A Planning Guide: Determining the Best IBOC Migration Path for Your AM or FM Radio Station

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INTRODUCTION

This presentation will give radio broadcasters a practical foundation for IBOC planning, whether they are intending to tackle the process with an in-house staff or an outside consultant. It will take a general look at each area of the physical plant that needs to be evaluated for IBOC readiness, from the studio through the transmitter and antenna system, so that technically intelligent priorities can be determined. A hands-on checklist that can be used as a starting point is also included.

YOUR IBOC READINESS

By now we all know what IBOC is, so let's begin by taking a look at how *you're* going to make the transition to IBOC by asking a few questions:

At what point can you go digital (the earlier the better)? Where is your studio in its equipment replacement cycle (from now on, noise in will be noise *heard*)? How will you process your new pristine digital audio (this may be a good time to change or enhance your signature sound)? Will your current STL make the grade (remember, you can transmit data streams now – maybe add a phone line while you're at it)? What kind of shape is your site in (more stuff = less room + more power consumption)? Does your current transmitter have the bandwidth for IBOC (wide and flat plus headroom)? How long has it been since your antenna system was analyzed (can't be ignored this time)? Is your datacasting, enhanced revenue-generating business model in place (it's a Whole New World)?

With these questions in mind, let's tear into your station and take a deep look at your current configuration to determine exactly what you will need to make the migration to IBOC. First we'll look at your existing traditional broadcast audio and transmission equipment and how it relates to the new technology. Then we'll briefly preview datacasting before making specific suggestions towards a successful transition for your station.

Studio

For a closer look, the first place to start is in your studio. Now will be the time to decide when and where you make the analog-to-digital (A/D) conversion. Keep in mind that once a signal has entered the digital domain, it is always good practice to keep it there and unaltered. Multiple digital-to-analog (D/A) or A/D conversions and/or sample frequency rate changes, and multiple data compression/decompression (codec) schemes can disrupt and distort the signal, causing very undesirable artifacts and noise. This conversion judgment will be an internal decision based on budget, existing equipment, in-house abilities and knowledge, future expansion plans, and the following information.

Another aspect of A/D conversions to consider is the necessity of strict level-control practices going into the converter. Too high of an analog signal can cause the converter to run out of bits, resulting in very ugly and unpredictable results. If such practices are not in place, a brickwall limiter just in front of the A/D may be a good idea to raise your confidence level.

Consoles/Audio Source

If you are in the replacement cycle for anything in your studio's chain, you will now need to look more closely at digital audio input and output (I/O) arrangements. Coupled with AES digital's inherent stereo audiophile specs, you'll also find smarter, more user-friendly equipment with multiple interfacing and expansion capabilities.

For some IBOC broadcasters, consoles are third in importance, following transmitter/antenna issues and then STL upgrades, in the IBOC migration process. In many cases, this single purchase will be the final link allowing a station to go totally digital.

If your console has been slated to be replaced soon, your timing couldn't be better. Plan to upgrade to a board with digital outputs at the very least. Many stations don't realize how 'digital' they already are, with CD changers, minidisk players, some telco and remote devices, certain microphone processors and of course HD digital audio servers already in place. A 44.1 kHz digital-output console that can input multiple sample rates and various digital formats, yet still handle analog sources, is highly recommended.

As mentioned above, compression schemes utilizing codecs use must be limited. If multiple codecs are unavoidable, attempts should be made to keep the codecs in the same family. Minidisks and certain hard disk audio storage systems employ some form of data compression algorithms. Certain processing equipment and routing systems utilize proprietary codecs. Again, the more times encoding/decoding takes place creating cascading algorithms, the more chances of degraded audio.

AM: The IBOC hybrid mode is <u>not</u> compatible with existing analog AM Stereo systems. If your station is currently broadcasting only AM Stereo, you will need to convert to a mono signal for the analog portion of your new IBOC programming. Of course, if you currently program only in mono and are looking towards the future, now would be the right time to convert your studio to digital stereo.

