Wireless Communication HW6

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Problem 1: Capacity of a SISO AWGN channel

Part 1

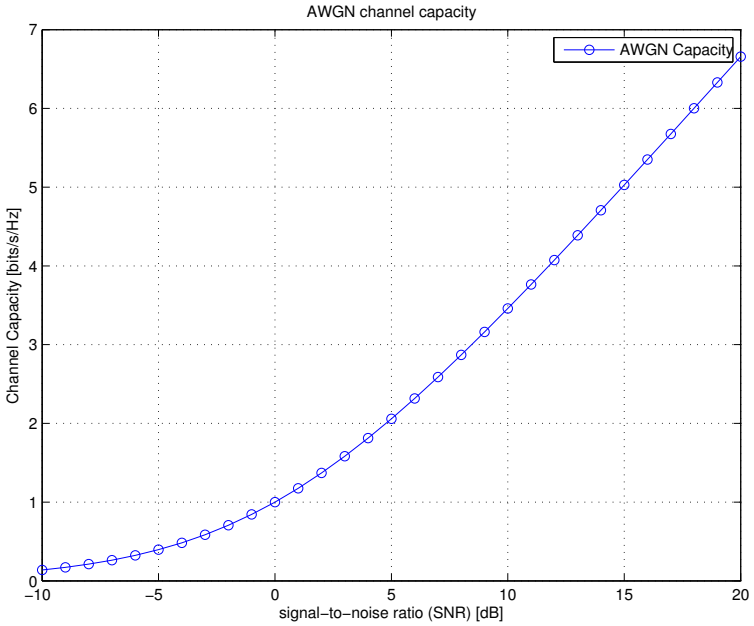

Figure 1: AWGN channel capacity

Part 2

In general, for QPSK one can achieve 2 bits/s/Hz. But at lower SNR it would be capped by AWGN channel capacity.
Therefore, it will be minimum of 2 bits/s/Hz and AWGN channel capacity

Part 3

Simplified mutual information term:

$$\mathbb{I}(\mathbb{X};\mathbb{Y}) = \frac{p(y|x)}{\sum_{s\in\chi} p(y|s)p(s)}$$

Part 4

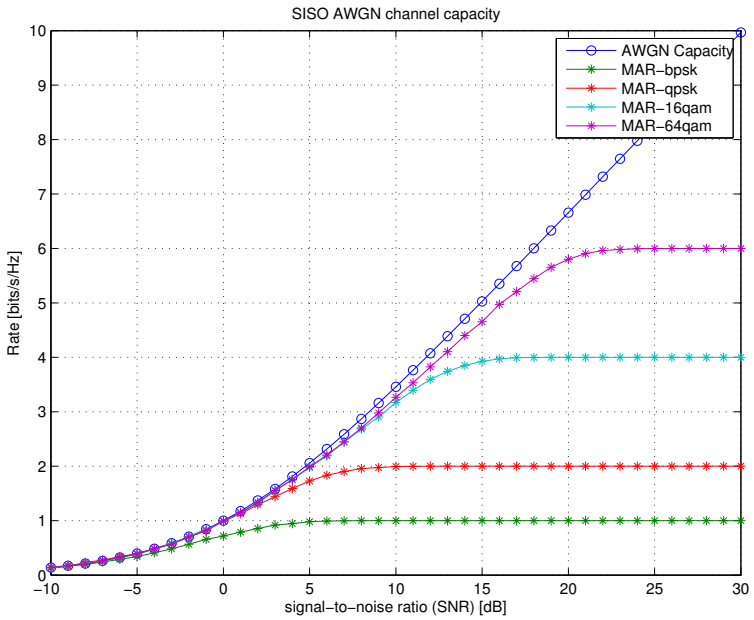

Figure 2: SISO AWGN channel capacity

Part 4

Yes the simulation results confirm the answer in part 2.

