IG.16 Sustainability Best Practices for Mobile Application Developers

Version 1.0

23 February 2024

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1 Introduction

1.1 Overview

With the continuing explosion in growth for applications on mobile networks, combined with the serious need to reduce carbon emissions across the mobile ecosystem, now is a critical time to look at ways to reduce the energy footprint of mobile applications. While there may be resources available to help mobile application developers optimize their applications to reduce battery drain, the GSMA Internet Group desires to offer holistic suggestions for these developers that also take into account the energy consumption on the mobile network as well as on the user device. Optimized apps offer faster, smoother experiences with reduced data transfer, saving users time, money, and battery life. Additionally, well-optimized apps can attract more users and improve user experience, leading to increased user loyalty and potentially better long-term financial success.

The purpose of this document is to provide an initial set of concise and useful Best Practices for application developers so they can better design mobile applications that conserve both battery power as well as energy drain on mobile network infrastructure. *The key idea here is that the reduction of mobile network traffic also reduces energy consumption and carbon emissions.*

1.2 Scope

This document will focus on practical guidance for application developers. It will not include in-depth details on how mobile networks function, but simply provide the key principles that will help guide application developers. The document is intended to be a living document, with the intention of adding new Best Practices over time.

For more general information on sustainability and mobile networks from an operator persective, please see "Energy Efficiency and Sustainability in Mobile Communication Networks", published by 5G Americas in December of 2023.

1.3 Intended Audience

This document is intended to be used by mobile application developers, test engineers, and UI designers that create applications that utilize mobile networks.

1.4 Definitions

Term	Description
Mobile Application	For the purposes of this paper, we are focusing on applications running on the major smartphone platforms.
Network	Network in this paper refers to the transport network, and specifically on the mobile portion of this network.
Operator	Operator refers to the companies that build and maintain mobile networks.
Mux	Mux is the practice of combinging audio and video tracks into one digital file stream. (vs de-muxed, where these tracks are kept separate until assembled at the video player on an end user device.

1.5 Abbreviations

Term	Description
GSMA	Global System for Mobile Communications Association
5G	5th Generation mobile network
MNO	Mobile Network Operator
OEM	Original Equipment Manufacturer
UI	User Interface
RRC	Radio Resouce Controller
CMAF	Common Media Application Format (a standard for packaging segmented media)

1.6 References

Ref	Doc Number	Title
1		

2 Best Practices

2.1 Avoid duplicate content

Properly cache content (especially images and design elements) that will then be displayed multiple times but should be downloaded just once or should be checked first, if they changed. Properly cache all ‘evergreen’ content so that the user does not need to download the same piece of content over and over again for no value.

Recommendation: **Cache everything you possibly can to reduce needless radio transmission**

2.1 Compress When You Can

Use advanced compression techniques as much as possible in order to minimize the size of every file and asset you transmit over the network. Additionally, be sure that your assets are properly sized (i.e. do not download a large image and then have the UI shrink it to a tiny image) and use the most modern and efficient formats (e.g., webp for images, H.265, VP9, AV1, etc. for video) and, if possible, those that are free of charges.

Recommendation: Compress and properly size assets

2.2 Ping Thoughtfully - Let the Radio Sleep

The cellular radio is one of the major power draws on a mobile device. Mobile devices generally have a type of state machine known as a Radio Resource Controller (RRC) that controls the activity level of the radio based on demands. From a ‘Sleep’ state, the RRC opens a connection with the cellular network at the start of communication and this

connection is held open for a period of time (often 10-20) seconds. In this state, the radio on BOTH ends (device and network) is using more power than when ‘Sleeping’.

From a Sleep state, if an application sends even a tiny ping over the network, the RRC will wake the radio back up. So, application developers should consider this very carefully to try to GROUP connections whenever possible in time and then let the radio sleep as much as possible, rather than sporadically pinging the network and keeping the radios on for no reason.

Excess ‘chattiness’ spread over a long period of time keeps radios on unnecessarily, draining device battery. Between the radio on the phone and the mobile network, this can waste energy and needlessly add to carbon emissions.

Recommendations: Use a simulator or a tool like AT&T Video Optimizer to model your traffic against the Radio state of the device and strive to keep the radio OFF as much as possible. In particular, avoid periodic pings that could be delayed.

2.3 Understand Your Plugins

While you may write perfect, well-designed, bug-free code, the various plug-ins you use may not be as optimized for sustainability. It is important (but challenging) to understand exactly what these plug-ins might be doing. In particular, ad tracking plugins, analytics etc may be using the network and power in sub-optimal ways by adding excess chattiness, etc.

