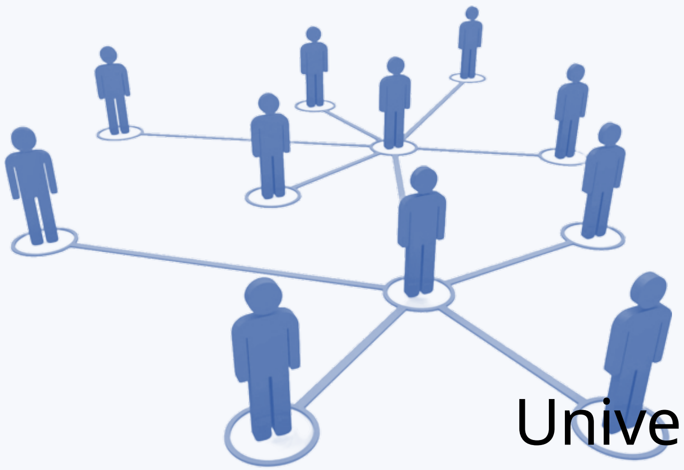
EIDA, a Best Effort Equitable Distributed id Assignment Mechanism for Heterogeneous Nanonetworks



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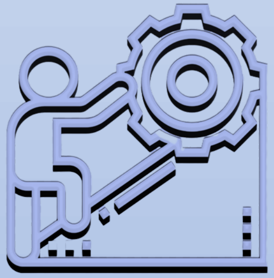
Plan

01 Wireless nanonetwork

- It is built from hundreds or thousands of tiny nodes called nanonodes
- Nanonode size is less than 1 micrometer (1 to 1000 nanometers)
- Nanonode limitations:
  - ~ Simple computing, sensing, and actuation
  - ~ Tiny resources due to fabrication constraints (CPU, memory, battery)
- Some applications require that all nodes have a unique id



Assigning id to nodes in such a dense nanonetwork is challenging due to the huge amount of packet exchanged needed

