INTERNET AUDIO STREAMING AND THE EMERGING MODEL OF RADIO

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ABSTRACT

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Internet audio streaming is enabling a new model of radio and expanding the medium's definition by challenging the conventions of the broadcasting industry. As broadband access approaches ubiquity, consumer and audience habits are shifting, markets are consolidating, copyright laws are evolving and advertisers are experimenting. It is in the midst of these interacting forces that the radio broadcaster must succeed online while adapting to the up-side down, emerging business model of Internet radio - where technology and licensing costs have a direct relationship with the size of the audience and the one-to-many broadcasting strategy may be irrelevant. The objective of this thesis is to contrast the emerging and traditional radio models according to their technologies, operations, laws and business practices by analyzing the perceptions of industry experts in the context of historical and contemporary issues. To this end, experts were recruited from the audio/music production, radio broadcasting and music education/performance fields to share their perceptions and insights with the industry through an anonymous online survey, yielding a set of recommendations regarding the application, usability and sound quality of current streaming technologies. The position of this thesis is that the practice of simulcasting is logical in the short-term; though short-sighted in the long-term, as the online amalgamation of markets will progressively require a narrowcasting approach.

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LIST OF ABBREVIATIONS

AAC-LC	Advanced Audio Codec – Low Complexity
AAS	Average Active Session
ABC	American Broadcasting Company
AC	Alternating Current
AFTRA	The American Federation of Television and Radio Artists
AIFF	Audio Interchange File Format
AM	Amplitude Modulation
ARB	American Research Bureau
ARPANET	Advanced Research Projects Agency Network
ASCAP	American Society of Composers, Authors and Publishers
AVG	Average
BMI	Broadcast Music, Inc.
CBS	CBS Broadcasting, Inc.
CD	Compact Disc
CDA	Communications Decency Act
DC	Direct Current
DJ	Disc Jockey
DMCA	Digital Millennium Copyright Act
DPRA	Digital Performance Right in Sound Recordings Act
FM	Frequency Modulation
FCC	Federal Communications Commission

FRC	Federal Radio Commission
kbit/s	Kilobits per second
kHz	Kilohertz
MBONE	Multicast Backbone
MP3	MPEG-2 Audio Layer III
NBC	National Broadcasting Company
IP	Internet Protocol
PCM	Pulse Code Modulation
PRO	Performing Rights Organization
QT	QuickTime
RA	RealAudio
RCA	Radio Corporation of America
SAG	Screen Actors Guild
SESAC	(Originally) Society of European Stage Authors & Composers
STDV	Standard Deviation
URL	Uniform Resource Locator
WAV	Waveform Audio File Format
WMA	Windows Media Audio

CHAPTER 1

HISTORY OF RADIO BROADCASTING

Internet streaming as an ancillary content delivery method has given radio broadcasters the opportunity to expand and possibly reinvent their products. Some believe that radio broadcast is threatened by streaming technology, but research is showing that traditional terrestrial broadcast is far from obsolete. Reports in 2008 revealed that nearly ninety-three percent of the U.S. population over twelve years of age tuned in each week[1] and recent studies suggest that the majority of listeners intend to continue their current radio usage habits regardless of future technology.[2] With their existing resources and capabilities, broadcasters have an advantage over others experimenting with Internet radio technology; however, as they expand their online capabilities, much of the traditional model to which they have grown accustomed is challenged, requiring a fresh understanding of the law, station operations and business practices. While audio streaming is challenging the paradigm of radio and inspiring new "typologies for radioness,"[3] the terrestrial medium has survived the introduction of numerous inventions over the last century, and the recent trends toward peer-to-peer music file sharing, music player portability and podcasting reveal that audio content is still as relevant as ever to consumers. In order to define what can now be considered the "traditional" approach to radio broadcasting and evaluate its evolution, a historical perspective is required.

The invention of radio cannot be traced to a single scientist or researcher; it was instead a worldwide curiosity about electricity, the physics of sound and wireless communication in the 1800s that gave birth to a technology that greatly influenced the twentieth century United States. The work that contributed to the traditional model of radio was initially scientific in nature, often

conducted in laboratories or academic settings and the discoveries that were made laid the groundwork for modern communications and electronics technology. In the early years of electronic communication, participants were limited to hobbyists, inventors and scientists, but as broadcasting transmission and reception technologies improved and were made public, a new type of research became relevant: audience research. With the help of audience research, the broadcasting industry has been able to craft radio programs and products relevant to consumers, as well as anticipate the future of the industry.

Early Scientific Research

The United States has more than a century of history with the application of radio science, but the evolution of the technology required worldwide effort. While this discussion is primarily focused on American broadcasting, it would be incomplete without briefly recognizing several key, international accomplishments. This work, with roots in both academia and industry, ultimately led to modern inventions such as the automobile, computers and the Internet.

Electromagnetic theory is a cornerstone of radio broadcasting science and the work of English physicist and chemist Michael Faraday (1791-1867) led to an increased understanding of the nature of electromagnetic induction. James Maxwell (1831-1879) of Scotland, known for taking the first color photograph, continued Faraday's work and in 1861 published a paper on electromagnetic theory entitled, "On Physical Lines of Force." In 1886, Heinrich Hertz (1857-1894) of Germany was able to produce and measure these lines of force in the form of Ultra High Frequency and Very High Frequency radio waves and it is his name that inspired the internationally adopted unit for frequency, the Hertz. Hertz's 1888 study, "Electromagnetic Waves in Air and Their Reflection," showed the scientific community that electromagnetic

waves travelling at the speed of light could be used to wirelessly transmit an electrical signal to a remote receiver; this work went on to help inspire Albert Einstein's famed theory of relativity.[4]

In the United States, electrical research was focused toward power distribution, motors and communication. In 1844, Samuel Morse's (1791-1872) wired telegraph system successfully transmitted news from Washington, DC to a Baltimore newspaper – a distance of nearly forty miles.[5] Nikola Tesla (1856-1943), an immigrant of Austria, explored alternating current (AC) and later invented the Tesla coil, a device capable of high voltages and radio frequency transmission. His counterpart was Thomas Edison (1847-1931), an American, who used direct current (DC) to power his motors. Alexander Bell (1847-1922) patented the first telephone in America in 1876, and later in life helped develop a wireless telephone that transmitted an audio signal short distances by varying the intensity of a beam of light. This was only one of several innovations at the turn of the century, as worldwide interest in wireless communication was gaining momentum.

The Italian inventor Guglielmo Marconi (1874-1937) contributed to the development of wireless communications through his work with antennas, receivers and transmitters, which his British company used to provide coded communications services to the navy and ships at sea. His primary goal in this work was to develop efficient and lucrative communications devices,[6] though broadcasting was eventually possible because of this work. To expand his profits, Marconi started the American Marconi Company in 1899, the same year he sent a wireless signal across the English Channel through his England-based telegraph company. A common issue for wireless telegraphy at this time was interference when multiple transmitters were operating in close proximity. Marconi changed the course of radio communications when he patented a new device in 1900: the tuned circuit; the next year, he used Morse's code to wirelessly transmit the

letter "S" more than 2100 miles across the Atlantic Ocean and a new age of wireless technology began.[7]

The First Radio Broadcasts

After the turn of the twentieth century, advancements in wireless communication made it possible to transmit signals more advanced than coded messages, and it was this content that would serve to define the essence of later radio; in effect, what was heard was the beginning of radio programming. On Christmas Eve of 1906, Reginald Fessenden (1871-1932) transmitted what might have been the first radio broadcast, when several ships received a signal that included "a violin solo, Bible verses being read, a singer, and a wish of 'Merry Christmas.'"[8] Similarly interested in combining art and science through radio transmission, Lee De Forest (1873-1961) successfully used radio technology to broadcast a live performance from New York's Metropolitan Opera in 1907.[9] His success was due in part to an invention he called the Audion,[10] a device that improved the sonic clarity of transmitted signals over Marconi's method. Fessenden and De Forest, among others, contributed to the rise of amplitude modulation (AM) broadcasting that dominated the airwaves for most of the twentieth century.

A few years later, a student at Columbia University in New York named Edwin Howard Armstrong (1890-1954) invented the regenerative circuit, an efficient means of both transmitting and receiving radio signals. He received a patent for his invention in 1914, but because the circuit was designed while making improvements on De Forest's Audion tube, Armstrong found himself involved in a series of lawsuits that involved years of defending the rights to his device against De Forest and AT&T, who had since purchased the Audion tube's patents.[11] Armstrong's new circuit helped make radio technology accessible for consumers, and after

World War I (1914-1918) commercial radio was finally practical. Armstrong licensed his patents to RCA, installed the first frequency modulation (FM) transmitter on the Empire State Building and successfully demonstrated his invention of FM radio technology by 1935.[12] By this time, AM radio was dominating the airwaves with about two thirds of American households owning radios and several large networks competing for their attention.

FM Technology

Despite FM radio's reduced static interference and higher audio fidelity, it took decades for the new technology to gain preference over AM. While FM offered substantial improvements to broadcast quality, its implementation was intentionally impeded by AM broadcasters due to millions of AM radio sets in circulation and station transmitters that faced potential obsolescence if FM succeeded; the conventional AM model was being challenged and change was resisted.[13] Armstrong personally experienced the effects of the stalling industry when, prior to his public 1935 demonstration, the AM reliant RCA corporation allowed him to expend two years proving FM's viability through the experimental W2XF station housed in their building, but then announced to the public their intentions regarding television while instructing Armstrong to remove his FM laboratory from the premises.[14] On a larger scale, the strategy of simulcasting AM content over FM channels may have been a defensive move on the part of the established stations and networks, as many of the available FM licenses were quickly occupied, limiting newcomers, and therefore competitors, to radio broadcasting.

"Radio's network-dominated AM establishment quickly gained control of the newer technology, first promoting and then mandating duplication. While the establishment argued that this would help promote the new service, in fact, as events would prove, simulcasting had just

the opposite effect – which may have been the intention all along. The biggest loss for FM was its inability to quickly develop a distinct image or brand."[15]

By 1948, about 600 of the 700 licensed FM stations were fueled by simulcast AM programming,[16] and with identical content available on associated AM and FM stations, there existed little incentive for listeners to purchase new FM radio sets. Also stifling FM's progress in the 1940s were deterrents such as World War II (1939-1945), during which many industries slowed due to focus on the war effort, and legislative uncertainty. The unanswered questions about FM's future in America made it risky for broadcasters and consumers to invest in FM. The FCC's 1945 legislation at the war's close dealt a blow to FM's progress when its use was reallocated to a higher frequency spectrum and transmission power was further limited; these decisions made hundreds of thousands of purchased FM radio sets useless.[17] It was not until the early 1980s that FM finally gained dominance over AM broadcasting, but Edwin Armstrong never saw the many results of his invention because, perhaps due to the pressures of his personal and legal hardships, he tragically took his own life in 1954.

Commercial Radio and Audience Research

As radio's listenership and potential for profit increased, the need for information about the listening audience became more important to convince advertisers to pay broadcasters for on-air promotion. Advertisers were already accustomed to paying magazine and newspaper publishers in exchange for publicity,[18] so radio advertising was a reasonable proposal as long as a substantial audience could be proven. It was with this goal in mind that figures to accurately describe the size of a radio station's audience, or ratings, were born. The earliest methods of audience research involved counting the number of radio sets sold or letters from fans received,

but these methods were hardly accurate in providing detailed information about the reach of a station during certain programs and times of day. The need for these figures was only becoming more urgent because the number of listeners and competing stations was rising each year. By 1924, there were over 500 licensed stations and in 1927 Americans were spending about $198 million dollars on radio sets each year.[19] In 1930, the United States Census included a question about radio ownership[20] – the first national radio ratings survey. Throughout the 1930s, when network radio became the leading medium and national advertisers required even more detail about the audience, Hooperatings and The Crossley Company conducted telephone and door-to-door surveys that gauged which households had tuned in to which programs.[21] In a 1986 interview for the Journal of Advertising Research, Archibald Crossley (1896-1995) discussed the work of his ratings company:

"The thing that gave us the most publicity was the origination of radio ratings in 1929, which, having never been done before, created quite a stir. Dan Starch, about the same time, had done a survey, asking people what kinds of programs they liked. But he didn't ask, 'What program did you just listen to in the past few hours?' We did that. Those ratings went on for some seventeen years…"[22]

The sophistication of audience research grew throughout the 1900s, with the A. C. Nielsen Company and American Research Bureau (ARB) emerging as the most prominent names in radio research. Starting in 1942, The A. C. Nielsen Company had a different method for measuring the success of radio programming than any of its predecessors. A portable, electronic device called the "audiometer" was temporarily installed in homes to measure the on, off and tuning status of the radio. Eventually, in the 1960's, the A. C. Nielsen company turned its focus toward television,[23] leaving the American Research Bureau as the leader in radio ratings.

For a time, the ARB's method for audience measurement involved a device called the "Arbitron", which soon became the company's new name. After lawsuits with Nielsen, the device was discontinued which gave way to various diaries, surveys and the more recent Portable People Meter (PPM). The PPM was released in 2007,[24] and is a portable device intended to be carried by the research subject for the duration of the study. The device "listens" to a person's surroundings and identifies the source of any incoming broadcast for later analysis.

Telephone surveys and portable measuring devices are still used broadly to provide valuable ratings data to broadcasters and their advertisers. Throughout the history of radio, scientific and audience research have been conducted to lead the industry into new territories. In much the same way that the invention of portable radio sets changed the way the public consumed media in the 1920s, the ubiquity of today's digital devices and broadband Internet access is changing the habits of the American audience once again. Technological innovation has provided broadcasters with tools like the World Wide Web and audio streaming, the potential of which has not yet been fully realized. With changes to what has become the traditional model of broadcasting underway and possible opportunities on the horizon, further research is needed to advise the industry and serve the consumer.

Regulating Radio

Much of radio regulation can be traced to two concerns: First, it is assumed that the airwaves are a limited resource to be strategically allocated and second, radio has the potential to be significantly influential; therefore, the use of the medium should be controlled to protect and better serve the public.[25] Radio, however, was not always regulated. Prior to the Radio Act of 1927, radio broadcasters and enthusiasts were free to use the airwaves without government

intervention, with the exception of a brief period of time during World War I when the U.S. Navy seized control of all radio stations and patents for military purposes.[26] When control of radio was returned to the public in 1918, programs could be transmitted using any power or frequency that was desired. Interest in broadcasting quickly grew throughout the 1920s, with the sixty commercial radio stations in 1922 growing to 536 just four years later, along with more than 15,000 amateur broadcasters also transmitting their signals.[27] Interference was a mounting issue and the direction of unregulated radio was becoming a concern for public figures such as Herbert Hoover, who attempted to organize these broadcasters, a task which proved difficult in the absence of legislation or a means of enforcement.[28] The various proposed methods of regulation had the potential to either favor or disadvantage the interests of the government, radio networks and the public. The resulting compromise was found in the Radio Act of 1927 which established the provisional authority of the Federal Radio Commission (FRC) to assign broadcasting licenses, frequencies and power limits. The Radio Act was the largest scale regulation of radio technology that had happened up to that point and involved the first official governing body created specifically for this purpose. Later, due to the Communications Act of 1934, the FRC was replaced by the permanent Federal Communications Commission (FCC).

The basic variables involved in the regulation of radio broadcasting can be described as frequency, power, time and geographical proximity. After the Federal Radio Commission was granted temporary authority to govern radio broadcasting, hopeful stations then had to apply for licenses and, once granted, were required to use their designated frequencies and broadcast time periods. Stations transmitting in the same cities were separated by at least 50 kHz and various measures were undertaken to govern the coverage of a station.

A key result of the Radio Act was the license requirement that a radio station operate in the "public interest, convenience and necessity" and this phrasing was inspired by the United States public utility law;[29] applying these words to radio implied that the electromagnetic spectrum was a public resource to be shared and utilized by all, similar to a park or a body of water. Ultimately, the FRC was mandating that the interests of the general public be held higher than those of radio broadcasters, a requirement unique to the broadcast industry, and when the FCC was permanently installed through the Communications Act of 1934, the public interest requirement was upheld, creating a foundation for broadcast regulation that was upheld throughout the twentieth century. What Congress did not define in the Communications Act was precisely what was meant by "public interest, convenience, or necessity," but the FCC's regulations over the years have revealed that central to its interpretation of this requirement is the promotion of localism, diversity and competition.[30]

Because the allocated frequency spectrum was limited, an early goal of radio regulation was to alleviate congestion on the airwaves, and as radio's profitability increased and networks became successful, the FCC worked to promote business competition. In 1941, the FCC's Report on Chain Broadcasting limited network domination of the radio market by withholding licenses from those stations that were affiliated with companies that maintained more than one network. This legislation specifically affected the two NBC networks owned by RCA, who were forced to sell one of the networks after a Supreme Court ruling upheld the chain broadcasting restrictions in 1943.[31]

Deregulation

Throughout the 1970s and 80s, the FCC and Congress thinned regulatory measures during a process now informally referred to as "deregulation." During the course of deregulation, the government worked to loosen or remove broadcast restrictions and laws that had built up over half a century of radio history. The premise behind these deregulatory acts might be compared to that of the Paperwork Reduction Act (44 U.S.C. Chapter 35), which was created in 1980 to "ensure that information collected…minimizes burden and maximizes public utility."[32] Radio broadcasters were given more freedom as the government no longer required the airing of certain amounts of non-entertainment, news and public-affairs programming; observation of the Fairness Doctrine which required coverage of both sides of controversial, public issues; or limiting the air time dedicated to commercials.[33] Furthermore, the FCC no longer required that broadcasters serve the public interest by formally and regularly determining the needs, problems and interests of their communities, assuming that the forces of the marketplace would be enough to ensure that stations remained devoted and relevant to their communities.[34] Advocates of deregulation argued that markets had enough radio stations for competition alone to generate enough programming diversity to serve the public interest, while opponents expressed fears that diversity would suffer and that "the radio station of the future may be a twenty-four hour drone of entertainment and commercials."[35] Broadcasters quickly made use of their newfound liberties and were later given even more control of their industry as the Internet and World Wide Web gained acceptance.

Consolidation and the Telecommunications Act of 1996

In response to the rapid technological development of the communications industry, the Telecommunications Act of 1996 took measures to modernize the regulatory framework, meeting a need that was recognized by broadcasters such as James H. Quello (1914-2010), and continuing the prior work of broadcast deregulation while simultaneously introducing guidelines for newer technologies. Two years prior to the act, with insight gained through a lifetime of distinguished broadcasting experience and years of service as a FCC commissioner, Quello commented on the state of communications law:

"In the past sixty years, since the passage of the Communications Act of 1934, the field of communications has grown from one where telephone, telegraph, and radio defined the field to one where television, cable, cellular, and satellite only scratch the surface of modern digital telecommunications. The next sixty years promise to further transform the field and make it a centerpiece of not only the national economy, but also the lives of all Americans. These changes, often driven by technological innovations, have brought tremendous competition to the business of communications that has required, and will continue to require, a modernization of the regulatory framework under which the entire telecommunications sector operates."[36]

Of particular interest to radio broadcasters, the Telecommunications Act removed the limit of commonly owned radio stations (though restrictions continued in individual markets); amended existing restrictions on foreign owners; increased license terms to eight years; protected current licensees against competing license applications (assuming the current licensee complies with others laws and serves the public interest); loosened restrictions on network affiliation and cross ownership; mandated the development and implementation of a ratings system for

potentially objectionable material; and gave the FCC the right to allocate additional portions of the spectrum for new broadcasting services.[37]

One of the immediately noticeable effects of the Telecommunications Act was that the number of station owners quickly decreased as large numbers of radio stations were bought by companies like Clear Channel, which was the first company to own more than one hundred stations and owned more than twelve hundred in 2002.[38] In less than two years after the legislation's enactment, four thousand of the eleven thousand radio stations were sold in the United States and consolidation continued throughout the decade, prompting criticism that localism and diversity of programming were suffering due to the airwaves being "dominated by a handful of companies" offering a "portfolio of similar-sounding radio stations."[39] Since the 1996 act, some studies have indicated that while radio "ownership concentration may not have an impact on format diversity," the number of listeners in a market generally decreases as ownership concentration increases.[40] Proponents of broadcast consolidation argue that economies of scale ultimately serve the public interest because efficient companies are able to pass profits "on to the consumer through improved facilities, stronger signals and more expensive talent."[41]

Safe Harbor

While the Telecommunications Act of 1996 did much to continue the deregulation of broadcast, it did require the development of a system for rating potentially objectionable material – a requirement aimed at television broadcasters since radio broadcasters were already observing "safe harbor" hours. In 1973, WBAI in New York aired a recording of George Carlin's "Filthy Words" routine, prompting a complaint from a citizen who was upset that his fifteen year old son

had heard the recording on the radio.[42] This complaint led to a series of court decisions and appeals that ultimately resulted in the differentiation between the concepts of indecent and obscene materials.

"In 1973, the U.S. Supreme Court established the following criteria to determine whether speech is obscene: (1) whether the average person, applying contemporary community standards, would find that the work, taken as a whole, appeals to prurient interest; (2) whether the work depicts or describes in a patently offensive way sexual conduct specifically defined by applicable state law; and (3) whether the work, taken as a whole, lacks serious literary, artistic, political, or scientific value. In 1978, the Court stated that whether the work could be deemed "patently offensive" would depend on context, degree and time of broadcast. …The Commission's generic definition of "indecency" is one that applies to language that describes, in terms patently offensive as measured by contemporary community standards for the broadcast medium, sexual or excretory activities and organs."[43]

Based on these definitions, the FCC allocated "safe harbor" hours for broadcasters, which were intended to protect children from objectionable content. Under this law, it became illegal for obscene programming to be aired at any time and profane or indecent material could only be aired during specific hours.

"Congress has given the Federal Communications Commission (FCC) the responsibility for administratively enforcing the law that governs these types of broadcasts… Regarding the safe harbor period, Congress and the courts have instructed the Commission only to enforce the indecency standard between the hours of 6 a.m. and 10 p.m., local time… when children are more likely to be in the audience. As a consequence, the Commission does not take action on

indecent material aired between 10 p.m. and 6:00 a.m. In this way, constitutionally-protected free speech rights of adults are balanced with the need to protect children from harmful content."[44]

Safe harbor laws currently affect over-the-air radio and television stations only and the FCC has no authority to enforce them with cable, satellite or Internet-based services. As an amendment to the Telecommunications Act, the Communications Decency Act (CDA) of 1996 dealt primarily with protecting minors from indecent or obscene content on the Internet, but various aspects of this early attempt to regulate online activity were challenged and overturned due to concerns about violating First Amendment rights. In 1997, much of the CDA was declared unconstitutional by the Supreme Court in *Reno v. ACLU* and the Child Online Protection Act (COPA) of 1998 was also struck down for violating civil liberties.[45] Other child-protection laws have succeeded in the United States,[46] many at a state level,[47] but the Internet has proven itself to be a difficult environment in which to regulate content. After all, regardless of what Congress or the FCC enacts, U.S. laws are limited in their global effect.

CHAPTER 2

HISTORY OF STREAMING: A NEW MODEL OF RADIO

Fundamentally, streaming describes the encoding and decoding of information between two locations in real time. While contemporary use in the context of the Internet describes digital packets of audio and video information synchronously transmitted and received by computers through the Internet medium, terrestrial television and radio stations have operated similarly for decades, with air serving as the transmission medium and AM/FM as the encoding method. The computer networks supporting the Internet were in development as early as the 1960s, with initiatives such as the Advanced Research Projects Agency Network (ARPANET), the world's "first large scale, wide area network." [1] With funding from the U.S. Department of Defense, ARPANET was intended to be a decentralized computer network and used a technology called packet-switching, which allowed "varying amounts of data to flow to different computers," even without being directly connected; it was this network consisting of four computers that served as "the forerunner to the modern Internet."[2]

Years later, it was the technology of the 1990s, notably the invention of the World Wide Web as an Internet interface, which made digital media streaming practical. Web browsers, such as the popular and free Mosaic software developed by the National Center for Supercomputing Applications in 1994,[3] granted Internet users global access to sound, picture and text. During the Web's early years, consumers used dial-up connections to access the Internet through modems and telephone lines with common data transfer rates in the range of 14.4 kbit/s to 56 kbit/s.

While contemporary broadband options offer consumers significantly higher data transfer rates, these early modems were sufficient to enable the first publicly available media streams. In 1994, a twenty minute clip of a Rolling Stones rock concert was multicast from Dallas using an experimental Internet multicasting platform called MBONE (an abbreviation of "multicast backbone"), during which performer Mick Jagger greeted the audience with the words, "I wanna say a special welcome to everyone that's, uh, climbed into the Internet tonight and, uh, has got into the MBONE. (sic) And I hope it doesn't all collapse."[4] Shortly thereafter, the newly formed company Progressive Networks, Inc., later called RealNetworks, Inc., released applications using proprietary codecs called RealAudio and RealVideo for media streaming.

