



Localization in Wireless Sensor Networks: Strategies to reduce energy consumption

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Introduction

WSNs

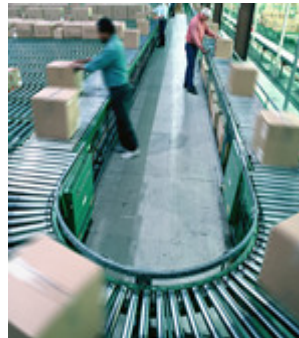
- ❖ Numerous
- ❖ Tiny & cheap nodes
- ❖ Spatially distributed
- ❖ Autonomous
- ❖ Communicate wirelessly
- ❖ Power constrained

Need for Localization in WSNs

Environment/ Forest monitoring



Inventory monitoring



Machine surveillance



Coordinate System

-Relative

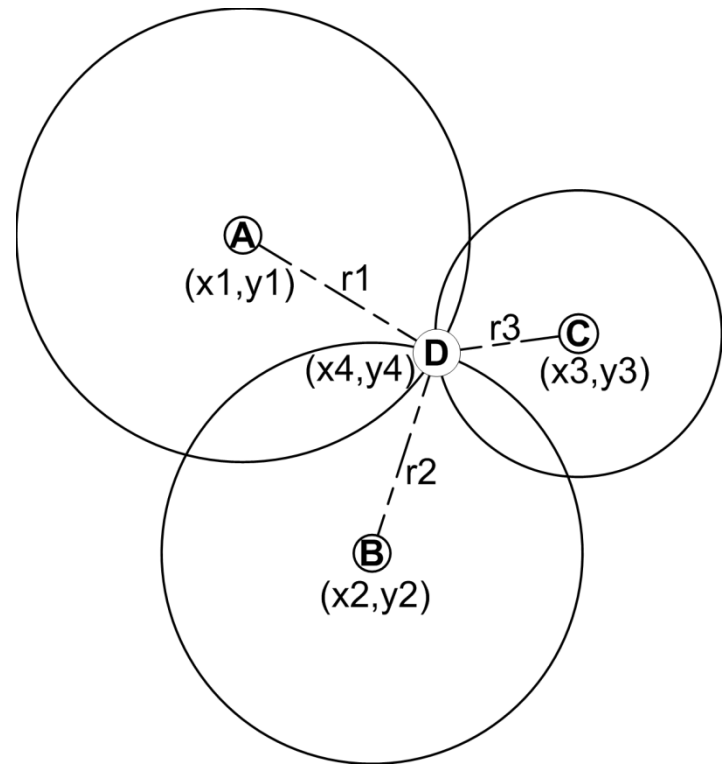
-Absolute

Our focus: localization with trilateration

-Coarse Grained Localization

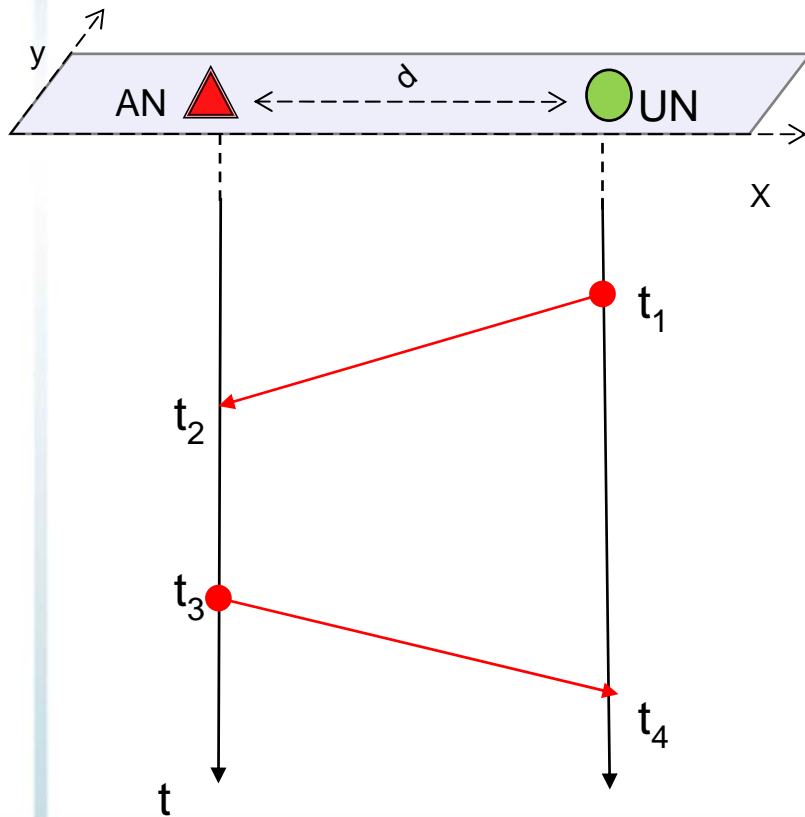
-Fine Grained Localization

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



Implementations

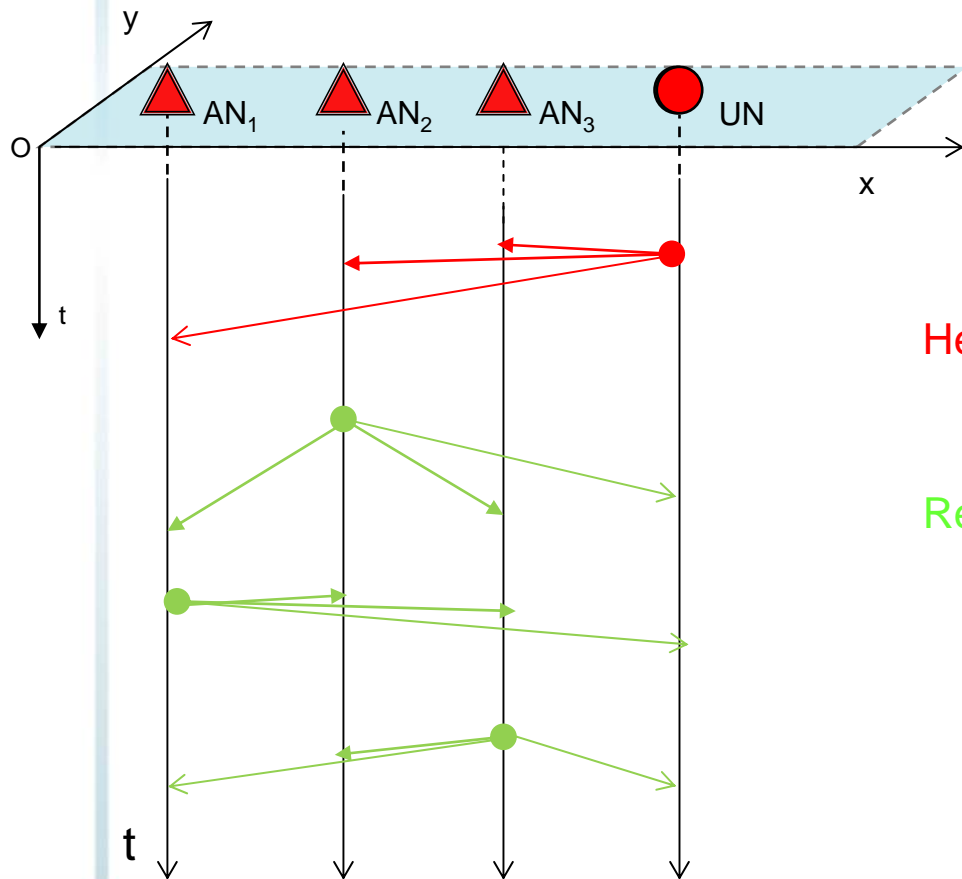