Plan

02 Random & ideal assignments

Random assignment

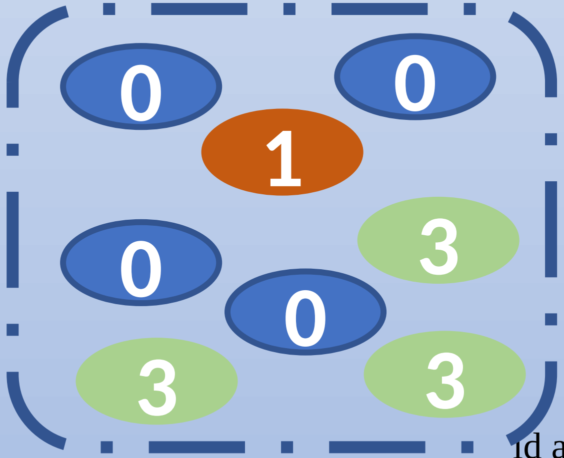
Advantage

- No communication needed: nodes assign ids distributedly

Disadvantage

- No equitability: no distribution into groups

Network with 4 groups



Ideal assignment

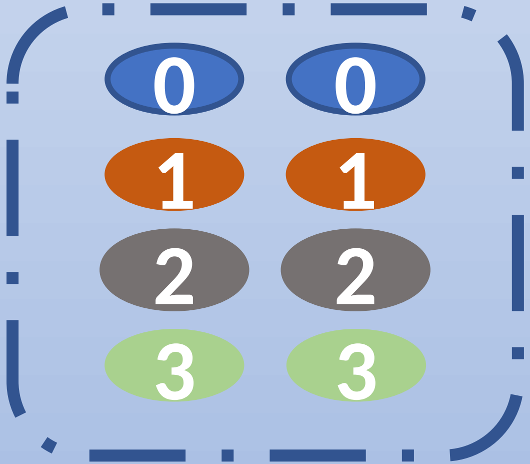
Advantage

- 100% equitable: ids are distributed equally to nodes

Disadvantage

- Communication: N exchanges
  - Big problem in a dense network

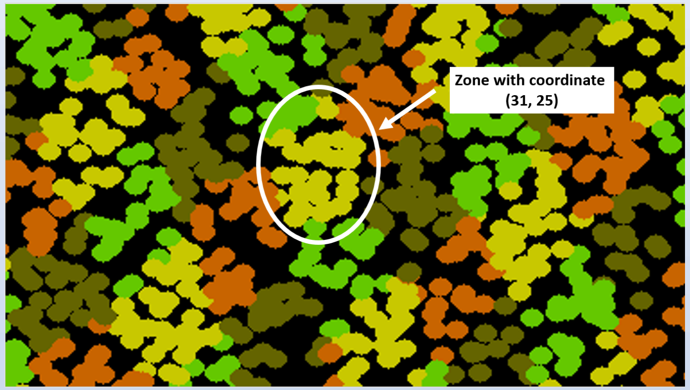
Network with 4 groups



Plan

03 EIDA mechanism

- Combination of ideal and random assignment
- The network is divided in zones, and EIDA is applied in each zone separately and independently



EIDA initialization:

- Parameters
  - Redundancy (r): The user's goal is to have r nodes per group
  - Guarantee (m): The minimum number of nodes per group is m
- Nodes compute the number of groups in each zone (g = n/r, with n the number of nodes in the zone) and the maximum number of packets exchanged allowed to achieve m (max_pkts = m*g)
- Each node chooses a random backoff to start with

03 EIDA mechanism

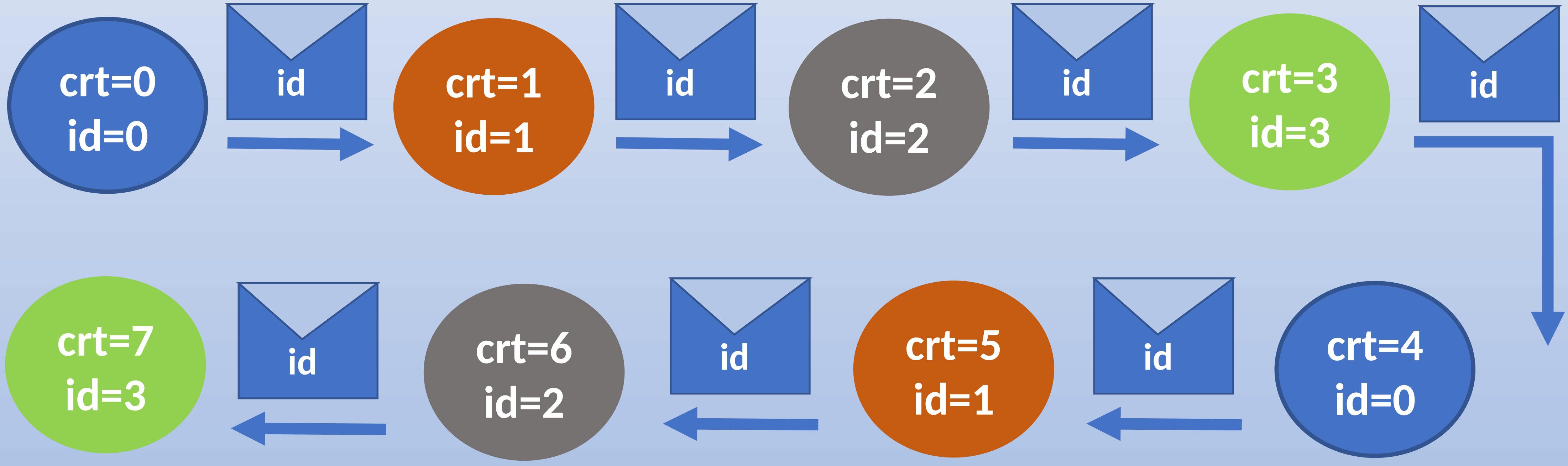
EIDA phase 1:

- The first node chooses its id (as 0) and sends a notifier packet
- All nodes have a counter crt that starts from zero and increment it upon every notifier packet reception
- Nodes stay in phase 1 as long as max_pkts packets have not been received (no packet loss is assumed)

