Networked Life: Homework 1

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1. **Answer:**

   (a) By coding on MATLAB, the ten iterations are plotted below:

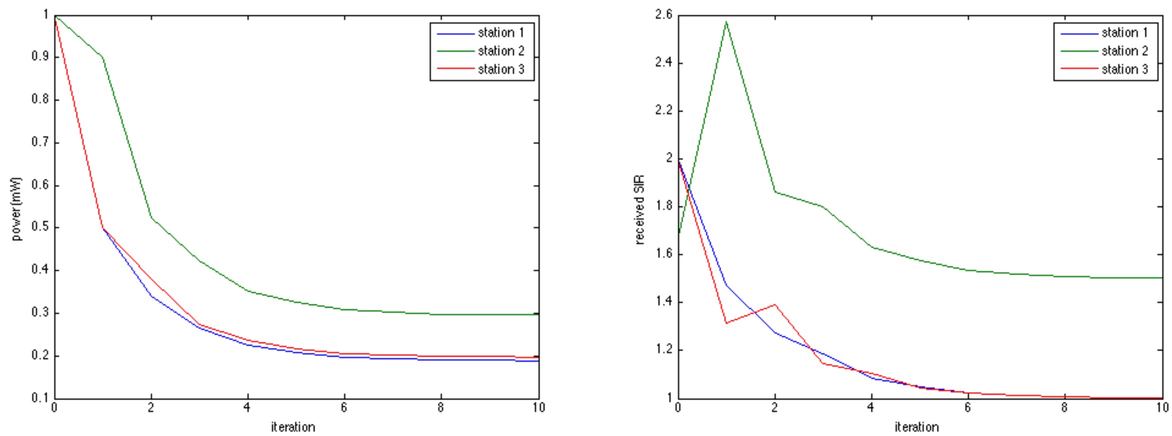

Figure 1: Evolution of transmit powers and received SIRs using DPC

   (b) At the new equilibrium, the powers of the previous three stations increased compared to the old equilibrium. This is because the inclusion of a fourth station created more interference. The SIRs also converged to their respective targets.

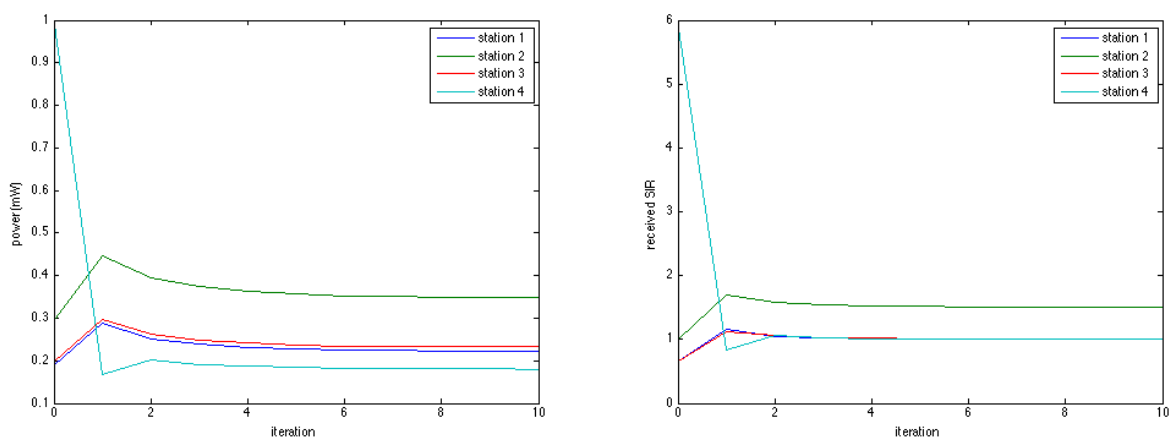

Figure 2: Evolution of transmit powers and received SIRs after including a new pair

2. **Answer:**
According to the definition of SIR, we can build expression for the SIRs of the three links, and set them equal to their respective targets. We have:

$$p_1/(0.5p_2 + 0.5p_3 + 0.1) = 1$$
$$p_2/(0.5p_1 + 0.5p_3 + 0.1) = 2$$
$$p_3/(0.5p_1 + 0.5p_2 + 0.1) = 1$$

Rearranging the equations:

$$p_1 = 0.5p_2 + 0.5p_3 + 0.1$$
$$p_2 = p_1 + p_3 + 0.2$$
$$p_3 = 0.5p_1 + 0.5p_2 + 0.1$$

Solving the series, we got $1.5p_1 = -0.6$. But a presumption is power transmit cannot be negative. Therefore, the set of target SIRs are infeasible.
We also showed the infeasibility by plotting 100 iterations below. The result shows that DPC wouldn't converge for this case.

