



 **PowerXtend**

# White Paper

## PowerXtend Touch™

PowerXtend Touch™ is an innovative, patent-pending software technology that enables smooth graphics during mobile device interaction. PowerXtend Touch provide a high-quality graphical user experience when various applications are used on the device, while extending the battery life. The PowerXtend technology is context-aware and optimized for various types of applications scenarios.

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## Preface – Content versus Mobility in Mobile Devices

In recent years, mobile smart devices became ubiquitous. Smartphones and tablets have become household products, with over 1.28 billion smartphones shipped in 2014 alone. The rapid increase in the number of devices has led to an exponential growth in the content available for these devices. Applications, web sites and media have all been adapted and ported to the mobile environment and many content developers today are already pursuing a 'mobile-first' strategy for their offerings.

This combination of device proliferation and availability of content led to an enormous increase in the amount of time consumers spend using their smartphones. Over the past 3 years, the average time consumers spent using their smartphone per day more than doubled. In terms of device usage, nearly all of this growth comes from using apps and consuming content while the amount of time spend on more traditional uses such as phone calls remains constant.

With millions of applications available today through the various app stores, consumers face endless possibilities for consuming content and apps. Consumers use apps for personal and professional communication using email and instant messaging, browsing the web, navigating, recreational activities and gaming. Recent statistics indicate that the average person uses nearly 30 different apps per month on their mobile device.

The mobile industry puts great emphasis on various topics that contribute to increased usability and enablement of mobile device use. Some examples to these endeavors are faster 4G networks with better coverage, improved connectivity through better Wi-Fi and larger screens on devices. Additional notable effort is focused on device components and features such as faster processors, higher resolution cameras and increased integration of sensors with device. These serve to increase consumers' ability to access content quickly, efficiently and with higher quality. The progress in battery technology, however, is much slower to the advancements in processing and wireless communications. The energy density of Li-Ion batteries used in mobile devices is reaching a plateau as it nears the theoretical limits of the chemistry behind these batteries.

Mobility is another key issue for mobile consumers. The combination between a device's physical size, weight and the battery life is a highly important factor in consumers' purchasing decisions. Device manufacturers face complex design decisions and trade-offs when working on new models. Consumers tend to prefer thin and light devices, but at the same time are not willing to accept devices that do not last at least a full day on a single charge. The recent trend of ultra-thin devices saw several manufacturers introduce mobile devices with a thickness of less than 5 millimeters, which introduces numerous design challenges both in terms of device battery life and generated heat.

**It is clear that the increase mobile content consumption and apps usage is contrasted by increased power requirements and design trends of mobile devices. Consumers and device manufacturers require a solution to significantly increase device mobility by enabling full device functionality while maintaining great battery life between device charges.**

## Existing Solutions

Since mobility has become a major concern for device manufacturers and consumers, numerous types of solutions were developed in order to improve the situation. Mobile device design trade-offs are limited, given the very limited selection of device form-factor. The dominance of the touchscreen form-factor leaves very little design choice for manufacturers, with major design decisions being screen size and device thickness. The fact that most manufacturers source device components from the same vendors, makes baseline device performance nearly identical. Manufacturers therefore seek differentiation and competitive advantage through optimization of device software and introduction of innovative and value adding software features.

Device power consumption is no exception, and numerous software techniques have been deployed with the goal of enhancing device battery life and increasing mobility. Currently implemented solutions include software to toggle or disable device features, reduce the brightness of the display or reduce CPU and GPU performance. While these solutions result in enhanced battery life, they all share a common trade-off in that there is a noticeable impact to the user-experience, making them less than ideal.

### “Battery Saver” Apps

A popular solution category amongst consumers are apps aimed to improve device battery life. These are available through the various app stores as aftermarket add-ons. Generally referred to as “Battery Saver” apps, these apps offer multiple software mechanisms that aim to increase battery life. Features offered by such apps include toggling the device data connection, turning off functionality such as Wi-Fi, Bluetooth or GPS, reducing screen brightness and killing apps that run in the background.

