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REQUIREMENTS DEFINITION
FOR THE
CSI426/KAYPRO II EMULATOR

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1.1 Overview

1.1.1 Overview

The purpose of these requirements is to specify an emulation program for the Kaypro II microcomputer.

The Kaypro II was a Z-80 based computer developed and distributed in the early 1980's. It was a successor to the popular Osborne computer. The Kaypro II was considered portable. Weighing 26 pounds, it was, at best, "luggable." The Kaypro II was self-contained. It had a built-in display, keyboard and floppy disk drives. For its time, the unit was extremely useful. In fact, Arthur C. Clarke was reported to have written 2010 on a Kaypro II. The Kaypro II used the popular CP/M operating system. It was a break-through computer, in that it was a basically a turnkey system.

1.1.2 History

Here is a history of the entire Kaypro line of computer systems. This history was compiled by Gregory Watson and posted to the CP/M newsgroup.

Year	Model	Notes
Late 1982	Kaypro II (a.k.a. Kaypro II '83)	2 SS/DD full-height floppies 2.5 MHz Z-80 1 serial port Bundled software from Perfect Software.
Middle 1983	Original Kaypro 10	1 DS/DD floppy drive 10 meg HD 4.0 MHz Z-80A CPU 2 serial ports light pen port Rudimentary graphics Real time clock (Absent on all or some models) Software from Perfect Software dBase II
Middle 1983	Kaypro IV (a.k.a. Kaypro IV '83)	Same as Kaypro II but... With DS/DD full-height floppy drives WordStar started being included in addition to the Perfect Software suite. The same was true for the Kaypro II'83

		Later versions included WordStar as well
Early 1984	Kaypro 4 (a.k.a. Kaypro 4 '84)	2 DS/DD half-height floppy drives 4.0 MHz Z-80A CPU 2 serial ports, Internal 300 baud modem Real-time clock Rudimentary graphics. Software from Micropro (WordStar, CalcStar, etc.)
Late 1984	Kaypro 2 (a.k.a. Kaypro 2 '83)	2 SS/DD half-height floppy drives, 4.0 MHz Z-80A 2 serial ports Rudimentary graphics. Software was from Micropro (WordStar, CalcStar, etc.)
Early 1984	Kaypro 2X	Similar to older Kaypro IV, or Kaypro 2 2 DS/DD half-height drives 4.0 MHz Z-80A 2 serial ports Rudimentary graphics Software from Micropro (WordStar, CalcStar, etc.)
Late 1984?	Kaypro Robie	The first non-portable Kaypro machine Black desktop 2 2.6 Megabyte floppy drives Motherboard is basically the same as a Kaypro 4 300 baud modem Rudimentary graphics Robies were not big sellers
1985	All models	Kaypro upgrades most of the machines to the "Universal ROM" Boot disk are now interchangeable
1985	Kaypro 2X	The Kaypro 4 '84 is renamed the Kaypro 2X (sometimes known as 2X MTC). Kaypro 2X, Kaypro 2 '84, and Kaypro 4'84 are dropped
Early 1985?	The "New" Kaypro 2	The "New 2" is introduced Basically an old 2X motherboard 1 DS/DD floppy drive Comes with only CP/M and WordStar for software
Early 1985	Kaypro II' 83	Kaypro starts producing the Kaypro II' 83 again Comes with Perfect software (as opposed to Micropro software)
1985	Kaypro 4X Kaypro 12X	Kaypro 4X is a Robie but in a standard portable case Kaypro 12X is a Kaypro 10 but with a Robie floppy drive (4X or a 12X may never have been produced)
1986	Kaypro 1	Equivalent to the old Kaypro 2X 2 DS/DD floppies 4.0 MHz Z-80A 2 serial ports, etc. Floppies are vertical as opposed to horizontal Came with CP/M and Perfect Writer for software
1986	Kaypro 1, Kaypro 2X MTC, Kaypro 10, Robie	After this. Kaypro produced just the 1, 2X MTC, 10 and Robie This continued until they got out of the CP/M machines
Ongoing evolution	Variations	After this, there were a few variations on some machines One variation was the Kaypro 4+88, which had a SWP (?) co-

		processor board with an 8088, 256K of memory (which could be configured as a RAM disk under CP/M), and could run some MSDOS software.
Unknown	Kaypro V	The Kaypro V was rumored to exist. It was supposed to be a precursor to the Kaypro 10, but with a 5 Meg HD and a single-sided floppy

