

MOBILE AD-HOC AND WIRELESS SENSOR NETWORKS

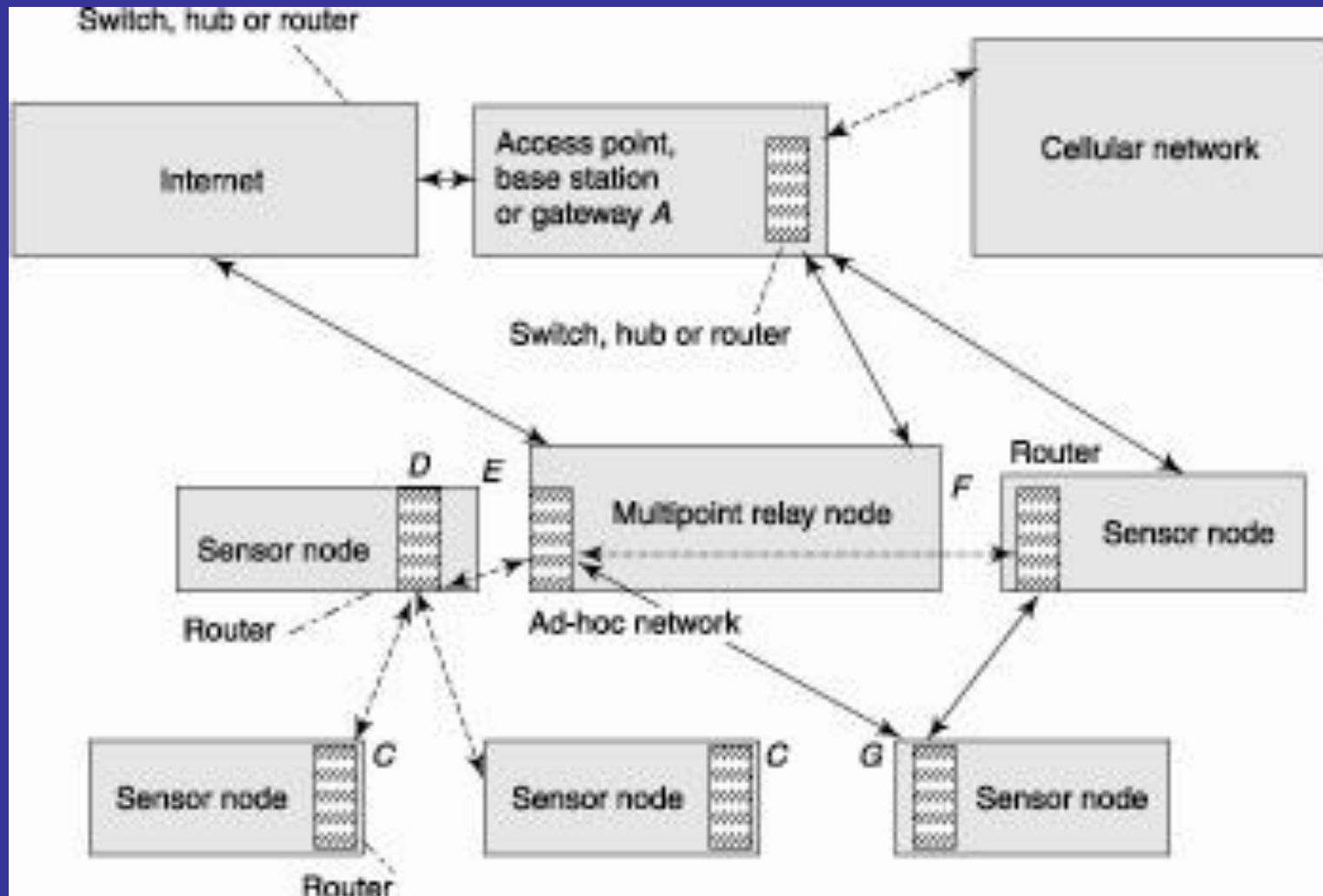
Lesson 07

Wireless Sensor Networks

MANET SENSOR NODES

- Sophisticated hardware, software and features
- Each node has an analog sensor with signal conditioner circuit
- Sensing can be of the light level, temperature, location shift, time stamps of GPS satellites , vibration, pressure, weather data, noise levels, traffic density, and nearby passing vehicles

