



The Audio Group

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October 16, 2000

Dr. Andrew Rawicz  
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Re: ENSC 340 Functional Specification for a MP3 to Stereo Gateway

Dear Dr. Rawicz,

Attached you will find The Audio Group's *Functional Specification for a MP3 to Stereo Gateway*. This document lists the functional specifications for our ENSC 340 project.

We are in the process of designing and building a handheld device that converts steaming MPEG3 (MP3) digital data from the Internet into standard RCA audio output for direct input to a stereo receiver. The device, which we call the Audio Gateway, features an interactive menu system with a display similar to normal stereo receivers, which will enable users to load and play music from servers on the Internet.

The purpose of this functional specification is to list the parameters that our completed Stereo Gateway will fulfill. The document lists the specifications that will be completed for the project deadline in December and the specifications that will be left for future development of a production-quality version.

TAG is comprised of 5 students: Tom Halford, Aaron Kaiway, Jeff Robinson, Ross Tulloch, and Ross Wightman. Please feel free to query us with any questions, Aaron Kaiway is our contact person and he can be reached at 925-6168 or akaiway@sfu.ca.

Sincerely,

Aaron Kaiway

Aaron Kaiway,  
TAG-340 Project Group

Enclosure: *Functional Specification for a MP3 to Stereo Gateway*.



**The Audio Group**

*tag-340@sfu.ca*

Functional Specification for a

# MP3 to Stereo Audio Gateway

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## Executive Summary

Recent developments in broadband technology, combined with the advent of illicit digital music distribution, suggest that commercialized digital music distribution is a likely proposition. The MP3 to Stereo Gateway is positioned as an infrastructure device to aid the growth of the Internet as a viable music distribution medium. It allows the ubiquitous home stereo unit to interface with the Internet and play digital music files.

The development of the Stereo Gateway will occur in two phases. After the completion of the first phase of development, the Stereo Gateway will support simple retrieval and playback of audio from remote servers. The device will have the following features:

1. The playback of multiple MPEG Layer 1 and Layer 2, and MPEG2 Layer 1 and Layer2 encoded audio files.
2. Audio performance characteristics akin to standard consumer audio devices
3. Easy to use user interface.

After the second phase of development, the device will also:

1. Be extensible for future developments in digital audio files.
2. Be a fully usable consumer device.
3. Perform as a reliable consumer device.

The first phase of development in the Stereo Gateway will be completed in December 2000.



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# 1 Introduction

The MP3 to Stereo Gateway is a device that integrates MP3 playback into the ubiquitous home stereo system. It does this by providing a link between the Internet and the home stereo by using standard Ethernet and RCA cabling. The MP3 to Stereo Gateway is a device intended to increase availability of infrastructure to distribute and playback digital audio, and increase the acceptance and availability of digital audio and digital audio distribution. The project will be developed in stages that include a proof of concept device deliverable for December of 2000, followed by further development in preparation for commercial deployment.

## 1.1 Scope

This document describes the functional requirements that must be met by a functioning MP3 to Stereo Gateway. A full set of functional requirements is supplied for the proof of concept device. Since it is expected that substantial experience will be gained while building the proof of concept device, only a partial set of functional requirements is supplied for the production device.

The requirements listed here drive the design of the MP3 to Stereo Gateway. The requirements are traceable in the design documents.

## 1.2 Acronyms

FAQ	Frequently Asked Questions
FTP	File Transfer Protocol
HTTP	Hypertext Transfer Protocol
LCD	Liquid Crystal Display
MPEG	Motion Pictures Expert Group
MP3	Motion Pictures Expert Group Layer 3 digital audio format
MTBF	Mean Time Between Failure
RFC	Request for Comments
TAG	The Audio Group.

## 1.3 Referenced Documents

- [1] Proposal for an MP3 to Audio Gateway. The Audio Group.
- [2] RFC 959 - File Transfer Protocol. J. Postel, J.K. Reynolds.
- [3] RFC 2428 - FTP Extensions for IPv6 and NATs. M. Allman, S. Ostermann, C. Metz.
- [4] RFC 2616 - Hypertext Transfer Protocol -- HTTP/1.1. R. Fielding, J. Gettys, J. Mogul, H. Frystyk, L. Masinter, P. Leach, T. Berners-Lee.



## 1.4 Intended Audience

Design engineers will use this document when developing the subsystems of the MP3 to Stereo Gateway.

The project manager will use this document to measure project performance and development objectives. The manager will also use this document to verify the project design.

Marketing personnel will use this document to develop initial promotional material.

