



Sensor News Network

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Motivation

- **Build a sensor news network (CNN without reporters!)**
 - E.g., equipment news network, physical space network,
- **Problem of gathering, managing, and presenting, rapidly changing information about physical space:**
 - Large scale micro-sensors networks
 - Billions of sensors (many of them mobile)
 - Fixed to mobile interaction
 - Thousands of datasets (mostly unstructured)
- **What is the information architecture?**
- **Web: example self organizing system**
 - E.g. Latest indexers find semantic information based on structure of the web as a graph
- **Can we automatically construct useful “indexes” --- maps --- for data distributed in mobile sensor networks?**



Current Wireless networks

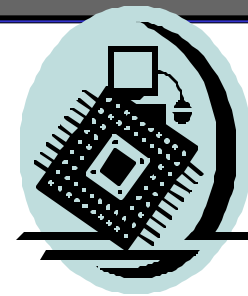
- **Too much focus is on access**
 - Fixed world protocols → wireless links
 - Access to the net from portable devices
- **Wider-area broadband wireless networks: Data over voice**
 - Cost per bit too high
- **Ubiquitous coverage**
 - Good for voice but not necessarily data
- **Wireless is not part of Information Technology (yet)**





What's coming?

- **Universal radio's**
- **Programmable/ single chip radios**
- **Incredible miniaturization (MIPS/Joule)**
- **Silicon cockroaches**
 - What do with them? Cant eat them
- **Millions/billions of physical objects inter connected and data about them made available on-line**
 - These elements will not only be the end units but also serve as network elements
- **Moore's law will get you there!!**





Scenario



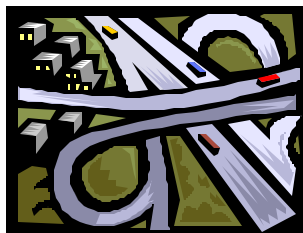
Where is the TA for 352?



What's around me?



are roads icy?



Don't call 911
Accident already reported



Mines around??





Approach

- **Build an infrastructure that will be able to provide an enhanced view of the surrounding physical space**
 - As users navigate physical space, they will be sprinkled with information (illuminated with information)
- **Idea: Closely tie location, communication (network), and information**
- **Main elements of webdust**
- **Dataspaces**
 - Scalable query /propagation methods by using network primitives (broadcast, multicast, anycast, geocast, gathercast)
- **Digital sprinklers**
 - Collect, aggregate and distribute data based on spatial relevancy
 - Resolution inversely proportional to distance from epicenter
- **Spatial web/landscape database**
 - Automatic indexing of spatial information
 - Crawl “physical space” to infer properties