Basic Lateration



- 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

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

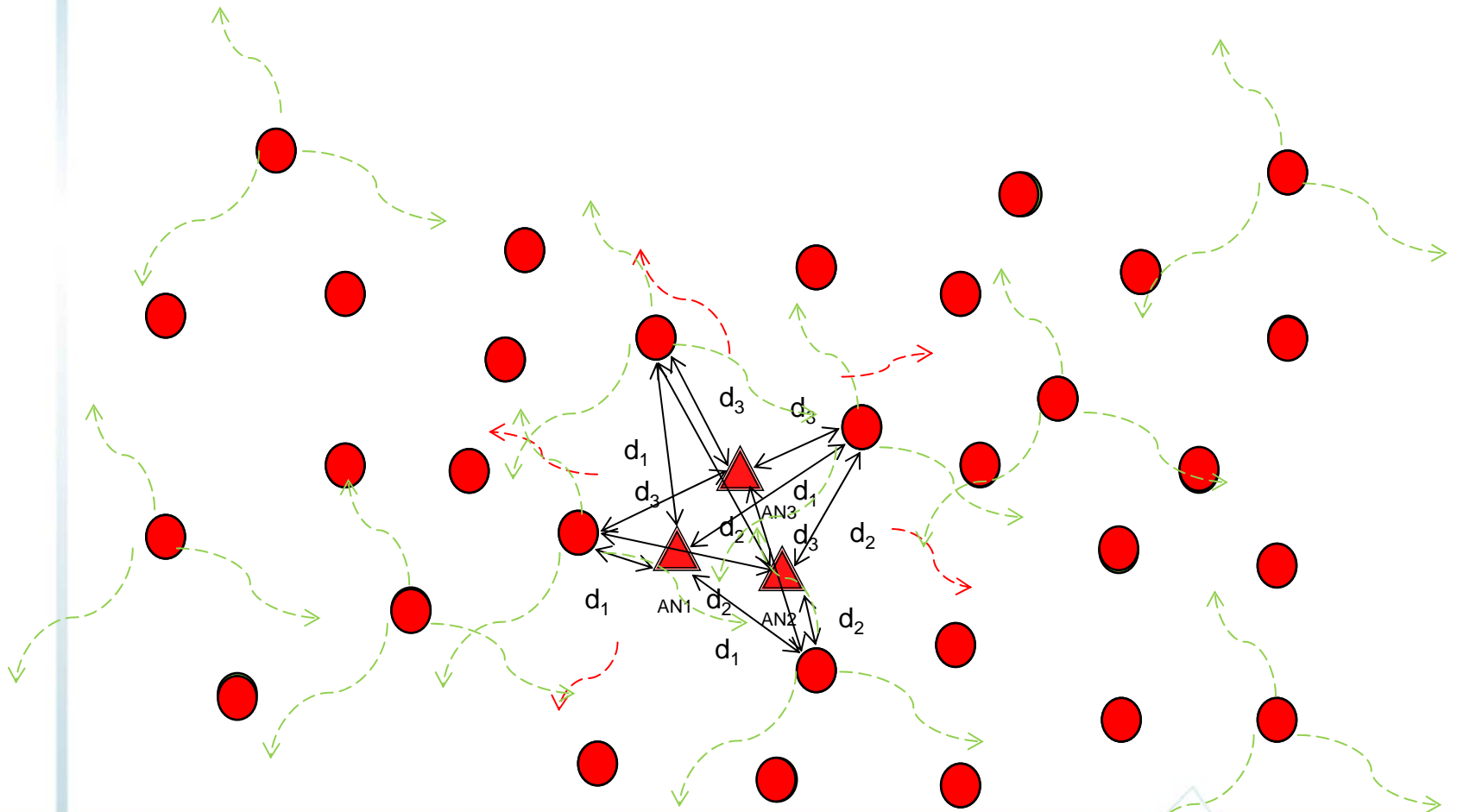
Intuitive way to implement Tri-lateration



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

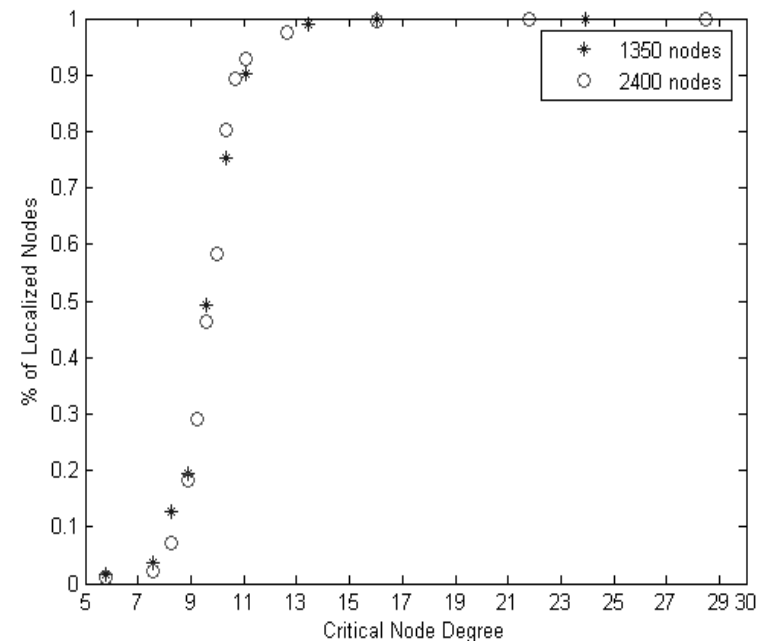
Reply msg : sent by ANs (2nd step of two-way ranging)

