Using Hierarchical Location Names for Scalable Routing and Rendezvous in Wireless Sensor Networks

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Introduction: provide scalable routing and rendezvous primitives using HLI

Scalable Routing Primitives using HLR

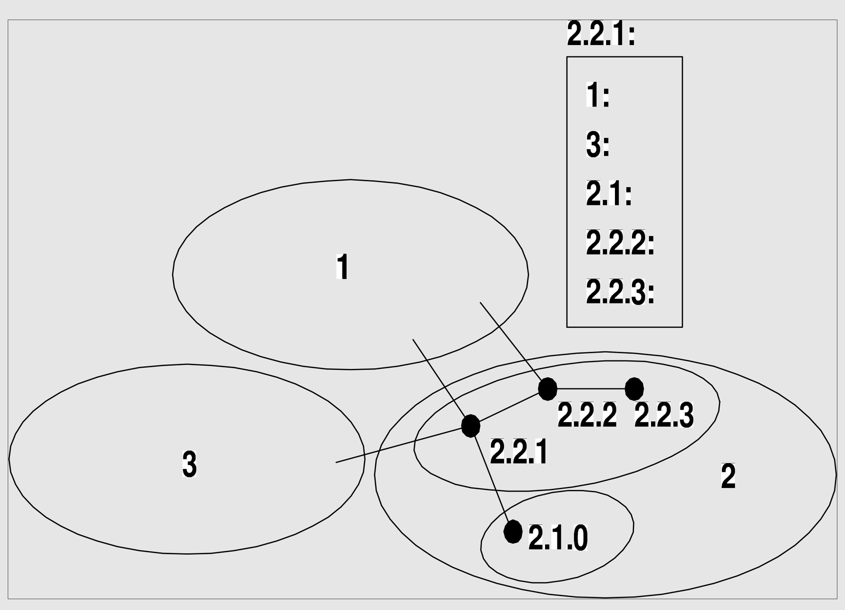
- **Manually configured *Hierarchical Location Identifiers (HLI)* are used to identify the location of the sensor nodes in deployed sensor networks without location services.**
- **We use *HLI* to design a scalable routing systems (termed *HLR*). *HLR* provides a number of routing primitives including *unicasting*, *scoped anycasting* and *multicasting*.**
- **The size of the routing table for *HLR* is *O(logN)*.**
- **HLR constructs and maintains the routing table using a variant of *DSDV*.**

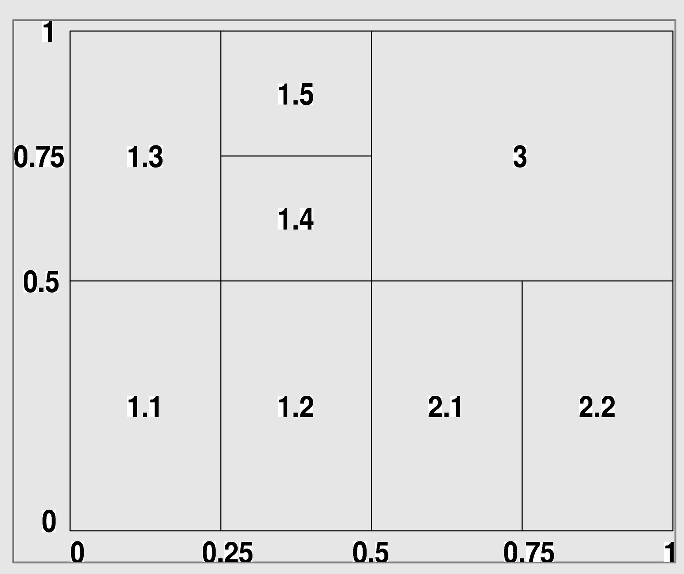
Scalable rendezvous using HLR

- **Rendezvous based on Random Hashing**
  - Provides a primitive ***hash-lookup(key)*** which consistently and randomly hashes an arbitrary ***key*** to a ***node*** in wireless sensor networks.
  - Can be used to build data-centric storage systems like GHT.
  - Can be used to implement triggering systems such as ***i3***.
- **Rendezvous based on Data-Locality Preserving Hashing**
  - Provides a data space multicasting primitive ***send-dsm(H, p)*** which delivers the packet ***p*** to all of the nodes who own part of the hyper-rectangle ***H***.
  - Can be used to implement data-centric storage systems like DIM.