Recommendation: Use tools to analyze the traffic from your application, such as Wireshark or Video Optimizer to identify sub-optimal patterns from the plugins and modify as needed.

2.4 Minimize reloading on screen rotation

Many applications need to dramatically rearrange the UI of an application when a user shifts from vertical to horizontal or vice versa. Developers sometimes re-paint the UI by reloading all content over the network, which uses more radio power and drains the battery more quickly.

Recommendation: You can reduce energy consumption by pulling elements from the local cache rather than having to re-download content over a mobile connection.

2.5 Don't overfill the buffer with content the user may not watch

Energy and radio spectrum are scarce and finite resources. Whether your application uses short or long-form video, be sure that your buffer size is reasonable, and strive to only fill it with content that you have high confidence will be viewed.

Recommendation: If you are not already doing so, closely monitor statistics on what downloaded content is actually viewed and constantly strive to increase performance

on that metric. In addition to making your users happier, it will also reduce needless power drain and radio use.

2.6 Deliver appropriate video quality for the target device

Studies have shown that most users cannot apreciate the difference between 1080p and 720p on a typical mobile device. The lower file size results in a commensurate savings in energy efficiency – both on the handset and on the mobile network, allowing faster connections if less resolution is required.

Recommendation: Closely manage your video track ladder based on target device and consider whether the highest track possible actually adds a Just Noticeable Difference (JND) and is worth the additional energy and data use.

2.7 Deliver appropriate audio quality for the target device

Similarly, pay attention to audio capabilities and needs of most users. There is almost never a need to deliver 16 channel ATMOS audio to users especially on a mobile device. The lower file size results in a commensurate savings in energy efficiency – both on the handset and on the mobile network.

Recommendation: If your content has options for extremely high quality audio, consider toggling it on only if the user has peripherals attached that can take advantage of that quality, or defaulting to 'standard' rather than playing the highest quality by default all the time.

2.8 Use High Efficiency Codecs

Codecs such as AV1 and VP9 can generate massive reductions in data transmission sizes and similar savings in transmission efficiency. Obviously, the higher complexity does require more energy to encode, however, if the video is to be viewed many times, the transmission energy savings will overtake the difference in encoding energy use. (Bitmovin published a calculator to help determine the 'break even' point for AV1 encoding.)

Recommendation: Encode 'popular' videos using AV1 or VP9.

2.9 Add toggle if user is casting to larger screen

Sometimes users may actually need a higher resolution video because they are casting to a larger screen. In general, this information is often not automatically passed back to the media server, so users may get low resolution videos on a bigger screen.

Recommendation: Rather than always serve a relatively high or too high resolution to a handset, add a toggle in your app settings that will allow the user to set resolution for larger device. Be sure to automatically size down after that session ends.

2.10 Be aware of video subscription policy

Many mobile operators offer subscriptions based on some video streaming options such as lower cost Standard Video plans in order to provide the user with more affordable choices.

Recommendation: Obtain info on the subscription restrictions either via UI or API with the network operator(where available) to be able to deliver video segments only up to the matching policy bitrate to reduce unnecessary network adaptation and maintain QoE while lowering the traffic to reduce energy usage both on the radio network and on the device (for decoding)

2.11 If possible, pre-fetch content during non-peak hours or via Wi-Fi

Energy peaks often happen at the same time that mobile network usage is highest. If possible, cache as much content as possible during non-peak energy hours.

Recommendation: If possible, predict what a user may be interested in during off hours, such as overnight when the device may be connected to Wi-Fi

2.12 Reduce data footprint by using CMAF and demuxed video to store fewer versions of content

While this is more about video storage power usage than transmission power usage, if possible use demuxed video and audio – especially for content that has audio in many languages over the same video.

Recommendation: Use CMAF and do not mux audio and video into one file for multiple variants.

2.13 Go Dark When Possible

Screen brightness is one of the biggest power drains on a mobile application. Depending on screen brightness, dark themes and colors can use between 9-40% of power use on the device. (Note, this particular tip only saves power on the device, not the mobile network.)

Recommendation: Use dark colors tied to the device theme or use dark colors by default.

Annex A Document Management

A.1 Document History

Version	Date	Brief Description of Change	Approval Authority	Editor / Company
IG.16 v1.0	23/02/2024	First version of document,	TG	Yolanda Sanz, GSMA

A.2 Other Information

Type	Description
Document Owner	5GA
Editor, Company	Yolanda Sanz, GSMA

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