Problem 2: Capacity in MIMO Rayleigh Fading Channel

Part 1

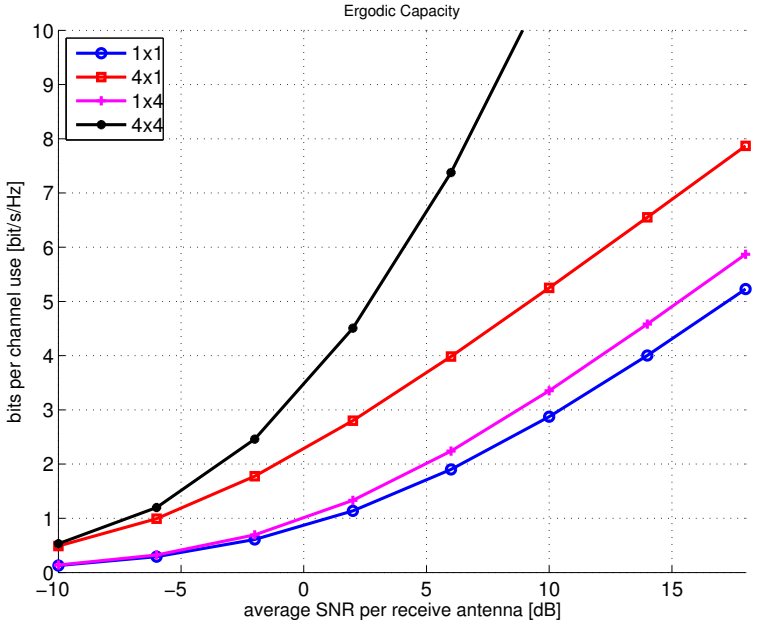

Figure 3: Ergodic capacity

Ergodic capacity increases with SNR which is expected.
Capacity also increases as the number of spatial streams available increase which is also expected.
So, yes the curves make sense except there is a difference between 1x4 SIMO and 4x1 MISO case which is unexplained.
Ideally, SIMO and MISO should match if we do the optimal thing.

Part 2

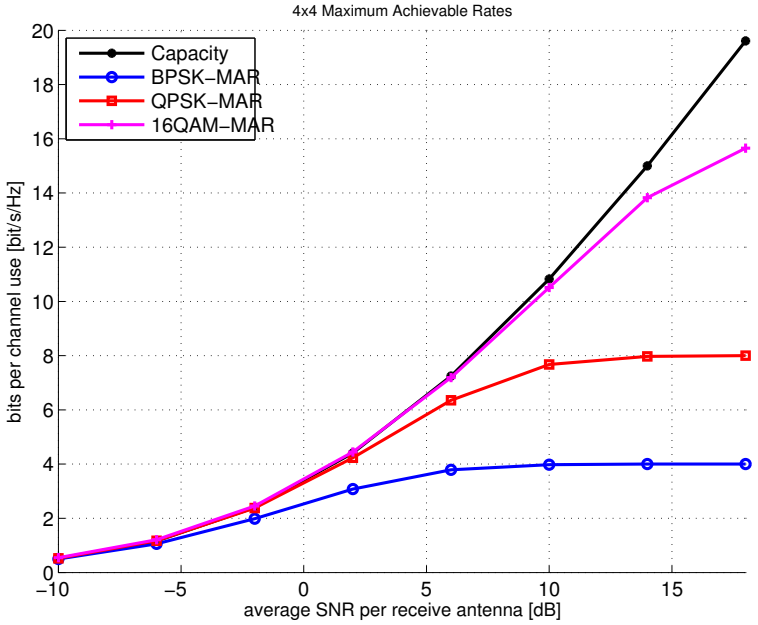

Figure 4: 4x4 Maximum Acheivable rates

If we are looking at the SNR range below 5dbm QPSK and 16QAM seems optimal. But in actual there would be lot of retransmission as QPSK or 16QAM would try to push higher throughput than channel can take.

