An Algorithm for Distributing and Retrieving Information in Sensor Networks

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The Problem

- To make data available to all nodes in a sensor network
  - e.g. posts to a white board
- Taking into account that
  - Data should be replicated
    - Nodes may fail
  - It is not possible to replicate everything at all nodes
    - Storage space is limited
  - Using as few messages as possible
    - Nodes have limited batteries
  - Replicas should be scattered over the network
    - Reduces access latency
    - Saves messages
- Assumption
  - Sensors are not aware of their location
    - i.e. they do not have a GPS device
  - Omni-directional antennas

Related Work

Hara:{01,04} Requires neighborhood awareness. Number of replicas depends of an estimated access pattern.

Datta:04 (Autonomous gossiping) Nodes advertise the profile of the data they are interested. Items migrate.

Yin:06 Assumes a single source of data.

Data centric Requires location awareness. Some (Li:00,Ghose:03,Liu:06) geographically distribute the replicas.

The Algorithm

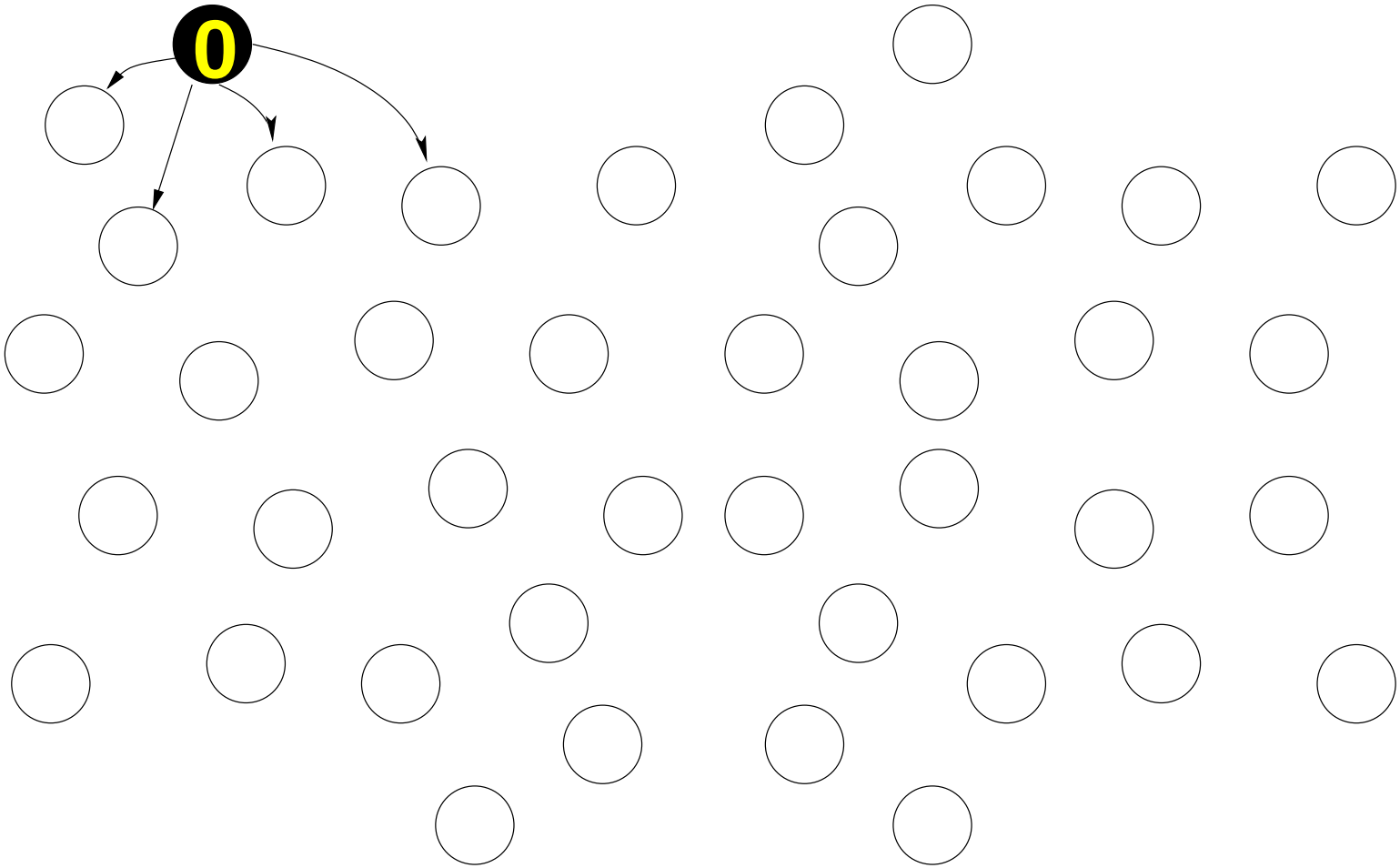
Idea

- Store a copy of each item at every n (DbC) hops
  - So that each node has a copy of each item at most $\left\lceil \frac{n+1}{2} \right\rceil$ hops away
- Use queries to fix the distribution

Requires

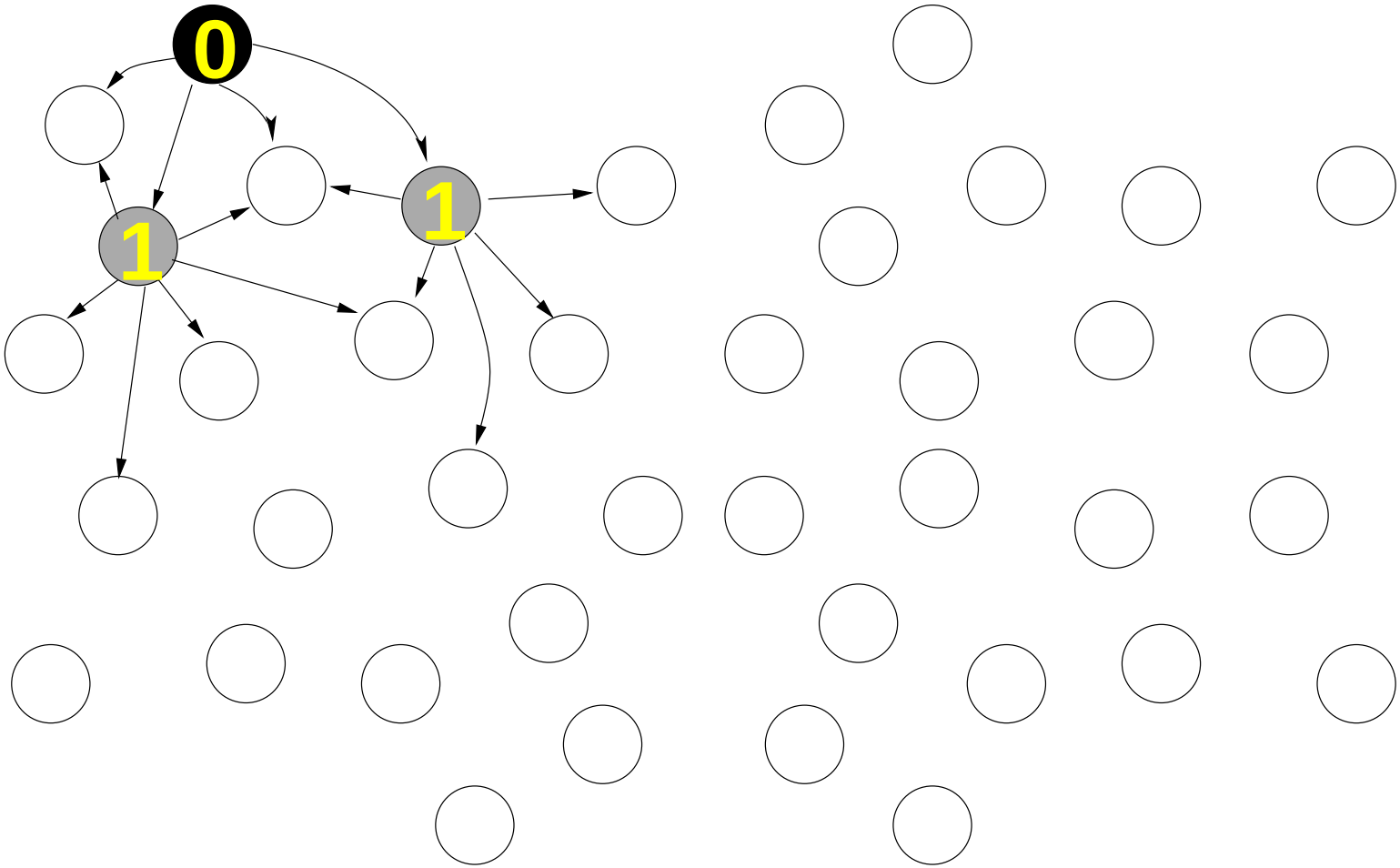
- A counter on the dissemination message (TFS)
  - Incremented by the nodes that forward the message
  - When the counter reaches DbC, the node stores the message and resets TFS
- An algorithm to prevent too many nodes from forwarding the message (PAMPA)
  - Sorts nodes according to the reception power of the messages
  - Only the nodes more distant to the source retransmit

