Localization in Wireless Sensor Networks: Strategies to reduce energy consumption

Sadaf Tanvir
Benoît Ponsard
{sadaf.tanvir, benoit.ponsard}@imag.fr

EMSoC 23-24 October 2008

Drakkar Group

Introduction

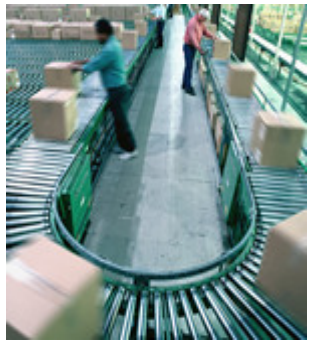
WSNs

- Numerous
- Tiny & cheap nodes
- Spatially distributed
- Autonomous
- Communicate wirelessly
- Power constrained

Need for Localization in WSNs

Environment/ Forest monitoring

Inventory monitoring



Machine surveillance

Coordinate System

-Relative

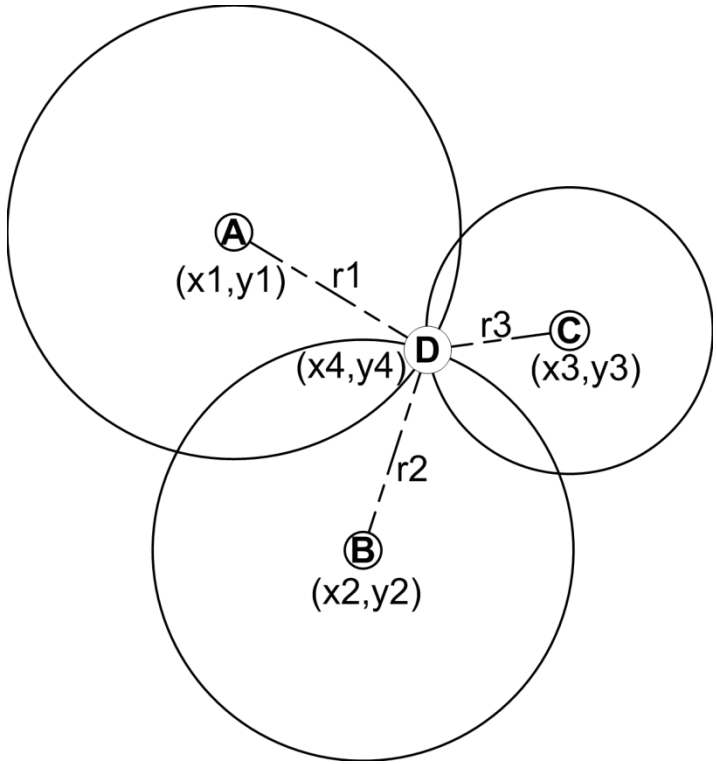
-Absolute

Our focus: localization with trilateration