1.2 Requirements Definition

1.2.1 Function

The Kaypro II emulation will allow the user to experience using a Kaypro II computer over the Internet. The user entry portions of the Kaypro II will be available to the user. These functions will closely resemble those of the original computer. There are numerous models of the Kaypro computer. The late 1982 version of the Kaypro II was chosen because a physical machine was available, and because of available documentation.

- The emulation program shall emulate the Kaypro II model of the Kaypro product line
- The user shall view the emulated version just as they would the original
- The emulator shall support the same character set as the original. Limitations in keyboard may apply. It is acceptable to substitute functionality when necessary.

1.2.2 Specifications

The Kaypro II emulator shall support a Kaypro II machine with the following specifications.

- 64K RAM
- 4K Video RAM
- 12K ROM (Not battery backed-up)
- 2 floppy drives, each capable formatted into 40 tracks, 10 sectors/track, 512 bytes/sector
- 80 character by 24 line text screen
- The emulated RAM shall be 64K bytes
- The emulated ROM shall be 12K Bytes
- The emulated video RAM shall be 4K bytes
- The emulator shall support 2 floppy disk drives
- The emulated floppy disk drives shall contain 40 tracks
- The emulated floppy disk drives shall contain 10 sectors per track
- The emulated floppy disk drives shall contain 512 bytes per sector
- The emulator shall support a 80 character per line by 24 line text screen

1.2.3 Platform

The platform for the emulated Kaypro II has been specified by the course. The goal is to have an archive of emulated machines from years past. The Kaypro II will be a single emulation within this archive. The archive will be available from outside via the Internet. The course requires the emulator to be implemented as a Java applet.

- The Kaypro II emulation shall be implemented in Java.
- The Implementation shall be pure Java (e.g. no Microsoft extensions)

- The Kaypro II emulation shall be implemented as an applet.
- The Kaypro II emulation shall be made available via the World Wide Web.

1.2.4 Emulation

Emulation will take place at the hardware level. That is, the hardware functions of the Kaypro II will be simulated. This means that specific ports and components will have to be emulated at the hardware/chip level. This method was chosen after careful analysis of the Kaypro internals. Emulation at this level allows the implementers to ignore much of the software functionality. The implementers will need a significant understanding of the hardware internals, however.

ROM and other software will be extracted from the original Kaypro II. This software will be converted into a suitable form, and used within the emulated version. The emulator will run

- Emulation shall be at the hardware level
- BIOS ROM shall be extracted from the original Kaypro II and inserted into the emulated version as executable code.

1.2.5 Functionality

The Kaypro II emulator shall include the following functionality

- Screen output
- Keyboard input
- Floppy disk support (simulated)
- CPU emulation
- Parallel printer port operation

The Kaypro II emulator shall not support serial port operation

- Screen output shall be supported
- Parallel printer output shall be supported
- Screen output shall resemble the original Kaypro II as closely as possible
- Keyboard input shall be supported. Keyboard input shall resemble the original Kaypro II as closely as possible
- The emulator shall support emulated functionality of 2 floppy disk drives
- The emulator shall support the emulation of the Z-80 processor
- The emulator shall support resetting of the Z-80 processor
- The emulator shall support necessary interrupts and state conditions of the Z-80 processor

1.2.6 Operating system

The operating system is CP/M 2.2. The OS is typically loaded from track 1. The emulation shall support this loading of CP/M into the actual machine. As such, all virtual floppy drives will contain a copy of CP/M on track 1.

