Wireless Sensor Networks Applications

Outline

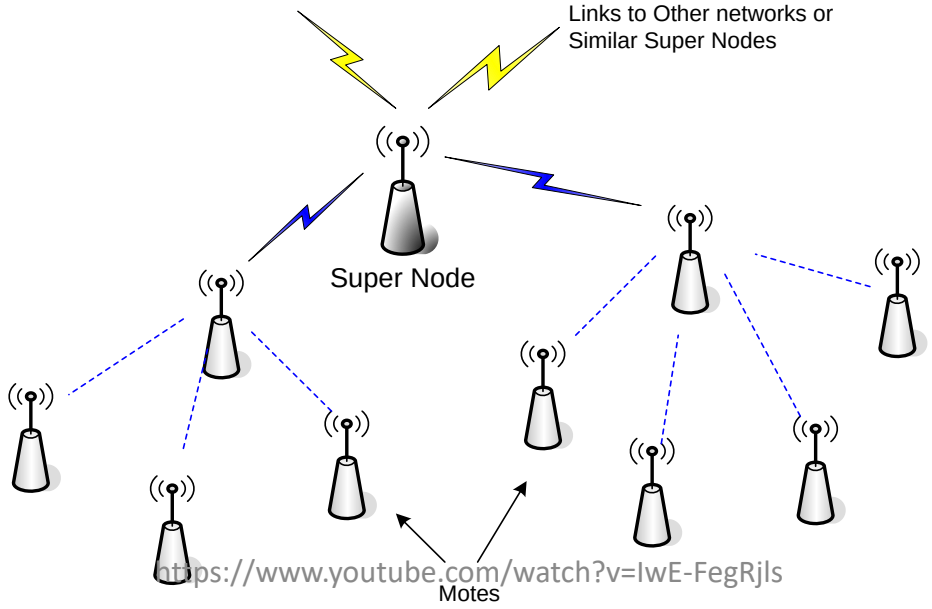
- What is Wireless Sensor Network
- Military Application
- Habitat Monitoring
- Health Application
- Environment/Nature
- Home Application
- Industry Application/Business
- Traffic / Automotive
- Intrusion Detection System
- Underwater Wireless Sensor Network
- Underground Wireless Sensor Netwoerk

https://www.youtube.com/watch?v=IwE-FegRjls

Wireless Sensor Networks (WSN)

*"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."*

- Wikipedia



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Applications of Sensor Networks

- **Military Applications**
  - Battlefield surveillance and monitoring, guidance systems of intelligent missiles, detection of attack by weapons of mass destruction such as chemical, biological, or nuclear
- **Nature/Environment Applications**
  - Forest fire, flood detection, habitat exploration of animals
- **Health Applications**
  - Monitor the patient's heart rate or blood pressure, and sent regularly to alert the concerned doctor, provide patients a greater freedom of movement

https://www.youtube.com/watch?v=IwE-FegRjls

Applications of Sensor Networks

- **Home (smart home) Applications**
  - Sensor node can be built into appliances at home, such as ovens, refrigerators, and vacuum cleaners, which enable them to interact with each other and be remote-controlled
- **Office building Applications**
  - Airflow and temperature of different parts of the building can be automatically controlled
- **Warehouse Applications**
  - Improve their inventory control system by installing sensors on the products to track their movement

https://www.youtube.com/watch?v=IwE-FegRjls

Using in Military:

- Monitoring friendly forces, equipment, and ammunition
- Battlefield surveillance
- Reconnaissance of opposing forces and terrain
- Targeting
- Battle damage assessment

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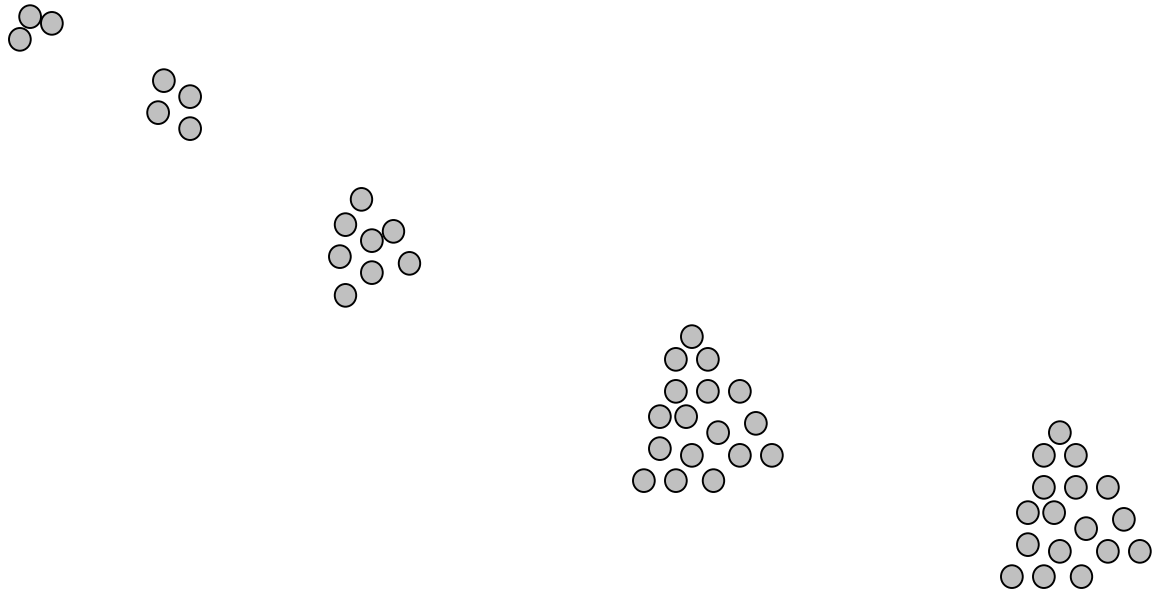
Using in Military:

Remote deployment of sensors for tactical monitoring of enemy troop movements.



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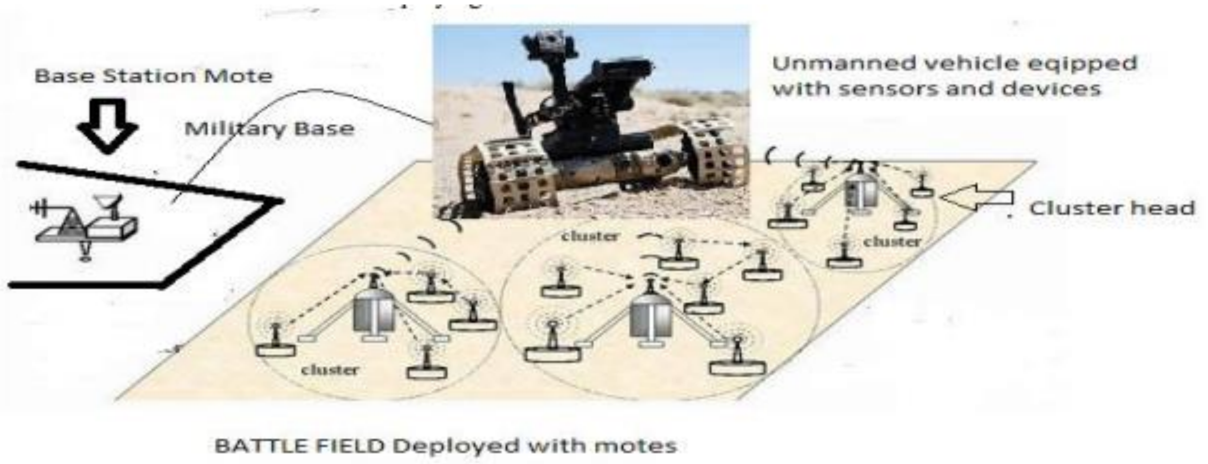
Wireless Sensor Network Security in Military Application using Unmanned Vehicle

- Unmanned vehicle controlled by wireless sensor network in Military application. This vehicle can navigate through the network and monitor the network security. The vehicle will be small and it will not get the enemy attention.



https://www.youtube.com/watch?v=Iw5-FegRjIs

Madhu A, Sreekumar A. Wireless sensor network security in military application using unmanned vehicle. International Journal of Electronics and Communication Engineering. 2014:51–8.