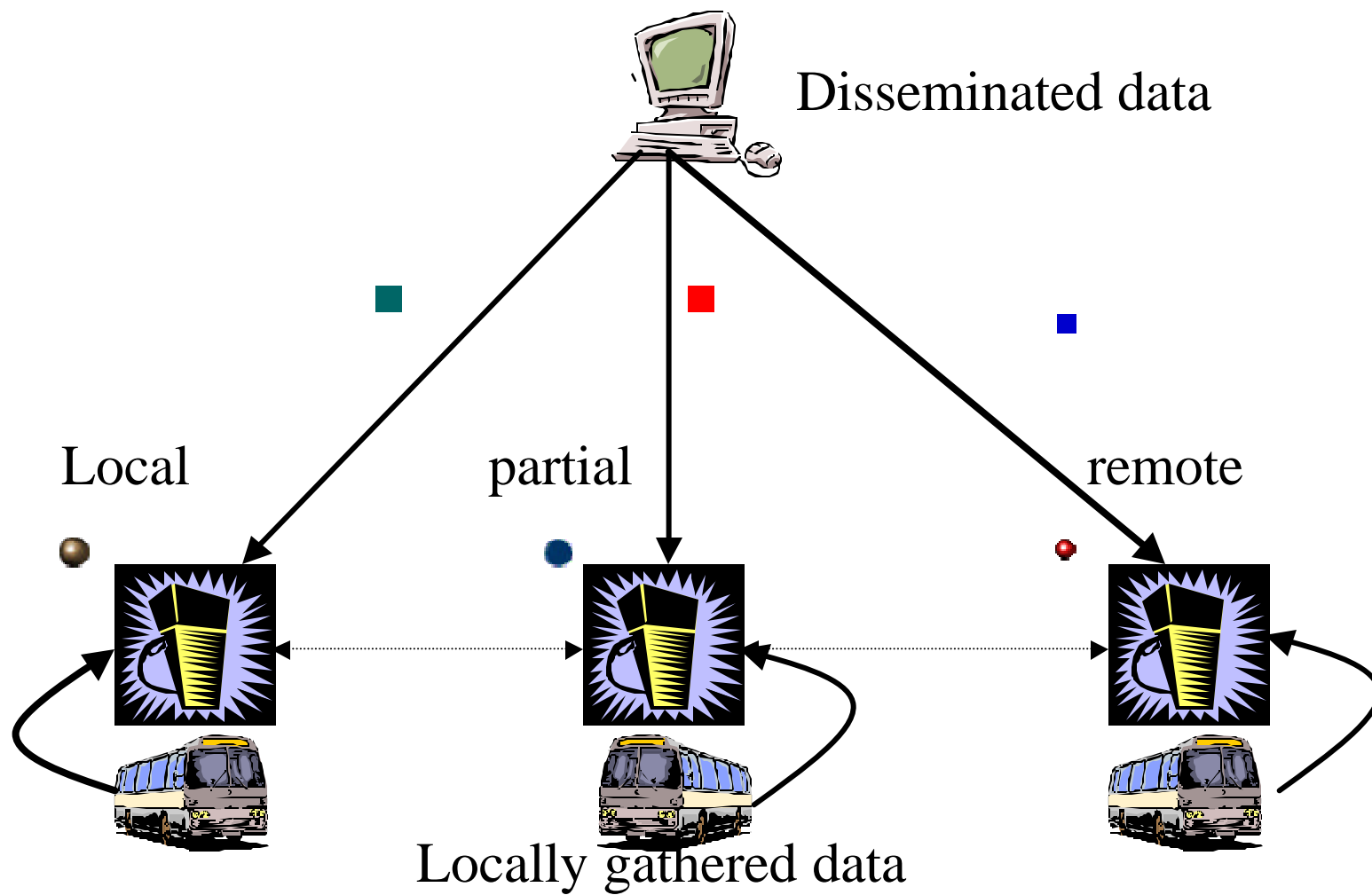
Digital Sprinklers

- **Sprinkle/Sniff** information based on spatial “relevancy”
- **Disseminators/aggregators** of information collected from **dataspaces/sensors**
 - Users who pass by will be sprinkled with information
 - Users can also park information on digital sprinklers – graffiti
 - Assist in answering aggregate queries
- **Aggregate query on physical space** → **contact surrounding digital sprinklers**
- **Conveying exceptional news or breaking news**
 - Use local and global prediction models to convey exceptional news
- **Challenges**
 - Distribution of updates, query execution, resolving proximity (5 mph vs 60 mph), resolving resolution, caching, distribution of updates





Information dissemination





Data/query possibilities

- **Locally gathered data**
 - When did the last bus leave? ●
- **Locally disseminated data**
 - What is the schedule for busses leaving this stop ■
- **Local + remote gathered data** ● ●
 - Has the last bus that left this stop reached the next stop
- **Remote gathered data + remote disseminated data** ● ■
 - How late are busses arriving at the next stop
- **Locally disseminated data + remote disseminated data** ■ ■
 - What is the scheduled travel time between this stop and next stop
-

