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An Optimized Degree Strategy for Persistent Sensor Network Data Distribution

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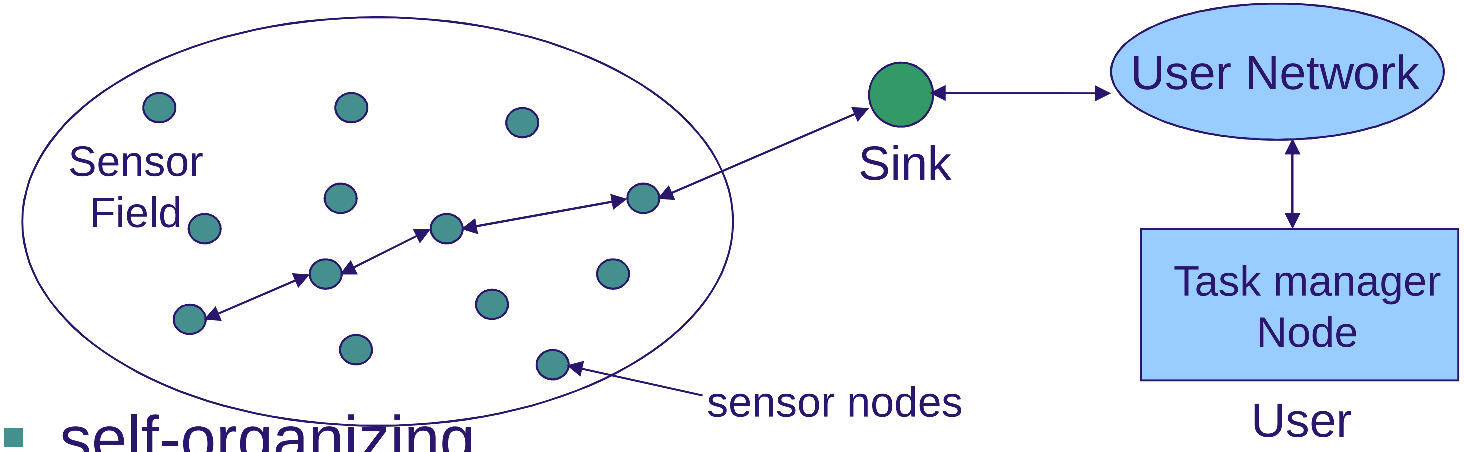
Outline

- Problem Description and Background
- LT Codes
- Our algorithm: PLTD-Alpha
- Experiments and result
- Conclusions and Future work

Wireless sensor network

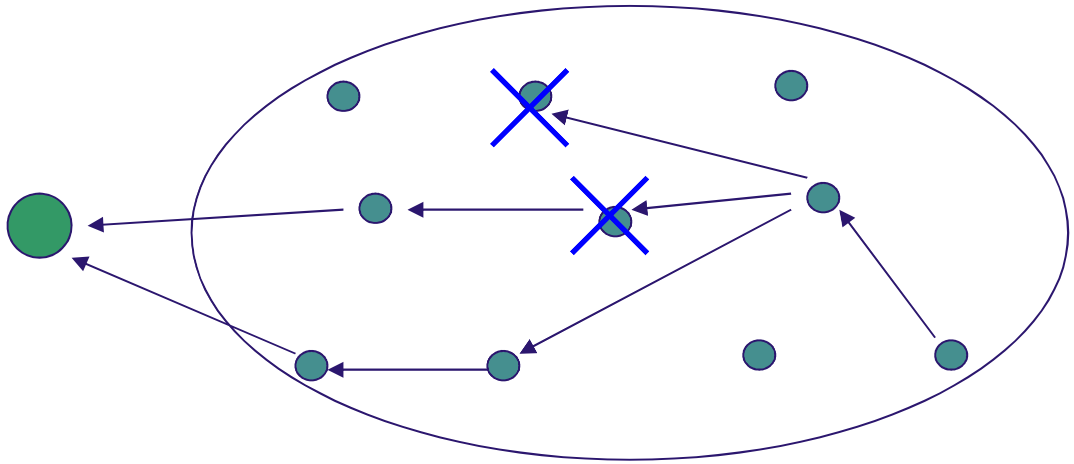
❖ WSN



- self-organizing
- multi-hop
- dynamic topology
- energy-resources restriction

Problem description

- **A typical sensor network**
  - Sensor nodes generate source data
  - Sink nodes or mobile collector node collect these data
- **Special Scenarios (Disaster)**



Problem description

❖ Data persistence

Preserve data from failed sensor nodes

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Deliver data to sink(s) **as much as possible**

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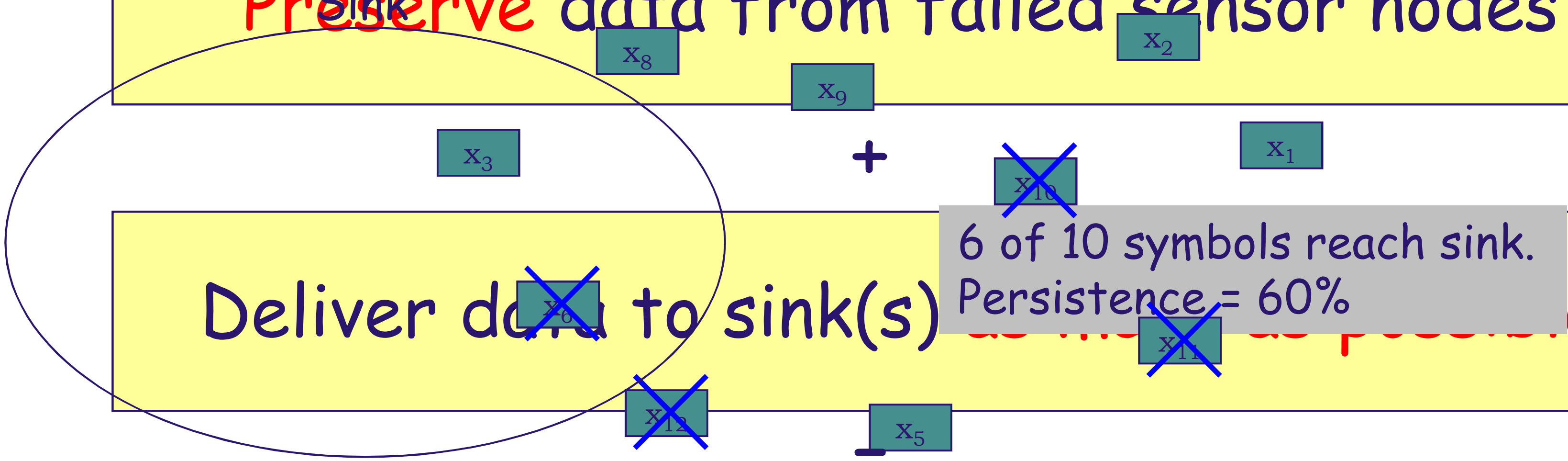
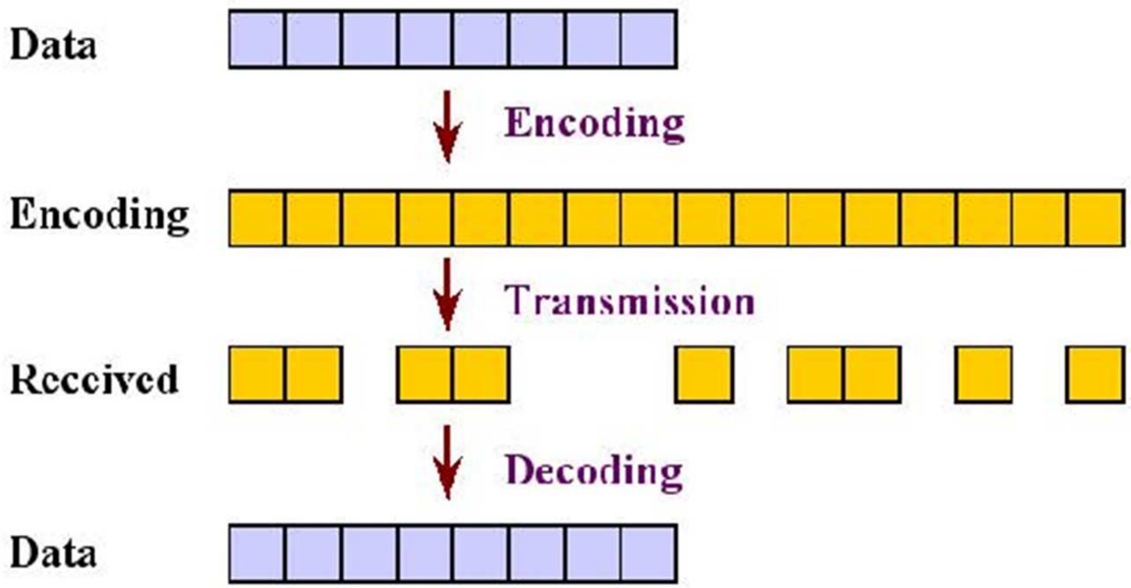
Maximize Data Persistence



