Designing an Efficient Search Algorithm for Internet of Things (IoT)

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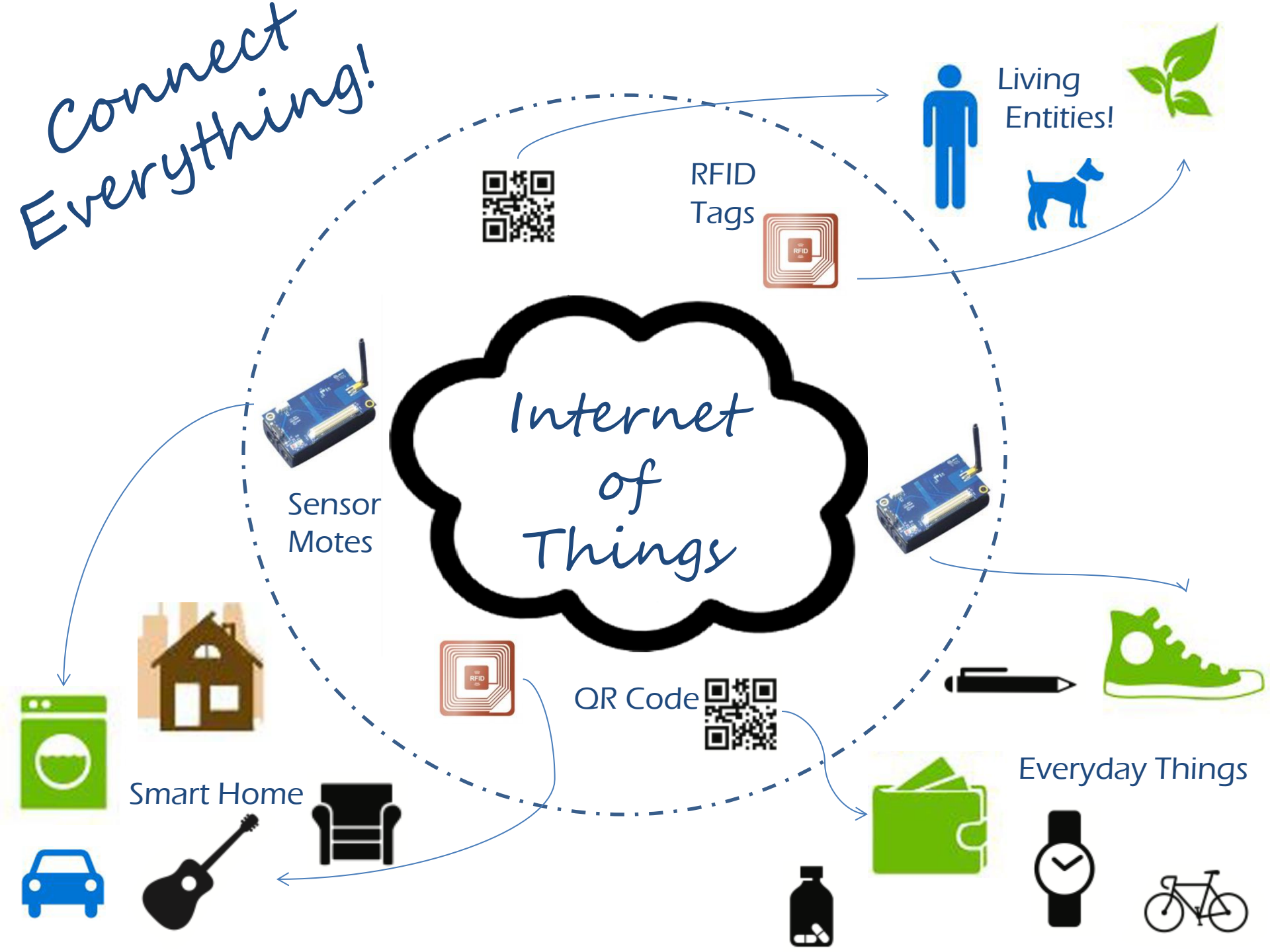
Internet of Things - What is it?


Connect Everything!
Living Entities!
RFID Tags
Internet of Things
Sensor Motes
QR Code
Smart Home
Everyday Things

IoT: Products

WEMO: Control your home appliances with motion or a simple smart phone app.

Botanicalls: Plants which talks to their owner when they need water!

Motivation

"The most important objective of technology is to make people's life better."

-Anonymous

Motivation

THIS!!

Motivation

6,700,000,000

Number of people on earth in 2008.

< Number of `things' connected to Internet in 2008!!

Literature Study

- Classifications
  - Object Search
    - Snoogle
    - MAX
  - Place Search
    - Dyser
  - Enabling Technologies for IoT
  - Description Models

Major Challenges

What makes IoT search difficult than normal web search?