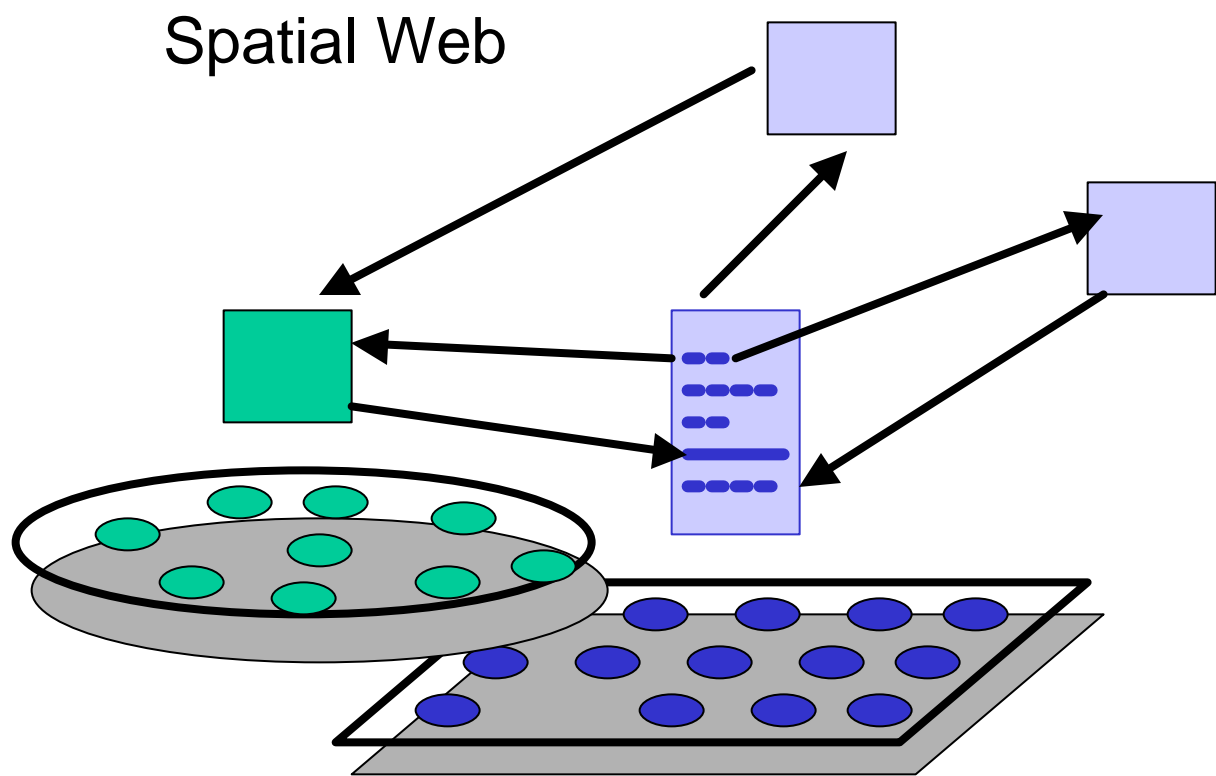


Spatial Web

- **Motivation**
 - Query the physical space
- **Inspiration**
 - Web is an ad-hoc structure on conceptual space
 - Millions and Millions of “producers”
 - My pages point to DCS Rutgers,UMASS, Berkeley, MIT who point to...
 - Rich theoretic structure based on social network research
- **Can we build a massive, ad-hoc representation of physical space?**
 - Anyone can add to the structure
 - How to automatically build useful representations?
 - Can we make meaningful queries against the spatial structure?



Physical Space as a graph





Spatial web

- **Establish a spatial link structure on surrounding dataspace**
- **Self-organizing web of links that correspond to the physical space**
 - Physical space represented by a graph
 - Answer queries about surroundings by crawling local space
- **Link information based on spatial proximity**
- **Answer queries by crawling**
- **Crawl using these links to obtain a semantic structure of the physical space**
- **Trade-off accuracy for time-to-crawl**
- **Challenges**
 - Crawling while on the move, on-line crawling vs offline crawling, prefetching, predicting trajectories, transforming web structure to spatial web structure and vice versa



Spatial Web

- **All Spatial web pages have a limited physical "DataScope"**
- **Links between the Spatial Web pages mirror the relevant structure in the physical space**
- **The DataScope is represented by a SPOT (SPatial ObjecT)**
 - Abstract Data Type of a spatial database viz. polygons, convex hull, etc.
- **SPOTs are mapped on to Spatial Tags :**
 - simple human readable strings
 - allow for the construction of a spatial database over all spatial web documents



Physical space as a graph

- Nodes or pages have embedded location tags
- Badri=in <scope=Room 345>
- Pages have spatial links <sref, URL (location tag)>
- Badri=in <scope =<Room 345> <sref, Room346> <sref = Core>
- Spatial link exists between SPOTS that are “adjacent”
- Adjacent may imply overlapping, containment, intersection, nearby