With the premier of RealAudio in 1995,[5] a sound could be digitally encoded by one computer, transmitted to other computers, and heard in near-real time through a computer's speakers with a sound quality exceeding that experienced through telephone lines. RealAudio 1.0 was compared with AM-quality sound and when version 2.0 was released for beta testing later that year, it was promised to offer "near-FM-quality" mono audio, attracting the attention of record labels such as Atlantic, Warner Bros., Elektra and MCA.[6] The new streaming technology emulated the experience of radio, with a streaming server connected to the Internet functioning similarly to the terrestrial broadcaster's antennae, and the listener's radio tuner replaced by a web browser and media player. Microsoft Corp. entered the streaming market in 1996 with the Netshow application and later rebranded the product as Windows Media. Apple Inc. released QuickTime in 1998 and these three companies are still at the forefront of commercial streaming technology.

While audio streaming technology was slowly growing in popularity in its early years, AM and FM radio were still able to provide a higher quality product without the constraints of file size and modem speed. Three important factors in the progression of audio streaming have been the development of higher bandwidth Internet connections, efficient audio compression codecs, and Internet protocols specifically designed to handle and ensure the delivery of time sensitive data packets. These three areas are continually progressing while RealNetworks, Apple and Microsoft are largely responsible for the development of the proprietary codecs and streaming media players that have optimized the web radio experience for much of the last two decades. However, the burgeoning streaming media industry is rapidly approaching the limits of the existing Internet infrastructure.

According to Sandvine's *Fall 2011 Global Internet Phenomena* report, the video-streaming company Netflix uses approximately thirty percent of the downstream bandwidth in the United States during peak times of the day.[7] With a single company able to approach nearly one third of the nation's downstream bandwidth through streaming, two observations emerge: 1) Streaming media has a substantial audience, and 2) American computer networks are unprepared to sustain the high numbers of simultaneous listeners that are possible through terrestrial radio. There are about 14,000 radio stations nationwide and about ninety-two percent (approximately 287 million) of the American population were listening to them in 2010.[8] In contrast, only fifty-two percent of Americans have ever listened to Internet radio with about 70 million listening each month in 2010.[9] The online radio audience is substantial but is yet to be as popular as terrestrial radio and advancements in Internet technology will enable the online audience to grow to its potential. As the availability of broadband Internet is increasing, so is competition among

webcasters for the attention of terrestrial radio's audience, but each medium has its own restrictions.

Regulating Online Radio

The history of streaming is relatively short and as streaming has developed alongside terrestrial radio since the late 1900s, much of the story that has unfolded is a legal one with legislators and business owners still volleying for favorable long term solutions. Radio broadcasters in the late twentieth and early twenty-first centuries have experienced some relief from earlier regulations that were once deemed necessary to serve the public, which may be partly due to competition from new media services. As radio is brought to the web, many of the legal issues and constraints relating to over-the-air broadcasts disappear. The traditional approach of using regulation to allocate portions of the electromagnetic spectrum, while promoting localism, diversity and competition, is yet to be translated for use with streaming audio, and may not be appropriate for the medium.

Streamers are not entirely free from legal constraints, though, and as streaming has become increasingly useful and popular, the "modernization of the regulatory framework" that Quello predicted has been well underway, with a challenging initial goal of defining the government's limitations with respect to Internet regulation. The government's priorities in this process are revealed through the remaining portions of the Communications Decency Act, and while much of the CDA was declared unconstitutional, Section 230 remains in effect to this day, outlining several U.S. policies relating to Internet communications and protecting service providers from liabilities relating to the activities of online users. According to Title 47, Section 230 of the United States Code, Congress observes that the "Internet and other interactive

computer services have flourished, to the benefit of all Americans, with a minimum of government regulation" and declares that,

> "It is the policy of the United States - (1) to promote the continued development of the Internet and other interactive computer services and other interactive media; (2) to preserve the vibrant and competitive free market that presently exists for the Internet and other interactive computer services, unfettered by Federal or State regulation; (3) to encourage the development of technologies which maximize user control over what information is received by individuals, families, and schools who use the Internet and other interactive computer services; (4) to remove disincentives for the development and utilization of blocking and filtering technologies that empower parents to restrict their children's access to objectionable or inappropriate online material; and (5) to ensure vigorous enforcement of Federal criminal laws to deter and punish trafficking in obscenity, stalking, and harassment by means of computer."[10]

Congress goes on to explain that these newer policies in no way affect current criminal, intellectual property, state or communications privacy laws. Interestingly, Section 230 is the only portion of the Telecommunications Act of 1996 that expressly refers to the Internet and there is disagreement about whether or not this section grants the FCC any authority over Internet policy at all.[11] This plot thickened in 2010 when a federal appeals court nullified a 2008 FCC cease and desist order issued against Comcast for network management practices at the expense of BitTorrent on the grounds that current laws do not give the FCC regulatory authority over Internet traffic,[12] a setback for the FCC's current network neutrality efforts. It is as the government attempts to create new legislation that satisfies each of Section 230's policies and existing laws that issues of constitutionality arise, and the results of the currently debated,

unresolved issues of network neutrality and Internet freedom will ultimately affect the strategies and operations of streaming media providers.

Network Neutrality

The idea of network neutrality can be described as all online content and data receiving equal treatment in terms of bandwidth and accessibility by those responsible for providing Internet services to customers. While not always specific to streaming, Internet regulation issues have significant implications for webcasters. When the Telecommunications Act of 1996 allowed cable television and telephone companies to offer competitive services, the potential was introduced for these companies to impose bias on which services would be convenient and available for customers. The issue is further complicated as Internet service providers (ISPs) are increasingly enabled to provide their own programming content, with Comcast's acquisition of NBC in late 2009 being a concern for some.[13] Biased ISPs have the means to block certain applications, competing products and information, potentially enabling discrimination and jeopardizing a healthy marketplace and first amendment rights. The issue of network neutrality has been the source of much debate and activism,[14] and the eventual outcome of this dispute has important implications for streamers.

In December of 2010, the FCC announced that its "New Rules for an Open Internet" had been approved by the Commission and would soon be enacted, granting rights to consumers and prohibiting the blockage of "lawful content, apps, services, and the connection of devices to the network."[15] In April of 2011, the House of Representatives, under House Joint Resolution 37, voted to disallow the FCC's network neutrality rules,[16] but the resolution must pass through the

Democrat-controlled Senate and is unlikely to be signed by President Barack Obama, openly a network neutrality proponent.[17]

Opponents of the FCC's rules argue that "the rules will discourage phone and cable companies from investing in costly network upgrades by barring them from offering premium services over their lines or prioritizing traffic from business partners in order to earn a return on those investments."[18] If these rules take effect, they will almost certainly continue to be challenged, as the concept of Internet freedom has more than one interpretation. On one hand, an open Internet could mean that everyone is entitled to equal access to all lawful Internet services without corporate intervention, even at the expense of a business owner's resources. This is currently the FCC's position, which carries with it the implication that the Internet, not unlike the electromagnetic spectrum, is a resource to be protected and that businesses controlling this resource have a responsibility to the greater public. Another viewpoint is that business owners should be free to use the Internet to conduct their businesses as they see fit, with the freedom to restrict competitors' content in favor of their own efficiency and to let the market dictate which businesses are successful rather than the government. If those holding the latter viewpoint prevail in undermining the FCC's declared authority, then it will be permissible for Internet service providers with media streaming products to block their competitor's streamed content from subscribers or charge extra for the right to use bandwidth intensive services on their networks. If the FCC's decision stands, cable and television stations will be required to provide unhindered access to their competitors' services, which may include bandwidth intensive streams, ensuring that all who use the Internet are able to access different services equally, regardless of their chosen provider. Network neutrality laws also have implications for mobile phone companies, who currently charge different rates for "data plans" and often offer their own proprietary online

services without supporting their competitor's online products or applications. Broadcasters in the twentieth century have shown that it is possible to have a thriving industry despite a responsibility to serve what the FCC defines as the public interest, but these broadcasters were never required to shoulder the expenses of those who listened to competing stations, while simultaneously reducing the reach of their own stations, as could be true of ISPs also in the streaming business.

As was true of the transition from wired to wireless communications and AM to FM broadcasts, adapting to new technology while defining regulation and healthy competition will likely involve years of attempted legislation and consequent appeals. As an acceptable strategy for balancing network management with First Amendment rights is sought, webcasters will need to stay abreast of the developments to ensure that their streams are secure and available to customers.

National Broadband Plan

The FCC and Congress may not currently be specifically targeting web radio broadcasters, but it is probable that the overall regulation of Internet communications will eventually affect them, particularly with respect to wireless services. Through the American Recovery and Reinvestment Act passed by Congress in 2009, the FCC was charged to propose a plan that would guide the country into the next phase of broadband Internet availability and efficiency.[19] With this charge, the FCC released the National Broadband Plan in March of 2010, which includes goals such as expanding the number of homes with "affordable access to robust broadband service" and leading the world "in mobile innovation, with the fastest and most extensive wireless networks of any nation."[20] It is claimed that broadband will transform the

country as "electricity, telephony, radio and television" did years ago and the language of this plan reveals similarities between the FCC's approach to broadband Internet and the electromagnetic spectrum:

> "The choice is whether we, as a nation, will understand this transformation in a way that allows us to make wise decisions about how broadband can serve the public interest, just as certain decisions decades ago helped communications and media platforms serve public interest goals. This plan is the first attempt to provide that understanding - to clarify the choices and to point to paths by which all Americans can benefit."[21]

This language is paving the way for the regulation that will be required as broadband and wireless technologies merge, a convergence which is already in process, and which increasingly puts webcasters under the authority of the FCC. Currently, media streaming is most available and dependable through wired communication, but some web radio stations, such as Pandora, are already available through mobile devices and have created software applications for Internet-equipped cell phones and music players. Various video streaming sites, such as YouTube, are also creating low-bandwidth streams for mobile devices and the smartphone market is competitive in the early 2010s. The rising popularity of these smartphones is of concern to FCC Chairman Julius Genachowski, who believes that the mobile networks are not prepared for future demand and that additional spectrum must be freed for mobile broadband use:

"To some, it was a surprise that the Broadband Plan included major sections on mobile broadband…Mobile broadband is being adopted faster than any computing platform in history. The number of smartphones and tablets being sold now exceeds the number of PCs…The clock is ticking on our mobile future. Demand for spectrum is rapidly outstripping supply. The

networks we have today won't be able to handle consumer and business needs. …To avoid this crisis, the National Broadband Plan recommended reallocating 500 megahertz of spectrum for broadband, nearly double the amount that is currently available."[22]

If the smartphone and web-enabled tablet trends continue, then there may be an opportunity for streamers to carve a niche in the mobile device and software application markets, which could expand their audiences as portable, transistor FM receivers did for radio broadcasters in the 1950s. If the FCC succeeds in reallocating spectrum for broadband use and in creating the extensive, state-of-the-art wireless network that it aims to create, then it will be at this point that regulations governing the wireless spectrum will be most relevant to web radio broadcasters.

CHAPTER 3

MODERN AUDIENCE RESEARCH

The addition of wireless to wired communication, FM to AM transmission, and digital to analog technologies were iterations in the evolution of broadcast. Moreover, audience expectations are shifting as Internet streaming expands their expectations of media utility, while broadcasters, advertisers, music industry leaders and the government look ahead to determine the most profitable and advantageous courses of action. It is in this process that several recent research initiatives are informing today's broadcasters. As will be discussed, portions of the American audience, specifically those more advanced in age, are using AM/FM radio as has been done for years while adding online streaming to their listening repertoires, while younger audience members influenced by streaming are developing new expectations for the radio experience. As the audience generations advance, Internet streaming will take on greater importance and while radio is still widely utilized, the traditional broadcast model is slowly challenged by the emerging streaming model. In this midst of these transitions, studies have been underway by Arbitron, Edison Research, Coleman Insights and others, focused on exploring audience trends and the affects of new media on radio.

Arbitron & Edison Research

Computer technologies were evolving throughout the 1980s and 1990s and with the notable invention of the World Wide Web in 1991, the general public was equipped to access online content. It was in the midst of these developments that Arbitron and Edison Research collaborated to begin the first of several studies regarding the effects of new media on the

broadcasting industry. Since this initial study in 1998, the Internet has become a dominant technology in American culture and its influence on the media industry has continued to be of interest. The most recent study in this series, *The Infinite Dial 2010: Digital Platforms and the Future of Radio*, involved 1,753 cellular and landline telephone surveys of people aged twelve and older and revealed fresh statistics about Internet access, smart phones, digital audio players, satellite and HD radio, social networking, podcasting, radio station web sites, AM/FM radio usage and perceptions, streaming video, and online radio.

Broadband Internet connectivity and media streaming activity have been directly correlated. The young Internet of the 1990s was primarily available to the population through slower, dial-up modems on standard telephone lines and these methods have given way to broadband. In 2001, Arbitron conducted a study with Coleman and determined that a third of online Americans had broadband connections.[1] These "speedies" spent nearly equal time with internet, radio and television services, and radio usage led the three by a small margin.[2] In the mid-2000s, broadband Internet and dial-up users were equally matched, but by 2010, broadband users outnumbered dial-up customers more than six to one.[3] While the 1998 study revealed that only six percent of Americans had ever listened to radio online,[4] in 2010, nearly twenty-seven percent of Americans were engaged in monthly listening.[5]

While terrestrial radio is yet to be overshadowed by Internet services, the newer broadband-driven technologies are perceived to be more valuable. In 2010, ninety-two percent of the U.S. population listened to local AM/FM broadcasts,[6] but only twenty-two percent of those surveyed by Arbitron and Edison Research reported that these broadcasts had a "big impact" on their lives. Subjects were also asked about other media technologies, including cell phones,

broadband Internet, television, iPods, satellite radio and E-readers: "Local AM/FM radio" was ranked last of all ten categories.[7] Audiences seem to be attracted by the new programming options available online, as comparing figures from 2006 and 2010 reveals that AM/FM stream listenership is decreasing and Internet audio listenership is increasing. In 2010, fifty-five percent of those listening to online radio each month were primarily using Internet-only streams.[8]

While online listening trends favor Internet radio over simulcasts and perceptions of terrestrial radio's value are suffering, the terrestrial medium is still a dominant form of communication in America. The discrepancy between radio usage and consumer perceptions may connote a promotional failure on the part of the radio industry or a consumer interest in new devices. After all, six percent of those surveyed admitted to listening to Internet radio "because it's new."[9] What radio lacks in novelty over emerging technologies, it makes up for in practicality and its heavy use indicates a greater influence on the audience than it has been credited.

Coleman Insights

At the same time that Arbitron and Edison Research were conducting *The Infinite Dial 2010*, another study was underway by the North Carolina-based research company, Coleman Insights. While Arbitron and Edison Research provided insight into the use of new-media technologies, Coleman Insights had a narrower focus. Specifically, the *Successful Audio Streaming Strategies* study was designed to investigate the motivations of the streaming consumer while simultaneously assessing the progress of brand formation in this new market.[10] To this end, a survey was designed after individually questioning consumers about their motivations and brand awareness in thirty-minute interviews. Over 1300 people aged fifteen to

fifty-four were surveyed online, all of whom had listened to at least five minutes of audio streaming in the past week.[11]

The findings of the Coleman Insights survey are highly relevant to radio broadcasters because many of the questions referred to AM/FM radio. It was determined that streaming customers overall use AM/FM streams less than Internet-only streams,[12] and that these customers also preferred "Internet-only streams over other sources of audio."[13] In 2010, AM/FM streams were collectively accessed more than Pandora, the Internet-only audio provider will the strongest brand recognition.[14] AM/FM and Pandora streams were reportedly used by twenty-eight and twenty-two percent of the streaming audience, respectively, and no other Internet-only station exceeded four percent usage.[15]

Successful Audio Streaming Strategies also considered the affects of streaming on younger listeners, revealing a disparity between generations and their interest in over-the-air radio. Only seven percent of listeners aged fifteen to thirty-four preferred over-the-air broadcasts, while it was the audio source of choice for more than a quarter of those aged thirty-five to fifty-four. Internet-only streaming was the audio source of choice for both age groups, but by a larger margin for younger listeners. If these data indicate a trend, then it is possible that Internet radio will be more popular than terrestrial radio within a few generations. Broadcasters are working to increase listenership through simulcasting, and these streams are attracting roughly half the audience of Internet only streams.[16] The decreased interest in traditional radio might be explained by exploring consumer interests and this study identified four factors that are important to the streaming audience:

> "…An examination of the images associated with AM/FM streams indicates that these brands are out of sync with the interests of streaming consumers. AM/FM streams have extremely weak association with the most important streaming attributes, including fast buffering, few commercials, variety, and personalized stations. At the same time, consumers strongly associate AM/FM streams with many of the least important product attributes, including personalities, local weather, local traffic, and local event information."[17]

In concluding the report, Coleman Insights recommended addressing these issues while the market is developing, and asserted that broadcasters will need more than simulcasts of existing programming to satisfy consumers.[18] If Coleman Insights is correct that simulcasting AM/FM will ultimately disappoint the online audience, then broadcasters need to rethink their online strategies, introducing complexity and new expenses to their stations.

CHAPTER 4

STREAMING AND THE LAW

The field of radio broadcasting as is observed today has taken form as a result of more than a century of evolution, and the emerging model can be better understood by analyzing the ways that technology, law, business practices and station operations have developed and are changing. Technology defines what is possible for broadcasters and the existence of the radio industry is due to the development of devices that capture, transmit and receive audio signals. The further development of communications technology creates opportunities for broadcasters, and radio history has shown that the tools of the trade are often replaced or challenged by the newest advancements. Laws that are then created to regulate the use of the technology tend to benefit the population, government or broadcasting industry, and all business or operational practices involving the technology are guided by these constraints. The business aspects of radio that will be discussed describe the means by which radio has become a profitable, self sustaining industry and the relationships which must exist with other industries and the community to achieve this end. The operations of a radio station describe the day-to-day tasks and strategies related to keeping a station on the air, as well as the management and programming decisions that are necessary to efficiently use the technology to meet business goals while observing the governing legislation. These four areas work interdependently to create the model of radio that dominated the twentieth century and the chapters that follow provide background while highlighting the ways in which streaming radio differs from, as well as challenges, the traditional radio model.

The emergence of streaming audio web sites in the 1990s and early 2000s might be compared to the radio broadcasts that existed prior to the Radio Act of 1927, when various hobbyists and experimental businesses competed with minimal government intervention and lacking a proven business model. Radio markets were yet to be delineated and the power of a hobbyist's transmission defined the station's reach. Today, the FCC has no specific jurisdiction over web radio, though the commission regulates various aspects of electronic communications. Because streaming does not rely on the electromagnetic spectrum, webcasters are unconcerned with broadcast licenses, spectrum assignment, power limits, Safe Harbor hours or standards for serving the public interest. American webcasters have no obligation to stream one type of programming over another, provided they are not violating other U.S. laws, such as those that protect children or copyrighted material. In the absence of FCC policy, it is primarily copyright and licensing issues that add legal complexity to Internet radio, as well as controversial new expenses for streaming radio stations.

Digital Copyright Law

While the FCC, Congress and the industry are debating constitutional rights in the context of regulating online services, a different type of right is immediately applicable to webcasters: the performance right. Digital copyright law is especially relevant to webcasters who do not hold the copyrights to sound recordings that they intend to transmit and new media technologies are continually inspiring updates to the existing copyright law.

Laws governing the rights to musical performances were introduced through the Sound Recording Act of 1971, an amendment to the original Copyright Act of 1909, and both of these acts received extensive revision through the Copyright Act of 1976, which laid the foundation

for copyright laws that are still in use today. According to the U.S. Copyright Office, copyright protects the authors of "original works of authorship," and Section 106 of the 1976 legislation generally gives the owner of the copyright the exclusive right (and ability to authorize others) to "reproduce the work"; "prepare derivative works"; "distribute copies or phonorecords of the work… by sale or other transfer of ownership"; "display the work publicly"; and "perform the work publicly," including by means of digital audio transmission.[1] Violating the rights of the copyright owner is illegal, but there are limited provisions for using these works, generally, by means of direct or compulsory licenses. A direct license is "granted voluntarily by copyright owners for a negotiated fee and pursuant to agreed upon terms and conditions," whereas a compulsory (or statutory) license is made available by the government, along with terms and rates. Currently, the most common use of compulsory licenses for musical sound recordings is for "non-interactive webcasting or Internet radio."[2]

Prior to 1995, there was no performance right for the digital transmission of sound recordings, and this right was created through the Digital Performance Rights in Sound Recordings Act (DPRA). The legislation discussed three types of digital transmissions: 1) "broadcast transmissions, which were exempted from the performance right"; 2) "subscription transmissions, which were generally subject to a statutory license"; and 3) "on-demand transmissions, which were subject to the full exclusive right."[3] While the act addressed some of the emerging digital technologies, streaming audio was not described in any of the three transmission categories. Because web streaming was gaining popularity through the 1990s, a new non-subscription transmission category was added to the DPRA through an amendment by the Digital Millennium Copyright Act (DMCA) of 1998 which included streaming.

Among the more controversial implications of the DMCA and amended DPRA was the lack of the performance right exemption for audio streaming, practically resulting in webcasters paying certain royalties from compulsory licenses that were not required for terrestrial radio operations. Broadcasters resisted this distinction because they would now be required to pay fees in order to simulcast their content. A decision by the Copyright Office in 2000 determined that "AM/FM streaming was subject to the statutory license provisions of the Copyright Act because streaming was not exempt from the public performance of a sound recording right."[4] Broadcasters had an opportunity to overturn this decision in *Bonneville v. Peters*, but the federal district court ruled that streamers are not exempt from the right.[5]

In the years following the DMCA, there were sharp disagreements between radio broadcasters, webcasters and the Recording Industry Association of America (RIAA) about royalty rates and their burden on smaller streaming operations; these issues found their way through the courts and eventually to Congress, where it was decided in 2002 that the non-profit organization, SoundExchange Inc., would negotiate rates and collect royalties on behalf of artists and master rights owners for web-based digital transmissions.[6] From the inception of the DMCA and DPRA, the marginalization of smaller webcasters has been a concern,[7] making it financially difficult for hobbyists and entrepreneurs to sustain streaming audio operations or introduce new ways of doing business.

> "The webcasting industry has been financially and legislatively abused as a forerunner of rapidly advancing digital technology. This is an unfortunate reaction by an old industry afraid of changing technology and unwilling to modify its marketing strategy. In order to increase the flow of ideas through the widening scope of technology, the legal system should not be used as a club to set high

> rates and scare off entrepreneurs. Instead, it should act as a mediator, encouraging the market while protecting the rights of intellectual property holders."[8]

The discrepancy in compulsory licensing between over-the-air and web radio stations, along with opposition to increased costs, have continued to be a source of contention in Internet radio licensing.[9] The Small Webcasters Act, intended to temporarily reduce the financial burden on streamers by allowing a "fee based on a percentage of revenue,"[10] expired in 2005 and prompted webcasters such SomaFM to fear the demise of their streaming operations as royalty rates were expected to increase by more than 30 times the previous rate:

> "Satellite broadcasters pay royalties based on a percentage of their revenue; local radio stations pay no royalties at all to labels or artists for their over-the-air broadcasts. …Internet radio is no longer being allowed to pay based on our revenues, and instead have pay per song, per listener. This means for 2006, the fees will be around $600,000... Based on our current listenership, these fees will be over $1 million dollars for 2007! …Now we're being forced to pay several times our total revenues."[11]

There are seemingly few aspects of streaming media licensing that have not been disputed and while this type of regulation is slowly evolving, it will likely require years before long term resolutions can be reached. The specific applications of the current royalty resolutions, as well as the factors introduced by the national labor unions, are discussed in the next chapter.

CHAPTER 5

STREAMING OPERATIONS

Programming Strategy

Audience research indicates that younger listeners are now more likely to turn to the Internet for new music than AM/FM radio and nearly 70 million people in the U.S. are listening to Internet radio each month.[1] With streaming now more popular than ever, radio stations are making their programs available to Internet users by webcasting a copy of their terrestrial signals, and for them, "simulcasting is a significant operational and marketing strategy."[2] Other stations, such as those associated with National Public Radio, offer web-based libraries of on-demand and podcast content in addition to their simulcasts.[3] Despite the trend of breaking into the online radio market through simulcasting, the FCC reported in June of 2011 that more Americans were listening to Internet-only stations than AM/FM simulcasts for the first time in the history of streaming,[4] a development that indicates a shift in audience needs and supports the findings of Coleman Insights' research into online programming preferences. This is not the first time in history that audience trends due to new technology have sounded the alarm for radio's potential demise.

"From the twenties to the mid-fifties, radio was a program-oriented medium. Listeners tuned in programs, and which station (or even which network) broadcast them was relatively unimportant. Television snatched away this function in the fifties, and at first, amid steep audience declines, it appeared that radio – the broadcast medium that didn't have pictures – had been made irrelevant by video. The funeral was premature."[5]

Ultimately, programming decisions brought radio into the next phase of its development, with the Top 40 format playing a critical role as "radio station owners began to apply demand marketing to their operations."[6] In the streaming age, the decrease in advertising dollars invested in terrestrial radio and changing audience needs indicate that programmers will once again need to consider what strategies are necessary to connect with the next generation of listeners. Terrestrial radio's existence as a medium is not yet directly threatened by streaming, since radio remains cost-effective and listening still dominates certain environments, such as in automobiles.[7] However, the growth of Internet-only radio audiences over AM/FM simulcast listenership signifies that the standard programming approach of providing one best-fit voice to the masses is less effective online due to the inherent differences between the mediums.