The Kaypro system shall run an operating system called CP/M version 2.2. The operating system shall act as the core link between hardware and software as well as the overall system management utility. The operating system will be loaded from a virtual image on a DOS formatted floppy disk equating to track 1.

The CP/M operating system and CBIOS will be responsible for the following:

- Loading and unloading of applications
- Managing random access memory
- Basic input and output capability (see Ports Section)

- Handling keyboard services (see Ports Section)
- Handling interrupt services if applicable
- Handling floppy disk accesses (see Ports Section)
- System warm and cold booting

The CP/M operating system shall not be emulated. It shall actually be run at the software level via an obtained copy of the CP/M operating system. The emulation software for the Kaypro-II will load the actual CP/M operating system from a virtual floppy disk image compatible with the Kaypro-II system emulation software and start its execution.

The CP/M operating system must be supplied on each virtual floppy disk at track 1. Any floppy disks that are to be compatible with the Kaypro II system need a copy of the actual CP/M 2.2 operating system on the floppy disk.

- CP/M 2.2 shall be supported
- CP/M OS shall be supplied on track 1 of each virtual floppy disk.
- The emulator shall support loading of the OS from floppy drive A
- The CP/M operating system shall actually be run at the software level via an obtained copy of the CP/M operating system

1.2.7 Direct writes to system ports/chips

One problem with emulators occurs when software circumvents software and OS entry points, and writes directly to specific ports and chips. Because the Kaypro II will be emulated at a hardware level, the probability that the emulated version will operate correctly increases. However, some functionality is not being implemented; specifically serial and parallel ports.

- PIO support shall be supported
- Serial port (external serial connector) functionality shall not be supported
- The emulator shall not crash due to writes to unsupported functionality. Specifically reads or writes to serial and parallel ports.

1.2.8 Ports

The emulator shall support the following ports

- SIO as it is used in keyboard control
- Baud rate generator
- Disk drive controller ports
- PIO ports

These ports are used to control emulated devices, such as keyboard and floppy drives. While serial communications is not supported, serial (SIO) ports are used to control the keyboard. This functionality will be supported. The same is true for baud rate generator and parallel ports.

SIO

The serial input/output chip will be emulated at the hardware level though serial communication will not be supported. SIO will be used for keyboard input.

Baud Rate/DART

The dual asynchronous receiver transmitter chip will be emulated at the hardware level. It is used to accomplish serial communication within the system. This will be used for supporting keyboard and serial I/O.

PIO

The parallel input and output chip will be emulated at the hardware level.

Disk Drive Control

Disk drive control will be emulated at the hardware level with virtual machine translation for a non-CP/M, RAM drives holding a virtual image of the CP/M operating system.

- SIO ports used for keyboard control shall be supported
- Baud rate ports used for keyboard control shall be supported
- Disk drive ports shall be supported
- PIO ports shall be supported

1.2.9 Bank selection

The Kaypro II uses a method of bank selection for switching BIOS ROM/video in and out of main memory. When this happens, the lower 16K of memory is mapped to ROM and video. This operation can be reversed via software control. When video is banked-in, video RAM is made available. The Kaypro II uses a memory-mapped video display scheme.

- The emulator shall support banking
- The emulator shall support memory-mapped video

1.2.10 MAR MBR

MAR and MBR function is a class requirement. The function is described below.

1.2.10.1 MAR

The MAR or Memory Address Register shall be emulated at the hardware level and be invisible to the running software. Its internal workings will include:

- The MAR will hold the contents of the current working memory address to be read from or written to (William Stallings 4th Ed).
- The MAR will work in conjunction with the MBR (see MBR).