Dissemination Example



Numbers show TFS of the message. DbC=2

Dissemination Example



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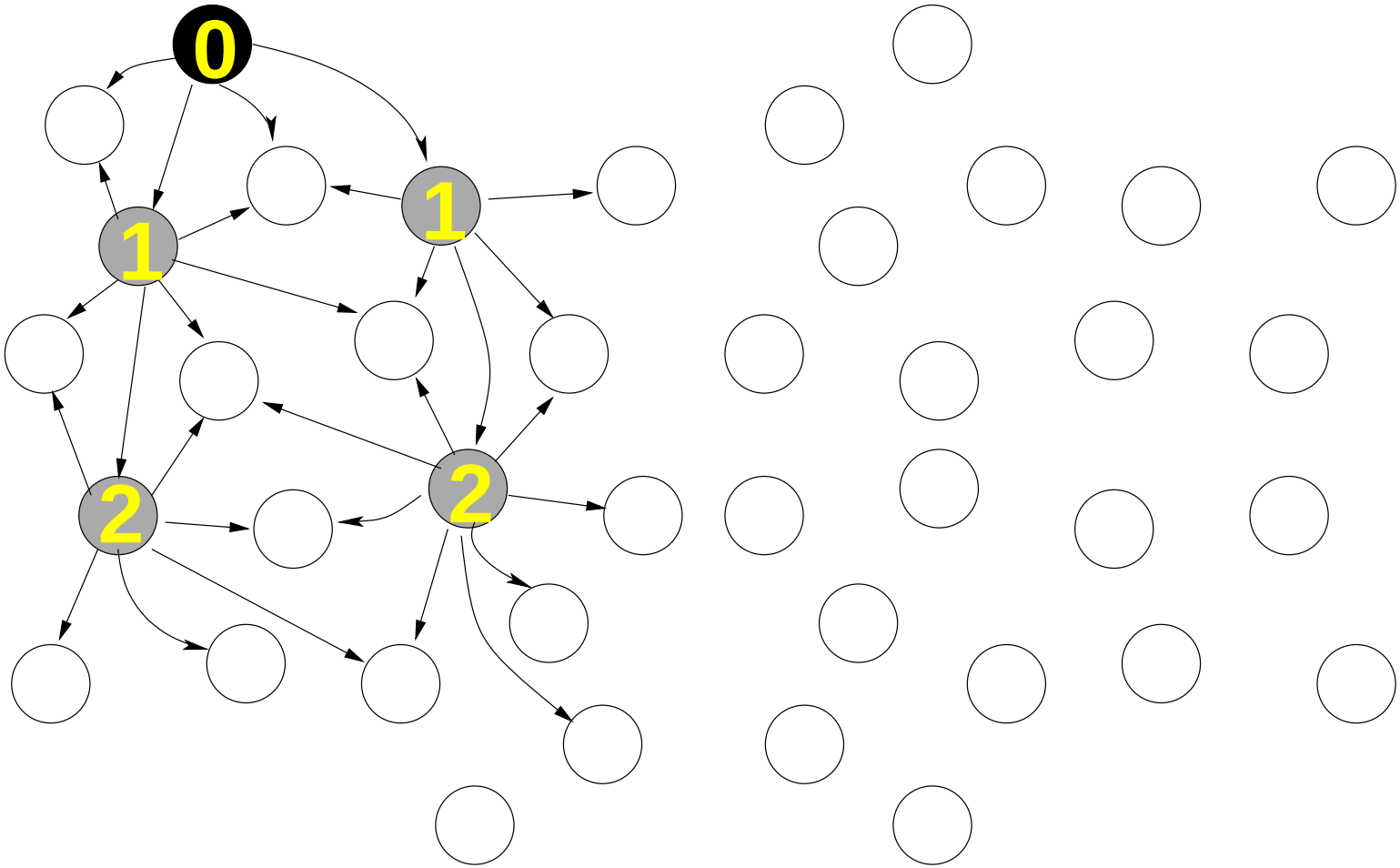

