

ECONOMIC GROWTH AND PROFITS IN HF BROADCASTING USING EXISTENT IS INFRASTRUCTURE

Jerry Plummer¹, Brady M. Murray²

¹Austin Peay State University, United States

²Tennessee State University, United States

Abstract

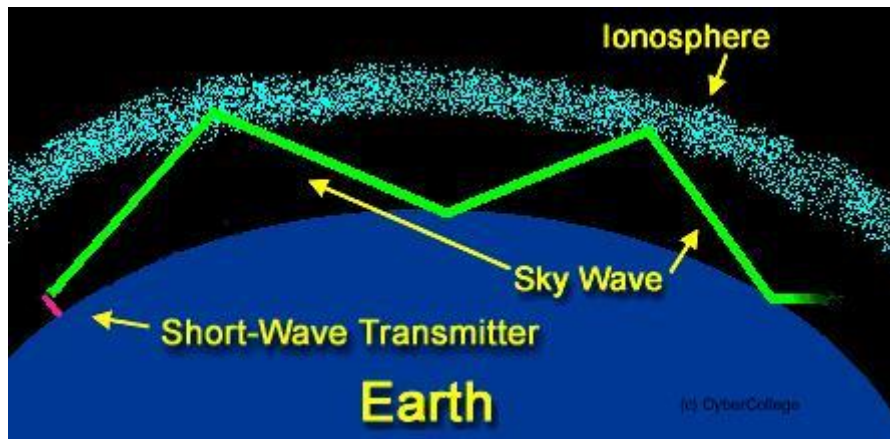
Existent HF analog infrastructures can be modified to digital ones using recent technology advances. The technology allows simultaneous transmission of voice and data on the same frequency, with similar IS systems. This opened an economic growth portal for existent HF operators to increase sales and profits using this new technology, while still retaining current analog use as desired. However, no receivers have been available for DRM technology; meaning no listener or data transmission market. New DRM receiver developments lead to release of affordable models in late 2018/mid 2019, which can lead to an economic revival in HF broadcasting. Economic models have been developed for the analog industry which can be modified to include DRM revenues to show increased profit levels. Small changes need to be made to existent IS infrastructures to allow for simultaneous analog/digital transmission protocols.

Keywords: *Economic Analysis, Information Systems, Teaching Technologies, MIS, Informational Economics, Management Information Systems, Economic Profitability Models*

INTRODUCTION. WHAT IS HF BROADCASTING?

Commonly referred to as “shortwave”, or “HF” [1] (Sensagent.com, 2020) HF/shortwave uses frequency ranges from 1.60-29.999 MHZ. Shortwave signals bounce off the F layer [2](QSL.net, 2020) back and forth to earth, making very long distance reception available; often in the thousands of miles. Graphs a and b following show how shortwave broadcasts extend so much farther than FM signals; the latter are “straight-line” transmissions and the first hill or mountain will block the signal from further reach. There are many existent commercial HF broadcasters, all using analog transmissions to reach areas far away; often areas without internet or even electricity. [3] (VoiceofHope.com, 2021) There are millions of analog shortwave radios in use daily around the world [4](WRMI.net, 2021).

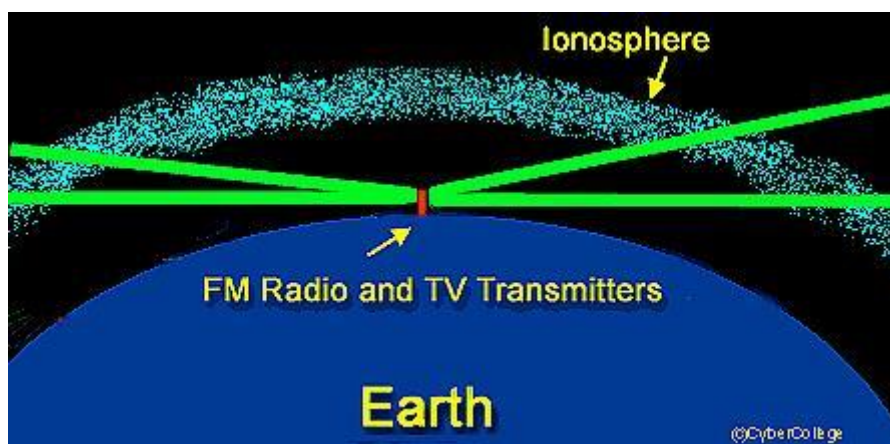
Additionally, shortwave transmissions know no national borders and cannot be blocked, compared to with the internet [5](RadioWorld.com 2019). The HF signals can only be blocked by another transmitter, broadcasting on the same band/channel [often referred to as “jamming”]. [6] (The Economist, 2013 [7])(Wikipedia, 2021). Jamming also occurs in many wireless computer networks. To avoid jamming, simply move to another frequency [8] (SWLing.com, 2020). This “dog and cat chase” occurs daily, across frequencies and countries, based on political climate.