03 EIDA mechanism

Example with n=20 nodes

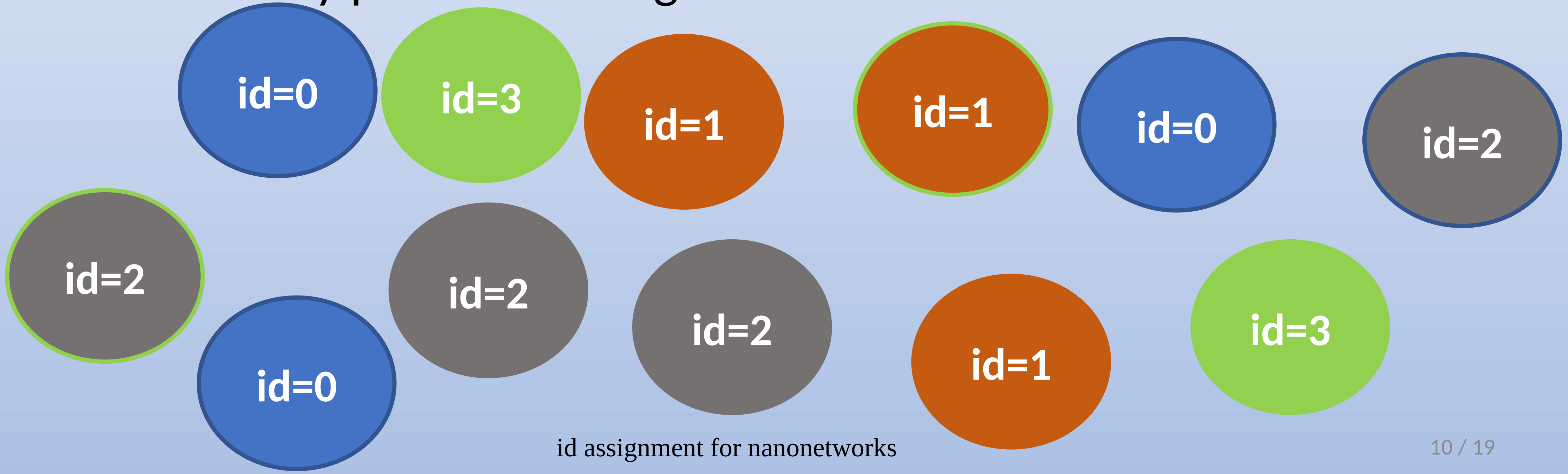
- Redundancy r=5, and at least m=2 nodes in each group
- Number of groups g = n/r = 20/5 = 4 groups
- => max_pkts = mg = 2*4 = 8 packets



