



# Analyzing ChromeOS's Boot Performance

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## Abstract

ChromeOS, Google's operating system, advertises a boot performance of 8 seconds. It only executes on specific hardware, which suggests that it is able to skip identifying the hardware during the boot process. ChromiumOS, the open source version of ChromeOS, requires 35 seconds to boot. We hypothesize that the difference in boot time is due to ChromiumOS's need to identify its hardware. To test our hypothesis, we modify ChromiumOS so that it, too, is hardware-specific. Hypothetically, it will exhibit boot performance similar to ChromeOS after our modifications. We are currently analyzing the boot performance and outputs of two modified versions and identifying factors associated with decreases or increases in boot time. This research is in its early stages, so this poster describes our experiments so far and our most recent results.

## Background

According to Google, ChromeOS, Google's operating system, was designed to get the user to the web browser faster. Google claims that there is no reason that a user should have to wait 45 seconds, the average boot time for modern operating systems, to get to a web browser. The average user spends 90% of their time on the internet in a web browser application. What if the web browser was the operating system? Samsung released the first Chromebooks shipped with ChromeOS in June 2011. Google advertises the Chromebook's average boot time is 8 seconds which, indeed, gets the user to the web browser faster. ChromiumOS is the open source project version of ChromeOS. ChromiumOS and ChromeOS fundamentally share the same code base, but ChromeOS has some additional firmware features and comes with binary packages that are not allowed to be included in the ChromiumOS project.



Figure 1. ChromeOS startup screen



Figure 2. Samsung Chromebooks

## Methods and Materials

### ChromiumOS

ChromiumOS version 27.0.1442.0 was used and modified to test our hypothesis.

### Kernel

ChromiumOS uses a modified version of the Linux kernel. The Linux kernel version in the ChromiumOS build used was 3.4.0.

### Hardware

The system used for testing is a Toshiba NB205 with 2GB DDR2 RAM and an Intel Atom processor.

### Measurements

Measurements of boot startup time were recorded using the bootperf script provided by the Chromium Project. The bootperf script measures ten iterations of the boot cycle. The measurements presented here are an average of results from all ten iterations.

### Experiments

As per our hypothesis, we have begun eliminating hardware checks during the startup stage of the boot process. So far, we have removed kernel checks for the following to make ChromiumOS hardware specific:

- Removed check for ACER temperature and ONE
- Removed Dell WMI extras check
- Removed HP WMI extras check
- Removed ChromeOS laptop check
- Removed ChromeOS LED keyboard check
- Removed Acer Aspire ONE temperature and fan driver
- Removed Dell WMI extras
- Removed HP WMI extras
- Removed Thermal Management driver for Intel menlow platform
- Removed ChromeOS specific ACPI extensions
- Removed ChromeOS laptop check
- Removed unnecessary hardware monitoring support
- Removed Allow booting SMP kernel on uniprocessor systems

## Results

After removing these hardware checks, ChromiumOS boot time was reduced from 35 to 33.4 seconds. We are encouraged that we have been able to reduce boot time with the removal of some kernel hardware checks. As this research continues, we believe we can improve boot time further to more closely match that of ChromeOS.

Table 1. ChromiumOS Initial boot results for 10 cycles

Event	Time (milliseconds)	s%	dt
startup	2992	3%	+2992
startup_done	9769	16%	+6777
x_started	23089	8%	+13320

Time – average total time in milliseconds

s% – sample standard deviation of the total time as a percentage of the average

dt – delta change in time between current and previous stage

Table 2. ChromiumOS with Kernel Modified to remove hardware checks results for 10 cycles

Event	Time (milliseconds)	s%	dt
startup	3560	2%	+3560
startup_done	9698	8%	+6138
x_started	22546	2%	+12848

Time – average total time in milliseconds

s% – sample standard deviation of the total time as a percentage of the average

dt – delta change in time between current and previous stage

Chart 1. Boot performance analysis and comparison between ChromeOS and ChromiumOS

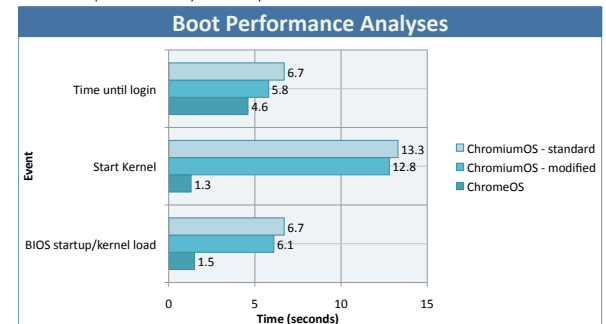


Figure 3. ChromiumOS logo



Figure 4. ChromeOS logo

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