Major Issues

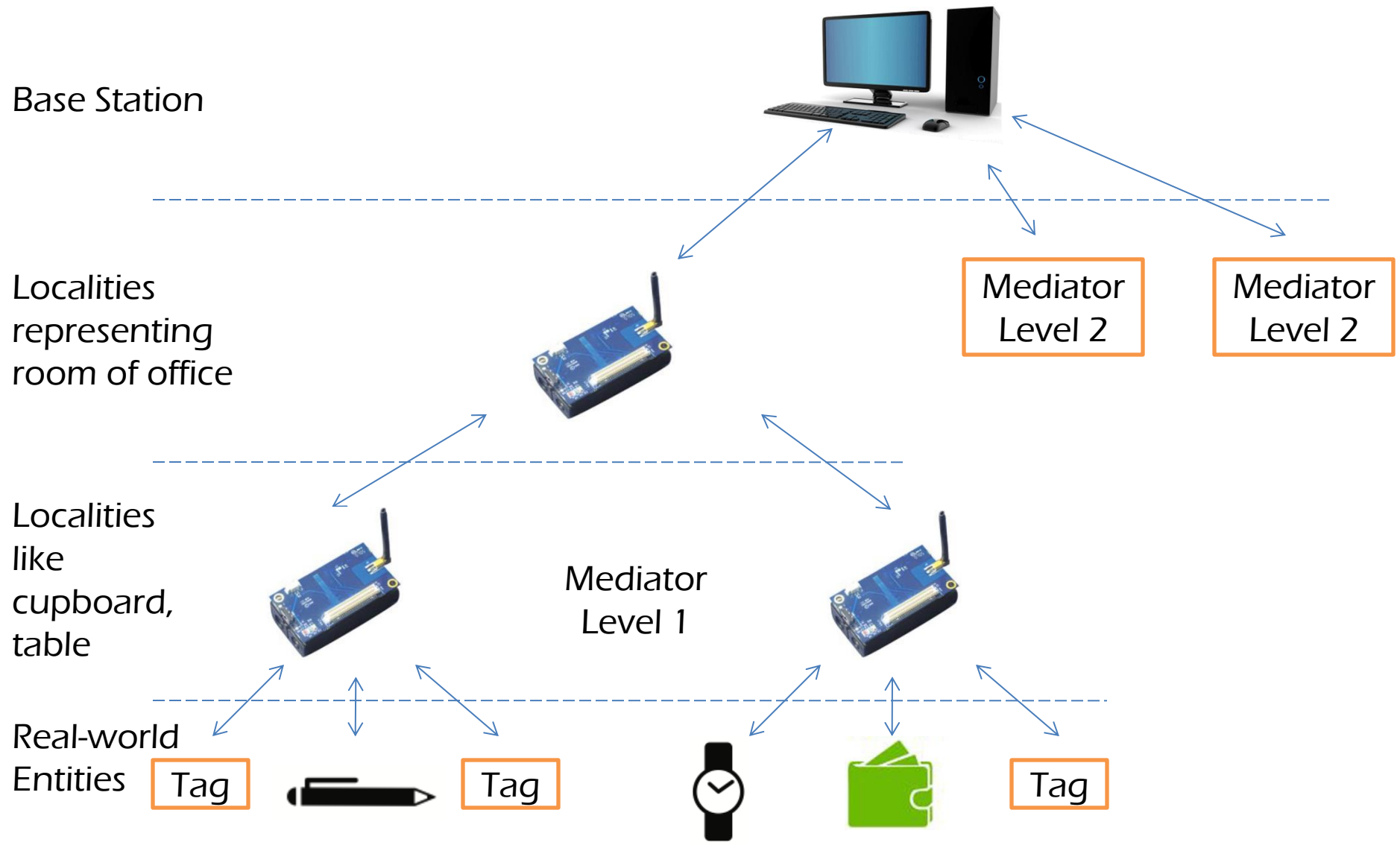
- Localized Search
  - Unlike web, users want to search for things which are physically 'near' to them.
- Real-time Nature/Frequent updates
  - The most important feature of IoT
  - In IoT, the updates are more frequent then traditional web.
    - Push Based
    - Pull Based

Major Issues

- Architecture Design
  - Due to high mobility current indexing, crawling and storage techniques wont work.
- Scalability
  - Billions of sensors and their huge readings + sensor reading posses short life span.
- Privacy and Security
  - Data is more important then traditional web data e.g. user's current location.