Network coding

❖ Fountain codes

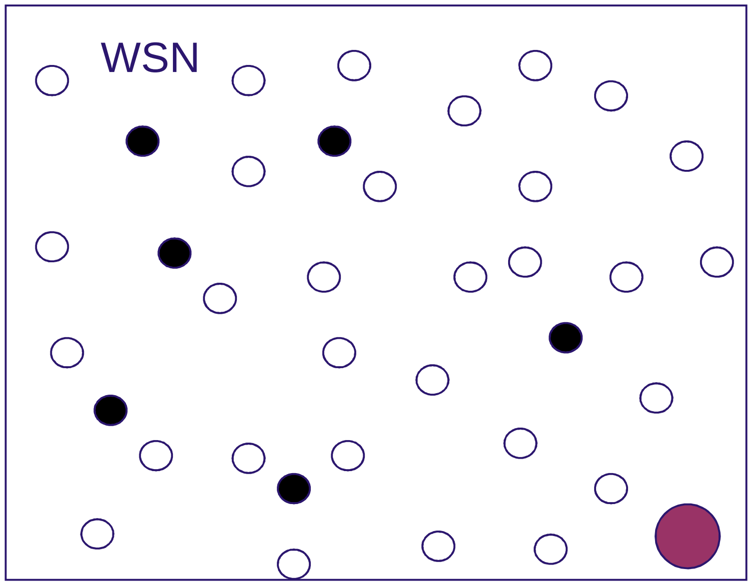
- *Michael Luby,"LT Codes" introducedthe first rateless erasure codes—LT codes*
- LT codes



LT Codes

❖ LT based storage system

- *Aly et al.* *"Fountain Codes Based Distributed Storage Algorithms for Large-scale Wireless Sensor Networks"*



● Sensor nodes

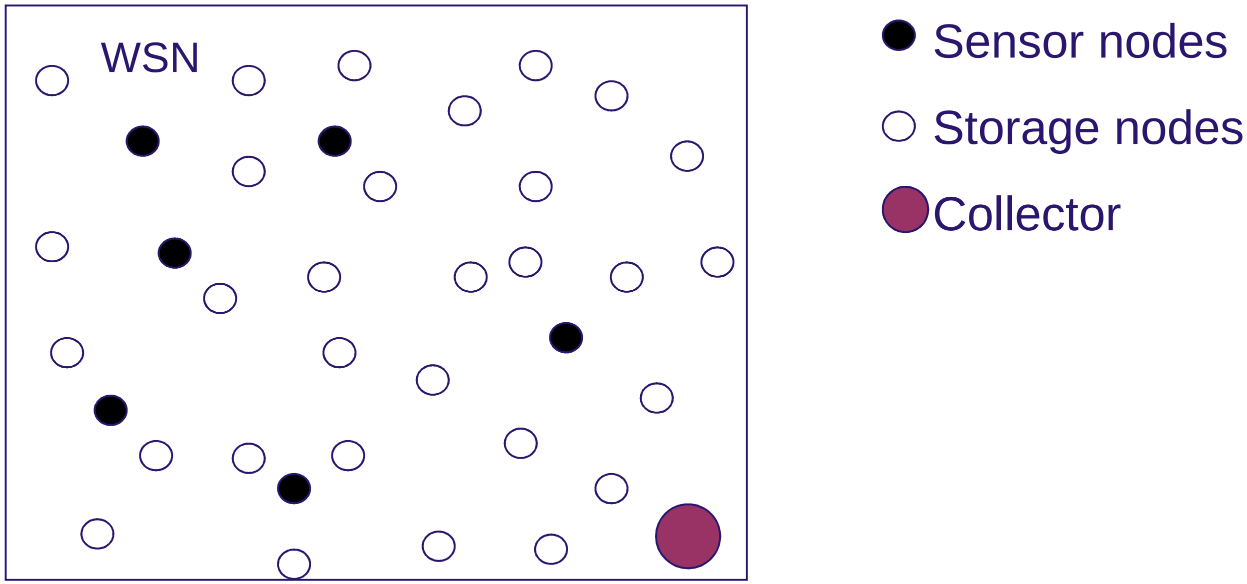
○ Storage nodes

● Collector

LT Codes

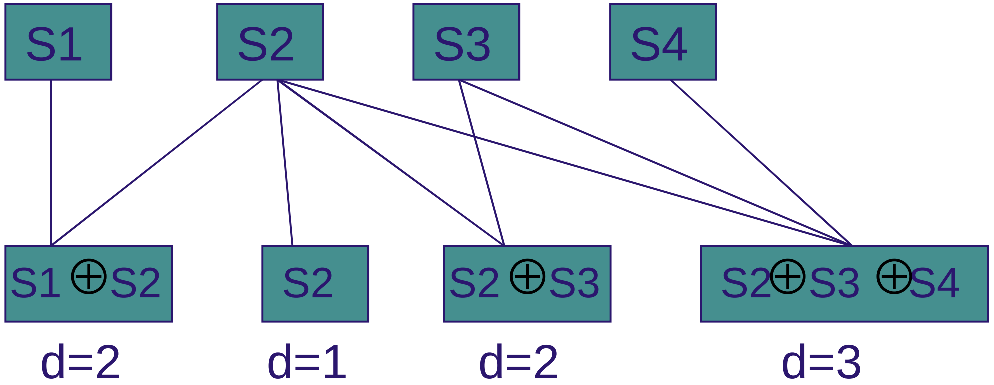
LT Codes based storage algorithm

- k sensor nodes and n storage nodes (k<n)
- WSN considered as a distributed data storage and collecting system