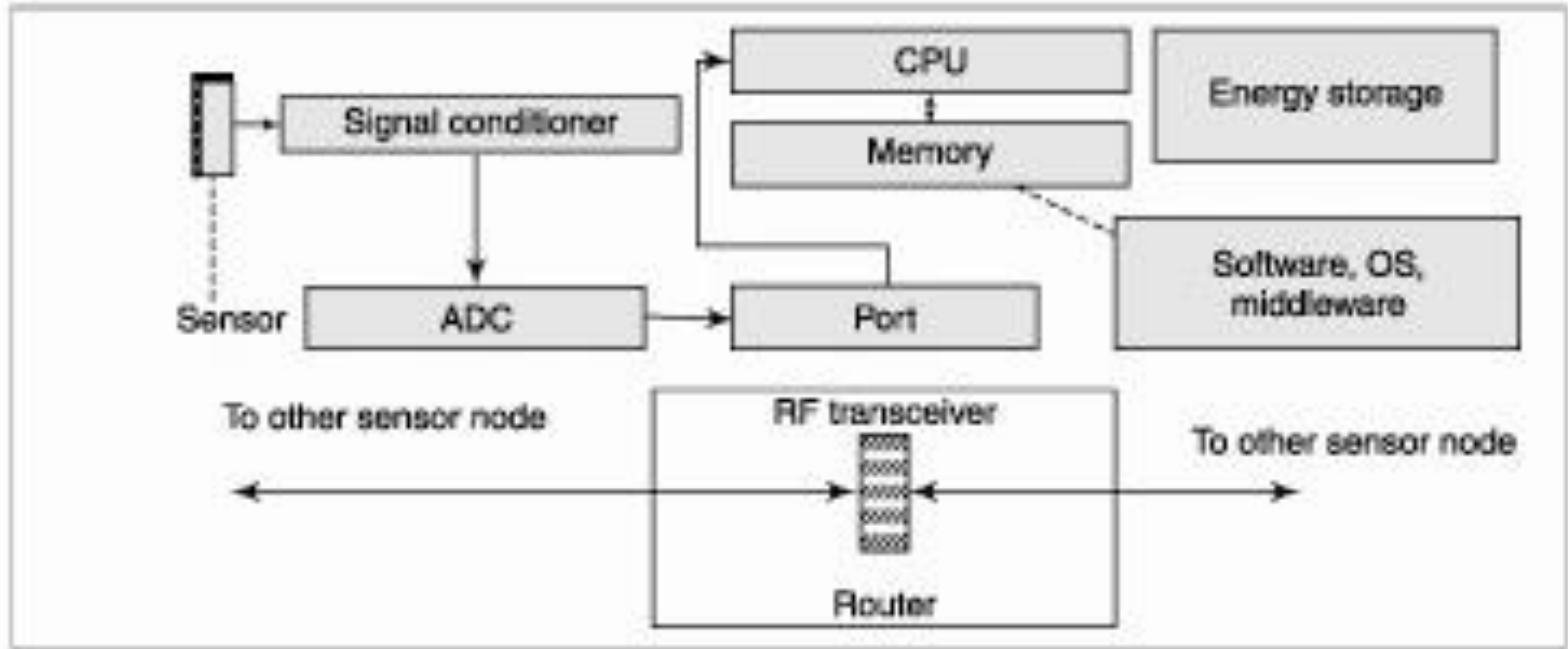
WIRELESS SENSOR NETWORK



MANET SENSOR NODES

- The smart sensors have computational, communication, and networking capabilities but are constrained by their small size, limited energy availability, and limited memory
- Since greater computational speed needs greater energy, these sensors operate at limited computational speed
- Moreover, these have limited bandwidth