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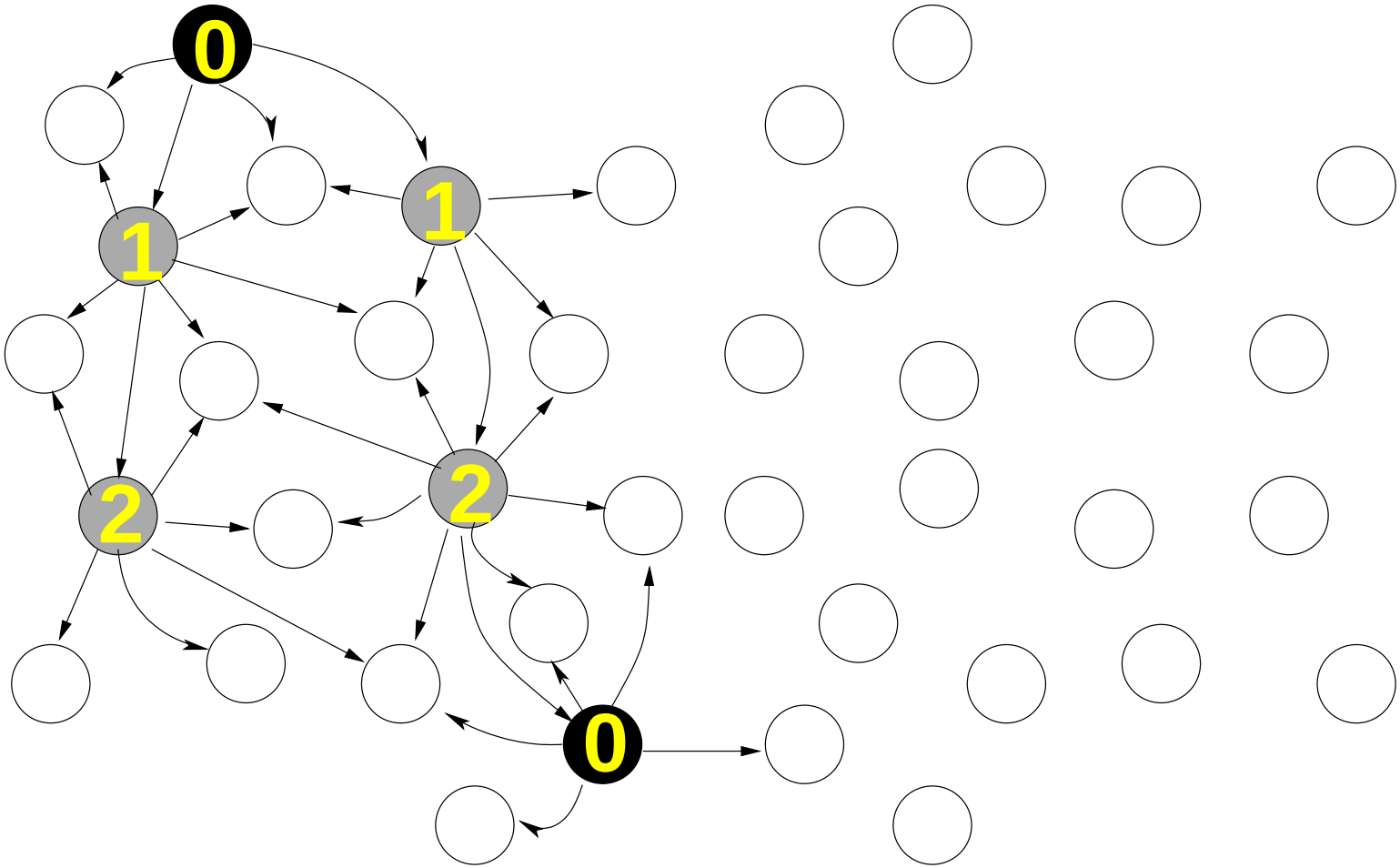

