Prolonging WSN Lifetime with an Actual Charging Model

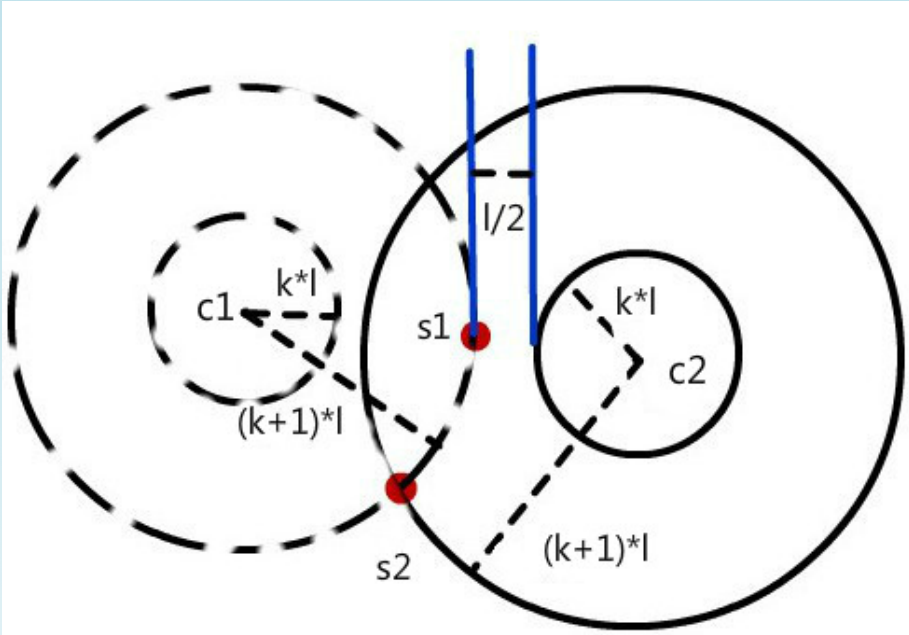
ZHI MA*†, JIE WU†, SHENG ZHANG*, AND SANGLU LU*
*STATE KEY LAB. FOR NOVEL SOFTWARE TECHNOLOGY, NANJING UNIVERSITY, CN
†CENTER FOR NETWORK COMPUTING, TEMPLE UNIVERSITY, USA
EMAIL: MARSZER@FOXMAIL.COM, JIEWU@TEMPLE.EDU, {SHENG, SANGLU}@NJU.EDU.CN

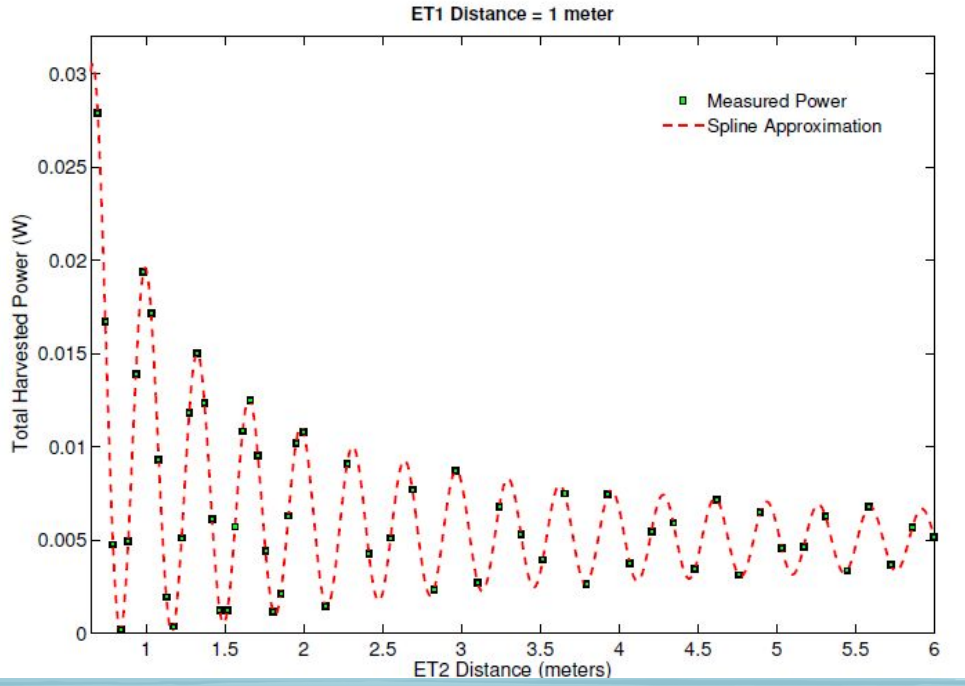
Outline

- Introduction
  - Nonlinear superposition
  - New problem in wireless charging
- Algorithm design
  - Related works
  - Weight-Greedy Picking
- Experiments
- Conclusion and future works

