Hi, Ms. Noland.

I am an 81-year-old “retired” electronics engineer and patent attorney who worked for RCA, GE and Samsung. In the 1970s I designed the first monolithic integrate circuit more than 100 mils square, the count-down FM stereo decoder that was used in FM and TV receivers for many years. I participated in ATSC up to 2 or 3 years ago.

My current concern is that while double-sideband COFDM allows fairly simple receivers with twenty years or so manufacturing experience behind us in their design, DSB-COFDM is pretty clearly not the best of the best technology insofar as over-the-air television broadcasting is concerned. Most of the current R&D seems to be funneled towards fiber optics communication, without directing much carry-over to RF over-the-air communication.   
  
COFDM dual-subcarrier modulation (DCM) will offer significantly better SINR than DSB-COFDM, enough so that 256QAM of OFDM carriers should be practical for DTV broadcasting. This provides 33% greater data throughput than with 64QAM. If one elects to stay with 64QAM of OFDM carriers, reception range over flat terrain should be at least 33% better.

My “R&D” journey towards reaching these conclusions began nearly 3 years ago when I reconsidered some North American Philips work on COFDM MIMO done a decade before. Monisha Ghosh and others found that diversity combining two DSB-COFDM signals at bit level, rather than symbol level, could improve SNR by 8.54 dB. This is about 2.5 dB better than the 6 dB gain obtained by symbol averaging.

I recognized that the customary practice of synchrodyning DSB-COFDM signal to baseband folded the frequency spectrum in half to obtain 6 dB gain in SNR, by symbol averaging the OFDM symbols in the lower and upper sidebands. It struck me that demodulating the DSB-COFDM signals as if it were single-sideband could support diversity combining the lower and upper sidebands at bit level to improve SNR by 8.54 dB.

I thought that an independent-sideband approach to demodulation might be the better way to demodulate the DSB-COFDM signal, borrowing a little from Leonard Kahn’s work on AM stereo. I designed some receivers DSB-COFDM signal that demodulate the lower AM sideband as if it were single-sideband and that also demodulate the upper AM sideband as if it were single-sideband. This work is described in considerable detail in a U. S. patent application titled “Double-Sideband COFDM Signal Receivers That Demodulate Unfolded Frequency Spectrum”,

filed 3 July 2017, published 1 February2018 as US-2018-0034677-A1, and found by the USPTO to contain allowable subject matter. Unfortunately, I wasn’t able to interest any company to support filing of non-US patent applications financially. I hope to sell the patent when it issues.

Larger monolithic IC is needed for the new-design receivers, but this should not be that formidable a problem nowadays.

When I contemplated my new designs of DSB-COFDM signal receivers, it occurred to me that they might be readily adapted to receiving COFDM dual-subcarrier modulation (DCM) signals. I described my initial thinking about this in a U. S. patent application titled “Communication Systems Using Independent-Sideband COFDM” filed 29 October 2017 and published 3 May 2018 as US-2018-0123857-A1. Unfortunately, thus far I haven’t been able to interest any company to support filing of non-US patent applications financially. There is still some sort of window in which non-US patent applications could still be filed, if you are interested.

I have since done considerable work concerning COFDM DCM signals wherein the lower and upper sidebands convey the same coded data, but do not mirror each other.

QAM symbol constellations that convey the same coded data in the lower and upper sidebands can exhibit labeling diversity. That is, the mapping of coded data to lattice points of QAM symbol constellations in the lower sideband can be different from the mapping of coded data to lattice points of QAM symbol constellations in the upper sideband. More than a decade ago Panasonic did considerable work concerning the use of labeling diversity for QAM symbol constellations used in mobile communications.

Panasonic Corporation sent a paper titled “Enhanced HARQ Method with Signal Constellation Rearrangement” to the TSG-RAN Working Group 1 for discussion during its Meeting #19 held February 27- March 2, 2001 in Las Vegas, Nevada, USA. Combining two 16QAM transmissions with labeling diversity between the labeling of the lattice points in their respective square 16QAM symbol constellations was reported to provide a 1.2 dB advantage in SNR, over Chase combining two 16QAM transmissions without labeling diversity. Combining two 64QAM transmissions with labeling diversity between the labeling of the lattice points in their respective square 64QAM symbol constellations was reported to provide a 1.8 dB advantage in SNR, over Chase combining two 64QAM transmissions without labeling diversity. Turbo coding rate was ¾ both for 16QAM transmissions and for 64QAM transmissions.

I speculate that combining two 256QAM transmissions with labeling diversity between the labeling of the lattice points in their respective square 256QAM symbol constellations will provide more than a 2 dB advantage in SNR over Chase combining two 64QAM transmissions without labeling diversity. A more than 4 dB gain in SNR from applying labeling diversity in addition to diversity combining at bit level, rather than symbol level, make the possibility of using 256QAM of OFDM carrier more likely to be practical from broadcasters’ commercial viewpoints.

Others have used labeling diversity of COFDM DCM signals to reduce PAPR significantly. While Doherty power amplification has made PAPR less of a concern to broadcast engineers, high PAPR still does present problems for receivers.

COFDM DCM signals preferably position OFDM carriers in the lower and upper sidebands that convey the same coded data so as to have uniform spacing between them, rather than them being spaced similarly from mid-band carrier as done in DSB-COFDM. SINR will be better since receivers can be designed better to overcome narrowband interference and selective fading. Such SINR advantage can be obtained, no matter the size of the QAM of the OFDM carriers.

If one is willing to accept memory in the receiver, COFDM DCM can provide capability for overcoming drop-outs in received signal energy of a second or so, which capability is particularly useful in mobile reception. This can be done without reduction of data throughput (in contrast to the halving that DSB-COFDM retransmission schemes suffer).

I don’t have the resources to simulate this stuff myself and haven’t been able to interest any academic persons in doing it. It may be a little beyond what one can do with MATLAB.

If you have any suggestions as to how this technology could get out of a blind alley, I would appreciate them.

I am awaiting license from the US government to disclose my latest developments. If you like, I can send the most recent work to you once I receive such license.

Best Regards,

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