## 1.5 Objectives

The following convention is used throughout this document to denote functional requirements:

**[R#]** A functional requirement

To denote the priority of each functional requirement, a number ( $n$ ) will be appended to the front of each functional requirement. The symbol ( $n$ ) shall signify:

- (1) A functional requirement for both the proof of concept device and the production device.
- (2) A functional requirement for only the proof of concept device.
- (3) A functional requirement for only the production device.



## 2 System Requirements

### 2.1 System Overview

This section is strictly informative. Figure 1 shows the overview of a streaming audio system. The Audio Gateway is connected over a network to a number of computers distributing digital audio. Upon user input, the Audio Gateway lists available songs and allows the user to select one or many songs for playback. It then retrieves the selected songs from the network and decodes the music data for just-in-time stereo playback.

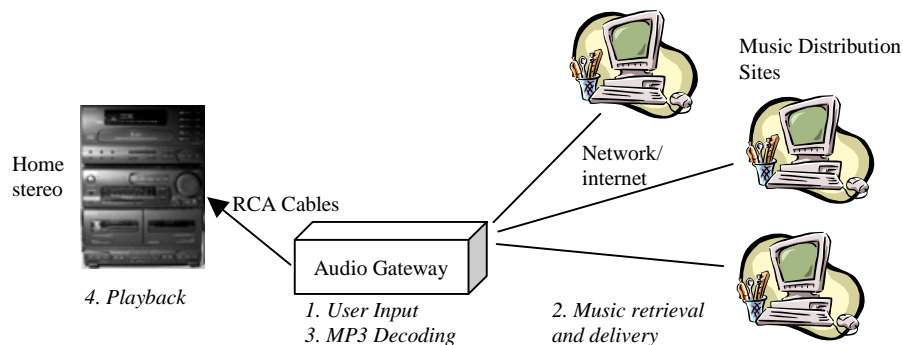


Figure 1 Streaming audio system overview

### 2.2 Physical Requirements

As the Audio Gateway is intended to integrate digital audio into a home stereo unit [1], the unit's requirements should be specified for easy integration into a home stereo unit. Functional requirements should also parameterize the Gateway as a consumer device, with performance characteristics similar to those of consumer audio equipment.

#### 2.2.1 General

- R[1]** The unit dimensions will be standardized for home audio equipment, or for easy use with home audio equipment. (1)
- R[2]** The unit shall be raised sufficiently so that ventilation is provided for devices beneath it. (3)
- R[3]** The unit shall be of sufficient mass so that the force from connections will not cause the device to move. (1)
- R[4]** Due to the size of the available LCD, the prototype unit shall be oriented for operation from the unit's top. (2)
- R[5]** Power, network, and stereo RCA connections shall be made at the rear of the unit. (1)





- R[6]** The prototype will be powered by a combination of external power supplies. (2)
- R[7]** The production unit will have an onboard power supply. (3)
- R[8]** With the exception of the interface and necessary power components, all device components shall be housed inside a rigid enclosure of sufficient strength. (1)
- R[9]** Network access to the unit shall be made using a standard 10/100 Base-T female Ethernet port. (1)
- R[10]** The Audio Gateway shall connect with an external audio amplifier through a pair of RCA audio jacks. (1)

## 2.3 System Requirements

### 2.3.1 General

- R[11]** The unit shall be capable of operating at the normal consumer temperature range of between 0°C and 40°C. (1)
- R[12]** The unit shall be capable of operating under all domestic humidity and pressure ranges. (1)
- R[13]** The unit's heat dissipation shall be such that the exterior of the unit will not be more than 30°C. (1)

### 2.3.2 Performance

- R[14]** The unit shall be able to process network traffic at a rate in excess of the maximum MP3 bit rate (320Kb/s), plus necessary overhead. (1)
- R[15]** Response to user input on the LCD screen refresh shall have upper limit of 250 ms. (1)
- R[16]** Response time between a user 'play' command and music being heard shall be less than 250 ms. (1)

### 2.3.3 Sound Quality

- R[17]** The unit shall meet audio specifications comparable to standard home audio equipment. (1)

### 2.3.4 Compatibility

The main compatibility concerns are with the input and output of the unit.

- R[18]** The RCA output voltage on the two RCA audio jacks should have a peak level of 2 Volts. (1)



- R[19]** The output impedance at the jacks should be in the range of 200-400  $\Omega$  for good performance with standard home stereo amplifiers. It should be noted that the audio output will be interfaced with an amplifier having an input impedance in the order of 50 k $\Omega$ . (1)
- R[20]** The modular Ethernet jack must conform to the TIA/EIA 568-A standard for use with category 3 cabling. (1)
- R[21]** The unit must communicate with standard Internet transport protocols. (1)

### 2.3.5 Reliability & Serviceability

With the exception of the unit's buttons, the Audio Gateway is a solid state device and as such should be a reliable unit. Points of possible failure reside mostly in the unit's operating system and firmware.

