Smart Sensor Networks

Introduction

- Miniature sensor devices
  - low-cost
  - low-power
  - Multifunctional
- A sensor network that can provide access to information anytime, anywhere by collecting, processing, analyzing and disseminating data.

- Sensor networks promise to revolutionize sensing in a wide range of application domains.
  - reliability
  - accuracy
  - flexibility
  - Cost-effectiveness
  - ease of deployment

Introduction

- Sensor networks enable：
  - information gathering
  - information processing
  - reliable monitoring of a variety of environments for both civil and military applications.

- The architecture of the sensor node’s hardware consists of five components:
  - sensing hardware
  - Processor
  - memory
  - power supply
  - transceiver
- These devices are easily deployed
  - no infrastructure and human control are needed

Introduction

- Each sensor node has
  - wireless communication capability
  - sufficient intelligence for signal processing and for disseminating the data
- Communication in sensor networks is not typically end to end.
- and wireless network
- Energy is typically more limited in sensor networks.—difficulty in recharging
- Bluetooth devices are unsuitable for sensor network applications
  - because of their energy requirements
  - and expected higher costs than sensor nodes
- a denser infrastructure would lead to a more effective sensor network.
  - It can provide higher accuracy
  - and has a larger aggregate amount of energy available
- if not properly managed, a denser network can intelligence for signal processing and also lead to a larger number of collisions and potentially to congestion in the network
  - increase latency
  - reduce energy efficiency

Smart Sensor Network Application

- Sensors are deployed to analyze remote locations
  - the motion of a tornado
  - fire detection in a forest
- Sensors are attached to taxi cabs in a large metropolitan area to study the traffic conditions and plan routes effectively.
- Wireless parking lot sensor networks that determine which spots are occupied and which spots are free.
- Wireless surveillance sensor networks for providing security in a shopping mall, parking garage or at some other facility.
- Military sensor networks to detect, locate or track enemy movements.
- Sensor networks can increase alertness to potential terrorist threats.