-Coarse Grained Localization

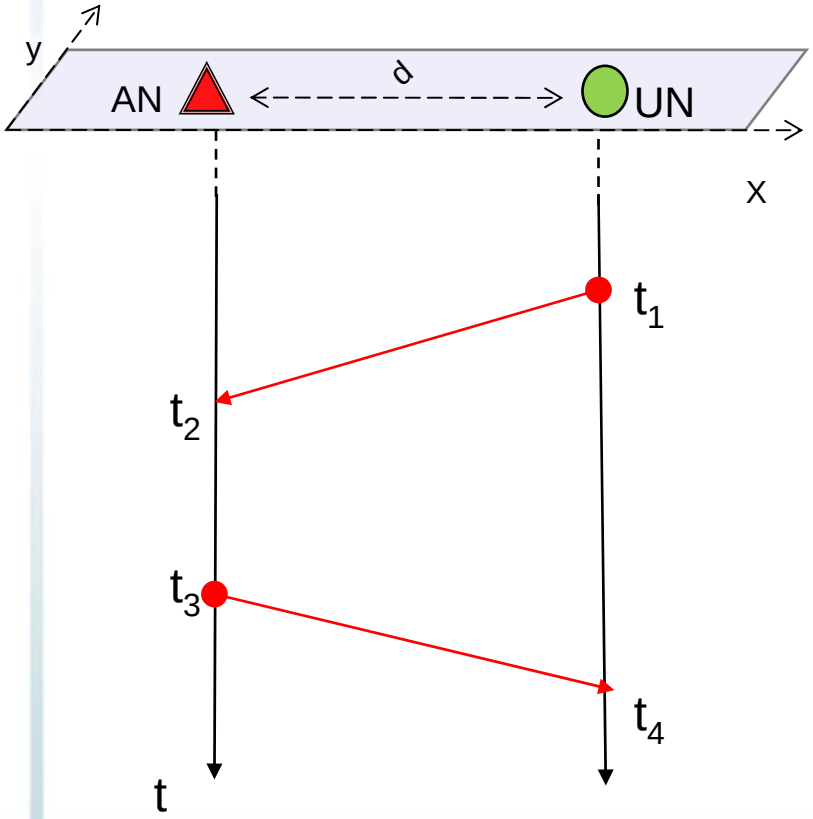
-Fine Grained Localization

$$\begin{cases} (x-x_1)^2+(y-y_1)^2=r_1^2 & r_1=t_1\times v \\ (x-x_2)^2+(y-y_2)^2=r_2^2 & r_2=t_2\times v \\ (x-x_3)^2+(y-y_3)^2=r_3^2 & r_3=t_3\times v \end{cases}$$



Implementations

Basic Lateration

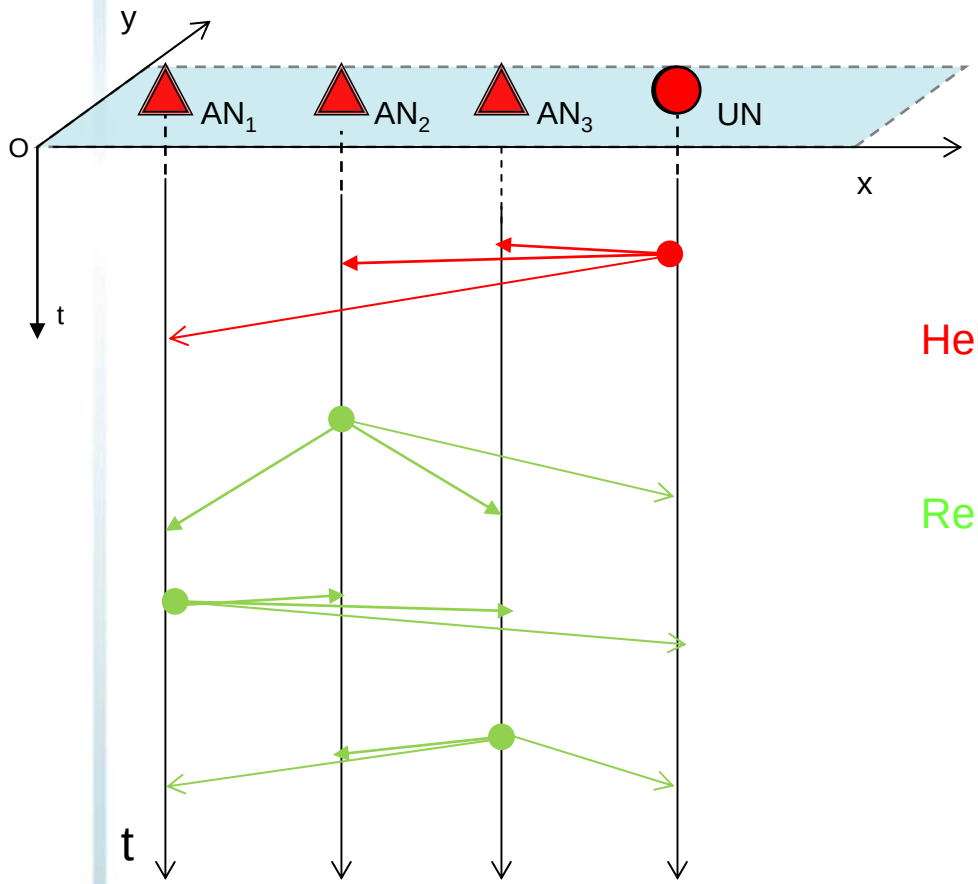


- t_1 et t_4 measured by node UN
- t_2 et t_3 measured by node AN
- t_3-t_2 : response time
- Ranging process carried out at the physical layer

$$d = \frac{v \cdot \left(\left(t_4 - t_1 \right) - \left(t_3 - t_2 \right) \right)}{2}$$

