# TNE090
# Wireless Sensor Networks
# Lecture 1

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## Course introduction

- **7 lectures + 2 Labs**
  - Lecture1: Introduction of Wireless Sensor Network
  - Lecture 2: Wireless Sensor Network Design – Hardware (Allan Huynh)
  - Lecture 3: Wireless Sensor Network Design – Software
  - Lecture 4: IEEE standard for wireless sensor network – IEEE 802.15.4 MAC layer
  - Lecture 5: ZigBee Application Layer
  - Lecture 6: ZigBee application layer management – ZigBee Device Object (ZDO)
  - Lecture 7: ZigBee network layer - Ad hoc On-Demand Distance Vector (AODV) Routing Algorithm
- 1 final project + project report + presentation
- Course Literature: Drew Gislason, ZigBee Wireless Networking, Newnes 2008, ISBN-10: 0750685972, ISBN-13: 978-0750685979

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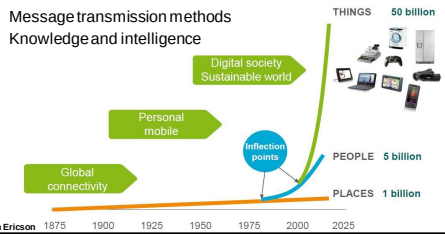
## Background information

- Internet of Things (IoT)

- Web1.0 - Web2.0 - Web3.0: Past - Present - Future (near)
- Applications
- Things are actively participate in different processes
  - M2M
  - User interface
- Three compositions of IoT:
  - Sensors and actuators
  - Message transmission methods
  - Knowledge and intelligence




Picture from Ericson

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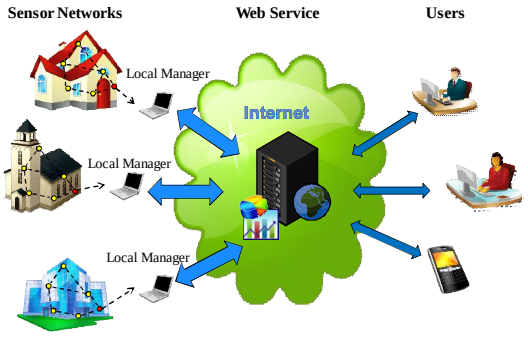
## System architechture

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## Wireless sensor networks

- Wireless Sensor Networks (WSNs) consist of small nodes with sensing, computation, and wireless communications capabilities.
- These sensors have the ability to communicate either among each other or directly to an external base-station (BS).

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## Network topology

- **Star network**
  All of the nodes on the network must be connected to one central device. All traffic that traverses the network passes through the central hub.
- **Tree network**
  A central 'root' node (the top level of the hierarchy) is connected to one or more other nodes that are one level lower in the hierarchy (i.e., the second level) with a point-to-point link between each of the second level nodes and the top level central 'root' node, while each of the second level nodes will also have one or more other nodes that are one level lower in the hierarchy (i.e., the third level) connected to it.
- **Mesh network (Partially connected)**
  Some of the nodes of the network are connected to more than one other node in the network with a point-to-point link – this makes it possible to take advantage of some of the redundancy that is provided by a physical fully connected mesh topology without the expense and complexity required for a connection between every node in the network.

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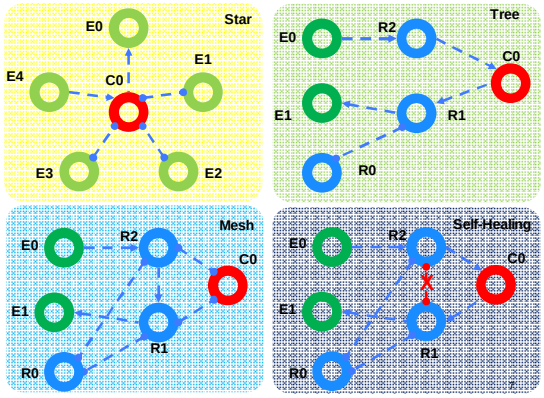
## Background information

- WSN network topology

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## Wireless sensor network applications

- Intrusion detection
- Weather monitoring
- Security and tactical surveillance
- Detecting ambient conditions such as temperature, movement, sound, light, or the presence of certain objects
- Inventory control
- Disaster management

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## WSN deployment

- Deployment of a sensor network in the applications can be in random fashion (e.g., dropped from an airplane) or can be planted manually (e.g., fire alarm sensors in a facility).

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## WSN design requirements

- In many applications, sensor nodes are powered by batteries and constrained in energy supply. Thus, innovative techniques that eliminate energy inefficiencies that would shorten the lifetime of the network are highly required.
- Fault tolerance is required.
- Certain delay is allowed when delivering data.
- Bandwidth is limited.

