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Department of Computer Engineering

Chromium OS on Freescale i.MX6q

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Contents

Contents	i
1 Project Charter	1
1.1 Project Overview	1
1.2 Client and Community Partners	1
1.3 Stakeholders	2
1.4 Framed Insights and Opportunities	2
1.4.1 Communication	2
1.4.2 Need Statement	3
1.5 Goals and Objectives	3
1.5.1 Goals	3
1.5.2 Objectives	3
1.6 Outcomes and Deliverables	4
1.7 Project Risk Analysis	4
1.7.1 Risks	4
1.8 Estimated Development Time	6
2 Formal Product Definition	8
2.1 Requirements	8
2.1.1 Marketing	8
2.1.2 Engineering	9

2.1.3	Constraints	11
2.2	Criteria	11
3	Related Work and Projects	12
3.1	The Chromium Projects	12
3.2	Other Related Works	13
4	System Integration and Testing	14
4.1	Test Plan	14
4.2	Test Results	14
4.3	Test Analysis	15
A		16
A.1	Budget	16
A.1.1	Requests and Justifications	16
A.2	Bill of Materials	16
B		17
B.1	Actual Development Time	17
	Bibliography	18

Chapter 1

Project Charter

This chapter will discuss the undertaking of this project, its' clients, goals, objectives, and analyze the risks involved. Using this information, this chapter will attempt to detail out the duration of the project through the use of a timeline with stretch goals.

1.1 Project Overview

I will attempt to port Chromium OS to the Gateworks© [Ventana GW5400](#) Single Board Computer with a Freescale i.MX6q processor with basic support of the board peripherals and will attempt several stretch goals to enable specific peripherals on the Ventana GW5400. After I determine risks in [Section 1.7](#), criteria in [Section 2.2](#), and related works and other research in [Section 3.2](#), I will use the knowledge gained at CalPoly and outside sources to allow Chromium OS to be installed by any user following the set of instructions I will have written up at the end of this project.

1.2 Client and Community Partners

Gateworks© will serve as the beneficiary of this project. The company was founded locally on the central coast with an emphasis on embedded software and firmware develop-

ment. The company then began embedded systems hardware and incorporated in 1998 [1]. This project will allow for the company to increase their repertoire of supported operating systems and thereby allowing for greater marketability of their products. In this sense, the undertaking of this project will directly benefit the Sales and Marketing group within Gateworks©, especially since no platform currently exists with a Freescale i.MX6q running Chromium OS.

1.3 Stakeholders

Table 1.1 will detail out the stakeholders involved with this project.

Stakeholder	Reasons
Gateworks©	The company would like to get involved with operating systems that are easy for users to use.
Engineering Group at Gateworks©	This group within Gateworks© would like to see this proof of concept become a reality to verify the ARM support within Chromium OS
Tim Harvey	Principal Software Engineer at Gateworks©. Tim maintains current BSP's for Gateworks©
Ron Eisworth	Executive Vice President of Sales and Marketing with a vested interest in the marketability of Chromium OS

Table 1.1: This table denotes this projects' stakeholders

1.4 Framed Insights and Opportunities

This section will outline the current contact I've had with the client and will then state the necessity of this project.

1.4.1 Communication

I was first approached to undertake this project by Tim Harvey (see Table 1.1 for more information on Tim Harvey). After further review, I deemed it a worthwhile project. Since then, Ron Eisworth, Executive Vice President of Sales and Marketing at Gateworks©,

also approached me to gear this project towards the usability of Chromium OS on Gateworks© Ventana family line. After discussions with all of the stakeholders, we agreed that the Ventana GW5400 would serve as the main focus of this project, with the rest of the Ventana Family coming after it, well after the end of this project.

1.4.2 Need Statement

Porting Chromium OS to a Freescale i.MX6q will further my inclination to contribute to the open source community and help shape my future endeavors.

1.5 Goals and Objectives

This section will lay out the goals and objectives of this project. Section [1.7](#) will then speak towards this projects' risk plan surrounding these goals and objectives.

1.5.1 Goals

The main goal of this project is go get Chromium OS running on a Ventana GW5400 with basic support, including HDMI Video Out and Ethernet networking. Any other peripheral support will serve as separate stretch goals of this project. For specific stretch goals, please see Figure [1.1](#).

1.5.2 Objectives

Table [1.2](#) will outline the main objectives of this project.