Nonlinear Superposition

- Radio interference occurs

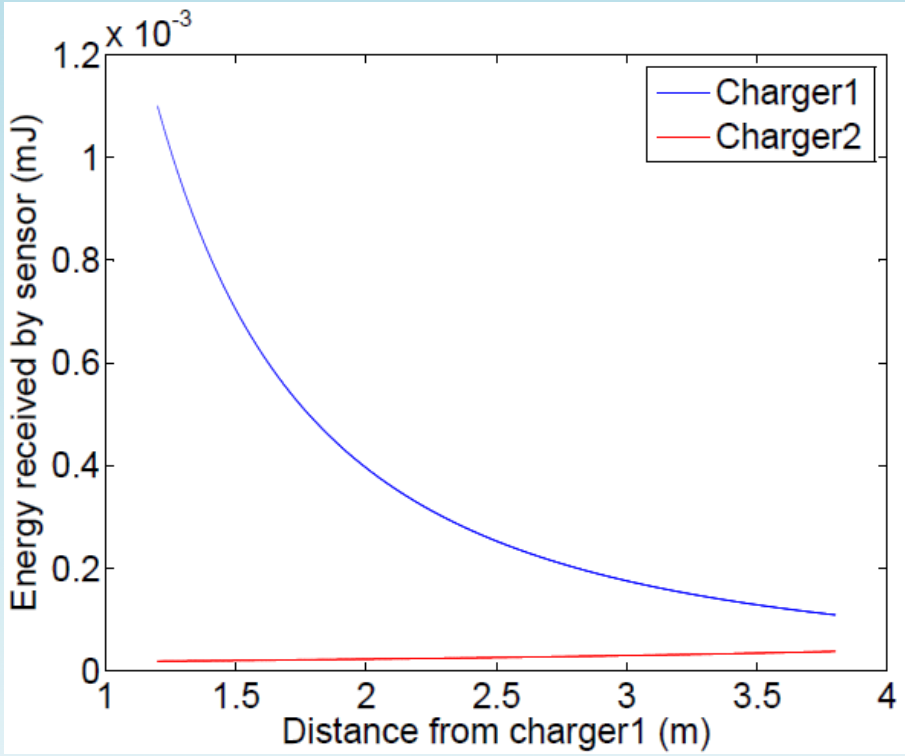


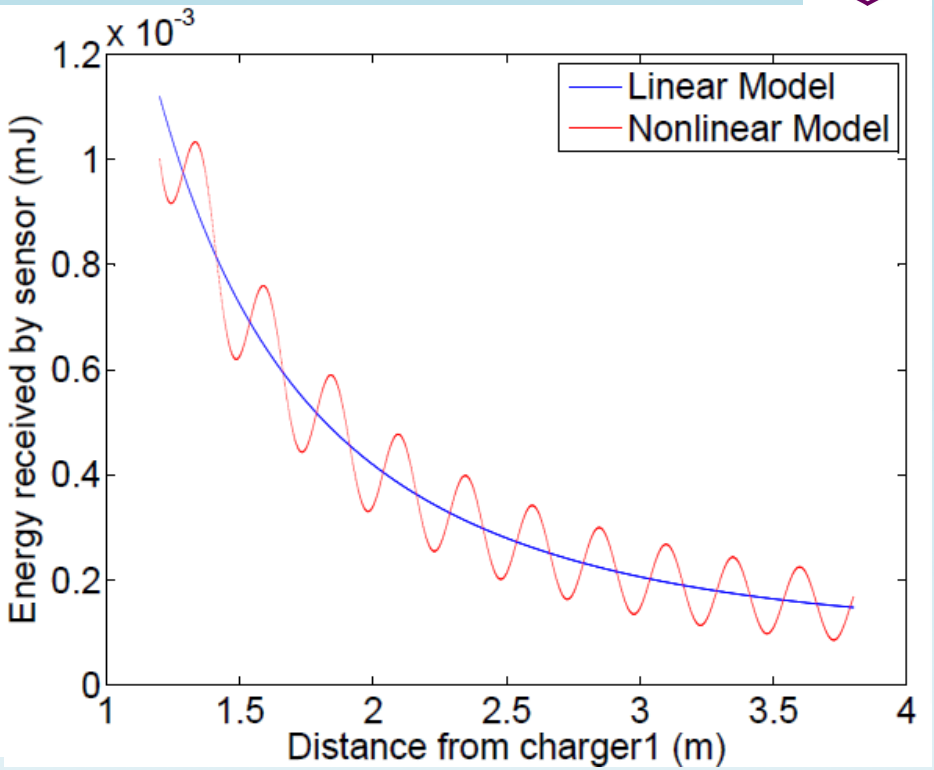


Nonlinear superposition

- Charging model
  - $a_{i0} = \frac{A_0}{4\pi d_{ij}/\lambda\omega_0}\cos(\omega_0 t + \varphi_0 - 2\pi\frac{d_{ij}}{\lambda\omega_0})$
  - $P_{j|C} = \int [A_0^j(t)]^2 d_\omega = P\sum_{c_i \in C}\frac{1}{{d_{ij}}^2} + P\sum_{c_i \in C}\sum_{c_m \in C c_m \neq c_i}\frac{1}{d_{ij}d_{mj}}\cos(2\pi\frac{d_{ij}-d_{mj}}{\lambda})$

The difference between these two charging model





Our problem in wireless charging

