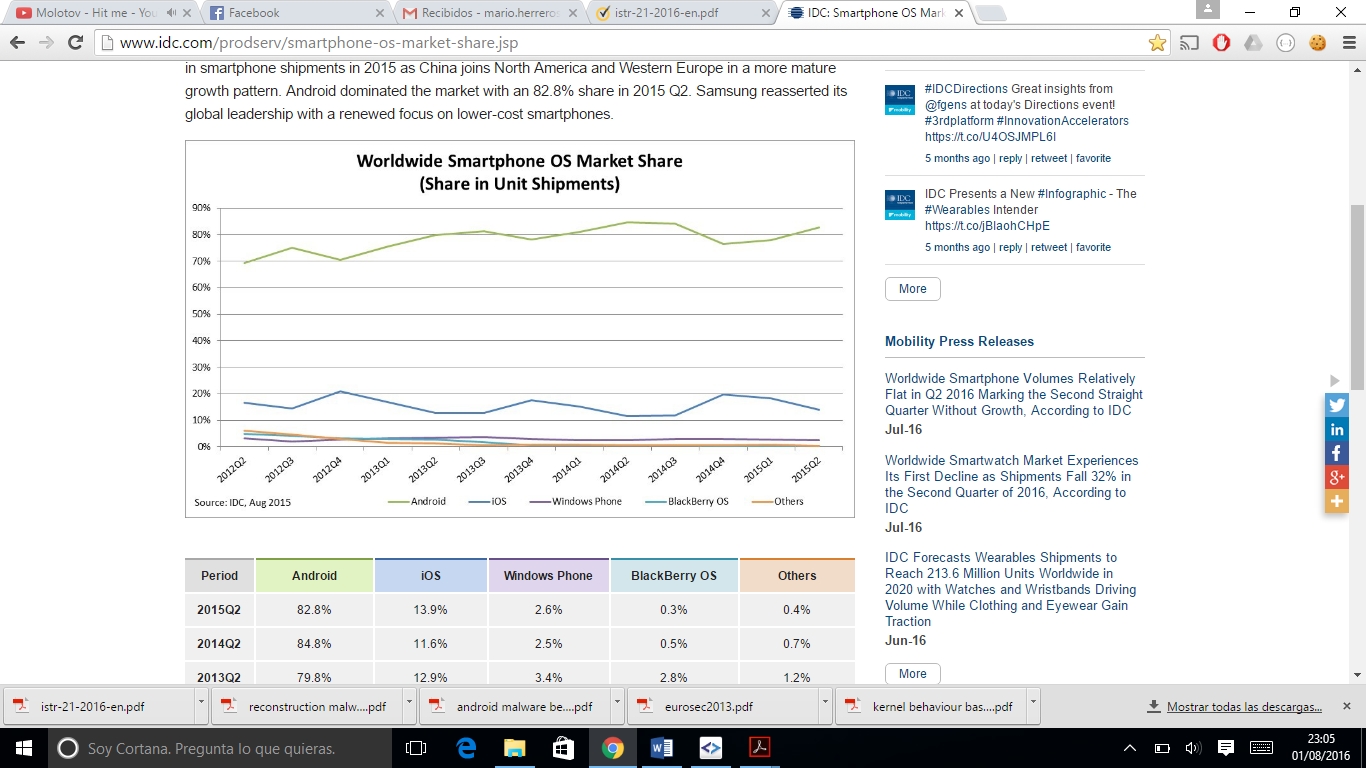
It has been designed a technique based on developing of a new language which defines each of the scenes and events to execute over the device to analyze the malware, in order to study their behavior depending on the characteristics of each context. In this way, it can detect the context features that makes triggering the malicious malware or greyware actions.

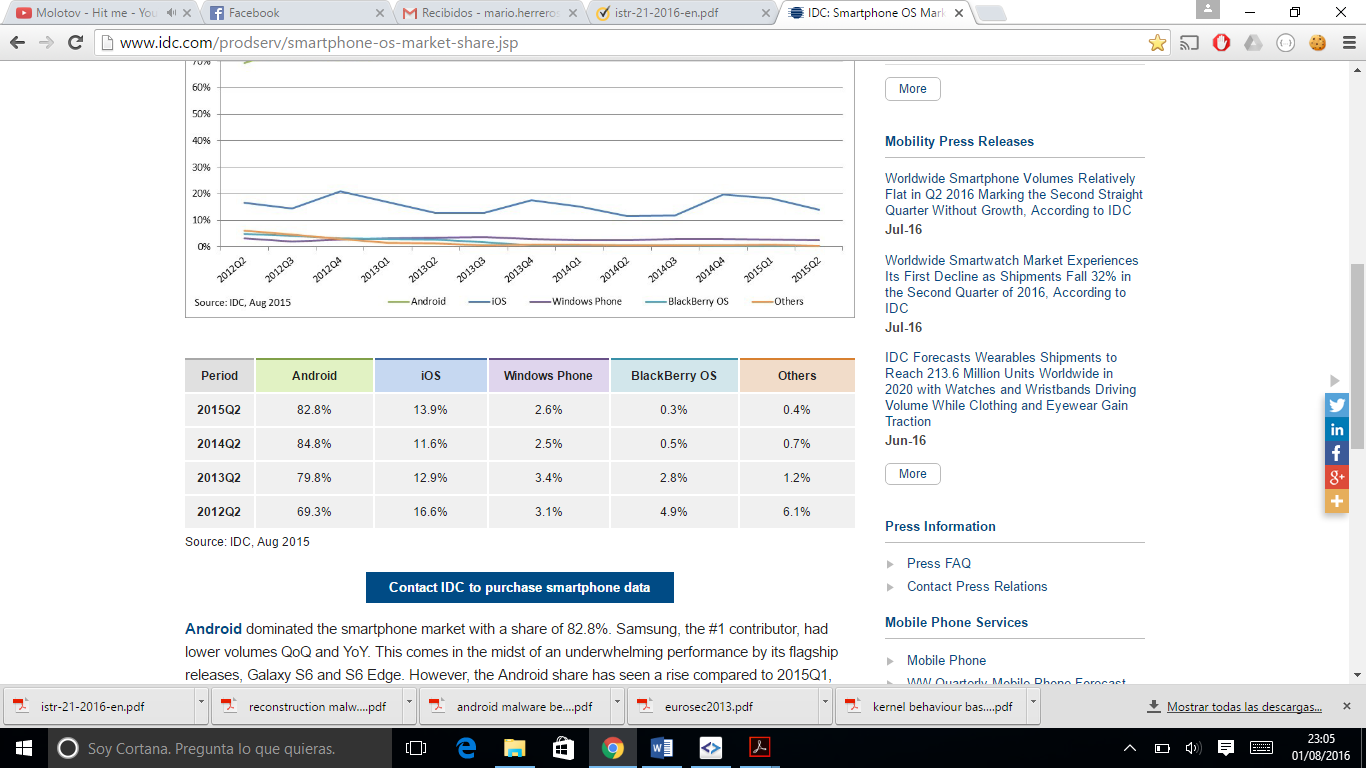
This Thesis focuses on analyzing all possible Android events to define a language and developing a system available to understand it and generate automatic executions to launch these events. With this system it is possible detect malware and grayware that a convetional static and dynamic analysis could not detect.