Proposed Work

System Architecture



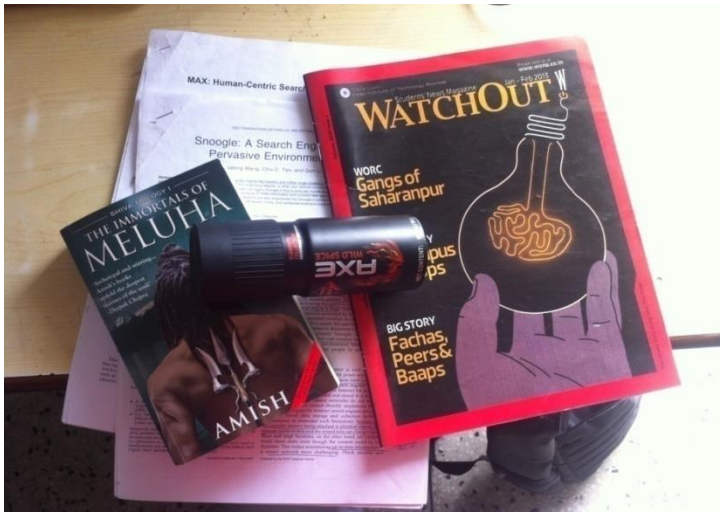
Real-Time Updates

- Push Approach: Tags keep pushing their details to central node.
- Pull Approach: Tags will just reply to keep alive message from central node whenever needed.

Communication Paradigm	Advantages	Disadvantages
Push Based Approach	Faster Search	High n/w traffic, Huge database, Energy inefficient
Pull Based Approach	Energy efficient Less traffic	Slow response to user query

Proposed Hybrid Approach

- Hybrid of both push and pull approach

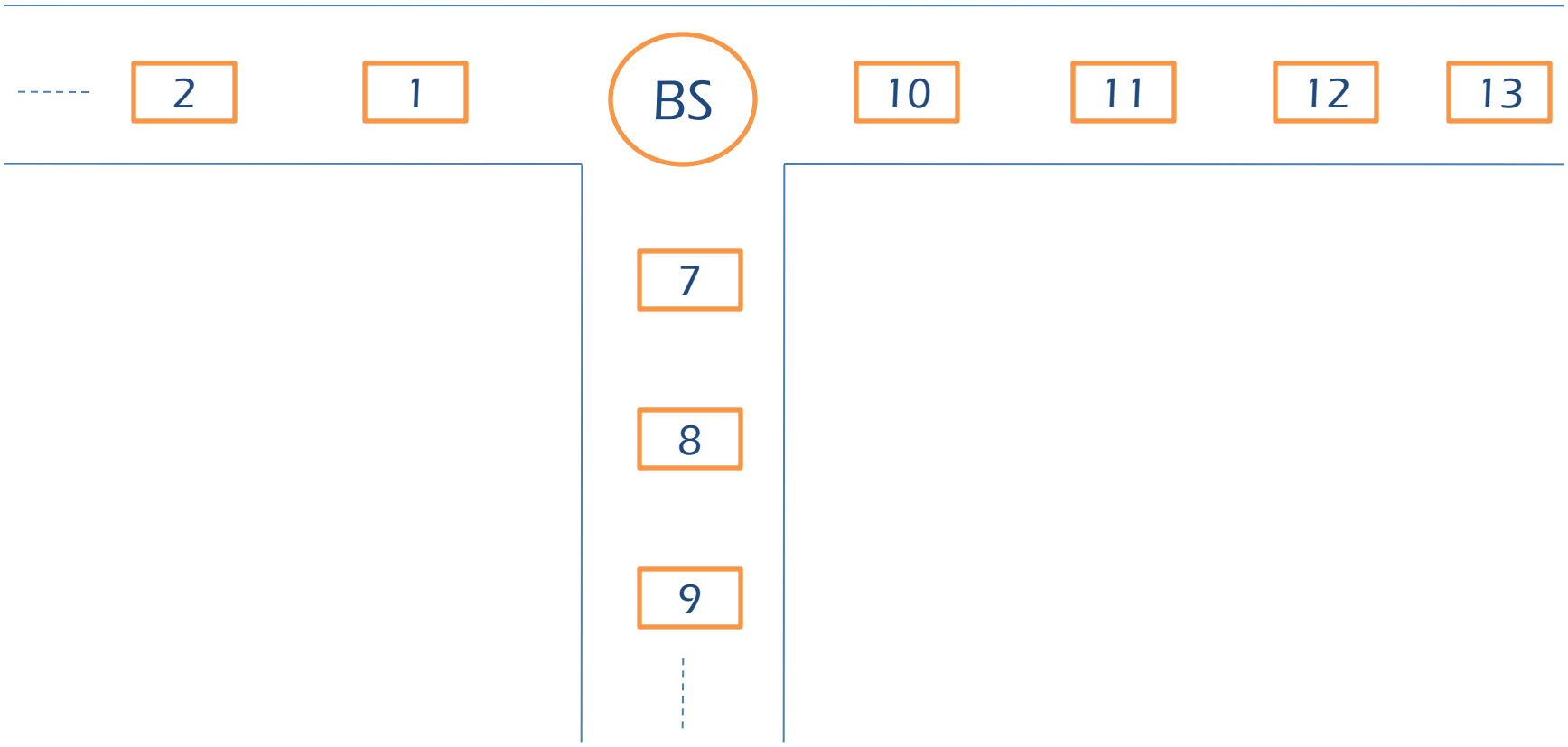


  - Push for the items which are misplaced frequently and required in emergency.
  - Pull approach for relatively static items.