Ref : L. de Nardis, M. Gabriella Di Benedetto (Univ. Rome), 2005

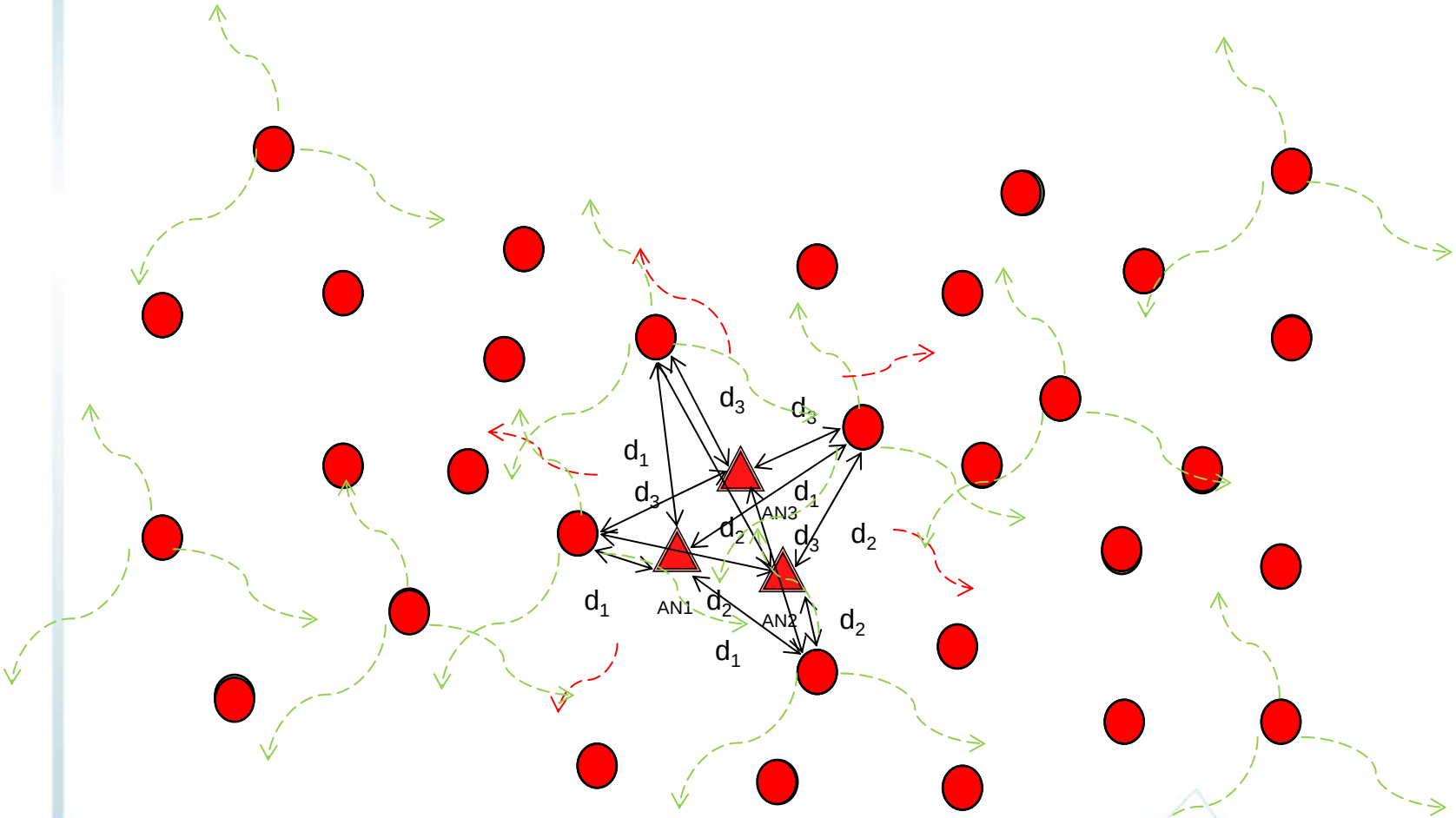
Intuitive way to implement Tri-lateration



Hello msg : sent by UNs (1st step of two-way ranging)

Reply msg : sent by ANs (2nd step of two-way ranging)

Propagation of localization wave



So, when does it work?

