

VPN Test Plan - Mobile Device Battery Life

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Introduction

The tests detailed in this document are designed to analyse the effect of a VPN app on mobile device battery in various use cases.

In Scope

- Non-Functional System Testing - manual tests performed on the mobile device to assess the battery
- Cross platform testing on Android and iOS mobile devices
- Smoke Tests - performed to briefly indicate test results at otherwise out of scope scenarios, such as 15% battery charge, 50% battery charge and on older mobile devices
- Comparison of enabling VPN Protocols OpenVPN and L2TP/IPsec on battery

Out of Scope

- Automated Testing - Currently there is no successful automated solution for battery testing
- System testing on older devices and older OS versions as this is considered lower priority
- System testing at 15% battery charge and at 50% battery charge as this is considered exceedingly time consuming

Objectives

- To produce a set of reusable tests that determine the impact of mobile device battery during typical use cases
- To calculate the rate of battery drain when using the VPN app in different scenarios
- To determine whether the impact of the app on mobile device battery is acceptable
 - What is deemed acceptable depends on the limitations of the technology, what users consider reasonable and competitors in the market
 - Table below will be used as a guideline for these tests and is based solely on what 1 user (myself) considers reasonable
 - Based on the assumption that a charged device under normal use lasts 12 hours
 - Based on assumption VPN will be enabled for full use

Impact	Negligible		Low		Medium			High		
Reduction in total device charge time	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%

Risk Assessment

Risk	Likelihood (1-5)	Severity	Mitigation
Third-party apps cease to exist or lose critical functionality	1	Medium	Ensure basic principles of test can still be performed without third-party apps
Third-party apps become unstable	2	Low	Contact the app's support team
Team resources become depleted due to staff holidays	2	Medium	Ensure holidays requests are submitted ahead of time and plans are made
Third-party app results are invalid or inaccurate	2	High	Smoke test values using multiple third-party apps

Assumptions

- WiFi connections are via routers that do not use VPN connections
- Mobile devices do not contain SD cards (potential data corruption)
- Encryption method is AES-256 in all cases when VPN is enabled
- Hashing function is SHA-512 in all cases when VPN is enabled
- Authentication method used is username and password in all cases when VPN is enabled
- Exploratory testing has been carried out on the app and no major problems regarding the battery were found
- Unit tests for the various features of the app have been written by the developers
- Functional testing has been performed on the app
- User acceptance testing has been performed on the app by selected users and no major problems regarding the battery were found

Roles

- Product team, QA team and Dev team to have input into discussions on acceptable battery life
- QA tester to perform tests, produce graphical analysis and write subsequent test report
- Dev team to read analysis and test report and to investigate validity of results and any methods of reducing battery drain based on test results
- Product team to read analysis and test report and advise on prioritisation of any test fails or potential areas of improvement

Methodology

Overview

The app was developed by an agile team utilising test driven development and the sprint method.

Tests have been designed with consideration for the Seven Principles of Software Testing:

1. Testing Shows The Presence Of Defects - it does not prove an application is error free
2. Exhaustive Testing Is Impossible - consider risks and prioritise when choosing test coverage
3. Early Testing - test as early on in the process as possible
4. Defect Clustering - based on the Pareto principle: approximately 80% of bugs are found in 20% of modules
5. The Pesticide Paradox - update tests often as updated software may become immune to older tests
6. Testing is Context Dependant - use of different methodologies, techniques and types of testing depends on the nature of the application
7. Absence of Errors Fallacy - zero failing tests do not necessarily indicate success

Test Types

Non-Functional System Testing - Battery Testing

Purpose	To ensure the battery drain caused by the VPN app is of an acceptable level and to seek ways to reduce the rate of battery depletion
Scope	The key feature of the production app - enabling and disabling a VPN connection
Method	Test cases as detailed in Deliverables section
Responsibility	QA Tester
Timing	Post production release

Software vs. Hardware Testing

There are two viable solutions for obtaining readings into how the battery of a mobile device performs over time - a software method and a hardware method.

