

Original Article

# Improving Mobile App Performance: A Comprehensive Approach

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**Abstract** - Mobile app performance is critical to user satisfaction, engagement, and retention. With users spending significant time on mobile apps, development teams must prioritize performance optimization. This article explores the key performance metrics that impact the user experience, including crash rates, app start time, page load time, scroll performance, and app size. It also outlines the industry benchmarks for each of these metrics. Discusses the process of improving app performance through offensive and defensive optimization strategies. Offensive opportunities focus on identifying and resolving specific performance issues, while defensive opportunities involve preventing and catching performance regressions early. By combining these strategies and continuously monitoring performance metrics, mobile app development teams can deliver high-quality user experiences and maintain a competitive edge in the app market.

**Keywords** - Application Performance Monitoring (APM), Industry benchmarks, Mobile app performance, Offensive and defensive optimization strategies, Performance metrics.

## 1. Introduction

In the modern digital era, mobile applications have become essential to our daily routines, offering crucial functionalities for communication, entertainment, productivity, and e-commerce. Recent research indicates that the average smartphone user has installed approximately 80 apps on their device and dedicates nearly 4 hours per day to app usage [1]. Given this significant time investment, users expect seamless and responsive app experiences. However, subpar app performance, characterized by sluggish interactions, high latency, and frequent crashes, can severely impact user satisfaction, retention rates, and overall engagement.

The competitive nature of today's app marketplace necessitates that development teams prioritize and invest in continuous performance improvement and maintenance. Industry data suggests that nearly half of users uninstall an app after encountering performance issues, while about a third abandon apps that take more than 6 seconds to load [2]. Moreover, even minor app responsiveness delays can substantially impact conversion rates, with a 1-second delay potentially leading to a 7% reduction in conversions.

To effectively address these performance challenges, mobile app developers must focus on key metrics that directly influence user experience. These include crash rates, app

launch time, page load speed, scrolling smoothness, and overall app size [3]. Developing teams can significantly enhance the user experience and maintain a competitive edge in the crowded app marketplace by dedicating resources to monitoring, analyzing, and optimizing these crucial metrics.

## 2. Impact of Key App Performance Metrics:

### 2.1. Crash Rates

App stability is paramount for user retention and satisfaction. Research shows that apps with crash rates exceeding 1% experience a 26% decrease in user retention over 30 days [4]. High crash frequencies frustrate users and erode trust in the application, potentially damaging brand reputation.

### 2.2. App Start Time

The initial launch experience significantly influences user engagement. Studies indicate that for every 100ms increase in app start time, conversion rates decrease by 1.8% [5]. Industry leaders aim for app start times under 2 seconds to maximize user retention and minimize bounce rates.

### 2.3. Page Load Time

The speed at which content loads within an app directly impacts user satisfaction and conversion rates. Google's research suggests that 53% of mobile site visits are abandoned if pages take longer than 3 seconds to load [6]. To ensure



optimal performance, developers should strive for page load times under 1 second, with 500 milliseconds being the gold standard for seamless user experiences.

**2.4. Scroll Performance**

Smooth scrolling is crucial for maintaining user engagement, especially in content-heavy applications. While specific metrics vary by app type, achieving a consistent 60 frames per second (fps) during scrolling is optimal for user satisfaction and prolonged app usage.

**2.5. App Size**

An app's initial download size can significantly impact adoption rates. Industry data shows that for every 6 MB increase in app size, install conversion rates drop by approximately 1% [5].

Users often prefer smaller apps due to device storage constraints and data usage concerns, making app size optimization a critical factor in user acquisition and retention strategies.

**3. Industry Benchmarks**

Industry benchmarks for performance metrics serve as crucial reference points for evaluating app performance. However, it's equally important to consider user feedback collected through app reviews, customer support interactions, and other channels.

**3.1. Crash Rate**

Recent industry studies suggest that the acceptable crash rate for mobile apps should be below 0.1% of user sessions [7]. Apps with crash rates exceeding 0.5% tend to experience a 25% higher user abandonment rate than those with crashes

below 0.1%. User expectations are high, with the majority considering crash rates above 0.2% unacceptable.

**3.2. App Launch Time**

Industry standards recommend app launch times of less than 5 seconds, with optimal performance achieved under 3 seconds [8]. Apps with launch times exceeding 7 seconds face significantly higher bounce rates. Even a 1-second delay in app launch time can lead to measurable reductions in user engagement and app revenue.

**3.3. Page Load Time**

For a responsive user experience, page load times should ideally be under 1 second, with 500 milliseconds considered excellent [9]. Research indicates that even a 1-second delay in page load time can substantially decrease page views, conversions, and customer satisfaction.

**3.4. Scroll Performance**

Smooth scrolling at 60 frames per second (fps) is the industry benchmark for optimal user experience. Apps with scroll performance below 30 fps face significantly higher user abandonment rates. Improvements in scroll performance correlate directly with increased user engagement and app revenue.

**3.5. App Size**

Industry standards suggest keeping app download sizes below 200 MB, with user preferences leaning towards even smaller sizes. Studies show that users are often hesitant to download apps larger than 100 MB, with a strong preference for apps under 50 MB. Increases in app size can lead to measurable decreases in downloads and increases in uninstall rates.