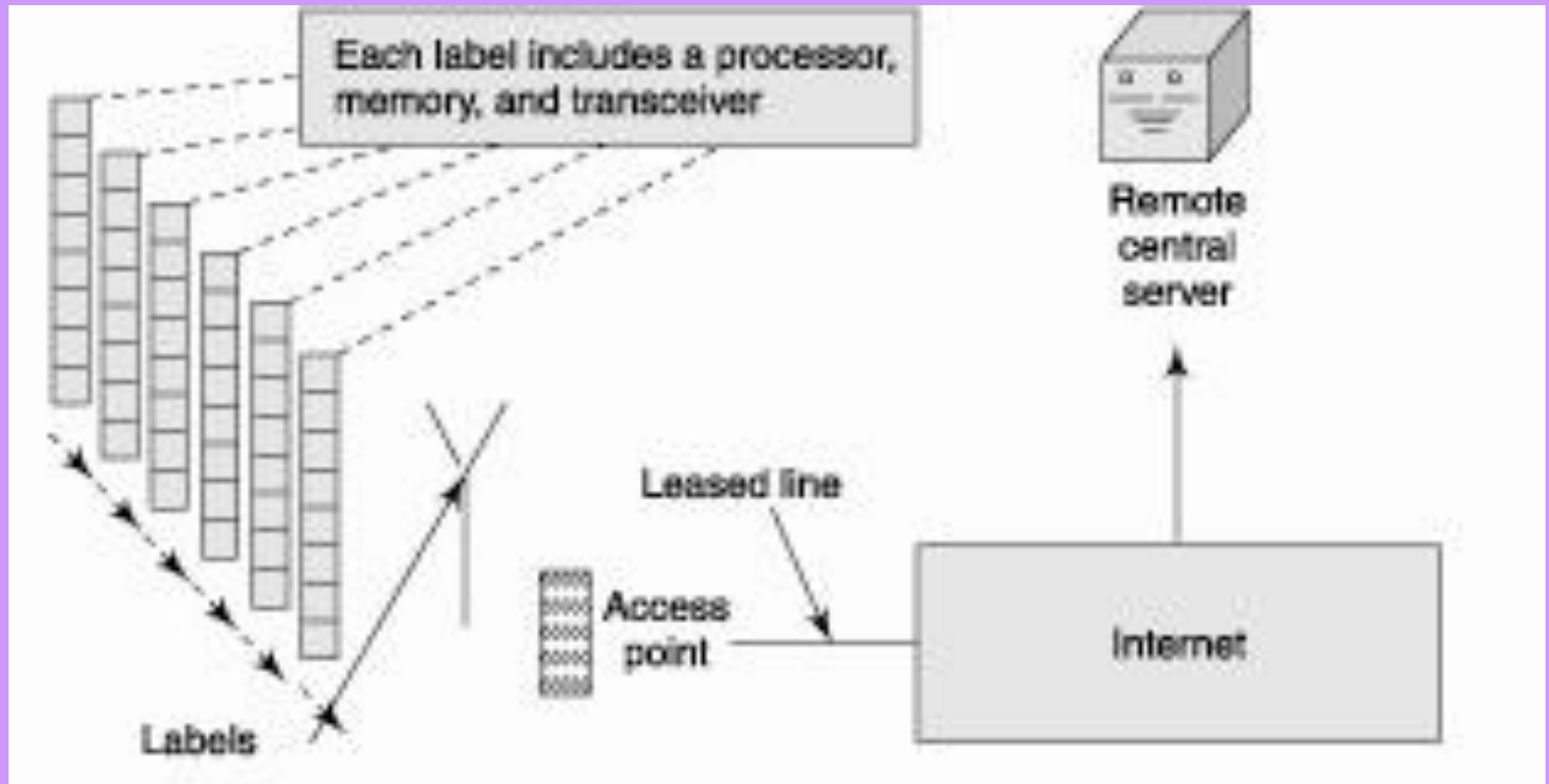
SMART WIRELESS SENSOR NODE ARCHITECTURE



EXAMPLE OF A LIBRARY WITH SMART LABELS ON EACH BOOK

- A set of wireless access-points in the library
- Also wireless Internet connectivity to a central server computer
- Smart labels network together to a central reading server through wireless access-points, Internet, and a centralized server

EXAMPLE OF WIRELESS SENSOR NETWORK IN A LIBRARY WITH SMART LABELS



EXAMPLE OF A LIBRARY WITH SMART LABELS ON EACH BOOK

- Cluster of labels form a MANET similar to a LAN network and the MANET connects to central server through wireless access-point and Internet

EXAMPLE OF A LIBRARY WITH SMART LABELS ON EACH BOOK

- When a labeled book is removed from the shelf, the smart label on the neighbouring book discovers service through another neighbouring label and MANET is reorganized and establishes connection to central server is established

EXAMPLE OF A LIBRARY WITH SMART LABELS ON EACH BOOK

- Smart labels are sensors of radiation from wireless access-points
- Therefore, the MANET of smart labels is also called wireless sensors ad-hoc network