Radio broadcasting has developed over more than a century into the form that exists today being defined largely by the capability of technology available. Initially, radio was considered a point-to-point device, allowing boats to communicate with the shore or hobbyists to exchange messages with one another. As commercial radio took form, the industry mastered the model in which content from a single station's antenna was simultaneously accessible to thousands of listeners through portable devices, cars and home stereo systems and this model has continued to this day. With broadcasting networks and radio consolidation, programmers benefit from economies of scale as much of the same content can be shared by any number of radio stations in different markets. Listeners are only able to access their local provider of that content with their receivers and may have little knowledge of what is broadcast in other markets. With a limited number of stations in each market from which the audience can choose and a single pool of listeners for which the stations compete, terrestrial programmers seek to maximize listenership

by providing programming with the broadest possible appeal to their target audiences. On the internet, however, audiences have access to wider selection of programming options.

Because of the magnitude of streaming audio choices and the consolidation of the global markets through the Internet, what online radio has achieved would be equivalent to designating an antenna to serve each listener or small community of listeners, for each type of programming that is desired. If a local terrestrial station does not provide precisely what a listener seeks, it is likely that a webcaster exists elsewhere on Earth who does and listeners are now able to choose from a vast pool of streams that more closely fit their interests. An example of this flexibility can be seen in the products created by Livio Radio, a consumer electronics company specializing in Internet radios that provide users access to "20,000 Internet radio streams from around the world without subscriptions or monthly fees."[8] Giving customers near-instantaneous access to more streams than there are terrestrial radio stations in the United States, the compact Livio Radio costs roughly two hundred dollars and functions much like a conventional radio set, with the ability to locate a numerous options for each genre of music and talk programming. It would not be technologically or fiscally feasible for a radio station to provide this type of personalized service to a local market via terrestrial transmission nor is there spectrum available to attempt it. Through streaming audio , small operations and independent program-makers are able to share the Internet "dial" with even the largest operations by removing the constraints that might prevent them from doing so through terrestrial means; these constraints include licenses, assigned frequencies, potentially large staff sizes, expensive or bulky broadcast equipment and plots of land for antenna placement. Depending on their goals, webcasters can communicate using point-to-point or single-to-many programming models, meaning that programs that are highly customized or broad in appeal are streaming in the same global market. For listeners, the

global nature of streaming technology expands the programming options beyond what can be accessed locally through AM/FM receivers, allowing those online to be more discriminating in their media consumption as emphasis is placed on the quality and type of content being offered. This advantage has quickly allowed listeners to form new expectations for online listening which conflict with traditional offerings. The streaming audience desires the ability "to control or choose the music being played" while choosing streams featuring "more music variety," "fewer commercials," "less DJ" involvement and programs cannot be gained elsewhere. [9]

Communicating a message to a narrow target audience has been described as "narrowcasting", as opposed to broadcasting which shapes a message to apply to a broader audience. Chris Priestman has described this phenomenon in terms of "vertical" versus "horizontal" communications operations. According to Priestman, vertical broadcast institutions "are large organizations reliant on economies of scale"; "need large audiences"; "are hierarchical and… managed centrally, at a distance from the listener"; and "must therefore appeal to majority of tastes"; while horizontal broadcasting institutions "are either small… or decentralized units"; involve "listeners directly in policy making and programmes (sic)"; "need only attract small audiences (though they may incidentally gain wider popularity)"; and "can serve minority interests, groups or communities."[10] While broadcasters who fit the description of a vertical institution can stream their programs with relative ease, they are immediately in competition with thousands of other streaming radio stations who may promote a very similar product (including stations within their own network) as well as smaller webcasters who are designing their programs for a very narrow target audience. Interestingly, the most successful of the Internet-only webcasting operations thus far, Pandora, has gravitated toward a narrower, highly customizable and interactive programming approach, and is in return attracting the masses. The practice of simulcasting

succeeds in complimenting terrestrial radio by giving listeners another method of accessing a station's existing programs, but broadcasters must be careful not to assume that their target audiences have the same expectations from their web browsers as they do from their radio dials.

Advertising and National Labor Unions

In the 1990s, The American Federation of Television and Radio Artists (AFTRA) raised objections when many radio broadcasters took their programming and associated commercials to the Internet. Broadcasters have long been familiar with AFTRA and the Screen Actors Guild (SAG), which are national labor unions responsible for collective bargaining and the negotiation of television and radio contracts for artists and performers.

> "AFTRA's scope of representation covers broadcast, public and cable television (news, sports and weather; drama and comedy, soaps, talk and variety shows, documentaries, children's programming, reality and game shows); radio (news, commercials, hosted programs); sound recordings (CDs, singles, Broadway cast albums, audio books); "non-broadcast" and industrial material as well as Internet and digital programming… AFTRA members perform in television and radio advertising, non-broadcast video, audio books and messaging, and provide their skills for developing technologies such as interactive games and Internet material."[11]

With respect to radio commercials, these agreements "are negotiated solely by AFTRA"[12] which sets the minimum fees for sessions and various types of radio performances including singing, acting, sound effects and announcing according to the intended use, length of the campaign and targeted markets.[13] Because radio broadcasters were streaming commercials

featuring AFTRA members during simulcasts, in April of 2001 the union demanded that broadcasters pay fees to air these performances and adjusted their policies accordingly. In response to this pressure and a bulletin "from the Joint Policy Committee on Broadcast Talent Union Relations of the Association of National Advertisers and the American Association of Advertising Agencies regarding the rules for paying talent in commercial spots on the Internet", hundreds of radio stations, including those associated with Clear Channel, ABC/Disney and Emmis Communications, responded by simply turning their streams off rather than comply with the new terms.[14] The streams were eventually reinstated despite the new fees, but the changing advertising landscape created a niche for advertisement insertion services, such as the Los Angeles-based company, Hiwire, which Clear Channel chose in June of 2001 to sidestep AFTRA's demands.[15] These services currently play a key role in many streaming operations by automatically removing spots from a stream and replacing them in real-time, allowing webcasters to do more than avoid unwanted fees; radio spots can now be customized to each listener's interests.

AFTRA's policies are currently well defined for the webcaster, with two fee structures that broadcasters who wish to webcast commercials must consider, depending on whether the spots were initially created for broadcast or Internet use. First, per an agreement lasting from April 1, 2009 to March 31, 2012; "for product moved over to the Internet or in New Media" from terrestrial radio, broadcasters must pay "1.3 times the minimum session fee for 8 weeks of use and 3.5 times the minimum session fee for one year's use" with the session fees creditable against the Internet use fees in the first cycle, and extended editing rights for Internet or new media use available through free bargaining.[16] "Internet contracts for use of these commercials are one-time up-front fees that do not include per-use fees. They cover unlimited usage on an

unlimited number of sites or stations during the contract period."[17] On April 1st of 2011, SAG and AFTRA's policies regarding commercials made for Internet and New Media took effect, disallowing "free bargaining with principal performers for sessions & use fees" for online purposes; under this second agreement, "the minimum session fee payment for a made for Internet or a made for New Media commercial shall be the same as the minimum scale session fee payment for a made for television or made for broadcast radio commercial", requiring broadcasters to pay performers 133 percent of the session fee for an eight week cycle of use and 350 percent of the session fee for a one year cycle of use.[18] As webcasters are expanding the definition of radio through new media outlets such as content designed for cell phones, AFTRA's Electronic Media Agreements are necessary and negotiations regarding performer compensation for new media projects are a continuing issue.[19] AFTRA's current rates and requirements regarding broadcast and Internet content are available through the union's website.

Royalties

Radio broadcasters in the United States are also familiar with the work of the three major Performing Rights Organizations (PROs) which are BMI, ASCAP and SESAC. These PROs facilitate the process of requesting and granting permission to publicly use copyrighted works by representing songwriters, composers and publishers; issue licenses for public performances of their copyrighted works; and collect royalties to distribute to their members. Radio stations have traditionally paid royalties to publishers and composers by obtaining special licenses, such as BMI's "Blanket/Per Program License"[20] or the ASCAP Radio License,[21] which grant broadcasters the right to transmit songs from the corresponding PRO's repertoire. With greater demand for the streaming of recorded works, the PROs have created new media licenses for non-

interactive Internet streaming,[22] the first of their kind made available in 1995 through BMI,[23] which grant webcasters the permission needed to electronically transmit the copyrighted musical compositions of the represented composers, publishers and authors. What radio stations have not traditionally been responsible to pay are royalties to featured performers and those who own the master rights to a recording (such as record labels), because these parties potentially benefit from the publicity that free air play can provide.

When the DPRA and DMCA established a performance right for digital transmissions and none of the standard PROs included a service for facilitating this right, the Copyright Royalty Board appointed SoundExchange Inc. to be responsible for the collection and distribution of "digital performance royalties on behalf of featured recording artists, master rights owners… and independent artists who record and own their masters."[24] SoundExchange Inc. is only concerned with performance rights, issuing statutory licenses for digital cable television, satellite television/radio and non-interactive webcasting services. SoundExchange Inc. is not, however, responsible for the licensing of interactive, on-demand or digital download services.[25] This distinction is important because in order to qualify for the right under Section 112 of the amended Copyright Act, the digital performance must involve making non-interactive, ephemeral copies. This means that the transmitted recordings are not downloaded or retained by the listeners and are temporary in the same way as an AM or FM broadcast. In order to legally provide an interactive stream or make digital copies of recordings available for download, then licenses involving the musical copyright owners can be requested through the Harry Fox Agency,[26] and will likely involve negotiation with individual record labels.

Table 1. Standard "Per Performance" Rate History

2006	2007	2008	2009	2010
$0.0008	$0.0011	$0.0014	$0.0018	$0.0019

The rates for digital transmission of copyrighted works under the statutory digital performance right have steadily risen over the last decade,[27] and will continue to do so based on the designation of the webcaster. For businesses eligible to operate under the compulsory license described in the U.S. Copyright Act (17 U.S.C., §§ 112 and 114), the Copyright Royalty Board has planned rate increases each year through 2015 and has designated streaming operations as Broadcasters, Small Broadcasters, Commercial Webcasters, Non-Commercial Webcasters or Non-Commercial Educational Webcasters; each designation is associated with specific "per performance" rates as well as minimum and maximum annual fees for each stream being maintained. Streamers designated as Broadcasters, including "commercial FCC-licensed AM/FM stations that are simulcasting on the Internet", are expected to "pay an upfront annual minimum fee of $500 per station per channel" up to $50,000 total which is nonrefundable and is "credited toward the broadcasters' monthly liability." A webcaster may be designated as a Small Broadcaster if less than 27,777 aggregated hours are streamed each year, which decreases the annual minimum fee to $100 per station per channel. [28] (The other designations and their associated rates/fees are available through the SoundExchange Inc. website.) "All services operating under statutory licensing must file a Notice of Use form with the Copyright Royalty Board before beginning operation" as well as complete monthly liability reports with account for total performances, stations and channels.[29] The 2011 rate of $0.0017 per performance is a temporary relief for broadcasters, as the rate is scheduled to jump to $0.0020 per performance in 2012, and will continue rising to $0.0025 per performance in 2015.

Table 2. Broadcaster/Small Broadcaster "Per Performance" Rate

2011	2012	2013	2014	2015
$0.0017	$0.0020	$0.0022	$0.0023	$0.0025

Stream Hosting

A radio station may not want to host their own streaming servers and instead may choose to pay someone else to serve their signal. In this case, there are companies available who will provide this service for a fee, such as Live365, which offers several packages for hobbyists and professional broadcasters based on the number of simultaneous listeners, bit rate and storage space. Live365 offers professional hosting packages that will sustain up to 500 simultaneous listeners (SL) costing up to $2000 / month and additional SL can be purchased for $50 to $100 per 25 additional SL.[30] Included in these rates are the royalties required to play the music and there are strict reporting requirements to this end. Live365's service makes it simple to manage a streaming operation and the all-inclusive rates quickly illustrate the costliness of maintaining a large online audience.

The Question of Quality

For streamers, audio quality is correlated with costs. The webcaster's streaming system is limited by the number and processing power of computers available to serve the streams and the bandwidth of the Internet connection. When an audio signal is converted into digital information, sonic detail is gained at the expense of smaller audio file sizes and transferring larger files over the Internet requires a greater portion of the available network bandwidth and resources.

Therefore, the quality of a stream must vary indirectly with the size of the simultaneous audience when bandwidth is fixed in a unicast streaming environment. Webcasters with few listeners often have the freedom to provide the highest quality streams to their audiences within the limits of their resources. If an Internet broadcaster is attracting a larger audience than the system can sustain, the option exists to degrade the audio quality that is served in order to increase the total number of listeners for a given maximum bandwidth. It may even be advantageous for web radio broadcasters to stream audio with less quality in order to encourage other business opportunities, such as music purchases. Many of the popular streaming servers and hosting services can manage this process automatically using a technology that has been generically called Variable Bit Rate or Adaptive Streaming;[31] but this is a business decision as much as it is an operational one because audio quality is part of the product that webcasters offer to online listeners, and this decision can position one station against another.

Multiple Streaming Venues

Terrestrial broadcasters are accustomed to having a single frequency with which to transmit content to listeners for each station. Similarly, simulcasting a station's signal also requires a single stream, but online radio has the potential for multiple streaming venues, expanding the means by which broadcasters can share and promote their content. In 2002, Chris Priestman offered five categories of broadcaster involvement in online streaming: 1) "the station website", 2) "the Simulcast stream of the terrestrial output", 3) "archive streams of parts of the terrestrial output", 4) "side channels" of narrowly targeted programming, and 5) "third party streaming sites."[32] For the broadcaster who is able to manage multiple streams, archive streams provide a means by which the broadcaster can selectively construct a new stream using programs

from a more diverse stream's repertoire. For example, a streaming format might involve a talk show at regular intervals and over time these shows could be harvested from the original format and combined to form a second continuous stream. This is similar to a side channel, with the distinction that existing, archived content is used to program the stream. Third party stream-hosting sites can simplify the process of webcasting, but this reduces flexibility for the broadcaster, who may require more control than is provided by the site. An advantage of third party sites such as Live365.com and SHOUTcast.com is that they often also provide a searchable Internet radio directory of their hosted webcasters,[33] simplifying the process of finding new streams.

With new devices and resources available to listeners, the list of potential streaming venues could be updated to include 1) smartphone and mobile streaming applications, such as those created by jacAPPS of Southfield, Michigan;[34] 2) social media websites, which "complement and strengthen listener engagement" with the radio medium[35] and provide opportunities for targeted advertising as sites like Facebook draw hundreds of millions of users;[36] and 3) streaming radio directories, which can access streams through hyperlinks, banner ads, and browser-embedded media players. As Internet radio broadcasters discover new means for sharing and publicizing their streamed content, special care will need to be taken to observe the current royalty laws and union policies.

Table 3. Examples of Streaming Radio "Tuner" Sites

Directories	Uniform Resource Locator (URL)
AOL Radio	http://music.aol.com/radioguide/bb
Radio List (Europe)	http://www.radiolist.net/
Live365	http://www.live365.com/
Nokia Internet Radio	https://irbcast.nokia.com/nmds/index.action
Penguin Radio	http://www.penguinradio.com/
Pirate Radio Network	http://www.pirateradionetwork.com/
RadioGuide.FM	http://www.radioguide.fm/
Radio Locator	http://www.radio-locator.com/
Radio Rage	http://radiorage.com
Radio Tower	http://www.radiotower.com/
SHOUTcast	http://www.shoutcast.com/
TuneIn	http://tunein.com/
Tuner24	http://tuner24.com/
Web Radio Central	http://www.webradiocentral.com/
Windows Media Guide	http://www.windowsmedia.com/radioui/home.aspx

CHAPTER 6

THE BUSINESS OF STREAMING

As the first decade of the millennium came to a close, The FCC reported an all-time low in radio advertising revenues, which steadily increased until 2005 and then dropped substantially each year thereafter, dropping from about $22 million in 2005 down to nearly $16 million in 2009.[1] Interestingly, Arbitron reports that 2006 was the first year that broadband Internet surpassed dial-up access at home, and by 2009, broadband users outnumbered dial-up users by a ratio of more than five to one in households across America.[2] As fewer advertisers are choosing to invest in terrestrial radio, the audience that they seek is connecting to the Internet with unprecedented efficiency. Advertisers are either spending less to promote their products, are investing their dollars elsewhere than radio, or both; regardless, the trend is in direct opposition to the traditional radio business model and has caused stations to lose more than a quarter of their advertising income in 3 years. Broadcasters need to re-envision advertisers to invest in radio spots to sustain the traditional business model; provide new and attractive opportunities for advertisers; or change their business approach entirely. As broadcasters have brought their programming to the Internet, there has been an online adaptation of the traditional model with additional avenues of advertising, while Internet-only webcasters have been less timid to attempt new strategies. Broadcasters will ultimately find new expenses and challenges relating to streaming technology and content licensing as they bring the terrestrial strategy to the Internet.

The Traditional Business Model

Radio broadcasters have historically produced revenue through selling advertising time, subscriptions or electronic devices. Today, radio's business model is based on the relationship that exists between advertisers, broadcasters and their audience.

> "The goal… is to attract as large an audience as possible so that the broadcaster can demand a relatively large amount of money from the advertiser. The advertiser, in turn, wishes to expose product messages to as many people and with as great an effectiveness as possible for the least necessary cost. The role of the audience is to watch or listen to the programs and buy the advertised products. The audience, therefore, becomes the commodity, and the program broadcast becomes the means by which the audience is delivered to the advertiser by the broadcaster."[3]

From this description, the traditional station can be seen to have two products, but only one of them is directly profitable. The first product is the programming content, which attracts the audience but generally yields no direct income, as content is traditionally offered as a free service to radio listeners. The second product is the listening audience which is made available to advertisers who pay the broadcaster for the right to be seen and heard in their presence. As radio has expanded onto the Internet, the industry has brought this basic model with it. The common practice of simulcasting AM/FM programming is evidence that terrestrial broadcasters are hoping that the current model will at least survive the technological jump, if not succeed with some adjustments, but earning advertising dollars in the online market requires a new understanding of the elements involved.

Audience and the Online Market

On the Internet, there are no geographical boundaries that define the size of a market and the reach of a web radio station is not defined by the power and height of an antenna, as are true of terrestrial radio. In 1980, nearly a decade before the rise of the now ubiquitous World Wide Web, author and broadcaster John Hasling described the relationship he observed between the size of a radio market and the listening audience:

> "The number of people in your listening range is important, because it will determine how likely it is that you will be able to get an audience for the program offerings you select. In a large metropolitan area you would likely be able to draw a sufficient audience for almost any kind of programming you might choose. Foreign language programs, for example, would be possible in New York or Chicago, but perhaps not in a small Midwestern town. …In a large market, you could be up against forty or fifty other stations. All of them are trying to attract and hold a particular audience segment, and all of them will be attempting to do it in their own unique way."[4]

Hasling's words regarding niche programming are still true for over-the-air broadcasts, but on the Web, outside of government intervention or technical limits, the success of a particular program or format is largely independent of the webcast location because all markets share the same space. An advantage of this online amalgamation of markets is that there is a accessible audience for nearly any program that can be conceived, assuming the audience is made aware of the program. With streaming, the success of a program is no longer limited by the local community's tastes and opinions. A disadvantage of a unified market is that all Internet radio stations must now compete in the same space, though this may serve to make their

offerings more diverse. Additionally, with weaker ties to the surrounding community, streamers may have difficulty targeting a specific or local audience with their advertising and content.

Internet Radio Ratings

Because the unified online marketplace requires that all web radio stations compete against one another for advertising dollars, gaining the confidence of advertisers through accurate demographic and ratings data will be critical for long-term success. Companies devoted to online ratings are emerging to meet this need, but some data can be generated from the stream itself. With web radio, stations can log the exact number of people listening at any moment since computers can monitor this information in detail. This data enables a web station to negotiate with advertisers based on actual listenership - a significant advantage over terrestrial radio - as well as make informed programming decisions based on past performance. For example, a stream's usage logs can tell a station's directors the times and dates that users sign on and off of the stream; this information, combined with the programming logs, can reveal which songs, commercials and on-air staff are potentially causing the changes in listenership. An advertiser may wish to run spots for a specified period of time and in this case it is possible to use existing logs to estimate the number of people that will be exposed to it. Internet Protocol (IP) addresses can sometimes be used to determine the cities and states where users are located,[5] but the streaming servers cannot report on other information that is useful for advertisers. This limitation enables the success of companies like TargetSpot, which launched in 2007 to allow advertisers to connect their digital audio content with consumers according to criteria such as demographics, geography, daypart and music genre.[6] Many of the larger broadcasting networks are now

utilizing the tools provided by TargetSpot, Ando Media and others, revealing a need for precise audience targeting in the developing streaming audio industry.

> "While the medium has proven itself a worthy buy for national campaigns, for example, Webcasters have yet to make significant inroads into the lucrative local marketplace. Agencies also complain that, in a frenzy to deliver sufficient impressions, some Webcasters end up annoying listeners by airing the same spot too frequently, while others mislead clients by padding their advertising proposals with international listeners that are not relevant to the buy. Perhaps most significantly, while Web-radio audiences can be quantified with far more precision than can those of terrestrial radio, advertisers universally complain about a death of reliable, comprehensive demographic data."[7]

While effort has been made to provide demographic and ratings data to webcasters and their advertisers, this aspect of the industry is still developing as there is yet to be a company to continue this work beyond a few years. MeasureCast was among the initial efforts to provide Internet radio ratings when the company launched in 2000 in order to provide "internet radio broadcasters, advertisers and media buyers with next-day reports on the size and demographics of streaming radio delivered over the Internet."[8] MeasureCast was subsequently licensed to Arbitron in 2002,[9] however, it was Ando Media that became the standard in web radio ratings by the end of the same decade.

With over 6000 customers including many of the larger broadcasting networks such as CBS Radio, Cumulus, Clear Channel, Pandora, ABC Radio and Virgin Radio,[10] Ando Media became the dominant provider of streaming radio ratings when Arbitron suspended ratings of online radio in 2009.[11] In addition to audience research, Ando Media offers additional services to

webcasters including music reporting for royalty purposes and the automatic insertion of advertisements into live streams or on-demand media during playback.[12] With real-time reporting and management of online advertising content, webcasters can sell spots and provide advertisers with a variety of detailed usage reports. Ando Media has been successful in providing services that bridge the traditional and emerging models of radio broadcast, using familiar terminology such as Average Quarter Hour and Cume Audience measurements, while utilizing automation to make the usage of streaming and new media technologies simpler to manage. Unlike Arbitron's terrestrial ratings system, which accounts for all radio stations in a given market, a limitation of Ando Media's method is that only paying customers are included in the calculations. While this results in incomplete reports, it is still an achievement given the scope of the online market and the nature of the Webcast Metrics platform, which requires the technical cooperation of a streaming operation in order to measure web traffic. While progress has been made, it is yet to be determined if a long term ratings solution has been found. Improving methods for acquiring accurate ratings and demographic data is a logical next-step for the streaming industry, as this will allow webcasters and advertisers to more effectively monetize their businesses.

The Emerging Model

Historically, terrestrial broadcasters have aimed to maximize their audiences in a given market and there have been only gains for doing so. It is the same today, as the operational cost for a station to transmit its signal a certain distance is ultimately the same whether the listening audience consists of one person or millions and a greater audience allows a station to negotiate higher rates with advertisers. With Internet radio, it is just the opposite; advertisers are still

motivated to expose their products to as many people as possible within their targeted demographics, but the station's expenses rise with each listener that is connected to the server and according to the audio quality of the stream being provided. The bandwidth required to serve a large audience is expensive and the web radio broadcaster faces a new, upside-down model in which the cost of transmission and the size of the audience have a direct relationship.

> "The dirty secret of Webcasting is that the business model for the emerging medium is still painfully fragile… It's not uncommon for Webcast listeners to reach the Internet equivalent of a 'busy signal' when they attempt to connect to a popular webcast feed. For example, a Webcast of a highly anticipated Victoria's Secret fashion show earlier this spring resulted in many frustrated computer users. Despite the anticipation of a large audience, the programmers were unable to offer enough programming feeds to accommodate demand for the sexy show."[13]

This Billboard newspaper article illustrates a difficulty that webcasters face in adjusting to the new model of online streaming: a streaming operation can only sustain so many simultaneous users. If the webcaster underestimates the traffic that a particular stream will generate, then potential users will be unable to access the program and it may damage the reputations of those involved. On the other hand, if the webcaster overestimates the popularity of a stream and invests in excessive equipment and network bandwidth, then money is inefficiently handled.