The software method involves using various third-party apps (or OS features) to gain readings from the device's internal hardware. These readings include CPU use, battery drain and network data transfer.

The hardware method involves connecting the mobile device to a high voltage power monitor (HVPM) and connecting that to a computer where the readings are recorded. The HVPM records power (W), current (amps) and voltage (V). As battery capacity is measured in amp hours (or alternatively Watt hours) this can be used to extrapolate further results.

Software Method	Hardware Method
<p>Pros:</p> <ul style="list-style-type: none">• Tools readily available from app store• A range of preset features to choose from• Results instantly exportable to .csv• Provides readings accurate to 100ms <p>Cons:</p> <ul style="list-style-type: none">• Limited configurability• iOS apps far more restricted in their features than Android apps• Uncertainty surrounding the validity of third-party apps	<p>Pros:</p> <ul style="list-style-type: none">• Highly accurate measurements (5000 samples per second)• Highly configurable• Allows for precise measurements of single user actions <p>Cons:</p> <ul style="list-style-type: none">• Costly equipment• Shipping lead time• Steep learning curve

The **Software Method** has been chosen as the solution for this set of tests. Whilst not as accurate as the hardware method, it nonetheless promises to produce accurate readings, certainly on Android. There is little to lose by performing the easier and cost effective tests first as they still enable large amounts of test data to be recorded and analysed. The potential benefit of the hardware method will become clearer after the completion of the software tests.

Smoke Tests

Purpose	To increase coverage and reliability of test methods in a time efficient manner
Scope	The key feature of the production app - enabling and disabling a VPN connection
Method	Undergo a sample of the Non-Functional System Tests in various other scenarios
Responsibility	QA Tester

Timing	Subsequent to obtaining results for each test scenario
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Defect Management

It is not expected that defects will be found during these tests as the tests will be undertaken on a production ready application.

Should defects be found they should be written up using standard team procedure.

Completeness

Testing shall be considered complete when:

- 100% of tests have been run 3 times
- 100% of test results analysed
- Test report completed

Test Suspension & Resumption

Suspension	Resumption
If third-party app loses functionality temporarily and assurances are made by their support team that a fix will be released imminently	Once issue has been fixed by external team
Third-party app loses critical functionality or is removed from app store	Once an alternate and suitable app has been found
If a major defect blocker appears in the VPN app	Once blocker has been fixed by dev team
Unavailability of external networks (WiFi, LTE)	Once connection returns or once an alternate connection has been found

Maintenance

- Tests are designed to be reusable throughout the life cycle of the app
- Attention should be paid to any external media and apps used in this test plan to ensure they are still available or replaced appropriately
- New and improved test methods should always be investigated when resuming tests after waiting a significant time period

Deliverables

Test Cases

See the accompanying **Test Case Suite - VPN Battery Tests** for details of how to perform the tests. Below is an overview that should be read alongside the Test Case Suite.

Non-Functional System Tests - Battery Testing

Test Basis

The basis for these tests stems from the following areas:

- The problem statement - Create a Test Plan for Mobile Device Battery Life
- My own experiences as a QA tester and app user
- App Under Testing (UAT)
- Research undertaken on resources including:
 - <https://www.howtogeek.com/260848/how-to-get-more-meaningful-battery-stats-on-your-android-phone/>
 - <https://www.testdevlab.com/blog/2016/10/how-we-test-mobile-app-battery-usage/>
 - <https://www.youtube.com/watch?v=Vdc8TCESlg8>
 - <https://developer.qualcomm.com/comment/10029>

All Scenarios

Key Points	Reason
Third-party apps used to provide results	Provide greater detail than default OS features and allow for exporting results
Tests to be performed on the latest version of the mobile operating system	Ensures no regressions have been introduced by latest OS updates
Tests must be repeated a minimum of 3 times each	Ensures test methods provide reliable consistent results
Tests will begin with battery at 100% charge	Exhaustive tests are impossible and whilst beneficial it has been decided to exclude battery tests at low % and medium % from the test suite

Note: iOS tests appear to be limited by Apple's restrictions on third-party App Store apps. Confirmation subject to further investigation on an Apple mobile device.

