

Date: 19 June 2009

Author: iolo Labs

Study #: R-001

## iolo Labs Research Study

# PC Responsiveness: Observed Changes Over Time

Introduction .....	1
Background .....	1
Purpose of study .....	1
Methodology and Procedures .....	2
Testing environment.....	2
Factors observed.....	2
Results.....	3
Memory availability .....	3
CPU idle usage.....	3
Number of registry errors .....	4
Discussion and Conclusion .....	5
Further Research.....	6
References .....	6

# INTRODUCTION

## Background

The responsiveness of a PC relates to how quickly programs and the operating system respond to user input. Responsiveness is a fundamental issue for positive human-computer interaction (HCI). One survey found that 80% of users considered a computer that reacted slowly a "serious problem," the highest ranking in the poll <sup>1</sup>. Recent research in the *International Journal of Human-Computer Studies* found that delays of only 1.6 seconds had a negative impact on users, both behaviorally and emotionally, with reactions that included annoyance, stress, and decreased productivity.<sup>2</sup> Quoting the study:

"The present findings demonstrate that even small delays in the performance of computers have negative effects....Our data suggests that eliminating even occasional small delays has the potential to improve work satisfaction and well-being, which may in turn result in increased productivity and decreased stress."<sup>3</sup>

Responsiveness is an issue critical to PC performance and one that iolo Labs is continuing to investigate.

## Purpose of study

This study was designed to observe various factors related to a PC's responsiveness. It is part of a larger, ongoing study on human-computer interaction and PC performance.

The study is designed to quantify changes over time by observing machines starting from a brand-new PC to one that is two years old, which has been reported as the average age that computers are discarded.<sup>4</sup> This paper presents preliminary results.

# METHODOLOGY AND PROCEDURES

## Testing environment

For testing, simulations were developed based on observation of real PCs obtained from real users. Both physical machines and PC snapshots were obtained to develop computer models of the average state of PCs at specific ages (or "machine states"), ranging from a new machine to one that is twenty-four months old. The study defines each of the machine states as follows:

- 0 month     A PC that simulates the typical state of a computer that is either brand-new or recently had its operating system installed.
- 3 month     A PC that simulates the typical state of a computer that has been used for three months.
- 6 month     A PC that simulates the typical state of a computer that has been used for six months.
- 24 month    A PC that simulates the typical state of a computer that has been used for twenty-four months.

All the simulations were:

- Created and tested using commercial virtualization software.
- Based on the machine class "Home Office." At the time of testing, a "Home Office" class was defined with the following configurations: 32-bit Windows XP operating system, 2 GHz CPU, and 1 GB RAM.
- Installed with the latest version of a 3<sup>rd</sup> party internet security product.
- Verified to be free of parasites, such as viruses, adware, spyware, and other malicious software.

## Factors observed

Experimenters observed and measured the following:

- **Memory availability** — reported by Windows Task Manager's data on Physical Memory Usage
- **CPU idle usage** — reported by Windows Task Manager's CPU Usage monitor
- **Number of registry errors** — reported by iolo System Mechanic version 8.5.6

# RESULTS

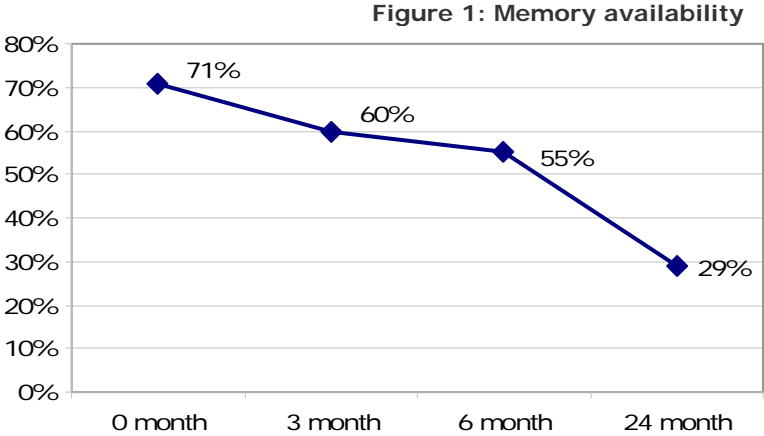
## Memory availability

Memory availability is the percentage amount of random access memory (RAM) a PC has available. RAM is the working memory where data is temporarily stored for various processes.

Results:

- 0 month: 71% (727 MB)
- 3 month: 60% (614 MB)
- 6 month: 55% (563 MB)
- 24 month: 29% (296 MB)

Figure 1 illustrates the decrease in memory availability. Over a 24-month period, available memory saw an average decline of 59%, with only 29% available at the end of the time period.