The common downside of these apps is that while they do enhance battery life, they limit device functionality and result in mobile devices being less “smart” and less functional.

### Limiting CPU and GPU Performance

Another approach to reduce the power by apps running on a device is to limit the performance of the CPU or GPU, for example by reducing their clock frequency. This method is equivalent to using a less capable processor, and therefore results in lower overall device performance and less resources available to applications. Since clock speed is reduced at the hardware level, the degradation in performance is evident system-wide across all types of applications and content.

While these method result in lower power requirements, the system-wide performance degradation is usually evident across all types of applications. This results in lower device performance, which is often noticed by users who report lower device responsiveness and an overall degraded user-experience.

### Limiting GPU Frame-Rate

Another approach to reduce the GPU power consumption is by limiting the number of frames that the GPU generates in a given time-frame. The implementation typically consists of a mechanism in the GPU driver that arbitrarily delays frame output in order to maintain the target rate, resulting in a lower overall frame-rate and lower power consumption.

Due to the nature of the arbitrary delay mechanism, there is usually a noticeable effect on the output. The added latency results in lower device responsiveness and an overall degraded user-experience. Further to that, the frame-rate change often results in unexpected behavior of the user-interface of many software applications that assume the GPU frame-rate is fixed.

## The PowerXtend Touch™ Technology

### Overview

Unlike existing solutions, the patent-pending PowerXtend Touch™ technology aims to reduce device power consumption without an impact to the user-experience. The Touch technology complements the PowerXtend solution by greatly improving the user-experience in dynamic scenarios when the user interacts with the device. PowerXtend Touch technology combines real-time analysis of the current user-experience when an app is running with measurements to identify device interaction. Using a proprietary algorithm, Touch accurately identifies in-real time events during which the user-experience may degrade and adjusts the PowerXtend power saving mechanism accordingly. The result is a smooth, flowing experience while maximizes the achieved power save.

### App Interaction with Power Saving Mechanisms

As mobile apps become more and more complex, numerous scenarios and use-cases appear. A typical social networking platform, for example, offers the following options:

- Text messaging
- Animated icons
- Multimedia messaging – audio and video
- Browsing web pages
- Viewing pictures in a gallery
- Playing games
- And many more...

Each of these scenarios is affected differently by software power saving mechanisms and use of these mechanisms results in varying user-experience when such mechanisms are applied. When a power saving mechanism such as limiting the frame rate of CPU frequency is applied, it is usually not aware of the currently running app.

More sophisticated mechanisms may be aware of the type of running app, optimize for specific apps or even change their behavior upon device events such as when a user touches the screen. Such mechanisms, however, are in many cases not effective since they cannot identify the scenario in-use and accurately predict the user-experience impact. The control loops of such mechanisms, changing the CPU frequency for example, are often indirect and therefore the impact on the resulting experience is often unpredictable or simply does not provide effective results.