Wiring/Cable/Clocking

Since IBOC will be transmitting *digital audio* into your customer's radios, the signal needs to be as clean as possible. Proper wiring, termination, and grounding techniques, along with quality cable and connector replacements, will be required to get the most out of your audio and data path. On the bright side, your cabling may actually be reduced by one half, since AES audio (the digital audio stream specification adopted by the Audio Engineers Society) routes the stereo digital signal serially on *one* cable as opposed to the pair currently needed for stereo. Also, for the digital audio signal path, the most recent installations are now using CAT-5, computer network high speed data cable, instead of digital audio (110 Ω) cable. This is proving to provide a completely RFI free, quick and simple, well-dressed installation with a significantly smaller footprint.

If you are a multiple-studio station, you may need to purchase or upgrade your master clock for facility-wide digital synchronization. To avoid digital level changes, clicks and pops, AES audio must be synchronized to a common time reference. At the very least, for a smaller studio you will need a digital console equipped with an internal clock to allow for silent switching and routing of various inputs. Highly diverse and complex systems may be timed via GPS or international time keeping systems.

Depending on where you make the switch from analog to digital, your current analog audio distribution amps (DA) may need to be replaced with their AES digital counterparts. Perhaps you'll opt for one of the new analog/digital routers that can be used to replace your isolation DAs, patch bay, and mechanical switchers. Again, a master clock will need to time-control all digitally clocked components in the on-air chain.

Speaking of inputs and routing, which sample rate will your station utilize? If you will be using several different rates from a myriad of input sources and the console is not capable of handling multiple rate inputs, you'll need to convert them to a single rate beforehand. These sample rate converters will also need to be clocked by your station master.

Will You Go Internet?

Another thing you may wish to consider while assessing your current and future needs is your Internet presence. This topic, of course, is an entire paper in itself, but management, storage and routing for an Internet radio station should be thought about at this upgrade point with regard to some of the equipment discussed in this paper.

Diversity Delay

Significant delay will be introduced on the received digital audio side due to the digitization and transport conversions of the transmitted audio. Additional delays will be introduced by the receiver as it decodes and manages the incoming stream. Therefore, the analog audio will be delayed from 6 to 8.5 seconds to achieve a smooth blend between digital and analog signals in the event the receiver determines a need to switch between the two based on reception quality.

Most talk radio format stations are already accustomed to and equipped for such a delay. If not, your station will need to alter its off-the-air monitoring practice to one of post-console/pre-IBOC signal for the on-air talent. Most stations will still want to confidence monitor for RF loss via an automated no-carrier detector alarm, or have off-air personnel monitor for quality. Provisions should also be considered for personnel doing remote location feeds to communicate with the studio directly, as opposed to monitoring the delayed air signal.

Processing

There has been much discussion and debate regarding placement of audio processors. Stations are finding if there's compression utilized at any one or more points in the chain between source and IBOC exciter, or they are forced to leave an outmoded STL system in place, they can improve their overall sound by placing the audio processor at the transmitter. This method will allow for tightening up and final adjustments of the audio just before transmission, sending the cleanest signal into the encoder. The PAC encoding will reduce the digital audio bitstream by 93% (at the highest resolution setting of 96 kbps), and will work best when the source is *clean with* ***mild*** *dynamic control* in place.

For stations with on-air personalities that prefer the fully processed sound of their voices, a mimicking processor can be inserted into the real-time monitor loop. This unit can closely simulate the transmitter processor, or produce a custom signature sound favored by the talent for comfort and confidence.

New processing technology will allow you to copy your signature analog sound on your digital signal, or you may envision optimizing differently for a new, fresh voicing. Also, new PAC codec-conditioning devices are being introduced to further enhance your IBOC signal. This will provide optimal encoding by prioritizing DSP (Digital Signal Processor) utilization according to frequency response, artifacts, and separation.

