CAN

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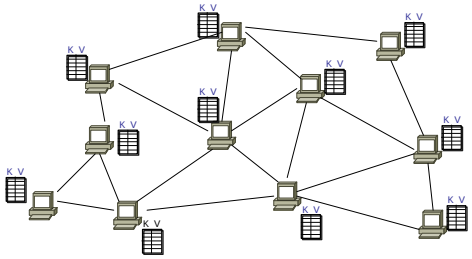
Fall 2003

Content-Addressable-Network (CAN)

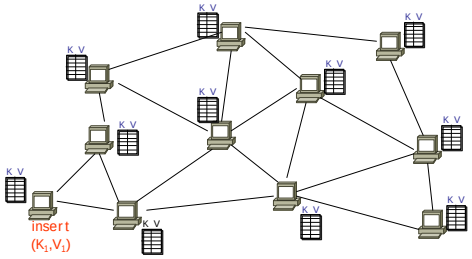
- CAN: Internet Scale Hash table
- Interface
  - insert(key,value)
  - value = retrieve(key)
- Idea: associate to each node and item a unique coordinate in an d-dimensional Cartesian space.
- Properties

–scalable
–operationally simple
–good performance

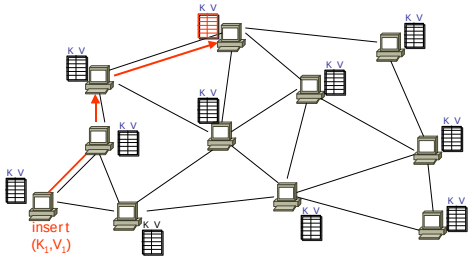
CAN: basic idea



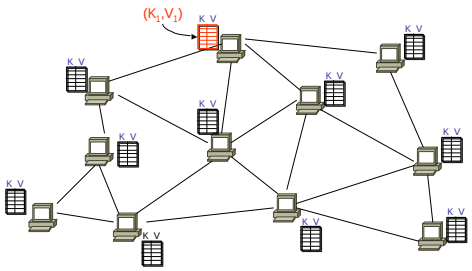
CAN: basic idea (cont.)



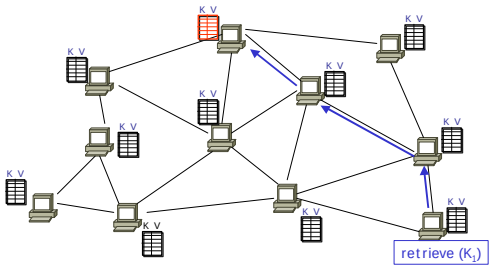
CAN: basic idea (cont.)



CAN: basic idea (cont.)



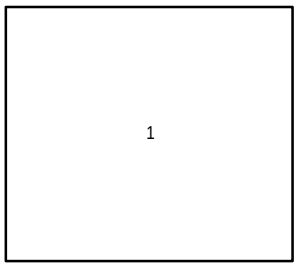
CAN: basic idea (cont.)



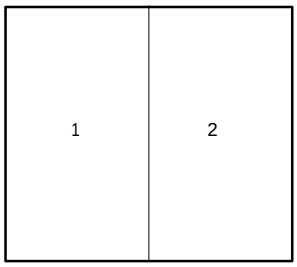
CAN (Solution)

- virtual Cartesian coordinate space
- entire space is partitioned amongst all the nodes
  - every node "owns" a zone in the overall space
- abstraction
  - can store data at "points" in the space
  - can route from one "point" to another
- point = node that owns the enclosing zone

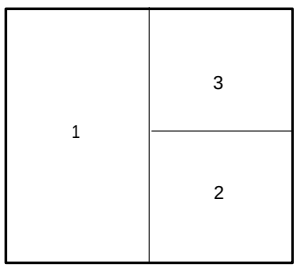
CAN (Simple example 2-dimension)



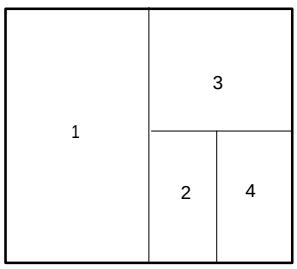
CAN (Simple example cont.)



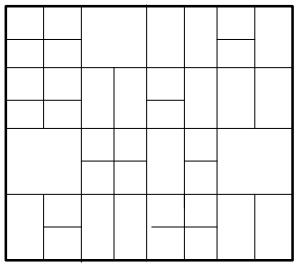
CAN (Simple example cont.)



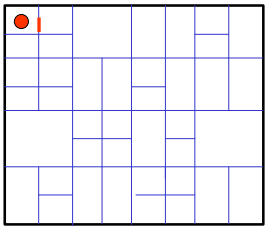
CAN (Simple example cont.)



CAN (Simple example cont.)

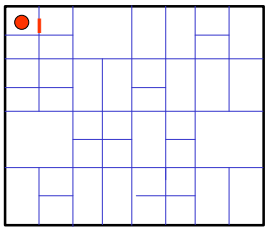


CAN (Insert)



CAN (Insert cont.)

