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October 15, 2001

Dr. Andrew Rawicz
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Simon Fraser University
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Re: ENSC 340 Functional Specifications for MRx Home Theatre Interface

Dear Dr. Rawicz:

The attached document, *MRx Home Theatre Interface Functional Specifications*, outlines the functional specifications of our project for the Engineering Science Project Course, ENSC 340.  Our project is a system that allows people to play MP3 sound files on their home theatre systems.

The functional specifications organize the requirements of the entire system according to various categories.  We also discuss the regulatory requirement and potential limitations in this document.

Bandwidth Unlimited is a team comprised of five highly skilled and talented engineering science students: Mavis Chan, Brian Fraser, Manpreet Gakhal, Ben Lake, and Gabrielle Sheung.  If you have any questions or concerns about our proposal, please do not hesitate to email us at bandwidth-unlimited@sfu.ca, or to phone me at (604) 298-6442.  Thank you for your time.

Sincerely,


Gabrielle Sheung
Bandwidth Unlimited




Enclosure: MRx Home Theatre Interface Functional Specifications

# Bandwidth Unlimited

## MRx Home Theatre Interface
## Functional Specifications

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# Executive Summary

The MRx Home Theatre Interface is an innovative project, testing the mettle of one of the finest Ensc340 groups ever assembled. The wide scope of the project allows Bandwidth Unlimited to deliver high quality MP3 encoded music to any home theatre system for all to enjoy.

Much thought and consideration was put into the planning of the project to ensure that the MRx Home Theatre Interface is a useful, inventive and exciting new product to bring to the electronics market. Several products are already commercially available that rival the MRx. However, we know we can produce a far superior product to those existing in the market already. With several key additions, we are confident MRx will gain a profitable niche in the MP3 audio marketplace.

This document outlines the MRx functional specifications Bandwidth Unlimited has decided upon. Requirements detailed in this document ranges from basic operational functionality to unique features that will give the MRx a clear edge over similar existing products. One such feature is giving users the ability to use a Palm Pilot as a remote control. This feature is found only on the MRx and allows a more graphical user interface than the ones presently offer by commercially available products. An outline of what can be expected of the MRx is given, as well as requirements set by regulatory standards.

# Table of Contents

# 1. Introduction

In the past few years, MP3 compression technology has refashioned the way we enjoy our favourite music.  New file sharing programs allowed people to create song libraries of enormous proportion on their computers.  With such a vast array of high-quality digital music, it is perplexing that people have only been able to enjoy this music on a pair of second-rate computer speakers.

The MRx Home Theatre Interface is a system that will enable people to listen to digital music in their home theatre system.  With the MP3 player interface to the home theatre system, people can finally play their favourite songs with the audio quality they deserve in any room of their home.

This document will present the functional specifications we feel are necessary to allow users this freedom.  Various requirements are detailed for each of the major components in this project: the host computer, the MRx unit and the Palm Pilot remote control.  Most of the requirements mentioned in this document will be implemented in the prototype (phase one).  Some may be deferred as a potential feature instead of a requirement for our prototype.  Reasons for these deferrals will be explained in detail in the design specifications and considered to be phase two requirements.  Also in this document are regulatory requirements, potential limitations on our project and some of our test plans for the final project.

## 2. System Overview

The MRx system will allow people to play MP3 sound files stored on the host computer on their own home theatre systems. Figure 1 below illustrates the basic structure of this system. The host computer contains the library of MP3 files, and will send a stream of MP3 encoded audio to the MRx device via an Ethernet connection. The MRx device will deliver the decoded sound to an adjacent home theatre.