Proposed Hybrid Approach

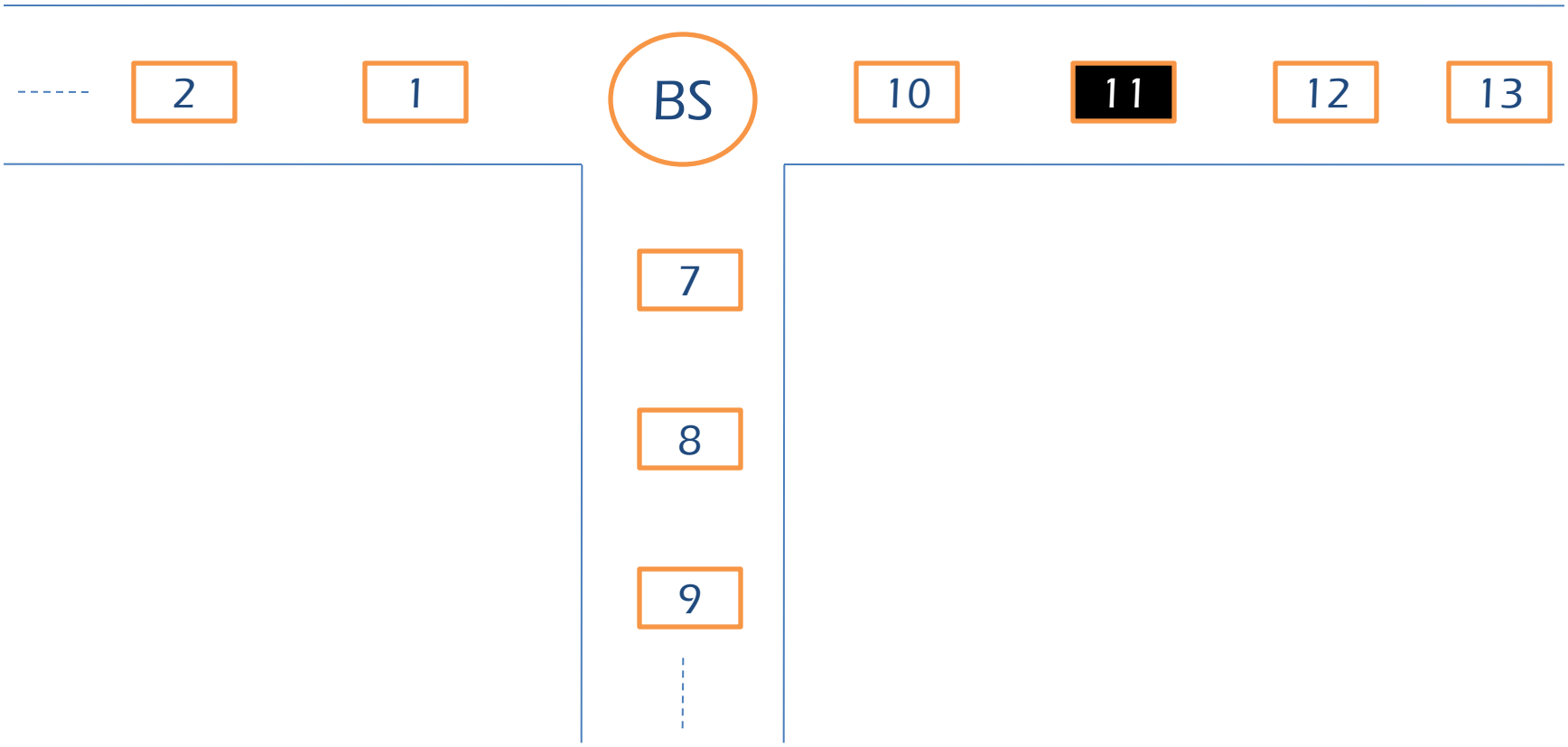
- Advantages
  - Less network traffic as there will small number of items using push approach
  - Faster results for the items which are required immediately.
  - Small database to maintain at server side.
  - Energy efficient approach.