- Variable: scheme chargers on/off state in every charging period.
- Objective: minimize charging periods.
- Constraint: charge each sensor with energy no less than E.

Related work

- Computation ahead

  Have to calculate the charging utility of each charger set at every sensor node in advance. As a result, the complexity of this step grows exponentially with the number of chargers, making it much more complex than previously thought.

Weight-Greedy Picking

Algorithm 1 Weight-Greedy Picking (WGP)

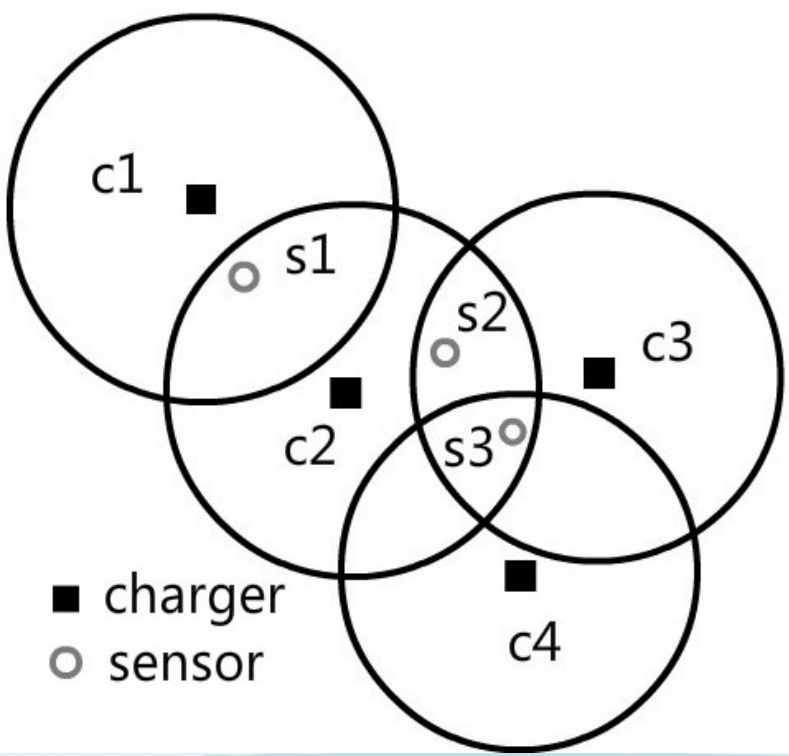
Input: C: Charger set, S: Sensor set, E: Energy capacity
Output: The time schedule