LT codes

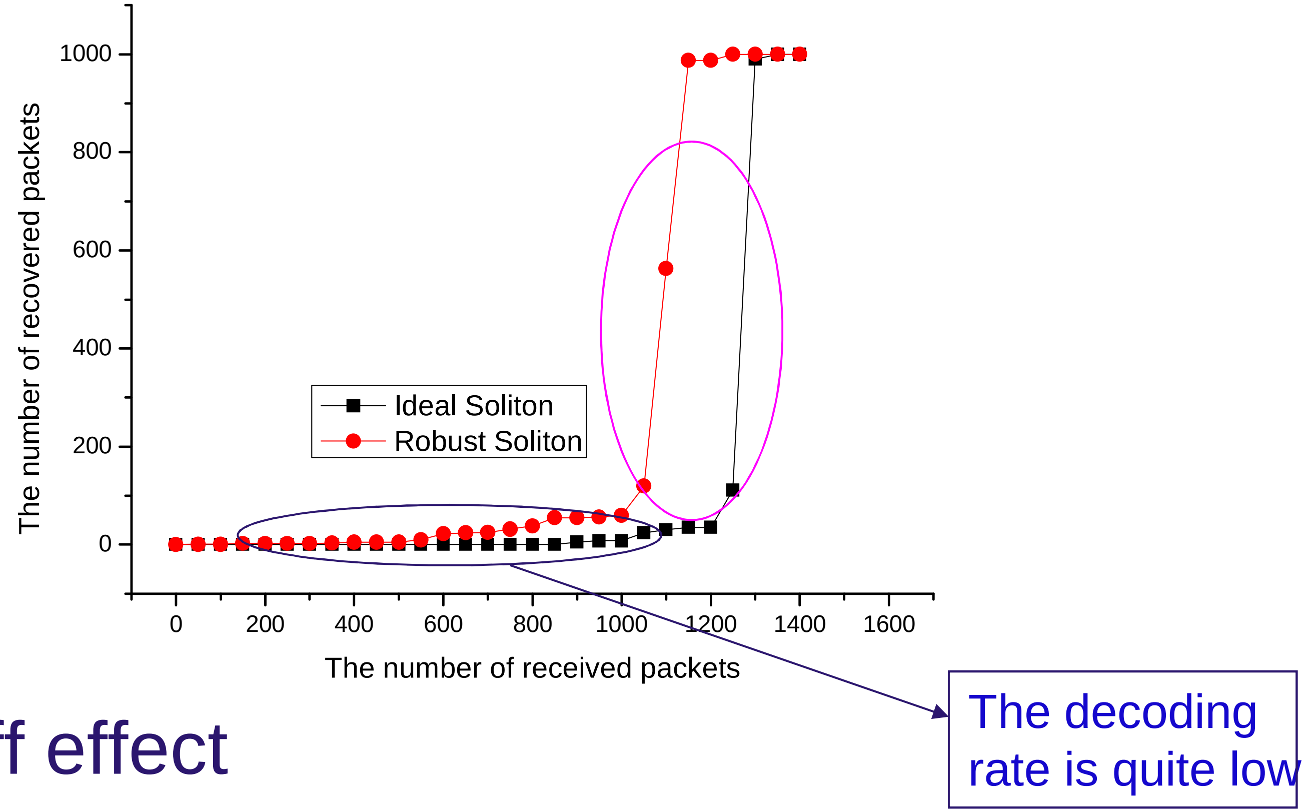
- Encoding



- Decoding
  - If not collect data S2,the other encoded data can not be decoded

LT codes

❖ Decoding Performance of classic Distributed LT Codes



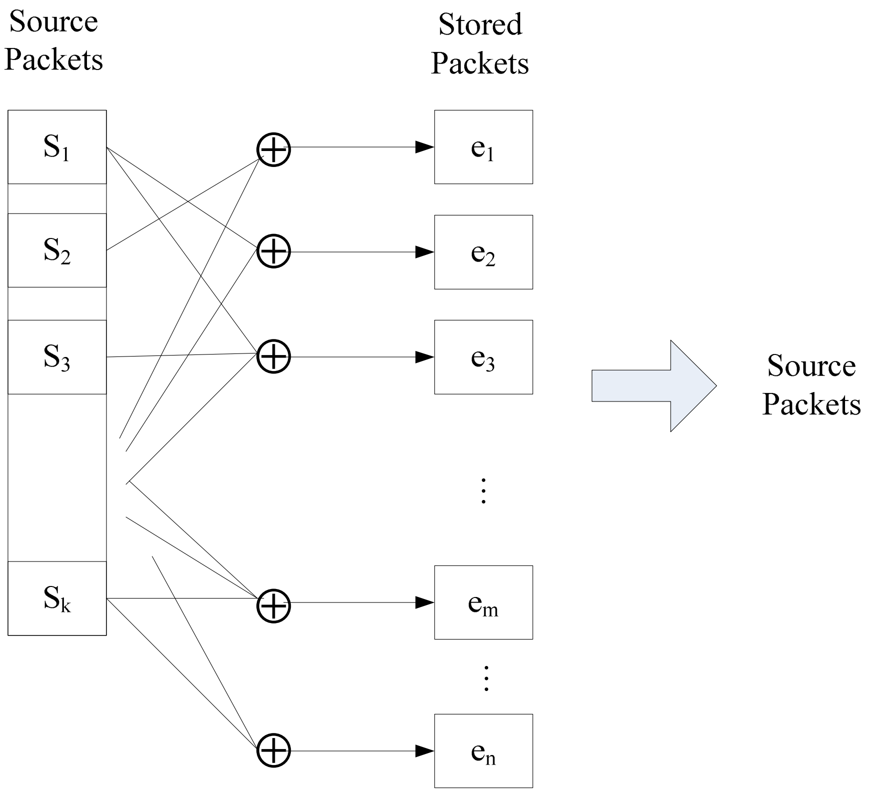
- cliff effect

Our approach

- **Two main purpose:**
  - To achieve better source data gathering and decoding performance.
  - To insure that the data persistence is not remarkably affected.
- **Network model:**
  - n sensor nodes, k source nodes (k<n)
  - There is a mobile collector S in the network
  - Limited storage: Each node can only possess one packet