AM: Unfortunately, due to the nature of the hybrid overlap of the IBOC signal, wideband AM will no longer be viable. In fact, true wideband AM receivers will most likely hear the IBOC carriers (hiss). To maintain their strong analog AM presence, stations will be encouraged to optimize their audio for, and establish a 5 kHz brick-wall filter to roll off the highs. This will not be noticed in normal automotive AM radios, however, on wideband or home hi-fi receivers it may sound slightly muffled when compared to the current analog signal. Once the transmitted audio is properly optimized with the 5 kHz rolloff, the vast majority of AM receivers will actually sound better due to the fact that most of today's receiver technology includes filters that can cause ringing (undesired harmonics) for any frequency higher than 5 kHz.

FM: If you are sourcing 44.1 kHz digital audio all the way through your studio and signal chain to the exciter, CD quality audio will now be attainable by your listening audience. This is where all the attention to detail and golden ear optimization of the signal path will pay off. If you can do it… you should!

STL

According to early IBOC adopters, the STL systems are appearing to be a major problem area and require close examination. After the transmitter upgrade and cleaning up any antenna issues, STL chains are the second most critical portion of the IBOC migration process. Again, maintaining high linearity across the bandwidth is crucial and compression algorithms are to be avoided, particularly when used after a studio codec.

Stations that are not able to relinquish their composite STL systems at this time will have to insert a conversion system to meet the AES input requirements of the IBOC exciter. Some stations have resolved this dilemma by decoding the composite back into two mono inputs for an AES converter. As stated earlier, multiple alterations of the audio are to be avoided, and the arrangement mentioned above is not recommended, and should be considered temporary.

Manufacturers are ramping up development of new HD-ready STLs as well as offering kits to update existing late-model systems. If you are replacing or performing a first-time installation of an STL, you'll need to take a close look at I/O capacities, keeping in mind that your hop may soon include a data stream in addition to digital audio. Quality STL systems should be capable of supporting 44.1 kHz sample rate, and be expandable to include frame relay and IP (Internet Protocol) transmission.

One ambitious station married a Harris Intraplex STL Plus™ to an Aurora spread-spectrum radio system for their several-mile RF link. Not only was this system capable of sending an uncompressed 44.1 kHz stereo AES audio channel, but it also incorporated 10 aux audio (compressed) signals, two bi-directional remote data channels, one LAN, one phone and one fax PBX connections.

Transmitter Site

How about the transmitter building? Lots of changes will take place here, and a close examination is required to cover all your bases.

Location Considerations

Do you have room to add a second transmitter, exciter rack (don't forget an uninterruptible power supply, or UPS, for your shiny new IBOC exciter that may take 30-60 seconds to reboot!), combiner, mask filter, etc.? It may be wise to spec an additional 2-3 foot clearance on all sides of new equipment planned to cover unforeseen changes.

One of the other sometimes-forgotten aspects of an IBOC facility upgrade is the adding of a main/aux switch if necessary, and its positioning in relationship to the combiner. Your decision will primarily be based on the power level of the backup transmitter as compared to the main, whether the digital transmitter can be operated at reduced power, and whether you wish the digital signal to be broadcast in the event of the failure of the main analog transmitter. If the main and backup transmitters produce equal power output, or if not equal, provision can be implemented to lower the digital signal proportionately, the switch can be placed before the combiner. If the auxiliary transmitter has a different power level than the main and the digital transmitter cannot be reduced, thereby upsetting the critical digital to analog power ratio, the main/aux switch will need to be located after the combiner. In this scenario the station engineer will also have to develop some means of muting the digital transmitter since it will be taken out of the RF path to antenna.

AC Power and HVAC

You'll most likely be increasing your AC power needs significantly, so your current power consumption will need to be reviewed and then applied to a total figure with the new equipment considerations. Once you've realized an aggregate AC consumption amount, add an additional 20% to afford some headroom and accommodate minor future additions. Don't forget your existing back up generator's rating will also need to be scrutinized to determine if it will meet your additional equipment needs.

If you're adding a second transmitter for separate combining, or purchasing a new common amplification system and utilize a test load for off-air repair and testing while running an aux transmitter, you'll be faced with greater cooling requirements. The combiner losses, reject load-generated heat, or less efficient linear amplifiers will produce more heat and requires greater air flow. This will need to be calculated and accommodated. If your current building simply cannot support any additional heat load, you'll want to consider situating the combiner in a 'hot room' or outside enclosure of some kind.