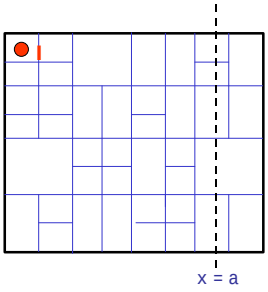
node I::insert(K,V)



CAN (Insert cont.)

node I::insert(K,V)

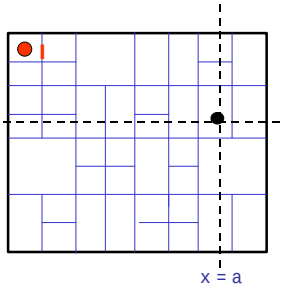
(1) $a = h_x(K)$



CAN (Insert cont.)

node I::insert(K,V)

(1) $a = h_x(K)$
$b = h_y(K)$

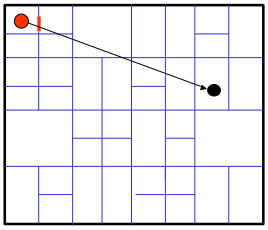


CAN (Insert cont.)

node I::insert(K,V)

(1) $a = h_x(K)$
$b = h_y(K)$

(2) route(K,V) -> (a,b)



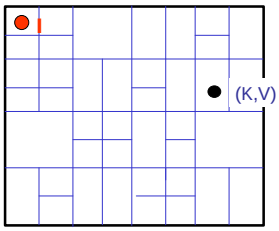
CAN (Insert cont.)

node I::insert(K,V)

(1) a = h_x(K)
b = h_y(K)

(2) route(K,V) -> (a,b)

(3) (a,b) stores (K,V)

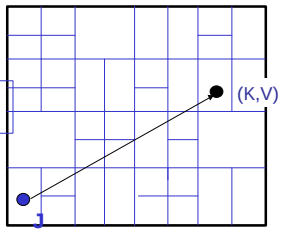


CAN (Retrieve)

node J::retrieve(K)

(1) a = h_x(K)
b = h_y(K)

(2) route "retrieve(K)" to (a,b)



CAN (A missing part)

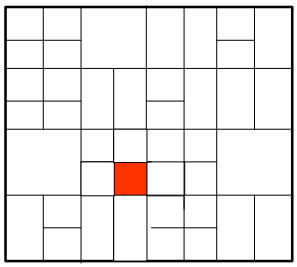
Data stored in the CAN is addressed by name (i.e. key), not location (i.e. IP address)

Question: What is missing in the procedure ?

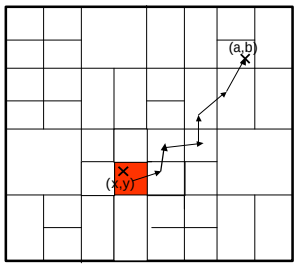
Routing !

CAN (Routing table)

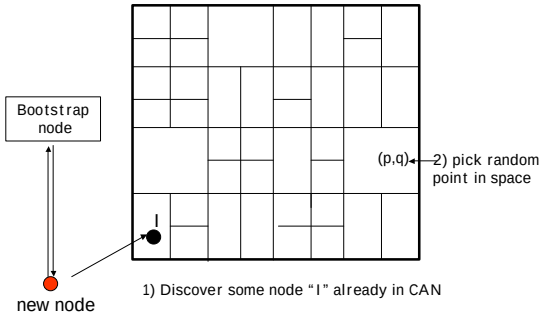
A node only maintains state for its immediate neighboring nodes



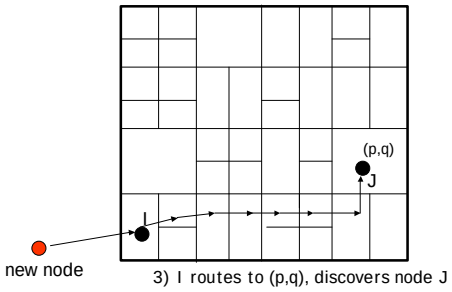
CAN (Routing)



CAN (Node Join)

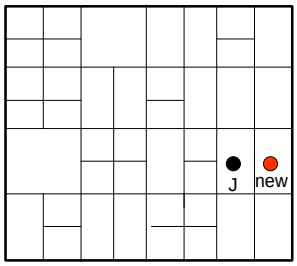


CAN (Node Join cont)



3) I routes to (p,q), discovers node J

CAN (Node Join cont.)



4) split J's zone in half… new owns one half

Inserting a new node affects only a single other node and its immediate neighbors

CAN (Node Failure)

- Need to repair the space
  - recover database
    - soft-state updates
    - use replication, rebuild database from replicas
  - repair routing
    - takeover algorithm
    - when a node fails, one of its neighbors takes over its zone

Only the failed node's immediate neighbors are required for recovery

CAN (Evaluation)

- Scalability
  - For a uniformly partitioned space with **n** nodes and **d** dimensions
    - per node, number of neighbors is 2d
    - average routing path is $(dn^{1/d})/3$ hops (due to Manhattan distance routing, expected hops in each dimension is dimension_length * 1/3)
  - Can scale the network without increasing per-node state
  - Chord/Plaxton/Tapestry/Buzz
    - log(n) nbrs with log(n) hops
- Load balancing
  - overloaded node replicates popular entries at neighbors
- Robustness
  - no single point of failure
  - Can route around trouble

CAN (Improvements)

- Topologically-sensitive CAN construction
  - distributed binning
- Goal
  - bin nodes such that co-located nodes land in same bin
- Idea
  - well known set of landmark machines
  - each CAN node, measures its RTT to each landmark
  - orders the landmarks in order of increasing RTT
- CAN construction
  - place nodes from the same bin close together on the CAN