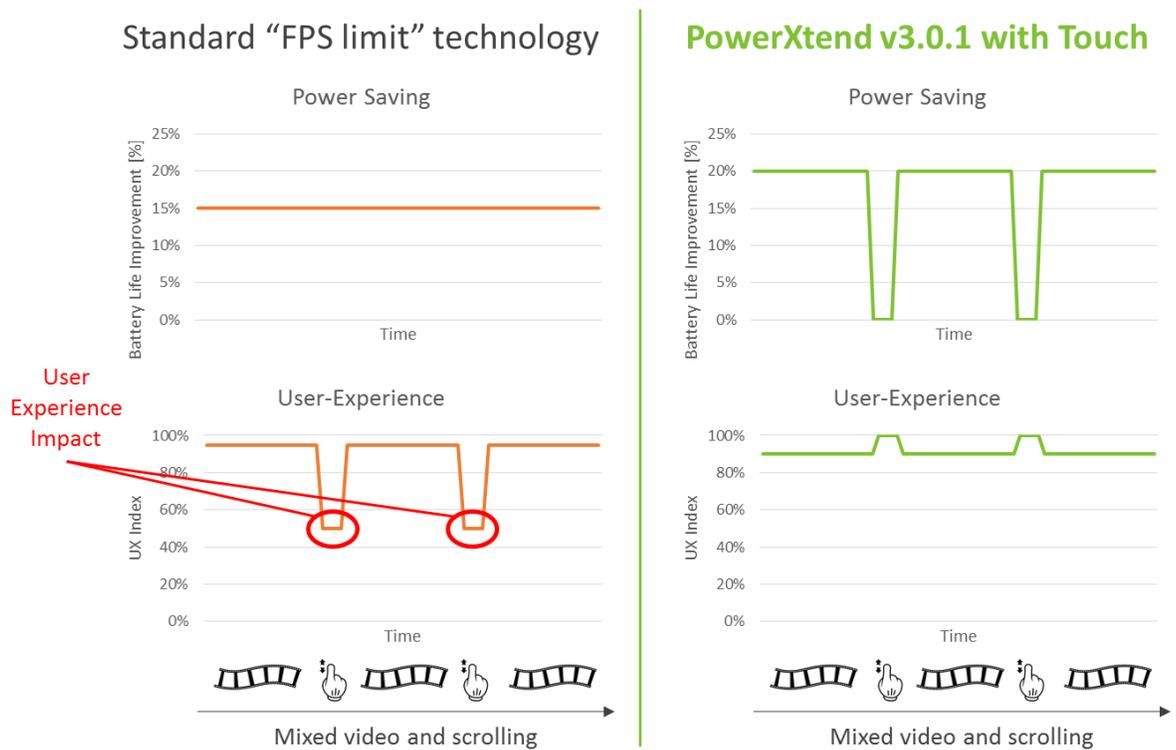
## The PowerXtend Touch Solution

PowerXtend Touch analyzes the currently running app in real-time. Inputs for analysis are factors that affect the user-experience as well as information on user-device interaction. PowerXtend Touch is thus able to distinguish events and scenarios in which the device is required to be more responsive or cases in which user-experience may be negatively impacted by power saving mechanisms.

For example, a common use of a browser or social networking app is to watch in-app videos or video messages and scroll between those messages. This is common when reviewing a Facebook feed or when exchanging short video instant messages in WeChat. Using traditional power saving methods such as “FPS limit” technology, power saving is achieved when watching videos with a barely noticeable effect on the user-experience. Using the same setting while scrolling though the screen, however, results in a noticeable effect that is usually not pleasing to end-users. The approach that traditional “FPS limit” solutions take in such cases is to choose a balanced frame-rate that does impact the experience during scrolling while providing some saving when watching a video.

PowerXtend Touch takes a different approach. By analyzing in real-time the user-device interaction, the power saving mechanism may be set to a highly effective setting when watching a video, while that setting is reduced or even turned off during device interaction.

The below diagram shows an example of how PowerXtend Touch works in PowerXtend v3.0.1:



**Figure 1 – PowerXtend Touch Compared to Standard “FPS limit” technology**

The diagram shows the power saving and user-experience impact achieved with standard “FPS limit” technologies compared to PowerXtend Touch. As the diagram shows, using standard “FPS limit” technology results in a degraded user-experience during device interaction such as scrolling or zooming the screen.

PowerXtend Touch, however, correctly identifies device interaction and controls the power saving mechanism in order to ensure a smooth and flowing experience.

As a result of using PowerXtend Touch, the power saving mechanism can be set to a high power saving setting when a video is being played, achieving a high and effective power save. This is contrasted with the standard “FPS limit” technique in which the same power save setting must be applied for all scenarios and therefore a lower setting is used. In the above example, watching a video yields a 20% improvement in battery life with PowerXtend Touch while only 15% is achieved with a standard technology.