A SMART WIRELESS SENSOR ARCHITECTURE

- Consists of an RF transceiver for communication, a *microcontroller* [CPU, memory, and ADC (analog-to-digital converter)], and an *energy source* or a power supply

A SMART WIRELESS SENSOR ARCHITECTURE

- A charge pump traps the charge from the radiations (for example, from WiFi transceiver or an access-point)
- Alternatively, an energy-harvesting module can be used to trap solar radiation and store the energy

A SMART WIRELESS SENSOR ARCHITECTURE

- The *RF transceiver* enables a node to receive data packets from nearby nodes and route these to next hop of the packet
- A wireless sensor node disseminates information to the network, central computer, or controller

DATA DISSEMINATION AFTER AGGREGATION

- Aggregation refers to the process of joining together present and previously received data packets after removing redundant or duplicate data

DATA DISSEMINATION AFTER COMPACTION

- Compacting means making information short without changing the meaning or context, for example, transmitting only the incremental data so that short information sent

DATA DISSEMINATION AFTER FUSION

- Fusion means formatting the information received in parts through various data packets and several types of data (or data from several sources), removing redundancy in the received data, and presenting the formatted information created from the information parts in cases when the individual records are not required and/or are not retrievable later

DISTRIBUTED NETWORK AND CHARACTERISTICS

- A wireless sensor network can be considered as a MANET of autonomous devices, which are spatially distributed
- Sensor devices cooperate with each other to disseminate the sensed or other data in the network