Graph a.

Shortwave broadcast popularity has declined dramatically with the advent of the internet, leaving much of the world populace moving from HF to internet broadcasts for reception. [9](WNYC.org, 2019) HF currently still reigns in the many areas of the globe without internet access; areas such as middle Africa, large parts of Asia and much of South America, among others.

Economically, there have been many HF operators close shop in the last ten years, citing internet competition as too great to allow sales revenue to maintain an acceptable profit margin. Additionally, HF operations incur a very high electrical usage, increasing costs versus the internet.



Graph b.

Economically, the very high energy cost requirements of a typical analog HF transmitter for effective signal propagation has done much to push many current HF broadcasters off the air. [10] (Plummer and Murray, 2017) Many countries have dropped HF broadcasting for the much lesser cost of Internet broadcasting for information transmissions, giving up broadcasts to the many areas of the globe without effective Internet capabilities, thus leaving these areas without daily communications, from a cost effective standpoint.

BACKGROUND OF THIS STUDY

The HF global market for the past century was self-supporting and growth oriented. As the premier method of long distance communications for this time frame, competition was non-existent. There was no other medium with anything near the global reach of the HF signals. The 1960's and 70's began the development of space borne satellites for telephonic transmissions and the beginnings of television signal transferal. Extreme costs associated with usage of these satellites made them beyond the reach of the vast majority of the earthly populace; although some slight competition to HF signals.

The rise of the Internet in the early 90's forward proved to be the competition to HF that was totally unexpected to the industry, and slow acceptance of the feasibility of the Internet to global usage put the entire industry in a position of near immediate overall demise. Many government owned shortwave broadcasters ceased broadcasts in the 1999-2014 time frame, leaving a major void in overall HF broadcasting hours.

As it appeared that HF broadcasting would become as the slide rule, a new digital technology was developed as an answer to making HF become competitive again; DRM (described below).

Little, if any, previous studies exist in the field of DRM broadcasting, of any nature. Newly formed groups, such as the DRM Consortium, based in Great Britain, publish technical data for installation and setup activities, but studies related to its actual usage in the field, as related to economic and financial viability and usage, do not exist.

This paper may be the first of its kind ever published in this particular segment of HF to DRM conversion, particularly from an economic and financial aspect.

ENTER DRM; A DIGITAL TECHNOLOGY

DRM [Digital Radio Mondiale] [11] (DRM.org, 2021) is a technical modification to HF bands allowing current transmitters to broadcast a digital pattern. It not only offers clearer, stereo reception, but also allows digital signals to be broadcast simultaneously on the same frequency with no detriment to the digital sound quality. This is similar to DSL signals for telecommunications.

DRM technology has been available for several years from a transmitter standpoint, with the addition of a DRM exciter to effectively convert the analog to digital signals for transmission. *DRM has not been employed to any large degree by shortwave broadcasters due to an almost total lack of acceptable DRM receivers available.* For-profit broadcasters cannot sell airtime for a product with no listeners (i.e.-no useful and affordable receiver for the millions of listeners to use). This is true for any market; economically blessed or not. As noted above, much shortwave usage currently is for areas with no internet and often no electricity; areas such as the "10-40" longitude areas of Africa, South America and large parts of Asia. A receiver for them must be very inexpensive; not the \$200 plus DRM receivers that have been available. For example, an analog shortwave radio can be purchased for a little as \$15-\$20 US currently.