*Keywords: Malware, Greyware, Android, Context, Malware detection, Dynamic analysis, Mobile device, Malware behaviour*

1. **Introduction**

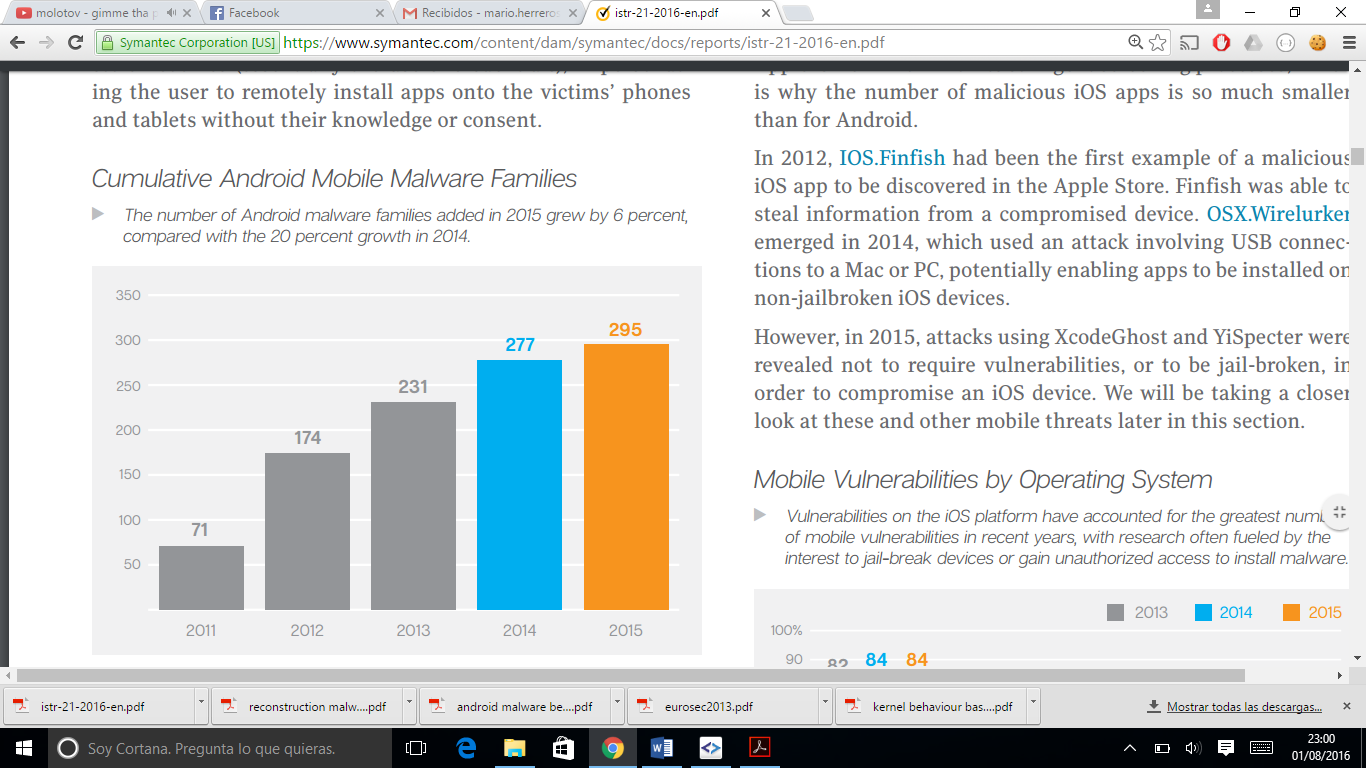
Nowadays mobile devices are very present within society and every people uses them in their personal and laboral life. The most popular smartphone OS is Android with a market share between 82 – 84 %, for this reason Android is the platform most targeted by malware and greyware.