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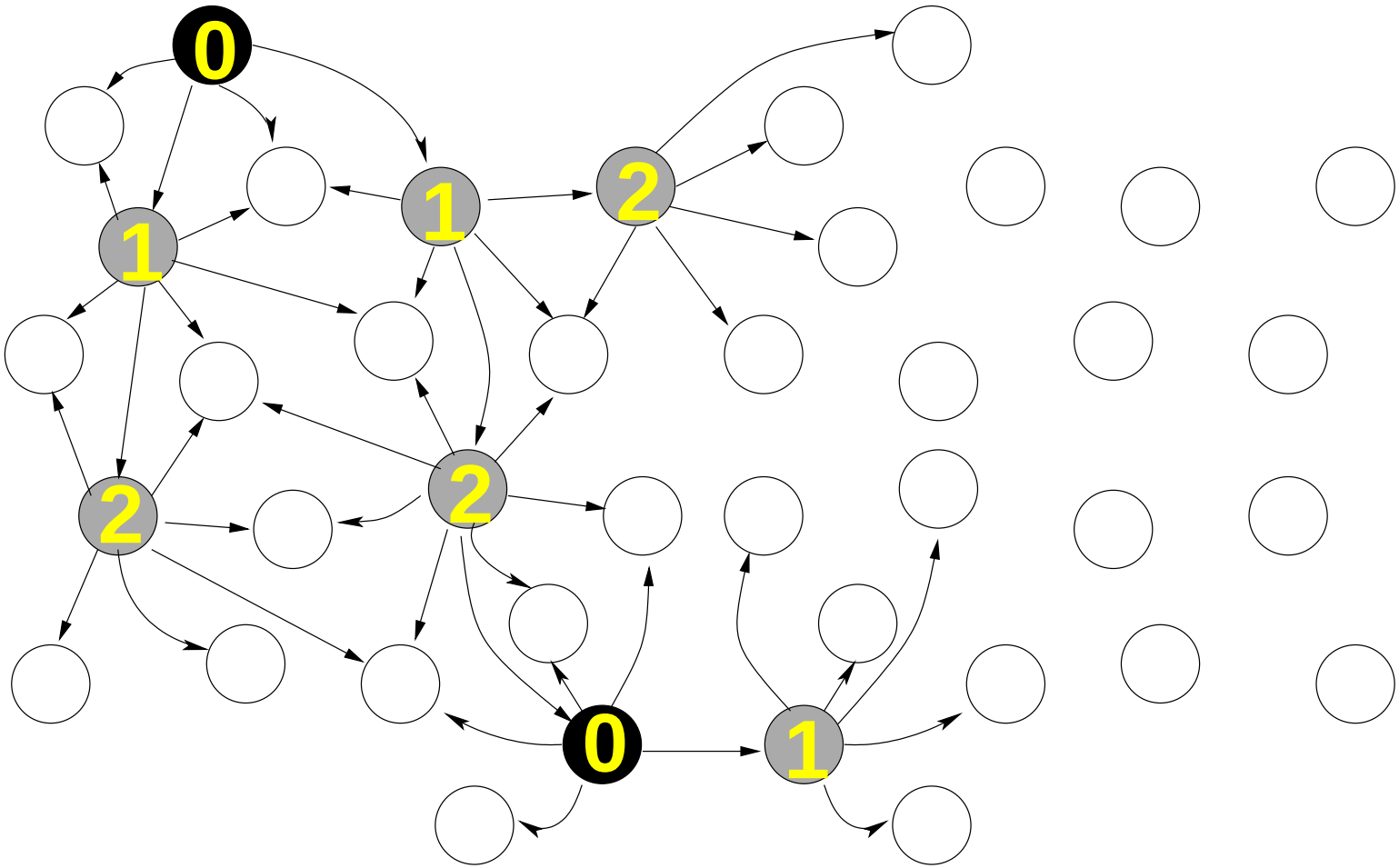