Smart Dust

- Smart Dust was one of the earliest applications of the WSNphenomenon. The main goal of this DARPA funded project is to provide technologies for sensor networks that will be used for military operations in hostile environments
- WSNs obtain information needed to assess critical situations by dropping a robust, self-configuring, self-organizing WSN onto the battlefield. The military applications include collecting information from enemy movements, hazardous chemicals, and infrastructure stability. The main goal of the Smart Dust project has been developing sensor platforms in cubic millimeter packages. Instead of focusing on a particular sensor, the transceiver and microcontroller unit (MCU) design are performed.

https://www.youtube.com/watch?v=IwE-FegRjls

VigilNet

- VigilNet is a large-scale surveillance network designed for energy-efficient and stealthy target tracking in harsh environments. The design and implementation of the network were based on 70 Mica2 nodes equipped with magnetic sensors that detect the magnetic field generated by the movement of vehicles and magnetic objects. The main goal of this application is to provide energy-efficient surveillance support through distributed sensor nodes.

https://www.youtube.com/watch?v=IwE-FegRjls

Using in Habitat Monitoring: Wildlife Tracking - ZebraNET

https://www.youtube.com/watch?v=IwE-FegRjls

Using in Habitat Monitoring: Wildlife Tracking - ZebraNET

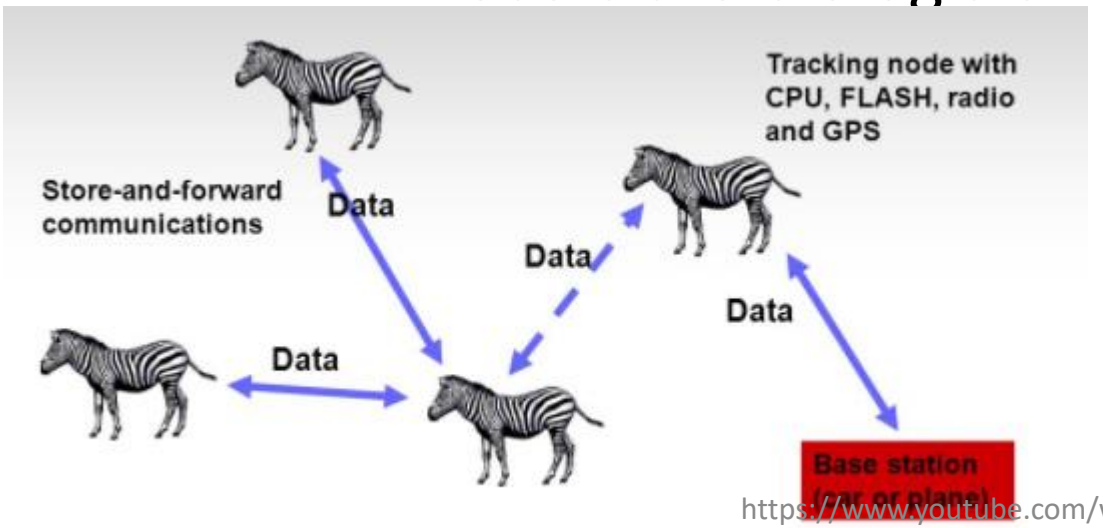
Zebranet: a WSN to study the behavior of zebras

- Special GPS-equipped collars were attached to zebras
- Data exchanged with peer-to-peer info swaps
- Coming across a few zebras gives access to the data

https://www.youtube.com/watch?v=IwE-FegRjls

Energy-Efficient Computing for Wildlife Tracking: Design Tradeoffs and Early Experiences with ZebraNet

- Application to track zebras on the field
- Sensors attached to the collars of the zebras to detect wildlife
- Special GPS equipped collars are attached to zebras
- 35,000 zebras around 40,000 square kilomateres
- Users are biologists



https://www.youtube.com/watch?v=IwE-Fe_KJls

Using in health:

- **MAX** - Asystem for human-centric search of the physical world. MAX permits folks to look and find physical objects once they are required

- **Matching Mother and Calf Reindeer -**The matter of matching newborn Greenland caribou calves to their mothers, and thus to their homeowners. wireless device networks supported wireless local area network enabled active RFID tags. It is projected to hold wireless local area network enabled RFID tags to the necks of the calf and mother reindeers on a short lived basis.

https://www.youtube.com/watch?v=IwE-FegRjls

Using in health:

Mobile Body Sensor Networks for Health Applications

Sleep Safe - It detects the sleeping position of associate child and alerts the parent once the child is lying on its abdomen to prevent sudden infant death syndrome (SIDS)

Baby Glove - System to observe organ. Baby Glove could be a swaddling baby wrap with sensors which will monitor associate infant's temperature, hydration, and heart

Efficient Patient monitoring For Multiple Patients - System that will monitor multiple patients' health parameters at the same time and may effectively deliver the info to a patient observance system

https://www.youtube.com/watch?v=IwE-FegRjls

Using in health:

Mobile Body Sensor Networks for Health Applications

- Monitoring CHF Patients
- Provide unobtrusive and persistent monitoring
  - Weight
  - Blood pressure
  - Heart rate
  - Energy expenditure
- Data analysis and feedback
  - Automated - based on thresholds (i.e. cannot allow rapid weight fluctuation, etc.)
  - Doctor intervention

Using in health:
Mobile Body Sensor Networks for Health Applications

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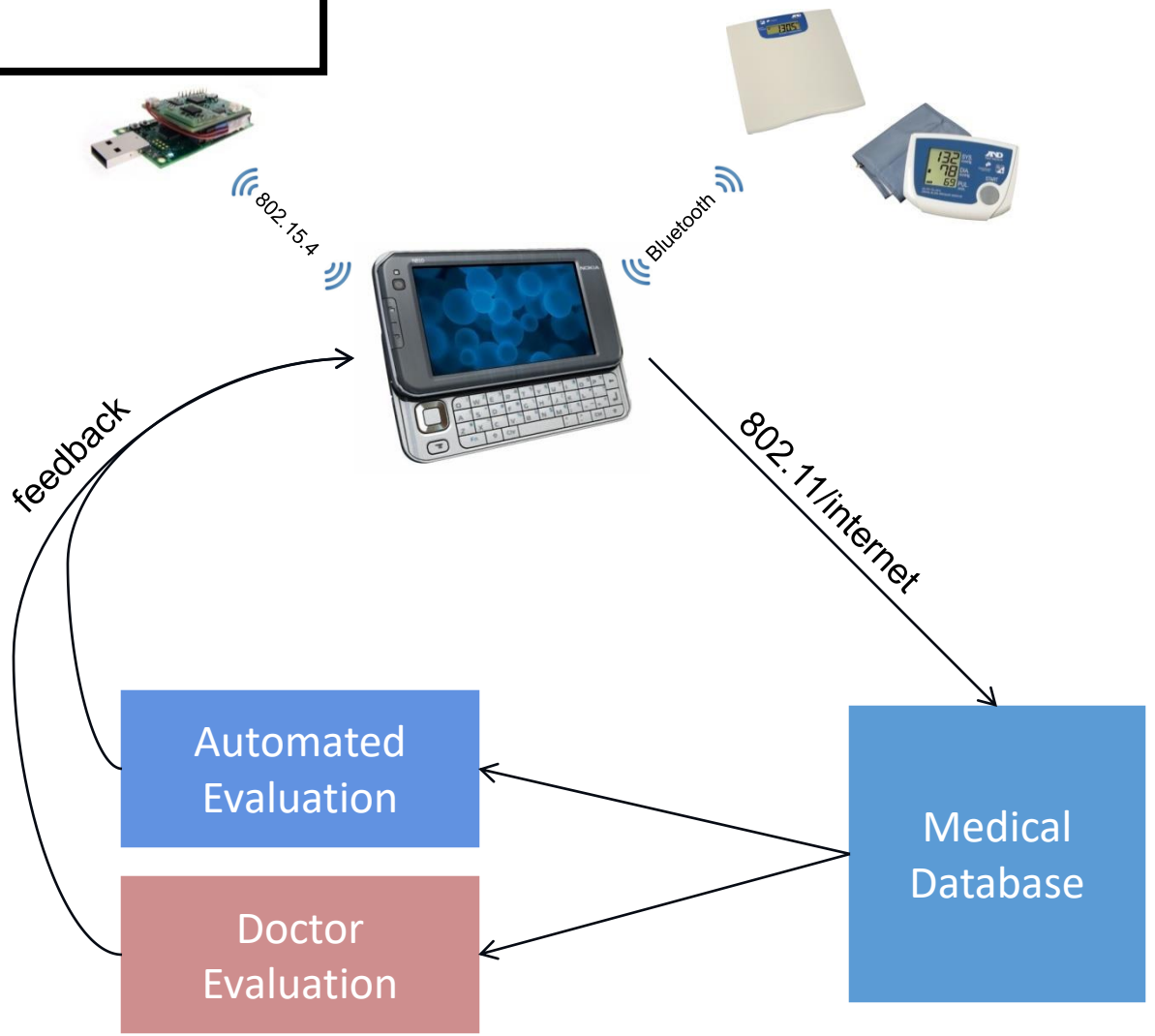
System Architecture