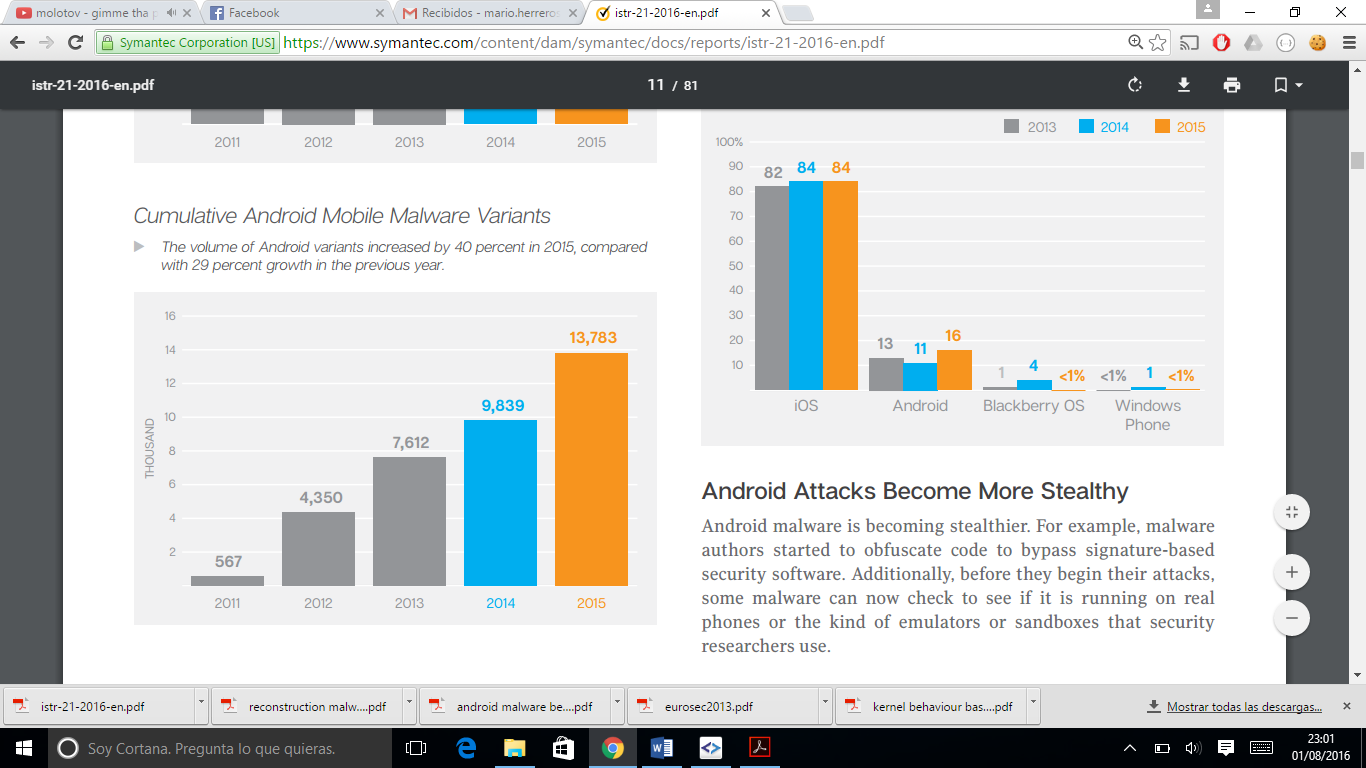


[**http://www.idc.com/prodserv/smartphone-os-market-share.jsp**](http://www.idc.com/prodserv/smartphone-os-market-share.jsp)

The amount of Android malware families has been incremented very significantly in recent years, it being categorized 295 different families



An important fact is the variability of the Android malware. There are thousand types of malware althought, the target functionality is similar. During the last years, the variability of malware has been rised considerably, reaching in 2015 the number of 13,783 thousand types.



The powerful capabilities of mobile devices in networking, computing and sensing has increased the complexity, power and variability of malware.

This allows the malware can evolve and adopt very specific functionality. There is a type of malware that focuses on a specific victims, known as malware targeted.  
This type of malware focuses on user behavior using his smartphone and other factors relating to him, such as his location, the information handled or applications installed in the device.

The main advantage of targeted malware against security systems is their difficult detection. This is due to the fact that only they execute his malicious code if a concrete context is fulfilled. This situation causes the need to use a lot of resources to detect this type of malware.

In the application stores a large number of applications that must be analyzed before publication are received each day.This causes malware analysis are not made sufficiently comprehensive to detect targeted malware.

This problem can be alleviated by using dynamic analysis techniques that allow the generation of different contexts and behaviors in an agile and automatic way.

1. *Motivation*

Deficiencies in malware detection systems and strong growth of the power and complexity of malware has caused the existence of a major security threat on mobile devices.

The analysis of targeted malware is a costly task, so the development of a system that will facilitate and automate the analysis can alleviate this problem existing in mobile security nowadays.

Focusing on Android system, which is one of the most affected OS by mobile malware, it has developed a system able to define and execute different behaviors and contexts, in an effective manner using a virtual sandbox.

1. *Main contributions*

This work provides the following contributions:

1. An analysis and study of Android system and architecture for inject different kind of events and context.
2. An analysis and study of targeted malware, focusing on key behaviors and contexts that used to trigger the malware.
3. Generation of a new language to easily define a set of behaviors based on different scenarios and contexts.
4. An analysis and developing of a new system, based in Targetdroid,   
   capable of computing the new defined language and generate a dynamic analysis based on the contexts and behaviors.
5. *Structure of the document*

The remainder of this document is structured as follows. First, section II presents the related work regarding Android targeted malware and Targetdroid.

