

Poster: Charge My Phone As I Instruct

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1. INTRODUCTION

Charging mobile devices fast alleviates users' impatience in waiting for their devices to be charged. So, fast charging has been the focus of both industry and academia, developing and deploying various technologies, such as Quick Charge by Qualcomm, TurboPower by Motorola, Flash Charge by OPPO, etc.

Fast charging, unfortunately, accelerates the capacity fading of device battery because it follows the *Constant Current, Constant Voltage* (CCCV) charge principle without considering the behavior of how users charge their devices. CCCV charging principle is a two-phase charging process consisting of (i) Constant-Current Charge (CC-Chg) and (ii) Constant-Voltage Charge (CV-Chg) [2] where CV-Chg is usually triggered at the end of charging (e.g., 80–100%) to stabilize the battery condition. However, fast charging technologies are agnostic of users' available charging time, resulting in premature termination of the planned charging if users only have limited time. This, in turn, leads to an incomplete CV-Chg phase or even skipping it completely. From our empirical measurements, we discovered that *CV-Chg relaxes the batteries and slows down their capacity fading by up to 80%* [1] — incomplete CV-Chg shortens the battery life significantly over time!

2. USER-INTERACTIVE CHARGING

The negative effects of fast charging motivated us the design of *iCharge*, a novel user-interactive charging paradigm that tailors the device charging to the users' real-time needs [1], as illustrated in Fig. 1. *iCharge* allows users to specify their available charging time, displays the charged capacity if Relaxation-aware (R-Aware) or fast charging is used, and adopts their selection of a charging method in the charging plan. Unlike fast charging, R-Aware maximizes the charged capacity while ensuring the use of CV-Chg to relax the battery, thus improving battery health and device operation time in the long run. We have evaluated R-Aware via laboratory experiments over 15 months with advanced battery testing systems, as shown in Fig. 2 — R-Aware slows down battery capacity fading by 36% on average. We have also implemented R-Aware as a system component on various Android devices, corroborating its compatibility with commodity devices.

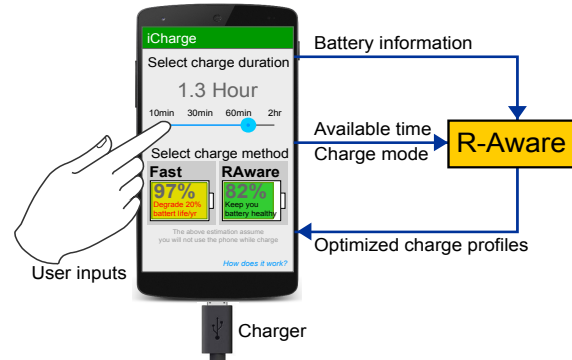


Figure 1: *iCharge* overview: tailoring the device charging to the user's available time and selection of charging method.

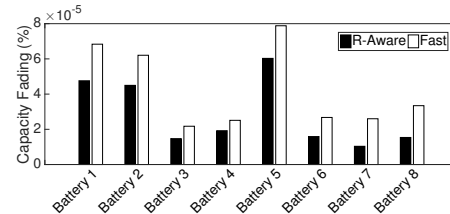


Figure 2: R-Aware slows down batteries' capacity by 36% on average.

Note that R-Aware is not designed to replace fast charging algorithms but offers an attractive alternative to keep the device battery healthier at the expense of a slower charging rate. For example, when no charging options are provided by users, *iCharge* charges the device by using the default fast charging algorithms to preserve user experience when a high charging rate is required. We have performed user studies to collect feedback on *iCharge*. First, we conducted a questionnaire-based survey of 146 participants, in which 89% of them noticed the capacity fading of their device batteries. Although some participants normally purchase new phones every year, 77% of them still want to use *iCharge* in order to keep their device battery healthy. Second, we had 13 users used a conceptual app of *iCharge* over 3 weeks, showing their preference of R-Aware to fast charging for 36% of all charging cases.

3. ACKNOWLEDGMENTS

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4. REFERENCES

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