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# UbiTtention: Smart & Ambient Notification and Attention Management

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**Abstract**

Users of digital devices are increasingly confronted with a tremendous amount of notifications that appear on multiple devices and screens in their environment. Today many users own different ubiquitous devices such as a smartphone, a tablet, a notebook and a smartwatch. If an email client is installed on every device an incoming email produces up to four notifications – one on each device. In the future, we will receive notifications from an increasing number of ubiquitous devices. Therefore, we need smart attention management for incoming notifications as well as novel ways to present and interact with notifications. One way for a less interrupting attention management could be the use of ambient representations of incoming notifications. This workshop brings together researchers and practitioners from academia and industry to explore how the flood of notifications on different computing devices and in smart environments can be managed, to avoid information overload.

**Author Keywords**

Notifications; Alerts; Attention; Ambient Interfaces

**ACM Classification Keywords**

H.5.m. [Information Interfaces and Presentation (e.g. HCI)]:  
Miscellaneous

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## Introduction and Background

In times of increasing amounts of information, human attention becomes a bottleneck. Ubiquitous devices and services therefore proactively seek people's attention through *notifications*: visual, auditory, or tactile alerts intended to draw attention to events that took place outside of a user's focus [11]. Notifications are rapidly becoming integral to many computing platforms, including smartphones, PCs, browsers, or even cars. They are used by an increasing number of applications and services [25, 32]. Notifications inform us about social network updates, the arrival of emails, or potential problems of one's car.

Research repeatedly showed that notifications can be distracting, which can negatively affect task performance [4, 7, 11, 15, 26]. Since notifications are often created by messengers and social networks [2, 20, 25], social expectations towards responsiveness create pressure to attend notifications timely. Thus, disabling notifications, despite their known disadvantages, is often not an option [11, 15].

It becomes increasingly stressful to pay attention and respond to all interruptions in appropriate ways. Consequently, users miss crucial information, become less efficient, and in the case of a missed message, even appear rude [22]. This leads to *information overload* and *overchoice* — two of the most pressing challenges in information technology for the next decades. In the era of the Internet of Things (IoT) we have to handle incoming notifications from an increasing number of devices. Recent research focus on the use of context data to deliver notifications at opportune moments [13, 19, 21, 23, 18], ambient information presentation (see Figure 1), and making it easier to cope with interruptions [3]. Besides work on the individual aspects, a major challenge is to combine the directions and apply the right strategy in the right moment.



**Figure 1:** This alarm clock uses ambient light to softly wake up its user. We envision that it could also be used as an helpful output device for other information, e.g., incoming phone calls or reminders.

## The Workshop's Themes

The workshop is a follow-on from the *Smarttention, Please!* workshops at MobileHCI'15 [24] and MobileHCI'16 [31]. While the MobileHCI workshops focused on mobile notifications, in this workshop we aim for a holistic understanding of the different roles notifications can play in a wide variety of computing environments including the office, the home, in cars, and other smart environments. We want to bring together people from industry and academia who are active in attention research, context-aware and ubiquitous computing, as well as ambient and multimodal interaction.

The workshop received a variety of submissions and accepted 16 of them. A set of papers explores affective systems and inferring cognitive states. Czerwinski et al. identify challenges for designing notifications for affective computing [6]. Tauch and Kanjo investigate Emojis in mobile notifications [27]. While Urh and Pejovic infer task engagement using sensor data from smartphones [28], Gollan et al. present a demonstrator that derives cognitive load from pupil dilation [10]. Another theme is incorruptibility. Colnago and Guardia discuss the preferred level of user control [5]. Okoshi et al. identify directions for incorruptibility research to create long-term impact [17] and Obuchi et al. identify activity breakpoints using activity recognition [16]. Anderson et al. highlight the importance of social roles for managing interruptions [1] and Exler et al. investigate the importance of place types for interruptibility [9]. Papers also explore notification in smart environments. Wiehr et al. provide challenges for the design of adaptive ambient notification environments [33] and Kubitzka et al. present an infrastructure for ubiquitous notifications in smart environments [14]. Authors also provide insights into specific areas. Verame et al. provide an initial investigation of users' inclination to attend to a monitoring system [29]. Voit et al. envision a calendar to support older adults using

ambient notifications [30]. Kataoka et al. look a guide sign systems [12] and Elbanhawy et al. at providing ambient awareness for battery storage systems [8].