Finally, Section III presents a series of recommendations and discusses about the importance of the security measures in Android malware and other Smartphone systems, and Section IV concludes the work.

Additionaly, two appedix…

1. **Background and related work**

The precursor knowledge of this thesis is the investigation explained in *Detecting Targeted Smartphone Malware with Behavior-Triggering Stochastic Models*. This investigation focuses on the needle of detect targeted malware in smartphones. For this, it has developed a system called Targetdroid that transforms differents inputs in a dynamic analysis using multiple behavioral models.

This system uses models that perform different emulations of user behaviors in order to detect the context makes activate the targeted malware or greyware. This system was based on Stochastic Models Triggering as Markov.

The principal problem is reproduce an appropriate set of conditions that will trigger the malicious behaviour. It is necessary execute all possible states and combinations in the worst case. In this paper, it has proposed a novel system for mining the behaviour of apps in different user-specific contexts and usage scenarios.

The target of this thesis focuses on evolving this system to accept flexible inputs and achieve a better definition of the user behavioral.

Other authors also studied the problema of detecting targeted malware such as PyTrigger, focusing on Personal Computers (PC), or CupperDroid that generates different behavioral profiles automatically to analyze malware.

1. **TargetDroid**

En esta sección se va a definir el Sistema desarrollado que extiende la funcionalidad de Targetdroid aceptando un Nuevo modelo.

1. Behavioural User Language

Se ha diseñado un lenguaje que permite la definición del comportamiento del usuario utilizando una jerarquía de escenarios, contextos y eventos.

Este lenguaje se trata de un JSON que cumple una determinado estructura y viene definida por el siguiente json schema (enlace).

Este lenguaje será utilizado para la generación de ficheros de comportamiento, utilizados como input e interpretados por el Sistema desarrollado para generar análisis dinámicos sobre un cloud (un emulador Android en este caso).

El lenguaje se estructura en los siguientes artefactos:

* Escenario: es un conjunto de contextos.
* Contexto: es un cojunto de eventos.
* Evento: acción atómica realizada sobre el Sistema cloud.

***Escenario***

Este artefacto define todos los posibles escenarios que se quieren ejecutar para simular un comportamiento específico de usuario.

La definición de escenarios permite realizar análisis en el que se quiera mantener configuraciones de contexto.

***Contexto***

Este artefacto define todos los posibles eventos que pueden ser realizados durante la simulación de comportamiento de usuario determinados por un momento en el tiempo.

Existen tres tipos de contextos diferentes:

* Contexto de configuración de emulador (t = -1)

En este contexto se define todas las propiedades al entorno en el que se van a ejecutar el resto de cotextos, es decir define las características del emulador que va a ser utilizado como sandbox durante el análisis dinámico.

Engloba todos aquellos eventos que van a ser ejecutar en el momento igual a -1 (utilizando una linea temporal como representante de la ejecución).

* Contexto de configuración del OS (t = 0)

En este contexto se define el estado inicial del sistema inicializado, es decir, configura el sistema Android emulado a nivel de sistema operativo.

Engloba todos aquellos eventos que van a ser ejecutados en el momento igual a 0, establece un estado inicial al sistema en el que se van a realizer la inyección de contextos de ejecución.

* Contexto de ejecución (t > 0)

En este context se define cada uno de los eventos que corresponderían con la manipulación del usuario con el dispositivo, como puede ser enviar un mensaje, recibir una llamada, ejecutar una aplicación o determiar una geolocalización.

Engloba todos aquellos eventos que van a ser ejecutados en momentos superiores a 0.

***Evento***

Este artefacto define cada una de las posibles acciones a realizer sobre el sistema para simular el comportamiento de un usuario.

Es la unidad atómica en este sistema y engloba un conjunto muy distinto de artefactos, desde configuraciones a nivel de hardware del emulador a llamadas Telnet que permiten emular una llamada telefónica.

**Arquitectura**

1. **Discussion**
2. **Conclusion**
3. **Future Works**

**References**

**Appendix A : json-schema**

**{**

**"$schema": "http://json-schema.org/draft-04/schema#",**

**"id": "input JSON to configure a scenario and launch android events",**

**"type": "object",**

**"required": ["name", "time"]**

**"properties": {**

**"name":{**

**"id": "scenario name",**

**"type": "string"**

**},**

**"time": {**

**"id": "definition of context in every execution time",**

**"type": "object",**

**"oneOf": [**

**{**

**"type": "object",**

**"required": ["id"],**

**"properties": {**

**"id": {**

**"id": "execution time",**

**"type": "integer",**

**"enum": [-1]**

**},**

**"emulator": {**

**"id": "emulator configuration params",**

**"properties": {**

**"name": {**

**"id": "emulator name",**

**"type": "string"**

**},**

**"port": {**

**"id": "emulator port",**

**"type": "integer"**

**},**

**"sdk\_version": {**

**"id": "emulator android version",**

**"type": "string",**

**"enum":["android-8", "android-10", "android-15", "android-16", "android-17", "android-18", "android-19", "android-20", "android-21", "android-22", "android-23"]**