A two-way infrared link between the Palm Pilot device and the MRx allows the Palm Pilot to be used as a remote control for the MRx. The user interfaces on the host computer and on the Palm Pilot device allow the user full control over the music selection and playback, and provide the user with updated status information from the MRx. The front panel of the MRx device also allows for limited control over the music playback and provides the user with graphical feedback via an LCD screen.
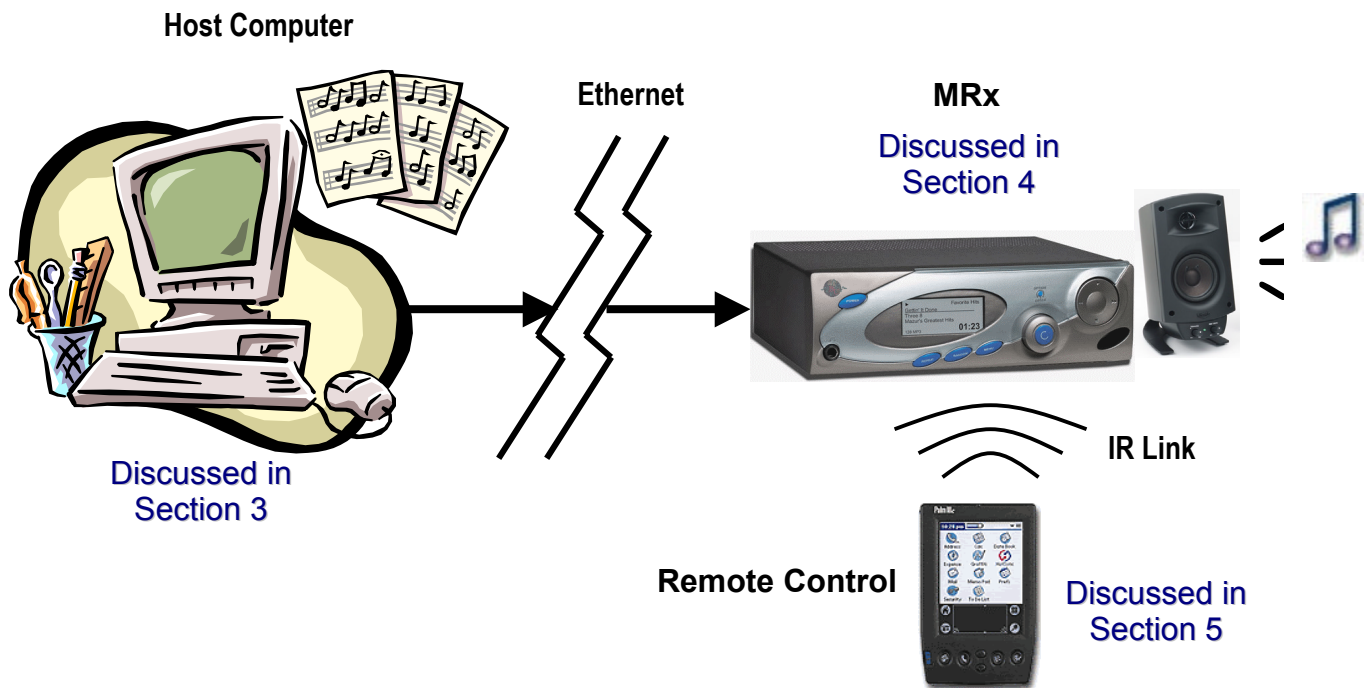
**Figure 3.1.1: System Overview**

**Functional Specifications**

# 3. Host Computer

The following sections detail the requirements of the host computer.

## 3.1   Physical Requirements

The host computer is a standard personal computer (PC) that must meet the following minimum requirements:

Requirement 3.1 –   The host PC must have a processor speed of Pentium 150MHz or AMD 150 MHz or better.
Requirement 3.2 –   The host PC must have a free hard drive space of at least 5Mb.
Requirement 3.3 –   The host PC must have at least 3Mb of available memory.
Requirement 3.4 –   The host PC must have a 10baseT Ethernet card.
Requirement 3.5 –   The host PC monitor must have a resolution of at least 640x480.
Requirement 3.6 –   The host PC must have a CD-ROM.
Requirement 3.7 –   The host PC must have a Microsoft Windows compatible mouse.

## 3.2   System Requirements

System requirements include general operational features and functionalities which are as follows:

Requirement 3.8 –   The host PC must have installed our MRx software.
Requirement 3.9 –   The host PC must store all available MP3's.
Requirement 3.10 – The host PC must store all playlists.
Requirement 3.11 – The host PC must provide an interface to the available files for the MRx.
Requirement 3.12 – The host PC must provide a physical interface with the MRx.

## 3.3   Performance Requirements

The host computer end of the project must meet the performance requirements mentioned below.

### 3.3.1 Compatibility

Requirement 3.13 – The host PC must be a system running Microsoft Windows 9x/2000 operating system.

## 3.3.2 Reliability
Requirement 3.14 – The host computer must handle unexpected errors gracefully.
Requirement 3.15 – If user attempts to delete a currently playing file, the host computer
                    will ask for confirmation for deletion.
Requirement 3.16 – If user attempts to delete a currently playing playlist, the host
                    computer will ask for confirmation for deletion.
Requirement 3.17 – If user attempts to save a playlist with the same name as an existing
                    one, the host computer will ask for confirmation for overwrite.