Data Aggregation Algorithm



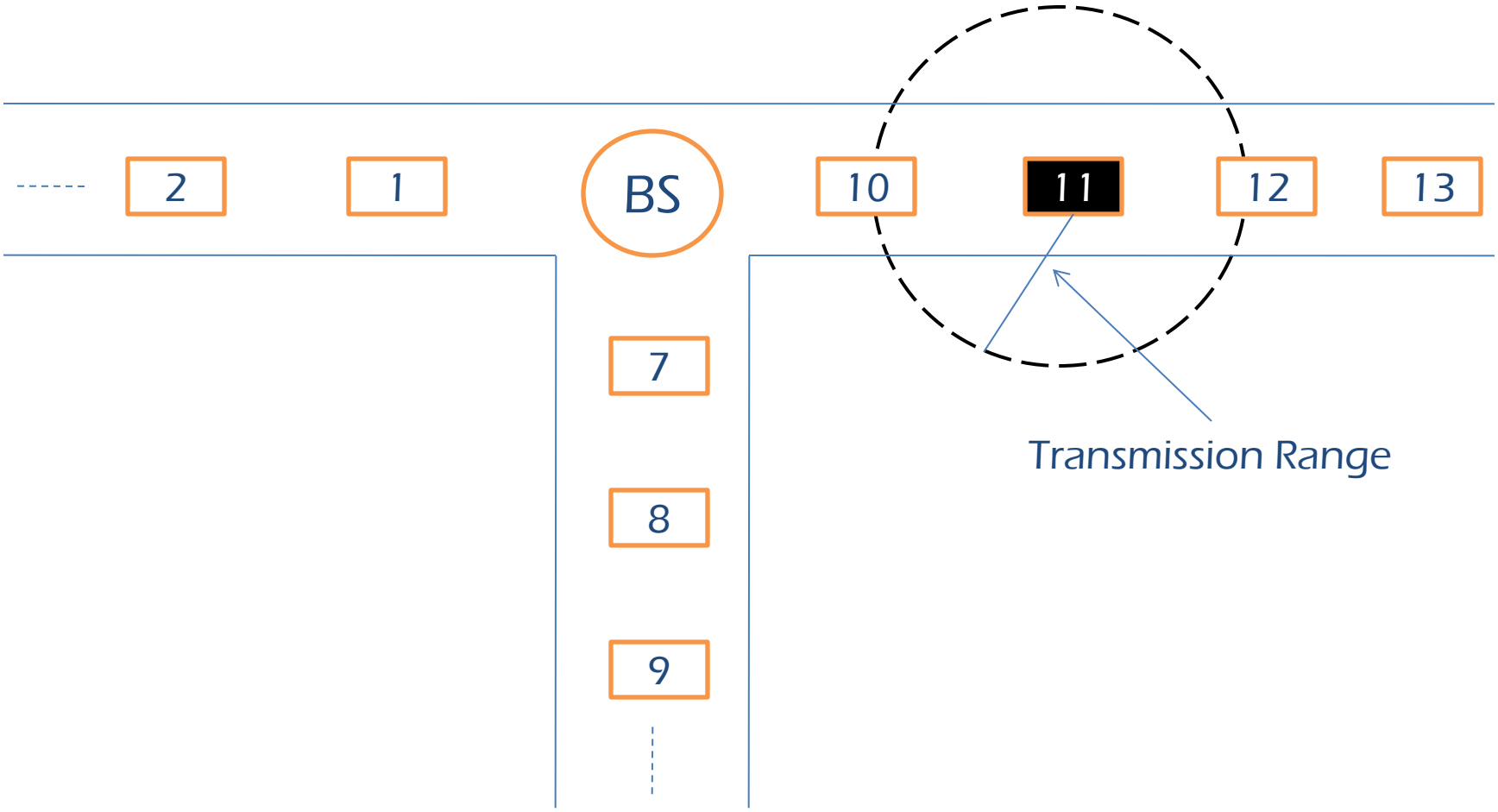
Consider a building structure like above

