**Wireless Sensor Networks (WSN)**

**What is Wireless Sensor Networks?**

**Ans:**  A wireless sensor network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations.

A collection of sensing devices that can communicate wirelessly.

**Characteristics:**

* Power consumption constraints for nodes using batteries or energy harvesting
* Ability to cope with node failures (resilience)
* Mobility of nodes
* Heterogeneity of nodes
* Scalability to the large scale of deployment
* Ability to withstand harsh environmental conditions
* Ease of use
* Cross-layer design

**Application of wireless sensor network**

Wireless sensor networks have gained considerable popularity due to their flexibility in solving problems in different application domains and have the potential to change our lives in many different ways. WSNs have been successfully applied in various application domains, such as

Military applications: Wireless sensor networks be likely an integral part of military command, control, communications, computing, intelligence, battlefield surveillance, reconnaissance and targeting systems.

Area monitoring: In area monitoring, the sensor nodes are deployed over a region where some phenomenon is to be monitored. When the sensors detect the event being monitored (heat, pressure etc), the event is reported to one of the base stations, which then takes appropriate action.

Transportation: Real-time traffic information is being collected by WSNs to later feed transportation models and alert drivers of congestion and traffic problems.

Health applications: Some of the health applications for sensor networks are supporting interfaces for the disabled, integrated patient monitoring, diagnostics, and drug administration in hospitals, tele-monitoring of human physiological data, and tracking & monitoring doctors or patients inside a hospital.

Environmental sensing: The term Environmental Sensor Networks has developed to cover many applications of WSNs to earth science research. This includes sensing volcanoes, oceans, glaciers, forests etc. Some other major areas are listed below:

* Air pollution monitoring
* Forest fires detection
* Greenhouse monitoring
* Landslide detection

Structural monitoring: Wireless sensors can be utilized to monitor the movement within buildings and infrastructure such as bridges, flyovers, embankments, tunnels etc enabling Engineering practices to monitor assets remotely with out the need for costly site visits.

Industrial monitoring: Wireless sensor networks have been developed for machinery condition-based maintenance (CBM) as they offer significant cost savings and enable new functionalities. In wired systems, the installation of enough sensors is often limited by the cost of wiring.

Agricultural sector: using a wireless network frees the farmer from the maintenance of wiring in a difficult environment. Irrigation automation enables more efficient water use and reduces waste

**Design issues of a wireless sensor network:**

There are a lot of challenges placed by the deployment of sensor networks which are a superset of those found in wireless ad hoc networks. Sensor nodes communicate over wireless, lossy lines with no infrastructure. An additional challenge is related to the limited, usually non-renewable energy supply of the sensor nodes. In order to maximize the lifetime of the network, the protocols need to be designed from the beginning with the objective of efficient management of the energy resources (Akyildiz et al., 2002). Wireless Sensor Network Design issues are mentioned in (Akkaya et al., 2005), (Akyildizet al., 2002), (SensorSim; Tossim, Younis et al., 2004), (Pan et al., 2003) and different possible platforms for simulation and testing of routing protocols for WSNs are discussed in ( NS-2, Zeng et al., 1998, SensorSim, Tossiim ). Let us now discuss the individual design issues in greater detail.