WSNs CONNECTED TO CENTRAL SERVER

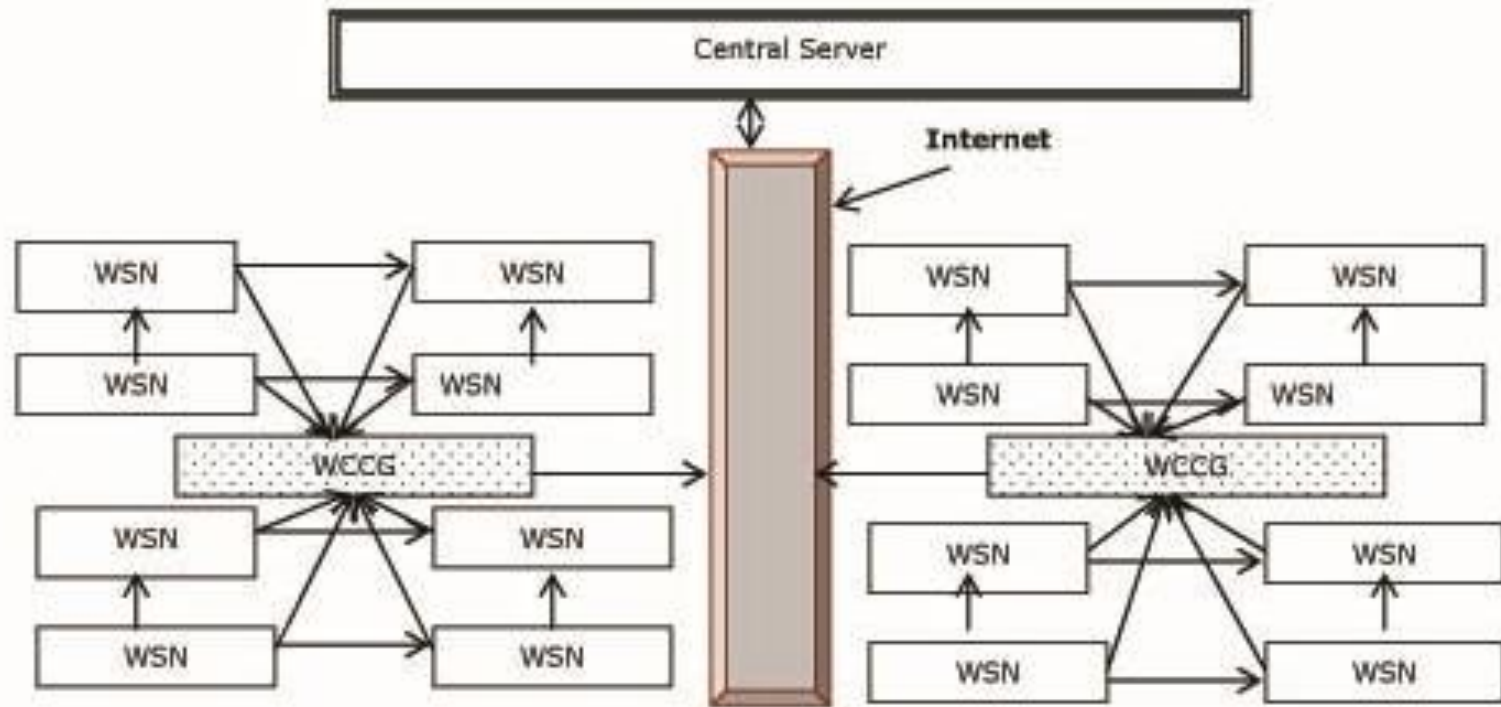


Fig. 11.5 Two WSNs (wireless sensor networks) in two clusters of a Wireless sensor network for street lighting deploying the wireless cluster coordinator gateways and connecting to Central server

WSNs CONNECTED TO CENTRAL SERVER

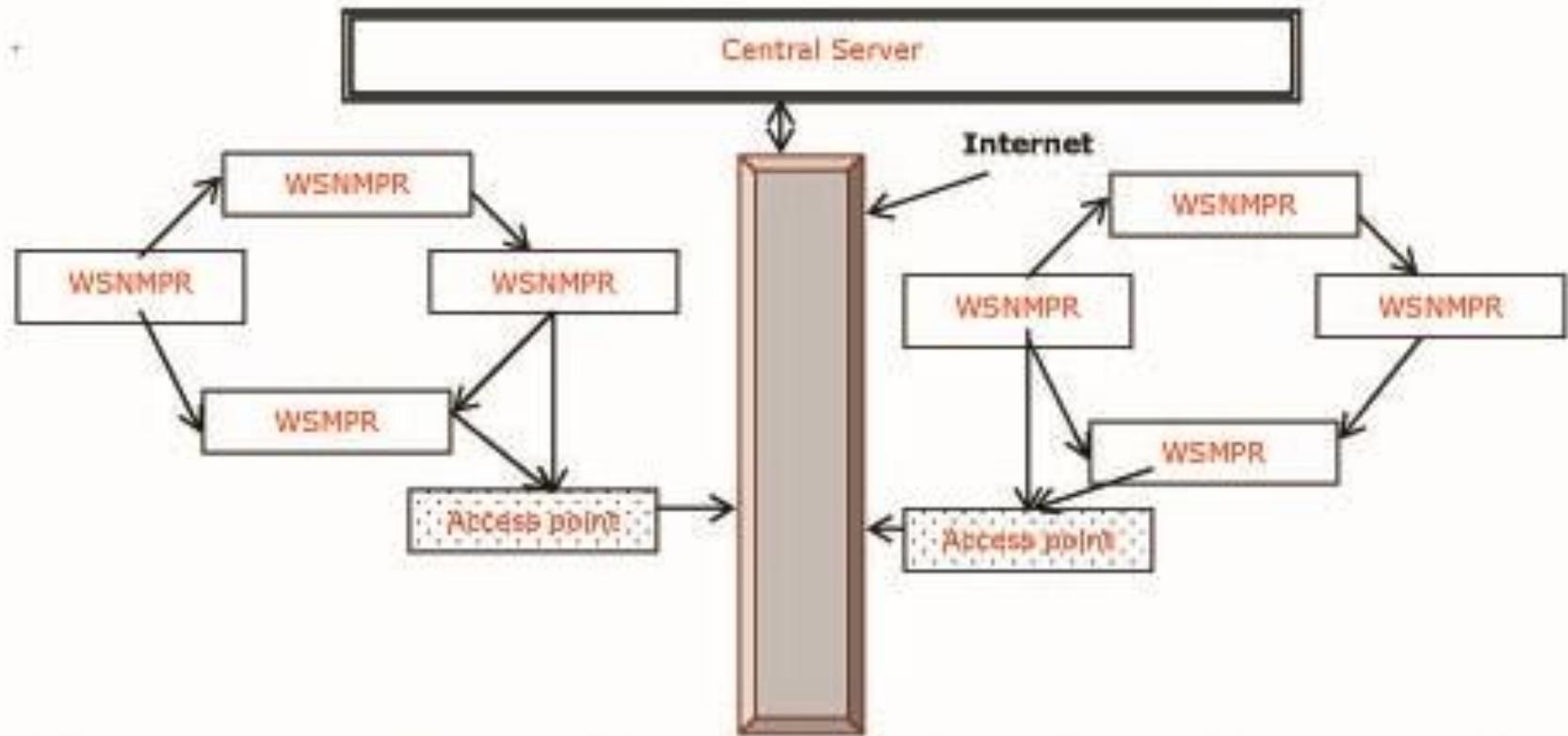


Fig. 11.6 Wireless sensor network for distributed network of traffic signalling and control system using Wireless sensor node with multipoint relays