## 3.4    User Interface
The following requirements describe the host computer user interface that allows the user
to control one or more MRx devices from the host PC.

Requirement 3.18 – The host user interface must be graphical.
Requirement 3.19 – The host user interface must have the ability to view a list of
                    available MP3's.
Requirement 3.20 – The host user interface must allow the user to search available
                    MP3's.
Requirement 3.21 – The host user interface must provide basic audio controls such as
                    play, stop, pause, resume, skip forward, skip backward, and return to
                    start of song.
Requirement 3.22 – The host user interface must allow the user to load playlists.
Requirement 3.23 – The host user interface must be able to create, edit, and save
                    playlists.
Requirement 3.24 – The host user interface must show available track information and
                    status of current MP3.
Requirement 3.25 – The host user interface must provide basic audio controls and
                    playlist control to all MRx devices on the network. (To be
                    implemented in next phase.)
Requirement 3.26 – The host user interface must be small enough to be viewed in its
                    entirety on a monitor as small as 12", 800X600 resolution.
Requirement 3.27 – The host user interface must operate concurrently with other
                    programs on the OS.
Requirement 3.28 – The host user interface must be a relatively low priority compared to
                    other programs on the OS.

# 4. MRx

The following sections discuss the requirements for our main unit, the MRx.

## 4.1    Physical Requirements

The unit must meet the following physical and operational requirements:

Requirement 4.1 –   The unit will be designed for easy use with standard home audio equipment.
Requirement 4.2 –   The maximum dimensions of the unit must be 11" width, 11" length, and 4" height.
Requirement 4.3 –   The maximum mass of the unit must be 3 kg.
Requirement 4.4 –   The unit must contain a minimum of 6 push buttons.
Requirement 4.5 –   The unit must contain an LCD screen with a minimum of two lines, and 40 characters width per line.
Requirement 4.6 –   The MRx must draw power required for operation from a standard 120VAC household power outlet.
Requirement 4.7 –   The MRx must have a front panel interface capable of allowing access to basic playback and control operations.
Requirement 4.8 –   The unit will be able to operate at 0 to 70 degrees C.
Requirement 4.9 –   The unit may be stored at –20 to 85 degrees.

## 4.2    System Requirements

System requirements include general functionality and features of the MRx unit.

Requirement 4.10 – The unit must interface with the host PC via an Ethernet connection.
Requirement 4.11 – The unit must interface with a Palm Pilot via IR.
Requirement 4.12 – The unit must be capable of receiving commands from both the host PC and the Palm Pilot.
Requirement 4.13 – The unit must process commands received from the both host PC and the Palm Pilot in an indiscriminate manner.
Requirement 4.14 – The unit must be capable of pulling MP3 songs from the host PC.
Requirement 4.15 – The unit must relay information to the host PC and the Palm Pilot when the state of the unit changes.
Requirement 4.16 – If necessary, the unit must relay commands received from the Palm Pilot to the host PC.
Requirement 4.17 – The unit must be able to perform 16-bit digital to analog conversion.
Requirement 4.18 – The MRx system must have some method of storing user configurable options such that when the MRx is powered up, the previous configuration is restored.

## 4.3    Performance Requirements

Performance requirements discuss the quality of performance we wish to achieve.

### 4.3.1 Sound Quality

Requirement 4.19 – The unit must be capable of providing CD quality audio.
Requirement 4.20 – The unit must handle a minimum sampling rate of 44kHz.

### 4.3.2 Compatibility

Requirement 4.21 – The unit will connect with an external audio amplifier through a pair
                   of RCA audio jacks.

### 4.3.3 Reliability

Requirement 4.22 – The unit must be able to gracefully handle unexpected conditions,
                   such as failure of the Palm Pilot.
Requirement 4.23 – The unit must have a mean time before failure of at least 4400 hours.
Requirement 4.24 – The unit should be able to withstand a 4-foot drop on any side.
Requirement 4.25 – If an error occurs causing the unit to malfunction, the unit must
                   notify the host computer and Palm Pilot of failure (if possible) and
                   not effect the operation of either device.
Requirement 4.26 – If the host computer and Palm Pilot both give conflicting commands
                   at approximately the same time, the latter command will be
                   followed.
Requirement 4.27 – The unit will update its status to both the Palm Pilot and the host
                   computer.
Requirement 4.28 – If the currently playing song is deleted by the user, the unit will stop
                   playing the song and skip to the next song in the playlist.
Requirement 4.29 – The MRx must automatically restore network communication with
                   the host if the Ethernet connection is temporarily disconnected.

