# Working Overtime: Patterns of Smartphone and PC Usage in the Day of an Information Worker

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**Abstract.** Research has demonstrated that information workers often manage several different computing devices in an effort to balance convenience, mobility, input efficiency, and content readability throughout their day. The high portability of the mobile phone has made it an increasingly valuable member of this ecosystem of devices. To understand how future technologies might better support productivity tasks as people transition between devices, we examined the mobile phone and PC usage patterns of sixteen information workers across several weeks. Our data logs, together with follow-up interview feedback from four of the participants, confirm that the phone is highly leveraged for digital information needs beyond calls and SMS, but suggest that these users do not currently traverse the device boundary within a given task.

**Keywords:** Mobile information work, multiple devices, cross-device interfaces.

## 1 Introduction

Information workers typically rely on an ecosystem of desktop and portable computers that span both work and home to support a wide range of professional and personal tasks [1]. Smartphones are a relatively recent addition to this ecosystem, and with increasing connectivity and computing power, they are well-poised to support productivity tasks beyond the basic capabilities of voice calls and SMS. For example, it is becoming commonplace for smartphones to handle email, and increasingly these devices can be used for reviewing and even editing documents. Yet relatively little is known about how activities performed on the phone relate to productivity tasks that people perform at their more capable desktop and laptop computers.

This paper seeks a better understanding of tasks that span smartphones and other computing resources. Such knowledge is crucial for creating additive experiences for situations when devices of differing form factors and computing capabilities are used together. With such a range of affordances, it may be infeasible to simply replicate users' desktop computing experiences across all of their devices [2]. Instead, we envision systems that allow tasks to be seamlessly shared across devices, while offering interfaces that are appropriately tailored to the device and usage context. To better understand the opportunities and requirements for supporting the continuation of tasks across devices, we began by examining how information workers currently use their smartphones and personal computers.

H. Tokuda et al. (Eds.): Pervasive 2009, LNCS 5538, pp. 398–405, 2009.

The study of mobile work practices, and the challenges mobile users face in managing multiple devices, has been an active area of research for several years. In 2001, Perry et al. [3] studied the issues that mobile workers face in planning for and working during scheduled business trips, primarily aided by laptops, paper, and standard cell phones. Recently, Oulasvirta and Sumari [4] studied how members of a highly mobile IT workforce manage and select among a variety of co-located mobile devices (laptops, smartphones, and standard cell phones) in an effort to balance convenience, input efficiency, content readability and information accessibility throughout a typical workday. Dearman and Peirce [1] extended this investigation to a population of academics and industry workers, and documented how these users manage data and tasks across primarily their personal and work laptops and PCs.

Together these reports paint a picture of how the increasing power and portability of mobile devices can boost productivity, but can also lead to pragmatic challenges in management and resumption of tasks across devices. The role of smartphones in these scenarios, however, has received relatively little attention, particularly the extent to which phones can be leveraged to continue tasks started on the desktop, or start tasks that are then transferred back to more capable devices for completion.

To gain insight into the value of enabling the transfer of activities or tasks between devices of vastly differing capabilities, we examined both the temporal and data access patterns that people exhibit when using their smartphones and PCs over the course of a typical day. While prior studies have employed interviews and self-reporting [1,3,4], we deployed automated logging tools to track sixteen participants' usage of their primary work computer and smartphone across several weeks. The detailed usage characteristics we gathered can be used to complement the findings drawn from previous ethnographic methods. For example, Dearman and Pierce [1] found that users might benefit from sharing web browser state between users' devices; our data can help suggest how and when this state might be shared when one of the devices in question is a mobile phone.

## 2 Understanding Patterns of Multi-device Use

While information workers often have several computing devices at their disposal [4], we focused our investigation on users' interactions with their smartphone and primary work computer. Smartphones and work PCs are a particularly compelling duo because they differ considerably in their level of portability, support for traditional information work, and acceptability for extending use into non-work hours. To avoid the potential for bias associated with self-reporting as well as to gather detailed cross-device usage behavior, we conducted a logging-based field study.

