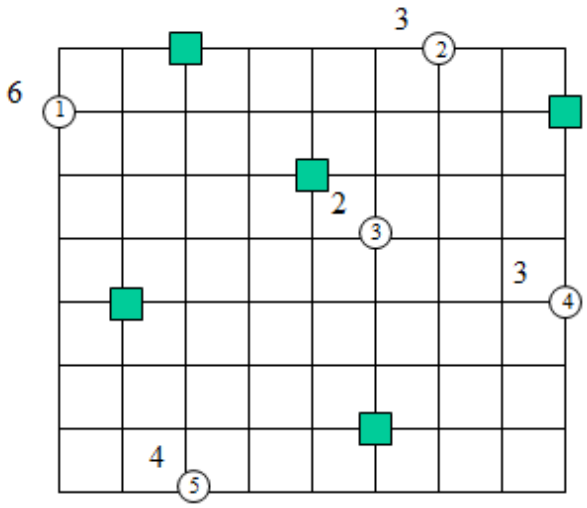
Given:
4 sensors (circles) and 4 targets (squares) that should be covered by sensors in the rectilinear (Manhattan) metric (the unit length of grid is 1), besides each sensor there is the initial number of batteries, the sensing radius is 5 (in rectilinear metric)
Write linear program formulation for sensor lifetime maximization problem




a) SC1={S1,S4}
SC2={S1,S3}
SC3={S2,S3}
SC4={S2,S5}

b) variables: Consider variables t1, t2, t3, t4 for sensor covers SC1, SC2, SC3,SC4 respectively. Number of variables=4; number of constraints=(5+4=9)

c) Objective:
maximize t1+t2+t3+t4

d) Subject to: t1, t2, t3, t4>=0
t1+t2<=6
t3+t4<=3
t2+t3<=2
t1<=3
t4<=4

2. Give the optimal solution for the above linear program

t1 = 3, t2 = 2, t3 = 0, t4 = 3

Optimal solution=8

Dual = 9

6y1+3y2+2y3+3y4+4y5-> min

y1+y4>=1

y1+y3>=1

y2+y3>=1

y2+y5>=1

y3, y4, y5=1; y1, y2=0

or

y1 = y2 = 1; y3, y4, y5=0

3. For the linear program formulation for sensor lifetime maximization problem for the problem 1 (see previous slide) apply Garg-Konemann algorithm from the sensor paper with epsilon = 1. (Please disregard D <1 in the paper and just make 3 iterations!)

Garg-Konemann:

| Iteration1 | Iteration2 | Iteration3 | Sensors | SC1 | SC2 | SC3 | SC4 | Battery |
|---|---|---|---|---|---|---|---|---|
| 1/20 | 1/20 | 1/30 | S1 | 1 | 1 | 0 | 0 | 6 |
| 2/15 | 1/15 | 1/15 | S2 | 0 | 0 | 1 | 1* | 3 |
| 1/10 | 1/10 | 1/10 | S3 | 0 | 1* | 1 | 0 | 2 |
| 2/15 | 2/15 | 1/15 | S4 | 1* | 0 | 0 | 0 | 3 |
| 7/80 | 1/20 | 1/20 | S5 | 0 | 0 | 0 | 1 | 4 |
| | | | | | | | | |
| | | | | 1/10* | 4/30 | 1/6 | 7/60 | |
| | | | | 11/60 | 3/20 | 1/6 | 7/60* | |
| | | | | 11/60 | 3/20* | 7/30 | 53/240 | |

Iteration1: SC1
Iteration2: SC4
Iteration3: SC2

4. Give all shifts of the Load Balancing Protocol for the instance above

| Sensor | B | S1 | B | S2 | B | S3 | B | S4 | B | S5 | B | S6 | B | S7 | B | S8 | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 6 | A | 5 | A | 4 | A | 3 | I | 3 | A | A | I | 2 | A | 1 | I | 1 |
| **2** | 3 | I | 3 | I | 3 | I | 3 | A | 2 | I | I | A | 1 | I | 1 | A | 0 |
| **3** | 2 | I | 2 | I | 2 | A | 1 | I | 1 | I | I | I | 1 | A | 0 | I | 0 |
| **4** | 3 | A | 2 | A | 1 | I | 1 | I | 1 | A | A | I | 0 | I | 0 | I | 0 |
| **5** | 4 | I | 4 | I | 4 | I | 4 | A | 4 | I | I | A | 3 | I | 2 | A | 1 |

I = Idle, A = Active,
B = Battery left

S1, S2 . . . = Shifts

Shift 1 = 1,4
Shift 2 = 1,4
Shifts 3 1,3
Shifts 4 2.5
Shifts 5 1,4
Shift 6 2,5
Shift 7 1,3
Shift 8 2,3,5
Shift 9 = 2,3,4 are dead; 1 & 5 cannot cover all the targets.
Time = 8