1: Initialize W, and set W_1' to be 1,i=1.
2: **while** $S \neq \emptyset$ **do**
3: Find a MCS, and divide chargers into two groups H_i, C'.
4: **while** W_1' is over 0 **do**
5: **for** each charger c_i in C' **do**
6: Compute the w_i'.
7: sort from largest to smallest in W'.
8: **if** W_1' is over 0 **then**
9: Add C_1' in H_i.
10: Make chargers in H_i work for time Δ.
11: **for** every sensor in S **do**
12: **if** s_i is fully charged **then**
13: remove s_i from S.
14: i++, W_1'=1,compute W;

First find a MCS: pick charger with the maximum weight, and the remove chargers and repeat;

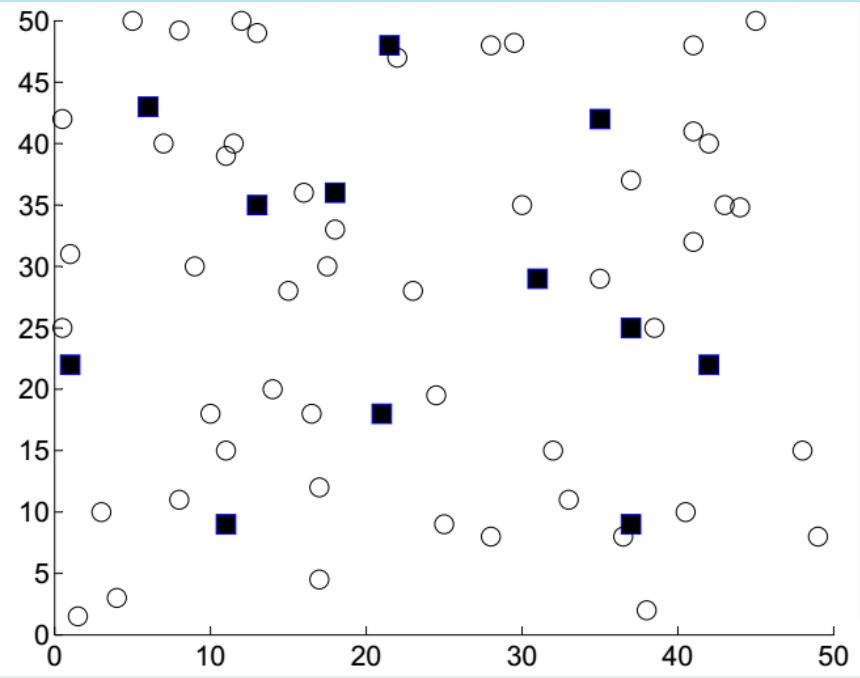
Add new chargers: add the charger which has the most effective