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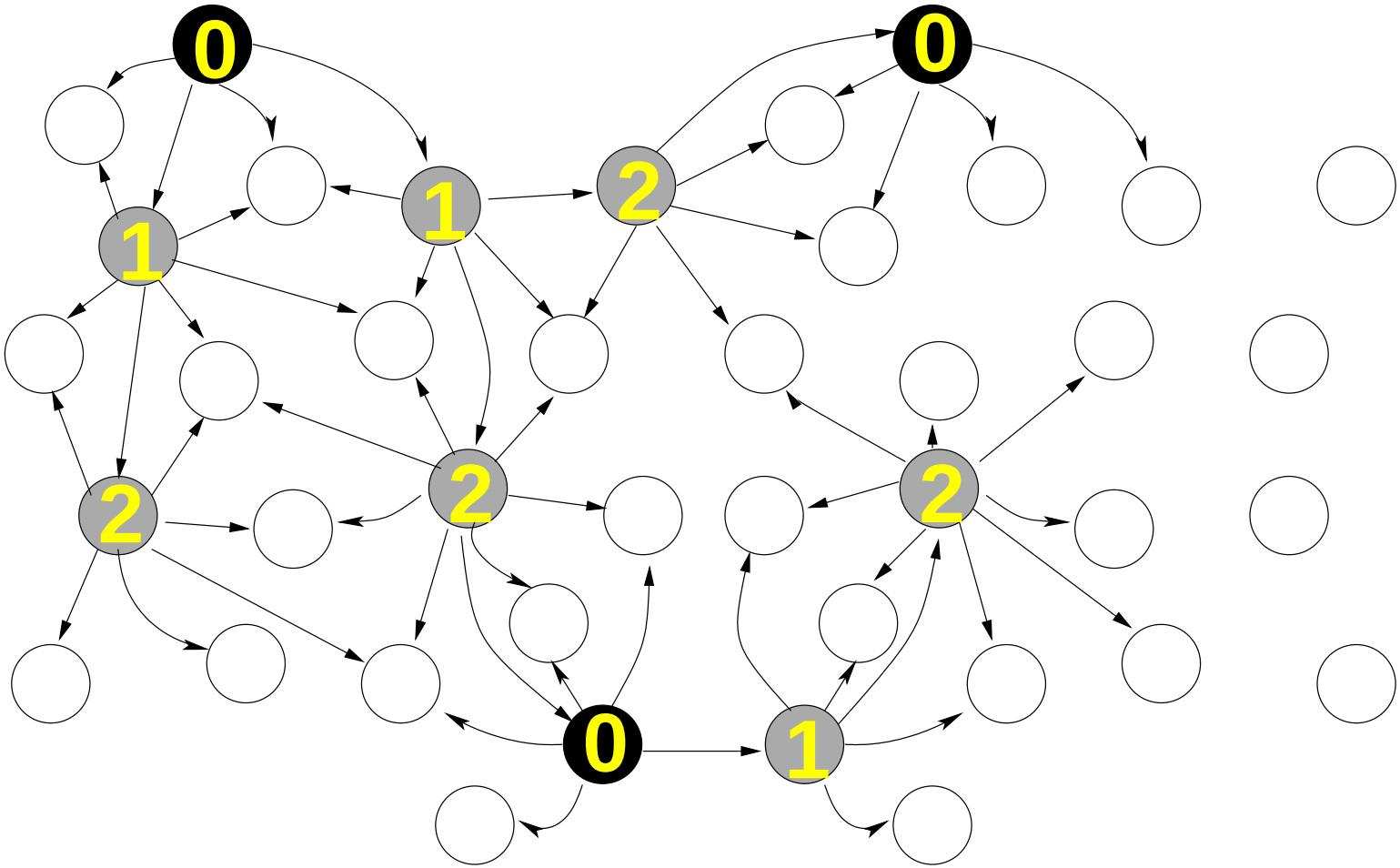