03 EIDA mechanism

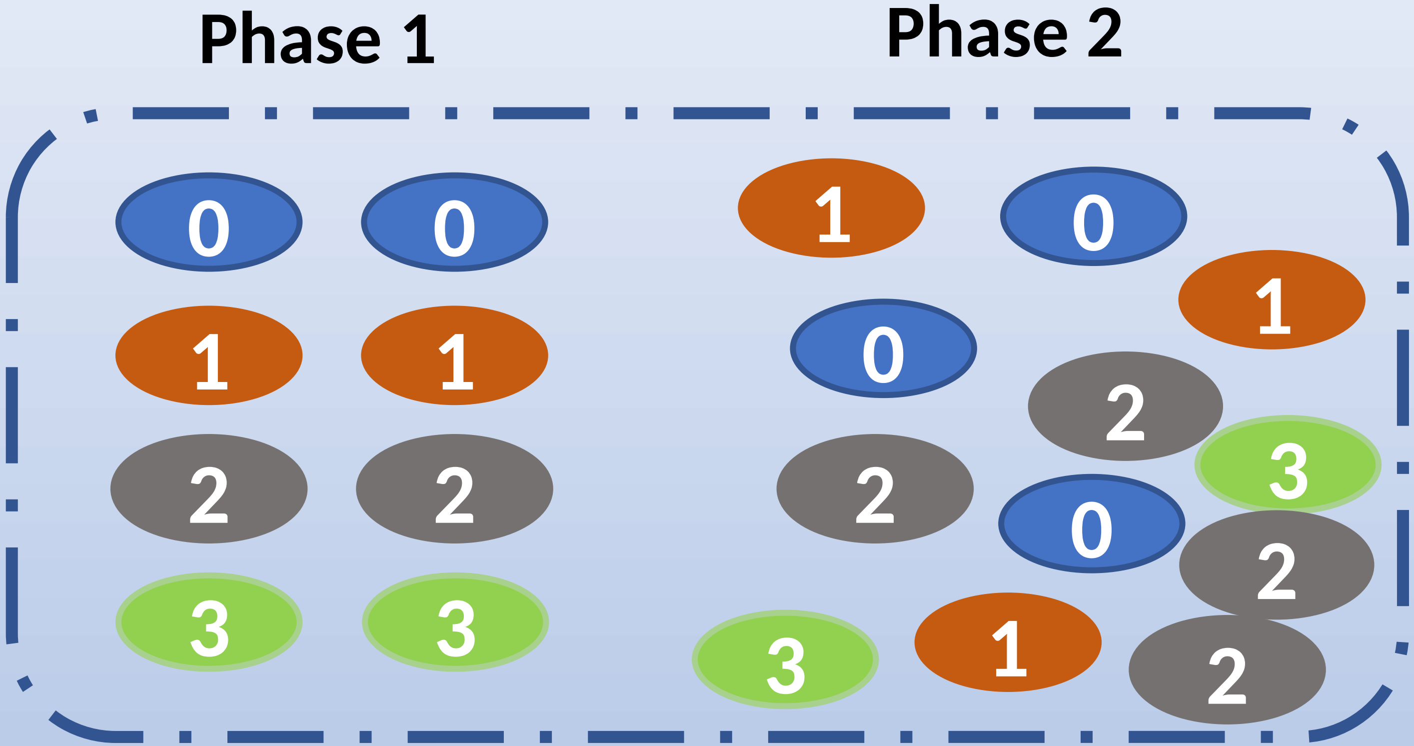
EIDA phase 2:

- All nodes have crt>max_pkts
- All unassigned nodes (12 nodes) assign their id randomly (0..g–1), without any packet exchange



03 EIDA mechanism

Full example: m=2 and g=4



The constraint on m is fulfilled
(at least m nodes in each group)
The constraint on r is best effort

Plan

01 Wireless nanonetwork

02 Random & ideal assignments

03 EIDA mechanism

04 Application of EIDA (FR-SLR)

05 Evaluation of EIDA

06 Conclusion & Future Work

04 FR-SLR protocol

SLR: 16 transmitters in zone i

FR-SLR: 4 transmitters instead of 16

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05 Evaluation of EIDA

- Network scenario:
  - ➢2D network area with 20 000 nodes
- BitSimulator
  - ➢Allows simulation of ultra-dense nanonetworks
  - ➢Comes with a visualization program that displays graphically the communication events

05 Evaluation of EIDA

EIDA id assignment simulation

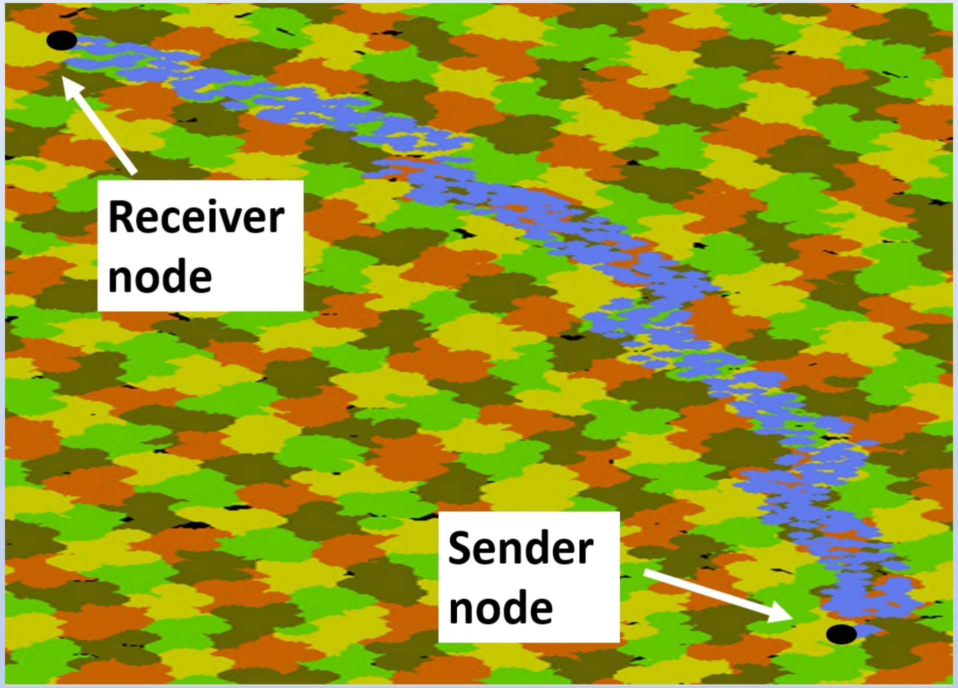
- Zone density is n=31
- Redundancy r=5
- Guarantee m=2
- g = 6 groups & max_pkts = 12