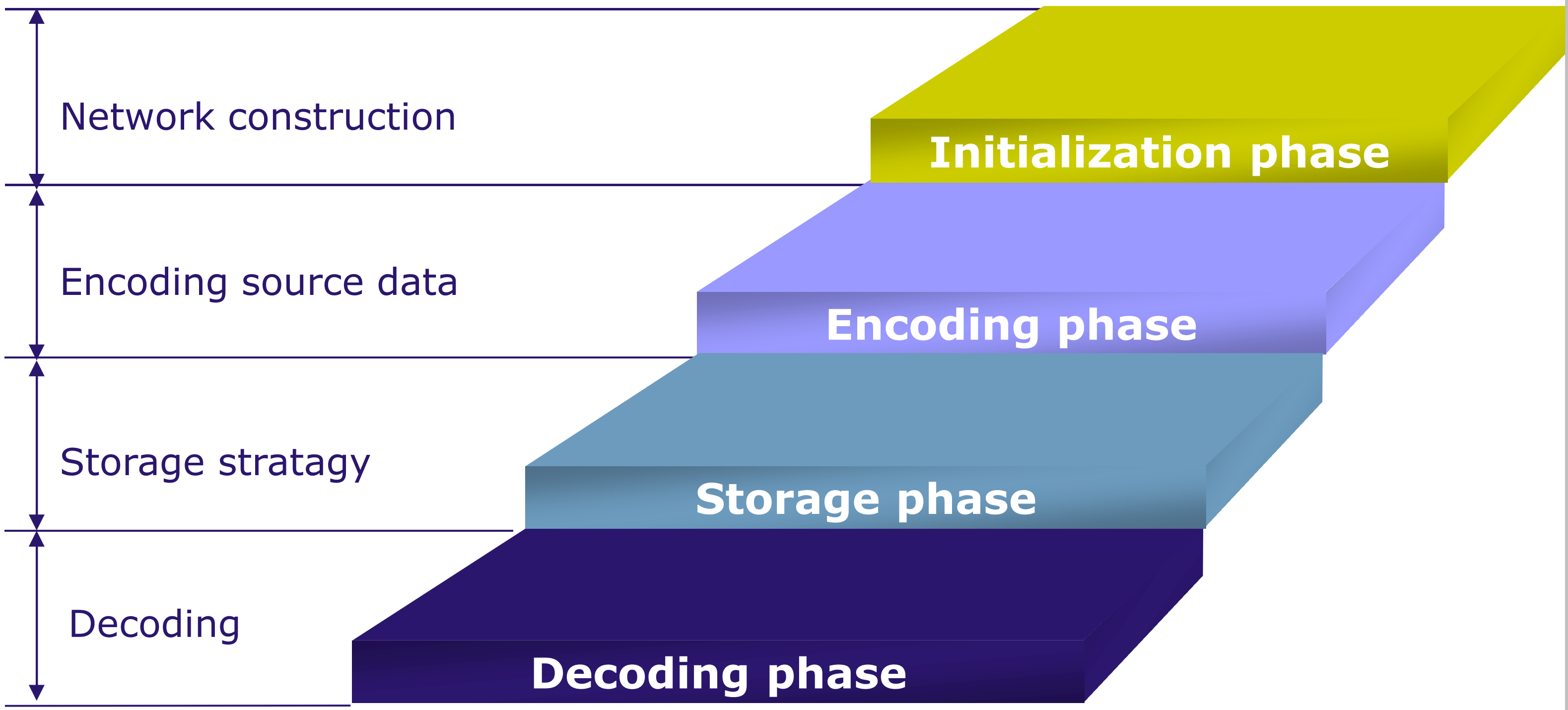
Network model

- The distributed storage system



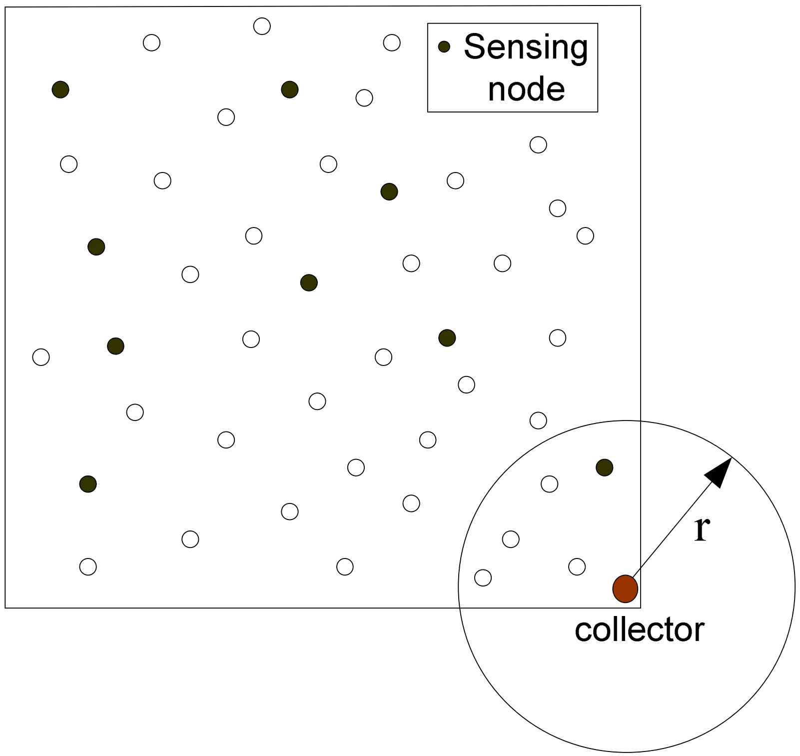
PLTD-Alpha

❖ Our algorithm: PLTD-Alpha



Initialization phase

- Network constructing with degree level
- The collector broadcasts a beacon



Initialization phase

- WSN
  - Sensor nodes (●)
  - Storage nodes (○)
  - Collector

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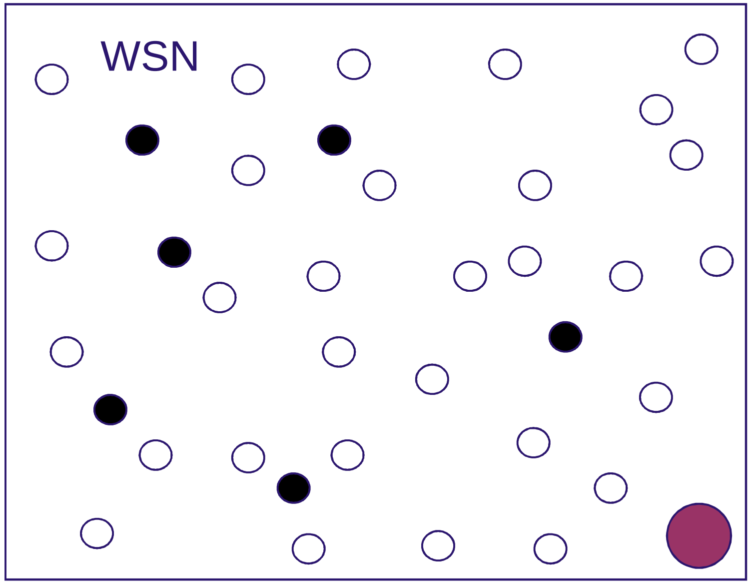
Packet header fields design