1. Fault Tolerance: Sensor nodes are vulnerable and frequently deployed in dangerous environment. Nodes can fail due to hardware problems or physical damage or by exhausting their energy supply. We expect the node failures to be much higher than the one normally considered in wired or infrastructure-based wireless networks. The protocols deployed in a sensor network should be able to detect these failures as soon as possible and be robust enough to handle a relatively large number of failures while maintaining the overall functionality of the network. This is especially relevant to the routing protocol design, which has to ensure that alternate paths are available for rerouting of the packets. Different deployment environments pose different fault tolerance requirements.
2. Scalability: Sensor networks vary in scale from several nodes to potentially several hundred thousand. In addition, the deployment density is also variable. For collecting high-resolution data, the node density might reach the level where a node has several thousand neighbours in their transmission range. The protocols deployed in sensor networks need to be scalable to these levels and be able to maintain adequate performance.
3. Production Costs: Because many deployment models consider the sensor nodes to be disposable devices, sensor networks can compete with traditional information gathering approaches only if the individual sensor nodes can be produced very cheaply. The target price envisioned for a sensor node should ideally be less than $1.
4. Hardware Constraints: At minimum, every sensor node needs to have a sensing unit, a processing unit, a transmission unit, and a power supply. Optionally, the nodes may have several built-in sensors or additional devices such as a localization system to enable location-aware routing. However, every additional functionality comes with additional cost and increases the power consumption and physical size of the node. Thus, additional functionality needs to be always balanced against cost and low-power requirements.
5. Sensor Network Topology: Although WSNs have evolved in many aspects, they continue to be networks with constrained resources in terms of energy, computing power, memory, and communications capabilities. Of these constraints, energy consumption is of paramount importance, which is demonstrated by the large number of algorithms, techniques, and protocols that have been developed to save energy, and thereby extend the lifetime of the network. Topology Maintenance is one of the most important issues researched to reduce energy consumption in wireless sensor networks.
6. Transmission Media: The communication between the nodes is normally implemented using radio communication over the popular ISM bands. However, some sensor networks use optical or infrared communication, with the latter having the advantage of being robust and virtually interference free.
7. Power Consumption: As we have already seen, many of the challenges of sensor networks revolve around the limited power resources. The size of the nodes limits the size of the battery. The software and hardware design needs to carefully consider the issues of efficient energy use. For instance, data compression might reduce the amount of energy used for radio transmission, but uses additional energy for computation and/or filtering. The energy policy also depends on the application; in some applications, it might be acceptable to turn off a subset of nodes in order to conserve energy while other applications require all nodes operating simultaneously.

**Advantages of WSN:**

1. It avoids a lot of wiring.
2. It can accommodate new devices at any time.
3. It's flexible to go through physical partitions.
4. It can be accessed through a centralized monitor.

**Disadvantages of WSN:**

1. Lower speed compared to a wired network.
2. Less secure because a hacker's laptop can act as Access Point.
3. If you connected to their laptop, they'll read all your information (username, password.. etc).
4. More complex to configure than a wired network.
5. Gets distracted by various elements like Blue-tooth.
6. Still Costly at large.  It does not make sensing quantities in buildings easier.
7. It does not reduce costs for the installation of sensors.
8. It does not allow us to do more than can be done with a wired system.

**Design Challenges:**

* Heterogeneity: The devices deployed may be of various types and need to collaborate with each other.
* Distributed Processing: The algorithms need to be centralized as the processing is carried out on different nodes.
* Low Bandwidth Communication: The data should be transferred efficiently between sensors.
* Large Scale Coordination: The sensors need to coordinate with each other to produce the required results.
* Utilization of Sensors: The sensors should be utilized in ways that produce maximum performance and use less energy.
* Real-Time Computation: The computation should be done quickly as new data is always being generated.

**WSN Vs MANET:**

|  |  |
| --- | --- |
| Wireless Sensor Network (WSN) | Wireless Adhoc Network (MANET) |
| 1. The medium used in wireless sensor networks are radio waves, infrared, optical media. | 1. The medium used in wireless adhoc networks is radio waves. |
| 2. Application dependent network is used. | 2. Application independent network is used. |
| 3. Query based (data centric routing) or location based routing takes place. | 3. Hop-to-Hop routing takes place. |
| 4. It is homogeneous in type. | 4. It is heterogeneous in type. |
| 5. The traffic pattern is any-to-any, many-to-one, many-to-few, one-to-many. | 5. The traffic pattern is point-to-point. |
| 6. Application level gateway is used as an inter-connecting device. | 6. Wireless router is used as an inter-connecting device. |
| 7. The data rate is low. | 7. The data rate is high. |