Problem Description: provides data-centric routing and rendezvous primitives using HLI.

How to provide scalable routing and rendezvous primitives without location information?





- **Localization systems are still an active research field and may not be practical for years.**
- **Without accurate location information, near- or mid-term deployed sensor network may name the nodes with approximate hierarchical location information (*HLI*).**
- **Most of proposed data-centric storage systems make use of either flooding or geographical routing.**
- **In absence of practical localization systems, yet equipped with manually configured hierarchical localization identifiers, we design efficient and scalable routing and rendezvous primitives using *HLI*.**

Proposed Solution:

HLR: Routing using HLI assuming connected areas

- **Modified DSDV – Conceptually maintain a route to each area instead of each node, yet record each route using the node's HLI to maintain the loop-free property of DSDV.**
- **Automatically aggregate routes to nodes in same area.**
- **Advertise routes periodically and assign a lifetime to each route to deal with route changes.**

HLR: Routing using HLI with potentially partitioned sub-areas

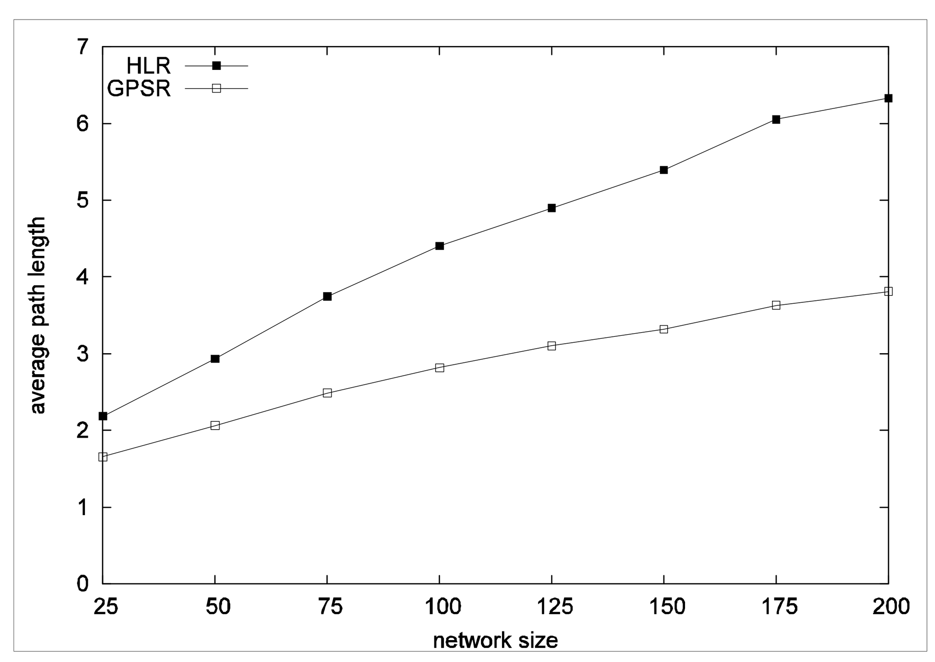
- **Conceptually treat partitioned sub-areas as separate areas, identified by cluster ID together with area HLI.**
- **Identify each partitioned area with a cluster ID by attaching the cluster ID to the advertised routes.**
- **Tag the routes to the same area through the other areas as potential routes to a partitioned sub-area.**
- **Hold down routes to potential partitioned sub-areas to avoid route churn.**