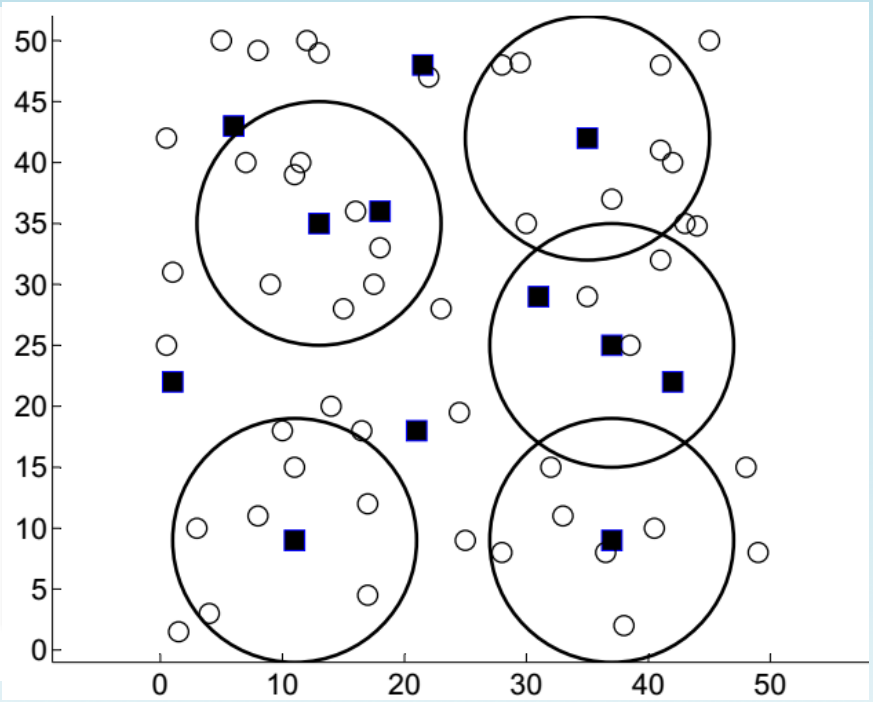
A simple Example



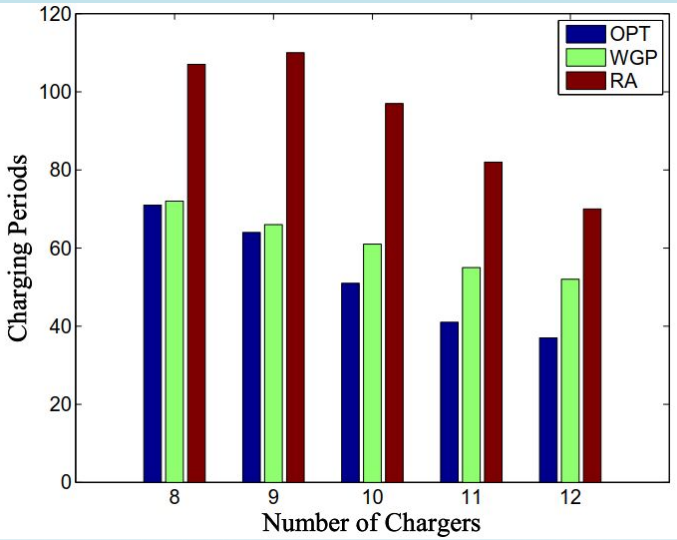
	S1	S2	S3
C1	3	0	0
C2	2	3	2
C3	0	3	3
C4	0	0	2
C2,C3	2	0	1
C3,C4	0	3	5
C1,C2	4	3	2
C2,C4	4	3	0
C2,C3,C4	2	0	2

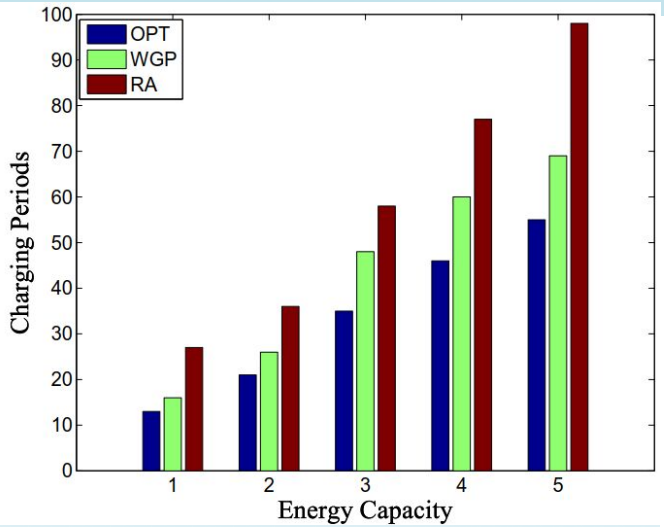
An example of a MCS

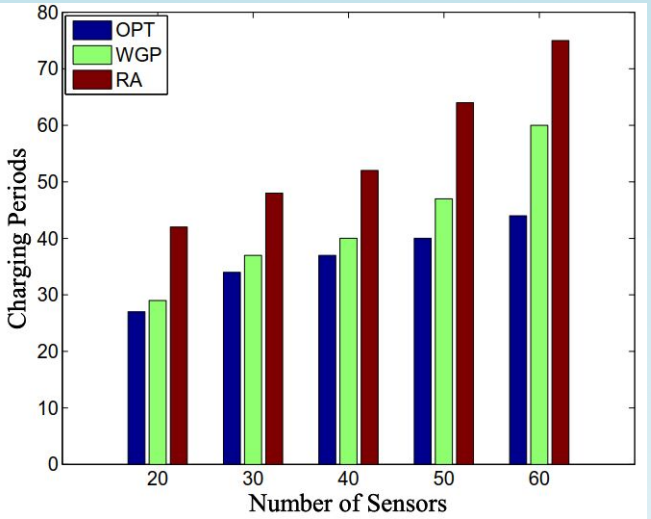




Experiments







Conclusion and Future Work

- Nonlinear superposition
- Adjustable initial phases
- Different duration of each charging period

Thank you!

marszer@foxmail.com