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

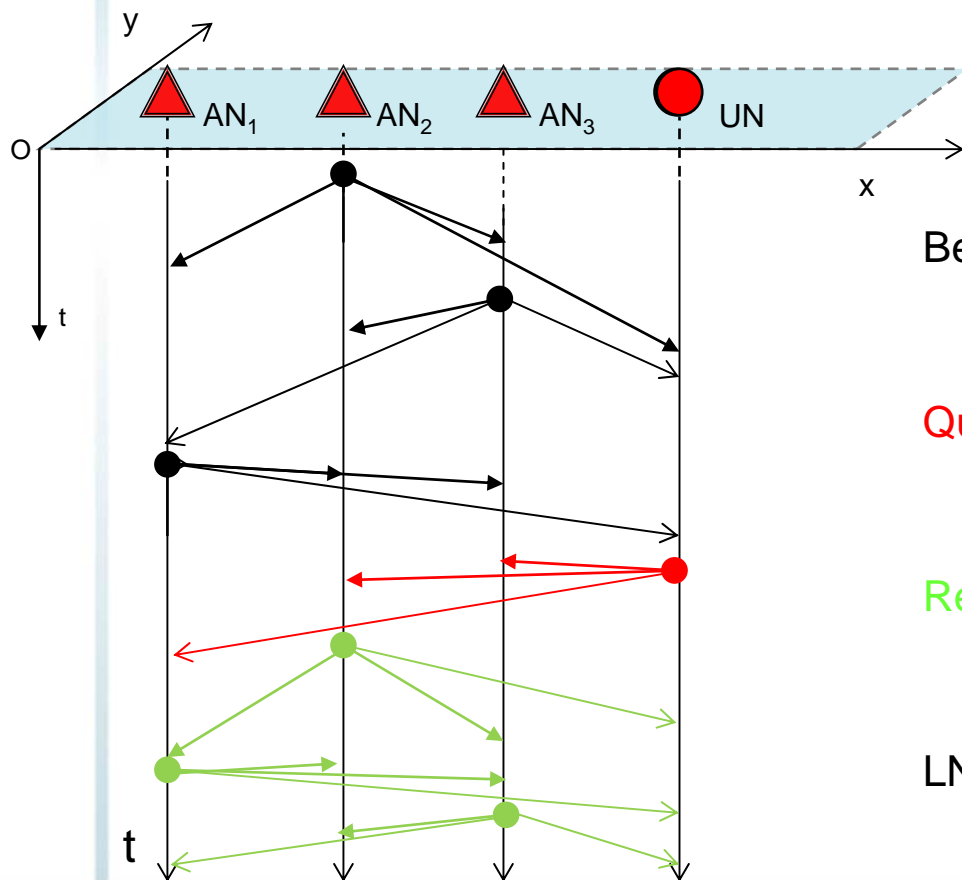
Network wide useless emission of “Hello” messages