**}**

**}**

**},**

**"phone": {**

**"id": "phone properties",**

**"type": "object",**

**"properties": {**

**"brand": {**

**"id": "phone brand name",**

**"type": "string"**

**},**

**"device": {**

**"id": "phone device name",**

**"type": "string"**

**},**

**"hardware": {**

**"id": "phone hardware name",**

**"type": "string"**

**},**

**"imei": {**

**"id": "phone imei",**

**"type": "string"**

**},**

**"imsi": {**

**"id": "phone imsi",**

**"type": "string"**

**},**

**"network\_provider": {**

**"id": "phone network provider name",**

**"type": "string"**

**}**

**}**

**},**

**"network": {**

**"id": "network properties",**

**"type": "object",**

**"properties": {**

**"IP": {**

**"id": "phone IP",**

**"type": "string"**

**},**

**"DNS": {**

**"id": "phone DNS server",**

**"type": "string"**

**}**

**}**

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**"type": "object",**

**"properties": {**

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**"id": "The CPU Architecture to emulator",**

**"type": "string"**

**},**

**"cpu\_model": {**

**"id": "The CPU model (QEMU-specific string)",**

**"type": "string"**

**},**

**"ram\_size": {**

**"id": "Device ram size",**

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**},**

**"screen\_type": {**

**"id": "Defines type of the screen",**

**"type": "string"**

**},**

**"main\_keys": {**

**"id": "Hardware Back/Home keys",**

**"type": "boolean"**

**},**

**"track\_ball": {**

**"id": "Track-ball support",**

**"type": "boolean"**

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**"keyboard": {**

**"id": "Whether the device has a QWERTY keyboard",**

**"type": "boolean"**

**},**

**"keyboard\_lid": {**

**"id": "Whether the QWERTY keyboard can be opened/closed",**

**"type": "boolean"**

**},**

**"keyboard\_charmap": {**

**"id": "Name of the system keyboard charmap file",**

**"type": "string"**

**},**

**"d\_pad": {**

**"id": "Whether the device has DPad keys",**

**"type": "boolean"**

**},**

**"gsm\_modem": {**

**"id": "phone DNS server",**

**"type": "string"**

**},**

**"gps": {**

**"id": "Whether there is a GPS in the device",**

**"type": "boolean"**

**},**

**"battery": {**

**"id": "Whether the device can run on a battery",**

**"type": "boolean"**

**},**

**"accelerometer": {**

**"id": "Whether there is an accelerometer in the device",**

**"type": "boolean"**

**},**

**"audio\_input": {**

**"id": "Whether the device can record audio",**

**"type": "boolean"**

**},**

**"audio\_output": {**

**"id": "Whether the device can play audio",**

**"type": "boolean"**

**},**

**"sd\_card": {**

**"id": "Whether the device supports insertion/removal of virtual SD Cards",**

**"type": "boolean"**

**},**

**"sd\_card\_path": {**

**"id": "SD Card image path",**

**"type": "string"**

**},**

**"cache": {**

**"id": "Whether we use a /cache partition on the device",**

**"type": "boolean"**

**},**

**"cache\_path": {**

**"id": "Cache partition to use on the device",**

**"type": "boolean"**

**},**

**"cache\_size": {**

**"id": "Cache partition size",**

**"type": "string"**

**},**

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**"id": "LCD pixel width",**

**"type": "integer"**

**},**

**"lcd\_height": {**

**"id": "LCD pixel height",**

**"type": "integer"**

**},**

**"lcd\_depth": {**

**"id": "LCD color depth",**

**"type": "integer"**

**},**

**"lcd\_density": {**

**"id": "Abstracted LCD density",**

**"type": "integer"**

**},**

**"lcd\_backlight": {**

**"id": "LCD backlight",**

**"type": "boolean"**

**},**

**"gpu": {**

**"id": "Enable/Disable emulated OpenGLES GPU",**

**"type": "boolean"**

**},**

**"camera\_back": {**

**"id": "Configures camera facing back",**

**"type": "string"**

**},**

**"camera\_front": {**

**"id": "Whether the device can run on a battery",**

**"type": "string"**

**},**

**"heap\_size": {**

**"id": "Max VM application heap size",**

**"type": "integer"**

**},**

**"sensor\_proximity": {**

**"id": "Whether there is an proximity in the device",**

**"type": "boolean"**

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**"sensor\_magnetic\_field": {**

**"id": "Provides magnetic field sensor values",**

**"type": "boolean"**

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**"sensor\_orientation": {**

**"id": "Provides orientation sensor values",**

**"type": "boolean"**

**},**

**"sensor\_temperature": {**

**"id": "Provides temperature sensor values",**

**"type": "boolean"**

**},**

**"use\_ext4": {**

**"id": "Specifies which file system to use: ext4 of yaffs2",**

**"type": "boolean"**

**},**

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**},**

**"kernel\_parameters": {**

**"id": "kernel boot parameters string",**

**"type": "string"**

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**"type": "string"**

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**"system\_partition\_path": {**

**"id": "Path to runtime system partition image",**

**"type": "string"**

**},**

**"system\_partition\_init\_path": {**

**"id": "Initial system partition image",**

**"type": "string"**

**},**

**"system\_partition\_size": {**

**"id": "Ideal size of system partition",**

**"type": "integer"**

**},**

**"data\_partition\_path": {**

**"id": "Path to data partition file",**

**"type": "string"**

**},**

**"data\_partition\_init\_path": {**

**"id": "Initial data partition",**

**"type": "boolean"**

**},**

**"data\_partition\_size": {**

**"id": "Ideal size of data partition",**

**"type": "integer"**

**},**

**"snap\_storage\_path": {**

**"id": "Path to snapshot storage",**

**"type": "string"**

**}**

**}**

**}**

**}**

**},**

**{**

**"type": "object",**

**"required": ["id"],**

**"properties": {**

**"id": {**

**"id": "execution time",**

**"type": "integer",**

**"enum": [0]**

**},**

**"install\_app": {**

**"id": "apks to install",**

**"type": "string"**

**},**

**"timezone": {**

**"id": "timezone for the emulator",**

**"type": "string"**

**},**

**"telnet": {**

**"id": "telnet commands",**

**"type": "object",**

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**"id": "power properties",**