Spatial Web

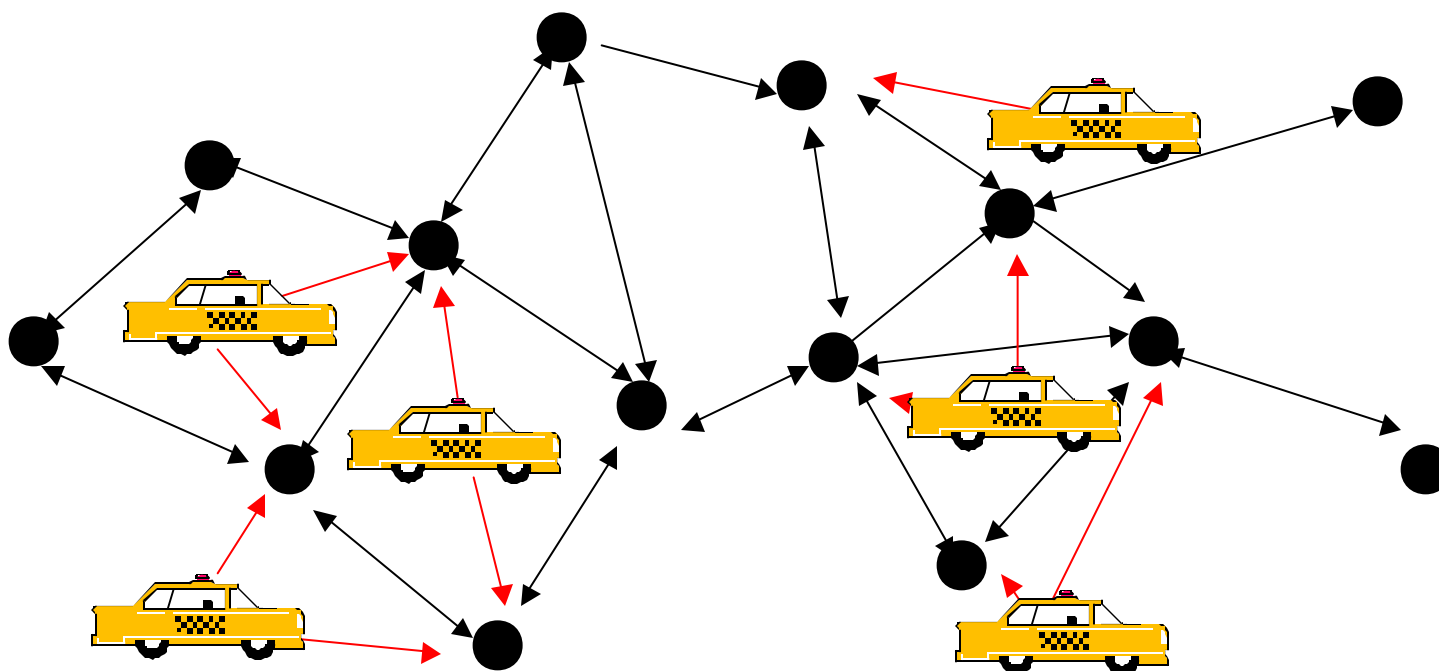
- **Tag Resolver** : mechanism to map tag names to actual SPOTs they denote
- **Web Presence for entities in the real world like places, sensors, things & people**
 - Eg.web page will comprise of the XML encoded SPOT, and “spatial” hyperlinks to nearby entities
- **Capability to build a spatial crawler over such an infrastructure to answer “whats around me?” type of queries dynamically**
- **Current Prototype** : Tags for barcodes, Resolvers, Compaq iPAQ for the PDA.



Motion through space

Stationary units
define a stable graph

Mobile units change link
structure by crawling or
"reassess surroundings"

