Towards Smart Notification Management in Multi-Device Environments

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Abstract
Notifications are a core feature of current *smart* devices and are used to proactively communicate with users. However, notifications are known to cause disruptive effects. With the increasing number of smart devices, these negative effects are multiplying. With mobile devices, like smartphones and smartwatches, being always connected and always with the users, it is necessary to find a balance between notifying users while respecting their attention. In this work, we provide an overview of our research on smart notification management in multi-device environments. We present our research questions, research conducted so far, and planned efforts. The expected outcomes are guidelines and models to manage notifications in multi-device environments.

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Motivation and research questions
Notifications inform users about various events, from new instant messages, emails, pending game invites, calendar reminders to available app updates. They use visual, tactile, and auditory signals to gain the user's attention. With smartphones being always connected and always with the user, notifications follow us throughout the day. Prior work highlighted the negative effects of interruptions caused by notifications, lowering the task performance and negatively affecting the attention of the user [1]. More and more apps on smartphones make use of notifications with the goal to engage users. Further, other types of devices are also notifying us throughout the day. Notifications are well known on desktop computers and laptops, and are joined by tablet computers, smartwatches, smartglasses, and fitness trackers in the growing list of devices that are able to notify us. With more and more apps using notifications to gain the user's attention on more and more devices, negative effects of interruptions are multiplying. It is to be expected that with the Internet of Things this will amplified even more. At this point, manually configuring notifications on all devices is no longer a viable option. With our research, we aim to answer the following research questions (RQs).

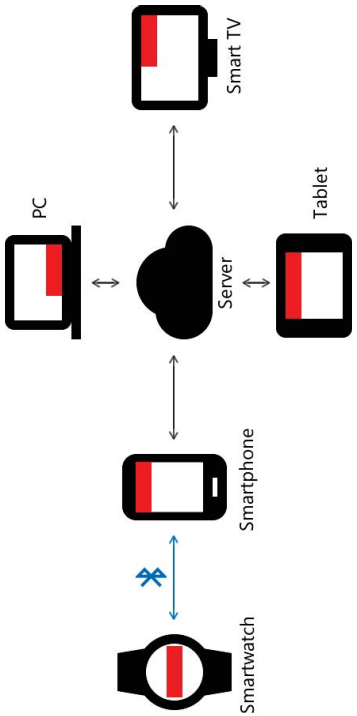

Figure 1: Our notification system *synchronizes* notifications between multiple types of devices [8]. Since the release, the app has been downloaded over 500k times. We plan to combine context information from all devices to select the optimal subset of devices to notify the user.

RQ1 What are attributes of notifications (device-specific/independent, importance levels, urgency, ...)

RQ2 How do types of devices differ when it comes to notifying the user (e.g., smartphone vs. tablet computer)?

RQ3 How to select the optimal subset of devices to notify a user, given a notification and context information?

Research conducted so far

How notifications are perceived depends, amongst other things, on the user's current context. Therefore, we focus on in-the-wild studies, trading *internal* for *external* validity. To learn about mobile notifications, we developed an app for Android devices and published it in the Google Play Store [3]. The app forwarded notifications from the user's smartphone to connected PCs, allowing the user to work on a PC without having to check the phone for new notifications. We collected ~200 million notifications from over 40k users. We later extended the system [8] by additionally synchronizing notifications across multiple Android devices (see Figure 1) (RQ2). In an in-situ study, we equipped participants with smartphones, tablets, smartwatches, and PCs. We combined activity logging on all devices with the Experience Sampling Method (ESM) to learn about the differences between the device types [9] (RQ2). Apart from personal devices, we also investigated notifications on shared devices, namely smart TVs [6] (RQ2). Last year, we organized workshops on MobileHCI'16 [7] and UbiComp'16 [4] with the topic of intelligent attention management. In recent late-breaking work, we investigated notifications in the era of the Internet of Things [2, 5] and created a tool that allows users to reflect on the notifications they receive on a daily basis [10].

Remaining efforts and expected results

We are currently preparing a publication about how the extended notification system is used in the wild (RQ1&2). Further, we are working on enhancing the notification system by combining context information from all connected devices (RQ3). Since the smartphone is the main notification device for many people, we are also working on ways to reduce distractions on mobile phones. The goal is to develop guidelines and models to reduce the negative effects of notifications in multi-device environments.

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REFERENCES

1. E. Cutrell, M. Czerwinski, and E. Horvitz. 2001. Notification, Disruption, and Memory: Effects of Messaging Interruptions on Memory and Performance. In *INTERACT '01*.
2. T. Kubitza, A. Voit, D. Weber, and A. Schmidt. 2016. An IoT Infrastructure for Ubiquitous Notifications in Intelligent Living Environments. In *UbiComp '16 Adjunct*. ACM.
3. A. Sahami Shirazi, N. Henze, T. Dingler, M. Pielot, D. Weber, and A. Schmidt. 2014. Large-scale Assessment of Mobile Notifications. In *CHI '14*. ACM.
4. A. Voit, B. Poppinga, D. Weber, M. Böhmer, N. Henze, S. Gehring, T. Okoshi, and V. Pejovic. 2016a. UbiTtention: Smart & Ambient Notification and Attention Management. In *UbiComp '16 Adjunct*. ACM.
5. A. Voit, D. Weber, and S. Schneegass. 2016b. Towards Notifications in the Era of the Internet of Things. In *IoT '16 Adjunct*. ACM.
6. D. Weber, S. Mayer, A. Voit, R. Ventura Fierro, and N. Henze. 2016. Design Guidelines for Notifications on Smart TVs. In *TVX '16*. ACM.
7. D. Weber, A. Sahami Shirazi, S. Gehring, N. Henze, B. Poppinga, M. Pielot, and T. Okoshi. 2016a. Smarttention, Please!: 2nd Workshop on Intelligent Attention Management on Mobile Devices. In *MobileHCI '16 Adjunct*. ACM.
8. D. Weber, A. Sahami Shirazi, and N. Henze. 2015. Towards Smart Notifications Using Research in the Large. In *MobileHCI '15 Adjunct*. ACM.
9. D. Weber, A. Voit, P. Kratzer, and N. Henze. 2016b. In-situ Investigation of Notifications in Multi-device Environments. In *UbiComp '16*. ACM.
10. D. Weber, A. Voit, H. Viet Le, and N. Henze. 2016c. Notification Dashboard: Enabling Reflection on Mobile Notifications. In *MobileHCI '16 Adjunct*. ACM.