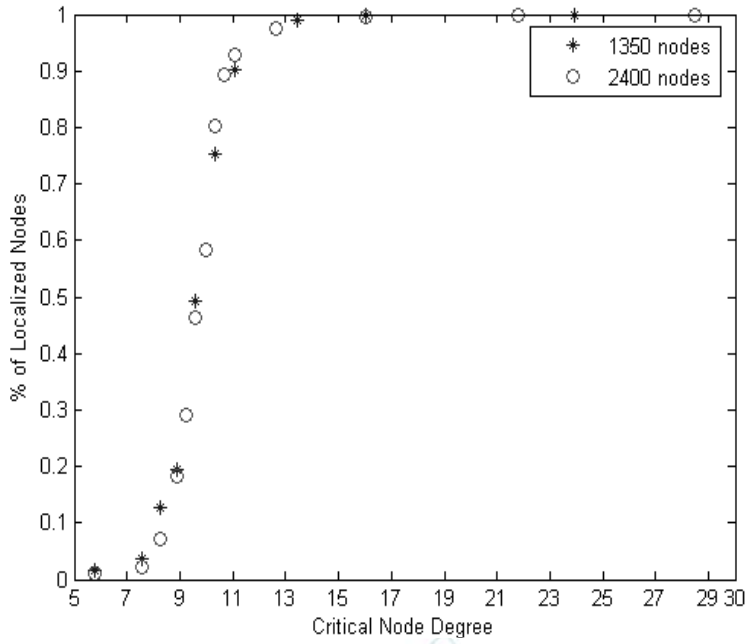
-Protocol simulated in OPNET

-LxL network with “AN nucleus” in the centre

-Random uniform distribution of UNs

-Unit disk graph model

-Need to have node degree above “threshold”



Consumption of energy

Intuitive process – easy to implement

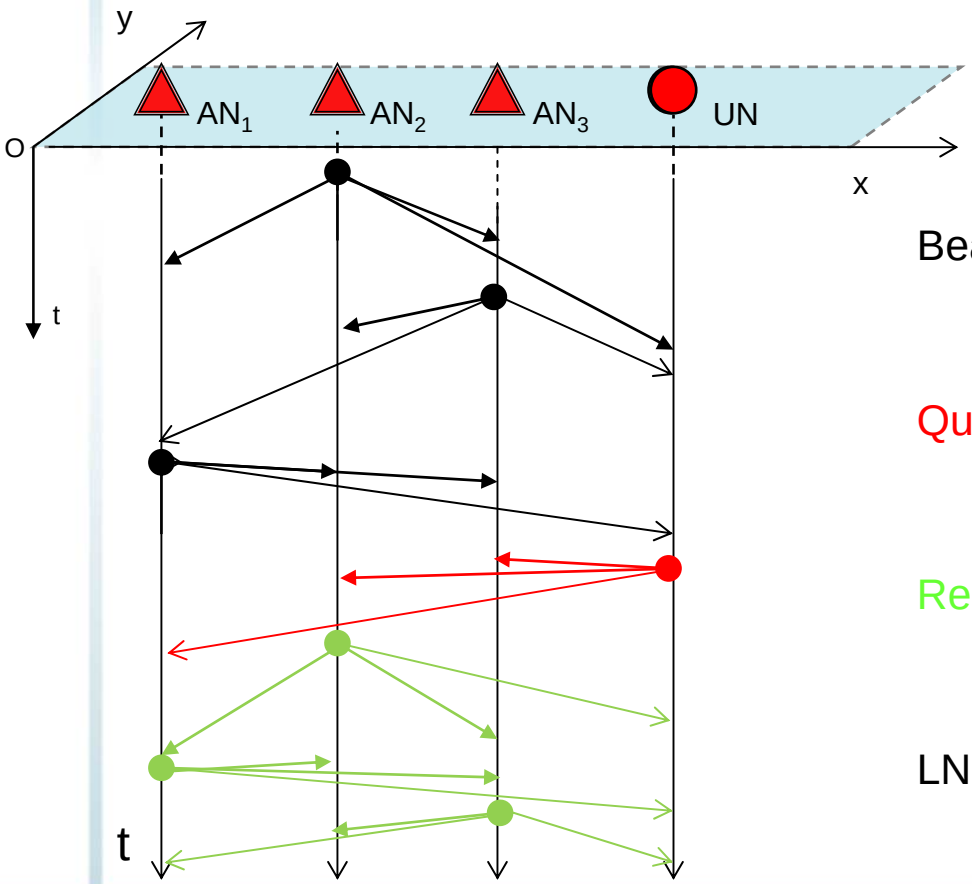
Network wide useless emission of “Hello” messages