Objective	Description
Create a Recreateable Build Environment	Create a system that will cross-compile ARM code for the Ventana GW5400
Create a Basic Board Port	Create a port of Chromium OS to the Ventana GW5400 with video out, Ethernet, and serial communication working.
Create a Board Support Package	Create a port of Chromium OS to the Ventana GW5400 with the Freescale i.MX6q processor. This also includes configuring Chromium OS to understand all the attached peripherals of the Ventana GW5400 so they may be utilized.

Table 1.2: This table denotes this projects' objectives

1.6 Outcomes and Deliverables

Table 1.3 will outline the outcomes and deliverables for this project to the client.

What	Description
Documentation	Any and all documentation on how to recreate this project
Source Code	Any and all source code written and obtained, including any driver support required for any peripheral on the intended target.

Table 1.3: This table denotes this projects' outcomes and deliverables

1.7 Project Risk Analysis

This section will describe risks involved with this project as well as any risk response strategies.

1.7.1 Risks

Table 1.4 and 1.5 shows the failure mode and effects analysis of this project.

Failure Mode and Effects Analysis								
FMEA Date (Orig): June 12, 2014								
Type: Project								
Process Function	Potential Failure Mode	Potential Effect(s)	Severity	Potential Cause(s)	Occurance	Detect	RPN	Recommended Action(s)
Simple Board Port Goal	Never gets completed	Project doesn't complete	10	Binaries not available	3	1	30	Keep working with required parties
				There is an issue with the hardware I'm using	2	3	60	Get new hardware
Technical Documents	Do not get completed	Project becomes difficult to recreate	3	Laziness	2	1	6	Overcome
Software Version Control	Agile Development not Utilized	Recreation becomes difficult	5	Laziness	2	2	20	Overcome
Chromium OS Compatibility	Chromium OS not compatible with Freescale Vivante Driver	3D Video Acceleration is not viable	5	Compatibility not present in Chromium OS	3	1	15	Write hooks into Freescale Vivante Driver
Video Input Drivers	Unavailable	Cannot create full-featured BSP	3	Drivers not written	4	2	24	Write Video Input Driver

Table 1.4: This is the FMEA for Project Occurrences

Failure Mode and Effects Analysis								
FMEA Date (Orig): June 12, 2014								
Type: User Interaction								
Process Function	Potential Failure Mode	Potential Effect(s)	Severity	Potential Cause(s)	Occurance	Detect	RPN	Recommended Action(s)
Remove Server Reliability	Can't get sources	Can't recreate build environment	10	Maintainer	1	1	10	Nothing
	Get wrong source	Build Bad BSP	8	Maintainer	1	9	72	Nothing

Table 1.5: This is the FMEA for User Interaction

1.8 Estimated Development Time

Figure 1.1 shows an outline of the timeline I will be following for the duration of this project:

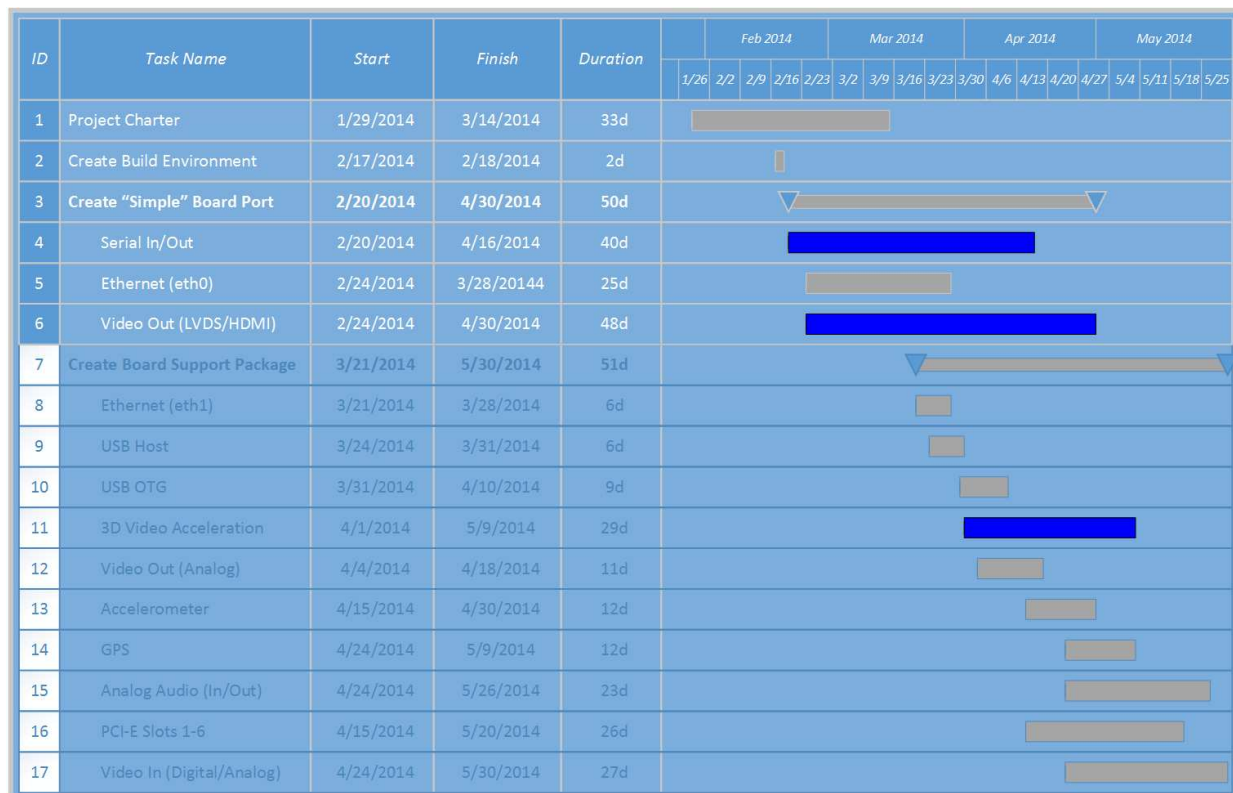


Figure 1.1: This is my estimated timeline

Notice task ID's 7-17 with the off color. This color represents this projects' stretch goals, while task ID's 1-6 represent immediate goals of this project.

Chapter 2

Formal Product Definition

This chapter will formally define the product in marketing and engineering terminology. Thus, it will allow for constraints to be created in order to logically go through with this project.

2.1 Requirements

The following sections will breakdown both the marketing and engineering requirements for this project.

2.1.1 Marketing

The following are the marketing requirements of this project:

- The project should be repeatable in its' entirety
- Chromium OS should have wireless Internet capabilities
- Chromium OS should have video out
- Chromium OS should have touchscreen abilities

2.1.2 Engineering

The following are engineering requirements of this project:

- Functionality
 - Ethernet on eth0
 - Gives network capabilities
 - HDMI Video Out
 - Requirement of Chromium OS
 - Analog Audio Out
 - Requirement of Chromium OS
 - Analog Audio In
 - Grants “MIC” options
- Performance
 - The Ventana GW5400 will utilize the Vivante Driver in the Freescale i.MX6q to allow full 3D Video Acceleration in OpenGL ES
 - This will allow for the full user experience Chromium OS aims to achieve
 - Gigabit speeds will be enabled on both eth0 and eth1 ports
 - eth0 is directly connected to the Freescale i.MX6q, with limiting speed at 480mbit while eth1 is connected to a gigabit switch at 1000mbit speeds
 - The GPS will get a lock on a minimum of 3 satellites within 1 minute with a reasonable antenna and outside location
 - Analog audio input and output streams shall be performed in real-time
- Economic
 - The Ventana GW5400 will come out of pocket of Gateworks©
 - Since Gateworks© both manufactures and sells the Ventana GW5400, they are willing to give up a product to further this project.
- Energy

- The Ventana GW5400 shall be powered either through PoE or directly through a DC power supply as specified by Gateworks©
- Legal
 - Any source code written shall conform to GNUv2 or MIT licensing
 - Part of the requirement for Chromium OS
 - All source code shall conform to Chromium OS's **coding style**
 - Part of the Requirement for Chromium OS
 - I will not divulge any secrets of the Gateworks© Corporation without expressed written consent
 - Part of our non-written NDA
- Maintainability
 - Any maintenance shall continue under the engineering group within Gateworks©
- Operational
 - Chromium OS shall not change or destroy the hardware it is running on
 - Any hardware drivers won't overdrive components on the Ventana GW5400
- Political
 - At the conclusion of this project, I will pass on all design information to my client, Gateworks© while still maintaining a public form
 - Any software will comply with the Digital Millennium Copyright Act
 - Prohibits dissemination of the device intending to circumvent measures
- Social and Cultural
 - System defaults to the English
 - Gateworks© is an American Company as well as most of the Chromium OS developers
- Usability
 - Binaries will be available on Gateworks© servers
 - This will allow for easy installation of Chromium OS for any users