Sensor ID	Source data	Hop Count	flag



Initialization phase

- WSN

● Sensor nodes

○ Storage nodes

● Collector

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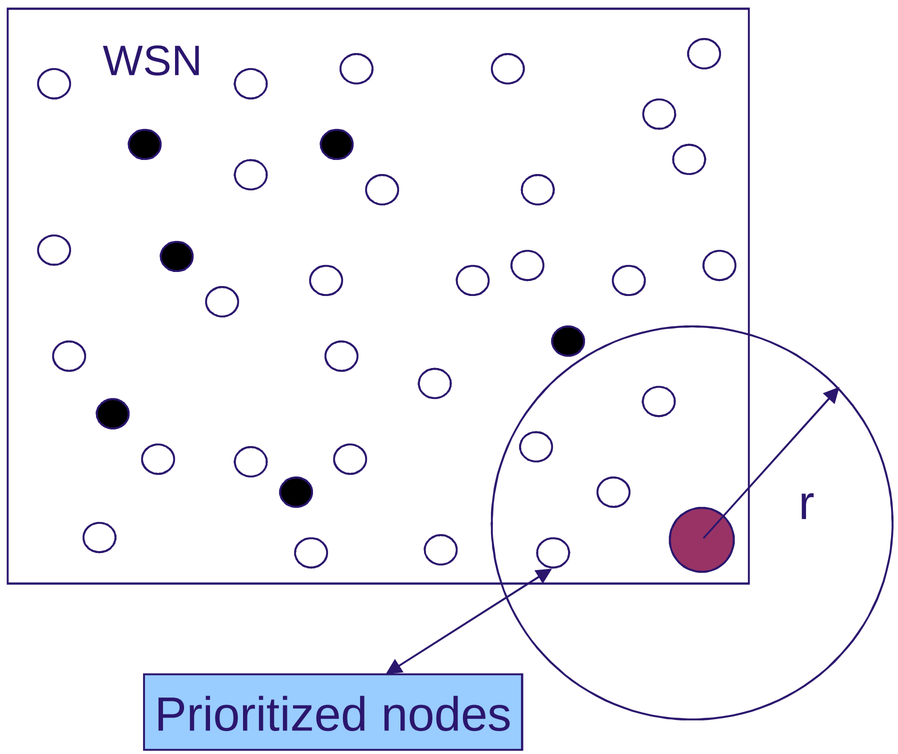
Network constructing with degree level

the collector at the predefined position broadcasts a beacon



Initialization phase

3

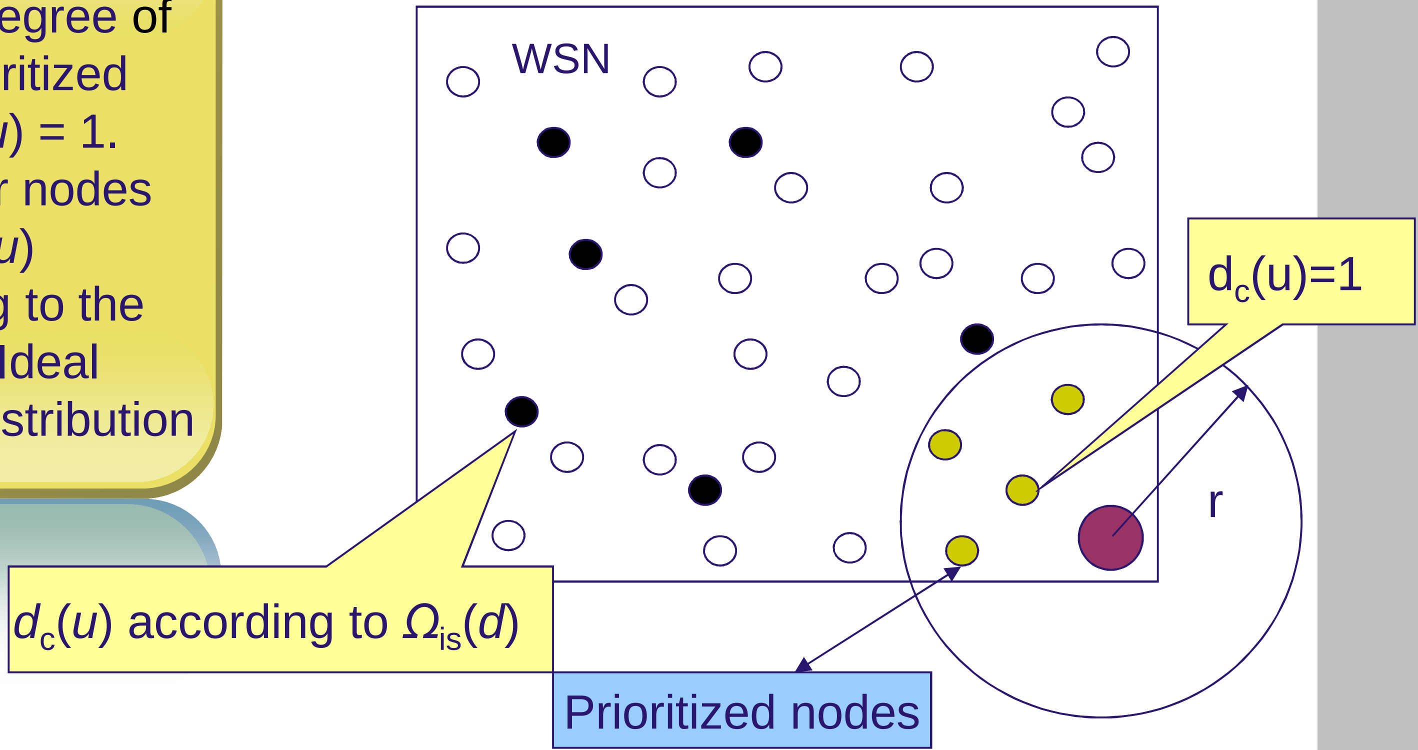
Coding degree of each prioritized node $d_c(u) = 1$. The other nodes make $d_c(u)$ according to the given by Ideal Soliton distribution $\Omega_{is}(d)$