The emerging streaming model is one where the business pays for each customer to participate, listen to content and be exposed to advertising; it is also a model where market divisions are lifted and anyone with the means can share their programs. Regardless of the legal

and technological challenges, many see the advantages and are participating in the global streaming experiment. AM/FM simulcasts are easily found in most Internet radio directories and the abundance of simulcast streams is not surprising since radio broadcasters already have programming available through their terrestrial operations. Radio stations and networks are not exclusively reliant on the revenue generated from simulcasts for their ongoing success because they are not primarily webcasting operations; essentially, they depend on the continued success of the traditional radio business model while they experiment with the emerging one. Launching an Internet-only, non-simulcast stream removes this safety net and requires the development of a profitable business model in an unconventional environment that has only existed for a few decades. It is not unanticipated then that most streaming operations in the U.S. are simulcasts supported by the terrestrial radio industry.[14] There are, however, some Internet-only streaming audio companies that are drawing large numbers of listeners – more than any single simulcast – and simulcast streamers can learn from these updated models.

Streaming Radio Profiles

In 2010, Coleman Insights explored the "perception of consumers" by comparing several Internet radio sources according to consumer brand awareness and discovered that consumers are most aware of the following stream providers: 1) AM/FM streams, 2) Pandora, 3) Satellite Radio streams, 4) Yahoo! Music/Launchcast, 5) AOL Radio, 6) iHeartRadio, 7) Last.fm and 8) Slacker.[15] While Coleman Insights did not consider the brands beyond Pandora to be generating significant usage, there was nonetheless some name recognition for those brands. It is notable that AM/FM streams as a category has the most brand recognition, but no single AM/FM stream is mentioned as a competitor to the non-simulcasting providers. Practically, this means that

Pandora's single website is effectively competing with all AM/FM websites combined in terms of image, and is likely far more popular than any one AM/FM stream. Related figures were released by Ando Media's Internet Audio Top 20 Ranker in January of 2011, which mainly consisted of broadcast network-affiliated streams, but also included Pandora as the overall leader and Slacker, Inc. in the fifth highest overall position for domestic listening in terms of Average Active Sessions (AAS).[16] The report also reveals that Pandora overshadows Slacker in terms of AAS by a ratio of nearly 18:1 and attracted about four times as many session starts and AAS than the nearest competitor, CBS Radio Inc. Pandora's dominating presence as an Internet-only radio source should cause radio broadcasters to evaluate the reasons why this success has been possible, as well as consider the strategies of other web-specific streamers, which in the absence of terrestrial stations to manage can focus their efforts on the needs of the online audience.

Table 4. Internet-Only Streaming Audio Sources

Internet Radio Source	Uniform Resource Locator (URL)
Acoustic Alternative	http://acousticalternative.com/
Classical Music America	http://www.classicalmusicamerica.com/
Grooveshark	http://grooveshark.com/
Jango	http://www.jango.com/
Last.fm	http://www.last.fm/
Maestro	http://www.maestro.fm/
MOG	http://mog.com/
Nu-Perception Radio	http://www.nu-perceptionradio.com/
Rdio	http://www.rdio.com/
Rhapsody	http://www.rhapsody.com/
SomaFM	http://somafm.com/
Spotify	http://www.spotify.com/us/

Pandora Media, Inc.

Pandora Media, Inc. began in 2000 and allows users to create up to 100 custom radio streams that adapt to musical preferences as listener feedback is communicated via Pandora's interface.[17] A process marketed as The Music Genome Project is claimed to be responsible for generating custom playlists as accepted or rejected songs are analyzed according to "up to 400 distinct musical characteristics", allowing Pandora to recognize and respond "to each individual's tastes."[18] Pandora is currently accessible via web browsers, as well as through Internet-equipped cell phones supported by many of the larger carriers,[19] and due to music licensing constraints is only legal to use within the United States.[20] Despite Pandora's popularity, the company experienced financial difficulties in the first decade of its existence due to expensive music licensing fees, but decisions such as limiting listening to forty hours per month for non-paying users and resolutions between "webcasters, artists and record labels" in 2009 put the company "on safe ground with a long-term agreement for survivable royalty rates," according to founder Tim Westergren.[21] Apparently, Pandora's in-stream and banner advertisement funding strategy was insufficient to offset the costs associated with unlimited, free listening for a large audience, indicating that the traditional business model is incompatible with online streaming.

There are essentially three types of accounts with Pandora. First, a free account allows up to forty hours of listening per month, six "skips" per hour, meaning that the undesired song is immediately stopped and replaced with the next song in the playlist, and twelve total skips per day. The second type of account involves paying $0.99 per month for unlimited monthly listening hours, six skips per hour and twelve total skips per day. The third type of account is

called Pandora One, and involves unlimited listening hours, no song skip limits, no advertisements and higher quality streams for $36 per year.[22]

Pandora's service is effective in helping listeners find new songs within their preferred genres, but what is not allowed is requesting a specific song, "rewinding" to a previous song, seeing the next song on the playlist or building a song list with specific titles. Using this strategy, Pandora is able to perform music under the same statutory license that is required for simulcasting radio stations, while avoiding costly negotiations with record labels for the use of their music, as would be the case if the company were designated as an interactive, on-demand streaming operation.[23] This distinction creates some immediate financial advantages for Pandora, but some believe that this strategy leaves room in the streaming audio market for competitors who are able to effectively operate as "on-demand license holders" and that the "eventual market winner will come from this group."[24]

Conventional radio wisdom emphasizes the importance of the radio personality. It has been said that "the product of radio broadcasting is music and the spoken word" and that the broadcaster's "most important job will be to produce the words."[25] With Pandora and many of the emerging Internet radio streams, there is no DJ or live personality speaking to the audience and yet Pandora is dominating the Internet radio scene, meaning that listeners are devaluing what has been seen as a staple of radio for more than a century or they do not know what they are missing.

Slacker, Inc.

Slacker, Inc. (http://www.slacker.com) was founded in 2004 after founder Celite Milbrandt was inspired to create his own radio service as he searched for less expensive

alternatives to satellite radio.[26] Slacker "provides Internet Radio Stations on the Web, Portable Players, and Mobile Phones,"[27] offering listeners the opportunity to customize their own radio streams; choose from "over 150 expert-programmed music stations"; access "ABC news, comedy, custom artist-hosted stations and leading music festival stations"; and boasts a music library "that is over ten times larger than the leading radio competitor."[28] Slacker positions itself against automated Internet radio services by stressing the human interaction involved in its programming strategy, claiming that Slacker Radio "is much more than a playlist creating computer that chooses songs that are similar to each other" and that "expert DJs hand-pick songs based on their extensive knowledge combined with [the listener's] personal preferences."[29]

There are three Slacker accounts available to users. The Basic Radio account is free to the listener due to regular audio and banner ads and allows listeners to customize streams, view partial song lyrics and skip six songs per hour for each stream. For $3.99 per month, the Slacker Radio Plus account allows users to listen without banner and audio advertisements; skip an unlimited number of songs; "play stations without a wireless connection" via caching on mobile phones; listen to news radio streams and view lyrics. The Slacker Premium Plus account costs $9.99 per month and adds the ability to access music on-demand and create "custom playlists."[30] The unlimited listening policy, large catalogue of music and on-demand functionality of the Premium Plus account sets Slacker apart from its nearest competitor, Pandora, though the on-demand feature requires more extensive licensing on the part of the provider, which the price of the premium account reflects.

CHAPTER 7

TECHNICAL ISSUES

Digital Audio Reproduction

Converting an acoustic audio signal into a digital audio signal involves a process called quantization, during which the continuous changes in frequency and amplitude are sampled, translated into discrete points with associated values, and stored in the form of Pulse Code Modulation (PCM). A PCM stream is essentially the raw audio data and can be imagined as a graph with a variable called bit depth on the y-axis and sample rate on the x-axis; simply put, the quality of a sound's digital representation is based on the detail of these two variables. Digital audio files are created or read using computer software or special devices called codecs, which are designed to encode and decode the material; using codecs, the audio data can be stored as practical audio file formats, such as lossless .WAV or .AIFF files, or compressed into lossy audio file formats such as .MP3 or .AAC files, meaning that some of the original PCM data is strategically discarded. (Practically, the term codec is often used to refer to either the audio file format or the encoder/decoder mechanism.) Audio compression degrades the signal while reducing file size, although the human ear cannot always detect this degradation. During audio compression, file size and audio fidelity are fundamentally opposed to one another and a delicate balance must be struck to minimize unnecessary file size and maximize intelligibility or listener enjoyment.

Streaming Technology

The process described above is common to digital audio production in terrestrial radio stations. When producing content for a streaming operation, however, compression becomes essential and the variable of file size ultimately affects the number of listeners that can be sustained in a unicast audio streaming environment. During a live audio streaming process, audio from a mixing console or other source is converted into a streamed file using an encoding computer and then transmitted in real time using a streaming server while the receiving computer decodes the stream as it is received, playing the sound immediately through the speakers. The receiving computer will usually decode the stream using a media player, which also serves as a user interface for controlling the stream. This scenario does not require the Internet; technically, streaming can occur via internal computer networks or wireless connections, but Internet streaming involves the web and its associated protocols as the intermediary between transmission and reception. In this sense, the web's role in streaming might be compared to the role of the electromagnetic spectrum in broadcasting, with zeroes and ones replacing AM and FM. As sound is streamed over the Internet, then a portion of the available Internet connection bandwidth is required to sustain the audio information being communicated.

The sound quality of an audio stream is limited by its bit rate, which is the amount of data that can be transferred in a given amount of time, measured in kilobits per second (kbit/s). A higher bit rate indicates that more audio information is transferred each second, resulting in a higher quality stream, assuming that the original file is properly prepared. A lower bit rate indicates that less data is transferred each second, and less of the total available bandwidth is required to sustain the stream. During the standard streaming process, the file is not retained on the receiving computer after playback, similar to an AM/FM broadcast. This is different than a

pre-downloaded podcast, or a file received through progressive download, which requires that the file be saved to the listener's computer in its entirety while being heard. This distinction is important because it means that the audio stream cannot be interrupted and if the streaming server's available bandwidth is exceeded by too many subscribers, there may be audible interruptions in the signal. With this in mind, online radio stations may choose to provide lower bit rate streams, at the expense of audio fidelity, in order to sustain more listeners with their available Internet connection bandwidth and server resources.

Commercial Bit Rates

Many streaming companies do not actively publicize information regarding their data rates and instead position themselves against the competition through their other features. If a streaming operation can identify and stream audio at the lowest acceptable bit rate, costs are minimized, and publicizing technical information may encourage the audience to compare stations according to this variable. Instead, many Internet radio sites compare their audio fidelity to that of standard compact discs:

> "All the audio played on Slacker is encoded to play at near-CD quality, even on slow connections. While the music is encoded using different bitrates and codecs based off of connection and platform, you should find the audio on all platforms to play at near-CD audio quality."[1]
>
> "Dig in to major-labels, indie artists and everything in between. Enjoy music at CD-quality and ad-free right on your browser, or else get MOG on your phone, and download as much as you can handle. Select individual songs, explore playlists, or just sit back and listen to radio with no limitations."[2]

The popular Pandora radio site also avoids the topic of data rate for its free and lower cost accounts, but revealed in a 2008 specifications document that audio advertisements were streamed at 128 kbit/s using a sample rate of 44.1 kHz and the MP3 codec.[3] For Pandora's upper-level, "Pandora One" subscription package, the data rate is promoted as a feature, though the codec is unidentified: "When listening on the web, experience 192K bits per second audio. More bits mean better sounding music."[4]

A more reliable strategy for determining industry-standard streaming bit rates is to investigate the services that sell streaming services to broadcasters, such as Live365. Live365 sells broadband-ready, broadcasting packages using the MP3 codec at bit rates of 64 kbit/s, 96 kbit/s and 128 kbit/s, with a recommended bit rate of 128 kbit/s. The company claims that the more expensive broadcasting packages use a proprietary codec called mp3PRO, which streaming at the same bit rates provides a superior sound quality.[5] A music stream may benefit from high bit rates, but a news/talk stream consisting mainly of the human voice would still be intelligible at lower bit rates. For example, most of the audio content from National Public Radio is streamed at 64 kbit/s, though it is common for music, concerts and other performances to be streamed at 128 kbit/s.[6]

While much of modern music is intended to be played using both the left and right channels of an audio system, a technique available to Internet radio stations is to provide monophonic streams of originally stereophonic content, as this halves the bandwidth required to deliver the program to each listener and doubles the number of listeners that the overall bandwidth can sustain. When a stereo music track is streamed at 64 kbit/s, for example, two mono signals are streaming at 32 kbit/s to compose the stereo image. If this were streamed monophonically at 32 kbit/s, the stereo image would be lost as the left and right channels yielded

identical content. This practice is preferable for use with talk programming, as loss of the stereo image is less noticeable than with musical content. Codecs also significantly affect the resulting audio quality of a stream, and well designed codecs may perform better at a lower bit rate than a poorly designed codec streamed at a higher bit rate.

CHAPTER 8

RESEARCH METHODOLOGY

Radio broadcasting has been a strong industry in the United States for much of the last century, though current Internet technology is changing the ways that the country uses media. While terrestrial radio still dominates the airwaves, Internet radio is gaining popularity over AM/FM simulcasts and broadcasters require new methods to succeed online. Efforts from research groups such as Arbitron, Edison Research and Coleman Insights are confirming the changes in audience perceptions and behaviors through large-scale, survey-based audience research, though fully defining the multifaceted emerging model of streaming radio will likely require many years, as has been true of the traditional radio model. Today's broadcasters require clarity regarding the programming strategies and streaming technologies that are likely to succeed online, as well as the ways that the emerging radio model practically differs from the traditional one. Experts from the fields of audio production, radio broadcasting and music education have uniquely experienced the ways that audio streaming is changing the media industry and can serve as resources in analyzing the components of Internet radio. It is hypothesized that a qualitative study involving experts from these fields would inform the technical, operational, legal and business decisions faced by broadcasters seeking effective, long-term approaches to Internet radio; specifically, it is posited that commonalities will exist among the experts' concerns and responses, revealing the advantages of certain radio programs, streaming media players, audio codecs and bit rates which directly affect the audience experience of Internet radio.

Sample

In order to explore and understand the technical, operational, legal and business aspects of streaming audio, a qualitative anonymous survey study was conducted using the expert analysis approach. The group was purposively sampled, consisting of experts with professional experience in at least one of three fields: 1) audio/music production, 2) radio broadcasting and 3) music education/performance. Of the fourteen experts invited, seven were available to participate with two experts representing the audio/music production field, two experts from the music education/performance profession and three experts from the radio broadcasting field. Those invited to participate in the study were of various ages and had demonstrated their expertise through their years of experience and various accomplishments, though it was required that each participant have at minimum ten years of experience in one of the three fields. The seven experts ranged from approximately twelve to forty years of experience in their professions with an average career length of approximately twenty-nine years. Additionally, five of the seven experts had worked between thirty and forty years in their current fields with four of the seven indicating "significant experience" in one of the other professional field categories. Overall, the sample included experts who had worked as broadcast engineers, producers, business owners, performing artists, composers, program directors, choral directors, on-air personalities, recording engineers, professional webcasters and university professors. The participants have earned national awards in their fields, worked with various terrestrial radio stations and professionally represented four Michigan-based educational facilities, including Michigan State University, the University of Michigan, Eastern Michigan University and Lansing Community College.

Method

A password-protected survey site, utilizing Secure Socket Layer encryption and server authentication technology, was created for the experts to anonymously access and record their responses to survey questions and listening tests. The three-part study involved 1) online survey questions, 2) a usability test of one of three popular media players and 3) listening tests comparing popular audio file formats/codecs and bit rates. The experts could access each of the three parts independently and it was not required that all three parts be completed consecutively; however, the participants were asked to complete each survey part during a single, continuous session. The survey questions are available in appendix A, and the three parts of the survey are as follows:

The first portion of the expert analysis focused on identifying operational, business and legal issues that affect online radio. Experts gave short-answer responses to open-ended questions about their own professional experiences involving streaming, as well as indicated through multiple choice questions the types of radio programming that they believed would or would not be successful online.

During the second portion of the study, the experts participated in a usability test of one of three streaming audio players and rated them according to a set of pre-determined heuristics. This part of the study informs operational decisions, as media players are often inseparable from their codecs, requiring webcasters to take both into account. Because the most popular proprietary streaming media players using their own codecs are RealNetworks' RealPlayer, Microsoft's Windows Media, and Apple's QuickTime, the experts chose and analyzed one of these players.

The third part of the expert study considered the technical aspects of audio streaming by comparing the codecs used by the previously-reviewed media players at several bit rates. During the listening tests, each expert was provided with a CD of sound samples and instructed to answer questions while using listening devices appropriate for their fields. Each expert used the same equipment for all of the tests, performed their analysis in one sitting and followed the procedure of the online questionnaire.

Qualitative Survey Data

The three survey parts involved a variety of response types, including ranking, comparison, multiple choice and short answer. Some of the online survey questions involved definitive, quantifiable responses, such as the number of experts with a certain media player installed on their computers. Other questions were more subjective, with responses choices including "Most Familiar" or "Least Familiar." These selections involved subjective criteria which the experts chose based on their own experiences. These data must therefore be cautiously interpreted as statistical analysis was not intended. During this qualitative analysis, the goal was to identify possible trends, inconsistencies or correlations that arose in considering the experts' responses. Because of the size of the sample and nature of the survey, the results cannot be extrapolated to a larger population. Instead, the aim of this research was to allow the perceptions and experiences of these seven experts to inform decisions made by broadcasters and potential webcasters, therefore, the application of this data will depend on their goals.

Media Player Evaluation Method

In addition to ranking and commenting on three media players according their use, familiarity, preference and perceived popularity, the experts conducted a hands-on evaluation of one of three media players. After choosing a media player, the participants were instructed to install or upgrade this player using the most current, available version, ensuring that each player would be evaluated according to the same features. The experts were given several tasks to accomplish and features to explore in "no more than five minutes" including 1) "playing an audio file" using a given URL; 2) "using the media navigation tool"; 3) using "displayed information during playback"; 4) identifying "options available for free versus those available if you pay"; and 5) "using the graphic equalizer." A list of potentially important media player characteristics was developed with which to test each media player and statements were created to coincide with those characteristics. After the five minute orientation to the media player, the experts were asked via the survey to indicate their level of agreement or disagreement with each statement by choosing a response of "strongly disagree," "disagree," "neither agree nor disagree," "agree," or "strongly agree." The characteristics and their associated statements are listed in the table below.

Table 5. Media Player Heuristics and Evaluated Statements

Fast Start Time	"The stream started promptly when I select an audio file"
Playing a File	"I was able to easily figure out how to play an audio file"
Continuity	"The audio stream hesitated a lot during playback"
Player Sizing	"The player occupies too much of my screen"
Player Sizing	"There were enough options for sizing the player"
Playback Controls	"The media controls were responsive"
Playback Controls	"The media controls were frustrating to use"
Aesthetics	"This media player has an attractive interface"
Intuitive	"When the player opened, I immediately knew what to do"
Menus	"The menus and their labels made sense to me"
EQ	"I easily located the graphic equalization tools"
EQ	"The equalization tools were effective"
Paid Options	"The free version of this player is very usable"
Paid Options	"I would pay for more features for this player"
Use	"I would listen to an online radio station using this player"
Use	"I would recommend this player to a friend"

Technical Details

The listening tests were intended to assess audio quality based on expert perception. To this end, samples were not streamed online, but were instead given to the experts on compact discs carefully prepared in an audio studio. While it may seem counterintuitive to analyze audio streaming technology using compact discs, this method allowed a more controlled environment for analysis than a web-based test would have provided. By analyzing stream-ready sound samples outside of the web environment, variables such as network congestion caused by Internet traffic, available Internet connection speed, software compatibility, computer processing power and media player brand bias were eliminated.

Sound samples were prepared for streaming using the encoding tools that RealNetworks, Microsoft and Apple provide to webcasters and then recorded to compact discs conforming to

the Red Book industry standard of CD-quality audio. Creating CD-quality recordings of the compressed sound samples allowed the audio clips to be auditioned consecutively without the need to continuously switch between media players. Because media players typically notify their users which bit rates, codecs and file formats are being accessed, using them for the listening exercises would have compromised the objectivity of the comparisons; “blind” listening tests were only possible when the codecs were separated from their commercial products. Finally, using compact disc recordings ensured that each expert received exactly the same materials for analysis, while many factors could compromise the reception and quality of a live stream.

Codecs are responsible for encoding an audio signal into a data stream, as well as decoding the stream for playback. By compressing audio files with the same codecs used for streaming, each prepared file was played using the appropriate codecs and recorded in real-time as CD-quality tracks. In order to accurately record these tracks, industry standard audio equipment was used in a recording studio scenario; the files were played using media players on a Quad-Core iMac computer through a Digidesign Digi 003 firewire audio interface, which was in turn connected to a Tascam CD-RW2000 disc recorder through digital inputs. This digital signal flow maximized the accuracy of the recording while avoiding the sound coloration that would have occurred from an analog workflow.

Four codecs were considered at three common stereo bit rates, as well as compared with a CD-quality .AIFF audio file: 32 kbit/s, 64kbit/s and128 kbit/s. Three of the codecs used were those utilized by the RealPlayer, Windows Media and QuickTime players and the fourth was the ubiquitous MP3 codec. These audio codecs have demonstrated commercial viability through widespread consumer and business use; other streaming codecs exist, but it is these codecs that are likely to be supported by the industry for several years to come. The chosen bit rates were

informed by the discussion in chapter 7 and these three bit rates were thought to be appropriate for both musical and verbal content.

Each track on the CD given to the experts consisted of four sound samples separated by a spoken identification of the track number and sample designation (A, B, C or D). The experts auditioned each track without knowledge of which codec or bit rate was used and were asked to rank the quality of the audio tracks, as well as indicate which tracks were of comparable quality. Comparisons were made by holding the bit rate constant and varying the codec, as well as by holding the codec constant and varying the bit rate. Each CD contained fourteen tracks, seven of which were musical samples and seven of which were speech samples; the CD tracks, as well as the samples on each track, were randomized. In the cases where the codec remained constant and only three samples were available, the fourth sample was of CD quality (44.1 kHz, 16 bit, .AIFF) to serve as a control and point of reference. For eight of the exercises, the experts compared the quality of each sample to their knowledge of AM, FM and CD quality sound, enabling each codec and bit rate in the experiment to be considered relative to existing and well known audio standards. A list of the codecs and bit rates that were compared in each track are available in Appendix B.

CHAPTER 9

SURVEY ANALYSIS AND RESULTS

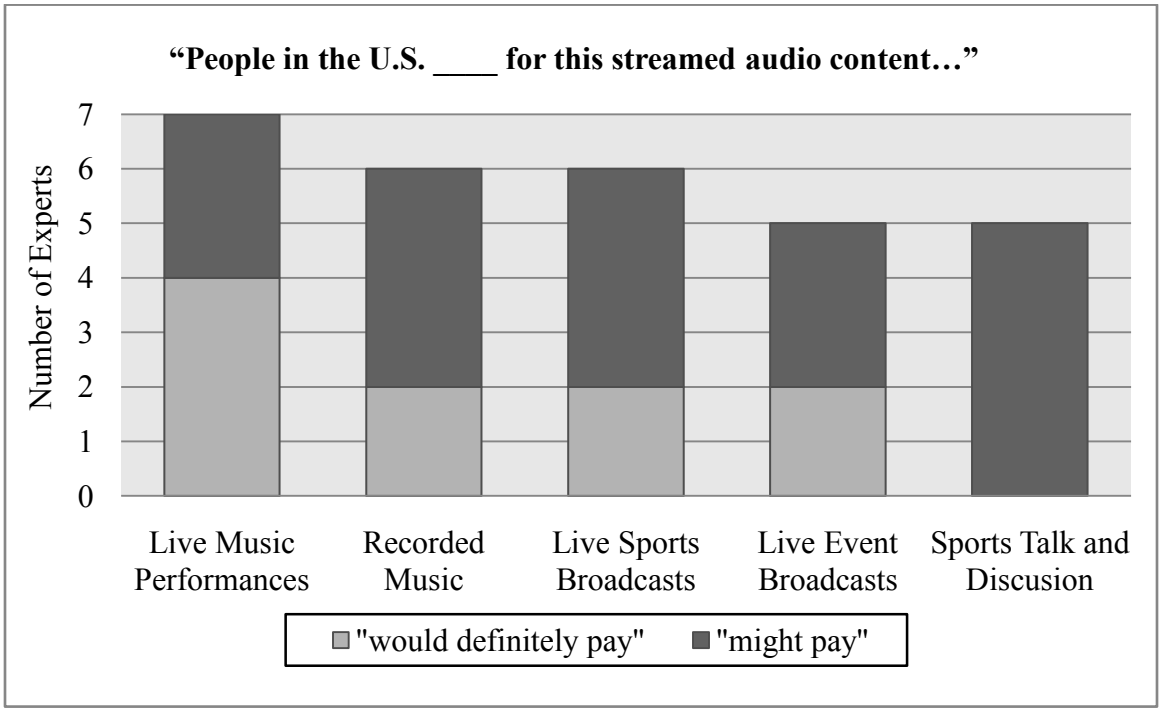
Part A - Questionnaire

The initial exercise in the Part A was intended determine which types of audio programming were likely to be profitable online. For each genre, the experts were asked to choose whether they believed people in the U.S. "would not pay", "might pay" or "would definitely pay" for access to this streamed content, or could also choose to respond that they were "unsure whether or not people in the U.S. would pay" for the given type of content. (The selections and actual questions have been abbreviated for this discussion and the original language of the survey can be found in appendix A.) Following the exercise involving the streamed content categories the experts were given the opportunity to "write a short explanation" of their "reasoning about why people in the U.S. would or would not pay for different genres of streamed audio content," as well as suggest additional categories of streamed radio programs that people in the U.S. "would be willing to pay a reasonable fee to access."

