



## **The Secret Life of Notebooks**

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We describe the secret life of notebooks in the hands of mobile professionals who use them as desktop replacement machines. Usage logs reveal that there are four key contexts of use, each with their own separate requirements: desktop, meetings, home and travel. Dynamic detection of and adaptation to these contexts could enhance the value and usability of notebooks and their applications.

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# The Secret Life of Notebooks

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## ABSTRACT

We describe the secret life of notebooks in the hands of mobile professionals who use them as desktop replacement machines. Usage logs reveal that there are four key contexts of use, each with their own separate requirements: desktop, meetings, home and travel. Dynamic detection of and adaptation to these contexts could enhance the value and usability of notebooks and their applications.

## Keywords

Laptops, mobile computing, networking, context awareness

## INTRODUCTION

One of the largest growth areas for notebook sales is the 'desktop replacement' market. Customers have the option of buying either a desktop or a notebook computer, yet many are prepared to pay the premium that a notebook computer incurs in exchange for the extra value a mobile system brings. These systems can be used at the desk, on the road or at home. From the company's point of view, it is the extra home work which justifies the extra expense [1].

Historically notebooks have been optimized for travel, although increasing attention is being paid to other contexts of use. However, very little is known about these new uses of notebooks, or how the Internet is affecting usage.

In this study we address this problem by logging the use of notebooks by 'desktop-replacement' users. We reveal the secret life of notebooks in order to identify opportunities for dynamically adapting notebook behavior.

## METHODS

A program was written to log events on the notebook, detecting power states and level changes, device additions

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and removal, and network state changes. To determine which application was active, the name of every foreground application was logged, but not the titles of the windows. The latter would have recorded web page titles and the subject lines of email messages, information which was too intrusive for our subjects to permit us to record.

The program was installed on three 'desktop replacement' systems within our company –one marketing user, one manager and one researcher. Data were collected for three months, then uploaded to a database and analyzed. The users were then interviewed to clarify ambiguous data. For control data we logged a home PC and an office desktop.

## RESULTS

Every user had their own pattern of use, which, although different from the other users, was quite habitual.

Among the users we identified four key operational modes: desktop, meeting, home, and travel. Key attributes of notebook use across these contexts are shown in Table 1.

| Location | Power | Networking | Tasks               |
|----------|-------|------------|---------------------|
| Desk     | AC    | LAN        | Office, email       |
| Meeting  | DC    | none       | Email, attachments  |
| Home     | DC/AC | Modem      | Email, office, play |
| Travel   | DC    | Modem/LAN  | Email, office       |

Table 1. Notebook operation in the four contexts

## Desktop

The notebooks were used at their owners' desk 3-6 days a week, except when the subjects were traveling. Monitors were used by two of the subjects, external keyboard and mice by all. In terms of application use, there was no difference between the notebooks and the control desktop. The applications used depended upon the users' role: word-processing, presentation and programming applications vied for being the most common. Email was the key secondary application for all users. When reading email, users would often switch to word processing and

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presentation applications, or to a web browser. Assuming the first two applications were used to view attachments, the latter was probably a result of the messages containing URLs to the real content of the message. The third 'category' of application was the screen saver, which was active for one or more hours every day, indicating an unused system.

### **Meetings**

The sole time that the notebooks were used away from their desk during normal working days was determined to be meetings, into which all users took their notebooks. Within these meetings, the key application was email. Users kept switching from email to attachment viewing programs-but not, in this location, to a web browser. With no web access, the value of URLs in incoming messages must have been significantly reduced.

Meetings lasted at most two hours, and the notebooks were only used intermittently. As a result the battery charge usually stayed above 70%.

### **Evenings and Weekends: Home**

Only two users took their notebooks home –the other had a home PC. When taken home, the systems filled two roles. Some were used for work, carrying on email and word processing tasks. Alternatively, the notebook was used for entertainment: games and music applications were started, and the notebook turned into a home PC. Most commonly the systems were used for work and play –providing music while work applications remained in the foreground

Power was either AC or battery. During weekday evenings battery use was most prevalent –AC power was common during the weekend. This suggests that the users can connect to AC power whenever they need to –they just do not bother until it is necessary.

Among the test group, home network access was via dial up connections–both to work and personal ISPs. Connections seemed limited to email and web tasks – remote disk drives were never mounted. User interviews revealed that external mice were often used at home when the notebook was to be used for any extended period.

### **Travel**

These users traveled weekly or monthly. This resulted in an entirely different mode of notebook use. Behavior seemed very chaotic –users had less of a rhythm of notebook use, network state or power charge

Email was the primary application. Word processing and presentation applications were used for longer periods than in the email attachment viewing cycle observed elsewhere, which suggests that users were performing somewhat different tasks.

Connectivity on trips was variable. Modems were common, but LAN access was used whenever users visited

different sites in the same enterprise. In this situation many of the network parameters changed, such as IP address, web proxy and printer. When on the LAN, email and web applications were ubiquitous –mounting a remote network share was a very rare event. This was in marked difference to the “desktop” context, where between one and five network shares were invariably mounted. The traveling notebook was therefore not a complete replication of the office desktop, even when the network made this possible.

One subject spent one day a week at a second site and tried to get through without a recharge, carrying a second battery to switch to. The other users also ran their batteries down before plugging in –down to 24-28% in many cases. At this point they either located AC power, switched batteries or shut down the system until power was available

The overall impression from the trip data is that users themselves do not know when the next battery charge or email opportunity is going to arise, so they make the most of the moments they get. For these users, travel is the only time when conserving power really matters.

### **CONCLUSIONS**

The findings illustrate wide but consistent differences in the style of notebook use across contexts. These differences have implications for the design of notebooks, the applications that run on them, and also for the services and infrastructure from which mobile devices could benefit.

The fact that the primary use of a notebook in meetings and at home is for email indicates a fundamental shift in the value of the notebook –from a document creation tool to a communications device. There is much scope for improving the connectivity and usability of notebooks in this direction.

As the notebook is used differently in each context, rudimentary context awareness could be used to improve the entire behavior of the system, from communications [2], to application and system policies [3,4]. Much of the information needed to determine this context can be derived from the same events which we logged. For example, home, desktop and meeting use can be predicted based on time, power and network states, while 'travel' can be inferred from sudden changes in behavior, or changes in the operational parameters of wired and wireless networks.

We now intend to experiment with adapting the behavior of notebooks in different contexts, using various heuristics to infer the context. A rollout of the logging software to different market segments is also planned, to determine how small business customers use their systems. Finally, we are very interested in analyzing how usage changes when wide area wireless networking is added to the notebook.

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