Grounding/Protection

Much of new technology's equipment has become more like a computer, requiring greater attention to proper grounding practices and the use of power conditioners. Will the new transmitter, IBOC exciter, or processing equipment utilize a phone line or some other dedicated hardwired link for remote control or status indication? Be sure all connections are properly terminated and isolated. If you're entering into the datacasting business, you'll need to add phone/data line surge and lightning protection throughout your serial system.

Like a PC, some of these new IBOC components need to boot up before they are ready for service. If one or more of these devices are in your critical chain, you must route power to it via a UPS to prevent an agonizing 30-second to 2-minute period of on-air silence or noise! Be sure the UPS has the capacity to power all critical components for the duration required for your set of circumstances. Power conditioners will also prove to be helpful for voltage fluctuation-sensitive equipment by monitoring for voltage variations and instantly compensating to protect susceptible circuits.

Of course the station's experience with transmitter grounding techniques still applies. Good engineering practices of grounding straps, star point grounding, and AC surge protectors, etc. for RF equipment are still mandatory and certainly desirable to protect your new transmitter and IBOC exciter investment. Inspect your current facility and verify grounding integrity throughout. Previous problems due to a deteriorated grounding system won't go away and may introduce new problems into your digital system.

Transmitter

FM: If your current transmitter is not capable of passing IBOC (narrow bandwidth, non-linear class C operation, little headroom, etc.), yet still fairly new with up to 10 years of service remaining, then **separate (or high-level combining) amplification** will be your recommended choice. Most, if not all, tube FM transmitters will be unsuitable to pass the IBOC signal without substantial cost-prohibitive modifications. Also keep in mind that in order to retain your existing coverage, your current transmitter must have the capability to boost its output power an additional 10-11% above the current TPO to cover combiner losses (1000W/0.9 = 1111W).

Lower power stations (7 kW or less) with late model transmitters running 30% or more below nameplate power may find they can upgrade them to be IBOC capable at a fairly reasonable cost. They can then operate using the **common (or low-level combining) amplification** method where the IBOC signal is also passed through the transmitter. If this upgrade cost approaches that of a new transmitter, or the current transmitter is operating at full power with no headroom available, then a new transmitter may be in order.

For further information to assist your decision making process of finding the best combining method for your station, see the "Determining Your Hybrid Method" section below. There you'll find listed the general advantages and disadvantages of each technique to supplement your planning.

AM: For AM there is only one combining method and that is low-level combining. For the lowest possible IMD products, your transmitter should be capable of audio bandwidth up to 50 kHz at the modulator to amplify the 30 kHz bandwidth audio component and 100 kHz of phase modulation of the carrier.

Also necessary is high linearity with low IQM/IPM (-35dB to -45dB) numbers. At this time, no known tube transmitters are capable of reaching the -45dB IQM figure. For PDM transmitters, a high switching frequency (>/=150 kHz) modulator is proving to be one of several qualifications, including Gain Flatness, Error Vector Magnitude (EVM), and Phase Noise – requirements that rule out many PDM units. Examine your current transmitter's specs and consult with the manufacturer to determine that it not only will pass the IBOC signal, but do so without introducing bit errors that produce a high bit error rate (BER). The next criteria to evaluate will be whether the necessary upgrade cost will approach the cost of a new IBOC-ready transmitter.

With regard to upgrading a current model **AM** transmitter, at the traditional analog audio input (which becomes the IBOC Magnitude input), an audio filter may need to be switched out for full audio passband. Secondly, the IBOC Phase signal is inserted where the oscillator normally originates. In the event of an IBOC exciter malfunction, a good idea is to install a switch/relay system for reversing this input configuration in order to return the analog signal to the audio input and restore the oscillator to its intended operation. If such a kit is not available from your transmitter manufacturer, you should consider crafting one. This rig could be remotely and/or automatically switched to quickly reestablish analog AM transmission should your station suffer an IBOC exciter failure.