Rendezvous based on Random Hashing

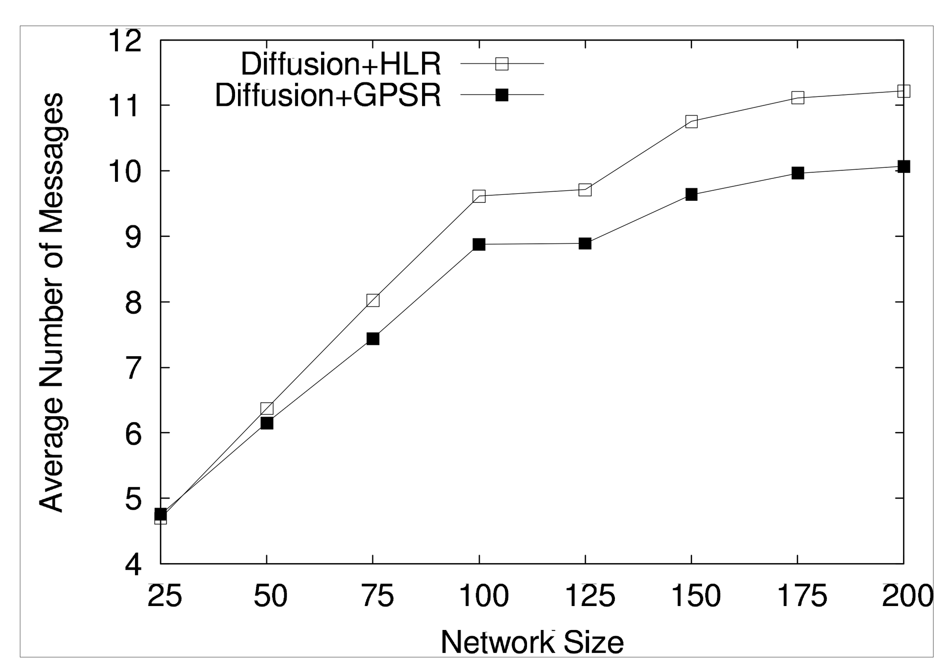
- **Hash the key to an HLI**
- **Make use of routing table to select one area with nearest area HLI to the hashed HLI**
- **Refine the destination area HLI along the path.**

Data-locality Preserving Hashing

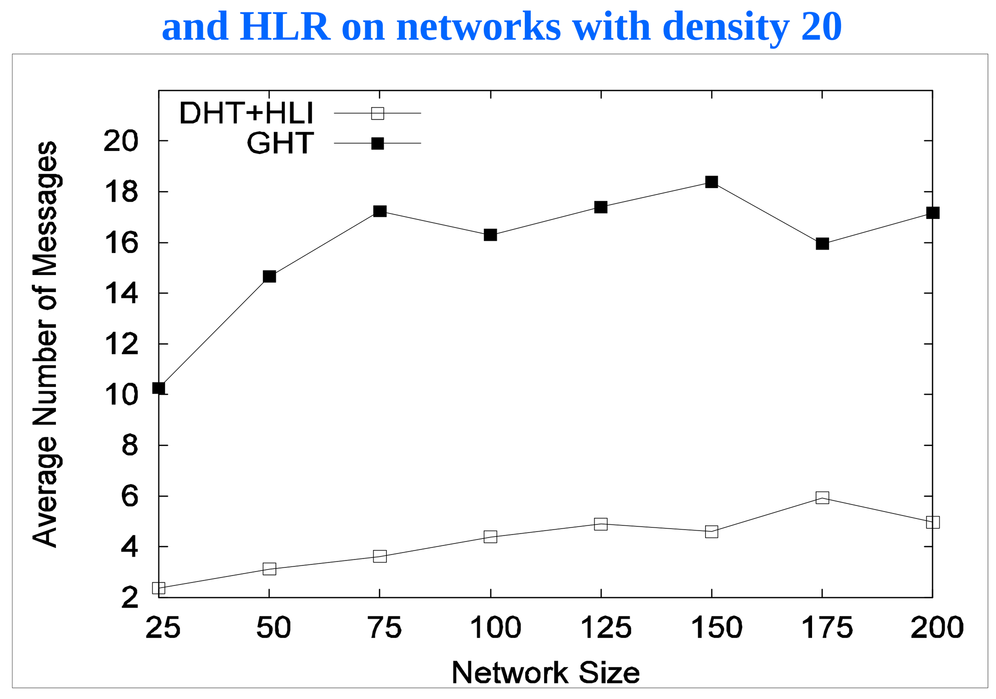
- **Map data hyper-rectangles to nodes in network similar to DIM.**
- **Divide the hyper-rectangle among the areas at same depth, and further divide the hyper-rectangle among the sub-areas.**