DISTRIBUTED NETWORK AND CHARACTERISTICS

- The characteristics are energy constraints, probability of node failure, mobile network topology, and nodes using heterogeneous protocols with no maintenance during their operation it is known as full copy replication

WSN APPLICATION LAYER PROTOCOLS

- Sensor management protocol
- Sensor query and data dissemination protocol
- Task assignment and data advertisement
- Application-specific protocols

WSN DATA LINK LAYER MAC AND COMMUNIZATION PROTOCOLS

- MAC provides protocols for power saving and error control.
- IEEE 802.15.4-2003 ZigBee (a set of communication protocols used by small-sized, low-power digital radio embedded in the sensors and home devices).

COMMUNICATION PROTOCOLS

- 6LowPAN (IPv6 over low-power wireless personal area network, which permits communication of IPv6 packets in a sensor network).

SOFTWARE

- Software once embedded into the sensor node is for lifetime
- Should be robust, fault tolerant, and should provide maximum features and middleware
- Software should have features of security, self-healing, and self-configuration

FEW SPECIFIC OPERATING SYSTEMS

- tinyOS and CORMOS (communication oriented runtime system for sensor networks)

EXAMPLES OF A FEW SPECIFIC MIDDLEWARE (AGENT OR DATABASE ADAPTER)

- tinyDB, SensorWare, and GSN (global sensor networks) application-oriented middleware

ROUTER

- Sensor networks deploy special routing protocols such as CGSR, DSR, or AODV

APPLICATIONS OF WIRELESS SENSOR NETWORK

- Industrial plant wireless sensor networks—Industrial plants use large number of sensors in instruments and controllers

APPLICATIONS OF WIRELESS SENSOR NETWORK

- **Pervasive computing networks—**
Mobile pervasive computing means *a set of computing devices, sensors, or systems* or a network having the characteristics of *transparency*, application-aware adaptation, and environment sensing

APPLICATIONS OF WIRELESS SENSOR NETWORK

- Traffic monitoring using traffic density wireless sensor networks
- Traffic density information aggregated at a central server
- The server relays this information to motorists on wireless Internet
- A traffic control server sends the traffic reports on Internet

APPLICATIONS OF WIRELESS SENSOR NETWORK

- The automobile owner can subscribe to a traffic control service provider which provides SMS messages about traffic slowdowns and blockades at various city points
- Enables a driver to select the roads with the least hurdles
- TTS (Text to speech) converters can also give voice messages to the drivers

APPLICATIONS OF WIRELESS SENSOR NETWORK

- Medical applications of wireless sensor networks— patients can be monitored by the sensors attached to them
- When a patient moves, the sensors form a MANET

APPLICATIONS OF WIRELESS SENSOR NETWORK

- Military applications of wireless sensor networks—The voice of a person can be sensed by a wireless sensor network deployed in remote border areas
- This monitors the enemy troop and machines movements

APPLICATIONS OF WIRELESS SENSOR NETWORK

- Smart labels and RFID-based wireless sensor network—It is used worldwide for monitoring movement of goods, movement of books in library, and supply chain management systems

APPLICATIONS

- Environmental monitoring wireless sensor network—Environmental parameters like temperature, pressure, light, rainfall, and seismic activity
- Home automation—including security using a wireless sensor network

SUMMARY

- Sensing of the light level, temperature, location shift, time stamps of GPS satellites vibration, pressure, weather data, noise levels, traffic density, and nearby passing vehicles
- Smart sensors have computational, communication, and networking capabilities

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... SUMMARY

- Constrained by their small size, limited energy availability, and limited memory
- Operate at limited computational speed
- Limited bandwidth
- RF transceiver for communication, a *microcontroller* [CPU, memory, and ADC (analog-to-digital converter)], and an *energy source*

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...SUMMARY

- Data Dissemination after Aggregation, Compaction and Fusion
- Distributed Network and Characteristics
- Applications of wireless sensor networks and MANETs

End of Lesson 07 Wireless Sensor Networks