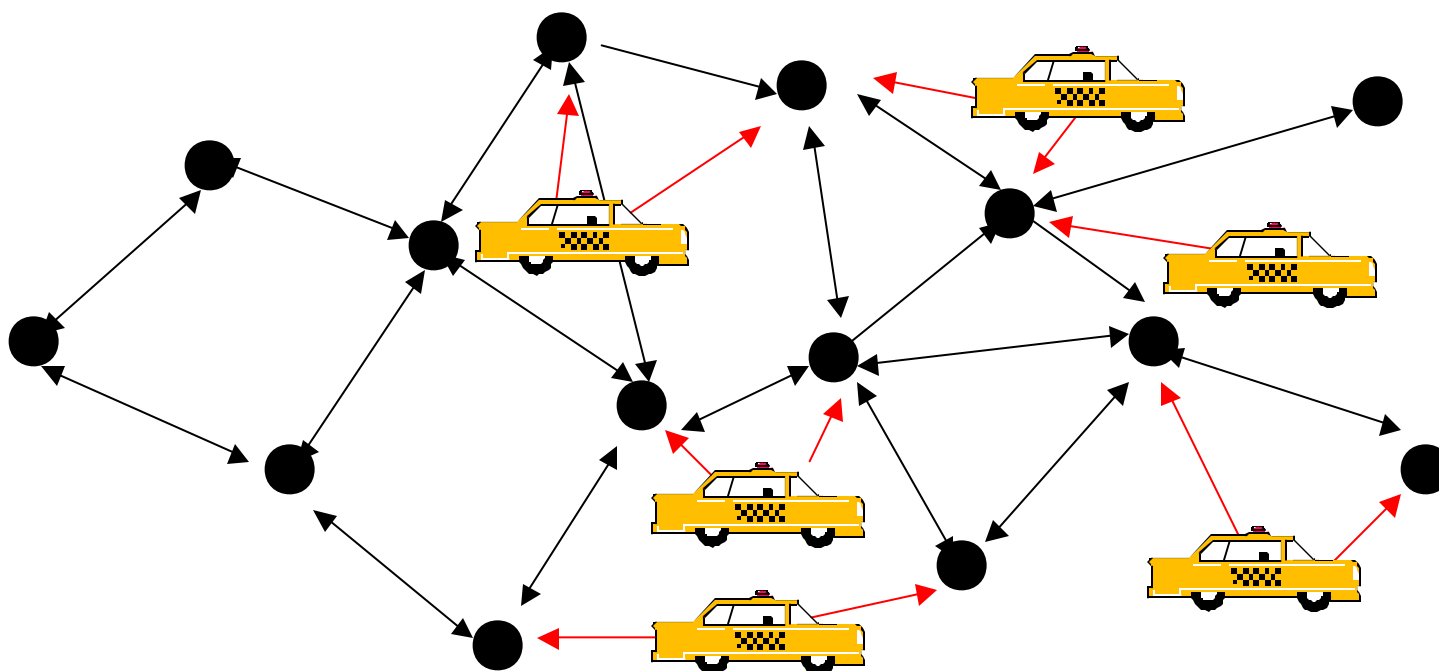




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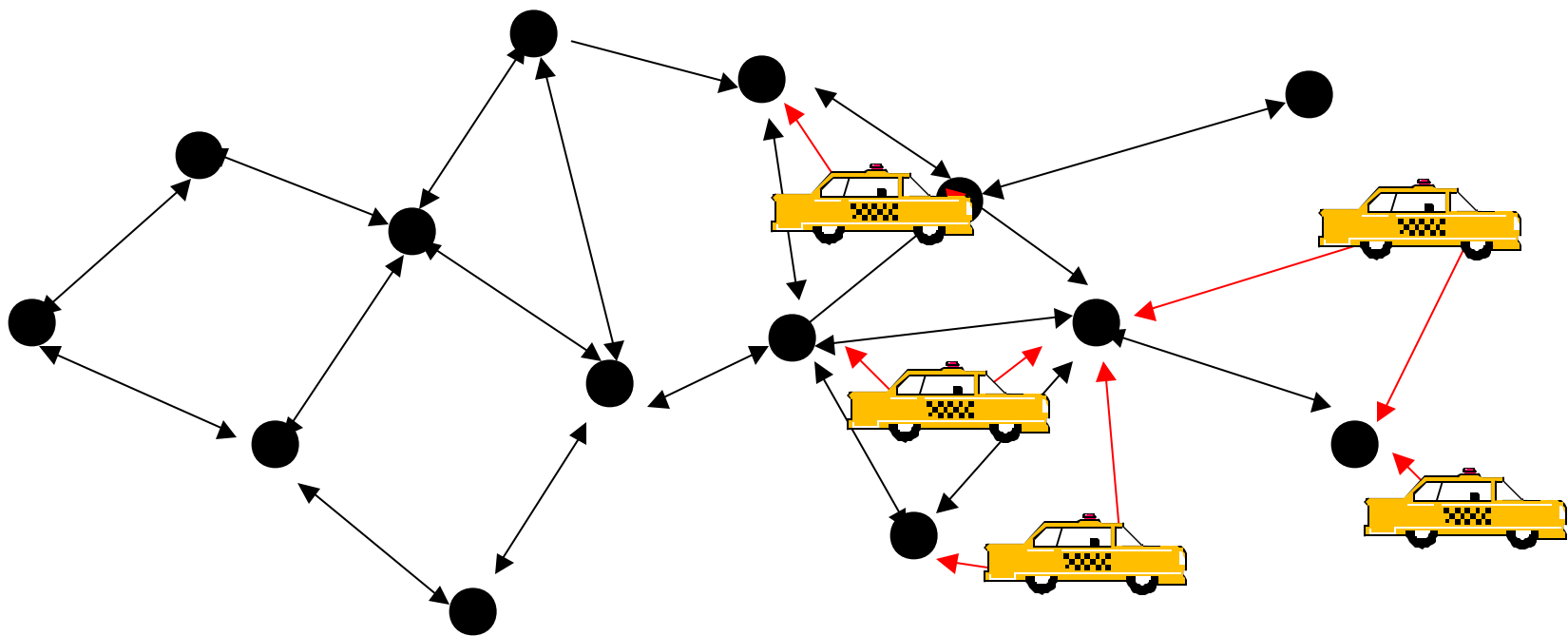




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