## 4.4    User Interface

This section details the requirements for the user interface of the unit.

Requirement 4.30 – The unit will provide graphical feedback to the user through an LCD
                   screen.
Requirement 4.31 – The unit will allow the user to perform a limited number of functions
                   such as playing, stopping, and skipping songs via push buttons on
                   unit's front panel.

# 5. Palm Pilot

The following sections detail the requirements of the Palm Pilot.

## 5.1　Physical Requirements

The Palm Pilot remote control interface is designed to utilize the Palm IIIe.  Any device that meets the following minimum requirements must also be sufficient:

Requirement 5.1 –　The OS of the Palm used must be at least OS 3.1.1
Requirement 5.2 –　The Palm used must have at least 500kb of available memory
Requirement 5.3 –　The Palm must have a touch screen interface (or compatible alternative pointing devices)
Requirement 5.4 –　The Palm must have an infrared port
Requirement 5.5 –　The Palm must have a speed of 12MHz or faster

## 5.2　System Requirements

System requirements include general operational features and functionality, which are as follows:

Requirement 5.6 –　The Palm must have installed our MRx software.
Requirement 5.7 –　The Palm must provide an interface to the available files for the MRx.
Requirement 5.8 –　The Palm must provide a physical interface with the MRx via IR.

## 5.3　Performance Requirements

The following sections detail the performance requirement for the Palm Pilot portion of the project.

### 5.3.1 Compatibility

Requirement 5.9 –　The Palm must be a Palm IIIe model or better.

### 5.3.2 Reliability

Requirement 5.10 – The Palm Pilot must handle unexpected errors gracefully.
Requirement 5.11 – If user attempts to delete a currently playing file, the Palm Pilot will ask for confirmation for deletion.
Requirement 5.12 – If user attempts to delete a currently playing playlist, the Palm Pilot will ask for confirmation for deletion.
Requirement 5.13 – If user attempts to save a playlist with the same name as an existing one, the Palm Pilot will ask for confirmation for overwrite.

## 5.4 User Interface

The following requirements describe the Palm user interface that allows the user to control an MRx device.

Requirement 5.14 – The Palm user interface must be graphical.
Requirement 5.15 – The Palm user interface must have the ability to view available MP3's.
Requirement 5.16 – The Palm user interface must allow the user to search available MP3's.
Requirement 5.17 – The Palm user interface must provide basic audio controls such as play, stop, pause, resume, skip forward, skip backward, and return to start of song.
Requirement 5.18 – The Palm user interface must provide available track information and status of current MP3.
Requirement 5.19 – The Palm user interface must allow the user to load playlists.
Requirement 5.20 – The Palm user interface must be able to create, edit, and save playlists.
Requirement 5.21 – The Palm user interface must not require the user to traverse more than 3 levels from the main menu to perform any command.
Requirement 5.22 – The Palm user interface must function across a non-permanent IR connection and handle if it cannot communicate to the MRx.

# 6. Internal Interface Requirements

The following sections describe the requirements needed for the interface between devices within the entire system.  Namely, between the host computer and the MRx unit, and between the MRx unit and the Palm Pilot control.

## 6.1    Host Computer to MRx Interface

Requirement 6.1 –    The host computer and the MRx device must have Ethernet connection between them.

Requirement 6.2 –    The Ethernet connection between the host computer and the MRx unit must have a speed of at least 10 Mbps.

Requirement 6.3 –    The data transfer between the host computer and the unit must be bi-directional.

## 6.2    Palm Pilot to MRx Interface

Requirement 6.4 –    The MRx must be able to maintain two-way infrared communication with a remote control up to 5 meters (15 feet) away.

Requirement 6.5 –    The Palm Pilot must resynchronize itself with the unit when it returns back into the infrared range of the unit.

Requirement 6.6 –    The data transfer between the Palm Pilot and the unit must be bi-directional.

# 7. Regulatory Requirements

This section details the regulatory requirements that the MRx will be required to pass as a completed and manufacturable device (phase 2 of project development).  These requirements do not need to be met during the prototype development stage, phase 1.

The MRx will be tested while in operation with a host computer and a Palm Pilot communicating with the device.  However, only the MRx will be subjected to the requirements, since the respective manufacturers have previously tested the other hardware components of the system.