Data Aggregation Algorithm



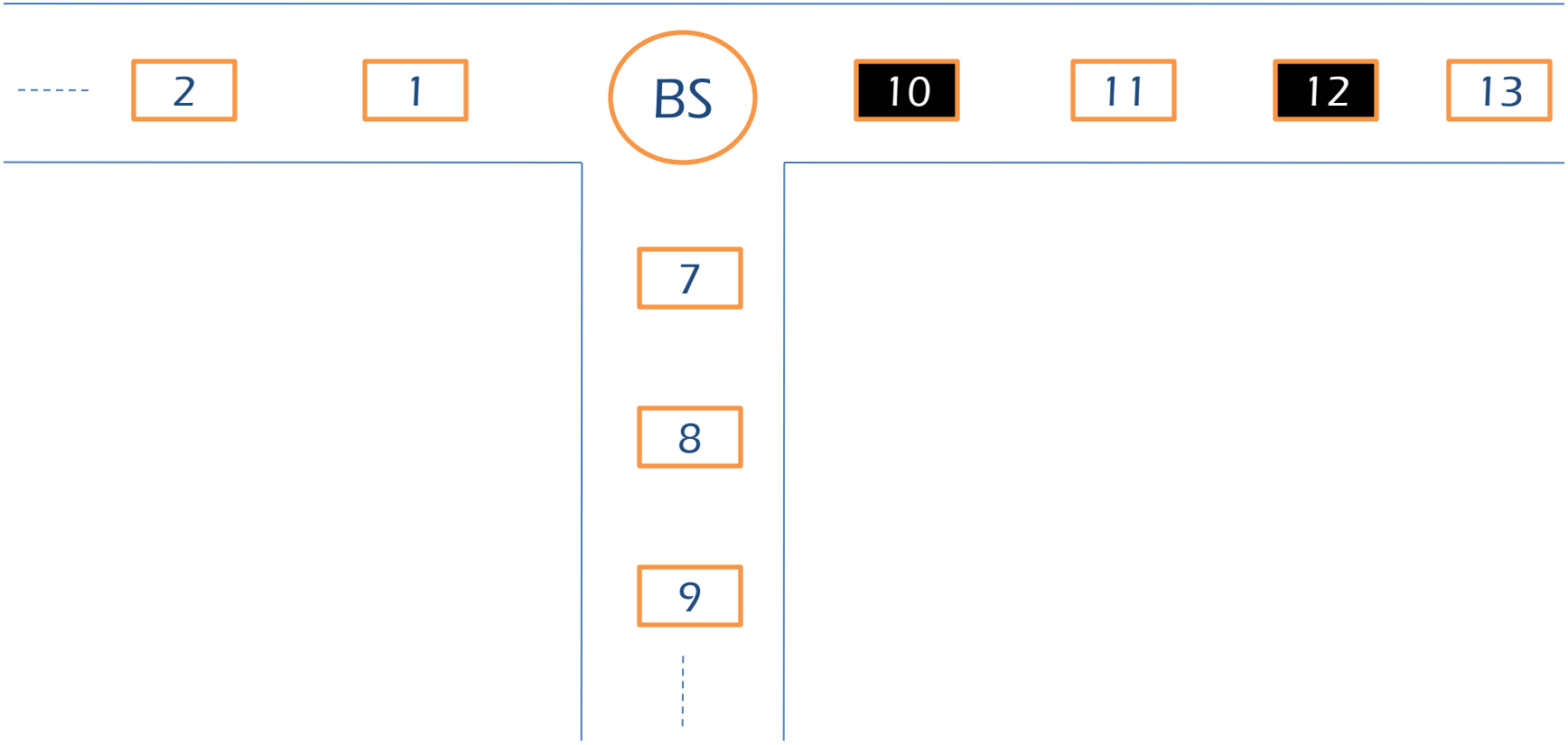
Node 11 wants to send a packet to BS

Data Aggregation Algorithm



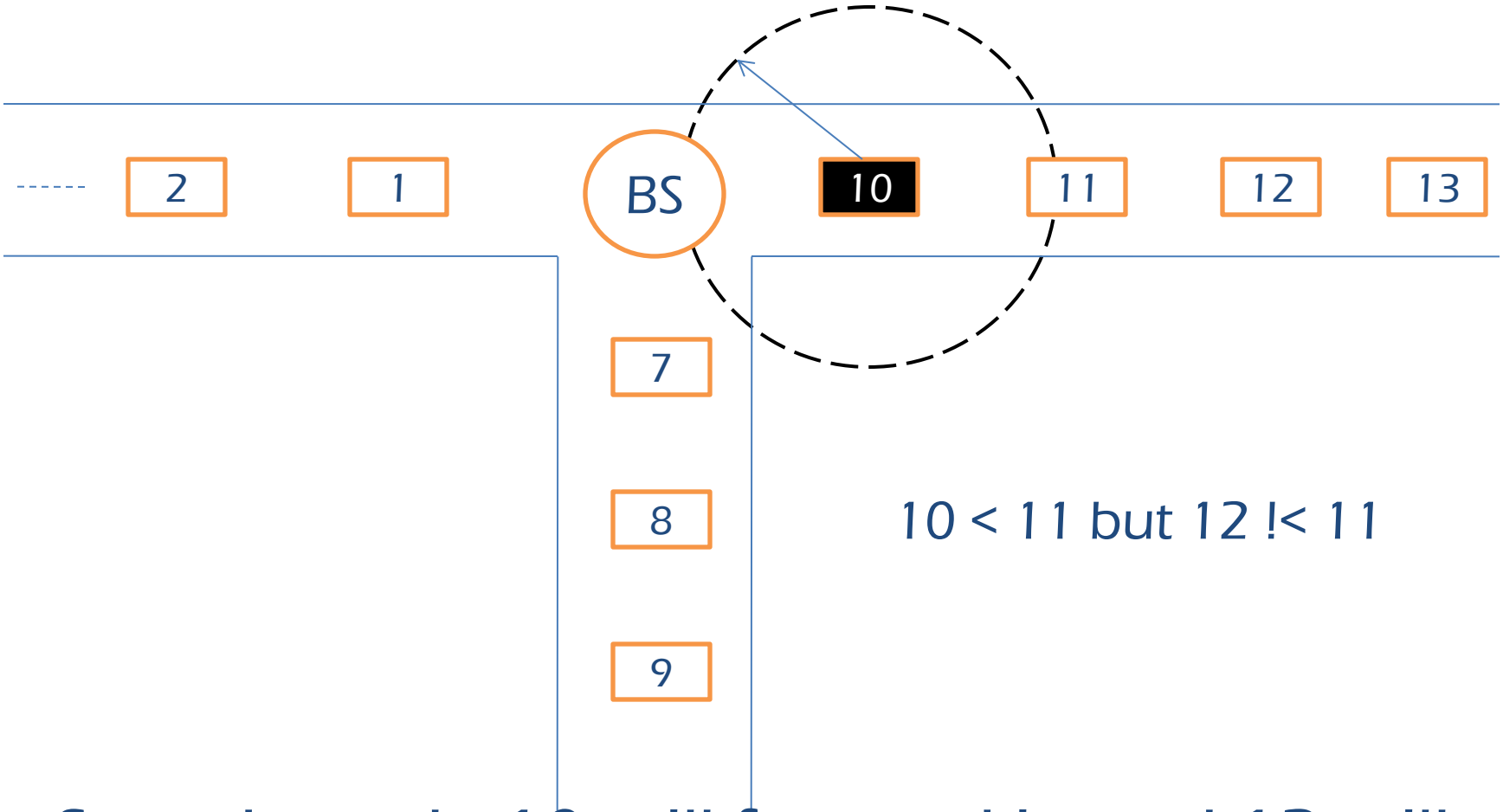
Node 11 will broadcast that packet in its range