**"type": "object",**

**"properties": {**

**"ac": {**

**"id": "ac properties",**

**"type": { "enum": ["on", "off"] }**

**},**

**"capacity": {**

**"id": "capacity properties",**

**"type": "integer"**

**},**

**"health": {**

**"id": "power health properties",**

**"type": {"enum": ["unknown", "good", "overheat", "dead", "overvoltage", "failure"] }**

**},**

**"present": {**

**"id": "battery presence",**

**"type": "boolean"**

**},**

**"status": {**

**"id": "battery status",**

**"type": { "enum": ["unknown", "charging", "discharging", "not-charging", "full"] }**

**}**

**}**

**}**

**}**

**}**

**}**

**},**

**{**

**"type": "object",**

**"required": ["id"],**

**"properties": {**

**"id": {**

**"id": "execution time",**

**"type": "integer",**

**"minimum": 1**

**},**

**"telnet": {**

**"id": "telnet commands",**

**"type": "object",**

**"properties": {**

**"power": {**

**"id": "power properties",**

**"type": "object",**

**"properties": {**

**"ac": {**

**"id": "ac properties",**

**"type": { "enum": ["on", "off"] }**

**},**

**"capacity": {**

**"id": "capacity properties",**

**"type": "integer"**

**},**

**"health": {**

**"id": "power health properties",**

**"type": {"enum": ["unknown", "good", "overheat", "dead", "overvoltage", "failure"] }**

**},**

**"present": {**

**"id": "battery presence",**

**"type": "boolean"**

**},**

**"status": {**

**"id": "battery status",**

**"type": { "enum": ["unknown", "charging", "discharging", "not-charging", "full"] }**

**}**

**}**

**},**

**"gsm": {**

**"id": "calling events",**

**"type": "object",**

**"properties": {**

**"call": {**

**"id": "call to a number",**

**"type": "string"**

**},**

**"accept": {**

**"id": "accept a call",**

**"type": "string"**

**},**

**"busy": {**

**"id": "busy a call",**

**"type": "string"**

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**"cancel": {**

**"id": "cancell a call",**

**"type": "string"**

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**"type": { "enum": ["unregistered", "home", "roaming", "searching", "denied", "off", "on"] }**

**},**

**"voice": {**

**"id": "voice connection status",**

**"type": { "enum": ["unregistered", "home", "roaming", "searching", "denied", "off", "on"] }**

**}**

**}**

**},**

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**"id": "send a sms message",**

**"type": "object",**

**"properties": {**

**"number": {**

**"id": "number phone to send a sms",**

**"type": "string"**

**},**

**"text": {**

**"id": "message",**

**"type": "string"**

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**"required": [ "number", "sms" ]**

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**"id": "location events",**

**"type": "object",**

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**"fix": {**

**"id": "http://jsonschema.net/t1/geo/fix",**

**"type": "object",**

**"properties": {**

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**"id": "longitude",**

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**"latitude": {**

**"id": "latitude",**

**"type": "string"**

**},**

**"altitude": {**

**"id": "altitude",**

**"type": "string"**

**},**

**"required": [ "longitude", "latitude" ]**

**}**

**},**

**"nmea": {**

**"id": "nmea",**

**"type": "string"**

**}**

**}**

**}**

**}**

**},**

**"adb": {**

**"id": "adb popular commands",**

**"type": "array",**

**"properties": {**

**"action": {**

**"id": "adb action name",**

**"type": "string",**

**"enum": ["connect\_wifi", "lock\_screen", "unlock\_screen", "volume\_up", "go\_home", "take\_screenshot", "start\_clock\_app", "stop\_clock\_app", "start\_wifi", "wifi\_status", "enable\_wifi", "disable\_wifi", "enable\_mobile\_data", "disable\_mobile\_data"]**