- R[22]** Must operate for reasonably long periods of time (3 days) without failing. (3)
- R[23]** In event of failure, the unit must be able to recover by cycling the power. (3)
- R[24]** Due to the low number of mechanical parts, the unit should have a mean time between failure (MTBF) exceeding 100,000 hours. (3)
- R[25]** The unit's buttons should have a duty cycle of at least 1,000,000 cycles (3)
- R[26]** The unit's firmware shall be upgradeable by the end user. (3)
- R[27]** The unit should not be serviceable by the end user. (1)
- R[28]** The unit should withstand continual play of audio by Zanfira (Master of the Pan Flute) and Conway Twitty without crashing. (1)



## 3 Interface Requirements

Requirements for the user interface are defined in terms of the menus that are displayed on the LCD and on the buttons that the user can press. Note that the user can play files individually or as part of a play list.

The first interface requirement defines the use of buttons to define menu buttons.

- R[29]** There shall be dedicated buttons for the functions of play, stop, advance, and reverse. (1 - tentative)
- R[30]** For the remainder of the buttons, each menu screen shall provide labels for the buttons. Thus many button functions are dynamic. (1)
- R[31]** The unit shall be able to save configuration information. (3)
- R[32]** The unit shall be able to save music play lists. (3)
- R[33]** Upon request, the unit shall be able to infiltrate and crash the United States Government's main web page. (1 – tentative)

### 3.1 Main Menu

From the main menu the user may navigate to the other menus. The main menu shall present the user with 5 options:

- R[34]** The audio playback option shall change the current context to an audio playback menu. Note that pressing any of the dedicated playback buttons will also cause the context to change to the audio playback menu. (1)
- R[35]** The file navigation option shall change the current context to a file navigation menu. (1)
- R[36]** The playlist management option shall change the current context to a playlist management menu. (1)
- R[37]** The server setup option shall change the current context to a server setup menu. (1)
- R[38]** The diagnostics option shall change the current context to a diagnostics option menu. (1)

### 3.2 Audio Playback Menu

- R[39]** The audio playback menu shall be the default menu upon power up. (1)
- R[40]** The song previously queued before unit power down should be ready for play, if available upon unit power up. (3)
- R[41]** The audio playback menu shall display information about the current song being played, or the current song in the song playlist. (1)



- R[42]** The back button shall skip to previous file in playlist. If a single file is playing rather than a playlist, this button returns to the beginning of that track. (1)
- R[43]** The play button shall start audio playback of current file on playlist. (1)
- R[44]** The stop button shall stop audio playback. (1)
- R[45]** The next button shall skip to the next file in the current playlist. (1)
- R[46]** Any time a dedicated playback button is activated, the audio playback menu will be displayed. (1)
- R[47]** The pause option shall pause audio playback. (1)
- R[48]** The main return option shall change the current context to the main menu. (1)

### 3.3 File Navigation Menu

Files are navigated by keeping track of the current file with a cursor. Note that the file tree includes files, directory names and server names. (1)

- R[49]** The cursor up option shall move the cursor up the server / file list. (1)
- R[50]** The cursor down option shall move the cursor down the server / file list. (1)
- R[51]** The up level option shall ascend the server / file hierarchy. (1)
- R[52]** The down level option shall descend the server / file hierarchy. (1)
- R[53]** If the cursor currently selects a file, the add file option shall add the file to the current playlist. (1)
- R[54]** If the cursor currently selects a directory, the add file option shall add all files in that directory to the current playlist. (1)
- R[55]** If the cursor currently selects a server, the add file option shall add all files on that server to the current playlist. (1)
- R[56]** The main return option shall change the current context to the main menu. (1)

### 3.4 Playlist Management Menu

Playlist management is similar to file navigation in that the user navigates through a list of files but with one level.

- R[57]** The cursor up option shall move cursor up the playlist. (1)
- R[58]** The cursor down option shall move cursor down the playlist. (1)
- R[59]** The shift up option shall shift the current file up the playlist. (1)
- R[60]** The shift down option shall shift the current file down the playlist. (1)
- R[61]** The remove option shall remove the current file (as indicated by cursor) from the file list. (1)



**R[62]** The main return option shall change the current context to the main menu. (1)

### 3.5 Server Setup Menu

**R[63]** The add server option shall allow the user to add a server to the unit's server repository. Servers can be named in either a text form (eg. wiggley.dhs.org) or in a numbers and dots form (eg. 111.23.43.223). (1)

**R[64]** The remove server option shall allow the user to remove a server from the unit's server repository. (1)

**R[65]** The save playlist option shall allow the user to save the current playlist in memory with a user-determined name. (1)