1.2.10.2 MBR

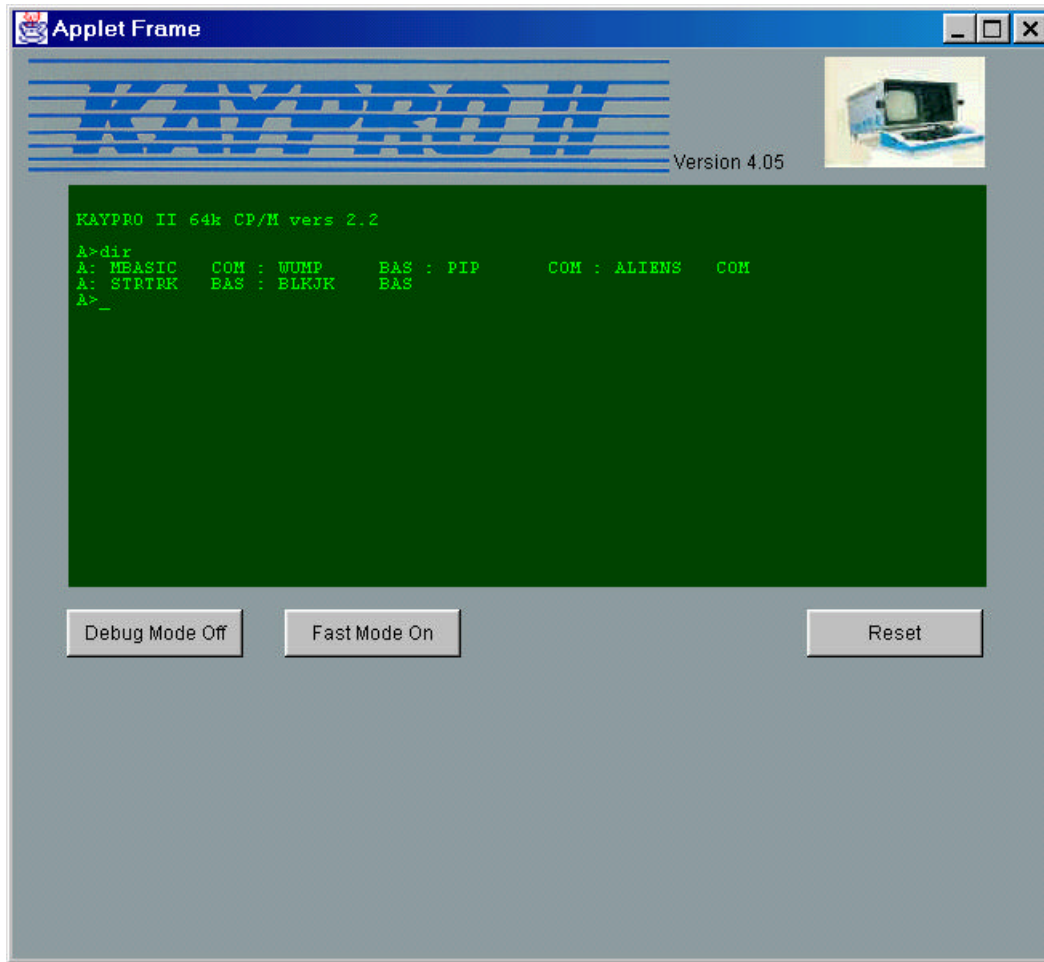
The MBR or Memory Buffer register shall be emulated at the hardware level and be invisible to the running copy of any actual software. Its internal workings will include;

- The MBR will contain a word to be stored from system memory or word to be written to system memory (William Stallings 4th Ed).
- The MBR will work in conjunction with the MAR (see 1.2.10.1)

The emulator shall support MAR (Memory Address Register) and MBR (Memory Buffer Register) registers. The MAR register is used to hold the address of memory being accessed by the CPU. Its contents are presented to the system bus. The bus accesses the data pointed to by this register and returns it to the MBR register.

- The emulator shall support MAR (Memory Address Register) and MBR (Memory Buffer Register) registers.
- An MAR register shall be contained within the CPU. It shall be used to buffer/latch the source/destination data address.
- An MBR register shall be contained within the CPU. It shall be used to buffer/latch the data to and from CPU and memory.

- The MAR will hold current working memory addresses and subsequently load the values at its address into the MBR.