Radio communication –most energy consuming operation

Communication to be limited

The “Beacon” based process

Tri-lateration with Beacon mode Implementation



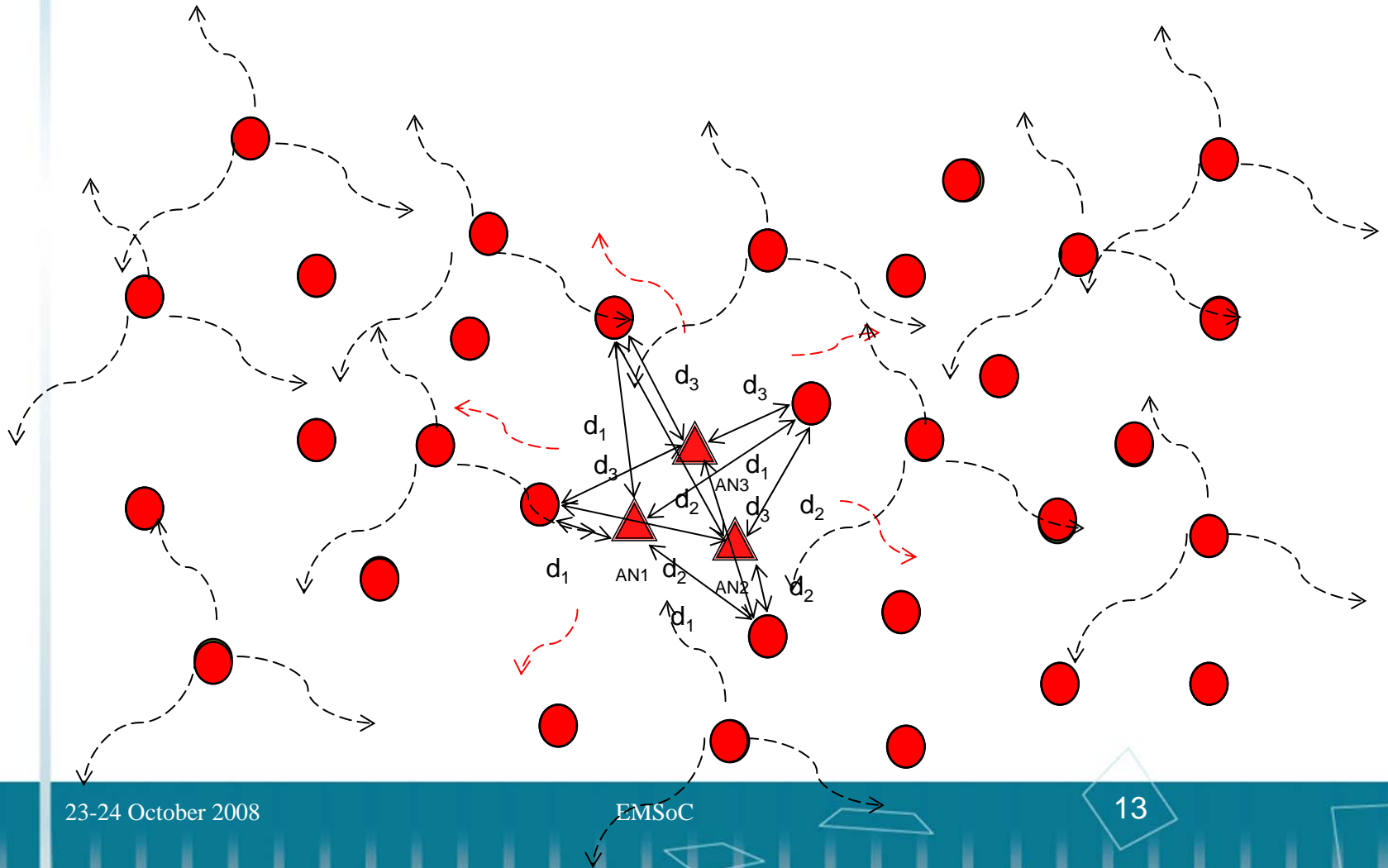
Beacon : sent by ANs to inform their presence