Requirement 7.1 –   The system must comply with the following electromagnetic compatibility standards:
a)  EN 55011:1991/CISPR 11:1992 +A2:1992 (Group 1, Class A) –RE/CE
b)  EN 50082-1:1997 – Radiated, EFT/Burst, ESD Surge, Conducted, Voltage dips/interrupts

Requirement 7.2 –   The system must be connected to an AC power outlet, and therefore must comply with the following safety standards:
a)  CSA C22.2 No 1010.1-92
b)  IEC 1010-1:1990 +A1:1992 +A2:1995
c)  UL 3111-1

Requirement 7.3 –   The system must comply with the following environmental specifications:
a)  Temperature – The system must safely operate in an ambient temperature of 0 to 70 degrees Celsius.  Derate 2 degrees Celsius for every 1000ft above sea level.
b)  Humidity – The system must safely operate in relative humidity of 5% to 95%.
c)  Vibration – The system must:
    i.   Withstand 0.5g of continuous multi-axial vibration during operation.
    ii.  Operate correctly after being subjected to 5.0g of multi-axial vibration for one hour, while packaged in final shipping crate.
d)  Shock – The MRx device must withstand a drop from 30cm onto a hard surface, on any face of the device.

# 8. Test Plan

This section outlines some test plans we plan on using to ensure we have met all our requirements as detailed in this document. The test plans are also designed to assess the integrity of our unit.

## 8.1 Installation and Setup.
8.1.1    The user will plug the MRx into a network with a PC running Windows 9x/2000.
8.1.2    The user will install the Host software onto the PC.
8.1.3    The user will install the Palm Pilot software onto the Palm.
8.1.4    The user will configure the MRx to correctly communicate with the Host PC over the Ethernet.

## 8.2 PC Playlist Editing:
8.2.1    The PC control application will show a list of available playlists.
8.2.2    The user will select a playlist, and edit it.
8.2.3    A list of songs currently in the playlist will be displayed
8.2.4    The user will browse the directories and add a song to the playlist.
8.2.5    The user will save the playlist.

## 8.3 MRx User Interface
8.3.1    The MRx will display a list of available playlists
8.3.2    The user will select one of the playlists and start it playing.
8.3.3    The LCD will indicate that the playlist is playing.
8.3.4    The user will skip a song on the playlist.
8.3.5    The LCD will display the information about the new song that is playing.

## 8.4 Palm Pilot
          (Assume that a playlist is currently playing.)
8.4.1    The Palm Pilot will display the current status of the MRx.
8.4.2    The user will command the MRx through the Palm Pilot to skip to the next song.
8.4.3    The Palm Pilot will indicate the new song that is playing.
8.4.4    The user will command it to stop playing.
8.4.5    The Palm Pilot will indicate that the unit has stopped.

# 9. Potential Limitations

The following are some potential limitations that may be implemented in the design of the product.  These limitations will be introduced as necessary to simplify the hardware and software for the system during the proof of product stage of development.  These constraints will need to be re-evaluated and eliminated in a final sellable product.

1. Only a single PC may function as the MP3 file server for the MRx.
2. Only a single PC may send control functions to the MRx.
3. Only a single MRx may be used on a network at a time.
4. Only a single Palm Pilot may be used as the remote control for the MRx.
5. The size of a play list may be limited to some maximum number of songs to facilitate transmission and processing of the play list.  It is expected that this limit will not be less than 100 songs.
6. The size of any particular MP3 song to be played may be limited to a certain file size. It is expected that this maximum file size will not be less than 8 megabytes.

# 10.  Conclusion

The MP3 market is an exciting and rapidly expanding area in today's digital world.  The numerous easily obtainable file-sharing programs allowed people to accumulate massive archives of MP3 encoded music.  Until now, users have been restricted to listening this music on their computers or on headphones of their portable MP3 players.  Bandwidth Unlimited will create the MRx Home Theatre Interface, to bring these massive MP3 libraries into any room of the house for enjoyment on real, full-sized home theatre systems.

The system consists of a host computer containing the music library, the MRx device receiving MP3 encoded audio via an Ethernet connection and a Palm Pilot remote control to provide a user-friendly interface to the MRx.  With the requirements and features as described in this document, the MRx will surely be the entertainment equipment of choice for music lovers everywhere.

## Acronyms

CD-ROM –   Compact Disk Read Only Memory.
IrDA –        Infrared Data Association.
MHz –        Megahertz.
MP3 –        MPEG (Moving Picture Experts Group) Audio Layer 3.
MRx –        MP3 Receiver.  (The device being designed and built by Bandwidth-Unlimited.)
OS –          Operating System.
PC –          Personal Computer.
RAM –        Random Access Memory.