A Hierarchical Sensor Network

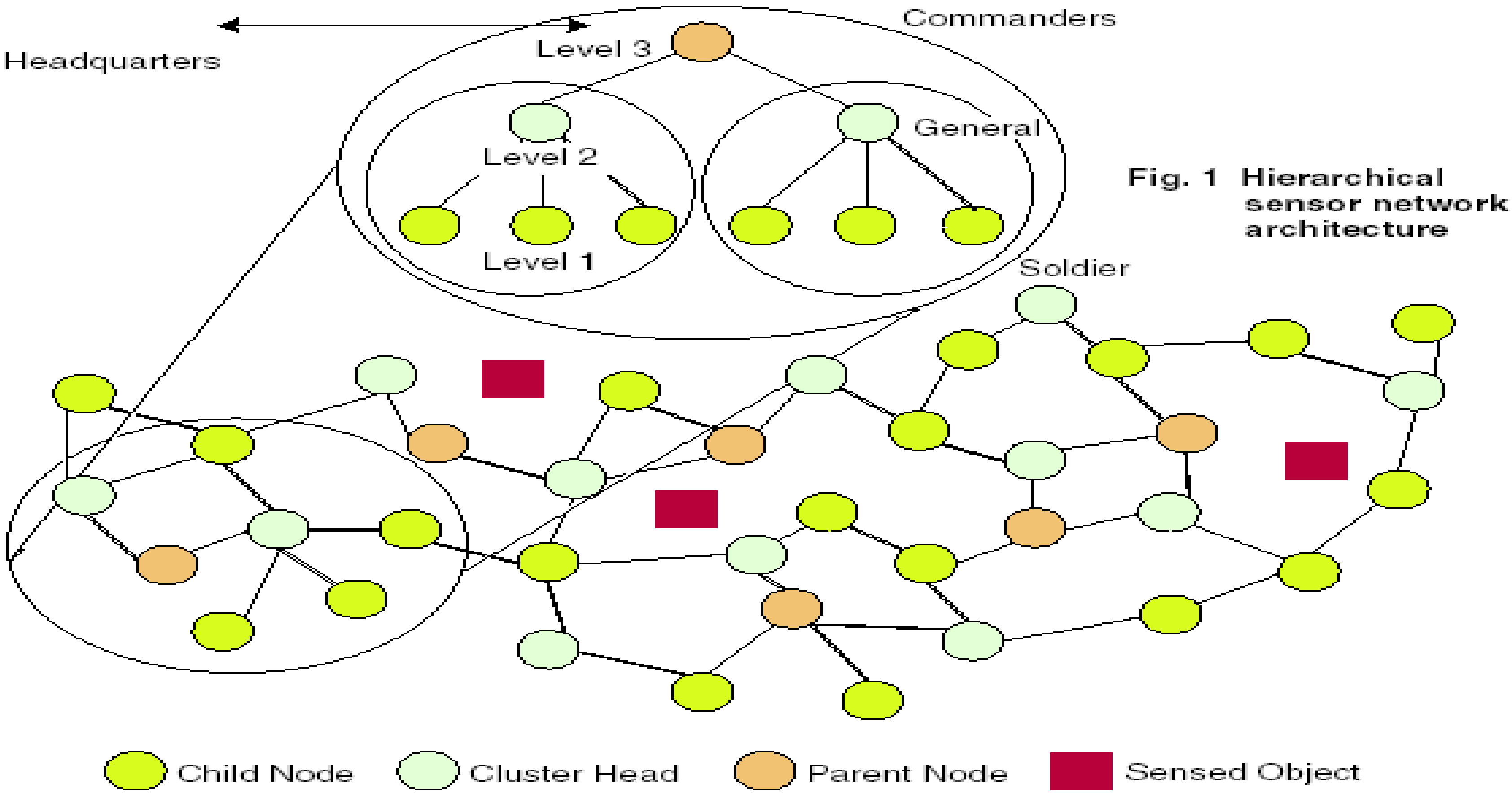

Fig. 1 Hierarchical sensor network architecture

Sensor Network Challenges

- extending the lifetime of the sensor network
- building an intelligent data collecting system
- Sensor networks’ topology changes very frequently.
- Sensors use a broadcast communication paradigm whereas most networks are based on point-to-point communications.
- Sensors are very limited in power, computational capacities and memory;
- Sensors are very prone to failures;

Sensor Network Challenges

- Sensors may not have global identification (ID) because of the large amount of overhead;
- Sensors are densely deployed in large numbers. The problem can be viewed in terms of collision and congestion. To avoid collisions, sensors that are in the transmission range of each other should not transmit simultaneously.
- Ad hoc deployment requires that the system identifies and copes with the resulting distribution and connectivity of nodes, and
- Dynamic environmental conditions require the system to adapt over time to changing connectivity and system stimuli.

Requirements of Sensor Networks

- Large number of sensors
- Low energy use
- Efficient use of the small memory
- Data aggregation
- Network self-organization
- Collaborative signal processing
- Querying ability

Advantages of Sensor Networks

- The advantage of using these sensors is their ability to maintain connectivity in case of movement.
- Sensor networks should maintain network connectivity even if some of their sensors are moved.

Key Definitions

- Sensor: A transducer that converts a physical phenomenon into electrical or other signals.
- Sensor node: A basic unit in sensor network, with on-board sensors, processor, memory, wireless modem & power supply.
- Network topology: A connectivity graph where nodes are sensor nodes & edges are communication links. The link represents a one-hop connection.
- Routing: The process of determining a network path from a packet source node to its destination.
- Data-centric: Approaches that name, route or access a piece of data via properties, such as physical location, that are external to a communication network.
- Geographic routing: Routing of data based on geographical attributes such as locations or regions. (Example of data-centric routing).

Key Definitions

- In-network: A style of processing in which the data is processed and combined near where the data is generated.
- Collaborative processing: Sensors cooperatively processing data from multiple in order to serve a high-level task. (requires communication among a set of nodes).
- Localization & tracking: The estimation of the state of a physical entity such as a physical phenomenon or a sensor node from a set of measurements.
- Sensor tasking: The assignment of sensors to a particular task and the control of sensor state for accomplishing the task.
- System performance goal: The abstract characterization of system properties. Eg. Scalability, robustness, throughput etc.
- Evaluation metric: A measurable quantity that describes how well the system is performing on some absolute scale. Eg. Location error, packet loss etc.

Thank You!