Transmission Line and Antenna

Probably the most troublesome aspect of an IBOC migration plan, antenna system considerations can prove to be a difficult, complex, and expensive task. This is a high-priority area of concern requiring attention to detail in order to prevent interference issues and equipment damage, and also assure conformance to safety regulations.

Site surveys are becoming common, especially for AM, and may be essential to raise your confidence level that your system can pass the IBOC signal correctly. A spectrum analyzer and time-domain reflectometer may be used to sweep the feedline, tower, and antenna as presented to the transmitter's output, to determine flatness, impedance bandwidth and VSWR symmetry. Keep in mind these figures will carry more weight compared to yesterday's typical RF considerations, and poor numbers here *will* produce bit errors that *will* reduce your digital coverage.

FM: Generally, most FM antenna systems are proving to be IBOC capable with little or no alignment needed. VWSR needs to be no greater than 1.1:1 at analog center carrier frequency (F_c) and then flat, or at the worst, a slight smooth rise up to 1.3:1 at ±250 kHz out from F_c. If you are seeing numbers other than these, some type of antenna match optimization may be necessary, particularly for side mount bays. Refer to equipment documentation for recommended performance adjustments.

AM: For most modern transmitters, IBOC operation will require that a 50 + j 0 Ω match be presented to the transmitter output, and your antenna (or common feed point for a directional array) be fairly flat and symmetrical. iBiquity bandwidth recommendations are Hermitian symmetry out to 5kHz, VSWR of 1.2:1 or less at 10kHz and 1.4:1 or less at 15kHz, each side of carrier. This may prove very difficult for directional systems, and the data simply does not yet exist that will provide an easy answer for your system. One positive note if your AM station is (or was) successfully transmitting AM Stereo: Results so far are suggesting that these antenna systems most likely will properly transmit the IBOC signal with minimal rework!

There are many techniques for and approaches to altering an AM antenna system. With so many variables involved and so little data available, this particular topic is ideally suited to an exclusive future publication. For now, however, you may find utilizing an outside specialist in AM antenna systems will be a requirement before you can move forward with your station's conversion.

Datacasting

Is your audio delivery system MPS (ID3 V.2) compliant? Don't even know what this means? iBiquity's HD Radio technology has in place the specifications necessary to insert data onto the digital broadcast stream. At the very least, IBOC broadcasters will be able to transmit – and the first generation receivers will be able to receive – snippets of data that will include information about the current song playing.

MPS stands for Main Program Service data specification, and it is the top level structure managing the synchronous transmission of audio and its identifying information such as: song title, artist and CD title. Other acronyms you'll be learning are PAD (Program Associated Data) PID (Program Independent

Data), ODP (On Demand Programming), and many more.

Initially, IBOC broadcasts will be able to include single-line text applications such as weather, traffic, news and stocks, plus other informational metadata. Further into the future radio stations will be capable of generating user-specific or locality-based messaging, advertisements and even commerce, as forthcoming receivers may include hard drives and even bi-directional capacities.

From this point on the possibilities are up to broadcasters, receiver manufacturers, and their new business model partners. Development of new technologies (and the deployment of other media techniques) for digital radio broadcasting will become the new revenue driver for forward-looking stations. (For further reading see "How Data Transmitted Over an IBOC Station Will Be Managed: Using A Gateway to Generate Data Revenue"[1])

TEST EQUIPMENT

At this time there are very few choices for verifying performance; however, it is definitely time to get familiar with a spectrum analyzer (SA). A modern digital SA (HP 8591 or equivalent), capable of power averaging, a 300Hz/50kHz (AM/FM) resolution bandwidth, and 90 dB of dynamic range is recommended. This will allow you to see the digital carriers imposed upon the analog carrier and verify that the FCC mask is indeed being met to avoid adjacent channel interference while providing maximum allowable coverage.

The outputs of both combining approaches will have peak-to-average ratios that will require an averaging power meter for stable and accurate TPO displays. The peak detector-type meters will not correctly follow the FM IBOC signal since the OFDM (Orthogonal Frequency Division Multiplexing) carriers will be constantly increasing and decreasing in amplitude resulting in an unpredictable readout.