Radio communication –most energy consuming operation

Communication to be limited

The “Beacon” based process

Tri-lateration with Beacon mode Implementation



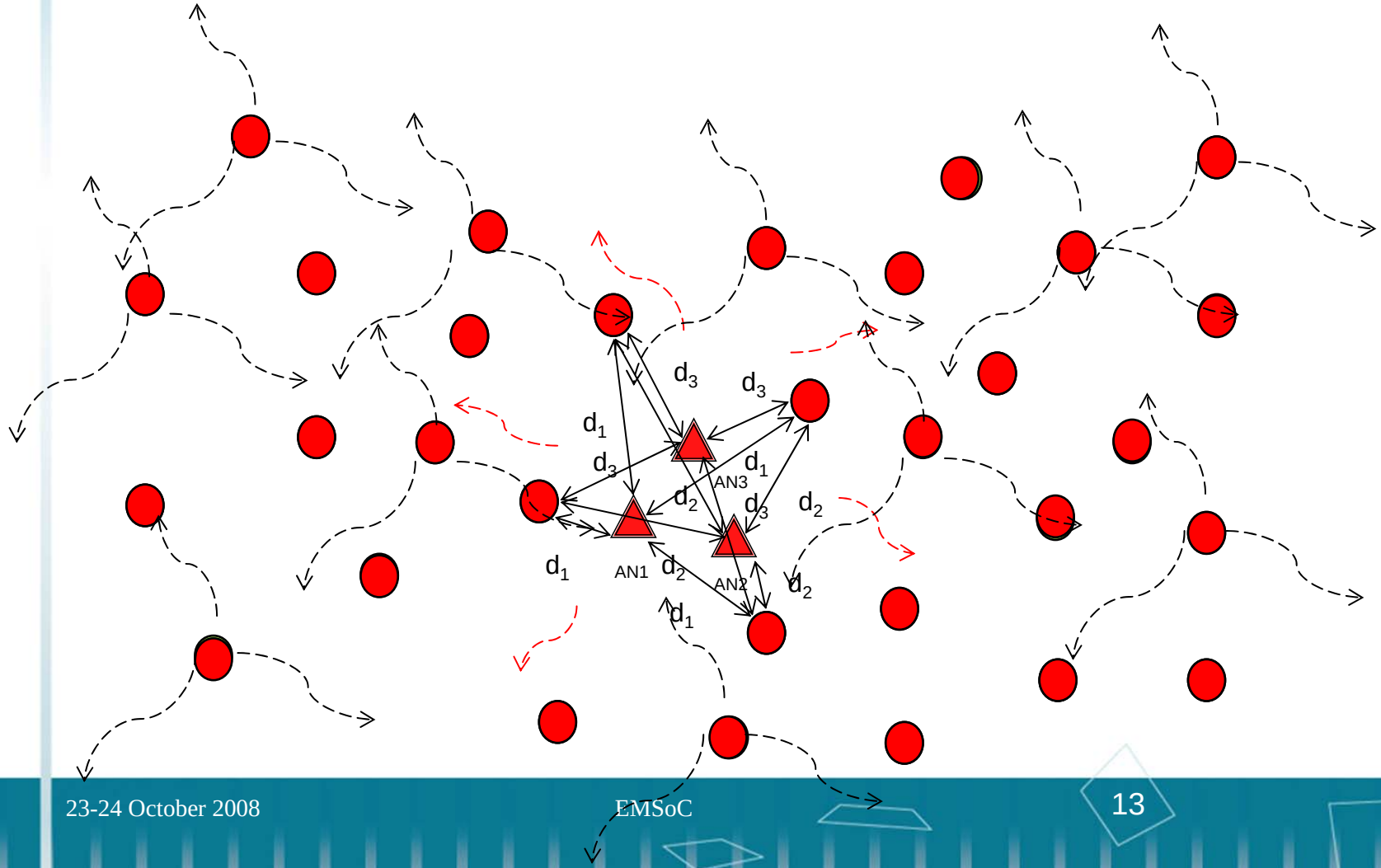
Beacon : sent by ANs to inform their presence

