Homework 3: Design Constraint Analysis and Component Selection Rationale
Due: Friday, February 10, at NOON

Team Code Name: The Soviet Challenge   **Group No.**   6

Team Member Completing This Homework: Greg Snow

Evaluation:

Component/Criterion	Score	Multiplier	Points
Introduction	0 1 2 3 4 5 6 7 8 9 10	X 1	
Analysis of Design Constraints	0 1 2 3 4 5 6 7 8 9 10	X 3	
Rationale for Component Selection	0 1 2 3 4 5 6 7 8 9 10	X 3	
List of Major Components	0 1 2 3 4 5 6 7 8 9 10	X 1	
List of References	0 1 2 3 4 5 6 7 8 9 10	X 1	
Technical Writing Style	0 1 2 3 4 5 6 7 8 9 10	X 1	
		TOTAL	

Comments:

_____

_____

_____

_____

_____

_____

1.0 Introduction

The purpose of this project is to create a handheld TetriNET client that communicates

with TetriNET servers wirelessly via 802.11. The device will support a local Tetris game

played by the user, as well as incoming information from the server regarding the state of

opponent's boards. A rechargeable battery will power the device so that it is completely

wireless and portable. Ten buttons, including a 4 button directional-pad, will allow the user the

functionality necessary to play the game. The user will also be able to store personal

preferences regarding game play and display.

2.0 Design Constraint Analysis

The main computational requirements of the device will be the ability to control a local

Tetris-like game and communicate with a server simultaneously. The microcontroller will have

to constantly issue commands to the LCD screen to update the status of the user's playing board

along with the boards of up to five opponents. There will also be space to view the next block

that will be entering the playing area. This will all be displayed on an LCD screen with a 2.7"

viewing display. The microcontroller will also need to have the ability to interface with a

number of different components. The main I/O functions of the microcontroller will be to

communicate with the compact flash wireless card, the LCD screen, and the user controlled

buttons. The LCD screen being used has in integrated microcontroller and LCD controller to

interpret commands from the main microcontroller. To do this, an RS-232 link will be

established between the LCD controller and the microcontroller. Because the device is

handheld, the power supply and packaging constraints are of immediate interest. The system

will need a rechargeable battery with the capability of providing power to the entire device for

extended periods of time. This poses a challenge because there are components such as the

LCD screen and the wireless card that have greater power requirements. Also, the battery must

be sized small enough as to not dramatically affect the size or weight of the device. Another

constraint that must be carefully considered is the type of packaging to be used. To play the

Tetris variant game, there will be 10 different buttons available to the user. These buttons will

need to be strategically placed so that the user will have quick, comfortable access to any

necessary button.

2.1 Computation Requirements

The main function of the microcontroller will be to run the local Tetris game and update

the LCD screen accordingly. Only the game being played on the TetriNET client will be run by

the microcontroller. The status of the other player's boards will be communicated through the

wireless Ethernet several times per second. The microcontroller will have to decode the packets

and update the opponent boards accordingly. Because the LCD screen provides commands to

draw shapes instead of having to draw the screen pixel by pixel, these computational

requirements will be met quite easily by the Atmel ATmega2561 [1] 8-bit microcontroller

which is capable or running at speeds up to 16 MHz.

2.2 Interface Requirements

There will be three main components that the microcontroller will need to interface with.

The first component, which will require the most frequent communication, will be the LCD

screen. The screen will need to be refreshed at a rate depending on the current speed of the

game and any button presses from the user. This communication will be done via RS-232,

which requires only 3 I/O pins from the microcontroller. When the user presses a direction on

the directional pad or one of the other six buttons, the microcontroller will need to make the

necessary computations and update the LCD accordingly. There will be ten total buttons that

will be interfaced to the microcontroller using a serial shift register implemented in a PLD.

This shift register will require 3 pins to communicate the possible button presses. The final

component that must be interfaced to the microcontroller will be the compact flash wireless

transceiver. To communicate with the TetriNET server via this card, 26 I/O pins will be

necessary.

Function	Component Interfaced	I/O Pins Required
Screen Display	LCD Controller/Screen	3
User Input	Directional-Pad, 6 Push Buttons	3
Wireless Internet	Compact Flash Wireless Card	26
Total I/O Pins		32

Figure 1, Interface Requirements

2.3 On-Chip Peripheral Requirements

According to the EarthLCD ezLCD-001 technical specification [2] (pg. 7), the ezLCD

communicates with the microcontroller via three wires and an asynchronous RS-232 handshake.

Two of the wires are the transmit and receive bits while the other is common ground. The MPU

on the LCD board will handle the RS-232 protocol. This serial interface is the only on-chip

peripheral necessary to the microcontroller.