Programs Most Likely to Succeed

The experts indicated that music, sports and live non-musical events were the only types of content for which listeners "would definitely pay." Interestingly, among all of the programming options, experts were most certain that people would pay for access to streamed Live Music Performances, with four experts believing that people "would definitely pay" for this content and three expressing that the public "might pay" for this content.

Figure 1. Programs Most Likely to Succeed



The experts considered the genres of streamed Recorded Music and Live Sports Broadcasts equally likely to sell, with two responses of "would definitely pay", four responses of "might pay" and one expert choosing "unsure." The group was only slightly less certain of the profitability of streamed Live Event Broadcasts, as two experts indicated that people "would definitely pay", three selected "might pay" and the remaining two were "unsure." "…This would take a special event" or a unique shared experience "only available online," explained the experts who predicted the genre's future success; "the more of a one-time performance or event a stream or broadcast might involve, the more people might be willing to pay for it."

Lastly, while no one predicted that the public "would definitely pay" for Sports Talk and Discussion content, the category is worthy of mention as five of the experts believed that people "might pay" for this service. "It has already been proven that people will pay for sports

programming," asserted one expert; another observed that sports programming "always seems high on the list of [genres] that people enjoy."

Programs Least Likely to Succeed

According to the perceptions of the experts, News and Weather/Traffic are least likely to succeed in a fee-based streaming model. National News was considered the least likely content category to be profitable online with four of the experts responding "would not pay" and no one believing that people "would definitely pay" for this service. The International News category created more uncertainty for the experts, but there were still no expressions that the public "would definitely pay" for this content and only one expert thought that web users "might pay" for this type of news. Additionally, no experts expressed that the public "would definitely pay" for weather or traffic information, while three indicated that listeners "would not pay" for this content. Outside of news and Weather/Traffic, no other content category garnered a strong "would not pay" response.

During the follow-up questions, four of the seven experts discussed free online content as a disincentive for consumers to pay for streamed programs. One expert explained that many genres, including news broadcasts, "are already free for listeners and some of them contain video, as well." Referring to news, weather and traffic streams; other experts commented that there are "too many free sources available" and that "it will be difficult to get people to pay for what they perceive [to be] free." Another expert conjectured more generally that "if there were no free genres for people to access", then "they would be willing to pay for this privilege." According to the experts, other potential threats to streaming radio programs included competition from cable television services and advertisement free Internet streams, which lower

the audience's tolerance for commercial interruptions. "If the content is unique and presented without commercial interruption, I believe there are people will [pay for it]," predicted another participant.

Programs with Potential

Based on the perceptions of the experts, Popular Culture-Based Talk and Quiz/Game Shows have potential for profit. Four of experts believed that listeners might pay for access to Popular Culture-Based Talk programs, indicating that webcasters may have an opportunity to develop this type of programming into a viable product. The Quiz and Game Shows category received five selections of "unsure", indicating that there may be potential for development of this genre, as well. Of the less conventional streaming genres, one radio broadcasting expert said, "I am having trouble understanding the appeal of this type of programming, especially in a pay-to-listen model." Game shows and variety programs involving celebrities have existed in various forms throughout broadcast history and there may be an appropriate Internet streaming model for these genres.

Generating Revenue

Through the survey, the experts were asked to explain the ways they could "envision audio streamers generating revenue from their streams." "That, of course, is the BIG question," affirmed one participant. The majority of responses involved streaming models currently in practice with five experts referencing advertising methods such as "in-stream ads, banner ads," and "product placement" in programs. Subscriptions or donations were suggested by three of the experts with one believing that "people are willing to pay for programming that does not include

advertisements." A single expert predicted that a successful model might be "generated by referral," for example, "a listener who likes sports is teased with additional programming or purchases that reflect an interest." Overall, the methods envisaged for generating streaming revenue included the traditional advertising model, with inserted audio commercials; regular subscription fees or donations, with the potential for listeners to avoid advertising exposure; and targeted advertising resulting from a listener's online activities and interests.

Table 6. In what ways can you envision audio streamers generating revenue?

"Product placement and direct advertising. I also believe people are willing to pay for programming that does not include advertisements."
"I believe revenue will primarily come from an advertiser-supported model; also from a donation listener-supported model."
"Traditional free programming with commercial content is probably the first model."
"[It] might be more an Amazon.com approach, where some revenue is generated by referral…A listener who likes sports is teased with additional programming or purchases that reflect an interest."
"Three ways basically: in-stream ads, banner ads on website and subscriptions."

Preparing for the Future

In order to determine the adjustments that will be necessary for radio broadcasters and current webcasters as the emerging streaming model solidifies, the following question was given to the recruited experts; "As audio streaming gains popularity, what changes do you believe will be necessary for current providers of audio content?" There was consensus among the experts that programming excellence will determine the future success of current radio providers, with experts suggesting "unbiased news reporting", "consistency" and "quality performances and interviews" to accomplish this goal. Three of the experts believed that increasing audio quality will be necessary for current radio services to succeed as streaming gains popularity, none which represented the radio broadcasting field. Other necessary changes described involved

overcoming bandwidth limitations, adapting to social media trends, using video content to enhance audio programs, defining universal technical standards and developing a streaming business model without reliance on banner advertisement revenue.

> "Sustainability would be the first goal. There is little doubt that streaming is gaining in popularity, but has not yet reached a critical mass. It is close in some markets, pushed by 4G smart phones, in-car connectivity in many new models and the popularity of the tablet PC. These personal devices make access much easier, very portable, and yes, the listening can be very directed to each personal taste. The income side of streaming must change to be reflective of this personal taste. Services like Pandora saw this early."
>
> "Right now almost 99% of all revenue is from banner ads. This must change as the inventory is being depleted by so many sites now running banner ads from Coca-Cola to American Express. None of the Fortune 500 companies want to miss out on a dime of revenue so that leaves slim pickings for online radio stations with smaller audiences. Thus, stations must embrace in-stream and audio/video gateways."
>
> "I believe there needs to be some technical standards for transmission of audio content. At the present time, there are too many different streaming technical formats (AAC, MP3, Windows Media, flash, etc.)."

What the Audience Wants

The experts were asked to describe what they believed to be "most important to those looking for audio content" on the Internet, with the goal of identifying the non-programmatic features and attributes most desired by the streaming audience. In response to this question, the experts provided several short phrases with explanations. Overall, there was little agreement between the experts on what is most important to online audio listeners. Only the subjects of sound production quality and ease of finding streams were mentioned by more than one expert, with the importance of each of these qualities receiving the corroboration of two total participants. "What I need is more time to look," one expert lamented, "My time is so crunched; I have little opportunity to seek out content and tend to revert to previously used sources."

Table 7. What is most important to those looking for audio content online?

"Choice of… when they listen… what to listen to"
"Portability of media between a user's computers and mobile devices"
"High level of quality both in content and production"
"Finding accurate information quickly about what content is available"
"Free [programming]"
"Little or no in-stream commercials"
"Reliability"
"Variety of content"
"Information that is not interrupted by buffering"
"Quality sound production"
"Little or no talking"
"No DJs"
"Ability to buy what is being streamed conveniently and reasonably"

Current Effects of Streaming

With access to experts from the radio broadcasting, audio/music production and music education/performance professions, it was hoped that understanding could gained regarding the

practical effects that streaming is having on these fields. Through the survey, the participants were asked to describe how their professions were being affected by streaming audio. Those representing the audio and music production field described three affects of streaming on their industry; 1) interest in accessing "musical performances as they happen" has increased, 2) "music recordings have been become more accessible," and 3) the audio quality of this music has "suffered immensely."

The experts representing the music education and performance field described the usefulness of audio streaming as a performance venue and "as a study tool," making it possible "to find speeches and information by notable composers, performers and conductors in the arts." One of the educators predicted streaming live concerts "will become more prevalent" but was critical of current attempts to do so, explaining that the practice is "often not done well."

In terms of streaming's affect on the radio broadcasting industry, one broadcaster revealed that streaming has been a source of revenue October of 2000. Two of the experts described streaming's affect on terrestrial radio as something that it is inevitable, but not yet fully realized. One expert predicted that "radio will be more about packets and IP addresses in the future [and] less about towers and antennas." Another radio professional believes that "streaming will eventually have an impact on radio broadcasting, assuming artist performance fees are stable and mobile bandwidth grows in major markets." Despite the ratings increases of certain streaming operations, many broadcasters are hesitant to incorporate streaming into their strategies:

> "We're already seeing a ratings impact in several major markets, with streaming gaining ratings equaling some of the leading stations. Traditional radio has been marketed to encompass a mass audience. Streaming will begin to divide that mass

audience into many smaller segments. When streaming is as easy as tuning in a radio, the differences of delivery method is of little importance. It will be content. Some broadcasters "get it" and are embracing streaming. But to a lot, it's barely an afterthought and I believe this is a mistake."

Legal Influences

The experts were asked to describe the extent to which copyright and royalty laws are relevant to their professions, the ways that audio streaming has changed the way they consider these laws. The results revealed that all seven of the experts had dealt with copyright and royalty laws to some extent in their fields, but only four of the seven had experience with the legal requirements associated with streaming audio. Of the three experts lacking experience with streaming laws, one represented the audio/music production field and the other two represented the music education/performance field. One educator was convinced of the overall importance of copyright and royalty laws, but admitted to avoiding posting or streaming audio material online because of unclear laws. Another concern expressed by an educator was that "students often post work on the network without the permission of their [instructors]" - an issue particularly troublesome if streaming copyright laws are unclear to these instructors.

> "I have worried a bit about composer's rights in the case of several sites. I have always tried hard to follow copyright laws with respect to photocopying and paying rights for recordings which would be for public sale. I know that composers and authors deserve the royalties they have worked so hard to garner. I would not put anything live online, either in Facebook or an audio format, because of the unclear rules of copyright."

Overall, the experts were in favor of artists being paid for their work, but were critical of the current state of online copyright and royalty laws. Reasons for criticism included cost, complexity, bias and decreased profits for radio stations. An additional concern was that counterproductive litigation based on these laws prevents the industry from progressing alongside listener habits. With respect to Internet radio, one broadcaster was concerned that the new artist royalty laws would prevent profitability: "Streamers face additional fees for any success... [It is] doubtful that revenue can simultaneously grow to meet those fees." Despite these expenses, "It still comes down to finding a working model," countered the response of another broadcaster.

> "Music publishing fees to ASCAP, BMI and SESAC have been a part of the broadcast industry for a long time, based on a model of rewarding those who composed the content [but] not to others who performed the content. The new music licensing fees for artists not only brings another layer of complexity, it can deny profitability to some stations."
>
> "…The RIAA and record companies have been too heavy-handed with lawsuits against listeners who have broken copyright laws. They should be more focused on going with the change in listeners' habits that is inevitable, and developing business models that take advantage of new ways of accessing content. People are always going to want to listen to music, and more so than ever before, they want their music to be freely available at any time from any web connection. At the same time, artists and producers of content should be able to retain copyright of any material they produce and collect any royalties made through the distribution of their work."

> "Online streamers have been treated differently than broadcasters, who traditionally…were provided their product free, in exchange for marketing it. The model was simple, but had flaws and was and still is, subject to abuse. The record industry greatly benefited from the arrangement, and sometimes, the artists did. It can be argued that the radio airplay made the record companies rich and the artists made most of their money in the live performances. New artists have new problems in maintaining copyright on their compositions and getting royalties from their recorded performances."

Internet vs. Terrestrial Radio

The final survey question for Part A involved contrasting the advantages of audio streaming over radio broadcasting, as well as the advantages of radio over streaming. In the short answer responses, the unique advantages of radio described by the experts included 1) the use of a radio announcer; 2) the ability to reach large audiences; 3) popularity among older listeners; 4) the availability of radio receivers; 5) the proven nature of the business model; 6) the availability of programming involving live performances; 7) the accessibility of radio stations "in almost any market"; 8) the ability to promote streams to the terrestrial audience; and 9) the ability to sell commercials both online and on the air. The unique advantages of audio streaming described in the survey included 1) Music-only options in the absence of a radio announcer; 2) the "ability to serve niche audiences with very narrow music and spoken word content"; 3) the ability to attract younger listeners; 4) smart phone compatibility; and 5) attention gained as the new technology becomes more popular.

Table 8. Contrasting Radio and Streaming Advantages

Advantages of Radio Broadcasting	Advantages of Audio Streaming
Radio announcer	Music-only options available
Can reach large audiences	Ability to serve niche audiences
Popular with older listeners	Relevant to younger audience
Availability of radio receivers	Accessed by smartphones
Proven business model	Newer technology attracting attention
More live performances	
Accessibility across the country	
Can promote their streams on-air	
Commercials sold on-air and online	

Table 9. Streaming Disadvantages

Disadvantages of Audio Streaming
Laws are still developing
Internet access required
Bandwidth Limits an Issue
Cost increases with listenership
Lack of technical standards
Finding streams can be difficult

While comparing the advantages of both mediums, the experts specifically described weaknesses for audio streaming but not for radio. These weaknesses included 1) laws that are still developing, 2) the requirement for Internet access, 3) bandwidth limits affecting both webcasters and listeners and 4) operational costs increasing with the size of the audience. Related responses from other questions revealed that streams are also difficult to locate and suffer for a lack of technical standards. Overall, more individual advantages were listed for terrestrial radio and only audio streaming was assigned disadvantages, however, much was said in favor of streaming and its potential to influence the future of radio. One professional from the radio broadcasting field believed that many streamers provided a “superior product” to a “more

appreciative" audience and another referred to streamers as "probably more agile" and "creative." These opinions demonstrate that despite the challenges associated with streaming, the medium is viewed with some admiration despite its potential to compete with terrestrial radio.

Table 10. Selected Comments on Audio Streaming

"[Many streamers] have a superior product that can be targeted to smaller, but more appreciative, audience segments. As a streamer gets more listeners their bandwidth overhead goes up and so do operating costs. Broadcasters don't suffer from this limiting effect."
"Audio streamers are part of a different mindset. They are probably more agile, creative and capture the definition of cool."
"Over-the-air broadcasters are in for intense competition as the public will begin to blur the lines of what they are listening to [in the same way that] cable viewers no longer differentiate between over-the-air TV and cable channels. In Detroit, CBS-TV 62 doesn't even mention their UHF channel number and hasn't for a year."
"Streamers have the ability to serve niche audiences with very narrow music and spoken word content."

Part B – Media Player Evaluation

Media Player Use and Perceptions

The experts were asked to compare three software media players according to their use, familiarity, preference and perceived popularity. The evaluated media players being considered for this evaluation were the RealPlayer, Windows Media and QuickTime players. The experts were asked which media players were installed on a computer that they "used regularly" and all seven experts responded "yes" to the QuickTime player. Four of the experts had Windows Media installed and only two had access to RealPlayer on a regularly used computer. Predictably, when ranking the media players according to their level of "familiarity with the operations and controls", the majority of experts ranked QuickTime as "most familiar" of the three. In terms of overall media player preference, RealPlayer and QuickTime stood out as the least and most preferred media players, respectively. Four of the Experts indicated that RealPlayer was the "least preferable" player, while four selected QuickTime as the "most preferable" player.

Figure 2. Installed Media Players

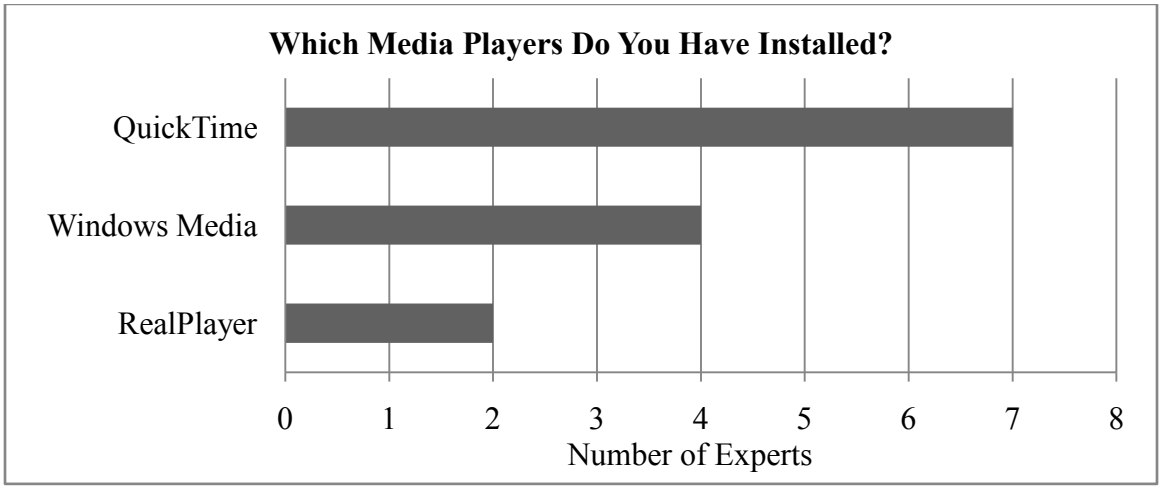


Figure 3. Media Player Preference

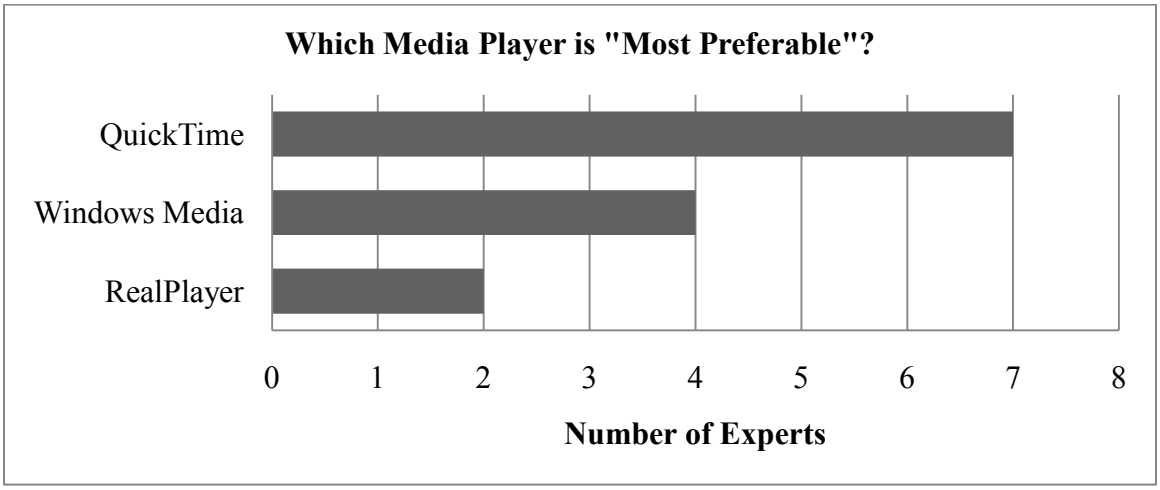
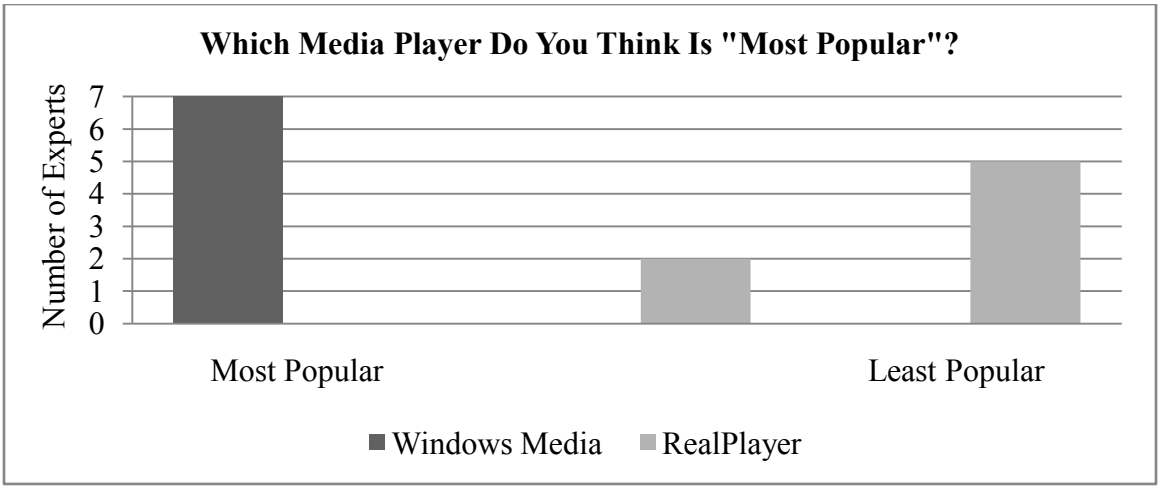


Figure 4. Media Player Perceived Popularity



Regardless of the preferences expressed or which player was most commonly installed, all seven of the experts believed that Windows Media was the "most popular" media player in the United States. This is surprising since 3 experts reported that they "never" used Windows Media or RealPlayer in describing how often they used each player. Although no one used QuickTime "daily", six of the seven experts reported using the player at least "monthly," while three of the experts reporting using the player "several times per week." QuickTime was the only

player that all of the experts used. None of the experts had ever paid to upgrade any of their media players to a "full version" with more features.

Figure 5. RealPlayer Use

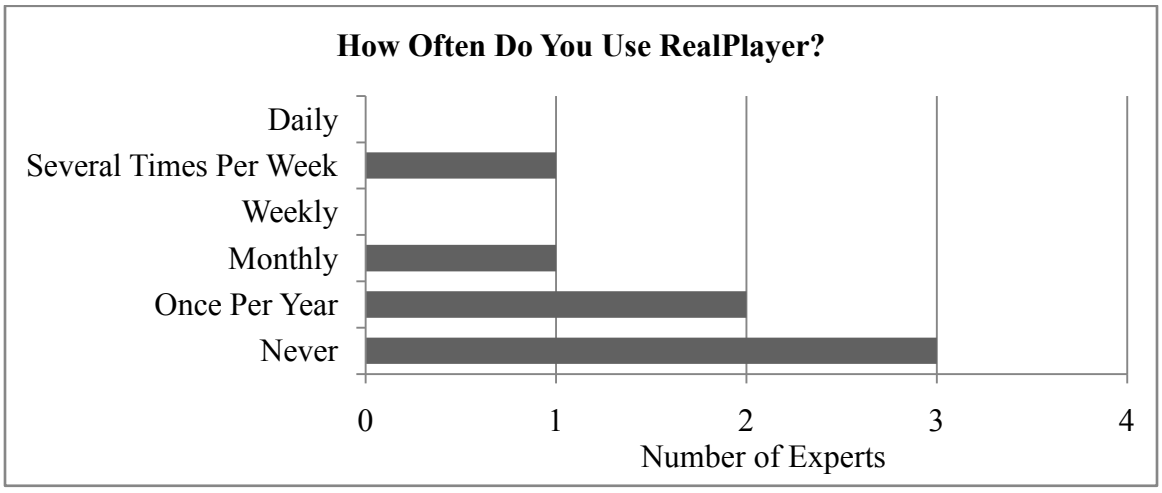


Figure 6. Windows Media Use

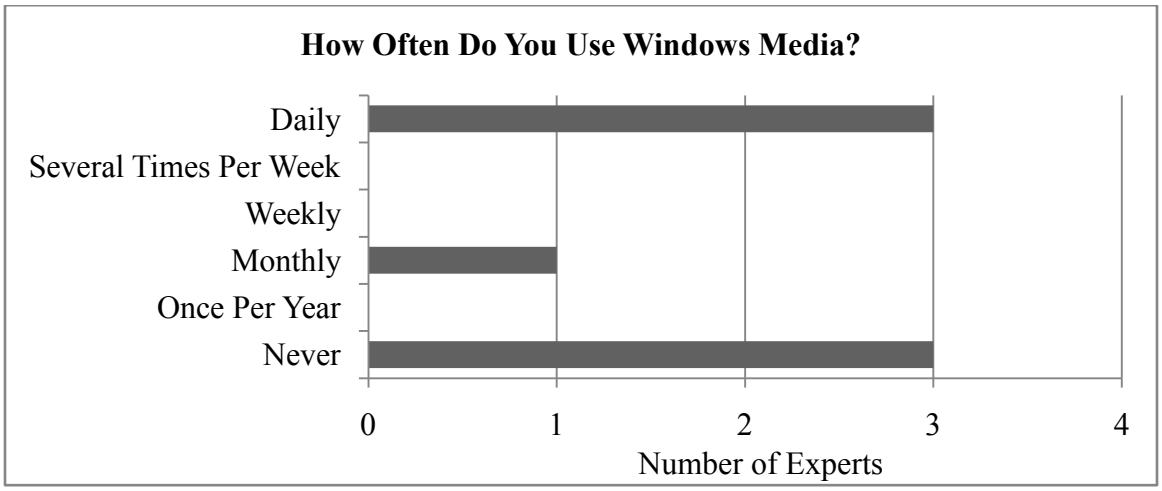
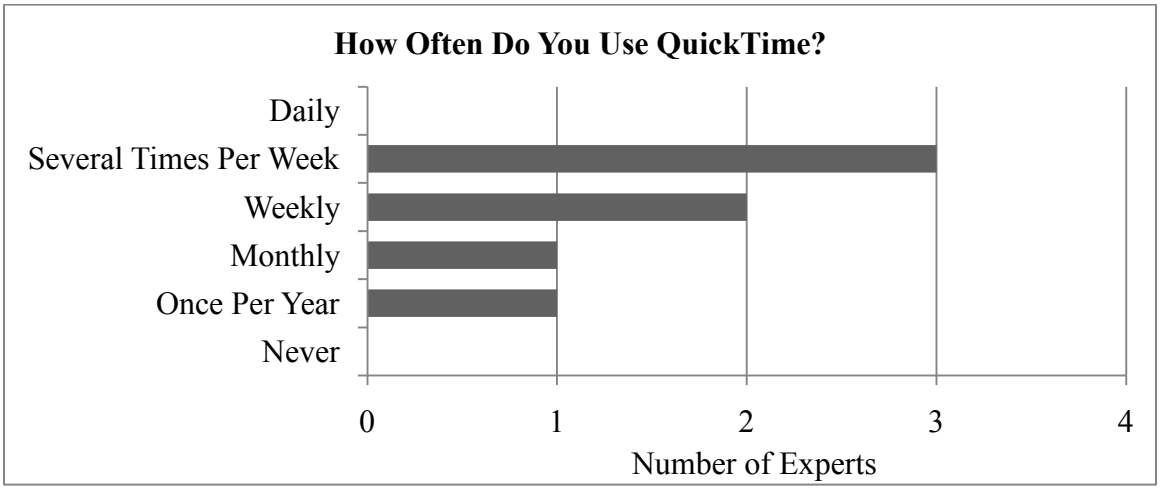


Figure 7. QuickTime Use



Important Attributes of Media Players

In the survey, the experts were asked to describe what was "most important" to them "in a media player for streaming audio." In their short answer responses, four of the experts used the exact phrase "ease of use" and one expert used the phrase "simplicity of use" in describing this attribute. Compatibility with various file formats and sound quality were also a highly valued attributes. The radio broadcasting experts used the following phrases in their lists of the "most important" media player features for them: "the ability to embed in web pages" and "lets us show our banner ads to visitors." The experts were asked to describe, based on their experience, what attributes were "most important to the online audience in selecting a media player." The only attribute shared between the experts was "ease of use", with three experts expressing this opinion. Other attributes they believed were "most important to the online audience" included "widely available," "reliability," "playlists… and skins," "east of installation" and already "installed on a purchased PC/laptop/smartphone/player." Overall, there was more agreement

among the experts in terms of attributes that they personally valued in a media player than in their impressions of what the online audience values.