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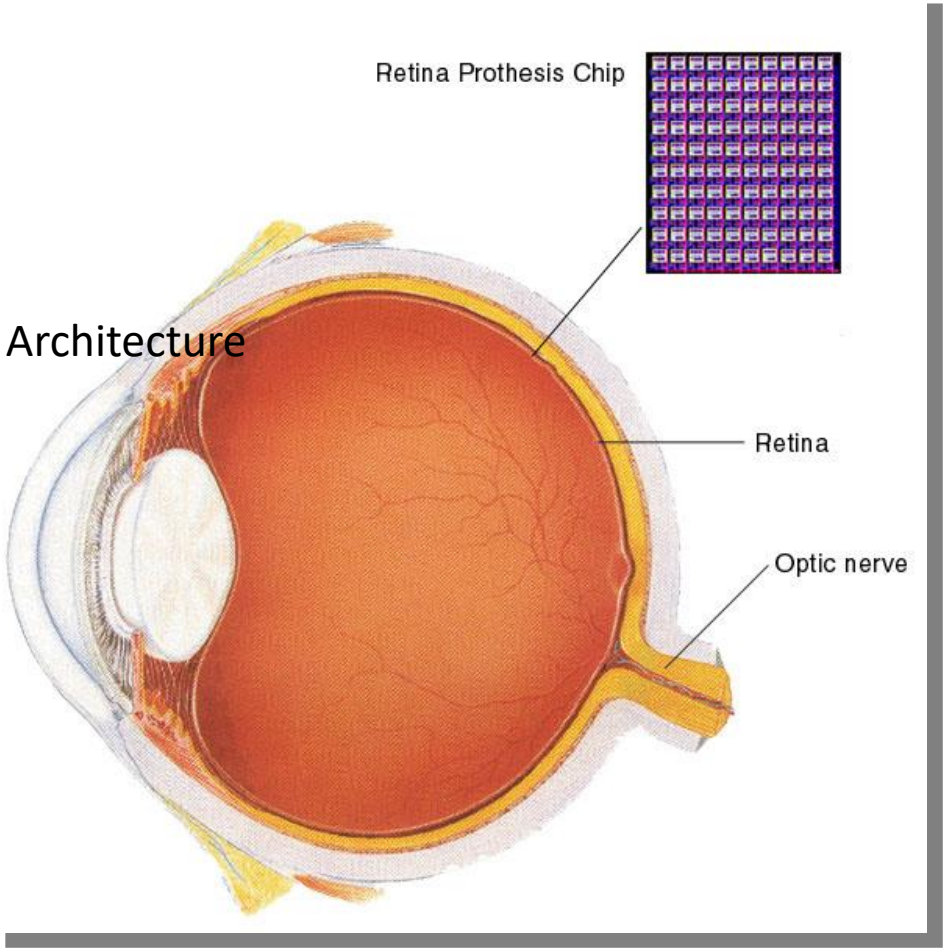
Using in health: Biomedical / Medical

- **Health Monitors**
  - Glucose
  - Heart rate
  - Cancer detection
- **Chronic Diseases**
  - Artificial retina
  - Cochlear implants
- **Hospital Sensors**
  - Monitor vital signs
  - Record anomalies



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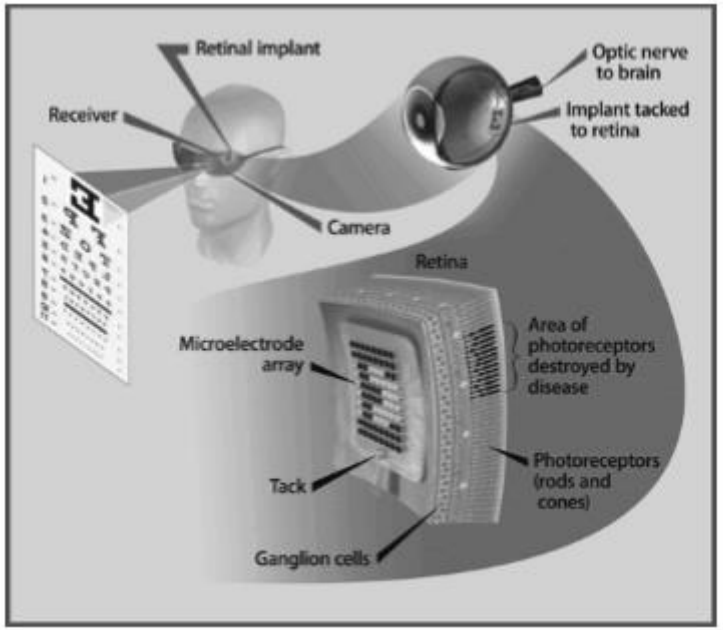
Artificial Retina

- The Artificial Retina (AR) project supported by the US Department of Energy aims to build a chronically implanted artificial retina for visually impaired people



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Using in Environment:

- **Volcanic monitoring** - Volcanic observance with WSN will facilitate accelerate the readying, installation, and maintenance method. WSN equipments ar smaller, lighter, and consume less power. The challenges of a WSN application for volcanic knowledge assortment embody reliable event detection
- **Forest fire detection** - Macroscope of redwood could be a case study of a WSN that monitors and records the redwood trees in Sonoma, California. every device node measures air temperature, ratio, and photo-synthetically-active radiation.
- **Greenhouse Monitoring**

https://www.youtube.com/watch?v=IwE-FegRjls

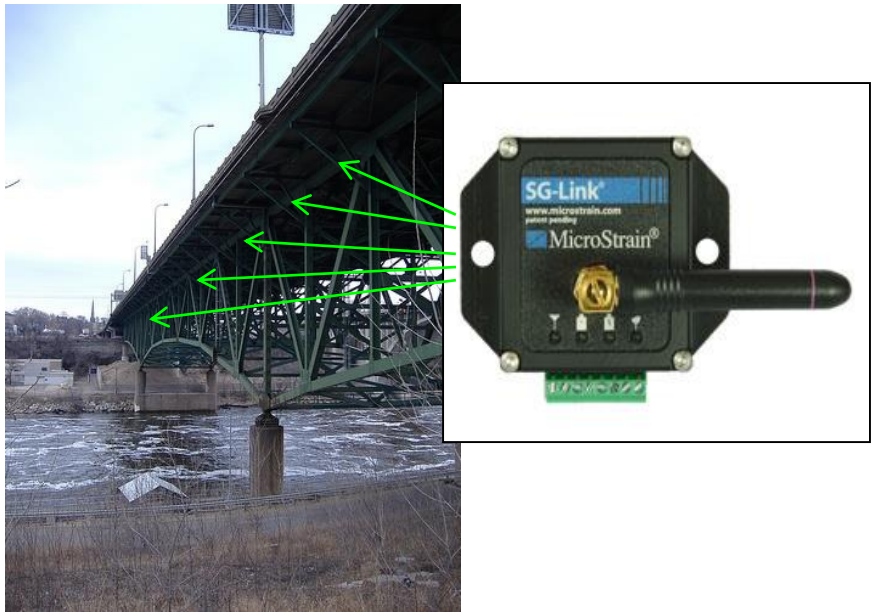
Using in Environment:

- **Flood detection** - Associate degree example of a flood detection is that the ALERT system deployed within the US. many sorts of sensors deployed within the ALERT system ar downfall, water level and weather sensors. These sensors offer data to the centralized info system in a very pre-defined means.
- **Water Quality and Air pollution Monitoring -** Here device nodes collects the environmental knowledge like water temperature, pH levels, dissolved chemical element levels, and wind speed and live the standard of water leve
- **detect and prevent forest fires**. Detect flames, heat and gases that help to identify the molecules of chemical compounds generated during combustion (CO and CO2). With GPS, allow the exact geolocation of the nodes.

https://www.youtube.com/watch?v=IwE-FegRjls

Using in Environment: Wireless Sensor Network for Structural Health Monitoring

- Wireless networks of stress/strain/vibration sensors can deployed to continuously monitor stresses on bridges and other civil infrastructure
- Distributed networks of wireless sensor nodes
  - gather critical information about the physical world
  - communicate the information to remotely located decision makers



https://www.youtube.com/watch?v=IwE-FegRjls

Using in Home: Pervasive Computing (Smart Home / Office)

- Sensors controlling appliances and electrical devices in the house.
- Better lighting and heating in office buildings.
- The Pentagon building has used sensors extensively.

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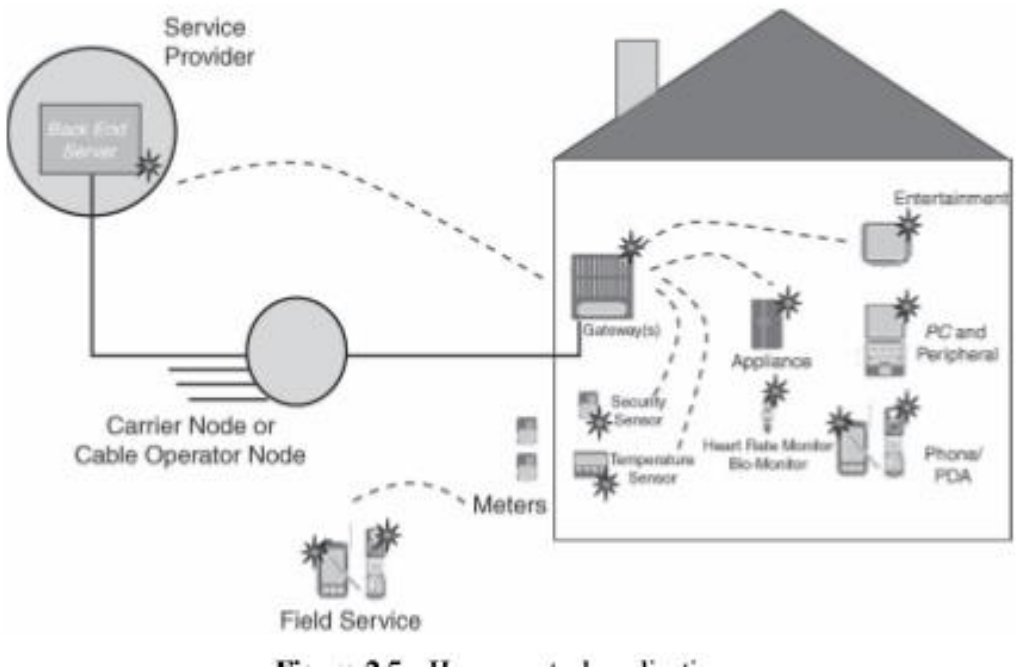
HOME CONTROL

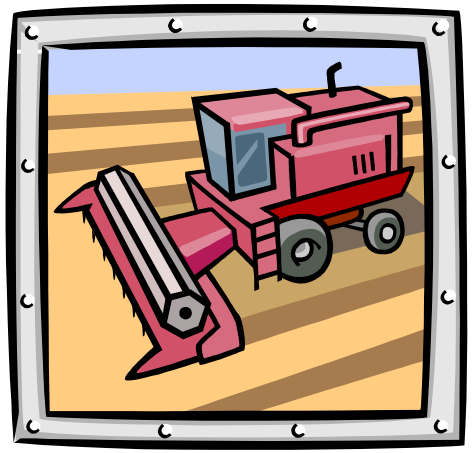


- Sensing applications facilitate flexible management of lighting, heating, and cooling systems from anywhere in the home.
- Sensing applications automate control of multiple home systems to improve conservation, convenience, and safety.
- Sensing applications capture highly detailed electric, water, and gas utility usage data.
- Sensing applications embed intelligence to optimize consumption of natural resources.
- Sensing applications enable the installation, upgrading, and networking of a home control system without wires.
- Sensing applications enable one to configure and run multiple systems from a single remote control.
- Sensing applications support the straightforward installation of wireless sensors to monitor a wide variety of conditions.
- Sensing applications facilitate the reception of automatic notification upon detection of unusual events.

https://www.youtube.com/watch?v=IWE-FegRjIs

Using in Industrial & Commercial

- Numerous industrial and commercial applications:
- Agricultural Crop Conditions
- Inventory Tracking
- In-Process Parts Tracking
- Automated Problem Reporting
- RFID – Theft Deterrent and Customer Tracing
- Plant Equipment Maintenance Monitoring



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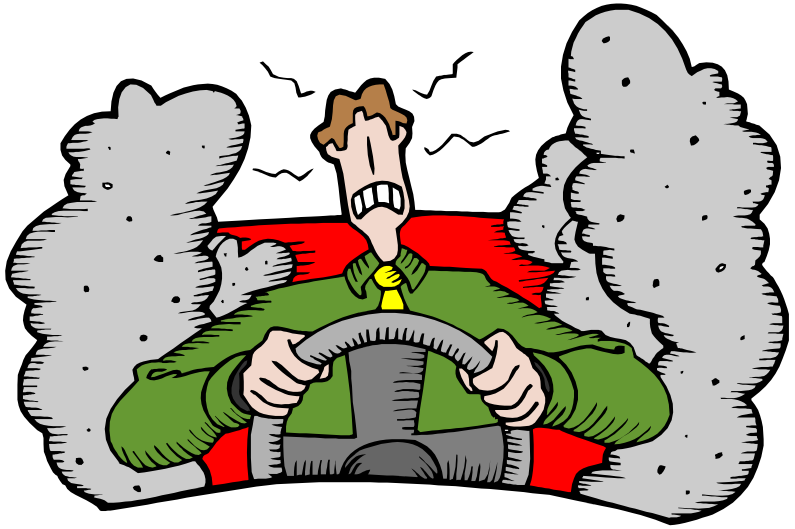
Using in Traffic Management & Monitoring

Future cars could use wireless sensors to:

- Handle Accidents
- Handle Thefts



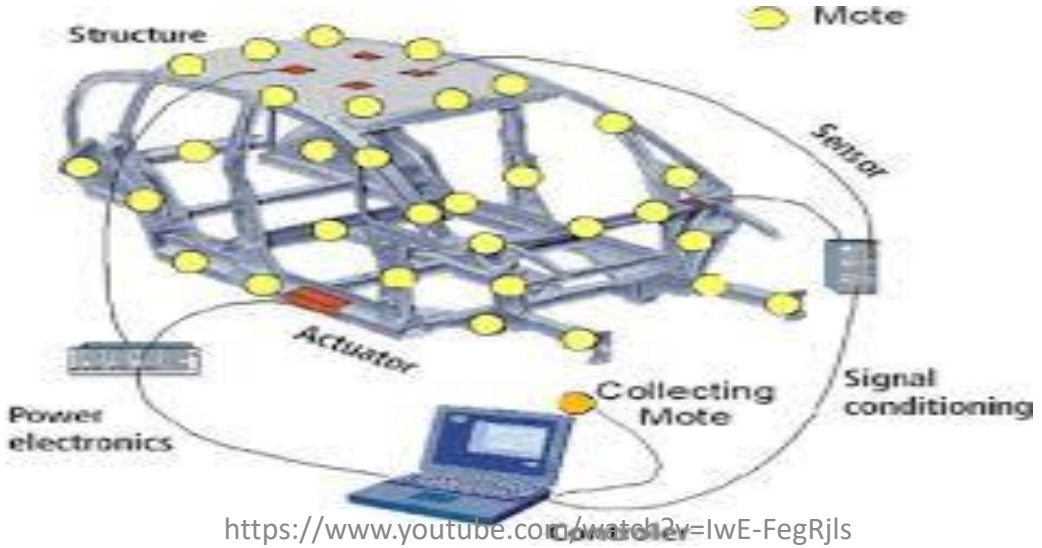
Sensors embedded in the roads to:

- Monitor traffic flows
- Provide real-time route updates

https://www.youtube.com/watch?v=IwE-FegRjls

Using in Automotive Applications

- Reduces wiring effects
- Measurements in chambers and rotating parts
- Remote technical inspections
- Conditions monitoring e.g. at a bearing



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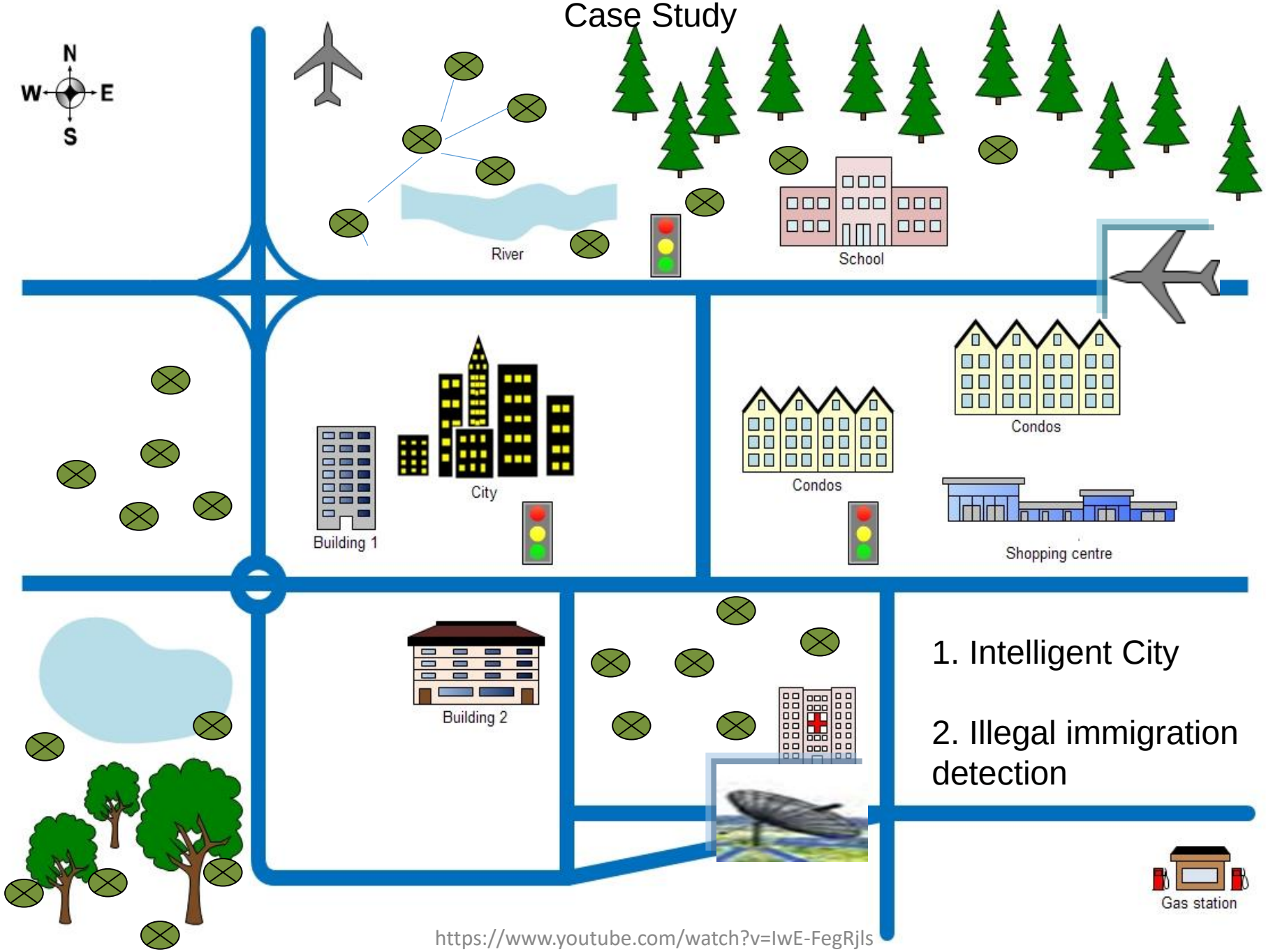
Case Study

