

Dynamic Misbehavior: Dumb Behavior

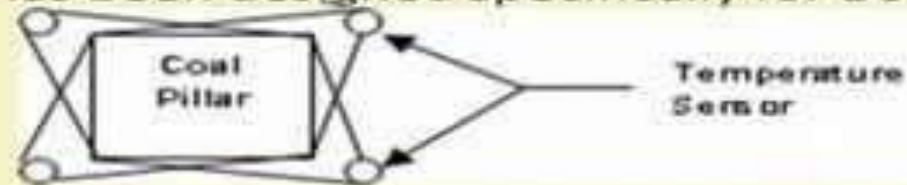
- Detection of such temporary misbehavior in order to preserve normal functioning of the network – coinage and discovery of dumb behavior
- In the presence of adverse environmental conditions (high temperature, rainfall, and fog) the communication range shrinks
- A sensor node can sense its surroundings but is unable to transmit the sensed data
- With the resumption of favorable environmental conditions, dumb nodes work normally
- Dumb behavior is temporal in nature (as it is dependent on the effects of environmental conditions)

Detection and Connectivity Re-establishment

- The presence of dumb nodes impedes the overall network performance
- Detection, and, subsequently, the re-establishment of network connectivity is crucial
- The sensed information can only be utilized if the connectivity between each dumb node with other nodes in the network could be re-established
- Before restoration of network connectivity, it is essential to detect the dumb nodes in the network.
- CoRD and CoRAD are two popular schemes that re-establish the connectivity between dumb nodes with others.

Applications of WSNs: Mines

- ✓ Fire Monitoring and Alarm System for Underground Coal Mines Bord-and-Pillar Panel Using Wireless Sensor Networks
 - WSN-based simulation model for building a fire monitoring and alarm (FMA) system for Bord & Pillar coal mine.
 - The fire monitoring system has been designed specifically for Bord & Pillar based mines



Source: S. Bhattacharjee, P. Roy, S. Ghosh, S. Misra, M. S. Obaidat, "Fire Monitoring and Alarm System for Underground Coal Mines Bord-and-Pillar Panel Using Wireless Sensor Networks", *Journal of Systems and Software* (Elsevier), Vol. 85, No. 3, March 2012, pp. 571-581.

Applications of WSNs: Mines (contd.)

- It is not only capable of providing real-time monitoring and alarm in case of a fire, but also capable of providing the exact fire location and spreading direction by continuously gathering, analysing, and storing real time information

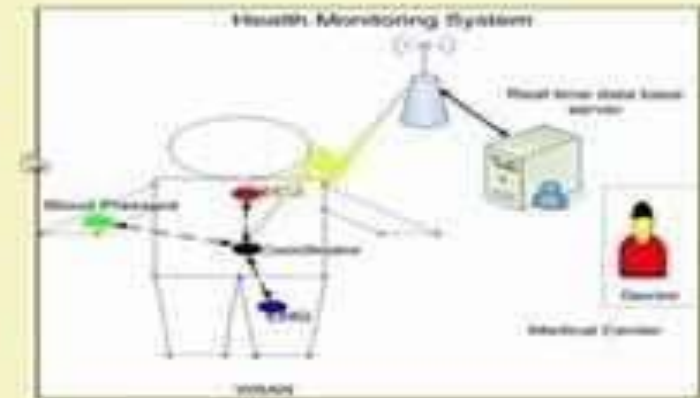


Source: S. Bhattacharjee, P. Roy, S. Ghosh, S. Misra, M. S. Obaidat, "Fire Monitoring and Alarm System for Underground Coal Mines Bord-and-Pillar Panel Using Wireless Sensor Networks", *Journal of Systems and Software* (Elsevier), Vol. 85, No. 3, March 2012, pp. 571-581.

Applications of WSNs: Healthcare

✓ Wireless Body Area Networks

- Wireless body area networks (WBANs) have recently gained popularity due to their ability in providing innovative, cost-effective, and user-friendly solution for continuous monitoring of vital physiological parameters of patients.
- Monitoring chronic and serious diseases such as cardiovascular diseases and diabetes.
- Could be deployed in elderly persons for monitoring their daily activities.