As noted above, electricity costs are, by far, the major cost component of HF analog broadcasting. DRM usage can cut these costs by as much as 50%, due to its digital construct and much more effective usage of an existent HF transmitter. Additionally, wear and tear of HF transmitter parts is substantially lessened, making DRM a much preferred method of HF broadcasting.

Economically, overall costs could be halved and expensive repair and replacement costs could be much curtailed.

Thus, the "chicken and egg" conundrum has existed for years; broadcast transmitters can be easily refitted for DRM broadcasts and would be a major economic cost relief-but there are no receivers for anyone to hear (and purchase or pay) the broadcast content or sales pitch. Of course, this has stopped virtually all HF broadcasters from using DRM.

From a domestic US standpoint, getting FCC approval to install and use a DRM exciter is relatively straightforward via completion of a construction form to the FCC with virtually guaranteed acceptance

by them for usage [12] (CP-DRM, FCC, 2015). A similar ease of construct is employed by the EU for European operators, for example; as is the bulk of Asian countries via ITU approval. [13] (ITU.org, 2020).

EXISTING IS INFRASTRUCTURE REQUIRES LITTLE CHANGE

Conversion to DRM requires a DRM modulator added to each transmitter, costing \$10,000 to \$45,000 maximum. This represents a small percentage to the plus two million dollar transmitter cost/value and the existent IS attachment congruent to broadcasting remains unchanged. All existent IS infrastructure, both hardware and software, adapt readily to digital conversion; since IS is, by definition, digital.

For some transmitters, overall IS cost will be lowered for transmitters using required digital to analog converters.

In some cases, existent IS digital converters can be used for existent transmitters, eliminating the need for a digital modular on the transmitter; a major cost reduction. Labour costs for digital to analog conversions can be reduced or eliminated, adding to the management-oriented profit escalation possibilities.

OTHER WAYS DRM COULD ECONOMICALLY IMPACT HF BROADCASTERS

Digital transmissions can be of many types; data transmissions for B2B for example. All this can be done while also broadcasting voice programming over the same frequency. In other words, the same digital frequency can be allocated for voice at the top of the signal, and data transmissions at the bottom part of the signal. This, in effect, creates a secondary market for the HF broadcaster; time can be sold for voice type programming, while data transfers of all types can occur simultaneously, all from the same single transmitter and frequency. Secondly, data transmissions of all types can be performed, with no blockage of the signal by political or national motives. Both these items are extremely good selling points for the current shortwave broadcaster and can mean the somewhat dormant industry could economically rise as a Phoenix from the Ashes.

Digital transmissions can take the form of educational lessons to areas that cannot currently utilize teaching of this nature. The whole concept of transmitting educational content via DRM has a wider range of possibility than any Internet, VOIP or other traditional method of transmission, [14] (Mccarthy and Plummer, 2016) due to shortwave's ability to be decoded in areas of little or no electricity, as the DRM receiver will allow both audio and visual content delivery with only battery requirements. The BBC states that over three billion analog receivers are in use currently today, with less than one percent being larger "tabletop" models requiring constant electrical connections.[15] (BBC.com 2019). Given an effectively priced DRM set, full scale of educational opportunities to the non-electrified areas of the world exist, at a much lower cost than sending teachers to the outreaches to establish classes.

Yet another economic advantage for the HF broadcaster, as well as the educational content provider relates to shortwave signals ability to cross governmental borders unimpeded. Compared to traditional Internet delivery, where signals can be blocked by varied governments (see China, Russian the Sudan and Cuba), shortwave signals cannot be blocked, unless a direct jamming method utilizing another shortwave transmitter is employed [16] (Radioworld.com, 2019 [17])(HFUnderground.com, 2019). This has historically been proven to be a generally ineffective means of signal blockage, and means the HF broadcaster could effectively sell the educational content with a good promise of effective delivery, regardless of the government's opinions and desires [18] (Radioworld.com, 2020).

In effect, the HF/DRM broadcaster can virtually guarantee delivery in areas where the Internet would fail and create an entirely new economic global market for air time sales.

