

## 2. Design Constraints

The competitive market of portable audio players requires that all newcomers meet a level of quality and usability set by previous products. WiRAD must maintain this level of quality, even though it addresses the niche market of wireless Internet radio receivers. Because of the newness of this market, WiRAD must effectively meet the requirements of consumers to combat potential competition. The WiRAD design focuses on the following ten technical and socio-economical constraints.

### 2.1 Technical Design Constraints

The technical design constraints of WiRAD are listed in Table I.

**Table I: Technical Design Constraints**

Name	Description
<b>Decoding Quality</b>	WiRAD is capable of decoding streaming audio encoded at bitrates of up to 128 kbit/s.
<b>Transmission Rate</b>	The 802.11b wireless link is capable of sustaining 1 Mbit/s transfer at an operating frequency of 2.4 GHz and range of 30 m from a base-station.
<b>Battery Life</b>	The battery provides at least 3 hours continued usage before recharging.
<b>Portability</b>	WiRAD is less than 10 cm (W) x 15 cm (H) x 5 cm (D).
<b>Audio Quality</b>	WiRAD provides 20-bit stereo audio at 48 KHz.

#### 2.1.1 Decoding Quality

MP3 format audio encoded at bitrates of 128 kbit/s is regarded as near CD quality [1]. It is at this bitrate that nearly all SHOUTcast Internet radio stations are broadcasted. Supporting bitrates of 128 kbit/s allows WiRAD to decode most MPEG-1 Layer 3 (MP3) format audio while placing only modest constraints on the wireless transmission quality.

#### 2.1.2 Transmission Rate

A sustained wireless transmission throughput of 1 Mbit/s is used to deliver streaming audio at the supported maximum bitrate of 128 kbit/s. Such a transmission rate allows enough bandwidth to handle a 100 percent increase in data size due to the addition of Hyper-Text Transport Protocol (HTTP) headers, which are utilized in the SHOUTcast protocol, to the raw data and a 300 percent safety margin. This rate is well within the specifications of the 802.11b wireless standard, which allow a maximum throughput of 11 Mbit/s [2].

#### 2.1.3 Battery Life

WiRAD's battery provides three hours of continued usage. After depletion, WiRAD is recharged using a 110 VAC to 5V wall transformer.

#### 2.1.4 Portability

Dimensions of 10cm (W) x 15cm (H) x 5cm (D) place WiRAD in the same size class as Apple's iPod while still allowing for a 2.4GHz antenna and rechargeable battery [3]. At this size, WiRAD may be carried or worn comfortably.

#### 2.1.5 Audio Quality

WiRAD's audio quality of 20-bit stereo audio at 48KHz allows for playback of CD-quality sound. This capability ensures that decoding artifacts such as "clicks" and "pops" are not introduced due to low-frequency digital to analog conversion. This constraint limits the maximum audio-quality of the player and might be improved in future firmware upgrades.

## 2.2 Practical Design Constraints

The practical design constraints of WiRAD are listed in Table II.

**Table II: Practical Design Constraints**

Type	Name	Description
Health and Safety	Volume Restrictions	Maximum volume is limited to 90 dB per watt meter.
Political	Streaming MP3 Licensing	To cover licensing issues, WiRAD must use a microprocessor whose manufacturer pays MP3 licensing fees.
Compatibility	Software and Hardware Compatibility	WiRAD uses a USB interface and is compatible with Windows XP and 2000. WiRAD can work on any existing 802.11b/g network.
Manufacturability	Mass Production	WiRAD can be easily mass produced.
Economic	Pricing	WiRAD is marketed to the consumer for under \$100.

### 2.2.1 Volume Restrictions

WiRAD is designed to ensure consumer safety. By restricting the noise level to under 90dB per watt meter, WiRAD eliminates the possibility of hearing loss due to long term exposure [4]. This limited maximum output minimizes consumer health risks and allows prolonged use of WiRAD as might be encountered during industrial or military use.

### 2.2.2 Streaming MP3 Licensing

Any profit-producing corporation wishing to provide tools for decoding MP3 content, whether it be in hardware or software, must pay appropriate licensing fees to Thomson Corporation [5]. By utilizing a hardware MP3 decoder for which licensing fees have already been paid by the developer, WiRAD is able to avoid legal and political fallback from the sale of an unlicensed MP3 product.

### 2.2.3 Software and Hardware Compatibility

WiRAD incorporates a standard Universal Serial Bus (USB) interface. This allows WiRAD to be configured from any computer with a USB interface and makes the device software compatible with any operating system that supports USB communications. WiRAD is additionally hardware compatible with the 802.11b standard.

### 2.2.4 Mass Production

WiRAD has many properties that contribute to its potential for mass production, such as a lack of moving parts and utilization surface mount chips. Additionally, WiRAD components are available in large quantities. All of these characteristics enhance WiRAD's manufacturability and speed deployment.

### 2.2.5 Pricing

WiRAD's list price is less than \$100 dollars. This relatively low price keeps WiRAD below the price range of brand-name, high-end iPod music players. When compared to Apple's products, WiRAD offers increased capabilities at a lower price. With this competitive edge, WiRAD is poised to seize much of the market for portable music devices.

### 2.3 References

- [1] MP3 Conversion. (2006, September 13). "MP3 Quality," *MP3 Conversion*. [Online]. Available: [http://www.cd-mp3.co.uk/mp3\\_quality.htm](http://www.cd-mp3.co.uk/mp3_quality.htm)
- [2] Institute for Electrical and Electronic Engineers. (2006, September 13). "Popular Wireless Local Area Networks Gain Large Boost in Speed," *IEEE Standards Organization*. [Online]. Available: <http://standards.ieee.org/announcements/80211gfinal.html>
- [3] Apple Inc. (2006, September 13). "Apple - iPod - Technical Specifications," *Apple iPod Technical Specifications*. [Online]. Available: <http://www.apple.com/ipod/specs.html>
- [4] R. Russell. (2006, September 13). "Listening and Hearing," *www.roger-russell.com*. [Online]. Available: <http://www.roger-russell.com/hearing/hearing.htm>
- [5] Thomson Technology. (2006, September 13). "mp3licensing.com - Home," *www.mp3licensing.com*. [Online]. Available: <http://www.mp3licensing.com/>