### 2.1 Method

Our study consisted of a data collection phase where interaction activity was logged on each participant's smartphone and primary work computer. To gather descriptive complements to our raw data traces, as well as to help us understand opportunities for improving multi-device use, follow up interviews were conducted with four participants who demonstrated varying patterns of device usage (Table 1).

**Apparatus.** Two software systems were deployed to capture participants' computing activities. The PersonalVibe [5] logger runs on Windows machines and records both window-level events (e.g., titles, applications, active times, and durations) and the existence of keyboard and mouse activity. A smartphone version of the logger was developed for Windows Mobile devices to capture users' phone interactions such as application switches, calls, device locks, and web access.

**Participants.** Sixteen (12 male, 4 female) Windows Mobile smartphone users, with a median age of 34 ($\mu$=33.9), were recruited through an internal mailing list at a technology company. Seven of the participants' phones had touchscreens. To ensure that we captured web access as one type of cross-device activity, we screened for regular (at least ten minutes per day) users of the mobile web. Four participants (3 male, 1 female) from a range of professional roles (publishing manager, software developer, product manager, and recruiter) and with a median age of 34.5 ($\mu$=36.5), participated in a follow-up interview. Participants were compensated monetarily in accordance with the length of their participation.

**Procedure.** After providing consent to participate in the study, participants were instructed on how to remotely install the logging software on their work PC and personal mobile phone. Logging for each participant was scheduled for two weeks, but individuals' schedule constraints and interest levels resulted in participation that ranged from 5–30 (median=21) days, during August and September of 2008.

Follow-up interviews were semi-structured, took place in the participant's office or a nearby conference room, and were restricted to one hour. Participants were asked about their job role, percentage of time typically spent in meetings, the set of computers (phones, laptops, and desktops) they interacted with both at work and at home, the general types of tasks they performed on their phone, and whether their phone activities were primarily related to work, personal, or a combination. Next, participants were presented with a graphical representation of their phone and PC activity over the duration of the study (see Fig. 2) and were questioned about the actions performed on their devices for five key scenarios: "pre-work", "start of workday", "end of workday", "concurrent phone-PC use", and "interleaved phone-PC use." During each walkthrough, participants were asked to comment on how typical the behaviors we recorded were and what relationship, if any, existed between the activities they performed on each device. The interview concluded with questions designed to elicit ideas for improving the interoperability of such devices, such as what might be supported by sharing task context between devices.

## 3 Study Results

We structured our analysis of the log data into three stages. First, we looked only at the types of applications people ran on their devices. Next we examined only the temporal patterns of device access across each day. Last, we crossed these approaches by looking at the temporal patterns of two important activities, email and Web use.

### 3.1 Activity Types by Device

The desktop logger recorded an aggregate of 55,011 minutes of active PC use across 269 days, with a median of 17 days per participant. Fig. 1 shows the total number of application activations (in 1000s), by application type, that our loggers captured on each device type across all participants. Although the figures suggest the relative usage rates of different applications overall, the relationships varied by user and day of study. If we examine the usage duration of each application we find that email and web access dominated other activities on the desktop. Based on the actual duration of use, the corporate email program accounted for 33.8% of participant activity on the desktop and Internet Explorer accounted for 24.1% of the activity.

The phone logger recorded activity on 262 days with a median of 16.5 days per person. We found that email was by far the most common activity performed on the phone, accounting for 55.3% of the application activations over the study period. To allow for comparison with desktop behavior, we report phone-based email access as either corporate email (6319) or other/personal email (704). Calls were the next most frequent activity, at 10.8% of total activations. Web usage was predictably lower at 9.4%. SMS, typically considered a large percent of phone usage, accounted for only 6.4% of the activations. As an additional comparison, we found that users loaded a total of 34,155 web pages on their desktops versus 8,999 pages on their phones.