**}**

**}**

**},**

**"intents": {**

**"id": "intents commands",**

**"type": "array",**

**"properties": {**

**"type": {**

**"id": "intent type",**

**"type": "string",**

**"enum": ["start", "start\_service", "broadcast"]**

**},**

**"params": {**

**"id": "intent params",**

**"type": "string"**

**}**

**}**

**},**

**"monkey": {**

**"id": "monkey script events",**

**"type": "object",**

**"properties": {**

**"path":{**

**"id": "path to monkey script",**

**"type": "string"**

**},**

**"package": {**

**"id": "apk package where run monkey script",**

**"type": "string"**

**}**

**}**

**}**

**}**

**}**

**]**

**}**

**}**

**}**

**Appendix B: event list**

# Eventos de configuración del entorno

|  |  |  |
| --- | --- | --- |
| Atributo | Valores | Descripción |
| emulator |  |  |
| Emuator.name | String | Nombre del AVD a crear |
| Emulator.port | Integer | Puerto en el que escuchará el AVD |
| Emulator.sdk\_version | String  "enum":[  "android-8", "android-10", "android-15", "android-16", "android-17", "android-18", "android-19", "android-20", "android-21", "android-22", "android-23"] | Versión del Android SDK utilizado por el emulador |
| phone |  | |
| phone.brand | string | Indica la marca comercial del dispositivo emulado |
| phone.device | String | Indica el modelo del dispositivo emulado |
| phone.imei | String | Indica el valor IMEI que tendrá el dispositivo emulado. |
| Phone.imsi | String | Indica el valor IMSI que tendrá el dispositivo emulado. |
| Phone.provider | string | Indica el nombre del proveedor de red del emulador |
| Network |  | |
| Network.IP | String | Indica la dirección IP del dispositivo emulado |
| Network.DNS | string | Indica las direcciones DNS a utilizar por el dispositivo emulado. Puede ser una lista de hasta cuatro direcciones IP o hostnames separado por comas. |
| ini\_properties |  |  |
| ini\_properties. cpu\_arch | String | Indica el tipo de la arquitectura de la CPU del emulador. |
| ini\_properties. cpu\_model | String | Indica el modelo de la CPU |
| ini\_properties. ram\_size | Integer | Indica el tamaño de la memoria RAM |
| ini\_properties. screen\_type | String  "enum":[  "touch",  "multi-touch", "no-touch"] | Define el tipo de pantalla |
| ini\_properties. main\_keys | Boolean | Activa/desactiva los botones de Volver/Inicio |
| ini\_properties keyboard | Boolean | Indica si el emulador utiliza es un teclado QWERTY |
| ini\_properties.keyboard\_lid | Boolean | Permite abrir el teclado QWERTY o no |
| ini\_properties.keyboard\_charmap | string | Nombre del sistemat charmap del teclado |
| ini\_properties.d\_pad | Boolean | Indica si el dispositivo presenta teclas DPad |
| ini\_properties.gsm\_modem | String | Indica el módem GSM del dispositivo |
| ini\_properties.gps | Boolean | Indica la presencia de GPS en el dispositivo |
| ini\_properties.battery | Boolean | Indica la presencia de batería en el dispositivo |
| ini\_properties.accelerometer | Boolean | Indica la presencia de acelerómetro en el dispositivo |
| ini\_properties.audio\_input | Boolean | Indica la pesencia de entrada de audio en el dispositivo |
| ini\_properties.audio\_output | Boolean | Indica a presencia de salida de audio en el dispositivo |
| ini\_properties.sd\_card | Boolean | Indica si el dispositivo soporta el uso de tarjetas SD |
| ini\_properties.sd\_card\_path | String | Presenta la ruta de la imagen de la tarjeta SD a utilizar |
| ini\_properties.cache | Boolean | Indica el uso de una partición cacheada en el dispositivo |
| ini\_properties.cache\_path | String | Presenta la ruta de la cache a utilizar |
| ini\_properties.cache\_size | String | Es el valor del tamaño de la caché |
| ini\_properties.lcd\_width | Integer | Ancho del pixel LCD |
| ini\_properties.lcd\_height | Integer | Alto del pixel LCD |
| ini\_properties.lcd\_depth | Integer | Profundidad de color LCD |
| ini\_properties.lcd\_density | Integer  "enum":[  120,  160,  240,  213,  320 | Densidad LCD |
| ini\_properties.lcd\_backlight | Boolean | Presencia de LCD Backlight |
| ini\_properties.gpu | Boolean | Indica el uso de una OpenGLES GPU emulada |
| ini\_properties.camera\_back | String | Configuración de la cámara trasera |
| ini\_properties.camera\_front | String | Configuración de la cámara frontal |
| ini\_properties.heap\_size | Integer | Define el tamaño máximo del heap del emulador |
| ini\_properties.sensor\_proximity | Boolean | Presencia de sensor de proximidad |
| ini\_properties. sensor\_magnetic\_field | Boolean | Presencia de sensor magnético |
| ini\_properties. sensor\_orientation | Boolean | Presencia de sensor de orientación |
| ini\_properties. sensor\_temperature | Boolean | Presencia de sensor de temperatura |
| ini\_properties. use\_ext4 | Boolean | Indica que sistema de ficheros utilizar:  Ext4/ yaffs2 |
| ini\_properties. kernel\_path | String | Presenta la ruta de la imagen del kernel a utilizar |
| ini\_properties. kernel\_parameters | String | Indica los parámetros a pasar al boot kernel |
| ini\_properties. system\_partition\_path | string | Indica la ruta de la partición del sistema |
| ini\_properties. system\_partition\_init\_path | String | Indica la ruta de la partición del sistema inicial |
| ini\_properties. system\_partition\_size | Integer | Tamaño del sistema de partición |
| ini\_properties. data\_partition\_path | String | Indica la ruta de la partición de datos |
| ini\_properties. data\_partition\_init\_path | String | Indica la ruta de la partición de datos inicial |
| ini\_properties. data\_partition\_size | Integer | Tamaño de la partición de datos |
| ini\_properties. snap\_storage\_path | String | Indica la ruta del snapshot a almacenar |

# Eventos de configuración inicial del contexto

|  |  |  |
| --- | --- | --- |
| Atributo | Valores | Descripción |
| Intall\_app | String | Instala la apk indicada (acepta el path) |
| Timezone | string | Configura la franja horaria del dispositivo |
| power |  | |
| power.ac | On  off | Indica si el dispositivo está conectado a la corriente eléctrica |
| Power.capacity | integer | Indica la capacidad de carga de la batería |
| Power.health | Unknown  Good  Overheat  Dead  Overvoltage  failure | Indica el estado de salud de la batería |
| Power.present | Boolean | Indica la presencia de batería o no en el dispositivo |
| Power.status | Unknown  Charging  Discharging  not-charging  full | Indica el estado de la batería |