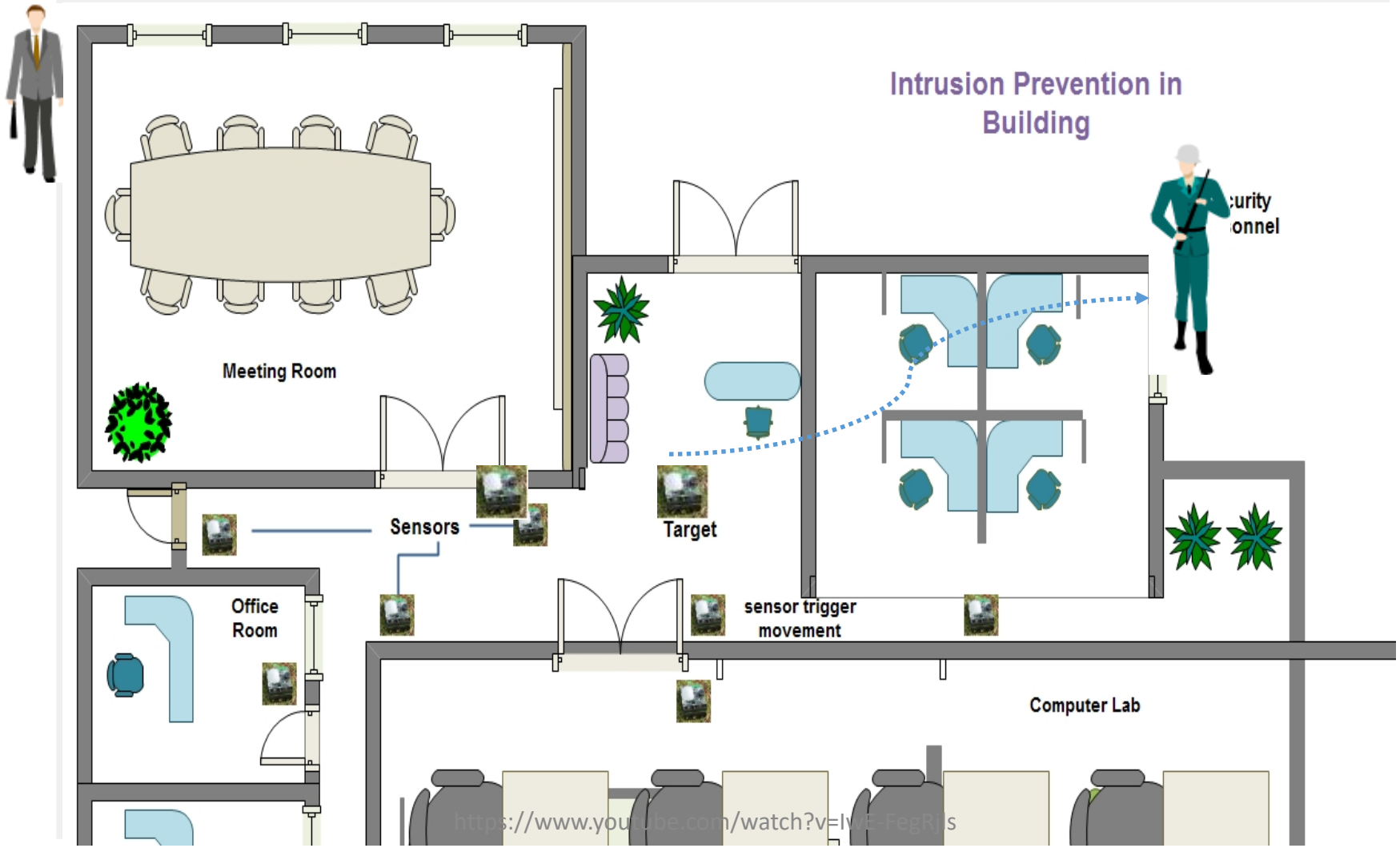


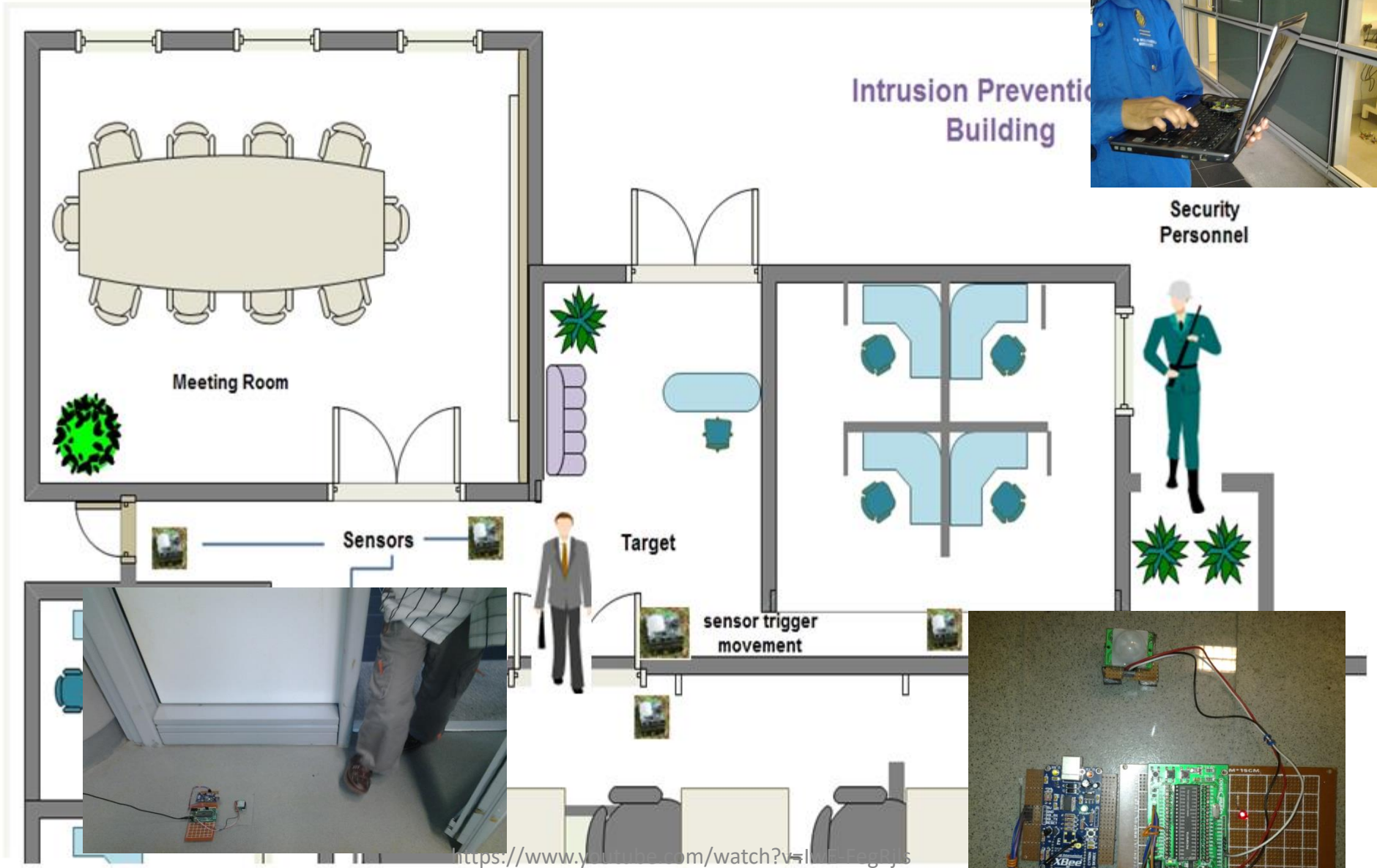
1. Intelligent City

2. Illegal immigration detection

https://www.youtube.com/watch?v=IwE-FegRjls

Using in Human Intrusion Detection (A Case Study)




Intrusion Preventio
Building
Meeting Room
Sensors
Target
sensor trigger
movement
Security
Personnel
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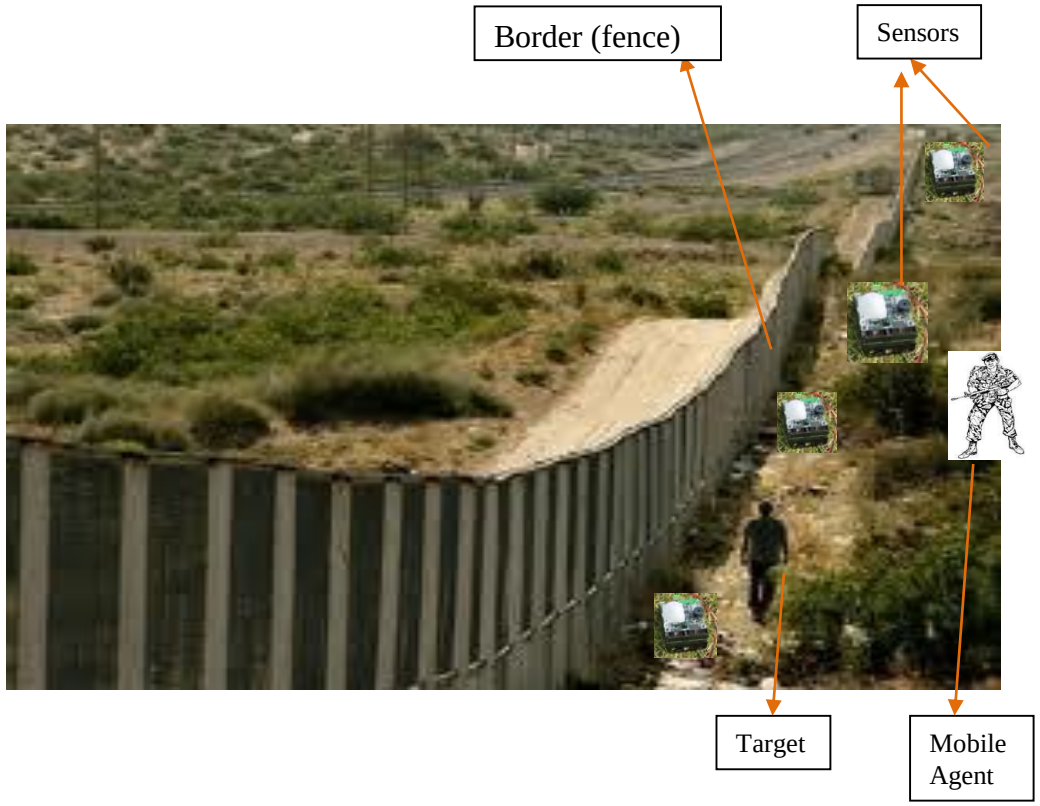
Using in Illegal Immigrant Detection