NEW DRM RECEIVERS ON THE HORIZON

Of course, none of this is economically feasible until the low cost DRM receiver becomes widely available. No for-profit HF broadcaster can afford DRM broadcasting without a market populated with the DRM receiver. However, there are at least three DRM receiver manufacturers with acceptable product coming out in late 2021. These include the Titus II [19] (Titusradio.com, 2020), the Avion [20] (Radioworld, 2020) and [20] (Avionelectronics, 2020) and the Gospell [21] (Radioworld, 2020). The Titus II offers the most possibility; being an Android tablet with DRM capability as well as a usable sized screen for data transmission rendering and the ability to take digital data and provide a readable screen for listener usage. The Titus II is expected to sell at less than \$100 US and its smaller brother, the Titus III will sell for about half as much. Both of these, particularly the Titus III, could offer good sale value to the areas of the world described above with no internet or electricity. The Titus is currently in pre-production.

At the time of publication, two other models, designed in Germany and produced in China, offer a similar price structure, with production also expected in late 2021.

Many religious broadcasters who currently purchase thousands of analog receivers yearly to distribute to people in the non-internet, non-electricity parts of the world, could begin purchase and distribution of these new models, while other parts of the world could purchase the lesser priced models and/ or the other receivers being developed.

Likewise, educational content providers can afford to include delivery of the noted DRM receivers to the intended markets as a part of their package cost, if needed.

SOLVING THE CHICKEN-EGG PARADOX

The release for sale of the noted DRM receivers will go a long way to encouraging HF broadcasters to ready transmitters for DRM broadcasting. Increasing distribution of the lesser priced DRM receivers will begin the planting of a potential new listener audience for the non-internet populations. Increased distribution of all three of the above DRM receivers will ready the HF broadcaster to reach out to data transmission industries for beginning data transmission via DRM.

Similarly, a new educational market can be opened for exposure to areas previously unable to receive digital transmissions. All of these markets can expand the currently stagnant HF market to economic expansion-particularly when existent infrastructure globally can be employed.

Continued adoption of DRM as a broadcasting standard by countries such as India will also aid in convincing HF broadcasters to consider DRM transmissions.

INCREASED VALUE MODELS FOR POTENTIAL APPLICATION TO A DRM-RICH ENVIRONMENT

Previous models developed earlier [22] (Plummer and Cochran, 2014) and added to afterwards [23](Plummer and Cochran, 2021) can be applied from what was then a pure analog revenue based economic environment into a DRM skewed market. One of the models for profitability indices is here, and is presented as a note that future transmitter valuation can be determined using DRM revenue pricing yet to be determined. We believe that application of this model (or others from the Plummer-Cochran development) to that environment can provide a usable industry analysis of DRM value versus pure analog. Development of this new model can be used to show transmitter owners the validity of adding DRM signals to their array.

The Broadcast Value number noted below is calculated using Harold Vogel's suggestion in the well-known Entertainment Industry Economics book [24](Vogel, 2015). His definition of broadcast value is (Assigned Multiple * Projected Cash Flow) less (Long term debt – net current assets).

The profitability index measures the cash flow available from the transmitter investment per dollar of the required investment. The profitability index is the present value of the cash flows over the investment horizon divided by the absolute value of the initial investment.

$$PI = \frac{\sum_{t=1}^n \frac{CF_t}{(1+r)^t}}{|CF_0|}$$

The average accounting return is the average net income over the project horizon divided by the average book value of the transmitter asset. The transmitter is assumed to be depreciated on a straight line basis.

$$AAR = \frac{\text{Average Net Income}}{\text{Average Book Value}}$$

Broadcast value as a matter of industry practice is approximated by multiplying projected annual cash flows by an assigned multiple in the range of 8 to 12 [24](Vogel, 2015), we assume a multiple of 10. From this multiple the difference of long-term debt and net current assets is subtracted.

$$\text{Broadcast Value} = (\text{Assigned Multiple} * \text{Projected Annual Cash Flow}) - (\text{Long - Term Debt} - \text{Net Current Assets})$$

Using the yet to be determined revenue values of DRM broadcasts can alter the transmitter broadcast value upward, reflective of DRM's addition to the operators signal reproductions.

CONCLUDING REMARKS

The release of suitable DRM receivers can create an entirely new economic market for existent analog HF broadcasters via conversion of their analog to digital transmitters. DRM's ability to piggyback data transmissions with simultaneous voice broadcasting opens a new, secondary market for the existent broadcasters. The concept of educational content delivered to areas previously unable to receive audio and visual content of this nature opens up an entirely new world of educational possibilities to areas of the world currently unable to effectively educate their populace.

