An Intro to Wireless Sensor Networks

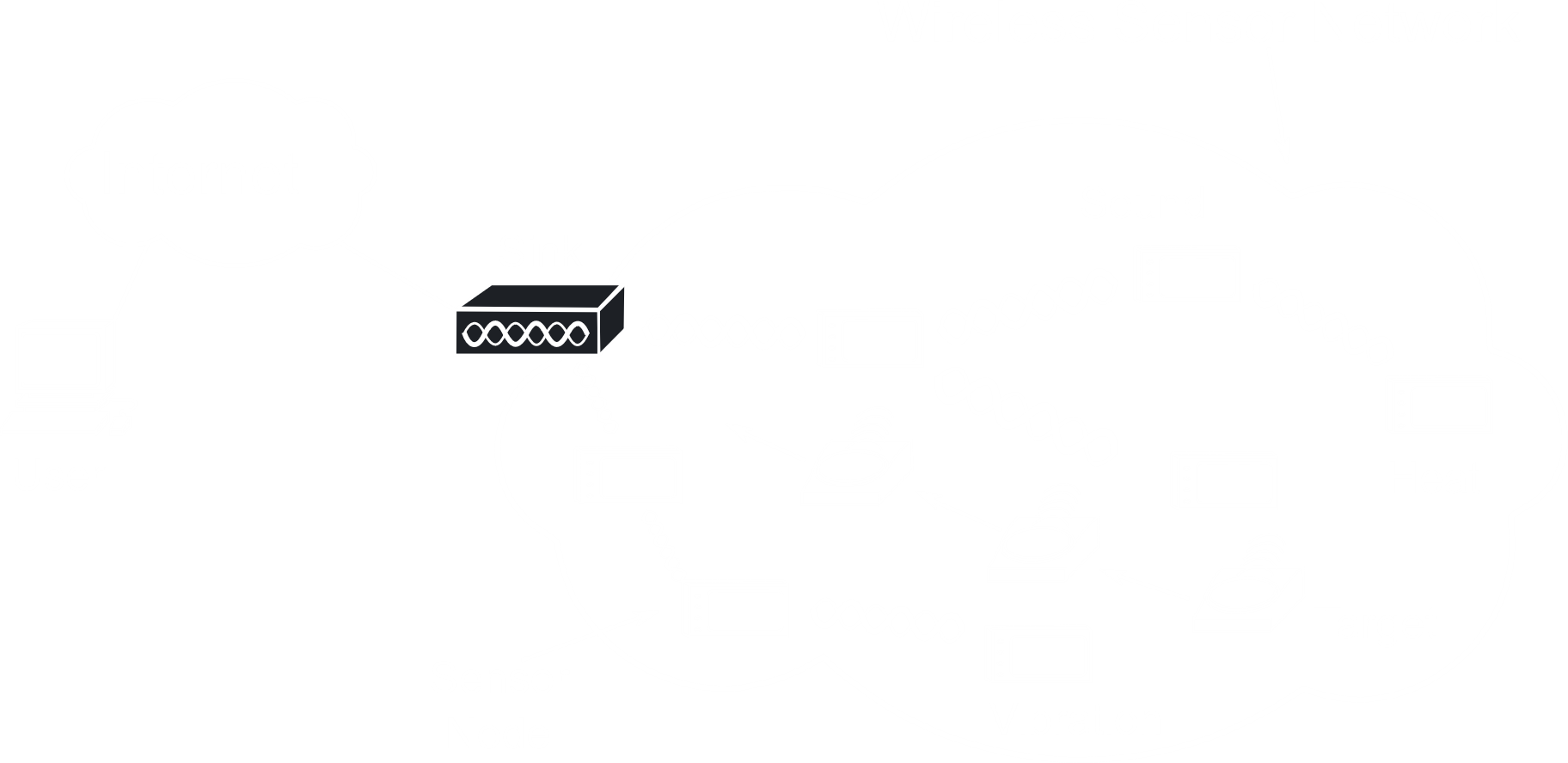
Table of Contents

[Challenges 2](#_Toc99659165)

[Lifetime Improvement 2](#_Toc99659166)

[Design Factors 3](#_Toc99659167)

One of the network types among the different Wireless Personal Area Networks (WPANs) is called a **Wireless Sensor Network** (WSN). A WSN is a wireless network consisting of spatially distributed autonomous sensor devices to cooperatively monitor physical and environmental conditions at different locations. Essentially, it is a bunch of **sensor devices**, called **nodes**, distributed throughout an environment in order to monitor it. The information from the nodes all go back to a single **base station** or **sink**.



Usually, the environment in which the sensors are deployed is a harsh one, like a volcano or the deep sea. Because of this, the sensors must be **low cost**, since it is unlikely that we will be able to retrieve the devices. The low cost means that it cannot have much computation power, and indeed it does not need to, due to its limited work. Additionally, the devices must be **battery-powered** and may or may not have other components like Bluetooth, GPS or Wi-Fi.

## Challenges

The main challenges we must face with WSNs are:

* Ensuring energy efficiency
* Coping with limited storage and computational power
* Coping with low bandwidth and high error rates due to
  + Wireless communications
  + Noisy measurements
  + Increased failure of nodes
* Ensuring scalability for a large number of sensor nodes
* Ensuring survivability in harsh environments
* Experimenting despite the intensive time and space requirements

## Lifetime Improvement

Since nodes are **battery powered**, they will quickly die out. To save energy and delay this event as much as possible we should:

* Sleep as much as possible
* Acquire data only if indispensable
* Transmit and receive only if necessary

In order to do this, there are several steps we can take:

* Reducing the amount of data traffic through mechanisms like data trend prediction and model based solutions
* Data fusion or compression
* Optimizing the wakeup interval so that no nodes are constantly awake and only the minimum number of nodes that are absolutely required remain awake while the others sleep
* Optimizing the beacon interval
* Reducing the probability of false wakeups
* Correctly identifying the cause of packet loss through false link detection and use of optimized routing

## Design Factors

The design factors we need to consider are:

* Scalability
* Fault Tolerance
* Power Consumption
* Network Architectures
* Data Collection
* Power Supply

For the **network architecture**, we can consider two, layered architecture and clustered architecture. For the **layered architecture**, the nodes are placed layer by layer starting from the base station. Each layer communicates with the layer before and after it finally reaching the base station. For the **clustered architecture**, the nodes are placed in clusters with an assigned **cluster head**. The cluster head is the only one which communicates with the base station.

For **data collection**, we need to consider that having a centralized point to collect data at puts a burden on the nodes closest to that point. We can use clever routing techniques to avoid this. We can also cluster the data from groups of nodes to reduce the number of transmissions. We need to consider that sometimes, getting data from an area is more important than getting data from individual nodes. Security and authenticity are also important, but the simple CPUs of the nodes cannot handle advanced encryption algorithms.

For the **power supply**, by far the best solution at the moment is to use rechargeable batteries that are recharged via natural mechanisms like solar power. This may not always be possible however.