Data Aggregation Algorithm



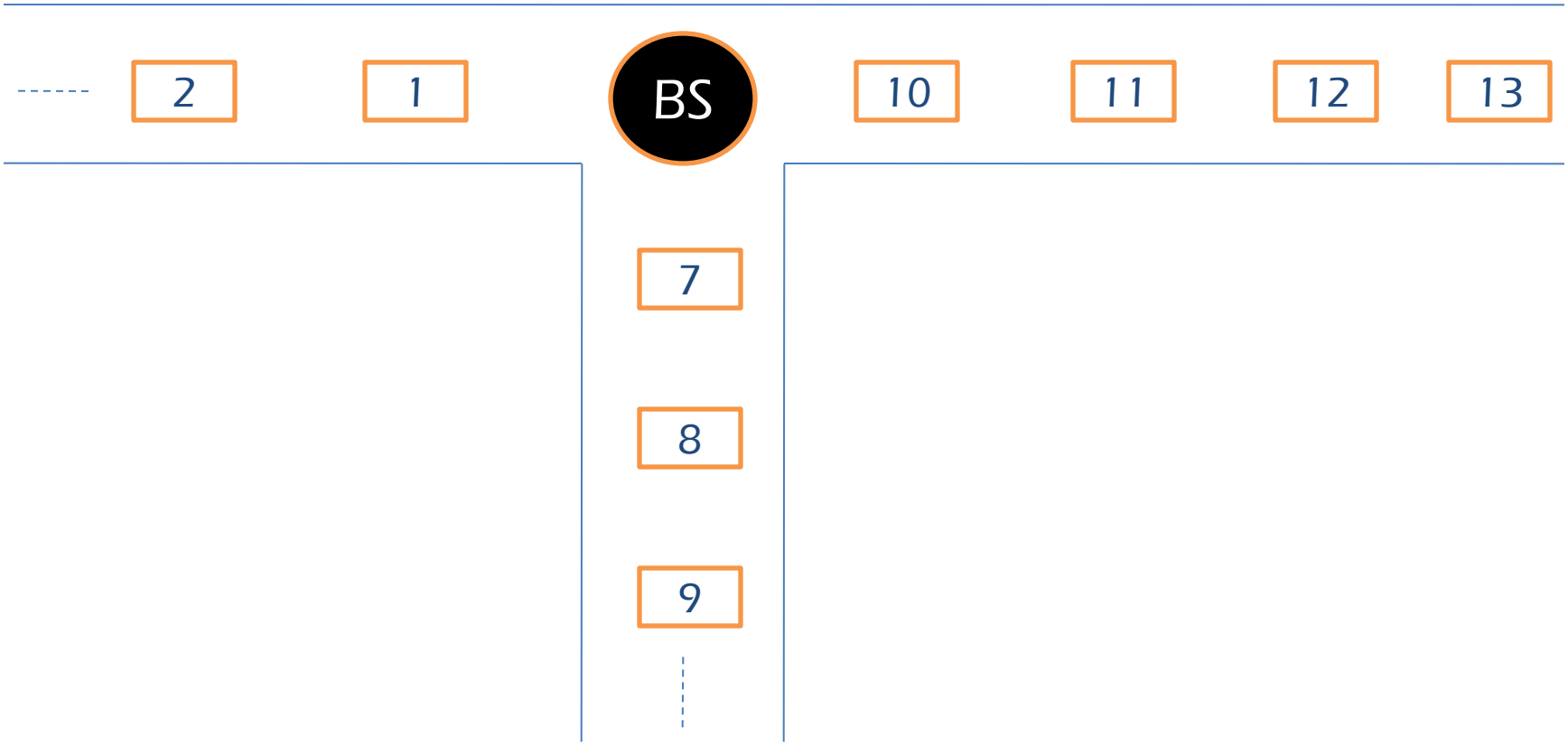
Node 10 and 12 would receive that packet