2.4 Power Constraints

Because our device will be handheld, the power supply is of great importance. The

battery will need to have a lifetime long enough to provide ample playing time without

requiring frequent recharging. In addition, the battery will require reasonable dimensions so

that the device packaging is practical in size. If the battery increases the size dramatically, the device may be awkward to hold and difficult to play. Other power considerations that may become a factor are the necessary voltages for the other components in the design, specifically the LCD screen. Many LCD screens require much higher voltage and current specifications to power the backlight. This would require extra circuitry to step-up voltages to the desired level. The LCD screen we have chosen (ezLCD-001 [2]) comes integrated with its own circuitry to acquire the necessary voltages. Because there are many components in the device that require a 3.3 volt supply, a DC power regulator will be necessary to generate these voltages.

2.5 Packaging Constraints

Packaging is of utmost importance in all handheld devices. The layout of the display screen and buttons must be one that provides an enjoyable visual experience and providing game play. With the large number of buttons that will be accessible to the user, there are many different possible layouts that must be considered. The buttons that are must often used (rotate left, rotate right) will need to be in locations are quickly accessible by the user. Along with the button placements, the overall size and shape also need to be reasonable for a handheld device. The packaging should provide a small, lightweight gaming device that fits comfortably in the users hands. A system that is too large provides awkward movements to reach the desired buttons. The weight of the device is important because a system that is too heavy will not provide the most pleasing experience. Because of these constraints, our components have been selected so that they fit neatly into a polystyrene casing with dimensions of 160 mm x 90 mm (6.3" x 3.55").

2.6 Cost Constraints

The Nintendo DS is the only product currently on the market that can provide a handheld Tetris-like game capable of playing against opponents wirelessly. The Nintendo DS system retails for around $115, and the Tetris DS game (release date set for March 2006) will retail for about $30. Because of this, a target price for a mass-produced version of our project would be close to the sum of these two products (approximately $145). This would serve as the main competition for our TetriNET device. Because we are only creating a single prototype of the device, the total cost of all the components in the system will exceed this $145 range.

3.0 Component Selection Rationale

Microcontroller

The microcontrollers we considered are all manufactured by Atmel. They all have very similar specifications which are listed below:

	Price	Flash	EEPROM	SRAM	I/O Pins	Max Freq.	VCC
Atmel ATmega2561 [1]	$17.09	256 KB	4 KB	8 KB	54	16 MHz	1.8-5.5 V
Atmel ATmega1281 [3]	$15.99	128 KB	4 KB	8 KB	54	16 MHz	1.8-5.5 V
Atmel ATmega2560 [4]	$17.97	256 KB	4 KB	8 KB	86	16 MHz	1.8-5.5 V

Figure 2, Microcontroller Comparison

The first necessary feature of the microcontroller is that it must provide a sufficient amount of I/O pins. Currently, our design requires 32 I/O pins to interface with all the necessary components. The first two controllers listed (ATmega2561 & ATmega1281) each have 54 I/O pins, which easily covers the necessary 32. The ATmega2560 comes in a 100-pin package which was determined to be too large for our design. Because our implementation will be very heavily software-based, it was determined that the ATmega2561 would be a better fit because it contains more flash than the ATmega1281. We decided that the

increase in flash memory justifies the small increase in price due to the uncertainty of code

size and the number of libraries that will need to be imported.

LCD Screen

Our main LCD choice consisted of screens from Hantronix, CrystalFontz, and EarthLCD.

The specifications that we considered are listed below:

	Price	Number of Dots	Colors	Viewing Area	Dot Size	Back Light	Controller
Hantronix HDM3224CL-S [5]	$122.64	240 x 320	8	3.9"	234 μm x 68 μm	LED	Excluded
CrystalFontz CFAG320240C-YMI-VZ LCD [6]	$132.90	320 x 240	1	5.96"	340 μm x 340 μm	LED	Included
EarthLCD ezLCD-001 [2]	$149.00	240x160	512	2.7"	80 μm x 240 μm	LED	Included

Figure 3, LCD Comparison

Initially, the Hantronix HDM3224CL-S [5] was chosen due to the large viewing area and

color capability. A controller would be necessary to drive the LCD and it was

recommended by a Hantronix customer service representative that the Epson S1D13504 [7]

works well for this particular screen. After being unable to locate this controller through

any vendor, the idea of coding our own controller was brought it. After discussion, it was

determined that our project was already heavily software oriented and that it would add a

high level of complexity to the design. The EarthLCD ezLCD [2] screen proved to be the

next most viable candidate. Although it has a smaller viewing area, the LCD controller and

voltage step-up circuitry eliminate some added difficulties. Also, with the ability to

transmit 512 colors, the screen produces a very high quality image.

Power Supply

To determine a suitable battery to use, we compared three batteries. The important

specifications of each battery are listed below.

	Price	Voltage	Current Lifetime	Size	Weight
2S-325085 Li-Polymer Battery [8]	$19.95	7.4 V	1500 mAh	3.25" x 2" x .125"	2 oz.
35H10008-80 PDA T-Mobile Battery [9]	$19.48	5.0 V	1000 mAh		
HP 359113-001Li-Ion Battery [10]	$25.00	3.6 V	3600 mAh	4.33" x 2.80" x .53"	3.899 oz.