1.2.11 Interface Description

The interface for the Kaypro II emulator shall be a simple Java style screen. All attempts should be made to keep load time down to a minimum. Since the Kaypro II is a text-based screen, the look and feel of the user interface should be simplistic. The screen should be displayed as large as possible for ease of use.

- Keyboard input shall be made directly into the Java page. The user shall be able to type directly into the emulated Kaypro II.
- The interface shall support resetting of the machine via a button on the emulation screen
- The screen shall be displayed in a simple text window
- Screen characters shall be as large as possible to afford readability
- The Java interface shall be kept minimal, to afford quicker load times
- Keyboard input shall be supported
- The interface shall support resetting of the machine via a button on the emulation screen

1.3 Debug

Because the system will be complex, some method of debugging will be needed. Much of this functionality will coincide with the ongoing development. However, certain functionality should be supported in the initial development.

- The developer shall be able to select (or deselect) a debug mode
- A method of register inspection shall be provided in debug mode
- A method of code examination shall be provided in debug mode
- A method of logging or displaying command opcodes shall be supported in debug mode

1.4 Utilities

A few utilities will be needed to accomplish the Kaypro II emulation. These utilities may be created programmatically, or hopefully, found in the public domain.

1.4.1 Diskette data extraction

A utility will be needed to extract data from a CP/M diskette. This utility will need to extract raw sector information. This information will be converted into virtual sectors on the emulated Kaypro II system

1.4.2 ROM data extraction

A ROM reader/blaster and associated software will be needed to extract the binary information contained within the Kaypro II EPROM. This information will be converted into binary information. The Kaypro II emulator will execute this code.

1.5 Kaypro Requirements Definition Glossary

<i>Applet</i>	- An internet application that runs inside an internet browser.
<i>Bank</i>	- A Computer science term used to describe a specific chunk of Random Access Memory (See Random Access Memory).
<i>BIOS</i>	- Basic Input and Output System. A set of programs, addresses or routines inside RAM (See Random Access Memory) that provide certain functionality for the computer system.
<i>Bit</i>	- The smallest value used to represent computer data or memory in a base 2 binary numbering system having a value of 1 or 0.
<i>Buad Rate</i>	- A term used to describe the ability of two devices ports (See Port) to establish a communication between them at a certain speed of data transfer.
<i>Buffer</i>	- A permanent or temporary area of storage used to hold data.
<i>Byte</i>	- A standard unit of measurement for computer data or RAM (See Random Access Memory)
<i>CPU</i>	- The Central Processing Unit.
<i>DOS</i>	- Disk Operating System.
<i>I/O</i>	- Input and Output.
<i>Interrupt</i>	- A term used to describe the need for a device or software program that must send a message to the Processor (See CPU) in order to gain its attention for useage.
<i>Java</i>	- A programming language with internet and platform independent capibility.
<i>Memory</i>	- Term used to describe an area of storage in a computer system. (See Random Access Memory, Bank, Buffer)
<i>Memory Mapped</i>	- A term used to describe how a computer system connects it I/O (See I/O) to RAM (See Random Access Memory).
<i>OP Code</i>	- The basic unit of instruction in a computer system. This is what is executed when a computer program is running.
<i>Operating system</i>	- The software program that manages low level hardwareand software management inside a computer system.
<i>Parallel</i>	- Data transmission that occurs in a side by side manor using multiple data lines to transmit data across a specific line.
<i>Port</i>	- A term used to describe the means for I/O (See I/O) internally and externally in a computer system.
<i>RAM</i>	- See Random Access Memory.

- Random Access Memory*** - The second fastest form of storage used inside a computer system commonly used for application execution and data storage.
- Register*** - The fastest form a storage inside a computer system usually constrained to a finite size depending on a particular system.
- ROM*** - Read Only Memory. Usually contains useful programs or data for Operating System (See Operating System), hardware and program useage.
- Serial*** - A term used to describe inline communication or data that is sent one after another either interanally or externally.
- Virtual Machine*** - A term used to describe a software or hardware program that emulates a given environment in which its executing applications are thought to be running.