2.1.3 Constraints

The following list shows some of my constraints:

- I have a budget for the price of a Ventana GW5400 + any other hardware given to me by Gateworks©
- I do not have access to the source code for the Vivante driver for the Freescale i.MX6q
- My build system has an AMD Athlon II X3 Triple-Core Processor with 8GB RAM
- The OS will be installed on a MMC card and therefore read/write speeds are slower than NAND Flash
 - Note that there mSata SSD might be able to replace MMC if I can acquire a card
- The Ventana GW5400 specifications are as follows
 - Freescale i.MX6 1GHz Quad Core Processor
 - 512MB DDR3 RAM

2.2 Criteria

Table 2.1 shows the criteria I've chosen for this project.

Criteria	Parameters	Standard
Build Time	Minutes	Lower is Better
Flash Time	Seconds	Lower is Better
Video Rendering	Minutes	Lower is Better
Network interface speed	Mbits/s	High is Better
File System Type	UBIFS/jffs2	UBIFS is preferred by the client

Table 2.1: This table shows my criteria for this project

Chapter 3

Related Work and Projects

This chapter shows all research found relating to this project, with the hopes of furthering my understanding of this project and any attempts made beforehand.

3.1 The Chromium Projects

The official channels for Chromium OS lay out their guidelines for creating an official board port and how to properly sync the code to their repositories [2]. The first step in this is to setup a development machine [3] which states the minimum system requirements are as follows:

- Ubuntu Linux (version 12.04)
- An x86_64-bit system
- 4GB RAM

In addition to the above requirements, there are some software requirements that are listed in [3] in the TOC-Prerequisites section.

After getting a development machine setup, a developer creating a board port creates a “board overlay” (the wording used by the Chromium OS development team) that will sync with their file management scheme. There is also the option of creating a private board

overlay that will not upload to the public repository until the developer is ready to publish the release of the board overlay.

There still exists empirical data gathering to determine the shortest method of developing the kernel and Chromium OS. Once this phase is done, I might be able to edit the [\[2\]](#) webpage to further their explanations on this subject matter.

3.2 Other Related Works

Nothing exists as of today. This is mainly due to the fact that this is the first project to try and port Chromium OS to Freescale i.MX6q. This may change in future versions of this document.

Chapter 4

System Integration and Testing

This chapter will discuss my methodology on what aspects of my project to test. It will then go over display the results and have a writeup to analyze them.

4.1 Test Plan

The following functionality will be tested for:

- Power Consumption
- eth0/1
- USB EHCI/OTG
- Mini-PCIE (6)
 - Testing with standard mini-pcie ath9k radios
- User LED
- Accelerated Video Out

4.2 Test Results

The following are the results:

- Power Consumption

- Passed - Less than 6W
- eth0/1
 - Passed eth0 - Greater than 100mbps
 - Passed eth1 - Greater than 100mbps
- USB EHCI/OTG
 - EHCI - Passed - USB hub detected by OS
 - OTG - Failed - Could not get into device mode
- Mini-PCIE (6)
 - Freescale i.MX6q Root Complex - Found
 - PLX Switch - Found
 - Marvel PHY - Found
- User LED
 - /sys/class/led/user1 - Exported and writable
- Accelerated Video Out - Failed

4.3 Test Analysis

The test results in Section 4.2 show what was tested with what results in a list form. As seen, I have tested both ethernet ports, USB Host and OTG, the PCIe, user LED, and accelerated video out.

Of these, all passed except USB OTG and Accelerated Video Out. USB OTG could not act as device mode due to limitations in Chromium OS's implementation of it. It could, however, act as a USB Host device. Accelerated video out failed due to Freescale's closed system for their Vivante GPU driver. Because Chromium OS currently only supports ARM Mali GPU's, I had a difficult time getting the Vivante GPU driver into Chromium OS. This will be a future goal of mine, if I continue this project.

Appendix A

A.1 Budget

This section will lay out any part requests I had.

