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HD Radio with RTL-SDR

As someone who sometimes tinkers with radios, I sometimes just scroll through channels with a cheap r820t2 dongle and gqrx.

Intro

Spectrum

The latest thing I noticed was bars of what is presumably digital signals alongside of some commercial FM radio stations.

(todo: add screenshot here)

I questioned whether it was interference, but ruled that out since it wouldn't be in such a clean pattern, and the very consistent bandwidth is very reminiscent of digital radio signals.

Digital Radio

At the time, the only digital radio standard I knew of was DAB, which is used in some parts of Europe.

Turns out, there's an (IMO crappier) standard for digital radio used in North America called HD Radio.

Some downsides I see

Proprietary

Unlike the rather open DAB standard, HD Radio is proprietary, which is enough for me to hate it already.

This means that if you even want to receive or broadcast HDr, you'll probably get hit with hefty fines.

It's also going to (IMO) slow the rate of adoption, since if you're going to spend so much to upgrade a station, who is going to listen to it?

Needs new $$$ receivers

The reason AM/FM radio still works and is kind-of used in the 21st century is that it's ridiculously simple to receive (more so for AM then FM), and for cheap.

Digital radio already has a major hurdle there. If I'm going to spend $100 on a new radio, that's not going to happen *(unless it's for ham radio).

Practically everyone has an AM/FM receiver in their house, probably in an old CD player, boombox or car. Why would someone spend that much money on a new radio?

At that point, you can just pay for Deezer/Spotify.

I mean, I get why it's more expensive, just like DAB, you need what are basically low power CPUs, since you're decoding a digital compressed audio stream.

AAC vs MP2

Adding to the cost and proprietary nature is that HD Radio uses what basically amounts to an AAC audio stream.

Now, at least HE-AAC isn't terrible at low bandwiths, and can at least usually do closer to fullband?

DAB for comparison uses MP2. Some users may be familiar with MP2 as some DVDs used it instead of AC3 for the audio track.

As a pro to HDR vs DAB, MP3, like MP3, is a rather old codec. I find it's only usable at ~ >192 kbit/s, but suffers far worse then AAC at low bitrates.

This means that theoretically at least, a 64 kb/s AAC stream is better then MP2.

On the other hand, AAC is very very patent encumbered.

MP2 has the advantage that all of it's corresponding patents have since expired so anyone can use hardware/software for MP2 without nasty royalties.

AAC is expensive to implement and I guess just hope to not get sued if you're using it.

OPUS really is ideal here - royalty free, which means you can get more widespread adoption, and it crushes the other codecs at low bitrates.

Speaking of sound at low bitrates:

Limited stream bandwidth

From what I've seen, it's also limited to ~96 kbit/s transmissions with up to 4 streams.

This means that stations need to allocate that limited digital bandwidth among all the content they want to stream.

I've seen some stations do a main stream at 64 kbit/s and a secondary at 32, and other stations that do 32/32/32. I've also seen 48/16/16.

That's not a lot of bits to go around.

I have yet to see a station use all four and I'm sure it would sound terrible if they did.

As mentioned above, AAC really starts to break down at 64 kbits and below.

HD? More like compression

When I first read the name “HD Radio” I assumed it was some form to do lossless or high bandwidth audio signals.

“HD”. What a joke that was.

True HD radio might be neat, since while FM doesn't have (digital) compression artifacts-, the volume levels are compressed with that is probably a brick-wall compressor–.

-except the few stations where I can clearly tell that they are just broadcasting off a s—y 64 kbit/s mp3 stream…

–ie: but a multiband compressor, and crank the ratio dial to the right.

I mean, I can kinda see why. You need to get a high SNR so people further away can actually hear your stream, but don't want to pass the max modulation limit so the FCC doesn't come knocking.

Digital on the other hand is either all there or none, so you could get much higher sound quality.

Digital TV with MPEG-2 basic compression allowed us to send 720p60 and 1080i60 signals after all, which was a huge step up from NTSC/ATSC*.

*That's also because video can be compressed digitally more then audio generally but the point stands. no random noise in a DTV signal.

Anyways, back to my point. HD-Radio uses up to what I counted to be around 100 kbit/s of audio.

Even with one stream, that would sound bad with mp2 and mp3, usable with vorbis and aac, and pretty good with opus.

But of course, stations like having a substream so most of them use 64 kbit/s or even 32 kbit/s for their main stream.

As advanced as AAC is, it still sounds terrible at 32 kbit/s. Even at 64, it sounds noticeably **worse** then the FM counterpart.

I heard a talk news AM station in a sub-station at 16 kbit/s, I guess it's usable for voice, but still sounds terrible.

For comparison, OPUS is also fine at around 64 kbit/s. You can hear the compression, but it's bearable, but it also starts to get worse around 32 for stereo music.

HD Radio sounds way worse overall then FM though. Bonus points for feeding the volume compressed-af signal to the digital stream too, even though it's unnecessary. Back to the loudness wars I guess.

Bandwidth usage

HD-Radio signals take up a lot of space.

I guess we're lucky here is NA that we don't have many stations in urban areas.

In Europe, most stations only get 100 kHz spacing, and at most 200 kHz.

When I was in Istanbul, they had over 100 stations in the city on all even numbers (100.0, 100.2, so on)

(they also had some questionable stations with questionable modulation on some off numbers interfering with everyone else…)

Meanwhile, in Toronto, forget about 200 kHz, from my room, I can only pick up ~15 stations in total. We have the space here to do a digital stream beside fm stations.

What I'm trying to say is that in Europe, allocating almost 100 kHz on the sides of the station will be impossible, since other stations are there.

Compared to DAB, HDr takes up more bandwidth from what I can tell. You'd probably need to use a different part of the spectrum.

Note: You can also do what Norway did and I guess just kill off FM and switch to DAB. I don't recommend this approach.

See my notes above, namely the $$$ receivers part for why.

Why would I listen to it

If I wanted to hear a crappy 64 kbit/s AAC audio stream. I'd just press the listen online button on their website.

Surprise! Most people already have a computer/phone with an internet connection that can play those streams.

Not to mention, by the time I open a bad sounding HDR stream, I'd just play the playlist I WANT, WITHOUT ADS from Deezer/Spotify.

I only put up with ads on FM since it's free to listen to, and FM radios are basically free most of the time.

I ain't paying 100$ to listen to ads at 64kbit/s where I don't even get to pick the music, and there are only 4 stations.

Even if a digital radio was free, I think it would gain limited adoption in this day and age.

Receiving signals on Linux

There is a program on GitHub that uses some reverse engineering to play the modified AAC streams.

You can find it here: https://github.com/theori-io/nrsc5

There's also a Python GUI should you prefer here: https://github.com/cmnybo/nrsc5-gui

It works on the cheap R820t2 receivers without many issues (except for the garbage antenna not receiving anything useful)

I guess the GUI can also show a traffic map and weather radar, if the stations bother broadcasting that. but again, anyone with a receiver fancy enough to show a traffic map probably has a freaking cellphone with google maps that also acts as navigation.

Conclusion

Maybe I'm acting like an old-person here, but the simplicity (and cheapness) of AM/FM made is so prevalent. The fact that it was so prevalent was what made it good.

Need to reach a city in an emergency? Chances are, 70% of them have at least a crappy radio.

Nobody (that I know of) would buy an HD Radio receiver (or DAB receiver for that matter). By the time you start putting a CPU and everything, that's already a basic computer.

For that money, why listed to compressed radio with ADS when you can just fire up a streaming service.

Thanks for reading. Leave any comments/questions down below.

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