Figure 8. Important Media Player Attributes

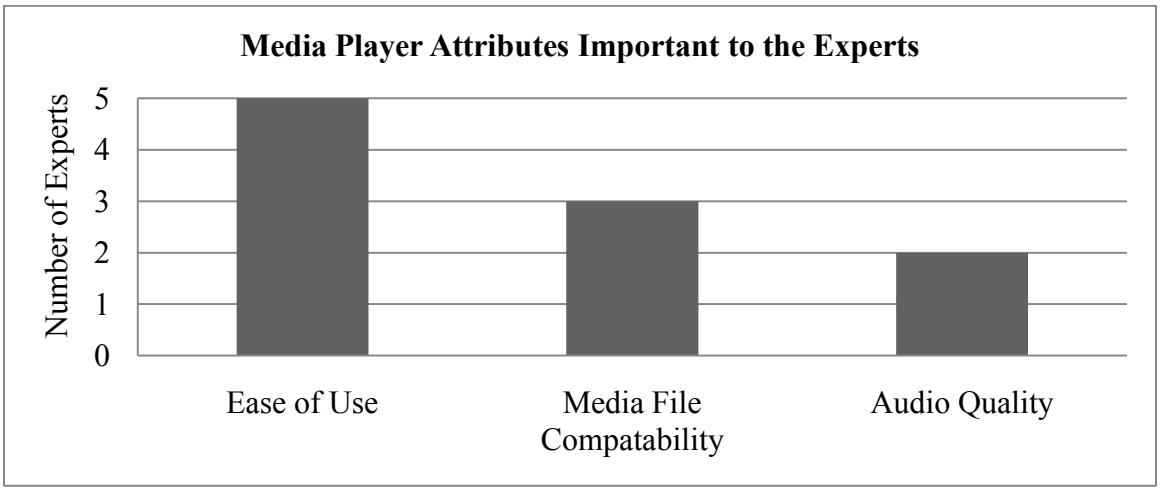


Table 11. Comments on Media Player Attributes

"Ease of use."
"Widely available."
"Installed on a purchased PC/laptop/smartphone/player."
"Playlists… and other features and skins."
"Ease of installation."
"Reliability."

Media Player Comparison

The experts were asked to choose one of the three media players (RealPlayer, Windows Media or QuickTime) for an evaluation via the online survey. Four of the experts chose to evaluate QuickTime and three of the experts chose Windows Media. Interestingly, all three of the radio broadcasting experts chose to review Windows Media. RealPlayer was not chosen for evaluation by any of the seven experts.

Overall, QuickTime and Windows Media performed well in allowing the experts to successfully and intuitively start an audio stream. Specifically, the experts agreed that both of these media players 1) allowed a stream to start promptly; 2) were intuitive when initially loaded; 3) easily played an audio file; 4) streamed without hesitation; 5) were aesthetically acceptable; and 6) suitable for Internet radio listening. The media players received opposing reviews in terms of player sizing, controls and use of the graphic equalizer feature, revealing possible weaknesses with both QuickTime and Windows Media.

Unlike those who reviewed Windows Media, the QuickTime evaluators were more unified in their agreement that the media player offered enough sizing options and occupied an appropriate area of screen space. Generally, the Windows Media evaluators disagreed that the player occupied too much screen space, though their responses were evenly distributed among "strongly disagree," "disagree," and "neither agree nor disagree." This alone cannot be used to conclude a weakness, but the case is strengthened when considered alongside responses to another statement. With respect to sizing options available for Windows Media, two experts agreed that the options were adequate, whereas one disagreed.

Figure 9. Screen Size Comparison

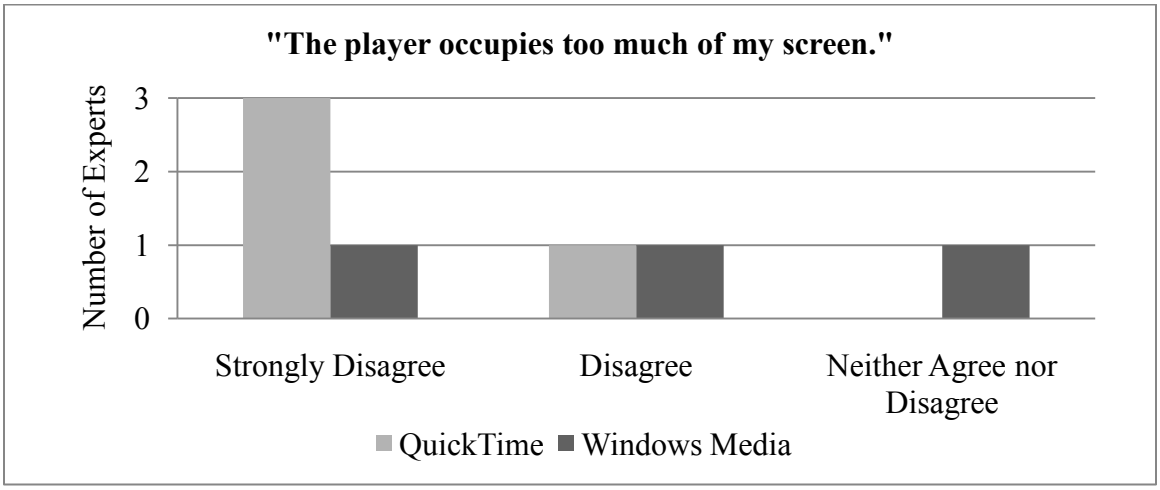
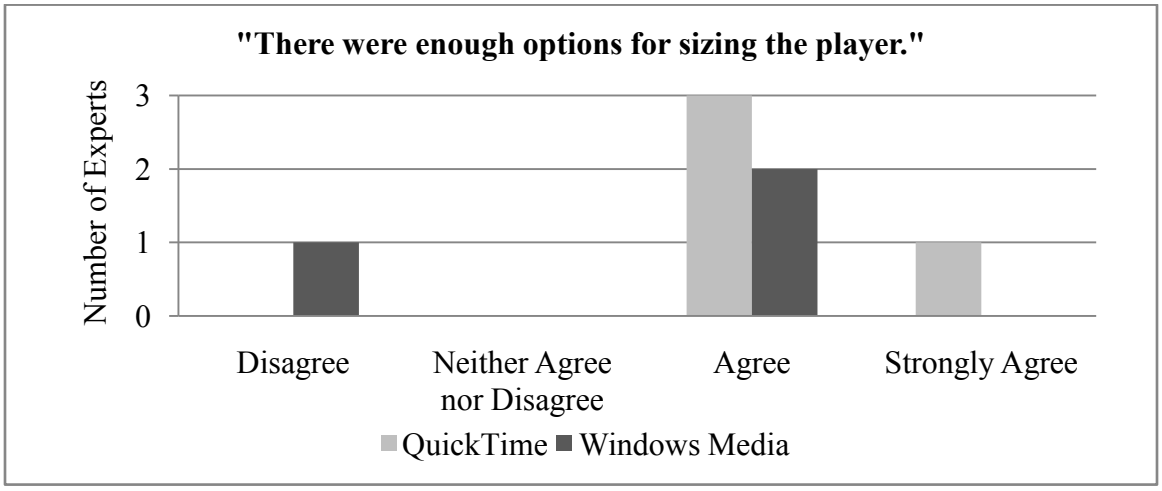


Figure 10. Media Player Sizing Options Comparison



The evaluation revealed that QuickTime's graphic equalizer feature is a weakness of the player. Whereas the evaluators of Windows Media generally agreed that the EQ feature was easy to locate and effective to use, the experts evaluating QuickTime did not reach this agreement. For both statements that assessed this quality, one expert "strongly" disagreed and two experts agreed, with the remaining expert selecting a response in between the two. Two experts agreed, though no one strongly agreed, that the tools were "easily located" and "effective", while at least one expert always strongly disagreed. It is uncertain what criteria the experts used in determining whether or not the EQ tools were effective, as none of the concluding comments revealed this. A possible explanation is that QuickTime's tools are labeled "A/V Control" in recent versions and only include the ability to adjust bass, treble and stereo balance. One expert commented that "there is no graphic EQ with QuickTime," indicating that this user failed to locate these A/V Controls during the evaluation or else was commenting that two bands provided for EQ were inadequate. In either case, the experts were divided about the success of QuickTime's A/V Controls.

Table 12. Weaknesses with QuickTime's Graphic Equalization Feature

	Strongly Disagree	Disagree	Neither Agree / Disagree	Agree	Strongly Agree
"I easily located the graphic equalization tools"	**1**	1	0	**2**	0
"The equalization tools were effective"	**1**	0	1	**2**	0

Media Player Evaluation Summary

While both QuickTime and Windows Media were found to be effective in most respects, the experts identified a possible area of weakness for each media player. The experts were divided regarding Windows Media's screen sizing options and the amount of screen space used by the player. The post-evaluation comments revealed that some experts prefer that players and tools be kept "out of the way" or minimized when not in use and a media player with minimal sizing options and a large interface will conflict with this preference. QuickTime users disagreed about the effectiveness and ease of locating the equalization controls, a critique consistent with earlier findings that "ease of use" was the most valued media player attributes among the experts. The identification of these potential weaknesses creates opportunities for future research regarding the usability of advanced features in media players and the habits of media player users. Evaluating the two potential weaknesses with a large sample could inform future design of streaming technology.

Part C – Sound Quality Evaluation

Two approaches were used in comparing the audio samples; first, the bit rate was held constant while the codec was varied; second, the codec was held constant while the bit rate was varied. The four bit rates used were 32 kbit/s, 64 kbit/s, 128 kbit/s and 1,411.2 kbit/s (using the Audio Interchange File Format and referred to as "CD-quality" throughout this document). The file types used for the evaluation were encoded using the Windows Media Audio (WMA), RealAudio (RA), QuickTime (QT) and MP3 codecs. While it may seem intuitive that the perceived audio quality of a stream would increase with its bit rate, there are two factors that might cause unexpected results. First, codecs handle audio information differently according their programming and discard unneeded information to reduce field size. During this process, it is uncertain how proprietary codecs influence the sound quality at different bit rates and it was an aim of this study to consider these influences. Second, perceived audio quality is subjective and dependent on the listener's ability to detect changes in the sound, resulting in the possibility that streams containing different levels of information could be perceived as equal in quality. This is why experts from fields which demand an acute attention to sonic detail were chosen for participation in this study; if proven experts in the audio, radio and music industry cannot perceive the differences between certain codecs and bit rates, then perhaps others would be unable to do so, as well. Similarly, as various codecs are compared at constant bit rates, the experts can use their trained ears to compare them. Due to the variety of radio programming genres that might be streamed online, the codecs and bit rates were compared using both music and speech samples.

At each bit rate, the stereo audio files were encoded using the highest available settings offered by each encoder. Constant bit rate was always used to ensure consistent audio quality.

The Windows Media Audio files were encoded with Microsoft Expression version 4.0.1651.0. The WMA Professional format was used with Encoding Quality set to Best Quality and Constant Bit Rate set to "2 pass." The RealAudio files were encoded using RealPlayer Converter version 14.0.3.647 and the RealAudio 10 format. This encoder provided the least amount of information during encoding and only revealed the bit rate used. The QuickTime files were encoded by the professional version of QuickTime Player 7.6.6 using the MPEG 4 AAC-LC (Advanced Audio Codec – Low Complexity) format and the Render Settings quality set to Best. For ease of discussion this codec will be referred to QT or QuickTime. With no standard MP3 stream encoder defined, the MP3 samples were encoded with the iTunes MP3 encoder without filtering or Smart Encoding Adjustments. Playback of each encoded file was performed using the QuickTime media player with the exception of RealAudio files, which conflicted with the computer's Core Audio device. For playback of RealAudio files, version 1.1.11 of the VLC media player for Mac was used. WMA playback by QuickTime was accomplished through use of Microsoft's Flip4Mac 2.3.8.1 component. During the process of encoding and playback, the issue of compatibility and hardware conflicts was observed as certain players and codecs failed to be interchangeable. In addition, the various tools available for encoding did not always provide information regarding the encoded sample rate and bit depth.

Table 13. Audio Sample Encoding Specifications

Codec	Bit Rate	Sample Rate	Bit Depth
WMA	32 kbit/s	32.0 kHz	16
WMA	64 kbit/s	44.1 kHz	16
WMA	128 kbit/s	44.1 kHz	16
QT	32 kbit/s	24.0 kHz	Unknown
QT	64 kbit/s	44.1 kHz	Unknown
QT	128 kbit/s	44.1 kHz	Unknown
RA	32 kbit/s	Unknown	Unknown
RA	64 kbit/s	Unknown	Unknown
RA	128 kbit/s	Unknown	Unknown
MP3	32 kbit/s	44.1 kHz	Unknown
MP3	64 kbit/s	44.1 kHz	Unknown
MP3	128 kbit/s	44.1 kHz	Unknown

In designing the listening exercises, it was determined that the experts must be allowed to indicate that two or more samples were of comparable quality. To enable this possibility, the online survey was created such that each expert had four sample titles to distribute among four ranking positions. A sample with a rank of one was considered of higher quality than those ranked two, three or four and a sample rank of two indicated less quality than a first-ranked sample but more than those ranked three or four, and so on. Using this system, the experts could rank the samples according to their perceived quality, and samples sharing a rank indicated that the sound quality was equal. For example, all four samples could be placed under rank one to indicate a four-way tie in quality. Similarly, the same four samples could be placed under rank four to communicate the same relationship. Rank one held no inherent quality difference over rank four; instead, it was the relationship between the rankings, specifically, the ranking of one sample higher than another, that was measured.

In analyzing the results of the each expert's rankings, there were 12 comparisons that could be made for each track of four samples because each sample could be compared with each

of the others. Sample A could be compared to Sample B, C or D; Sample B could be compared A, C or D; Sample C could be compared A, B or D; and Sample D could be compared with A, B or C. (Throughout this analysis, these comparisons have been denoted as A:B, A:C, A:D, B:A, B:C:, B:D, C:A, C:B, C:D, D:A, D:B and D:C.) In tabulating the results, if Sample A was ranked higher than Sample B, then A:B was given a numerical value of one, whereas if Sample A was less than or equal to Sample B in ranking, then A:B was assigned a zero. The resulting scores for A:B, A:C and A:D were averaged and labeled "AVG A." The same process was completed for the other samples ranked by the same expert yielding AVG B, AVG C and AVG D values. These values were determined for all of the experts and averaged, yielding overall "Expert AVG" scores ranging from zero to one for each sample. For reference, an Expert AVG of zero for a sample indicates that all experts ranked the sample lower than all other samples, and an Expert AVG of one would mean that all experts ranked the sample the higher than all other samples. These Expert AVG scores were then translated into an overall "Expert Rank," which represents an approximation of how the group of experts viewed the audio quality of the samples in relation to one another, and these Expert Ranks were normalized such that the highest ranking sample is designated by the first ranking position. The data and resulting calculations with standard deviations (STDV) are included in Appendix C.

The comparison of these codecs and bit rates was useful in identifying the strengths and weaknesses that exist between them, but does not indicate whether or not they are suitable for streaming or broadcast use. It was for this reason that each sample was compared with AM, FM and CD-quality audio according to each expert's knowledge. These data regarding these comparisons are found in Appendix C.

Music and Speech Samples (32 kbit/s)

When all four codecs were compared using music samples at 32 kbit/s, Windows Media Audio performed the best, with five of seven experts ranking it the highest among the four. The Expert AVG score for WMA was 0.86 and the standard deviation for the scoring of these samples ranged from 0 to 0.24. The MP3 codec was ranked last of the four samples by all seven experts, with an Expert AVG score of 0.

Table 14. Music Rankings (32 kbit/s)

Sample	Codec	Bit Rate	Expert Rank
7A	MP3	32	4
7B	QT	32	3
7C	RA	32	2
7D	**WMA**	**32**	**1**

Table 15. Speech Rankings (32 kbit/s)

Sample	Codec	Bit Rate	Expert Rank
10A	MP3	32	3
10B	**WMA**	**32**	**1**
10C	RA	32	2
10D	QT	32	2

When the test was repeated using speech samples, the results were the same, with WMA as the clear leader of the four samples with an Expert AVG of 0.76. QuickTime and RealAudio were essentially tied with Expert AVG scores of 0.38 and 0.76, respectively. Again, MP3 ranked last, with six of the seven experts ranking the codec lower than rest.

Music and Speech Samples (64 kbit/s)

The music sample evaluation for codecs using a bit rate of 64 kbit/s a tie between Windows Media Audio and RealAudio. Three experts ranked RA the highest, whereas only two ranked WMA the highest, and the Expert AVG was similar between these two with RealAudio's rating of 0.71 and Windows Media scoring 0.67. The standard deviation for all four samples was between 0.24 and 0.31. The lowest ranked of the four codecs using music was the MP3 codec, which earned an Expert AVG of 0.14 after five of seven experts ranked it last.

Table 16. Music Rankings (64 kbit/s)

Sample	Codec	Bit Rate	Expert Rank
14A	**RA**	**64**	**1**
14B	MP3	64	3
14C	**WMA**	**64**	**1**
14D	QT	64	2

Table 17. Speech Rankings (64 kbit/s)

Sample	Codec	Bit Rate	Expert Rank
1A	MP3	64	3
1B	QT	64	1
1C	WMA	64	3
1D	RA	64	2

In evaluating the speech samples with a 64 kbit/s bit rate, one expert omitted information from the survey and this data was therefore not included in the analysis. For speech samples, the six experts determined that QuickTime had the highest audio quality with an Expert AVG of 0.61 and the standard deviation for all four samples was between 0.16 and 0.37. RealAudio was also highly ranked over WMA and MP3, as they earned Expert AVG scores of 0.50, 0.17 and 0.11, respectively. MP3 ranked lowest of the four codecs in speech audio quality.

Music and Speech Samples (128 kbit/s)

Comparing the four codecs using music samples playing at 128 kbit/s yielded very close rankings and varied opinions regarding three of the samples. QuickTime and MP3 were both ranked first and shared an Expert AVG of 0.48, with RealAudio scored at 0.38. However, standard deviation among these three average scores was high at 0.37. The current ranking of these three is reasonable when considering that only one expert ranked RealAudio the highest of the four samples, whereas two experts ranked QuickTime and MP3 the highest at this bit rate. Still, the broad range of rankings among these samples indicates that they are of very similar quality. The strongest consensus reached during the music evaluation of 128 kbit/s samples was regarding Windows Media Audio as the weakest codec in terms of audio quality. The Expert AVG for this codec was a low 0.10, as three experts ranked Windows Media Audio last of the four samples, and the standard deviation among the experts for this one codec was 0.15.

Table 18. Music Rankings (128 kbit/s)

Sample	Codec	Bit Rate	Expert Rank
13A	RA	128	2
13B	**QT**	**128**	**1**
13C	**MP3**	**128**	**1**
13D	WMA	128	3

Table 19. Speech Rankings (128 kbit/s)

Sample	Codec	Bit Rate	Expert Rank
8A	RA	128	3
8B	WMA	128	2
8C	MP3	128	4
8D	**QT**	**128**	**1**

The experts determined that QuickTime was the strongest codec of the four for speech content streamed at a bit rate of 128 kbit/s. The QuickTime codec's Expert AVG was 0.86 and the second highest was Window Media Audio, which scored 0.38. RealAudio and MP3 received Expert AVG scores of 0.29 and 0.19, respectively, and only two experts ranked the MP3 codec higher than any other codec. The standard deviation of the four sample rankings ranged from 0.16 to 0.37. QuickTime's high ranking was the most conclusive aspect of this speech sample comparison.

Varying Bit Rate with Windows Media Audio

For music samples, Windows Media Audio performed well at 64 kbits/s and 128 kbit/s, as the experts perceived the codec to be almost as good as the CD-quality sample at these bit rates. The AIFF sample received an Expert AVG score of 0.62, whereas the 128 kbit/s and 64 kbit/s samples both score 0.57. The Expert AVG for the 32 kbit/s sample was .10 with the standard deviation ranging from 0.15 to 0.37 for all four samples.

Table 20. Music Rankings (WMA)

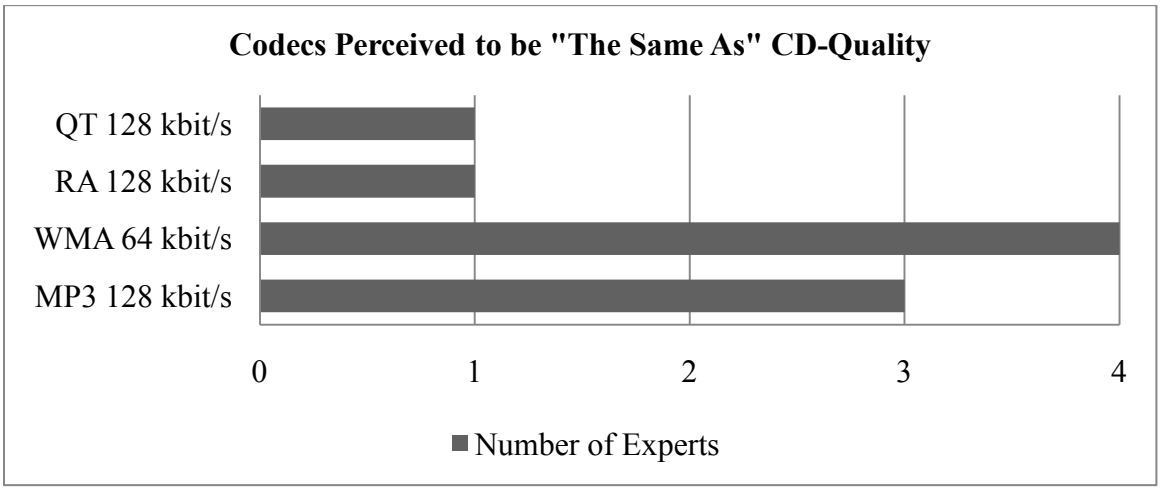
Sample	Codec	Bit Rate	Expert Rank
6A	AIFF	CD	1
6B	WMA	128	1
6C	WMA	32	2
6D	**WMA**	**64**	**1**

Table 21. Speech Rankings (WMA)

Sample	Codec	Bit Rate	Expert Rank
5A	AIFF	CD	1
5B	WMA	128	2
5C	WMA	32	3
5D	**WMA**	**64**	**1**

For speech samples, the experts ranked the 64 kbit/s sample significantly higher than the 128 kbit/s sample and equal to the AIFF sample. The 64 kbit/s and 128 kbit/s samples had Expert AVG scores of 0.62 and 0.33, respectively. What is most surprising is how well the WMA codec performed for both music and speech at 64 kbit/s. While the AIFF and 128 kbit/s samples contained more information and logically should have had higher fidelity, it is possible that the WMA codec's design alters characteristics of the audio differently as the bit rate is varied.