# Eventos de configuración de contexto

|  |  |  |
| --- | --- | --- |
| Atributo | Valores | Descripción |
| power |  | |
| power.ac | On  off | Indica si el dispositivo está conectado a la corriente eléctrica |
| Power.capacity | integer | Indica la capacidad de carga de la batería |
| Power.health | Unknown  Good  Overheat  Dead  Overvoltage  failure | Indica el estado de salud de la batería |
| Power.present | Boolean | Indica la presencia de batería o no en el dispositivo |
| Power.status | Unknown  Charging  Discharging  not-charging  full | Indica el estado de la batería |
| Gsm |  | |
| Gsm.Call | String | Llamada al número indicado |
| Gsm.Accept | String | Acepta una llamada desde el número indicado |
| Gsm.Busy | String | Rechaza una llamada desde el número indicado |
| Gsm.Cancel | String | Cancela una llamada desde el número indicado |
| Gsm.Data | Unregistered  Home  Roaming  Searching  Denied  Off  on | Define el estado de la conexión de datos |
| Gsm.Voice | Unregistered  Home  Roaming  Searching  Denied  Off  on | Define el estado de la conexión de voz |
| Sms |  | |
| Sms.number | String | Indica el número al que se va a enviar el SMS |
| Sms.message | String | Contenido del SMS |
| Geo |  | |
| geo.fix.longitude | String | Indica la longitud en la geolocalización |
| geo.fix.latitude | String | Indica la latitud en la geolocalización |
| geo.fix.altitude | String | Indica la altitud en la geolocalización |
| Geo.nmea | String | Emulación NMEA |
| Intents |  |  |
| Intents.type | String | Tipo de intent |
| Intents.params | String | Parámetros del intent |
| Adb |  |  |
| Adb.action | String  Enum = [  “connect\_wifi”,  “lock\_screen”,  “unlock\_screen”,  “volumen\_up”,  “go\_home”,  “take\_screenshot”,  “start\_clock\_app”,  “stop\_clock\_app”,  “start\_wifi”,  “enable\_wifi”,  “wifi\_status”,  “enable\_mobile\_data”,  “disable\_mobile\_data”  ] | Tipo de comando a ejecutar |
| Monkey |  |  |
| Monkey.path | String | Path del script monkey |
| Monkey.package | String | Package sobre el que se ejecutará el script |

**Appendix C: Planning and budget**

In order to comply with the regulations of MsC Thesis by Universidad Carlos III de Madrid, this appendix presents the Planning and Budget of the Thesis.

First, it is going to be presented a planning that defines this project in different tasks. It has been generated a typical Gantt chart presenting in a graphical form the duration of each phase.

The resume of the phases is shown in Figure X with its start and end date. Gantt chart with detailed information is shown in Figure X+1.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Duration (days) | Start Date | End Date |
| Definition of goals | 27 | 16/01/2016 | 23/02/2016 |
| Analysis | 34 | 01/03/2016 | 15/04/2016 |
| Design | 14 | 24/05/2016 | 10/06/2016 |
| Development | 16 | 13/06/2016 | 04/07/2016 |
| Testing | 4 | 5/07/2016 | 10/07/2016 |
| Report | 34 | 18/07/2016 | 1/09/2016 |





Last, it is going to be presented the budget. It is broken down into various estimations by type cost:

* Personal cost: 31.600 €
* Hardware cost: 30 €
* Software cost: 0 €
* Indirect cost: 301 €
* Total cost: 31.600 €

Note: VATs are included.

|  |  |  |  |
| --- | --- | --- | --- |
| Concept | Time (hours) | Fees | RRHH cost |
| Security Engineer | 500 | 50 €/hour | 25.000 € |
| PhD | 120 | 55 €/hour | 6.600 € |
| TOTAL | | | 31.600 € |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Concept | Units | Unit price | Estimated life time | Airtime (months) | Cost |
| Acer Aspire 5740 | 1 | 600 € | 60 months | 4,3 | 30 € |
| TOTAL | | | | | 30 € |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Concept | Units | Unit price | Estimated life time | Airtime | Cost |
| Ubuntu Linux | 1 | 0 € | - | 4,3 | 0 € |
| Sublime Text 3 | 1 | 0 € | - | 4,3 | 0 € |
| SmartGit Hg 7.1 | 1 | 0 € | - | 4,3 | 0 € |
| Github | 1 | 0 € | - | 4,3 | 0 € |
| Bitbucker | 1 | 0 € | - | 4,3 | 0 € |
| MiKTeX | 1 | 0 € | - | 4,3 | 0 € |
| TeXnic Center | 1 | 0 € | - | 4,3 | 0 € |
| Adobe Reader | 1 | 0 € | - | 4,3 | 0 € |
| Google Chrome | 1 | 0 € | - | 4,3 | 0 € |
| TOTAL | | | | | 0 € |

|  |  |  |  |
| --- | --- | --- | --- |
| Concept | Monthly price | Airtime (months) | Cost |
| Electricity | 40 € | 4,3 | 172 € |
| Internet | 30 € | 4,3 | 129 € |
| TOTAL | | | 301 € |

|  |  |
| --- | --- |
| Concept | Amount |
| Personal cost | 31.600 € |
| Hardware cost | 30 € |
| Software cost | 0 € |
| Indirect cost | 301 € |
| TOTAL | 31.931 € |