For **high-level combining**, you may want to consider adding a second power meter to easily and consistently verify the power ratio between the digital and analog transmitter outputs. By looking at the input of the reject load from the combiner, and doing a little simple math utilizing the power level displays of the transmitters, you can derive the actual digital portion of the total output: Subtract the total power output on the combiner output monitor from the displayed TPO of the analog transmitter. Then subtract that result from the reading on the reject load Wattmeter. Subtracting *that* result from the digital transmitter's displayed power will give you the power level of the digital signal. This will afford you a confidence reading that depicts the correct IBOC specified power relation of -20 dBc.

AM: For verifying a transmitter's IQM/IPM performance, a C-Quam AM Stereo Modulation Monitor can be brought back to life. IQM (Incidental Quadrature Modulation) defines the amount of crosstalk from the magnitude to phase channel at the quadrature point within the PA. IPM (Incidental Phase Modulation) is a measure of the amount of phase modulation created within the system with only the amplitude input of the transmitter being driven. Numbers less negative than -35 to -40 dB will cause the transmitter to broadcast bit errors, contributing to reduced digital coverage.

For data integrity measurement functions, an AES digital audio analyzer will be a requirement for troubleshooting your digital audio chain. These types of devices must be able to determine data errors and specify the type, thereby pointing to the possible source. Self-generating pure digital audio bitstreams is a feature that should also be included to assist the technician. To subjectively audition the decoded AES audio, revealing any inaccuracies there, a speaker or headphone jack should be offered as well. Whether your AES path extends all the way back through your console or is simply an A/D converter before the IBOC exciter, you'll want to verify and audition the digital stream immediately prior to the PAC encoding.

The ability to read and measure PAC and data transmission impairments (such as the eye pattern for DTV signals) will be part of a future dedicated IBOC Monitor. Such a tool does not exist as of this writing, so for now if you can't acquire an iBiquity Reference Receiver, you may need to settle for a consumer receiver. Some stations already have an automotive receiver and speakers placed in a transmitter hall rack for local 'listening experience' checks. Such an arrangement could be an inexpensive requirement for a new HD system's demodulated and decoded audio assessment.

Also early on, a station may wish to equip a car with an IBOC radio to help determine what your digital coverage actually is. Keep in mind that certain transmitters may be able to 'pass' the IBOC signal but may not provide the expected coverage due to transmitter and antenna related non-linearity issues. These concerns will influence the cliff effect point where the receiver's error correction will not be able to keep up with erroneous data, and the receiver will be forced to step-down to analog mode.

TRAINING

"Knowledge is your first line of defense for continued transmitting reliability" is the Harris Broadcast Technology Training Center's motto.

It is also the truth.

But knowledge is also a *prerequisite* for new equipment purchasing decisions, transmitter plant planning, installation and initial turn-on procedures. In addition to product brochures, internet sites and salesman recommendations, a manufacturer or third-party instructional program is an ideal way to really learn about the product you're planning to invest in. It is also a great way to network with other professionals as they carve their way into new technologies right along side of you.

DETERMINING YOUR HYBRID METHOD

This section lists advantages and disadvantages of hybrid methods, to help you determine the best IBOC migration path for your station. (For that matter, this *entire* paper is to be used along with common knowledge, sound work practices, organization, and attention to detail to best process the vast amounts of gathered data in order to pursue your course towards IBOC.)

In general terms, the factors to consider when determining the best way to create your IBOC hybrid signal include:

- Operating power (current v. desired TPO)
- Availability of transmitter space
- Cooling capacity
- Availability and cost of tower space
- Initial cost
- Desired redundancy
- Existing equipment's IBOC capabilities
- Complexity tolerance

Separate (High-Level Combining) Amplification

In addition to an IBOC exciter, this method requires the purchase of a second digital-only transmitter, a high-power combiner with reject load, a patch panel, and coax, etc. For FM stations currently operating at 7 kW TPO and above, this will be the most likely scenario.