**Table 1. Key app performance metrics on user experience and business outcomes [6-15]**

<b>Performance Metric</b>	<b>Impact</b>
Crash Rate	25% higher abandonment rate for apps with >1% crash rate
	65% of users lose trust after >2 crashes
	29% of users abandon the app after ≥3 crashes
App Start Time	30% higher bounce rate for start times >5 seconds
	7% reduction in user engagement per 1-second delay
	4% decrease in app revenue per 1-second delay
Page Load Time	11% decrease in page views per 1-second delay
	7% reduction in conversions per 1-second delay
	16% decrease in customer satisfaction per 1-second delay
Scroll Performance	50% higher user abandonment rate for scroll performance <30 fps
	3% increase in user engagement per 1% increase in scroll performance
	2% increase in app revenue per 1% increase in scroll performance
App Size	50% of users are hesitant to download apps >100 MB
	70% of users prefer apps <50 MB
	1% decrease in app downloads per 10 MB increase
	2% increase in app uninstalls per 10 MB increase

**Table 2. Industry benchmarks for key mobile app performance metrics and their impact [16–29]**

Metric	Industry Benchmark
Crash Rate	< 0.1% of user sessions
App Launch Time	< 5 seconds
Page Load Time	< 1 second for a responsive experience
Scroll Performance	60 frames per second (fps) for a smooth experience
App Size	< 200 MB download size

By adhering to these industry standards and continuously monitoring and optimizing app performance, mobile app development teams can deliver high-quality user experiences and maintain a competitive edge in the market.

#### 4. Process to Improve Performance

Enhancing app performance requires a systematic and iterative approach, with careful planning and prioritization based on long-term benefits and return on investment.

##### 4.1. Establish Baseline

Begin by measuring current performance metrics using available resources. For iOS, utilize MetricKit to gather data on crash rates, app launch times, scroll performance, and app size. For Android, leverage the Google Play console for similar metrics. Note that these platforms may have slight variations in metric representation. Custom logging is necessary for measuring page load times.

##### 4.2. Prioritization

Compare baseline metrics with industry benchmarks to identify performance gaps. However, prioritization should also consider user feedback and concerns specific to the app's purpose. For instance, users of a business bookkeeping app may prioritize quick page load times over app size.

##### 4.3. Offensive Strategies

Offensive strategies focus on directly improving specific performance metrics. For example, addressing the top crash-causing issues can significantly reduce crash rates [10]. These strategies may involve resolving code issues, memory leaks, and optimizing resource-intensive tasks.

##### 4.4. Defensive Strategies

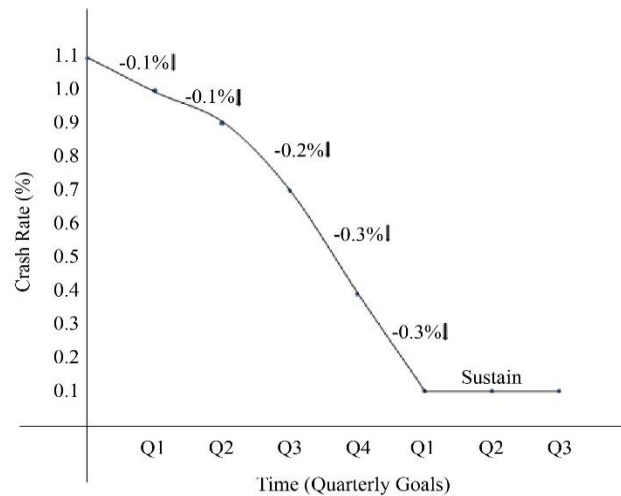
Defensive strategies involve building infrastructure to sustain improvements and prevent performance regressions. This includes implementing continuous performance testing, enhancing monitoring and logging capabilities, and establishing performance budgets [11]. Real-time monitoring tools can help detect and resolve issues faster than relying solely on user feedback.

##### 4.5. Balancing Offensive and Defensive Efforts

A sustainable approach involves balancing both offensive and defensive strategies. Initially, focus on building robust infrastructure through defensive measures, then set aggressive

goals for performance improvement. For example, when addressing high crash rates, start by implementing code linting tools and improving code coverage before aggressively targeting crash reduction [12].

By combining these strategies and maintaining a balance between offensive and defensive efforts, mobile app development teams can achieve and sustain significant performance improvements, ultimately delivering high-quality user experiences in the competitive app marketplace.



**Fig. 1 Sustainable decrease in crash rate achieved by setting less aggressive goals in the beginning**

#### 5. Conclusion

Mobile app performance is a multifaceted issue that requires a comprehensive optimization approach. By understanding the impact of key performance metrics on the user experience and adhering to industry benchmarks, development teams can set clear goals and prioritize their optimization efforts.

Offensive optimization strategies, such as resolving crash-causing issues, conducting code reviews, and optimizing resource-intensive tasks, can significantly improve app stability, startup time, and battery efficiency. Defensive strategies, including continuous performance testing, real-time monitoring, and setting performance budgets and alerts, help prevent performance regressions and ensure that apps maintain optimal performance over time.

Implementing offensive and defensive optimization techniques is crucial for delivering high-quality user experiences and staying competitive in the ever-evolving mobile app market. Since various factors like user behavior, device capabilities, and network conditions can affect app performance, regular monitoring, testing, and optimization efforts should be continuous.

Mobile app development teams can create apps that meet and exceed user expectations by dedicating time and resources to performance optimization and staying up-to-date with industry best practices. Ultimately, investing in app performance is essential for driving user satisfaction, engagement, and loyalty, which are key factors in the success of any mobile app.

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