### Post-Workshop Activities

The workshop will lead to a deeper understanding of notifications and attention management. A central component to disseminate the gained insights will be the workshop's website<sup>1</sup> that we will actively maintain after the workshop. We will use the website to present the workshop contributions as well as the results of the discussions. Furthermore, we aim to use the workshop's website to collect and distribute datasets related to notifications and attention provided by participants and workshop organizers. Our Facebook group<sup>2</sup> provides a lightweight mechanism for community building and knowledge sharing.

We aim to consolidate the findings from the workshop in an article that highlights the main insights. A potential venue for publishing the article is ACM Interactions. We also aim to use the workshop's drive to prepare a special issue of a journal, e.g., IEEE Pervasive. Overall, we hope that the workshop sparks an active and long-lasting community around the workshop's theme.

### REFERENCES

1. Christoph Anderson, Clara Heißler, Sandra Ohly, and Klaus David. 2016. Assessment of Social Roles for Interruption Management: A New Concept in the Field of Interruptibility. In *Proc. UbiTention*.
2. Jeremy Birnholtz, Jeff Hancock, Madeline Smith, and Lindsay Reynolds. 2012. Understanding Unavailability in a World of Constant Connection. *interactions* (2012).
3. Matthias Böhmer, Christian Lander, Sven Gehring, Duncan P. Brumby, and Antonio Krüger. 2014. Interrupted by a Phone Call: Exploring Designs for Lowering the impact of call Notifications for Smartphone Users. In *Proc. CHI*.
4. Jelmer P. Borst, Niels A. Taatgen, and Hedderik van Rijn. 2015. What Makes Interruptions Disruptive?: A Process-Model Account of the Effects of the Problem State Bottleneck on Task Interruption and Resumption. In *Proc. CHI*.
5. Jessica Colnago and Hélio Guardia. 2016. How to Inform Privacy Agents on Preferred Level of User Control?. In *Proc. UbiTention*.
6. Mary Czerwinski, Ran Gilad-Bachrach, Shamsi Iqbal, and Gloria Mark. 2016. Challenges for Designing Notifications for Affective Computing Systems. In *Proc. UbiTention*.
7. Mary Czerwinski, Eric Horvitz, and Susan Wilhite. 2004. A Diary Study of Task Switching and Interruptions. In *Proc. CHI*.
8. Eiman Y. Elbanhawy, Andrew F. W. Smith, and John Moore. 2016. Towards an Ambient Awareness Interface for Home Battery Storage System. In *Proc. UbiTention*.
9. Anja Exler, Marcel Braith, Andrea Schankin, and Michael Beigl. 2016. Preliminary Investigations About Interruptibility of Smartphone Users at Specific Place Types. In *Proc. UbiTention*.
10. Benedikt Gollan, Michael Haslgrübler, and Alois Ferscha. 2016. Demonstrator for extracting Cognitive Load from Pupil Dilation for Attention Management Services. In *Proc. UbiTention*.
11. Shamsi T. Iqbal and Eric Horvitz. 2010. Notifications and Awareness: A Field Study of Alert Usage and Preferences. In *Proc. CSCW*.
12. Haruno Kataoka, Kyoko Hashiguchi, Kae Wago, Yusuke Ichikawa, Hirohisa Tezuka, Shinichiro Yamashita, Yusaku Kuhara, Shinichiro Yamashita, and Tetsuo Akiyama. 2016. Dynamic Guide Signs System to Control Pedestrian Flow. In *Proc. UbiTention*.