- WSN

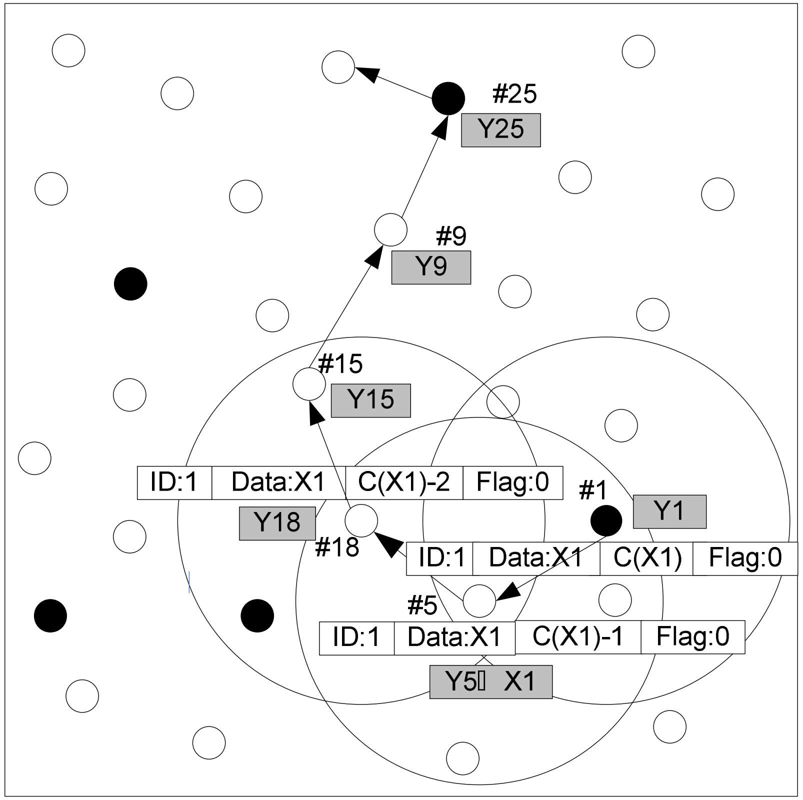
Sensor nodes

Storage nodes

Collector

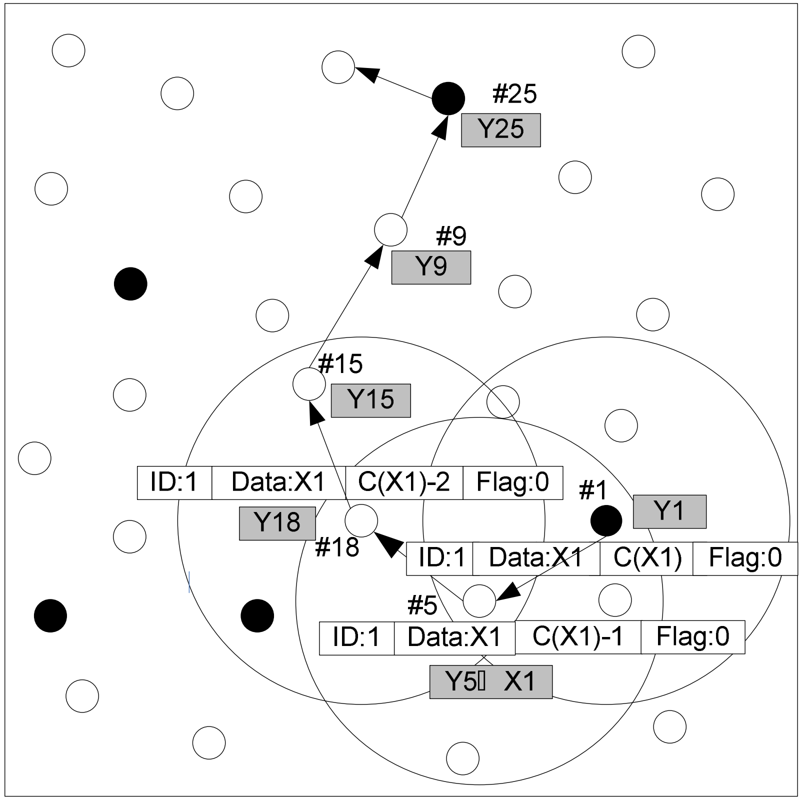


Encoding phase

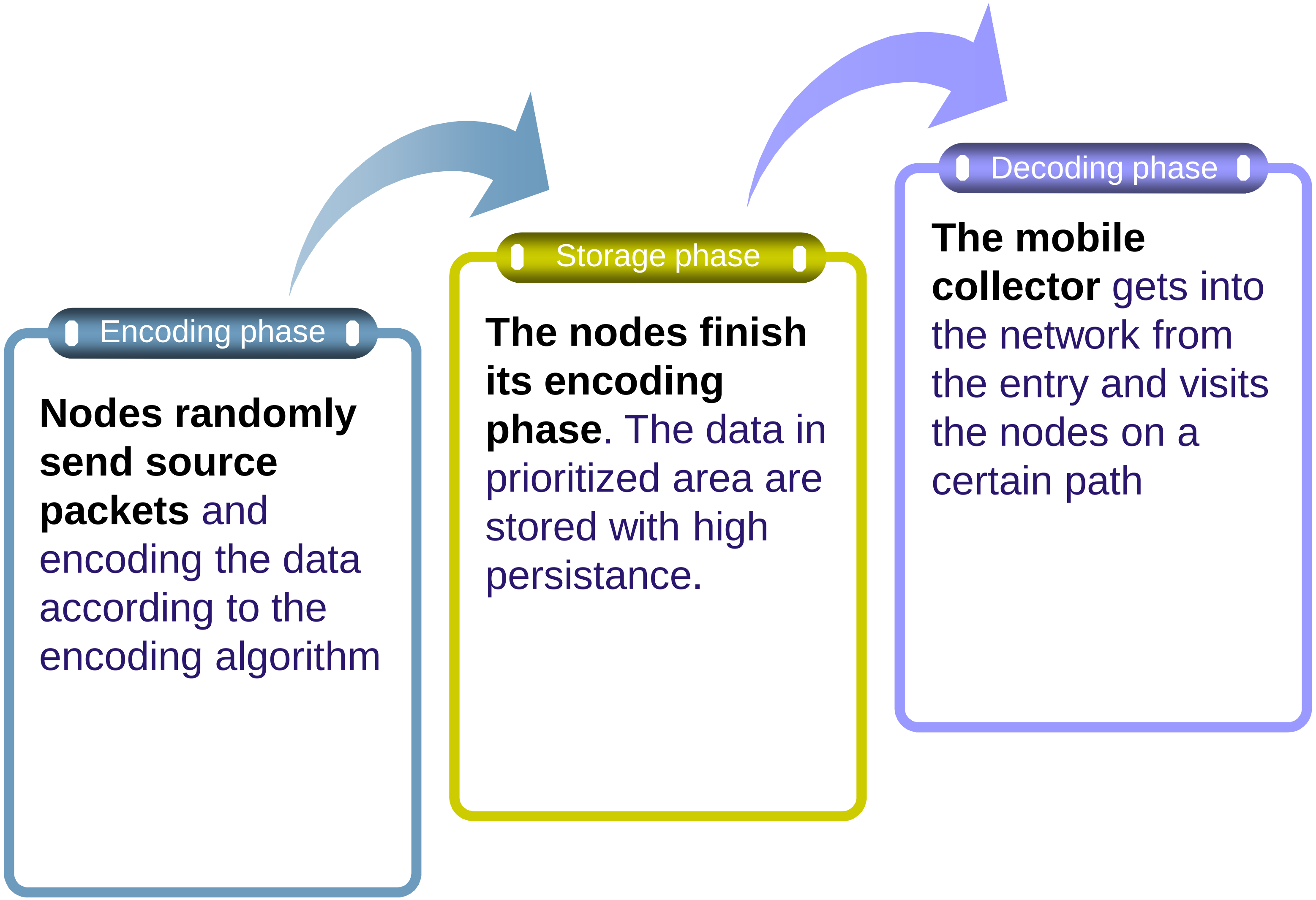


Encoding & Storage phase

- Example of a data packet forwarding in the network



PLTD-Alpha


Encoding phase
Nodes randomly send source packets and encoding the data according to the encoding algorithm
Storage phase
The nodes finish its encoding phase. The data in prioritized area are stored with high persistance.
Decoding phase
The mobile collector gets into the network from the entry and visits the nodes on a certain path