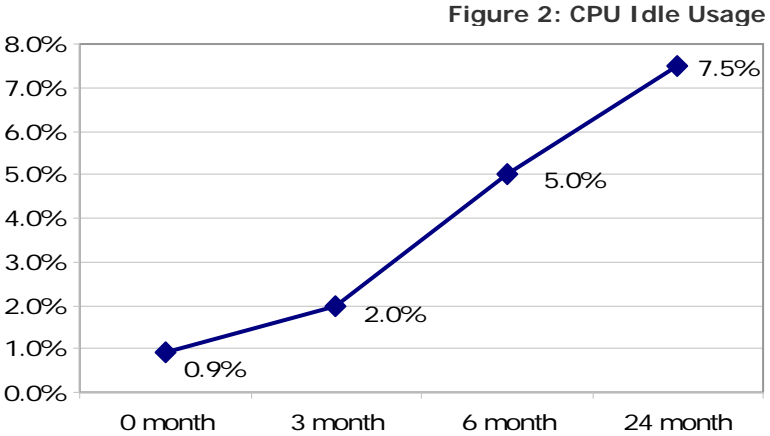
## CPU idle usage

CPU usage is the amount of time the CPU spends processing user applications and high-level Windows functions. CPU idle usage is the percentage of CPU usage that occurs when a computer is idle (on but not being used by a person).

Results:

- 0 month: 0.9%
- 3 month: 2.0%
- 6 month: 5.0%
- 24 month: 7.5%

Figure 2 illustrates the increase in CPU usage when the PC is idle. Over a 24-month period, this utilization increases from 0.9% to 7.5%.



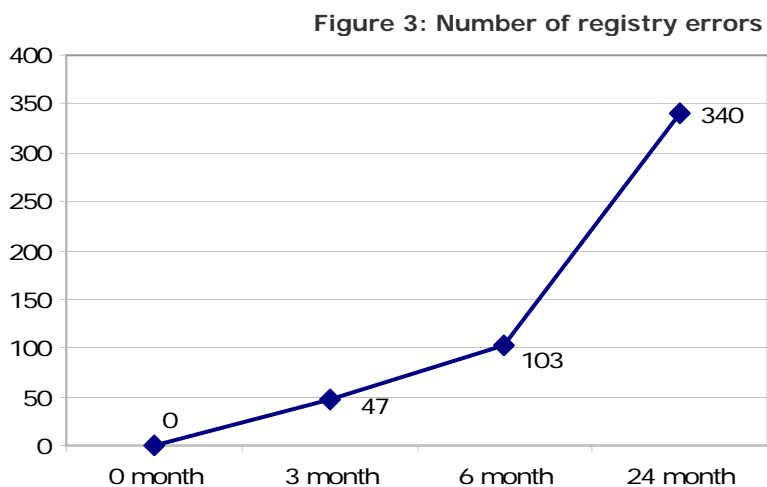
## Number of registry errors

The registry stores key data that Windows requires and continually references, such as user profiles and settings for installed software and hardware. Registry errors are obsolete or corrupted settings stored in the registry.

### Results:

0 month: 0 errors  
3 month: 47 errors  
6 month: 103 errors  
24 month: 340 errors

*Figure 3* illustrates the increasing number of registry errors over a 24-month period, from none to 340. In just the three-month period for a relatively new machine (6 months), errors jump 119%.



## DISCUSSION AND CONCLUSION

This study found that over a two-year period:

**Finding:**        **Memory availability decreases, by an average of 59%**

**Implication:**    A higher amount of physical memory means more space is available for temporary data storage. When there is a shortage of this memory, programs do not have enough memory to function properly. The implication is that as memory availability decreases, programs will begin to open and run slower.

**Finding:**        **CPU idle usage increases roughly sevenfold, from 0.9% to 7.5%**

**Implication:**    During idle time, a PC may be running desired actions, such as a virus scan, but a consistently high CPU idle usage percentage indicates an excessive number of background processes are running while the computer is on. The implication is that this background processing reduces the resources available when the PC is in use, thereby impacting program responsiveness.

**Finding:**        **The number of registry errors increases, from none to 340**

**Implication:**    As the number of registry errors increases, Windows is forced to decipher obsolete or corrupted settings while loading programs and carrying out basic operations. The implication is that as registry errors increase, the system will have to search for more non-existent commands, causing temporary freezing or halting while programs are used and while the operating system executes fundamental tasks.

Additionally, because most of the registry is cached in memory, the additional space required to hold errors translates into additional memory requirements which, as noted above, results in decreased resource availability.

## FURTHER RESEARCH

This study presents initial findings related to PC responsiveness. iolo Labs will continue to:

- Identify additional measures for quantifying responsiveness.
- Study the relationship between responsiveness and human-computer interaction (HCI).
- Include responsiveness testing based on other machine classes and machine states.

## REFERENCES

---

<sup>1</sup> Survey by Pew Internet & American Life Project and Princeton Survey Research Associates International, May 4-June 7, 2005. From the iPOLL Databank, The Roper Center for Public Opinion Research, University of Connecticut.

<sup>2</sup> Szameitat, André J., Jan Rummel, Diana P. Szameitat, and Annette Sterr. 2009. "Behavioral and emotional consequences of brief delays in human-computer interaction." *International Journal of Human-Computer Studies* 67, no. 7: 561-570.

<sup>3</sup> Ibid, p. 569.

<sup>4</sup> Greenpeace. *The e-waste problem*. Retrieved from <http://www.greenpeace.org/international/campaigns/toxics/electronics/the-e-waste-problem>