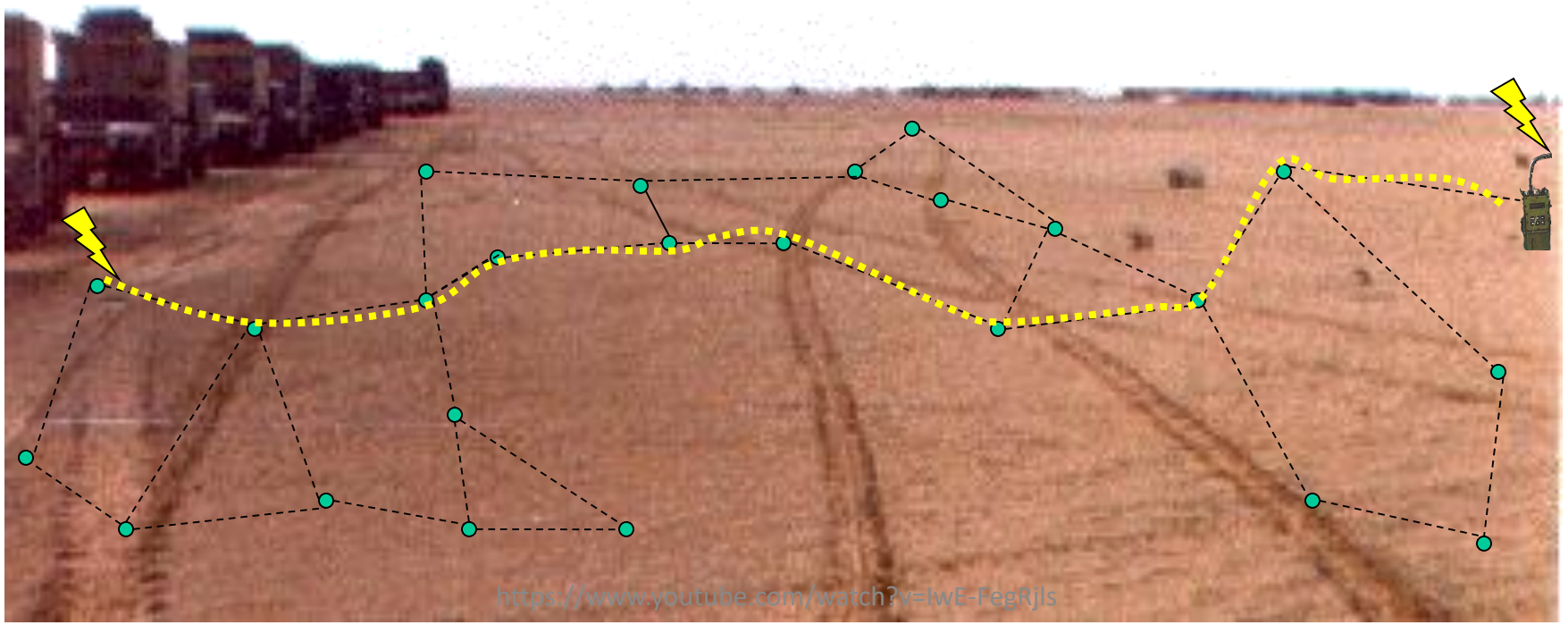


An overview of the prototype for illegal immigration detection

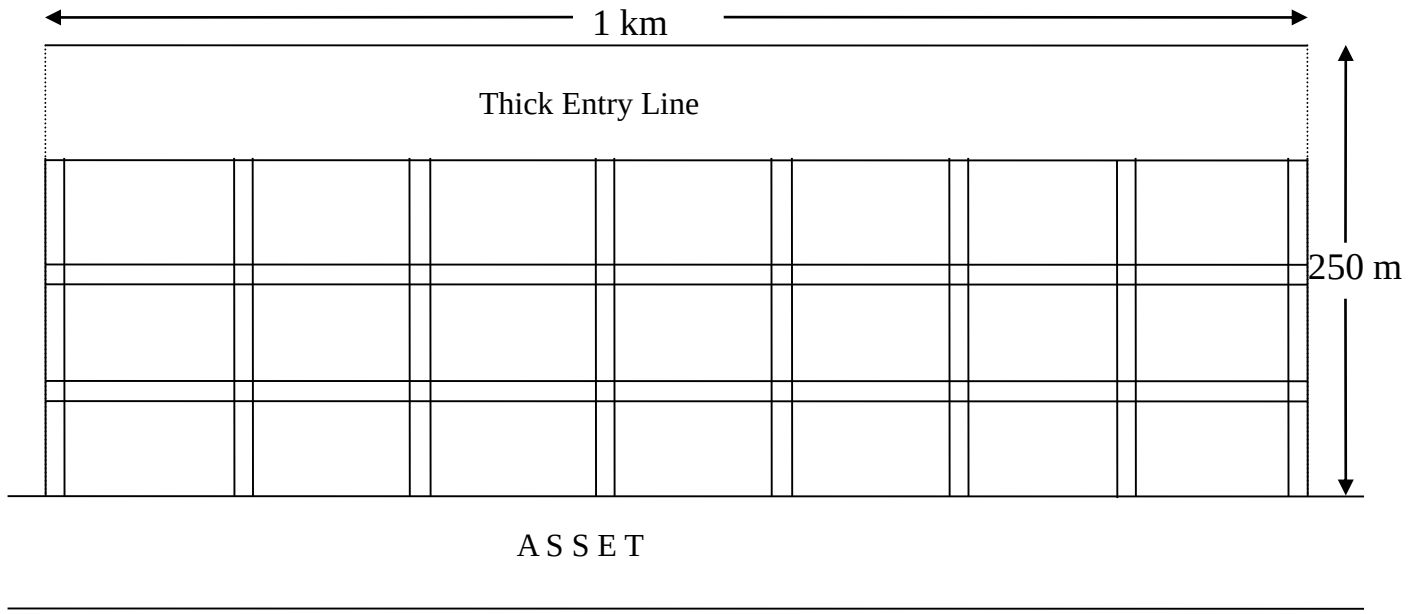
https://www.youtube.com/watch?v=IwE-FegRjls

A Sample Project - Project ExScal

Put tripwires anywhere—in deserts, other areas where physical terrain does not constrain troop or vehicle movement—to detect, classify & track intruders



A Sample Project - Line in the sand Project



- Thick line allows detection & classification as intruders enter the protected region; also allows fine grain intruder localization
- Grid of thin lines allows bounded uncertainty tracking