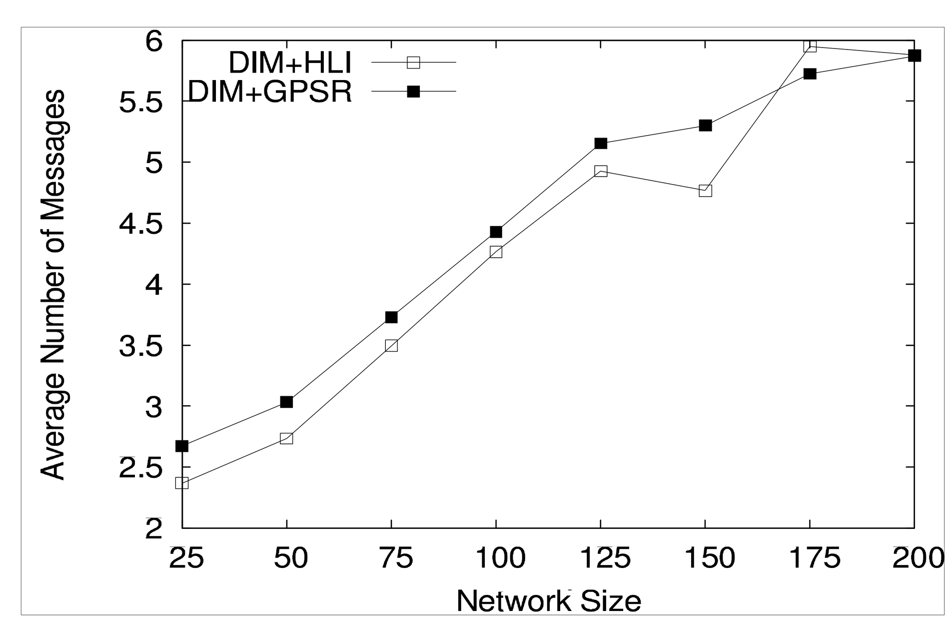
Comparison of Average Path Length in GPSR and HLR on networks with density 20