Data Aggregation Algorithm



So only node 10 will forward it, and 12 will discard

Data Aggregation Algorithm



Data finally reached at Base Station

Implementation Details

TinyOS

Base Station

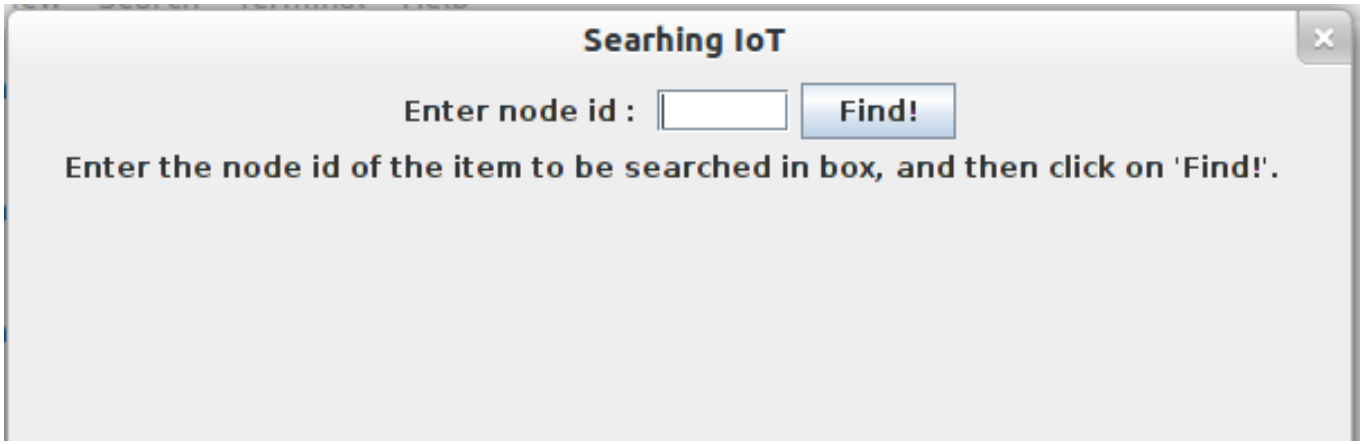
IRIS Mote

Implementation Details

- System Modules
  - Tags
    - Items which keep broadcasting their location (Push)
    - Items which will respond to only user queries (Pull)
  - Mediators
    - Used to pass data from Tags to BS and vice-versa
  - Base Station
    - Network sink, which collects whole n/w data.
    - Provides query interface and shows results.

System Operation

- Query Interface



- Enter node id of the item to be found.

System Operation

- Results are displayed with the help of preloaded image of every place.

Live Demonstration

(Finding bag's location in Information Security Lab)

Conclusions

- IoT is future of Internet
- Searching will be an important application as we misplace our items frequently.
- Our system helps person to find any item in home/office or with preloaded image.
- It also handles various issues like scalability, quick results, minimal setup.

Research Publication

- Mitul Shah, Anjali Sardana, "Searching Internet of Things using VCS", *1st International Conference on Securing Internet of Things,* ACM, August 2012.

Key References

- Wang, Haodong, Chiu C. Tan, and Qun Li. "Snoogle: A search engine for pervasive environments." IEEE Transactions on Parallel and Distributed Systems, pp. 1188-1202, 2010.
- Yap, Kok-Kiong, Vikram Srinivasan, and Mehul Motani. "Max: human-centric Search of the physical world." In Proceedings of the 3rd international conference on Embedded networked sensor systems, pp. 166-179. ACM, 2005.
- Romer, Kay, Benedikt Ostermaier, Friedemann Mattern, Michael Fahrmair, and Wolfgang Kellerer. "Real-time search for real-world entities: A survey."Proceedings of the IEEE, no. 11: 1887-1902, 2010.

Thank you!

Queries??