<sup>1</sup><http://projects.hcilab.org/ubitiontion>

<sup>2</sup><https://www.facebook.com/ubitiontion>

13. Yasumasa Kobayashi, Takahiro Tanaka, Kazuaki Aoki, and Kinya Fujita. 2015. Automatic Delivery Timing Control of Incoming Email Based on User Interruptibility. In *Proc. CHI EA*.
14. Thomas Kubitz, Alexandra Voit, Dominik Weber, and Albrecht Schmidt. 2016. An IoT Infrastructure for Ubiquitous Notifications in Intelligent Living Environments. In *Proc. UbiTention*.
15. Gloria Mark, Stephen Vaida, and Armand Cardello. 2012. "A Pace Not Dictated by Electrons": An Empirical Study of Work Without Email. In *Proc. CHI*.
16. Mikio Obuchi, Wataru Sasaki, Tadashi Okoshi, Jin Nakazawa, and Hideyuki Tokuda. 2016. Investigating Interruptibility at Activity Breakpoints using Smartphone Activity Recognition API. In *Proc. UbiTention*.
17. Tadashi Okoshi, Jin Nakazawa, and Hideyuki Tokuda. 2016. Interruptibility Research: Opportunities for Future Flourishment. In *Proc. UbiTention*.
18. Tadashi Okoshi, Julian Ramos, Hiroki Nozaki, Jin Nakazawa, Anind K. Dey, and Hideyuki Tokuda. 2015. Reducing Users' Perceived Mental Effort Due to Interruptive Notifications in Multi-device Mobile Environments. In *Proc. UbiComp*.
19. Veljko Pejovic and Mirco Musolesi. 2014. InterruptMe: Designing Intelligent Prompting Mechanisms for Pervasive Applications. In *Proc. UbiComp*.
20. Martin Pielot, Karen Church, and Rodrigo de Oliveira. 2014a. An In-situ Study of Mobile Phone Notifications. In *Proc. MobileHCI*.
21. Martin Pielot, Rodrigo de Oliveira, Haewoon Kwak, and Nuria Oliver. 2014b. Didn't You See My Message?: Predicting Attention to Mobile Instant Messages. In *Proc. CHI*.
22. Martin Pielot and Luz Rello. 2015. The Do Not Disturb Challenge: A Day Without Notifications. In *Proc. CHI EA*.
23. Benjamin Poppinga, Wilko Heuten, and Susanne Boll. 2014. Sensor-Based Identification of Opportune Moments for Triggering Notifications. *IEEE Pervasive Computing* (2014).
24. Benjamin Poppinga, Martin Pielot, Niels Henze, Nuria Oliver, Karen Church, and Alireza Sahami Shirazi. 2015. Smarttention, Please! Intelligent Attention Management on Mobile Devices. In *Proc. MobileHCI*.
25. Alireza Sahami Shirazi, Niels Henze, Tilman Dingler, Martin Pielot, Dominik Weber, and Albrecht Schmidt. 2014. Large-scale Assessment of Mobile Notifications. In *Proc. CHI*.
26. Cary Stothart, Ainsley Mitchum, and Courtney Yehmert. 2015. The attentional cost of receiving a cell phone notification. *J. Exp. Psychol.-Hum. Percept. Perform.* (2015).
27. Channary Tauch and Eiman Kanjo. 2016. The roles of Emojis in Mobile Phone Notifications. In *Proc. UbiTention*.
28. Gasper Uhr and Veljko Pejovic. 2016. TaskyApp: Inferring Task Engagement via Smartphone Sensing. In *Proc. UbiTention*.
29. Jhim Kiel M. Verame, Jacob Kittley-Davies, Enrico Costanza, and Kirk Martinez. 2016. Designing Natural Language Output for the IoT. In *Proc. UbiTention*.
30. Alexandra Voit, Elizabeth Stowell, Dominik Weber, Christoph Witte, Daniel Kärcher, and Niels Henze. 2016. Envisioning an Ambient Smart Calendar to Support Aging in Place. In *Proc. UbiTention*.
31. Dominik Weber, Benjamin Poppinga, Alireza Sahami Shirazi, Martin Pielot, Sven Gehring, Tadashi Okoshi, and Niels Henze. 2016. Smarttention, Please! Intelligent Attention Management on Mobile Devices. In *Proc. MobileHCI EA*.
32. Dominik Weber, Alireza Sahami Shirazi, and Niels Henze. 2015. Towards Smart Notifications Using Research in the Large. In *Proc. MobileHCI-EA*.
33. Frederik Wiehr, Alexandra Voit, Dominik Weber, Sven Gehring, Christoph Witte, Daniel Kärcher, Niels Henze, and Antonio Krüger. 2016. Challenges in Designing and Implementing Adaptive Ambient Notification Environments. In *Proc. UbiTention*.