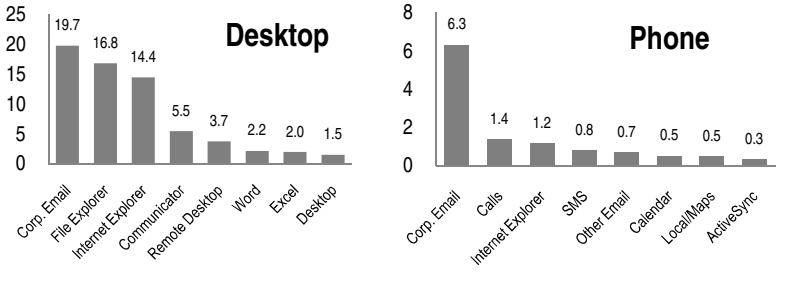


**Fig. 1.** Application use on the Desktop and the Phone (# of application activates in 1000s)

### 3.2 Interaction Patterns between and Across Devices

Next we examined the temporal patterns between participants' phone and PC usage. Fig. 2 depicts five consecutive workdays for three of our participants, and demonstrates the wide range of behaviors we observed in our logs. P9 used her phone for long periods at a time, nearly to the exclusion of her PC, and including hours typically reserved for sleeping. P10 used his PC extensively and sometimes into evening hours, but also interacted frequently with his phone for short bursts of time. Finally, P19 spent most of each day interacting with his desktop PC, accessing the phone relatively infrequently and generally between PC sessions.

Given the importance of email and the Web for productivity tasks and their high usage on both devices (Fig. 1) we decided to further investigate access patterns to these two applications. Fig. 3 illustrates the email and Web use for each device during one of P19's work days: 3a shows overall device usage, 3b shows the email and Web

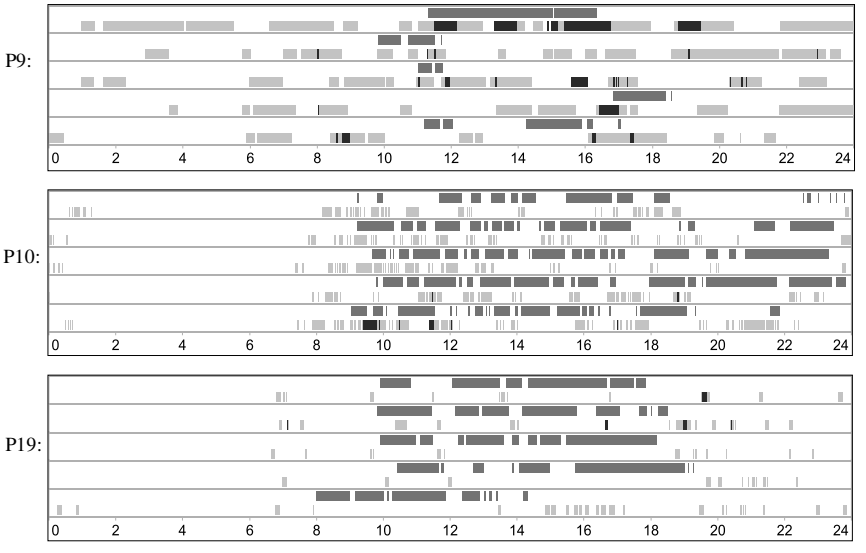


**Fig. 2.** Usage of the PC and phone during 5 consecutive work days for 3 different participants. For each day, the top line is desktop activity and the bottom line is phone activity. For the phone, light gray represents the phone being unlocked and black represents phone calls.

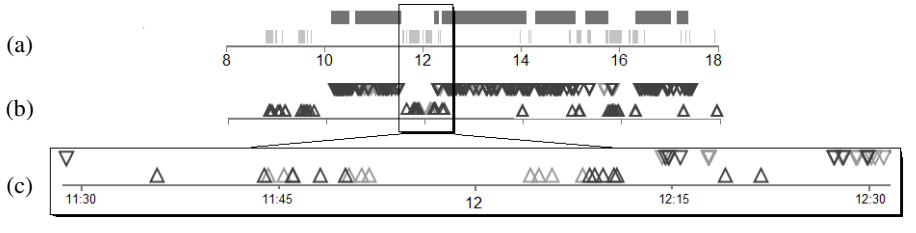


**Fig. 3.** (a) P19's PC and phone use during one workday; (b) email (dark gray) and web (light gray) access during the same period for each device; (c) a detailed view of P19's lunch hour