Query : sent by UNs (1st step of two-way ranging)

Response : sent by ANs (2nd step of two-way ranging)

LN transmits beacon msgs

Propagation of localization wave



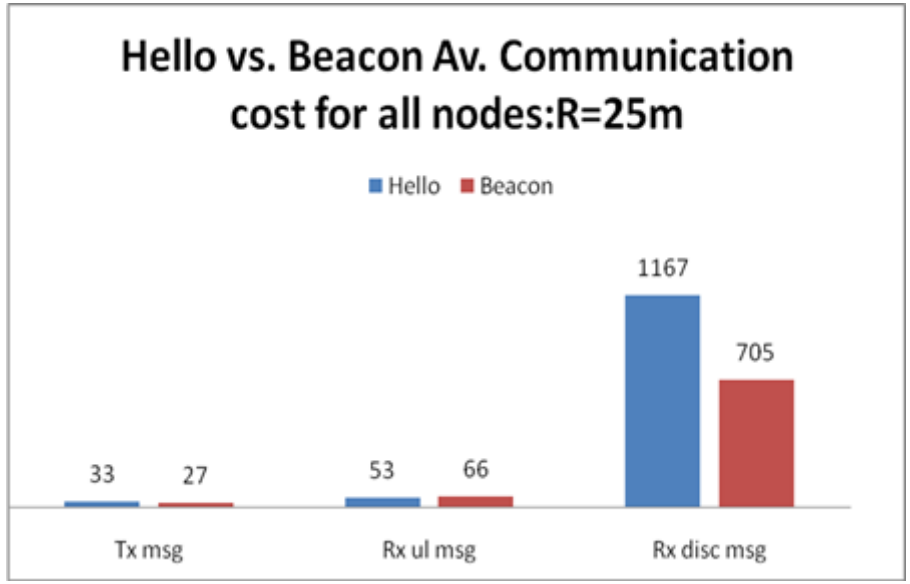
Simulation Results

Energy Consumption: Radio communication

Tx msg: msg tx by a node to get localized

Rx ul msg: useful msg rcvd by node to get localized

Rx disc msg: msg rcvd by a node but are useless for it



On going work: Optimized protocol

Idea of an optimized protocol

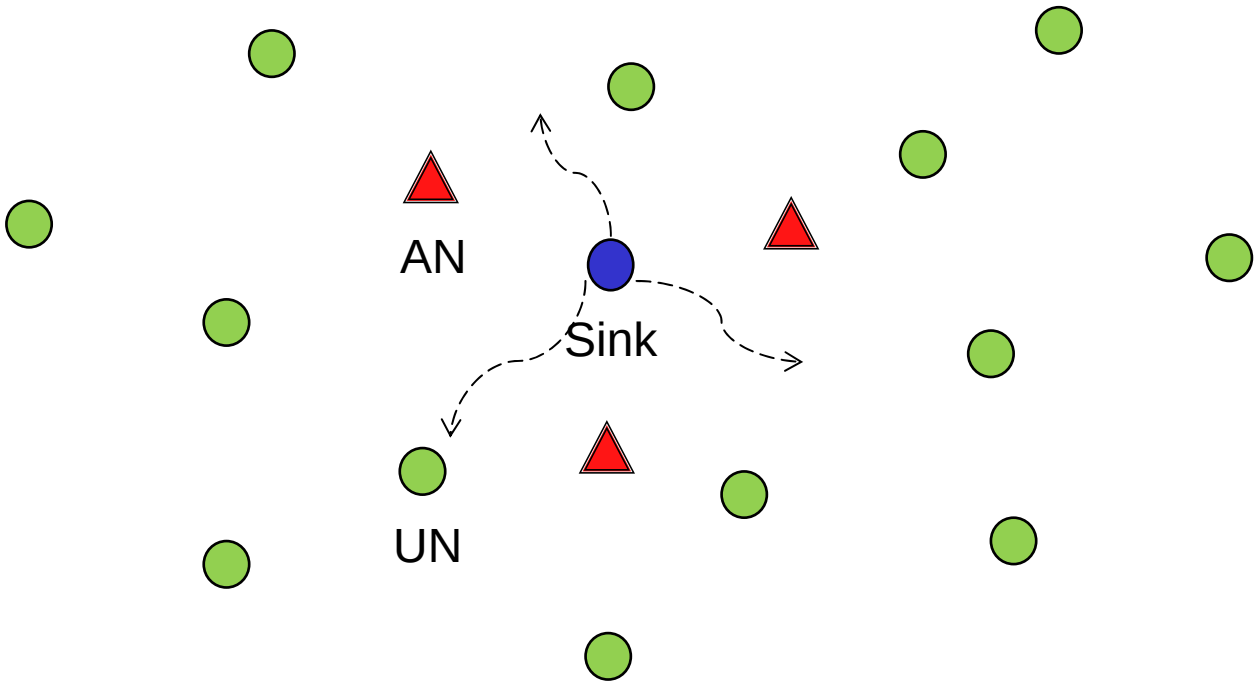
Shortcomings of the two previously proposed approaches:

1. No limit on the emission of messages

2. Starting messages incur significant protocol overhead