Figure 11. WMA (64 kbit/s) Compared to CD-Quality



Varying Bit Rate with RealAudio

In evaluating music samples encoded with the RealAudio codec, the experts perceived that audio quality increased with higher bit rates. Those surveyed agreed that the CD-quality sample was of the highest sound quality, followed by 128 kbit/s, 64 kbit/s and 32 kbit/s and they

had Expert AVG scores of 0.67, 0.48, 0.29 and 0.24, respectively. The standard deviation was high for this exercise, ranging from 0.30-0.40, which could indicate that all samples were of reasonably high quality. The experts reached less agreement when evaluating the RA speech samples. CD-quality, 128 kbit/s and 64 kbit/s were perceived to be of equal quality for speech with Expert AVG ratings of 0.62, 0.57 and 0.52, respectively. The 32 kbit/s sample had an Expert AVG of 0.10 and the standard deviation among the experts for this sample was 0.15, approximately half that of the other samples. With the 32 kbit/s sample clearly ranked as the lowest quality, it appears that the RealAudio codec decreases sharply in quality at some point below 64 kbit/s. A possible explanation for the three-way tie is that the speech sample may not have contained enough different frequencies for the experts to fully compare these bit rates.

Table 22. Music Rankings (RA)

Sample	Codec	Bit Rate	Expert Rank
11A	RA	32	3
11B	AIFF	CD	1
11C	RA	128	2
11D	RA	64	3

Table 23. Speech Rankings (RA)

Sample	Codec	Bit Rate	Expert Rank
4A	AIFF	CD	1
4B	RA	32	2
4C	**RA**	**64**	**1**
4D	**RA**	**128**	**1**

Varying Bit Rate with QuickTime

For music samples encoded using the QuickTime audio codec, the experts ranked 128 kbit/s and CD-quality nearly the same. The 128 kbit/s sample had an Expert AVG of 0.62 and CD-quality had an Expert AVG of 0.67, with the standard deviation among the four samples ranging from 0.24-0.35. In evaluating speech samples using the QuickTime codec, the experts indicated a consistent decrease in quality as bit rate was lowered. The 128 kbit/s sample again ranked highly and nearly indistinguishable from the CD-quality sample, as the two had Expert AVG scores of 0.57 and 0.62, respectively.

Table 24. Music Rankings (QT)

Sample	Codec	Bit Rate	Expert Rank
2A	QT	32	3
2B	AIFF	CD	1
2C	**QT**	**128**	**1**
2D	QT	64	2

Table 25. Speech Rankings (QT)

Sample	Codec	Bit Rate	Expert Rank
12A	QT	64	2
12B	**QT**	**128**	**1**
12C	AIFF	CD	1
12D	QT	32	3

Varying Bit Rate with MP3

For both music and speech MP3 samples, the experts perceived 128 kbit/s and CD-quality to be essentially equal in quality. As bit rate dropped below 128 kbit/s the experts' rank decreased, and in both cases 32 kbit/s was clearly identified as the lowest quality sample. For music, CD-quality and 128 kbit/s samples received Expert AVG scores of 0.72 and 0.67, respectively. For speech content, the CD-quality and 128 kbit/s were highest ranked and shared an Expert AVG of 0.72. The standard deviation for the 32 kbit/s music sample was zero, where this calculation for the three remaining samples ranged from 0.19 to 0.30. For speech, the standard deviation ranged from 0.12 to 0.23. **(**Both of these MP3 evaluations were performed with six experts instead of the seven due to incomplete survey data which was not included in the calculations.)

Table 26. Music Rankings (MP3)

Sample	Codec	Bit Rate	Expert Rank
3A	MP3	128	1
3B	MP3	64	2
3C	**AIFF**	**CD**	**1**
3D	MP3	32	3

Table 27. Speech Rankings (MP3)

Sample	Codec	Bit Rate	Expert Rank
9A	AIFF	CD	1
9B	MP3	64	2
9C	**MP3**	**128**	**1**
9D	MP3	32	3

Table 28. Codecs Compared with Constant Bit Rate (Music Samples)

	32	64	128	AVG RANK
WMA	1	1	3	1.67
RA	2	1	2	1.67
QT	3	2	1	2.00
MP3	4	3	1	2.67

Table 29. Codecs Compared with Constant Bit Rate (Speech Samples)

	32	64	128	AVG RANK
WMA	1	3	2	2.00
RA	2	2	3	2.33
QT	2	1	1	1.33
MP3	3	3	4	3.33

Table 30. Bit Rates Compared with Codec Held Constant (Music Samples)

	WMA	RA	QT	MP3	AVG RANK
CD	1	1	1	1	1
128	1	2	1	1	1.25
64	1	3	2	2	2
32	2	3	3	3	2.75

Table 31. Bit Rates Compared with Codec Held Constant (Speech Samples)

	WMA	RA	QT	MP3	AVG RANK
CD	1	1	1	1	1
128	2	1	1	1	1.25
64	1	1	2	2	1.5
32	3	2	3	3	2.75

Sound Evaluation Summary

When the experts evaluated the codecs at fixed bit rates, all four codecs had some success, but certain codecs did emerge as more successful than others for music and speech content. For music codec comparisons, WMA and RA were preferred by the experts at bit rates of 32 kbit/s and 64 kbit/s. WMA was ranked first for 32 kbit/s and shared the highest rank with RA at 64 kbit/s. For bit rates of 128 kbit/s, the experts preferred QuickTime and MP3, which shared the highest rank. The speech codec comparisons yielded different results, with QuickTime being the overall preferred codec with the highest rankings of the 128 kbit/s and 64 kbit/s samples. WMA was the highest ranked speech codec at 32 kbit/s and MP3 was ranked the weakest codec of the four for both speech and music.

When the codec was held constant and the bit rate varied, the experts easily identified the CD-quality and confirmed that quality generally decreases directly with bit rate. However, for both the music and speech sample tests, CD-quality was equally ranked with 128 kbit/s for three of the four comparisons. WMA surprisingly ranked equally with the CD-quality AIFF sample for both music and speech. Based on this data, CD-quality appears to be indistinguishable from 128 kbit/s for most codecs. In some cases, 64 kbit/s can replace 128 kbit/s with little noticeable quality degradation.

During the comparison of each sample with AM, FM and CD quality sound, the majority of experts designated 32 kbit/s music samples as “better than” or “the same as” AM-quality audio. The experts overall considered 32 kbit/s speech samples to be equal in quality to AM. For comparisons of 64 kbit/s samples with FM-quality, the majority of the experts ranked both music and speech samples as “better than” or equal in quality to FM audio. The MP3 codec performed

the weakest for both 32 kbit/s and 64 kbit/s, with the experts consistently designating this codec as “worse than” AM or FM-quality audio.

Surprisingly, when comparing samples to their knowledge of CD-quality audio, the experts considered 128 kbit/s to be “worse than” CD-quality for music and primarily chose either “the same as” or “worse than” for speech samples. This final comparison conflicts with the earlier findings that the experts did not differentiate most 128 kbit/s samples from CD-quality, revealing a discrepancy between the perception and recognition of CD-quality. These designations are to be interpreted loosely, since the experts were instructed to compare based on their “experience and recollection of AM, FM and CD quality sound,” however, these comparisons may aid in identifying listener expectations.

CHAPTER 10

CONCLUSIONS AND RECOMMENDATIONS

Radio's future is uncertain as broadband technologies are more popular than ever, advertisers are focusing their efforts online and listeners are increasingly turning to the Internet to find information and music. In response, broadcasters are hoping to build online audiences through the use of simulcasting, a method of Internet streaming with an improbable future which relies on a model of broadcasting designed for terrestrial use. The moment broadcasters begin streaming they step into a new paradigm of radio with different technologies, laws and requirements for operational and business success. Existing research has been helpful in identifying general audience trends and provides broadcasters with an understanding of which technologies and platforms are being utilized, but more focused data are needed to practically inform the design and implementation of effective streaming radio services. Combining the insights gained regarding the technological, operational, legal and business aspects of streaming audio, these conclusions and recommendations are therefore directed toward the owners and managers of terrestrial radio stations, who through innovation and effective use of their resources have the potential to redefine the next century of radio.

The traditional radio business model is fundamentally different than that of the emerging streaming radio model. As listenership increases for terrestrial radio, costs remain the same and revenue increases, but as listenership increases for Internet radio, costs increase and proven revenue sources are unavailable. The most significant streaming costs are legal and technical in nature, with laws requiring webcasters to pay fees for streaming copyrighted sound recordings

and equipment costs that increase directly with the size of the audience. Broadcasters face the following new costs of streaming radio:

- Royalties paid to featured artists and master rights holders
- Union fees for online use of recorded talent
- Internet bandwidth
- Server resources

Generating revenue to cover the new costs of streaming is the largest concern for streamers and the familiarity of the advertising model seems to have influenced much of the Internet marketplace. However, in-stream and banner advertisements, while popular, are not lucrative enough to sustain the costs associated with the high audience numbers possible through terrestrial means. Broadcasters may temporarily rely on terrestrial revenue to fund streams, but Internet-only radio services have proven that ads alone are insufficient. Therefore, for long-term success, streaming broadcasters must either adjust their expectations of streaming reach or challenge this convention. Some services have mitigated costs by selling subscriptions featuring higher audio quality, increased interactivity, on-demand content or commercial-free streams. On-demand services are growing in popularity and while this service currently introduces additional licensing requirements, this method may prove to be effective.

Ultimately, attracting listeners to a radio stream and therefore increasing revenue is dependent on the relevance, technical quality, uniqueness and exclusivity of the programming. While this may also be true for terrestrial radio, it is critical for online success where markets converge. The increased competition and drive to be distinct that occurs in large terrestrial markets is magnified on the Internet, where a threat faced by all streamers is obscurity, and

broadcasting as an approach may lose its effectiveness. With streaming, similar formats compete and streams succeed based on the quality of their programs.

It has been determined that the simulcasting of terrestrial signals can provide additional listeners, but independent from external operations will prove to be ineffective because

- early simulcasts of AM/FM were unsuccessful in fully establishing the FM audience;
- simulcasts ignore the inherent advantages of the new medium, such as interactivity;
- simulcasting assumes the online success of the traditional advertising model;
- simulcasting is financially dependent on the terrestrial model; and
- research indicates that listeners prefer Internet-only streams over simulcasts.

A possible revenue means is to charge listeners a fee to access certain programs. Based on the expert analysis, the following conclusions have been reached regarding this method:

- Unique, one-time, live events limited to streaming (including musical performances, sports and other non-musical events) have the most profit potential.
- Programs with the least profit potential are news, weather and traffic programs, as listeners are unlikely to pay to access content that is freely available.
- Programs with potential include sports and popular culture-based talk, as well as quiz or game shows.

Choosing a streaming codec often limits listeners to the use of certain media players. It is recommended that a station choose one of the commercially supported codec/player options to maximize compatibility, as a weakness of Internet streaming is the lack of universal standards. The QuickTime, RealPlayer and Windows Media players are all suitable for streaming an audio

signal. Interestingly, while the experts in this study revealed that Windows Media is perceived to be the most popular player, QuickTime is most preferred and used, with RealPlayer generating little interest. This study also found simplicity of use to be the most valued attribute in a media player.

Audio quality and bit rate often have a direct relationship, but it was discovered that perceived audio quality can be the same for different bit rates. For the streaming station, this means that lower bit rates can be used for certain codecs to reduce cost while the listening experience will not suffer. Internet radio does have the capability to exceed CD-quality, but the expenses involved may outweigh the benefits. The sound quality evaluation yielded the follow results:

- The WMA, AAC-LC, RA and MP3 codecs are all suitable streaming audio.
- 32 kbit/s is perceived to be comparable with AM-Quality.
- 64 kbit/s is perceived to be comparable with FM-Quality.
- 128 kbit/s and CD-Quality are often nearly indistinguishable.
- In some cases, 64 kbit/s is adequate over 128 kbit/s (particularly for speech).
- Overall, MP3 was the weakest codec.
- 64 kbit/s WMA surprisingly outperforms higher bit rates.

It was beyond the scope of this study to survey a large population, as the perceptions of experts from specific fields were desired. However, the broadcasting community could benefit from similar research involving a larger sample and representing a broader age range. By gaining insights from industry experts, it was guaranteed that they would represent an older demographic. This study also did not explore the differences between the unicast and multicast streaming topologies as unicast is currently the standard for streaming radio services and

simulcasting. Multicast streaming requires the use of multicast-enabled online routers, which are far from ubiquitous at this time, and this approach functions best in controlled environments. This subject would also be relevant for future research; multicast is a more efficient streaming architecture for large audiences and it is assumed that this method will eventually become the standard with its lighter consumption of network bandwidth. Additionally, this study discovered through expert perceptions that some codecs and bit rates perform counter intuitively to their specifications. A strictly quantitative exploration of this phenomenon may reveal additional data useful in codec design.

Internet streaming changes the media landscape and interrupts the routine of many broadcast operations, as well as those of countless other industries. However, the Internet should not be viewed as radio's competition, but merely as a tool for disseminating information and content to large audiences - a goal of the radio industry since its inception. Radio's task is not merely to survive the digital transition through simulcasting, as a defensive position will guarantee that no new ground is gained. Inventing the medium's technologies, laws, processes and strategies was the concern of the previous century's innovators, while using this existing framework to create a new model is the responsibility for those in the present. With no one medium or method cornering the market or an online code to define the public's interests, radio broadcasters are challenged to understand and serve both their on-air and online audiences in ways that perhaps have never been required, as the listening public tunes in briefly to decide if they are still interested.

APPENDICES

APPENDIX A: ONLINE SURVEY CONTENT

Informed Consent Form

1. EXPLANATION OF THE RESEARCH and WHAT YOU WILL DO:

SUMMARY:
- Because you have been identified as an expert in a related field, you are being asked to participate in research that explores the emerging issues related to radio broadcast and web-based audio streaming.
- You are being asked to complete all three parts of the study within one week of receipt of your compact disc and survey access information. You do not need to complete all three parts of the study in one sitting, although you may if you wish.

REQUIREMENTS:
- You must be at least 18 years old to participate in this research.
- To participate in all aspects of this research, you must not have any medical issues related to hearing loss or that would prevent you from critical listening exercises.
- In order to participate, you will need a computer with an internet connection for the duration of the study, an installed media player program, a compact disc player, and a listening environment that is appropriate for your profession. The duration of the use of your equipment will be approximately one hour and twenty minutes. (Not all participants in this study require complex listening environments in their workplaces. You will be asked to choose a listening location that is appropriate for the type of the work that you do.)
- Participation will require your time, energy and critical evaluation skills.
- You will not directly benefit from participation in this study, but you will have the opportunity to participate in research that could benefit your industry through a deeper understanding of cutting-edge technologies.

PROCEDURE:
- There will be three parts to this study and participation will require an estimated 80 minutes, but possibly more or less depending on your answers and the number of times you choose to repeat the compact disc tracks. There is no time limit and you may take as long as you like to answer the questions to your satisfaction.
- You will be asked to complete several multiple choice and short-answer questions regarding your professional experiences in a related field.
- You will be asked to explore and review a media player program that is installed on your computer. If none of the three common media players being studied are installed on your computer, you will be asked to install one.
- You will be asked to conduct a series of listening tests involving tracks on a compact disc which has been mailed to an address of your choosing.
- Your survey responses will be completely anonymous, meaning that you will not personally be connected to the responses you submit. The researchers of this study will not know which participants submitted which responses, and while your anonymous answers may be quoted and

analyzed for the research report, your identity will never be connected to your answers. Your identity as a participant will never be reported.
- You will not be asked to enter your name or other identifiable information. The survey system will not collect your IP address during participation.

Please click "Next" to continue the description of the research. You will be given the opportunity to express your consent on the next page.

YOUR RIGHTS TO PARTICIPATE, SAY NO, OR WITHDRAW:
- Participation in this research project is completely voluntary.
- You have the right to say no, change your mind at any time and withdraw from the study.
- You may choose not to answer specific questions or to stop participating at any time.
- Whether you choose to participate or not will have no affect on any professional, academic or personal relationship that may exist between you
and the researchers or the source of referral.
3. If you have concerns or questions about this study, such as scientific issues or how to do any part of it, please contact the research supervisor.

DOCUMENTATION OF INFORMED CONSENT:
By clicking on the "Next" button below, you indicate your voluntary agreement to participate in this online study and will proceed to Part A.

Part A – Questionnaire

This first portion of the study asks several short-answer and multiple choice questions relating to your professional experiences and your opinions about audio streaming and content. Please be as detailed as possible in your responses. Your responses in all aspects of this study are anonymous and there are no right or wrong answers to the questions. (Estimated Time Required: 20 minutes)

1. Which of the following three categories best describes your professional field and experience?
A) Audio/Music Production
B) Radio/Broadcasting Industry
C) Music Education/Performance

2. How many years have you worked in this field?
If applicable, please choose a secondary professional field to describe your experience. (This field is not your primary profession, but is instead a field in which you also have significant experience.)
A) Audio/Music Production
B) Radio/Broadcasting Industry
C) Music Education/Performance

3. If applicable, please choose a secondary professional field in which you also have significant experience.
A) Audio/Music Production
B) Radio/Broadcasting Industry
C) Music Education/Performance
D) Not Applicable

4. Below are several genres of audio content that could be streamed online. For each genre, please assign the one of the following statements that you believe is most true of the content category.
A) People in the U.S. would not pay for this streamed audio content.
B) I am unsure whether or not people in the U.S. would pay for this content.
C) People in the U.S. might pay for this streamed audio content.
D) People in the U.S. would definitely pay for this streamed audio content.

Genres of audio content:	*Your Selection:*
National News	___
International News	___
Live Sports Broadcasts	___
Sports Talk and Discussion	___
Recorded Music	___
Live Music Performances	___
Live Event Broadcasts (non-music)	___
Weather / Traffic	___
Fiction Programming	___
Interview / Topical Non-Fiction	___
Popular Culture-Based Talk	___
Talent / Variety Shows	___
Quiz and Game Shows	___

5. Please write a short explanation of your reasoning about why people in the U.S. would or would not pay for different genres of streamed audio content.

6. What other genres of audio content (if any) can you think of that people in this country would be willing to pay a reasonable fee to access?

7. In what ways can you envision audio streamers generating revenue from their streams?

8. As audio streaming gains popularity, what changes do you believe will be necessary for current providers of audio content?

9. What do you believe is most important to those looking for audio content online?

10. How does streaming audio affect your profession?

11. To what extent do copyright and royalty laws affect your profession?

12. How has online audio streaming changed the way that you consider copyright and royalty laws in your profession?

13. Based on your experience, what legal opportunities and threats exist for audio streamers today?

14. Based on your experience, are there any advantages that radio broadcasters have over audio streamers, and vice versa?

Part B – Media Player Evaluation Content

In this next exercise, you will need one of the three media players installed on your computer for review (RealNetworks' RealPlayer, Microsoft's Windows Media and Apple's QuickTime). If you are using a currently installed media player, please make sure it is upgraded to the latest version. If none of the three players being considered are installed on your computer, please visit the media player's web page (linked below) to download one. Any relatively new computer with Internet access and a browser is appropriate for this exercise. Please be as detailed as possible in your responses and refrain from sharing any details that would identify you personally. Your responses in all aspects of this study are anonymous. (Estimated Time Required: 20 minutes)

1. Which of the following three categories best describes your professional field and experience?
A) Audio/Music Production
B) Radio/Broadcasting Industry
C) Music Education/Performance

2. How many years have you worked in this field?

3. If applicable, please choose a secondary professional field to describe your experience. (This field is not your primary profession, but is instead a field in which you also have significant experience.)
A) Audio/Music Production
B) Radio/Broadcasting Industry
C) Music Education/Performance

4. If applicable, please choose a secondary professional field in which you also have significant experience.
A) Audio/Music Production
B) Radio/Broadcasting Industry
C) Music Education/Performance
D) Not Applicable

5. Before this study, which of the following media players did you have installed on a computer that you use regularly?
RealPlayer ___, Windows Media ___ and QuickTime ___.

6. Please rank your familiarity with the operation and controls of the following media players (1 to 3, 1 being "Most Familiar" and 3 being "Least Familiar"):
RealPlayer ___, Windows Media ___ and QuickTime ___.

7. Please rank these 3 media players in the order you currently prefer them
(1 to 3, 1 being "Most Preferable" and 3 being "Least Preferable"):
RealPlayer ___, Windows Media ___ and QuickTime ___.

8. Please rank the following media players according to how popular you think they are in this country (1 to 3, 1 being "Most Popular" and 3 being "Least Popular"):
RealPlayer ___, Windows Media ___ and QuickTime ___.

9. Some media players provide additional features (i.e., "Full Version") for a cost. Please indicate which of the following media players you have ever paid to upgrade (Yes / No):
RealPlayer ___ Windows Media ___ QuickTime ___

10. For the players you have paid to upgrade, please describe what features compelled you to make the purchase. (If you have never paid to upgrade a media player, please skip this question.)

11. For each of the 3 players, please select the phrase or word that best describes how often you use a certain media player.
(Never, Once Per Year, Monthly, Weekly, Several Times Per Week, Daily)
RealPlayer ___ Windows Media ___ QuickTime ___

12. What is most important to you in a media player for streaming audio?

13. In your experience, what is most important to the online audience in selecting a media player?

14. Which of the three media players have you chosen to review?

15. What version of the player are you using?

16. Are you using an upgraded, paid version of the software? (YES/NO)

17. Was it necessary to install the player before proceeding with this study? (YES/NO)

18. If installation was required, please briefly describe the installation experience in terms of ease of installation, time required, visual components, etc.

Please take no more than five minutes to familiarize yourself with these features of the chosen media player:
- Playing an audio file (URL provided)
- Options for displaying and resizing the player
- Using the media navigation tools (volume, play, pause, etc.)
- Displayed information during playback
- Options available for free versus those available if you pay
- Using the graphic equalizer

When you are finished, please continue to the next page.

18. Please indicate the degree to which you agree or disagree with the statements in the column to the left: (Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

"When the player opened, I immediately knew what to do"
"It was easy to figure out how to play an audio file"
"The stream started promptly when I selected an audio file"
"The audio stream hesitated a lot during playback"
"The player occupies too much of my screen"
"There were enough options for sizing the player"
"The media controls were responsive"
"The media controls were frustrating to use"
"This media player has an attractive interface"
"The menus and their labels made sense to me"
"I easily located the graphic equalization tools"
"The equalization tools were effective"
"The free version of this player is very usable"
"I would pay for more features for this player"
"I would listen to an online radio station using this player"
"I would recommend this player to a friend"

19. Please write a short paragraph to describe your experience with using the media player.

Part C – Sound Quality Evaluation Content

(Due to the repetitive nature of this evaluation, this portion of the survey has been condensed, with track numbers replaced by the variable "X".)

As track X plays, you will rank the four samples from highest to lowest sound quality. You may listen to a track as many times as necessary to answer the questions.

1) After listening to all of the samples in this track, please rank the four samples from 1 to 4, where 1 indicates the highest quality and 4 indicates the lowest quality of the four samples. You may use the same ranking more than once to indicate that two or more samples are of comparable quality. (For example, if all four samples are comparable, you might rank all four samples as "1". If samples B and C were of the same audio quality but of less quality than both A and D, you would rank them both as "3".)

Track X / Sample A ___
Track X / Sample B ___
Track X / Sample C ___
Track X / Sample D ___

(The following comparison's only existed for tracks 2, 3, 4, 5, 6, 9, 11 and 12. In the online survey, these questions appeared as a grid and gave the participants the opportunity to compare each sample with AM, FM and CD Quality audio.)