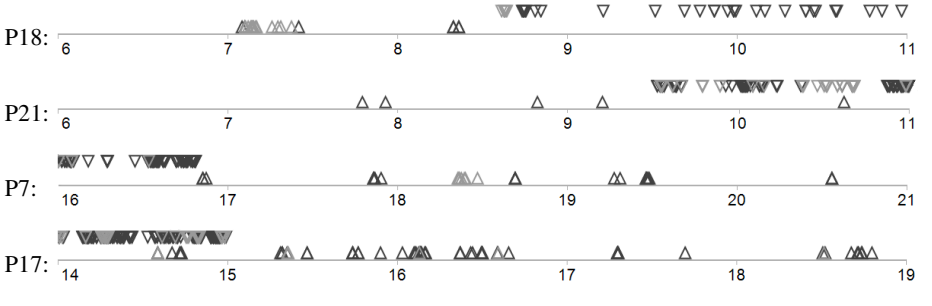


**Fig. 4.** Web and email use on both the PC (down pointing triangles) and phone (up pointing triangles) for four participants. Dark gray is email access and light gray is web access.

activity during that time period, and 3c shows the hour from 11:30am to 12:30pm at high detail. Our follow-up interview confirmed that Fig. 3c represents a lunch break, with the participant leaving the office just before 11:30, checking email on the phone at 11:35, again at 11:43, and then followed by a combination of web surfing and email triage until 11:53. Email and Web access resume on the phone at 12:04 and continue until P19 returns to his desk just before 12:15. This example demonstrates users' device transitions, and their persistent connection to email and the Web.

Fig. 4 illustrates common patterns of phone access we observed at opposite ends of the workday. P18 and P7 exemplify pre- and post-work activity, respectively, and in both cases we find that participants access work email outside of typical work hours. P18's morning includes frequent accesses to work email, starting shortly after waking up and continuing after the morning commute. At the end of the work day, P7 accesses email on the way out of the office, shortly after the commute home, and periodically throughout the evening. P21 and P17 demonstrate similar morning and evening patterns, even though their work hours are less typical than P18's and P7's.

These usage patterns were not relegated to these participants alone. Across all participants, on the 226 days in which both devices were used in the same day, the phone was used before the desktop 88.1% of the time. In addition, in 87.6% of those days, the phone was accessed after the last time the desktop was used. A systematic review of all participants' usage throughout the day led us to conclude that people do this not merely in extraordinary situations, but as part of their daily routines. Even people who do not use their phone heavily still generally touch it every morning, evening, and when they are away from their PC for extended periods.

### 3.3 Interview Findings

While the above data revealed a variety of compelling usage patterns, a logging study alone cannot provide insight into user intentions, needs, or desires which might then be used to inform the design of supportive technologies. For example, understanding the daily balance that participants maintain between work and personal use of the phone, together with feedback on how their current phone activities differ from their *preferred* activities, could suggest quite different directions for cross-device system design. We therefore conducted follow-up interviews to help us develop a more complete representation of multi-device use. In order to capture as wide a range of responses as might be expressed in our participant pool, we selected four participants who exhibited distinctive device usage patterns (Table 1), and served different roles within the company. Despite our efforts at diversity, we were surprised at the consistency of user responses, the most striking of which are summarized below.

**Continuous Connectivity:** During the interviews we discovered all four informants used their phones primarily or extensively for work purposes, and reported "always" keeping their phone with them. All informants expressed that the most valuable role of the phone was for accessing and responding to work and personal email, so much so that it was the first thing they each checked upon waking up. This confirms our observations from the logged data. Perhaps unsurprisingly, all gave work email higher priority than personal email, rarely accessing their phones to check personal email only. As P21 put it, "none of [my personal email] is really urgent. If somebody needs me […] they'll text me." Having continuous phone-based access to work email was

viewed very positively, helping users stay current (P19: "If I'm headed to work, then I usually want to know if I'm headed into any problems."), and on top of their inboxes (e.g., P7: "The phone's always with me and I frequently triage emails with it"; P4: "I'm a little OCD when it comes to my inbox. So, if I can resolve it on my phone, then I just do it").