When user-interaction such as scrolling occurs, the traditional FPS limit technology results in a degraded user-experience that is highlighted with red circles in the diagram. When PowerXtend Touch is used, it immediately modifies the power saving mechanism setting in order to maximize the user-experience in this case. In the example, power saving is turned off for the duration of scrolling. This results in a smooth scrolling experience, at the expense of power saving which is reduced to 0 for that period. Since scrolling periods are usually short, the overall average effect is not significant and the resulting device battery life is greatly improved.

## PowerXtend Touch™ in Action

The below figure shows PowerXtend Touch running on a target device as part of the PowerXtend Suite:

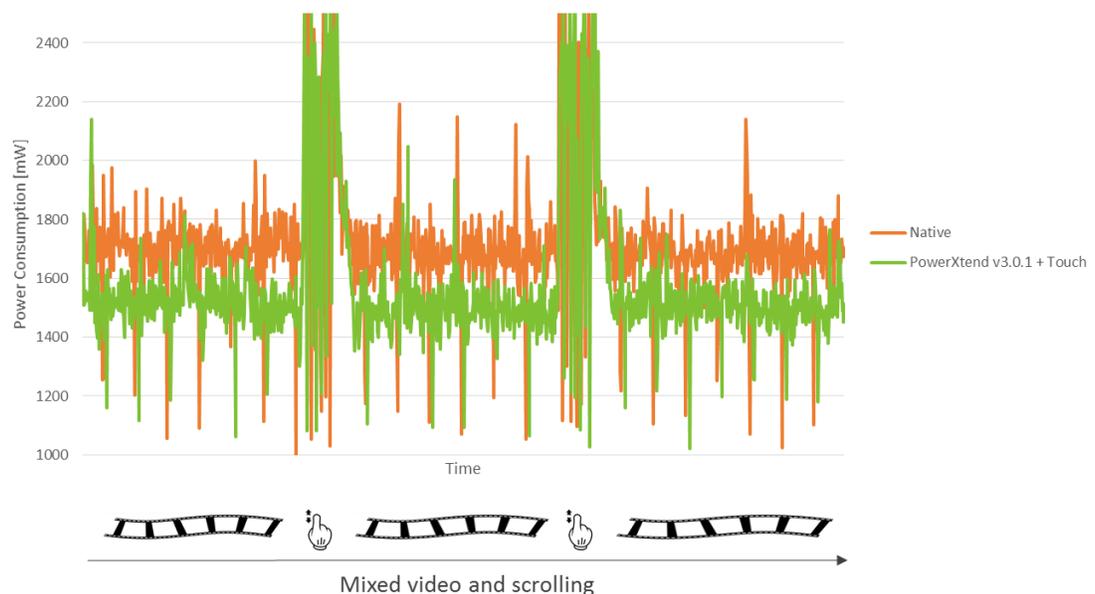


Figure 2 – PowerXtend Touch in Action

The test scenario included mixed use of watching videos and scrolling through a conversation containing several video clips in WeChat. In this scenario, the user watched each video for a few minutes, and then scrolled down to watch the next video. As shown in the graph, the power consumption during the time when videos are watched is considerably lower when PowerXtend is enabled compared to the native experience.

When the user scrolls between videos, PowerXtend Touch immediately identifies the situation and turns off the power saving mode. As a result, power consumption for the native test and the PowerXtend enabled test are

identical. Turning off the power saving mode during this period enables a smooth scrolling experience, identical to the native experience.

The overall result is that power saving is achieved and the device battery life is enhanced by 10% on average in the above scenario. This allows the end-user to enjoy a no-compromise experience, almost identical to the native experience while achieving longer battery life.

## Conclusion

PowerXtend Touch™ is an innovative, patent-pending technology that greatly enhances the PowerXtend suite allowing a wider reach and use of the PowerXtend power saving technology in numerous use-cases. The increasing use of social networking, web browsing and navigation apps highlights the need for a power saving solution that delivers an exceptional, smooth and flowing experience while enhancing device battery life. PowerXtend Touch allows device manufacturers to build devices without compromising on device mobility and performance.

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