**R[66]** The load playlist option shall allow the user to choose a playlist stored in memory as the current playlist. (1)

**R[67]** The remove playlist option shall allow the user to remove a playlist from the unit's playlist repository. (1)

**R[68]** The main return option shall change the current context to the main menu. (1)

### 3.6 Diagnostics Menu

**R[69]** The check connection option shall allow the user to verify the presence of a network connection. (1)

**R[70]** The reset option shall cause the unit to reset as for a power down. (1)

**R[71]** The firmware update menu shall present the user with a screen that guides the user through the firmware update process. (3)

**R[72]** The main return option shall change the current context to the main menu. (1)

### 3.7 Host Computer User Interface

These requirements define the types of servers with which the unit can interface. See section 4.2 for a further description.

**R[73]** The unit shall interface with FTP servers following the protocol defined in RFCs 959, 2428. (1)

**R[74]** The unit shall interface with HTTP servers following the protocol defined in RFC 2616. (3)



## 4 Compression Protocol Requirements

The compression protocol requirements define the compression protocols that Audio Gateway will support. Both the device and host computer capabilities are defined.

### 4.1 Device Capabilities

While the main focus of the device is the playback of MP3 audio, it should be extensible to meet the changing and improving nature of digital audio formats.

- R[75]** The unit shall support all standard sample rates 11kHz to 44.1kHz. (1)
- R[76]** The unit shall be able to decode MPEG1 Layer 1, and Layer 2 data. (1)
- R[77]** The unit shall be able to decode MPEG2 Layer 1, and Layer 2 data. (1)
- R[78]** The unit shall be able to decode MPEG1 Layer 3 data. (1)
- R[79]** The unit shall be able to decode MPEG2 Layer 3 data. (1)
- R[80]** The unit shall be extensible to support additional digital audio formats through firmware upgrades. (3)

### 4.2 Host Computer Capabilities

As host computers are expected to use standardized Internet transfer protocols, these requirements are statements of pre-existing functionality. See section 3.7 for more information.

- R[81]** The host computer shall be able to transfer MPEG1 Layer 1, Layer 2, and Layer 3 data to the Stereo gateway (1)
- R[82]** The host computer shall be able to transfer MPEG2 Layer 1, Layer 2, and Layer 3 data to the Stereo gateway (1)
- R[83]** The host computer shall be able to transfer additional digital audio formats as necessary. (3)



## 5 Regulatory Requirements

As the Audio Gateway is a device intended for home use it is subject to a set of government regulations.

- R[84]** The Audio Gateway will be UL, CSA and CE approved for domestic use. (3)
- R[85]** It will follow EN 50082-1:1997, and EN 55011:1991/CISPR 11:1992 +A2:1992 (Group 1, Class A) – RE/CE relating to electromagnetic compatibility. (3)
- R[86]** It will follow the CSA C22.2 No 1010.1-92 safety specification, IEC 1010-1:1990+A1:1992+A2:1995, and UL 3111-1 (3)
- R[87]** The assembly will have smooth and symmetric edges and corners. All electrical connections will be enclosed and yield no danger to the user. (1)

Note that the user is expected to use caution when handling the Audio Gate and should always pull the plug instead of the power cord, and should not ever handle the unit with wet hands. TAG also cautions that users should never place the unit near sources of water, such as a bathtub, even if White Rabbit, by Jefferson Airplane, is about to peak.



## 6 Documentation & User Training

While the immediate market for this device is savvy internet users, it is expected that streaming audio will become a standard used by less technically proficient users. With these users in mind, the following requirements have been set for documentation and user training.

- R[88]** Documentation for the production version of this device will consist of one thirty page user manual with instructions in English, French, German, Spanish, and Japanese. (3)
- R[89]** The user manual will be written for an audience with minimal experience with electronics devices, and include descriptions of basic functionality. (3)
- R[90]** The manual will also include material for more experienced users such as using playlists, upgrading unit software, and creating manual server addresses. (3)
- R[91]** The manual will also include a troubleshooting section and a device characteristics list. (3)
- R[92]** Additional documentation will be provided on TAG's website and will consist of FAQs and whitepapers, as necessary. (1)
- R[93]** Minimal user training should be necessary for the use of this device. (1)
- R[94]** Training for the production device will be provided completely by the unit's documentation. (3)
- R[95]** Users of the proof of concept device will be instructed by the project developers, or use the device under the supervision of the project developers. (2)





## 7 Conclusion

The requirements set out by this document are rigorous. However, they specify a final production device that we feel will combine our intended functionality with ease of usability. The requirements preceded by a (1) or a (2) will be completed as part of a prototype device for December 2000. Requirements preceded by a (3) will be completed as part of future device development.