Some Ideas for Medium Wave DXing

This season, Christoph Ratzer, OE2CRM, triggered a deeper interest in medium wave reception at me; thanks! It also led to discover some aspects of Simon Brown’s, G4ELI, excellent SDR software V3 of which I had been unaware, so far.

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Live Offset

Let me start with what I call “Live Offset”. The concept is easy, as medium wave broadcast has been designed mainly to serve a very limited region – compared to HF broadcast. This concept bears the chance to pack many stations onto one single channel. To avoid interference, they must be separated by propagation conditions and/or time. ITU provides a workflow for this, consisting of e.g. Rec. ITU-R P.1147-4 for calculating field strengths and Rec. ITU-R BS.560-4 for calculation protection ratios.

These recommendations are meant to work only within the service area of a station. DXing, as per definition, is receiving stations outside their intended service area.

If you can hear the station, you don’t need any other tool than a receiver and your ears. But as actual carriers on a given channel may differ from a fraction of a Hertz to even several 100s Hertz from each other, this “offset” is a strong tool to raise signals which are too weak to be heard.

Even more: these “offsets” are often unique to a station. Together with sign on/off and/or fade-in/out times, this pattern maybe some kind of a fingerprint. There even is a collection of a plethora of these offsets around – see the “Offsets…” hyperlink at each frequency entry of the indispensable MW List.

Simon’s V3 software can show these offsets during reception “on the fly” – maybe live or from a HF recording. You simply have to follow the screenshots and their captions.

Figure 1: Playing an HF file 1,536 MHz which had been recorded at a center frequency of 1.008 kHz; tuned to 801 kHz.
Figure 2: To get the resolution needed to separate the carriers as best as possible, you have to change “Resolution” from “Default” to “x8” and ...

Figure 3: ... change likewise “Speed” from “Default” to a much lower value like “10”.

Figure 4: Then center in on the tuned frequency, 801 kHz in this case – just click on the “center” icon, where the mouse pointer is. Compare this Figure to the position of spectrum/spectrogram on Figure.
Figure 5: In the last step, maximize "Zoom". The window is now reduced to about 30 Hz width, and in the spectrogram you can easily see that there are at least four stations on 801 kHz, and read their offsets.

Figure 6: As this method is very sensitive, you may even see the pattern of miniscule signals – as here the sign on of Ethiopia just under 890,990 kHz with their definite s/on ad scheduled; see next Figure.

Figure 7: MW List’s Offset feature matches offset as well as sign on, revealing EBC Ethiopia being the weak signal to the left of TRT 1 Radyo Bir. You will hear only the latter.
Figure 8: Here I stepped through the hours on 1.400 kHz, an exclusively American channel. Nothing seen at 19:00 UTC, but at 20:00 UTC the first Canadians begin to fade in, followed by at least five other stations. CBC Gander remains the strongest one and had been also identified by their CBC News at 23:00 UTC.

Figure 9: The spectrogram shows a pattern like a pearl necklace, with a faint carrier on the left. This is thanks to three stations on this channel, 891 kHz. Two are apart about 0,3 Hz, a difference too small to be separated into two visible carriers with this method (there are others, revealing even smaller differences, but of course they need more time). “Signal History” on the bottom shows the beat of 0,3 Hz by the bigger hills, and the left carrier by the cockscomb-like pattern, topping the hills. See next Figure, to get a more detailed view.
Figure 10: A more detailed view of part of the data, made with (free) web service Plotly. Software V3 takes a probe each 50 ms, so this method has an upper frequency limit of 10 Hz. It is an excellent tool to reveal even very tiny differences. Even if transmitters are GPS-controlled, there will be a phase difference on the air which will result in a visible effect.

All screenshots above had been made “on the fly”, i.e. during actual listening to the stations. With “Signals Analyzer” tool of software SDR Console V3, you may, however, go down to a resolution of 0,023 Hz – but “offline”, see next Figure.

Figure 11: Here you see 891 kHz ±5 Hz at a resolution of 0,023 Hz. You see different behavior of different carriers. From these details like sign on/off, fade-in/out or frequency control (the zig-zag) you may guess their location which had been done for some. Note, there is a very small drift upwards of the receiver.
Signal Level, Intelligibility and Signal-to-Noise Ratio [SNR]

At last, let’s have a very short look to signal, carrier and noise.

Figure 11 shows the level of the carrier of IRIB Radio Qom/Iran on somewhat odd channel of 1,467,368 kHz. The advantage of this example is, that you can be sure that just this one stations is measured within the 50 Hz filter.

I had measured the carrier at 50 Hz bandwidth. SDR Console V3’s “Signal History” took on measurement at each 50 ms, resulting in nearly 20,000 points – the black curve in Figure 12. The red stepped curve shows the estimated overall intelligibility of the audio. At no big surprise, it largely follows the carrier level.

Figure 12: IRIB Radio Qom, 3.726 km, 100 kW – intelligibility largely follows signal strength, as each about +8 dB causing a rise in QRK of one point.

The measurement of the audio SNR is another animal. The audio on the upper sideband (75 Hz from carrier to 1.575 Hz) peaks at 65.5 dBm at exactly this bandwidth, whereas the noise level is about 92.7 dBm. This results in a peak-SNR of 27.2 dB.

To calculate the real SNR is quite complex, please see here for an introductory paper. Generally speaking, you have to compare the noise energy to the energy of signal plus noise. One approach is free PRAAT software: Compare “mean-dB intensity in SELECTION” via Intensity->Get Intensity menu) of two parts of an audio recording: pure noise and signal plus noise. Then subtract the noise from “signal plus noise”, and you get some estimate of the SNR in dB.