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

Fang Bian, Ramesh Govindan and Scott Shenker
USC/ENL – http://enl.usc.edu

Introduction: provide scalable routing and rendezvous primitives using HLR

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.

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.

Problem Description: provides data-centric 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.