Part 3

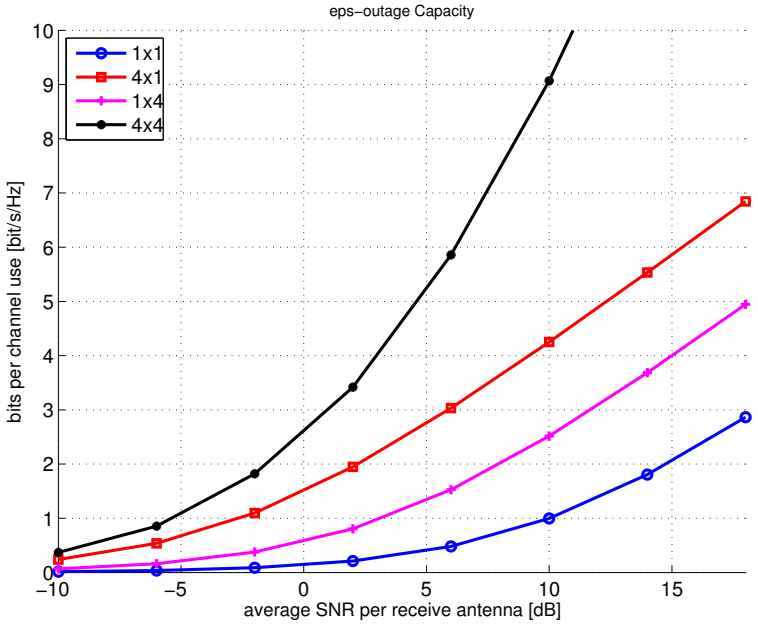

Figure 5: epsilon-outage capacity

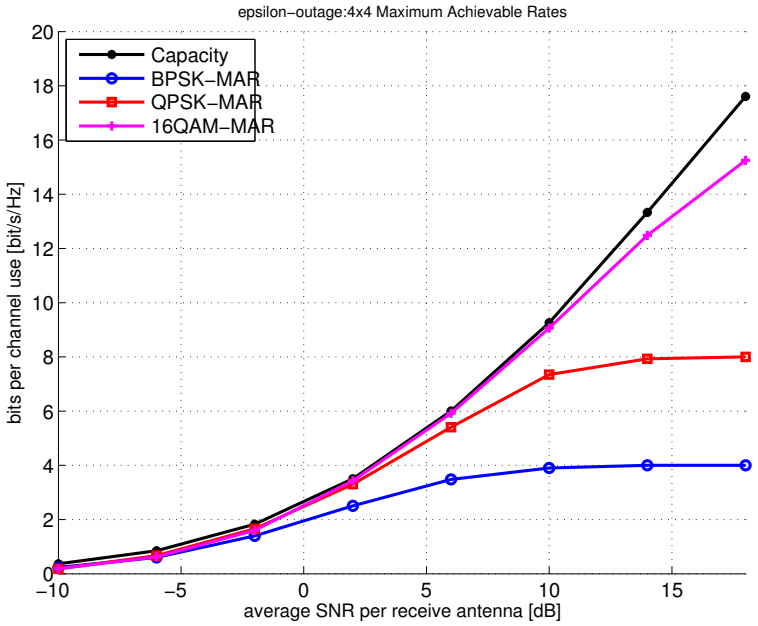

Figure 6: epsilon-outage 4x4 Maximum Acheivable rates

Problem 3: Complexity of Zero Forcing MIMO Detector

Part 1

$$Number of multiplication = 4 * nTx * nRx$$

Part 2

$$Number of multiplication = 2 * nTx * nRx + 4 * nRx * sum(0 : nTx - 1)$$

Part 3

$$Number of multiplication = 4 * nTx * sum(0 : nMT - 1) + 4 * nTx^3$$

Part 4

$$Number of multiplication = 4 * nTx^2$$

Part 5

$$Number of multiplication = 2 * nTx * nSymbols$$

Part 6
As can be seen below Part 3(inverse of Gram matrix) is the most complex one.

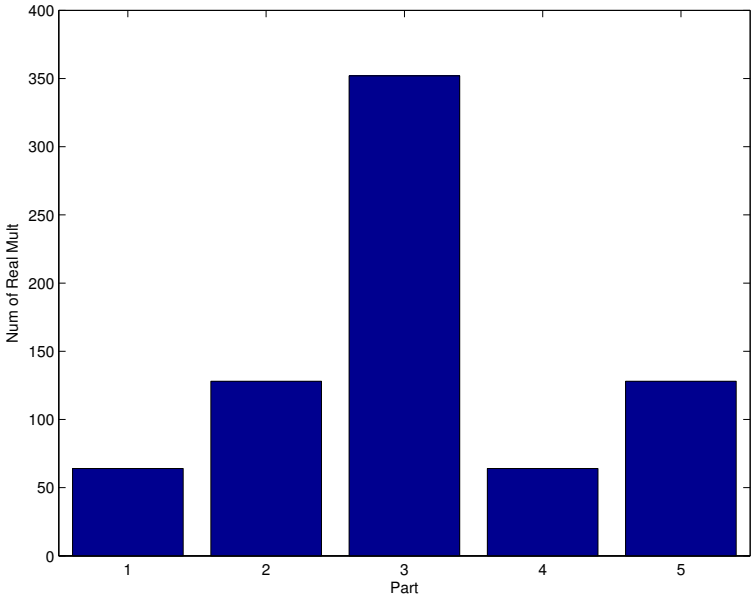

Figure 7: Complexity of each part

Part 7

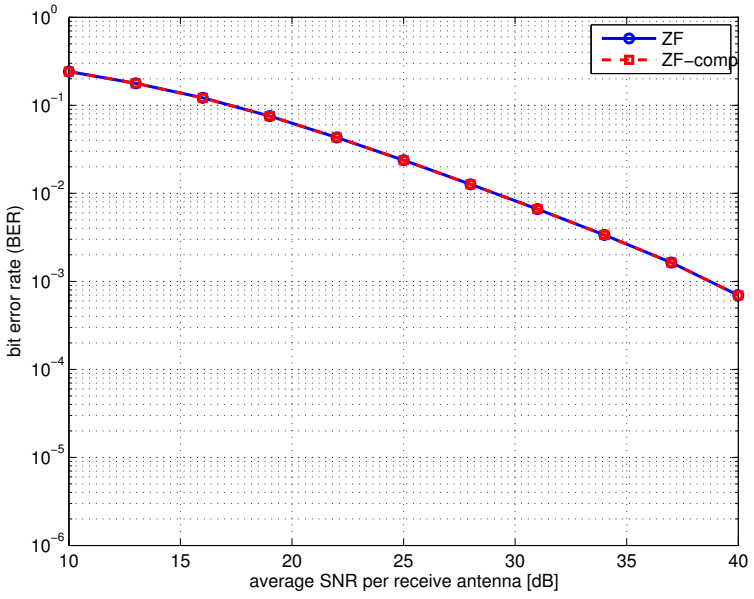

Figure 8: Comparison of two ZF implementation