Figure 4, Battery Comparison

Two of the batteries we considered were very similar and one was slightly larger. The

main comparison was between the first two batteries because we felt that the HP battery

was too large for our design. The main difference between these two is the lifetime of each

battery. The Li-Polymer battery provides 1500 mAh as opposed to 1000 mAh for the PDA

battery. Because our device will only be powered by the battery, this was the main factor

for determining which battery to use. Also, this battery is very small and lightweight,

which matches the packaging constraints discussed earlier. Another feature of the Li-

Polymer battery that influenced our decision is the fact that it comes packaged with a

protection IC [11] that prevents battery over charge and over discharge.

Wireless Interface

The last major component of our design will provide wireless access to the internet and

TetriNET servers. The important features of the products we considered are listed below:

	Price	Interface	Dimensions
DigiConnect Wi-ME [12]	$275.00	Serial	.75" x .75 x 1.95"
Lantronix WiPort [13]	$150.00	Serial	1.335" x 1.280" x 0.415"
DPAC Airborne WLNB-SE-DP101 [14]	$108.00	RS-232	1.60" x 1.17" x .46"
PRISM 2.5-based CompactFlash [15]	$39.99	Compact Flash 8-bit mode	1.433" x 1.685" x .130"

Figure 5, Wireless Interface Comparison

We decided to go with the Compact Flash interface because of several reasons. This interface stuck out originally because of the price. After further research on each of the different products and the interfaces they use, it was found that the Compact Flash implementation using the Prism 2.5 chipset is very well documented and seems to be the easiest to implement. It was very difficult to find documentation and distributors able to sell the other three devices. The Compact Flash card also matched our packaging constraints due to its small size relative to the other options.

4.0 Summary

Design constraints pose a major obstacle in completing a large scale project such as the TetriNET client discussed. Without the right components and thoughts of how they will interface and communicate together, a successful implementation is nearly impossible. The microprocessor mentioned above will provide the necessary computational power to run the local Tetris game and communicate with the TetriNET servers. The ezLCD with the built in controller will exhibit an attractive display and help eliminate some unnecessary circuitry. Packaging and power constraints are very important to the design of any handheld device and this is no exception. The packaging has been designed to provide an easy interface for the user to communicate with and the battery has been chosen to prevent the necessity for frequent recharging.

List of References

[1]   Atmel ATmega2561 8-bit microcontroller
        http://www.atmel.com/dyn/resources/prod_documents/doc2549.pdf

[2]   EarthLCD ezLCD-001
        http://www.ezlcd.com/files/ezLCDmanual_0105.pdf

[3]   Atmel ATmega1281 8-bit microcontroller
        http://www.atmel.com/dyn/resources/prod_documents/doc2549.pdf

[4]   Atmel ATmega2560 8-bit microcontroller
        http://www.atmel.com/dyn/resources/prod_documents/doc2549S.pdf

[5]   Hantronix Technical Specification
        http://www.hantronix.com/down/s3224cl-s.pdf

[6]   Crystal Fontz CFAG320240C-YMI-VZ Graphical LCD
        http://www.crystalfontz.com/products/320240c/CFAG320240CYMIVZ.pdf

[7]   Epson S1D13504 LCD Controller
        http://www.gaw.ru/pdf/lcd/Chips/Epson/S1D13504_MF1072-04.pdf

[8]   Li-Polymer Battery Module
        http://www.batteryspace.com/index.asp?PageAction=VIEWPROD&ProdID=2362

[9]   35H10008-80 PDA Battery for T-Mobile
        http://store.l-f-l.com/cgi-bin/cp-app.cgi?rrc=N&pg=prod&ref=35H10008-80

[10] HP 359113-001 Li-Ion Battery
        http://www.shentech.com/hepa3535fafa.html

[11] PCB Battery Protection Module
        http://www.batteryspace.com/index.asp?PageAction=VIEWPROD&ProdID=1343

[12] DigiConnect Wi-ME
        http://www.digi.com/products/embeddedmodules/digiconnectwime.jsp

[13] Lantronix Wi-Port
        http://www.lantronix.com/device-networking/embedded-device-servers/wiport.html

[14] DPAC Airborne WLNB-SE-DP101
        http://www.dpactech.com/wireless_products/embedded-802.11-wireless-module.asp

[15] PRISM-2.5 based CompactFlash
        http://www.solwise.co.uk/wireless-cflash.htm

Appendix A: Parts List Spreadsheet

Vendor	Manufacturer	Part No.	Description	Unit Cost	Qty	Total Cost
Digi-Key	Atmel	ATmega2561	8-bit Microcontroller w/ 256 KB Flash	$17.09	1	$17.09
EarthLCD	EarthLCD	ezLCD-001	Intelligent 2.7" Color LCD Display Module with LCD Controller	$149.00	1	$149.00
Battery Space	Battery Space	2S-325085	7.4 V, 1500 mAh Rechargeable Li-Polymer Battery	$19.95	1	$19.95
Ebay	Senao	NL-2511CF	Wireless Compact Flash Card	$29.99	1	$39.99
Digi-Key	National Semiconductor	LM1086CS-3.3	3.3 V Voltage Regulator	$2.42	1	$2.42
					TOTAL	**$228.45**