2) Complete each statement below by choosing the response that best completes the sentence: "better than", "the same as", or "worse than." The 3 terms along the left side of each table (AM, FM and CD Quality) create three different statements to complete. Please base these comparisons on your experience and recollection of AM, FM and CD quality sound.
"Track X / Sample A sounds _____ ... (AM, FM, and CD Quality)"
"Track X / Sample B sounds _____ ... (AM, FM, and CD Quality)"
"Track X / Sample C sounds _____ ... (AM, FM, and CD Quality)"
"Track X / Sample D sounds _____ ... (AM, FM, and CD Quality)"

APPENDIX B: LISTENING EXERCISES EXPERIMENT KEY

Table 32. CD Track and Sample Key 1

TRACK	SAMPLE	CODEC	KBPS	TYPE
6	C	WMA	32	M
	D	WMA	64	M
	B	WMA	128	M
	A	AIFF	CD	M
3	D	MP3	32	M
	B	MP3	64	M
	A	MP3	128	M
	C	AIFF	CD	M
11	A	RA	32	M
	D	RA	64	M
	C	RA	128	M
	B	AIFF	CD	M
2	A	QT	32	M
	D	QT	64	M
	C	QT	128	M
	B	AIFF	CD	M
7	D	WMA	32	M
	A	MP3	32	M
	C	RA	32	M
	B	QT	32	M
14	C	WMA	64	M
	B	MP3	64	M
	A	RA	64	M
	D	QT	64	M
13	D	WMA	128	M
	C	MP3	128	M
	A	RA	128	M
	B	QT	128	M

Table 33. CD Track and Sample Key 2

TRACK	SAMPLE	CODEC	KBPS	TYPE
5	C	WMA	32	S
	D	WMA	64	S
	B	WMA	128	S
	A	AIFF	CD	S
9	D	MP3	32	S
	B	MP3	64	S
	C	MP3	128	S
	A	AIFF	CD	S
4	B	RA	32	S
	C	RA	64	S
	D	RA	128	S
	A	AIFF	CD	S
12	D	QT	32	S
	A	QT	64	S
	B	QT	128	S
	C	AIFF	CD	S
10	B	WMA	32	S
	A	MP3	32	S
	C	RA	32	S
	D	QT	32	S
1	C	WMA	64	S
	A	MP3	64	S
	D	RA	64	S
	B	QT	64	S
8	B	WMA	128	S
	C	MP3	128	S
	A	RA	128	S
	D	QT	128	S

APPENDIX C: SURVEY DATA

Table 34. Would people in the U.S. pay for these audio streams?

	"would not pay"	"unsure"	"might pay"	"would definitely pay"
National News	4	0	3	0
International News	3	3	1	0
Live Sports Broadcasts	0	1	4	2
Sports Talk and Discussion	0	2	5	0
Recorded Music	0	1	4	2
Live Music Performances	0	0	3	4
Live Event Broadcasts	0	2	3	2
Weather / Traffic	3	2	2	0
Fiction Programming	1	3	2	0
Interview / Topical Non-Fiction	1	3	3	0
Popular Culture-Based Talk	1	2	4	0
Talent / Variety Shows	1	3	3	0
Quiz and Game Shows	1	5	1	0

Table 35. QuickTime Post-Evaluation Comments

"The QuickTime player always works the best out of the three media players for me. It plays almost all content, it doesn't freeze, it is very responsive - the interface is simple but gives enough controls to make it useable. There is no graphic EQ with QuickTime but I wouldn't use it anyway."
"Easy to use, takes up little space on the desktop. I like that the A/V controls are in a separate window - accessible if I want them, but completely out of the way otherwise."
"QuickTime was easy to use and intuitive."

Table 36. Windows Media Post-Evaluation Comments

"The media player was simple to use. The sound is adequate but I would have preferred hearing it on my component system."
"I've used it many times before this exercise. My only complaint about Windows Media Player is finding controls again after changing skins."
"Effective enough for my daily use. EQ works OK, really not interested in skins, colors, etc… I find the 'bars' display useful."
"I have been using Windows Media Player for over 10 years. I just open it up, make sure the stream plays and then minimize it."

Table 37. Windows Media Evaluation Results (Three Evaluators)

	Strongly Disagree	Disagree	Neither Agree / Disagree	Agree	Strongly Agree
"When the player opened, I immediately knew what to do"	0	0	0	2	1
"It was easy to figure out how to play an audio file"	0	0	0	1	2
"The stream started promptly when I selected an audio file"	0	0	0	1	2
"The audio stream hesitated a lot during playback"	2	1	0	0	0
"The player occupies too much of my screen"	1	1	1	0	0
"There were enough options for sizing the player"	0	1	0	2	0
"The media controls were responsive"	0	0	0	2	1
"The media controls were frustrating to use"	0	3	0	0	0
"This media player has an attractive interface"	0	0	1	2	0
"The menus and their labels made sense to me"	0	0	0	2	1
"I easily located the graphic equalization tools"	0	0	1	0	2
"The equalization tools were effective"	0	0	0	1	2
"The free version of this player is very usable"	0	0	0	1	2
"I would pay for more features for this player"	1	1	0	1	0
"I would listen to an online radio station using this player"	0	0	0	2	1
"I would recommend this player to a friend"	0	0	0	2	1

Table 38. QuickTime Evaluation Results (Four Evaluators)

	Strongly Disagree	Disagree	Neither Agree / Disagree	Agree	Strongly Agree
"When the player opened, I immediately knew what to do"	0	0	0	2	2
"It was easy to figure out how to play an audio file"	0	0	0	2	2
"The stream started promptly when I selected an audio file"	0	0	0	2	2
"The audio stream hesitated a lot during playback"	4	0	0	0	0
"The player occupies too much of my screen"	3	1	0	0	0
"There were enough options for sizing the player"	0	0	0	3	1
"The media controls were responsive"	0	0	0	3	1
"The media controls were frustrating to use"	2	1	1	0	0
"This media player has an attractive interface"	0	0	1	2	1
"The menus and their labels made sense to me"	0	0	1	2	1
"I easily located the graphic equalization tools"	1	1	0	2	0
"The equalization tools were effective"	1	0	1	2	0
"The free version of this player is very usable"	0	0	0	3	1
"I would pay for more features for this player"	0	4	0	0	0
"I would listen to an online radio station using this player"	0	0	1	2	1
"I would recommend this player to a friend"	0	0	1	2	1

Table 39. Sound Quality Expert Comparisons (Tracks 1-6)

Track 1								Track 2								Track 3							
	1	2	3	4	5	6	7		1	2	3	4	5	6	7		1	2	3	4	5	6	7
A:B	0	0	0	0		0	0	A:B	0	0	0	0	1	0	0	A:B	0	1	1		0	1	1
A:C	0	1	0	0		1	0	A:C	0	0	0	0	1	0	0	A:C	1	0	0		0	1	0
A:D	0	0	0	0		0	0	A:D	0	0	0	1	0	0	0	A:D	1	1	1		1	1	1
B:A	1	1	0	1		1	1	B:A	1	1	1	1	0	1	1	B:A	0	0	0		0	0	0
B:C	1	1	0	0		1	1	B:C	0	1	0	1	1	0	1	B:C	1	0	0		0	0	0
B:D	0	1	0	1		0	0	B:D	0	1	0	1	0	1	1	B:D	1	1	1		1	1	0
C:A	0	0	0	1		0	1	C:A	1	1	1	1	0	1	1	C:A	0	1	1		1	0	0
C:B	0	0	0	0		0	0	C:B	1	0	1	0	0	0	0	C:B	0	1	1		1	1	1
C:D	0	0	0	1		0	0	C:D	1	1	0	1	0	1	1	C:D	1	1	1		1	1	0
D:A	1	1	0	0		1	1	D:A	1	1	1	0	1	1	1	D:A	0	0	0		0	0	0
D:B	0	0	0	0		0	1	D:B	0	0	1	0	1	0	0	D:B	0	0	0		0	0	0
D:C	1	1	0	0		1	1	D:C	0	0	1	0	1	0	0	D:C	0	0	0		0	0	0
Track 4								**Track 5**								**Track 6**							
	1	2	3	4	5	6	7		1	2	3	4	5	6	7		1	2	3	4	5	6	7
A:B	1	1	0	1	1	1	1	A:B	0	0	1	1	1	1	0	A:B	0	0	1	1	1	0	0
A:C	0	1	0	1	1	0	1	A:C	0	1	1	1	1	1	1	A:C	0	1	1	1	1	1	1
A:D	1	0	0	1	1	0	0	A:D	0	0	1	1	0	0	1	A:D	0	1	1	1	1	0	0
B:A	0	0	1	0	0	0	0	B:A	1	0	0	0	0	0	1	B:A	1	1	0	0	0	1	1
B:C	0	0	0	0	0	0	0	B:C	0	1	0	1	0	1	1	B:C	0	1	1	1	1	1	1
B:D	1	0	0	0	0	0	0	B:D	0	0	0	0	0	0	1	B:D	0	1	0	1	0	0	0
C:A	1	0	1	0	0	0	0	C:A	1	0	0	0	0	0	0	C:A	1	0	0	0	0	0	0
C:B	1	1	1	1	1	1	1	C:B	1	0	1	0	1	0	0	C:B	1	0	0	0	0	0	0
C:D	1	0	1	0	1	0	0	C:D	0	0	0	0	0	0	0	C:D	0	0	0	0	0	0	0
D:A	0	0	1	0	0	1	0	D:A	1	0	0	0	1	1	0	D:A	1	0	0	0	0	1	1
D:B	0	1	1	1	1	1	1	D:B	1	0	1	0	1	1	0	D:B	1	0	1	0	1	0	0
D:C	0	1	0	0	0	1	1	D:C	0	1	1	1	1	1	1	D:C	0	1	1	1	1	1	1

Table 40. Sound Quality Expert Comparisons (Tracks 7-12)

Track 7								Track 8								Track 9							
	1	2	3	4	5	6	7		1	2	3	4	5	6	7		1	2	3	4	5	6	7
A:B	0	0	0	0	0	0	0	A:B	0	0	0	0	1	1	0	A:B	1	1	1	0		1	1
A:C	0	0	0	0	0	0	0	A:C	0	0	1	0	1	1	0	A:C	1	0	1	0		0	0
A:D	0	0	0	0	0	0	0	A:D	0	0	0	0	1	0	0	A:D	1	1	1	1		1	1
B:A	1	1	1	1	1	1	1	B:A	0	1	0	1	0	0	1	B:A	0	0	0	0		0	0
B:C	0	1	0	0	0	0	0	B:C	0	1	1	1	1	1	0	B:C	0	0	0	0		0	0
B:D	0	0	0	0	0	0	0	B:D	0	0	0	0	0	0	0	B:D	1	1	0	1		1	1
C:A	1	1	1	1	1	1	1	C:A	1	0	0	0	0	0	1	C:A	0	1	0	0		0	1
C:B	0	0	0	0	1	1	1	C:B	1	0	0	0	0	0	1	C:B	1	1	1	0		1	1
C:D	0	0	0	0	0	0	1	C:D	0	0	0	0	0	0	0	C:D	1	1	1	1		1	1
D:A	1	1	1	1	1	1	1	D:A	1	1	1	1	0	1	1	D:A	0	0	0	0		0	0
D:B	1	0	1	1	1	1	0	D:B	1	0	1	1	1	1	1	D:B	0	0	1	0		0	0
D:C	1	1	1	1	1	1	0	D:C	1	1	1	1	1	1	0	D:C	0	0	0	0		0	0
Track 10								**Track 11**								**Track 12**							
	1	2	3	4	5	6	7		1	2	3	4	5	6	7		1	2	3	4	5	6	7
A:B	0	0	0	0	0	0	0	A:B	0	0	0	0	1	0	0	A:B	0	0	0	0	1	0	0
A:C	0	0	0	0	0	0	0	A:C	0	0	1	0	1	0	0	A:C	0	0	1	0	1	0	0
A:D	0	0	0	0	0	1	0	A:D	0	0	1	0	1	0	0	A:D	1	1	1	1	1	1	1
B:A	1	1	1	1	1	1	1	B:A	1	1	1	1	0	1	1	B:A	1	0	0	1	0	1	1
B:C	1	1	0	1	1	1	0	B:C	0	1	1	1	0	0	1	B:C	0	0	1	0	0	0	0
B:D	1	1	0	1	0	1	0	B:D	0	1	1	1	0	0	1	B:D	1	1	1	1	1	1	1
C:A	1	1	1	1	1	1	1	C:A	1	1	0	1	0	1	1	C:A	1	0	0	1	0	1	1
C:B	0	0	0	0	0	0	1	C:B	0	0	0	0	0	1	0	C:B	0	0	0	0	0	1	1
C:D	0	0	0	0	0	1	0	C:D	0	0	1	1	0	1	1	C:D	1	1	1	1	1	1	1
D:A	1	1	1	1	1	0	1	D:A	1	1	0	0	0	1	1	D:A	0	0	0	0	0	0	0
D:B	0	0	0	0	0	0	1	D:B	1	0	0	0	0	0	0	D:B	0	0	0	0	0	0	0
D:C	0	0	0	0	1	0	0	D:C	1	0	0	0	0	0	0	D:C	0	0	0	0	0	0	0

Table 41. Sound Quality Expert Comparisons (Tracks 13-14)

Track 13								Track 14							
	1	2	3	4	5	6	7		1	2	3	4	5	6	7
A:B	0	0	1	0	1	0	0	A:B	0	1	1	1	1	1	1
A:C	0	0	0	0	1	0	1	A:C	0	1	0	1	0	1	0
A:D	0	1	1	0	1	0	1	A:D	1	1	0	1	1	1	1
B:A	1	1	0	0	0	1	0	B:A	1	0	0	0	0	0	0
B:C	0	1	0	0	0	1	1	B:C	0	0	0	0	0	0	0
B:D	0	1	1	0	0	1	1	B:D	1	0	0	0	1	0	0
C:A	1	0	0	1	0	1	0	C:A	1	0	1	0	1	0	1
C:B	1	0	1	1	0	0	0	C:B	0	1	1	1	1	1	1
C:D	1	1	1	1	0	0	0	C:D	1	0	0	0	1	1	1
D:A	1	0	0	0	0	1	0	D:A	0	0	1	0	0	0	0
D:B	0	0	0	0	0	0	0	D:B	0	1	1	1	0	1	1
D:C	0	0	0	0	0	0	0	D:C	0	0	1	0	0	0	0

Table 42. Music Sample Scoring Averages (WMA)

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert AVG	STDV
6A	0.00	0.67	1.00	1.00	1.00	0.33	0.33	0.62	0.37
6B	0.33	1.00	0.33	0.67	0.33	0.67	0.67	0.57	0.23
6C	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.23
6D	0.67	0.33	0.67	0.33	0.67	0.67	0.67	0.57	0.15

Table 43. Music Sample Scoring Averages (MP3)

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert AVG	STDV
3A	0.67	0.67	0.67		0.33	1.00	0.67	0.67	0.19
3B	0.67	0.33	0.33		0.33	0.33	0.00	0.33	0.19
3C	0.33	1.00	1.00		1.00	0.67	0.33	0.72	0.30
3D	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00

Table 44. Music Samples Scoring Averages (RA)

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert AVG	STDV
11A	0.00	0.00	0.67	0.00	1.00	0.00	0.00	0.24	0.39
11B	0.33	1.00	1.00	1.00	0.00	0.33	1.00	0.67	0.40
11C	0.33	0.33	0.33	0.67	0.00	1.00	0.67	0.48	0.30
11D	1.00	0.33	0.00	0.00	0.00	0.33	0.33	0.29	0.33

Table 45. Music Sample Scoring Averages (QT)

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert AVG	STDV
2A	0.00	0.00	0.00	0.33	0.67	0.00	0.00	0.14	0.24
2B	0.33	1.00	0.33	1.00	0.33	0.67	1.00	0.67	0.31
2C	1.00	0.67	0.67	0.67	0.00	0.67	0.67	0.62	0.28
2D	0.33	0.33	1.00	0.00	1.00	0.33	0.33	0.48	0.35

Table 46. Music Sample Scoring Averages (32 kbit/s)

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert AVG	STDV
7A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7B	0.33	0.67	0.33	0.33	0.33	0.33	0.33	0.38	0.12
7C	0.33	0.33	0.33	0.33	0.67	0.67	1.00	0.52	0.24
7D	1.00	0.67	1.00	1.00	1.00	1.00	0.33	0.86	0.24

Table 47. Music Sample Scoring Averages (64 kbit/s)

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert AVG	STDV
14A	0.33	1.00	0.33	1.00	0.67	1.00	0.67	0.71	0.28
14B	0.67	0.00	0.00	0.00	0.33	0.00	0.00	0.14	0.24
14C	0.67	0.33	0.67	0.33	1.00	0.67	1.00	0.67	0.25
14D	0.00	0.33	1.00	0.33	0.00	0.33	0.33	0.33	0.31

Table 48. Music Sample Scoring Averages (128 kbit/s)

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert AVG	STDV
13A	0.00	0.33	0.67	0.00	1.00	0.00	0.67	0.38	0.37
13B	0.33	1.00	0.33	0.00	0.00	1.00	0.67	0.48	0.39
13C	1.00	0.33	0.67	1.00	0.00	0.33	0.00	0.48	0.39
13D	0.33	0.00	0.00	0.00	0.00	0.33	0.00	0.10	0.15

Table 49. Speech Sample Scoring Averages (32 kbit/s)

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert AVG	STDV
10A	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.05	0.12
10B	1.00	1.00	0.33	1.00	0.67	1.00	0.33	0.76	0.29
10C	0.33	0.33	0.33	0.33	0.33	0.67	0.67	0.43	0.15
10D	0.33	0.33	0.33	0.33	0.67	0.00	0.67	0.38	0.21

Table 50. Speech Sample Scoring Averages (64 kbit/s)

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert AVG	STDV
1A	0.00	0.33	0.00	0.00		0.33	0.00	0.11	0.16
1B	0.67	1.00	0.00	0.67		0.67	0.67	0.61	0.30
1C	0.00	0.00	0.00	0.67		0.00	0.33	0.17	0.25
1D	0.67	0.67	0.00	0.00		0.67	1.00	0.50	0.37

Table 51. Speech Sample Scoring Averages (128 kbit/s)

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert AVG	STDV
8A	0.00	0.00	0.33	0.00	1.00	0.67	0.00	0.29	0.37
8B	0.00	0.67	0.33	0.67	0.33	0.33	0.33	0.38	0.21
8C	0.67	0.00	0.00	0.00	0.00	0.00	0.67	0.19	0.30
8D	1.00	0.67	1.00	1.00	0.67	1.00	0.67	0.86	0.16

Table 52. Speech Sample Scoring Averages (WMA)

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert AVG	STDV
5A	0.00	0.33	1.00	1.00	0.67	0.67	0.67	0.62	0.33
5B	0.33	0.33	0.00	0.33	0.00	0.33	1.00	0.33	0.31
5C	0.67	0.00	0.33	0.00	0.33	0.00	0.00	0.19	0.24
5D	0.67	0.33	0.67	0.33	1.00	1.00	0.33	0.62	0.28

Table 53. Speech Sample Scoring Averages (MP3)

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert AVG	STDV
9A	1.00	0.67	1.00	0.33		0.67	0.67	0.72	0.23
9B	0.33	0.33	0.00	0.33		0.33	0.33	0.28	0.12
9C	0.67	1.00	0.67	0.33		0.67	1.00	0.72	0.23
9D	0.00	0.00	0.33	0.00		0.00	0.00	0.06	0.12

Table 54. Speech Sample Scoring Averages (RA)

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert AVG	STDV
4A	0.67	0.67	0.00	1.00	1.00	0.33	0.67	0.62	0.33
4B	0.33	0.00	0.33	0.00	0.00	0.00	0.00	0.10	0.15
4C	1.00	0.33	1.00	0.33	0.67	0.33	0.33	0.57	0.29
4D	0.00	0.67	0.67	0.33	0.33	1.00	0.67	0.52	0.30

Table 55. Speech Sample Scoring Averages (QT)

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert AVG	STDV
12A	0.33	0.33	0.67	0.33	1.00	0.33	0.33	0.48	0.24
12B	0.67	0.33	0.67	0.67	0.33	0.67	0.67	0.57	0.15
12C	0.67	0.33	0.33	0.67	0.33	1.00	1.00	0.62	0.28
12D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 56. Windows Media Audio Music Comparisons

WMA Music (32 kbit/s)				WMA Music (64 kbit/s)			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	3	3	0	AM radio	6	0	0
FM radio	0	0	6	FM radio	1	3	2
CD quality	0	1	6	CD quality	0	4	3
WMA Music (128 kbit/s)				**AIFF Music (CD-Quality)**			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	6	0	0	AM radio	6	1	0
FM radio	1	5	1	FM radio	3	2	1
CD quality	0	2	4	CD quality	0	4	2

Table 57. Windows Media Audio Speech Comparisons

WMA Speech (32 kbit/s)				WMA Speech (64 kbit/s)			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	1	5	0	AM radio	6	0	0
FM radio	1	0	6	FM radio	2	4	1
CD quality	0	0	6	CD quality	0	4	2
WMA Speech (128 kbit/s)				**AIFF Speech (CD-Quality)**			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	6	0	0	AM radio	6	1	0
FM radio	2	4	1	FM radio	2	4	0
CD quality	0	3	3	CD quality	0	4	2

Table 58. MP3 Music Comparisons

MP3 Music (32 kbit/s)				MP3 Music (64 kbit/s)			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	0	1	6	AM radio	2	0	4
FM radio	0	0	6	FM radio	1	1	4
CD quality	0	0	6	CD quality	1	1	5
MP3 Music (128 kbit/s)				**AIFF Music (CD-Quality)**			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	6	0	0	AM radio	6	0	0
FM radio	1	4	1	FM radio	4	3	0
CD quality	1	3	3	CD quality	1	3	2

Table 59. MP3 Speech Comparisons

MP3 Speech (32 kbit/s)				MP3 Speech (64 kbit/s)			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	0	3	4	AM radio	4	3	0
FM radio	0	0	6	FM radio	0	2	4
CD quality	0	0	6	CD quality	0	0	6
MP3 Speech (128 kbit/s)				**AIFF Speech (CD-Quality)**			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	5	1	0	AM radio	6	0	0
FM radio	2	4	1	FM radio	3	4	0
CD quality	0	3	3	CD quality	0	4	2

Table 60. RealAudio Music Comparisons

RA Music (32 kbit/s)				RA Music (64 kbit/s)			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	4	1	2	AM radio	4	2	0
FM radio	1	1	4	FM radio	0	5	2
CD quality	0	1	5	CD quality	0	0	6
RA Music (128 kbit/s)				**AIFF Music (CD-Quality)**			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	6	1	0	AM radio	6	1	0
FM radio	1	5	0	FM radio	1	4	1
CD quality	0	1	5	CD quality	0	4	2

Table 61. RealAudio Speech Comparisons

RA Speech (32 kbit/s)				RA Speech (64 kbit/s)			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	2	4	0	AM radio	6	0	0
FM radio	1	0	6	FM radio	2	4	0
CD quality	0	0	6	CD quality	1	3	3
RA Speech (128 kbit/s)				**AIFF Speech (CD-Quality)**			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	5	1	1	AM radio	6	1	0
FM radio	3	2	1	FM radio	3	3	0
CD quality	0	3	3	CD quality	0	6	0

Table 62. QuickTime Music Comparisons

Quicktime Music (32 kbit/s)				QuickTime Music (64 kbit/s)			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	4	2	1	AM radio	6	0	0
FM radio	1	1	4	FM radio	1	3	3
CD quality	0	1	5	CD quality	0	2	4
QuickTime Music (128 kbit/s)				**AIFF Music (CD-Quality)**			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	6	0	0	AM radio	6	0	0
FM radio	1	4	1	FM radio	4	3	0
CD quality	1	1	5	CD quality	0	4	2

Table 63. QuickTime Speech Comparisons

QT Speech (32 kbit/s)				QT Speech (64 kbit/s)			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	0	4	2	AM radio	6	0	0
FM radio	0	0	5	FM radio	3	4	0
CD quality	0	0	5	CD quality	0	3	3
QT Speech (128 kbit/s)				**AIFF Speech (CD-Quality)**			
Answer Options	**better than**	**the same as**	**worse than**	**Answer Options**	**better than**	**the same as**	**worse than**
AM radio	6	0	0	AM radio	5	1	0
FM radio	5	0	1	FM radio	4	1	1
CD quality	0	4	3	CD quality	0	5	2

Table 64. 32 kbit/s Music Samples Compared to AM-Quality

	WMA 32 kbit/s	RA 32 kbit/s	QT 32 kbit/s	MP3 32 kbit/s	Total
better than	3	4	4	0	11
the same as	3	1	2	1	7
worse than	0	2	1	6	9

Table 65. 32 kbit/s Speech Samples Compared to AM-Quality

	WMA 32 kbit/s	RA 32 kbit/s	QT 32 kbit/s	MP3 32 kbit/s	Total
better than	1	2	0	0	3
the same as	5	4	4	3	16
worse than	0	0	2	4	6

Table 66. 64 kbit/s Music Samples Compared to FM-quality

	WMA 64 kbit/s	RA 64 kbit/s	QT 64 kbit/s	MP3 64 kbit/s	Total
better than	1	0	1	1	3
the same as	3	5	3	1	12
worse than	2	2	3	4	11

Table 67. 64 kbit/s Speech Samples Compared to FM-quality

	WMA 64 kbit/s	RA 64 kbit/s	QT 64 kbit/s	MP3 64 kbit/s	Total
better than	2	2	3	0	7
the same as	4	4	4	2	14
worse than	1	0	0	4	5

Table 68. 128 kbit/s Music Samples Compared to CD-quality

	WMA 128 kbit/s	RA 128 kbit/s	QT 128 kbit/s	MP3 128 kbit/s	Total
better than	0	0	1	1	2
the same as	2	1	1	3	7
worse than	4	5	5	3	17

Table 69. 128 kbit/s Speech Samples Compared to CD-qualilty

	WMA 128 kbit/s	RA 128 kbit/s	QT 128 kbit/s	MP3 128 kbit/s	Total
better than	0	0	0	0	0
the same as	3	3	4	3	13
worse than	3	3	3	3	12

NOTES

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