Advantages:

- Virtually all existing FM transmitters can continue to be utilized for the analog portion of the IBOC hybrid
- Digital-only transmitter – new design and features
- Down time on one transmitter may not affect operation of the other

Disadvantages:

- Greater space requirements: two transmitters, combiner, reject load, etc.
- 10-11% additional RF power needed from current analog transmitter
- Injection Loss: 90% of IBOC power, 10% of analog FM power wasted
- Antenna and dummy load changes can alter isolation in combiner (good load characteristics are essential)
- May be more expensive to implement
- More complex

Common (Low-Level Combining) Amplification

A single new transmitter purchase (or modification of existing, if possible) to broadcast both analog and IBOC signals will be required. For FM stations currently operating at 7 kW TPO and below, this will most likely be the recommended choice, and is the only **AM** method as mentioned above.

Advantages:

- Saves space, only one transmitter
- Less complex
- Both FM and IBOC using latest technology transmitter

Disadvantages:

- Linear amplification and possibly a mask filter required
- Single transmitter loss takes both analog and digital off-air
- If existing transmitter: Powered back approximately 30% for new peak power requirements (or more amplifiers necessary to achieve original TPO)
- No single-box solution for high power FM stations

The main criteria regarding 'modified' v. 'new' is whether your current transmitter can be modified to cleanly pass the IBOC signal, and whether this modification can be performed for a cost that is significantly less than a new transmitter. You'll also need to consider whether even with a modification an additional mask filter will be required, further increasing the cost and physical footprint.

Separate Antenna

This method utilizes two completely independent transmitters, feed lines and possibly antennas.

Advantages:

- No combiner and associated losses
- Smaller IBOC transmitter required (20 dB below main TPO – only 100W digital needed for 10kW analog when both antennas have identical gain)
- Most efficient operation of existing main transmitter
- Lowest operating cost

Disadvantages:

- Additional antenna, feed line, tower space required
- More variables in performance and coverage
- Still experimental
- May be complex

Other issues to consider for Separate Antennas:

- Isolation required between antennas – 36 to 40 dB
- Mounting on same structure, at comparable height for comparable terrain propagation
- Antenna gain (ERP) to maintain signal ratios
- Vertical radiation pattern issues (close-in)

WHAT NOW? WHAT LATER?

What were the results of your Site Performance Inspection? If your AM station's antenna system is going to require a major rework, you'll be forced to spend upgrade dollars on site improvements. Early A/D conversions, studio and STL enhancements will have to wait for the next update cycle. Any major site overhaul decisions will all have to be weighed according your station's requirements and abilities.

How far back from the transmitter's new IBOC exciter can you afford to make the switch to digital? If you're budgeted to replace your console soon, you'll find that some of today's digital consoles cost less than their analog counterparts. Some stations are choosing a new STL to use as their A/D conversion point: An analog studio signal input resulting with a digital output at the transmitter site. Other options are using an audio processor for the analog to digital transition, or just a simple A/D converter box placed just before the IBOC exciter.

Will you jump into the datacasting arena immediately – or sit back and wait to see what happens? Much is yet to be developed and much stands to be gained in this field. The recommendation here is to balance being first on the block with keeping up to speed on the advances being made.

What should your station plan for? Most stations will find they will be replacing a transmitter or adding a new model to their lineup. Coupled with the new IBOC exciter, this purchase is a minimum requirement to initiate your IBOC service. Your specific set of conditions including budget constraints, existing equipment, complexity tolerance and strategy for the future will influence your journey down the IBOC path.

SUMMARY

In conclusion, the IBOC migration path may be based on new technology and wrought with complexity. It also will initially be a costly proposition. But, ultimately it will be much more than an enhancement to existing technology. Not only will your listeners appreciate the improvement in audio quality and comprehensive coverage, but station management and advertisers will have an innovative vehicle with which to generate new revenue streams.

This may well be one of those defining moments in broadcast history where it truly is up to us and our collective imaginations to create and develop applications that will have far reaching impact. Now that even AM radio can broadcast 'in color', the future should be able to provide new forms of entertainment utilizing the very airwaves that have served us so well for so long.