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



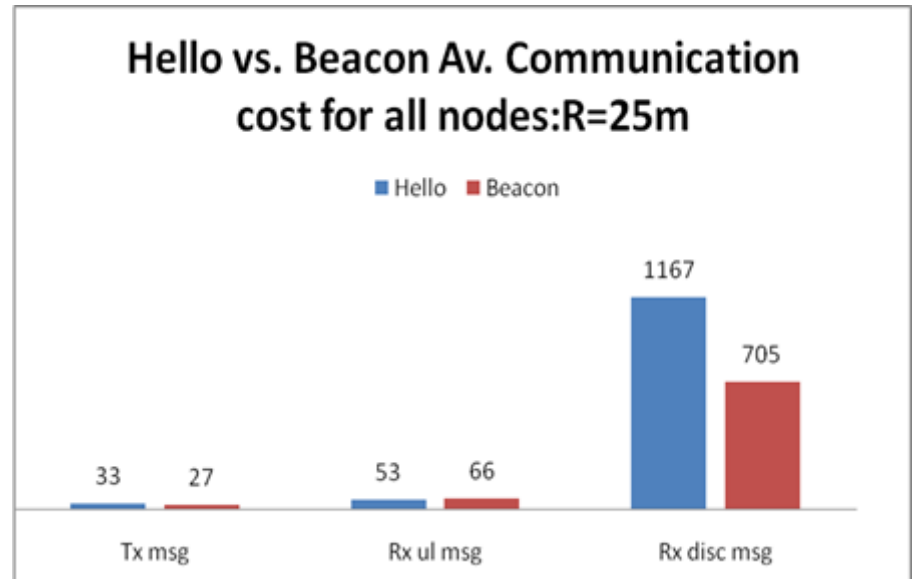
Simulation Results

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



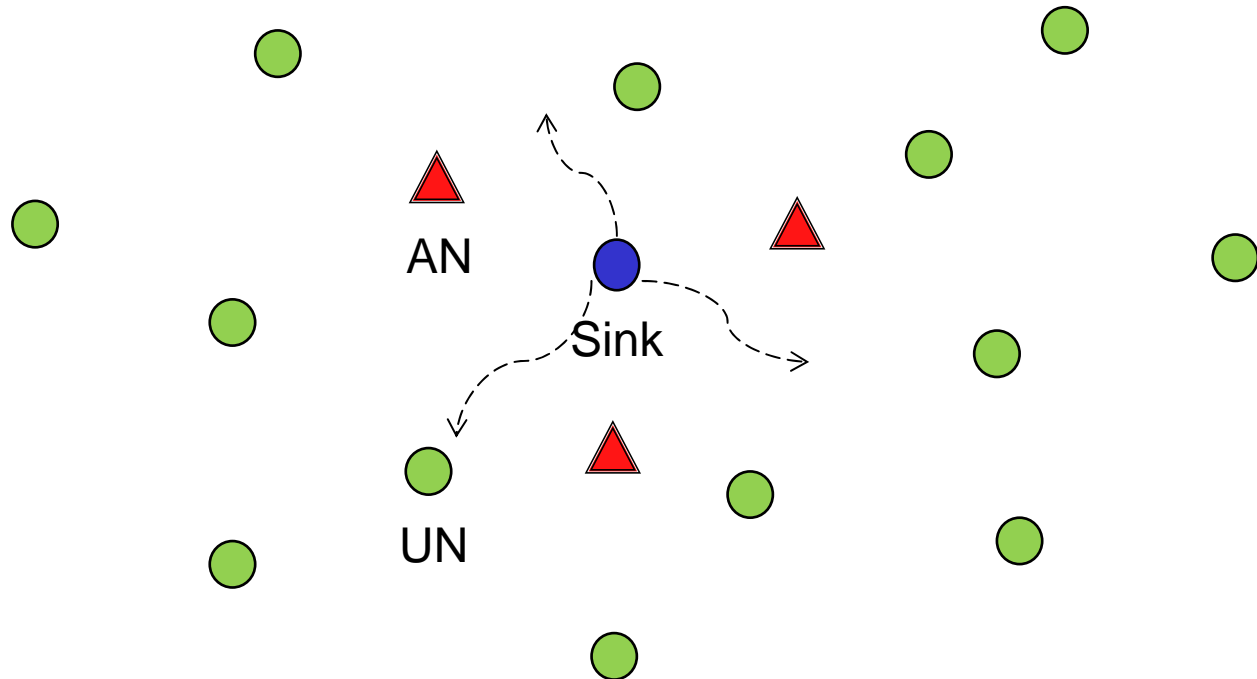
On going work: Optimized protocol

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

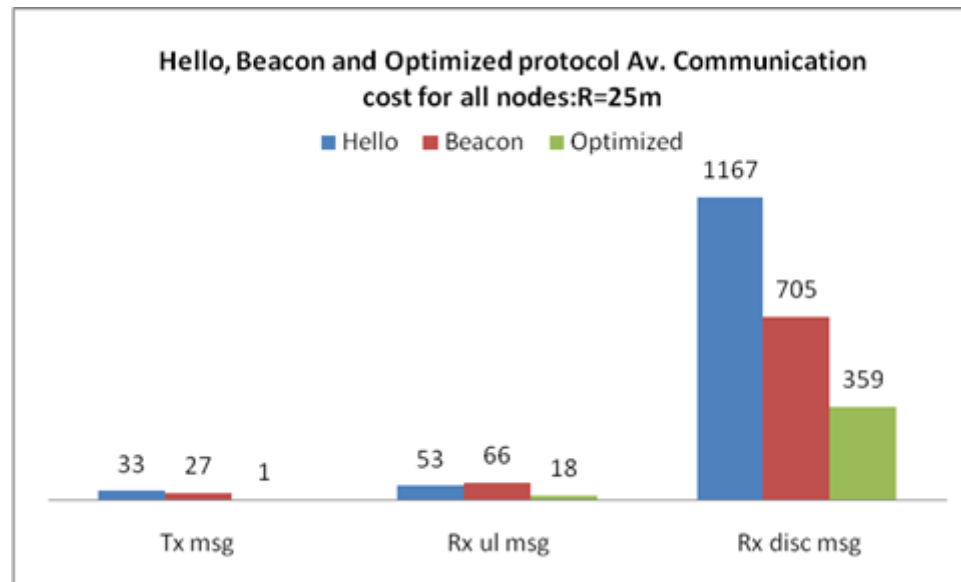


UNs overhear other UN's QM to start their own QM emission

- 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 its 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!