3. Inefficient usage of wireless medium

Let the sink node start the process



UNs overhear other UN's QM to start their own QM emission

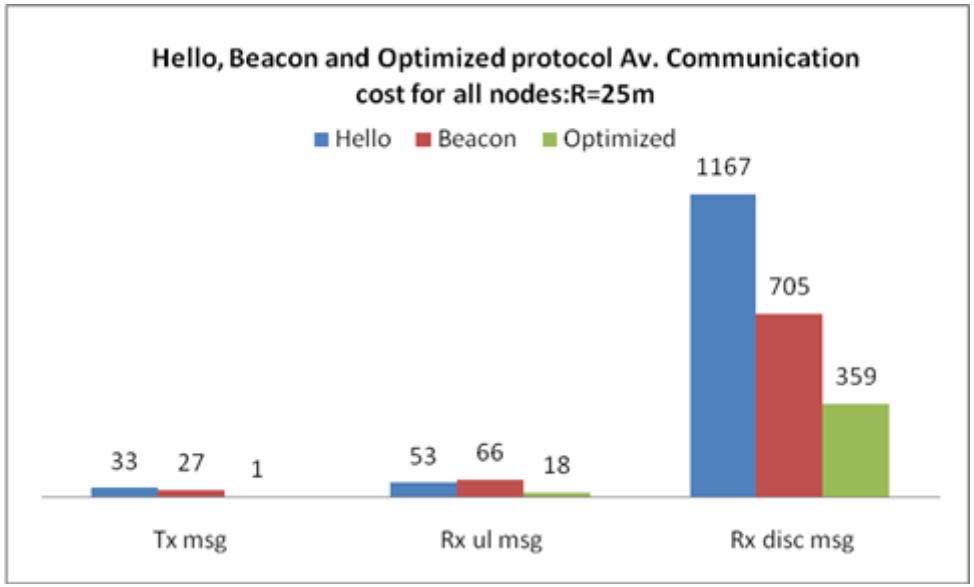
-A UN hears a Query Message from its neighboring UN

-it starts an internal counter to wait for a certain time during which the neighboring UN is sure to become LN

-upon expiration of this timer, it broadcasts it Query Message

Limit the emission of messages by LNs/UNs through counters

Initial Results



Future work

-Consider packet loss

-Use of additional Anchor nodes → limit error propagation

-Comparison with existing localization approaches: energy consumption vs. the achieved localization accuracy

MERCI!