A.1.1 Requests and Justifications

This project had no requests for parts, other than what Gateworks© had donated.

A.2 Bill of Materials

This project does not have a Bill of Materials (BOM) as all hardware was provided by Gateworks©. However, there were several development costs, shown in Table [A.1](#)

Equipment	Cost
AMD FX-8350 Processor	183.59
Class 10 SD Card	16.11
Total	199.70

Table A.1: This table denotes this projects development costs

Appendix B

B.1 Actual Development Time

Figure B.1 shows how my developmental time was actually used.

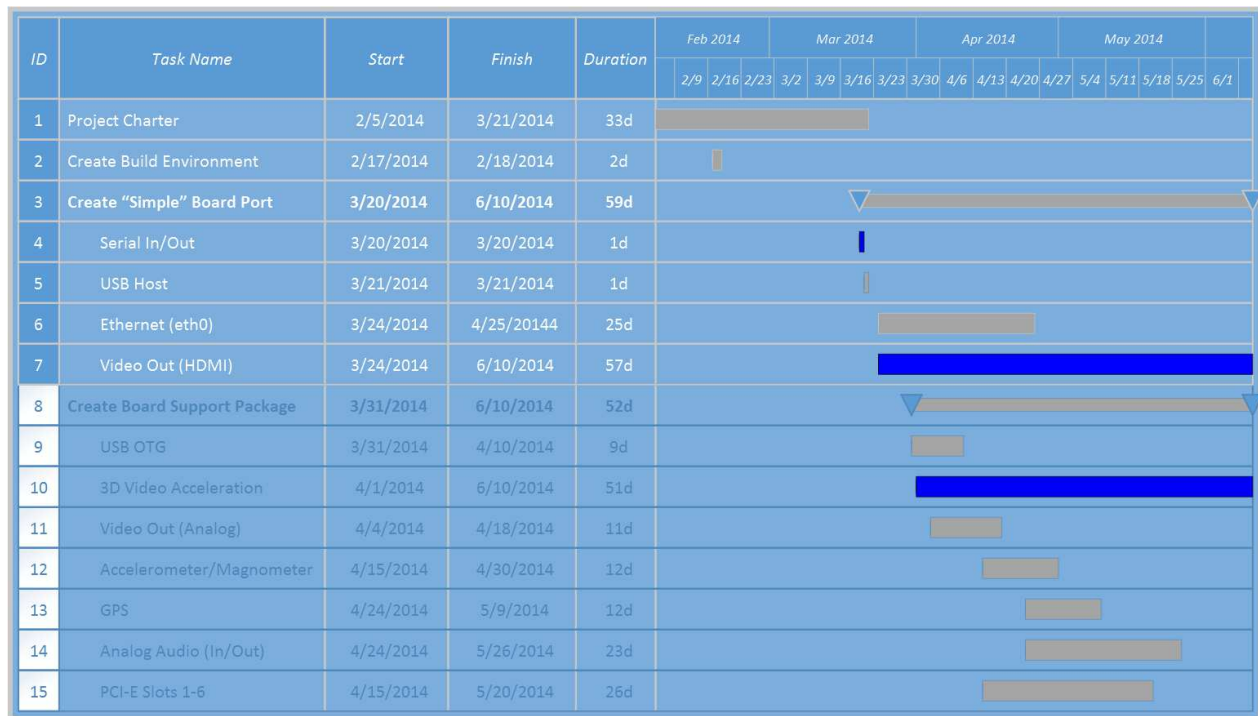


Figure B.1: This is my final timeline

Bibliography

- [1] *Company*. [Online]. Accessed Web. 08 Feb. 2014. Available: <http://www.gateworks.com/company>
- [2] *The Chromium Projects*. [Online]. Accessed Web. 08 Feb. 2014. Available: <http://www.chromium.org/chromium-os/>
- [3] *The Chromium Projects*. [Online]. Accessed Web. 08 Feb. 2014. Available: <http://dev.chromium.org/chromium-os/developer-guide>
- [4] *The Chromium Projects*. [Online]. Accessed Web. 08 Feb. 2014. Available: <http://www.chromium.org/chromium-os/how-tos-and-troubleshooting/chromiumos-board-porting-guide>
- [5] *The Chromium Projects*. [Online]. Accessed Web. 08 Feb. 2014. Available: <http://www.chromium.org/chromium-os/u-boot-porting-guide/u-boot-drivers>