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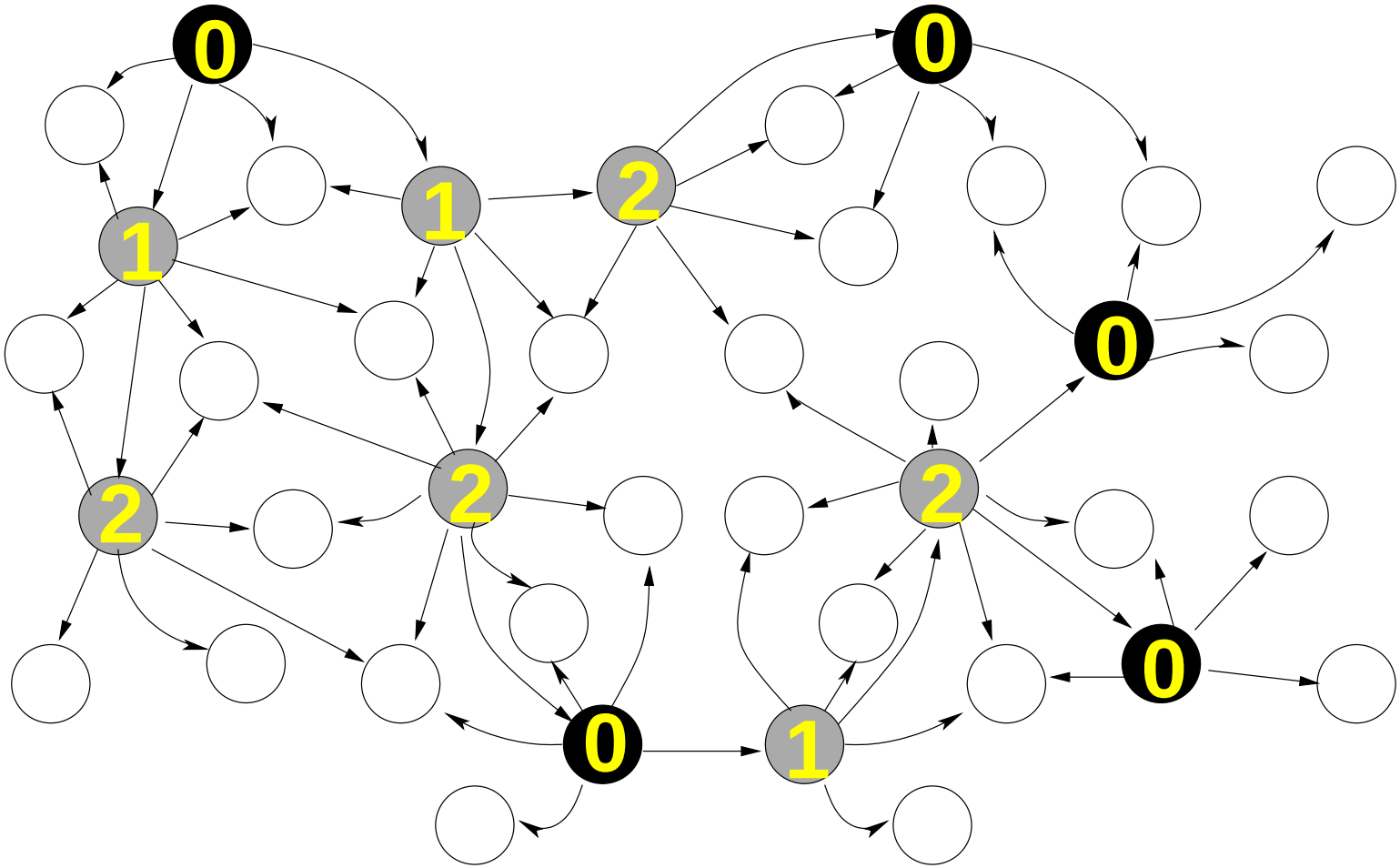