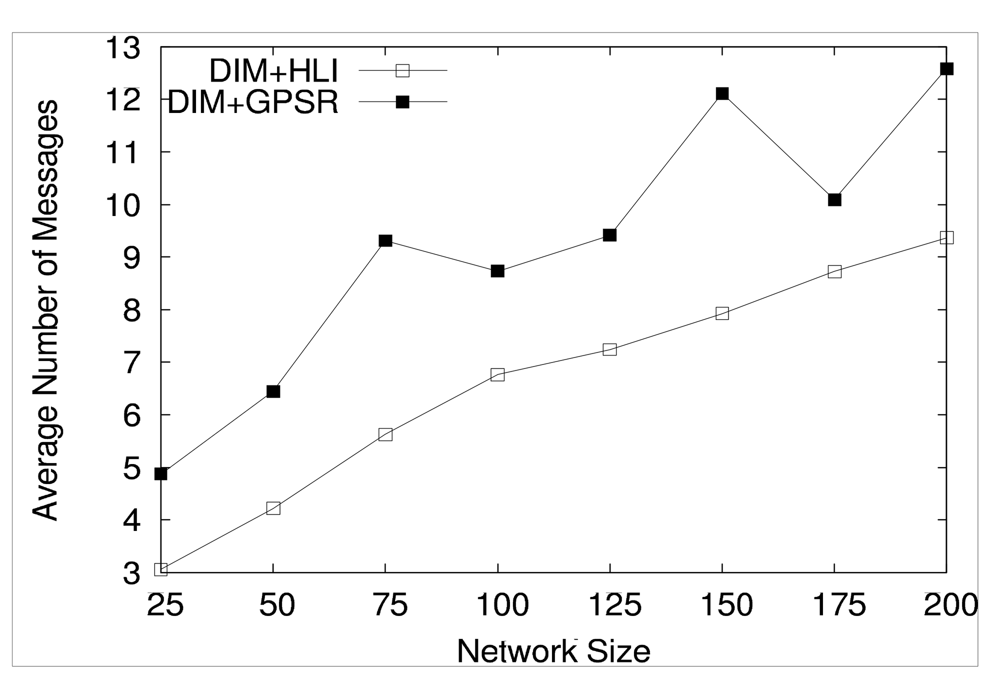
Comparison of Average Query Cost in Diffusion on networks with density 20



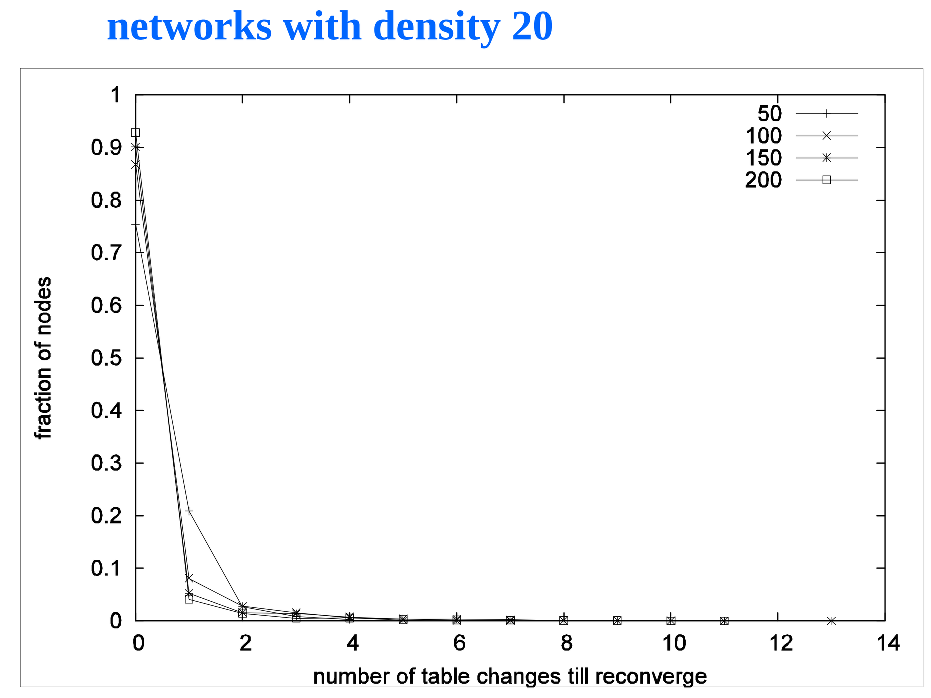
Comparison of Average Query Cost in DHT over HLR and GHT on networks with density 20



Comparison of Average Insert Cost in DIM on networks with density 20



Comparison of Average Query Cost in DIM on networks with density 20



Average number of routing table changes on single node failure on networks with density 20 and size 50, 100, 150 and 200