ID	0	1	2	3	4	5
Number of nodes	8	7	3	4	4	5

Phase 1		Phase 2			
Node order	id	Node order	id	Node order	id
1	0	13	0	25	3
2	1	14	1	26	1
3	2	15	5	27	0
4	3	16	5	28	0
5	4	17	0	29	1
6	5	18	0	30	0
7	0	19	1	31	3
8	1	20	4		
9	2	21	4		
10	3	22	1		
11	4	23	5		
12	5	24	2		

05 Evaluation

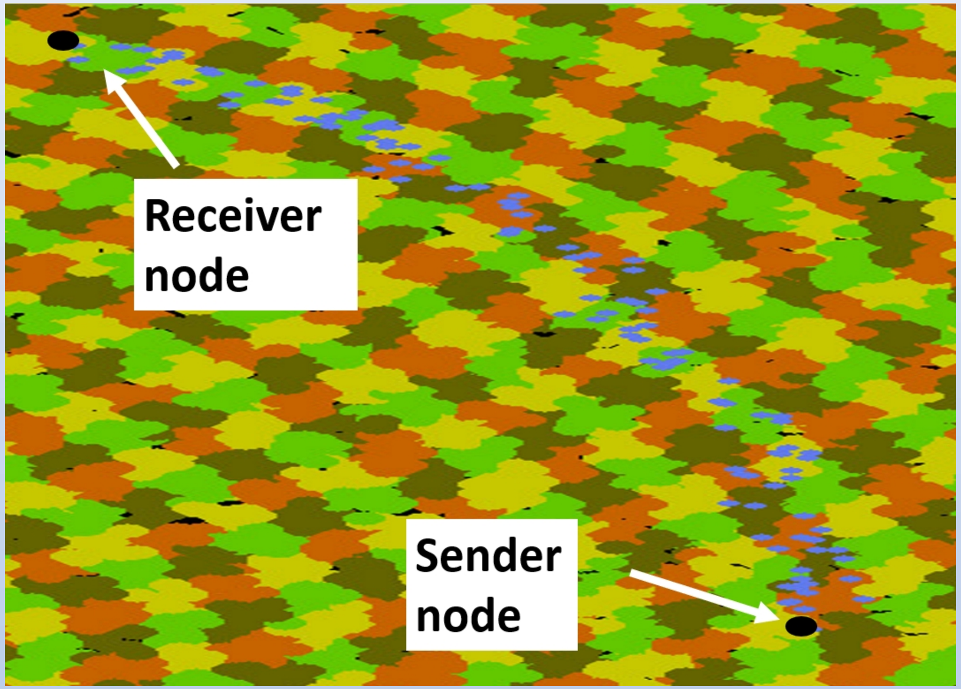
SLR



All nodes in a zone belonging to the transmission path reforward the packet

619 forwarders

FR-SLR



Only a group of nodes in each zone belonging to the transmission path reforward the packet

168 forwarders

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06 Conclusion and future work

- Goal: assigning node id in dense network while minimizing the number of packet retransmissions based on the guarantee
  - ✓ Maximize network lifetime
  - ✓ Preserve network resources (energy, CPU, memory,…)
- Future work
  - ✓ Improve EIDA to make it support zones with different densities while avoiding die-out