Although we might expect the bleeding of work into personal time to cause stress, the continuous access to work email instead seemed to provide peace of mind, (e.g., P21: "I'll wake up in the middle of the night, check [work] email, if it's something I can answer right then, I'll go ahead and do it. It's more convenient to go ahead and do it, and then I can forget about it"; P7: "I triage emails in the evening for work. […] If I can answer it quickly and I have the time, I might just punch it out"). These comments help explain our observations from the log traces: the phone is being used to help keep a close watch on email throughout the day because users prefer to be kept up-to-date.

**Table 1.** Profiles for interviewed participants

| | | **Studied devices,** *other owned devices* | Level of phone use: primary work purpose<br>Sample 24 hour Timeline (as described in Fig. 2) |
|---|---|---|---|
| P7 | M<br>35 | **HTC Tilt, work PC**, *work laptop, home PC & laptop* | Heavy during day, tapers at night: email triage, calendar |
| P9 | F<br>34 | **Blackjack II, work laptop** | Heavy, 24 hr: email read/writing, doc review, calendar |
| P19 | M<br>25 | **HTC Tilt, work PC**,<br>*home PC, home laptop* | Light but consistent across day: email awareness |
| P21 | M<br>52 | **HTC Touch, work laptop,**<br>*home PC, home laptop* | Modest during day and night: email triage, calendar, news |

**Fast and Always On.** The advantages that the participants felt the phone offered over their PC echoed those that have been reported previously (e.g., [1,4]). Besides the phone's high portability, informants often found it was faster and easier to check email and calendar on their phones, even while sitting near their PCs. Reasons included nonexistent boot-up, fast password entry, high density and at-a-glance information presentation, and discretion in meeting settings.

**Phone as Primary Computer.** For one informant (P19), the phone was clearly only used to fill in the gaps between access to a more capable system. The others instead seemed to prefer the ultra-portability their phone offered, and only fell back to desktops and laptops when absolutely necessary. In their own words: P7: "I've pretty much selected the most powerful one they make. I want this to be powerful enough to do all the tasks I want", P21: "If I have this [phone], I can go a long time without my laptop", and P9: "I'd just prefer to use my phone for everything."

**Cross-Device Data, not Tasks.** Because we consistently observed patterns of activity hand-off between phones and PCs in the data (e.g., Figs. 3 and 4), we asked users about the tasks they typically performed at these transition points, and ways we might

create more seamless experiences during their shifts between devices. To our surprise, but as noted in previous research [1], participants rarely if ever engaged in an activity on one device that they were interested in continuing on another, and expressed very little interest in the type of "hand-off" capability we suggested. Of course, email and calendar were clearly being used extensively on both devices, but interviewees felt the current synchronization tools were sufficient for their needs. Rather than having their devices work in concert to stitch an activity together, the "seamlessness" participants desired was much more about data synchronization and universal data access. Participants were otherwise proficient and content with using the phone as an independent, auxiliary communication and information channel.

## 4 Summary

Support for the notion that people are using their phones extensively throughout the day was abundant, both from our logged data and from the interviews. Although this finding might seem obvious, we believe that the extent to which this happens in practice has not been fully appreciated. Far from "keeping work and personal life separate" we find that our participants were, and in fact *preferred* to be, continually connected to their work email. Whereas in the past this might be associated with a person obsessed with work, it now seems that people are engaging in this activity to maintain a sense of calm and control in their work lives during their personal time.

We observed that the phone is emerging as a primary computing device for some users, rather than as a peripheral to the PC. The amount of email and web activity recorded in the logs alone supports this, but in addition, each of the people we interviewed stated that they wanted their smartphone to be as powerful as a laptop, and in fact, frequently preferred it to the overhead of using their laptop.

Finally, the concept of task carryover between the phone and the PC was not widely embraced by our participants. Log analysis and interview feedback suggest that tasks were either completed on the phone or delayed until the PC was available. Of course with current technology, such a crossover is inherently difficult, and so we believe there is still value and opportunity for further development in this arena.

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