Experiments and results

Group A

Data collecting in random networks

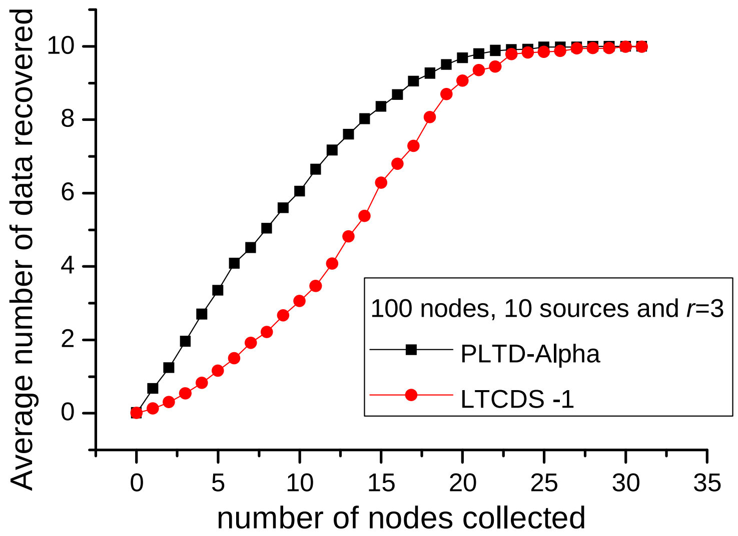
- Data recovery performance in network with n=100，k=10 and n=100，k=20

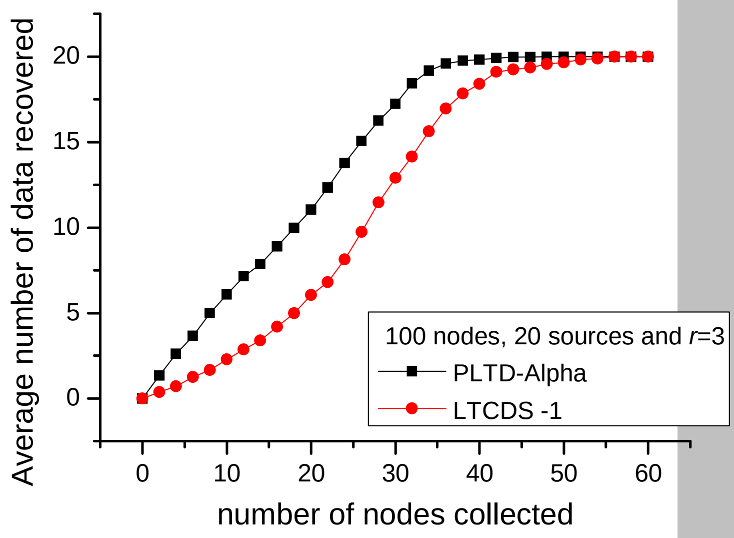
Experiments and results

Group A

❖ Data collecting in random networks

- Data recovery performance in network with *n*=100 , *k*=10 and *n*=100 , *k*=20





Experiments and results

Group B

Data collecting in random networks

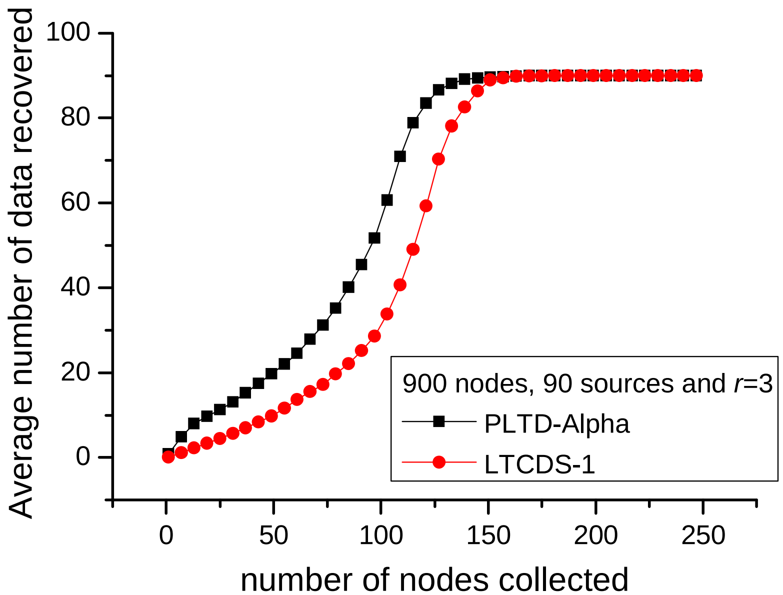
- Data recovery performance in network with n=900, k=90 and n=900, k=180