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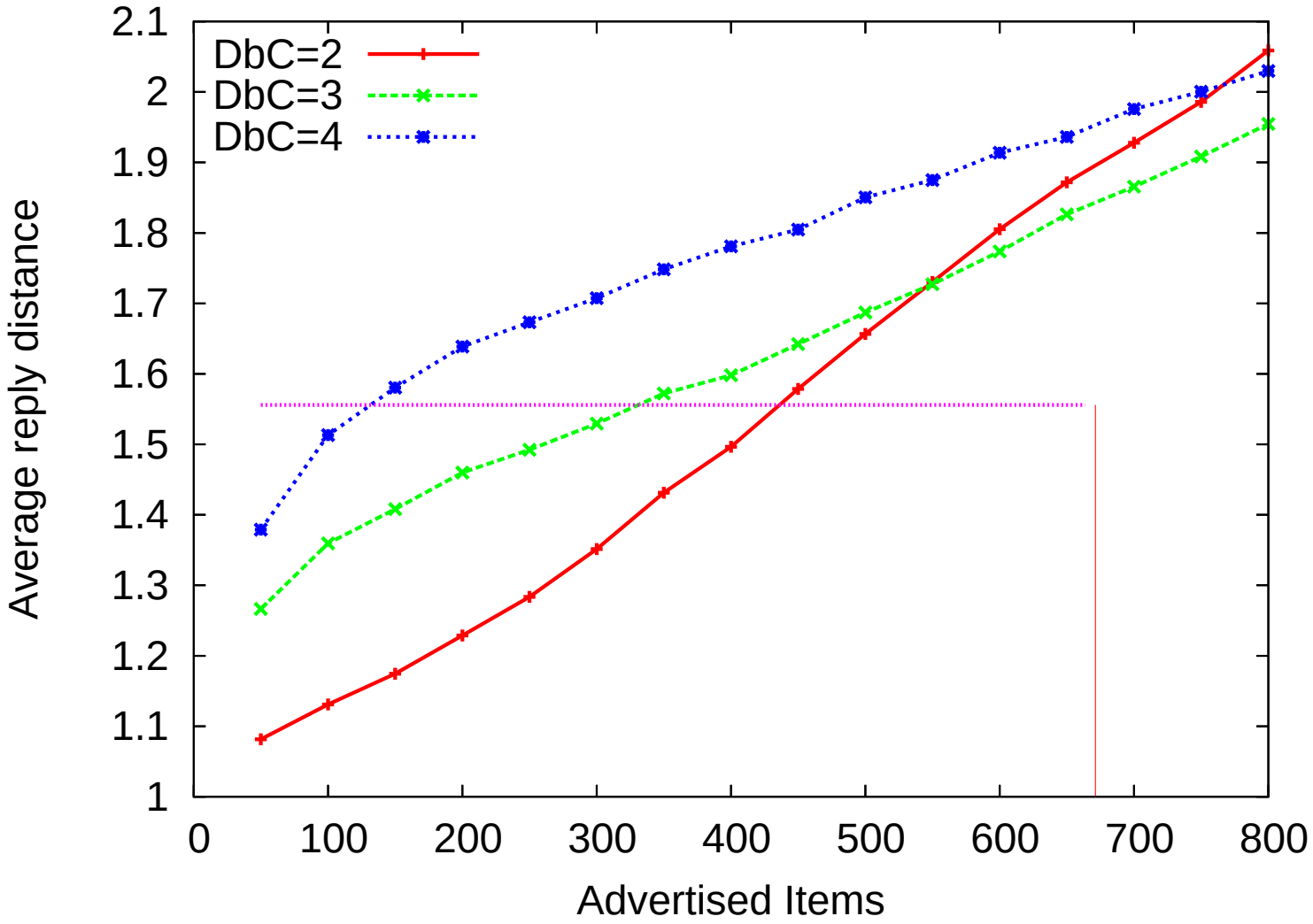
Query

- Nodes first broadcast the query with a small TTL
  - Adaptive value from past experiences
- If no reply is received, flood the network
- Locally store the item if the reply was received from far away
- Replies are sent point-to-point
  - Use the route constructed during query propagation (like DSR)

Evaluation

Distance of the replies



- Simulations in *ns-2*, 100 nodes
- Square defines the theoretical limit for DbC=2
- Degrades gracefully with the number of items

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Summary

- We presented an algorithm for disseminating replicas of data items that
  - Geographically distribute the replicas
    - Even when nodes are not aware of their location
  - Creates a number of replicas depending of the size of the network
- Future Work
  - "Repair" the distribution when nodes move