Target Tracking

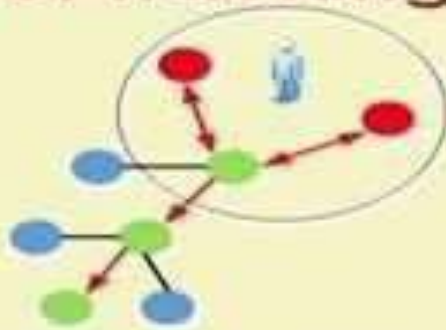


Fig. a: Push-based formulation: Nodes compute the position of the target and periodically notify the sink node. A cluster structure is commonly used in this case.

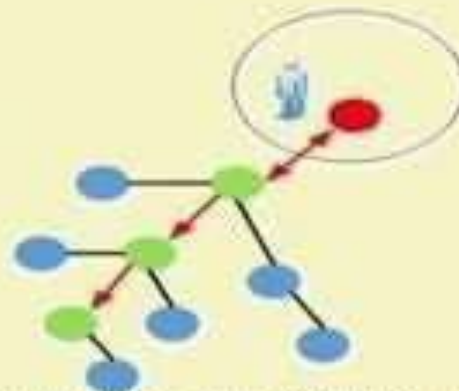


Fig. b: Poll-based formulation: Nodes register the presence of the target to permit a low-cost query. Data reports are sent toward the sink only when there is a query to be answered. Tree structure is often used in this case.

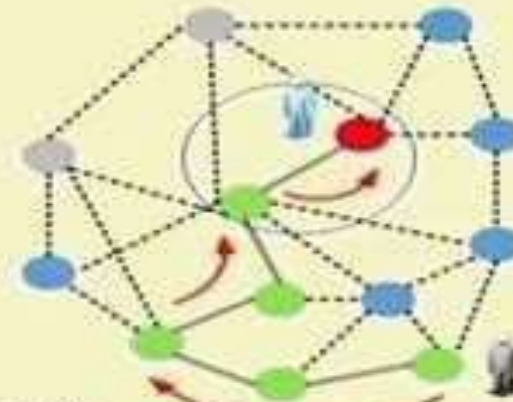
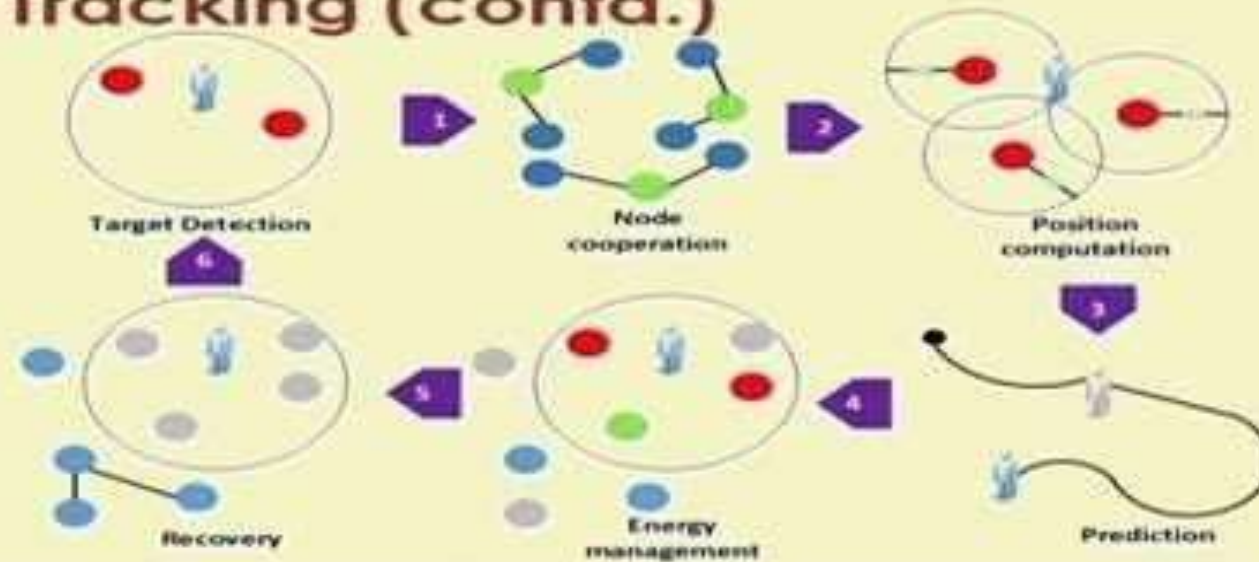


Fig. c: Guided formulation: Some nodes (beacon nodes) define a trajectory to the target. The tracker follows this trail to intercept the target. Face structure is often used in this case.