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## WSN design requirements

- Self-configuration and reconfiguration
- Localization
- Low component cost
- Low maintenance cost (no maintenance in some applications)
- High reliability
- High security
- Scalability

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**Wireless sensor network devices**

End device

Wireless controller

Router / Coordinator

Local manager

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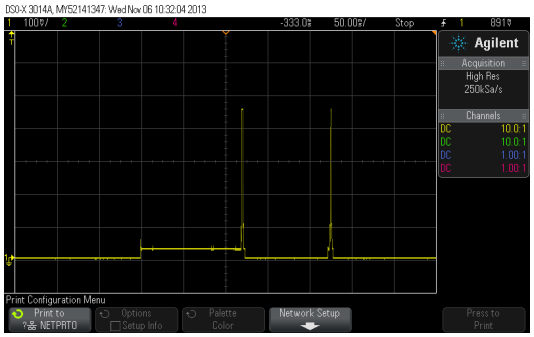
## Battery driven device power consumption

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| Name | Current (mA) | Period (ms) | Current Consumption (mA*ms) |
|---|---|---|---|
| Sensor working | 7.14 | 119.8 | 655.4 |
| RX on | 27.8 | around 1.7 | 47.26 |
| Tx on | 128.6 | 1.44 | 185.2 |
| Total | | | 887.86 |

Battery lifetime calculation: Battery capacity: 1200mAh

| Interval (min) | Lifetime (days) |
|---|---|
| 1 | 3378.9 |
| 15 | 50683 |

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## Classification of Routing techniques based on network structures

- Almost all of the routing protocols can be classified according to the network structure as **flat**, **hierarchical**, or **location-based**.
- In flat routing protocols, all nodes are typically assigned equal roles or functionality.
- In hierarchical protocols, the nodes are clustered so that cluster heads can do some aggregation and reduction of data in order to save energy.
- Location-based protocols utilize the position information to relay the data to the desired regions rather than the whole network.

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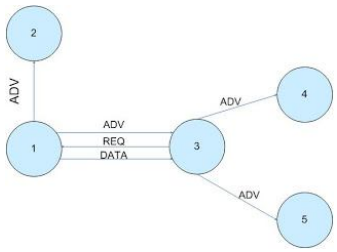
## Sensor Protocols for Information via Negotiation (SPIN)




Node 1 sends ADV message to all its neighbors, 2 and 3.Node 3 requests for the data using REQ message, for which node 1 send data using message DATA to node 3. After receiving the data Node 3 sends ADV message to its neighbors 4 and 5 and the process continues. It does not send to 1 because 3 knows that it received data from 1.
The data is described in the ADV packet using high level data descriptors, which are good enough to identify the data. These high level data descriptors are called meta-data. The meta-data of two different data's should be different and meta-data of two similar data should be similar. The use of meta-data prevents, the actual data being flooded through out the network. The actual data can be given to only the nodes which need the data. This protocol also makes nodes more intelligent, every node will have a resource manager, which will inform each node about the amount various resources left in the node. Accordingly the node can make a decision regarding, whether it can as forwarding node or not.

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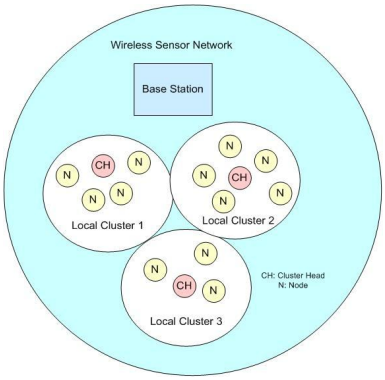
## LEACH : Low Energy Adaptive Clustering Hierarchy

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- LEACH is a cluster-based protocol, which includes distributed cluster formation.
- LEACH randomly selects a few sensor nodes as clusterheads (CHs) and rotate this role to evenly distribute the energy load among the sensors in the network.
- In LEACH, the clusterhead (CH) nodes compress data arriving from nodes that belong to the respective cluster, and send an aggregated packet to the base station in order to reduce the amount of information that must be transmitted to the base station.

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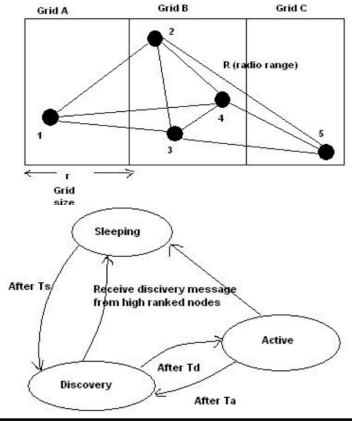
## Geographic Adaptive Fidelity

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Thank you!

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