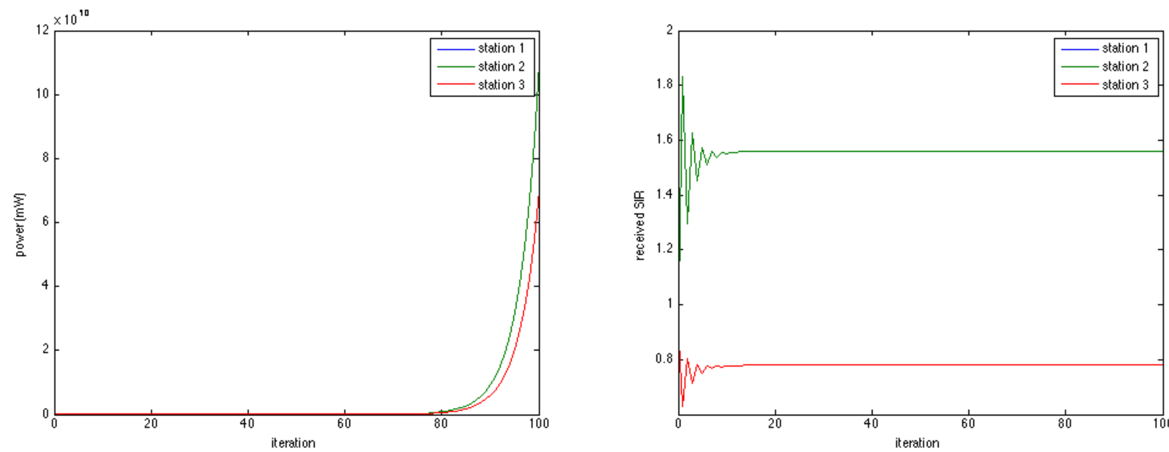

Figure 3: Evolution of transmit powers and received SIRs in 100 iterations

3. **Answer:**
When Bob is playing strategy a, Alice will choose b; when Bob is playing b, Alice will choose b. So currently cell (b, a) and (b, b) are within our consideration.

Then let's analyze column player. When Alice is playing strategy a, Bob will choose a to maximize his payoff; when Alice is playing b, Bob will choose a. Therefore cell (b, a) is the only pure equilibrium where Alice and Bob will settle on.

4. **Answer:**

(a) First let's write out the condition for feasible solutions:

$$p_1 \geq \frac{\gamma_1(G_{12}p_2 + n_1)}{G_{11}} = \frac{4(0.5p_2 + 0.3)}{2} = p_2 + 0.6$$

$$p_2 \geq \frac{\gamma_2(G_{21}p_1 + n_2)}{G_{22}} = \frac{2(0.5p_1 + 0.3)}{2} = 0.5p_1 + 0.3$$

Plotting the two lines and their feasible region:

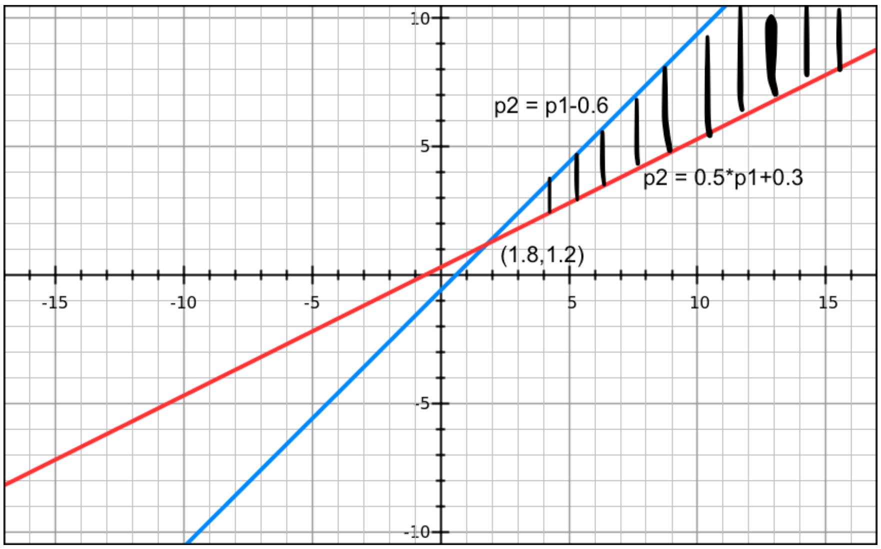

Figure 4: Feasible region of (p_1, p_2)

(b) $SIR_1(1,1) = 2.5 < \gamma_1 = 4$. So $u_1(1,1) = u_1(1,2) = u_1(1,3) = -\infty$.
$SIR_1(2,1) = 5 > \gamma_1 = 4$. So $u_1(2,1) = -2$.
Similarly, do calculations for all the cells. The final payoff matrix is:

	1	2	3
1	$(-\infty, -1)$	$(-\infty, -2)$	$(-\infty, -3)$
2	$(-2, -\infty)$	$(-\infty, -2)$	$(-\infty, -3)$
3	$(-3, -\infty)$	$(-3, -2)$	$(-\infty, -3)$

(c) The Nash equilibrium of the game is at cell $(3, 2)$ where payoff for player 1 is -3 and payoff for player 2 is -2.