Scenario 1

Test the impact of VPN app on a mobile device battery by streaming 1080p video for 30 minutes.

Key Points	Reason
Video streaming used as it is a reliable and high impact power drain	Video streaming requires the transfer of relatively large amounts of data
1080p video to be watched at maximum brightness	To maximise battery intensive process
'video1' (tbc) from YouTube	Video accessible on all devices

Scenario 2

Test the impact of VPN when the mobile device screen is off by leaving device uncharged in sleep mode for 2 hours.

Key Points	Reason
WiFi will be enabled but not connected to a network and LTE will be enabled	To maximise background processes during sleep as device should periodically search for WiFi connections and be able to transfer data over LTE
Root device or use alternate method (https://www.xda-developers.com/betterbatterystats-2-3-android-oreo-support-unrooted/)	Allows BetterBatteryStats to record stats in greater detail
BetterBatteryStats Summary to be recorded	Time and percentage spent in Deep Sleep, Screen On and Awake (Screen Off) modes used to indicate time spent running processes whilst in sleep mode
BetterBatteryStats Kernel Wakelock to be recorded	Kernel wakelocks are operating system processes that occur when the phone screen is off. Results recorded to observe whether VPN App utilizes any of these in sleep mode
BetterBatteryStats Partial Wakelocks to be recorded	Partial wakelocks are app processes that occur when the phone screen is off. Results recorded to observe the impact of VPN App wakelocks
BetterBatteryStats Network to be recorded	Data transfer (MB) - more data transfer incurs more battery drain

BetterBatteryStats CPU States to be recorded	Percentage each CPU state is in use - higher frequency CPUs incur more battery drain
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Scenario 3

Test the battery impact of VPN App when disconnecting and reconnecting back and forth between WiFi and LTE.

Key Points	Reason
iOS test not possible (unless appropriate app located or hardware method utilised)	Test is short in duration and requires a higher accuracy of readout than iOS provides
Establishing a network connection requires power	A data packet is sent in the form of a radio signal and this data transfer uses power
60 second wait time between each reconnection	<p>The device's wireless radio is in full power state when establishing a connection. Once a connection has been established, if there is no further activity, the radio goes into low power mode after a few seconds. After 20-30 seconds more the radio returns to standby mode.</p> <p>The wait time is to allow the state to return to standby mode.</p>

Smoke Tests

A selection of the above non-functional system tests should be repeated in a variety of wider cases to check for any anomalous results and ensure reliability of some results, such as whether third-party apps give accurate readings.

Smoke tests should cover:

- Low battery starting charge (15%)
- Medium battery starting charge (50%)
- Alternative third-party apps
- Older devices
- Older OS versions

Schedule

Software battery testing and analysis should be carried out over 1-2 days with the subsequent review and discussion with other teams taking place afterwards.

Tests have been scheduled to begin on date X.

Progress Report

<i>Scenario</i>	<i>Test Case No.</i>	<i>Passed</i>	<i>Failed</i>	<i>Not Completed</i>	<i>Total</i>	<i>Pass Rate (%)</i>
1	1.1					
	1.2					
	1.3					
	1.4					
	1.5					
	1.6					
	1.7					
2	2.1					
	2.2					
	2.3					
	2.4					
	2.5					
	2.6					
	2.7					
3	3.1					
	3.2					
	3.3					
Total						

Environment

As testing is performed on a production app, there is no major test environment to set up. The items listed below are required.

Apps

- BetterBatteryStats (Android)
- VPN App
- Trepn Profiler (Android)
 - Check FAQ page: 'What devices report accurate battery power?'
 - Ensure devices are covered
- YouTube

Documentation and Analysis

- GoogleDrive or similar word processor and spreadsheet editor

Mobile Devices

- Samsung S9 or similar (Android)
- Apple iPhone X or similar (iOS)

Network

- An established WiFi connection
- A reliable LTE connection