Source: Efrén L. Souza, Eduardo F. Nakamura, and Richard W. Pazzi, 2016. Target Tracking for Sensor Networks: A Survey. *ACM Computing Survey*, 49, 2, 2016

Target Tracking (contd.)



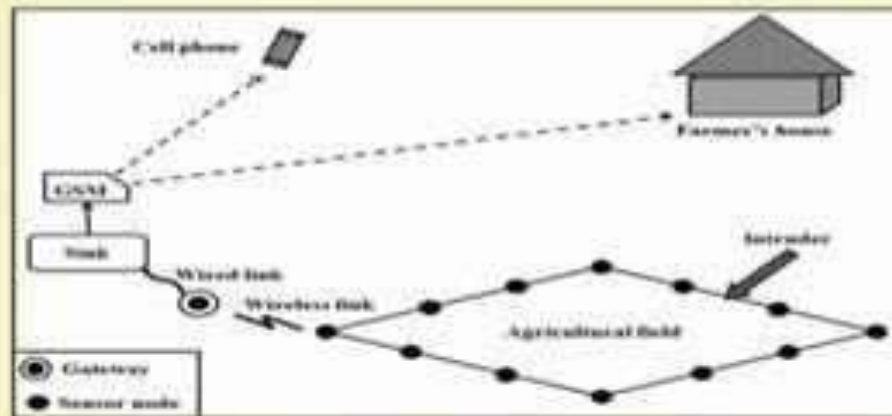
Source: Eren L. Souza, Eduardo F. Nakamura, and Richard W. Pazzi, 2016. Target Tracking for Sensor Networks: A Survey. ACM Computing Survey, 49, 2, 2016

WSNs in Agriculture

- ✓ AID: A Prototype for Agricultural Intrusion Detection Using Wireless Sensor Network
 - A set of sensor nodes are deployed over an agricultural field
 - Each of the board are enabled with two type of sensors:
 - a) Passive Infrared (PIR)
 - b) Ultrasonic
 - When an intruder enters into the field through the boundary (perimeter) of the field, the PIR sensor detects the **object**.
 - The ultrasonic sensor senses the **distance** at which the object is located

Source: Sanju Kumar Roy, Arijit Roy, Sudip Misra, Narendra S. Raghunvarshi, Mohammad S. Obaidat, AID: A Prototype for Agricultural Intrusion Detection Using Wireless Sensor Network, IEEE International Conference on Communications (ICC), 2015

WSNs in Agriculture (contd.)



Wireless Multimedia Sensor Networks (WMSNs)

- Incorporation of low cost camera (typically CMOS) to wireless sensor nodes
- Camera sensor (CS) nodes
 - capture multimedia (video, audio, and the scalar) data, expensive and resource hungry, directional sensing range
- Scalar sensor (SS) nodes
 - sense scalar data (temperature, light, vibration, and so on), omni-directional sensing range , and low cost
- WMSNs consist of less number of CS nodes and large number of SS nodes

Wireless Multimedia Sensor Networks (WMSNs)

- WMSNs Application
 - In security surveillance, wild-habitat monitoring, environmental monitoring, SS nodes cannot provide precise information
 - CS nodes replace SS nodes to get precise information
 - Deployment of both CS and SS nodes can provide better sensing and prolong network lifetime

WSN COVERAGE

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- Coverage- area of interest is covered satisfactorily
 - Connectivity- all the nodes are connected in the network, so that sensed data can reach to sink node
 - Sensor Coverage studies how to deploy or activate sensor to cover monitoring area
 - Sensor placement
 - Density control
 - Two modes
 - Static sensors
 - Mobile sensors