Shortwave signal's ability to travel across borders without governmental interference or cessation can make the DRM transmission, both voice and data, more valuable in terms of reachability to all areas of the earth.

Economic impacts of the DRM receiver distribution can breathe new life into the HF community, by moving to a digital era with both primary and secondary markets opening, as well as retention of existent analog broadcasters. As noted, existent IS infrastructures can be used with the addition of the DRM exciter to convert the analog to digital signal. Small IS changes can allow simultaneous digital/analog data transmission protocol to effectively occur.

The much debated "chicken and egg" conundrum can be solved with the distribution of the DRM receivers, now set at an affordable level for mass sale and distribution.

There is a great opportunity for HF broadcasting to dramatically increase its economic pie size by adopting DRM broadcasting in the near future, as the new DRM receivers begin to proliferate amongst varied populations.

More research needs to be undertaken regarding the market size and effective content employment globally. Data needs to be collected to determine modeling and shaping to maximize model

efficiencies. Continued development of previous analog-based revenue models must be developed using DRM broadcast rates yet to be established. Actual implementation of above noted IS changes must occur and be tested to allow for variances in further IS changes that may be needed to increase efficiencies.

REFERENCES

- [1] <http://dictionary.sensagent.com/Shortwave%20radio/en-en/> Accessed January 11, 2021.
- [2] http://www.qsl.net/ki0eg/propagation/f_layer.html. Accessed November 16, 2020).
- [3] <http://www.voiceofhope.com/shortwave.html>. Accessed March 6, 2021.
- [4] <http://www.wrmi.net/index.php/broadcast-us/shortwave-audience/> .Accessed February 4, 2021.
- [5] <https://www.radioworld.com/news-and-business/radio-reaches-blocked-countries> Accessed November 11,2019.
- [6] <https://www.economist.com/blogs/analects/2013/02/radio-transmissions> Accessed March 29, 2021.
- [7] https://en.wikipedia.org/wiki/Radio_jamming Accessed January 9, 2021
- [8] <https://swling.com/blog/tag/shortwave-radio-jamming/> Accessed October 5, 2020.
- [9] <https://www.wnyc.org/story/132095-bbc-switches-off-short-wave-in-north-america/>. Accessed March 12, 2020.
- [10] Murray and Plummer, ECONOMIC AND INFORMATION SYSTEMS CHALLENGES TO GLOBAL EDUCATIONAL TECHNOLOGIES, Journal of Applied Global Research, Volume 10, Issue 24, 2017, pp.78-92.
- [11] <http://www.drm.org/> Accessed February 4, 2021.
- [12] CP-DRM 2015 FCC public document.
- [13] <https://www.itu.org> Accessed January 27, 2020
- [14] McCarthy and Plummer, Management Information Systems and the Protection of Private Information: An Ethical Framework for Decision Makers in Organizations Journal of Information Systems Technology and Planning, Volume 8, Issue 19, 2016, pp. 128-143.
- [15] <https://www.bbc.com>. Accessed October 23,2019.
- [16] <https://www.radioworld.com/news-and-business/radio-reaches-blocked-countries> Accessed November 11,2019.
- [17] <https://www.hfunderground.com/wiki/index.php/Firedrake> Accessed January 5, 2021.
- [18] <http://www.radioworld.com/business-and-law/0009/international-broadcasters-reconsider-shortwave/331994> Accessed April 11,2021
- [19] <https://titusradio.com/> Accessed October 17 2020.
- [20] <http://www.avionelectronics.in/index.aspx> Accessed December 12, 2020.
- [21] <http://www.radioworld.com/digital-radio/0014/gospell-announces-new-drm-receiver/338119> Accessed April 2, 2021.
- [22] Plummer and Cochran, Shortwave Radio Broadcasting Station Valuation Approaches in a Challenging Business Environment, 2014.
- [23] Plummer and Cochran, unpublished paper, 2021.
- [24] Vogel, Harold. Entertainment Industry Economics, A Guide for Financial Analysis. 9th Edition 2015.