So while AM and FM stations are choosing the best IBOC migration path for their stations, I hope we can challenge ourselves to begin the process of thinking ahead. What else can we do with this new thing called high definition digital radio?

IBOC READINESS: A HANDS-ON CHECK LIST

The following list is a collection of issues that developers and early adopters have encountered, and may benefit your station as a preliminary guide toward your IBOC migration process. These suggestions and recommendations should help you sort through the diverse elements of information, and serve as a reminder and thought-evoking process for unknown or sometimes-overlooked tasks.

Studio Considerations – New Console

☐ Determine number of analog, digital, and miscellaneous sources

☐ Exacting level controls in place just before A/D conversion such as a brickwall limiter

☐ Master clock requirements

☐ Compare items above with manufacturer specifications with future expansion in mind

Studio Considerations – Signal Routing

☐ Upgrade mono station to stereo – if AM Stereo now, provide mono signal for analog portion of IBOC

☐ Upgrade to AES distribution amplifiers

☐ EAS (Emergency Alert System) interfacing

☐ Digital router switch system requirements

☐ Determine CAT-5 cable run amounts for digital audio/data, and install

☐ Verify clean installation and proper grounding, termination, lightning and surge protection for all equipment and cable runs

☐ Install power conditioning for voltage sensitive equipment

☐ No, or very few cascading codecs or digital sample rate conversions

☐ Post-microphone monitor (and processing if necessary) system in place

☐ Automated RF carrier alarm or non-air personnel monitor delayed signal

☐ Uninterruptible Power Supplies for all PC based or slow start-up equipment

☐ Internet interface gateway equipment in place

STL Considerations

☐ Already fully digital operation

☐ No, or high quality compression codecs

☐ Ability to link additional data streams

☐ Can be easily updated to IBOC-ready

☐ If composite, convert to AES prior to IBOC exciter

☐ Back up STL capability

Processing Considerations

☐ Fully digital operation

☐ Determine processor location – studio vs. transmitter site

☐ Analog AM: 5 kHz brickwall rolloff in addition to processing optimized for 5 kHz bandwidth

☐ Digital FM: Full 44.1 kHz bandwidth possible – medium dynamic compression recommended

Transmitter Site Considerations – Mechanical

☐ New aggregate HVAC + 10% upgrades as necessary

☐ New aggregate AC power + 10% upgrades as necessary

☐ Backup generator upgrade to meet new needs

☐ Room for additional transmitters, racks, combiners and reject loads, etc.

Transmitter Site Considerations – Transmitter

☐ Determine combining method

☐ Purchase and install new transmitter, IBOC exciter, combiner and reject load, etc.

☐ New remote control (including mute and power level) and status lines, data lines

☐ Uninterruptible Power Supplies for all PC based or slow start-up equipment

☐ Necessary RF plumbing and hangers for new combiner

☐ New or repositioned main/aux switch

☐ Verify clean installation and proper grounding, termination, lightning and surge protection for all equipment and cable runs

Transmitter Site Considerations – Antenna

☐ Verify linearity across full bandwidth - ±250 kHz for FM; ±20 kHz for AM

☐ Verify symmetry

☐ Previous AM Stereo operation antenna system may only require minimal rework

☐ Optimize antenna/matching as needed

☐ Separate antenna combining method STA filed at FCC

☐ Order new antenna and transmission line, or reconfigure and align existing for separate antenna method

Test Equipment Considerations

☐ Digital spectrum analyzer

☐ Averaging power monitor(s)

☐ C-Quam AM Stereo Modulation Monitor

☐ AES digital audio testing device

☐ iBiquity Reference Receiver, or IBOC capable auto or home receiver

☐ Future IBOC monitor - TBD

REFERENCES

[1] *How Data Transmitted Over an IBOC Station Will Be Managed: Using A Gateway to Generate Data Revenue.* David Maxon, Managing Partner, Broadcast Signal Lab, LLP; and Paul Signorelli, CTO, Impulse Radio, Inc. (See Datacasting Whitepaper link at http://www.impulseradio.com)

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