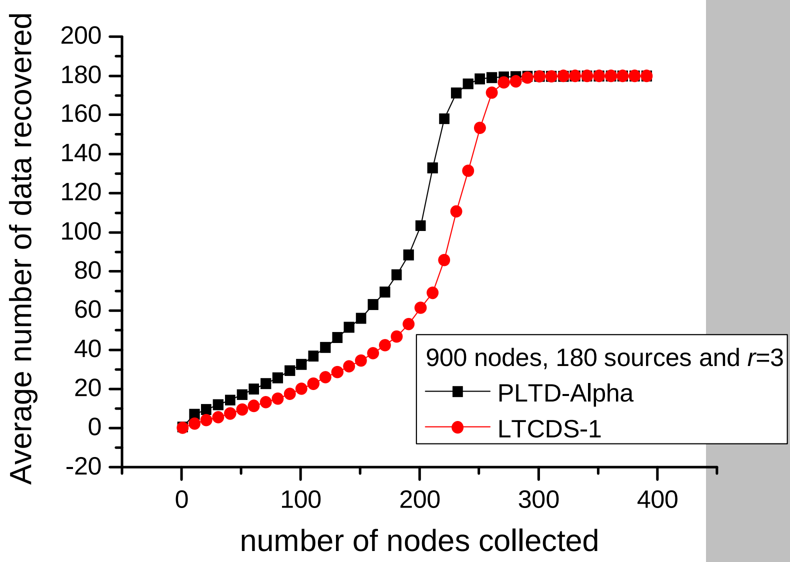
Experiments and results

Group B

Data collecting in random networks

- Data recovery performance in network with *n*=900, *k*=90 and *n*=900, *k*=180



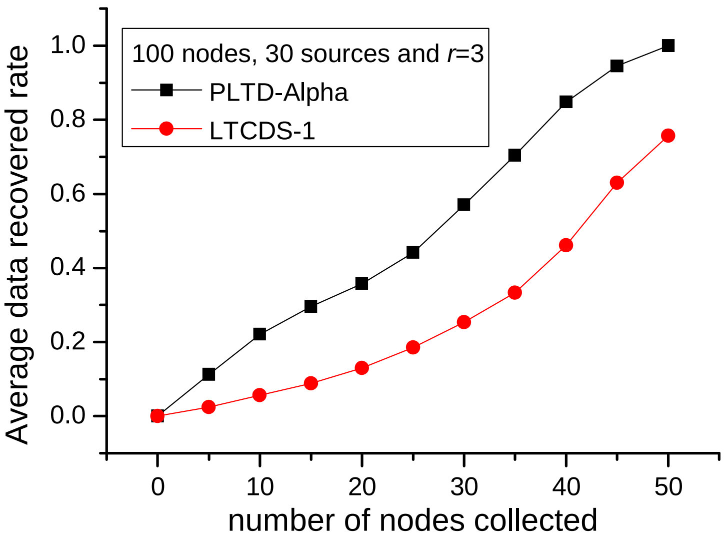


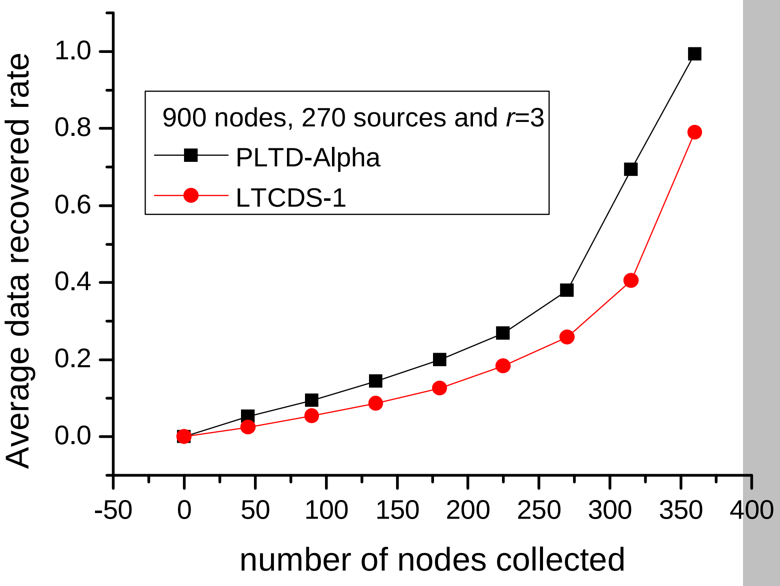
Experiments and results

Group C

❖ Data collecting in disaster networks

- a subset of the sensor nodes may be destroyed and stop working



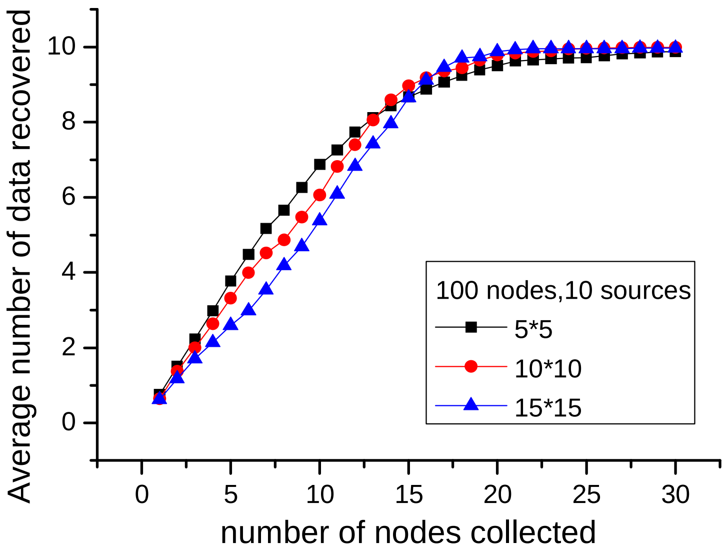


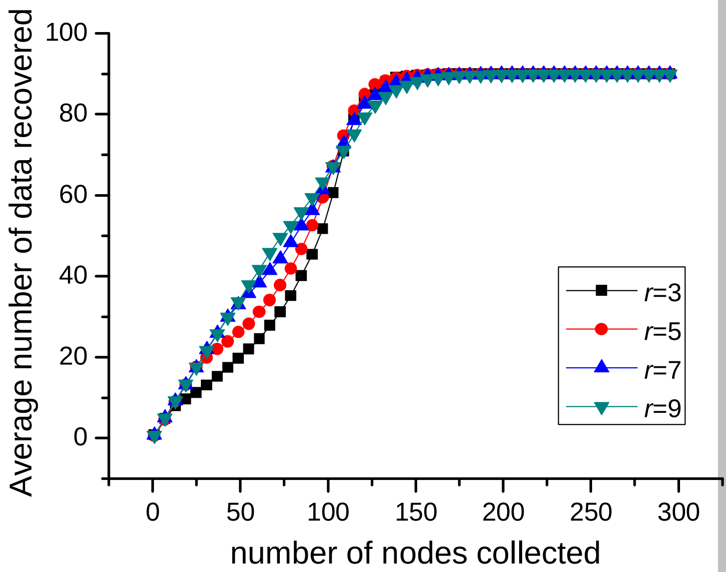
Experiments and results

Group D

❖ Network connectivity

- Data recovered with different network density
- And with different communication radius





Conclusions and future work

- Cliff effect is observed and PLTD-Alpha algorithm is proposed.
- With PLTD-Alpha, persistent data packets can be submitted to the sink node according to its degree in order.
- PLTD-Alpha can greatly improve the data collection and decoding efficiency of sensor network while data persistence is not notably affected
- In our future work, we will focus on the self-adaptation feature of PLTD, in order to further improve the performance and reduce the dependency

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