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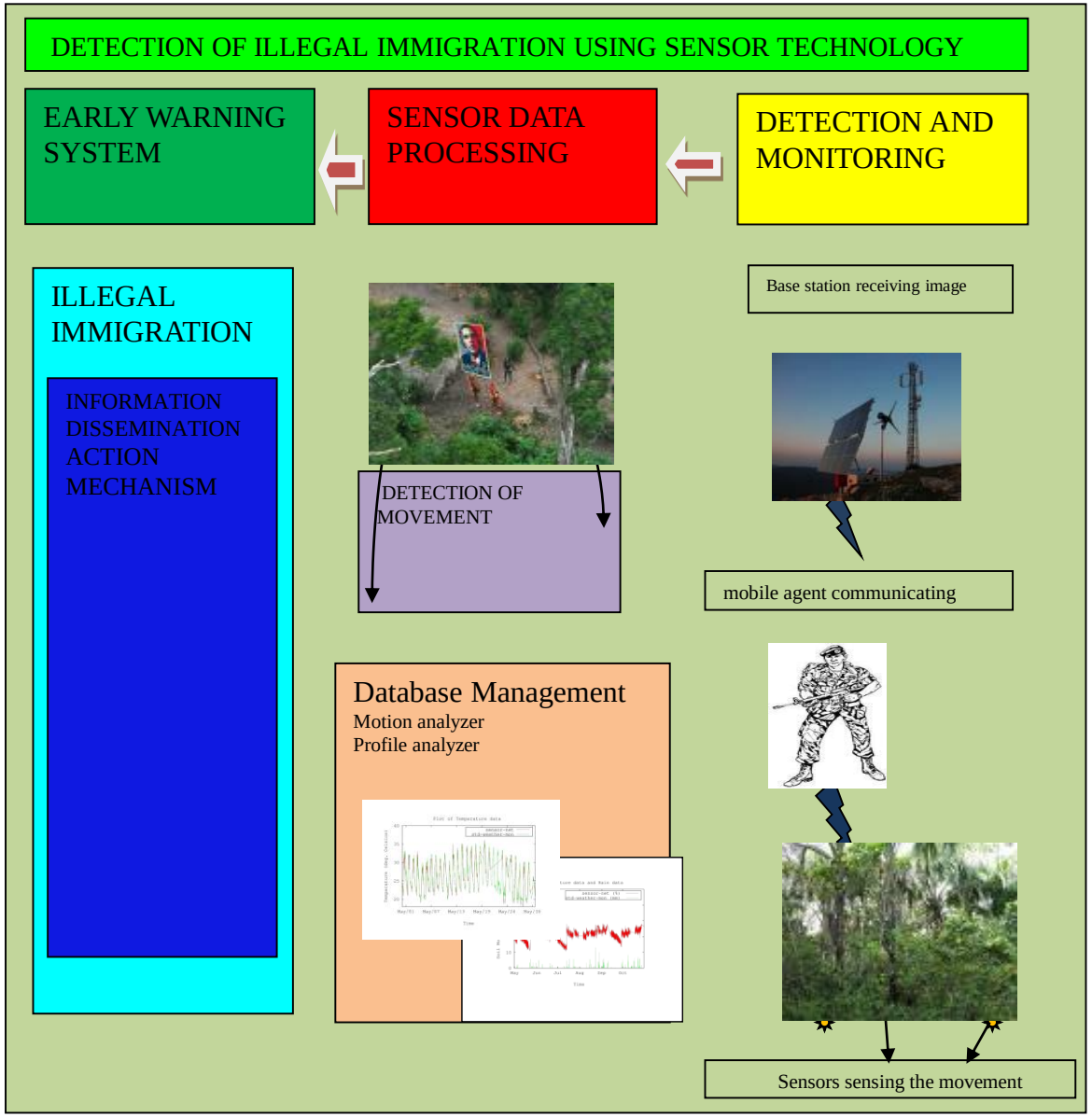

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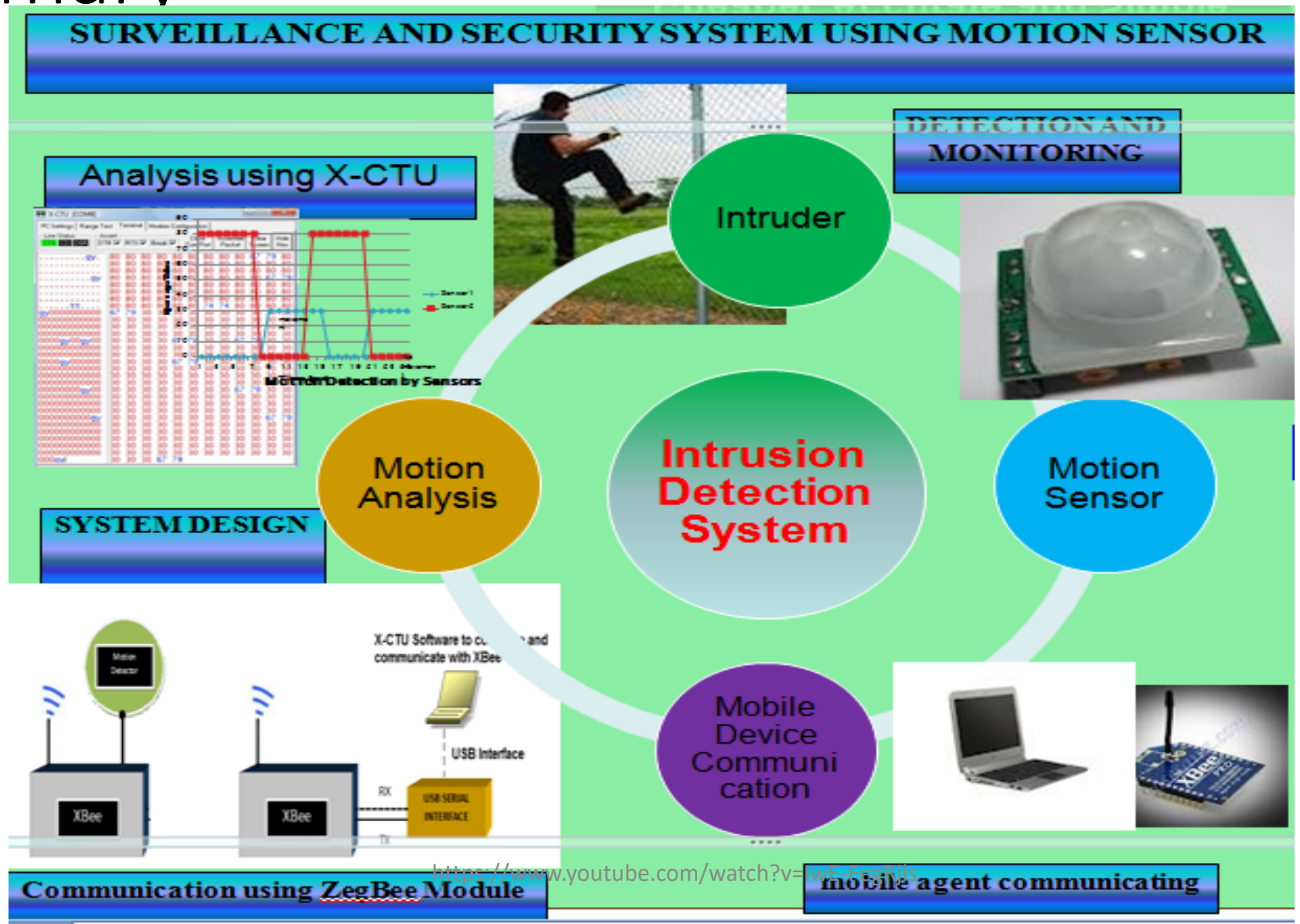
Summary



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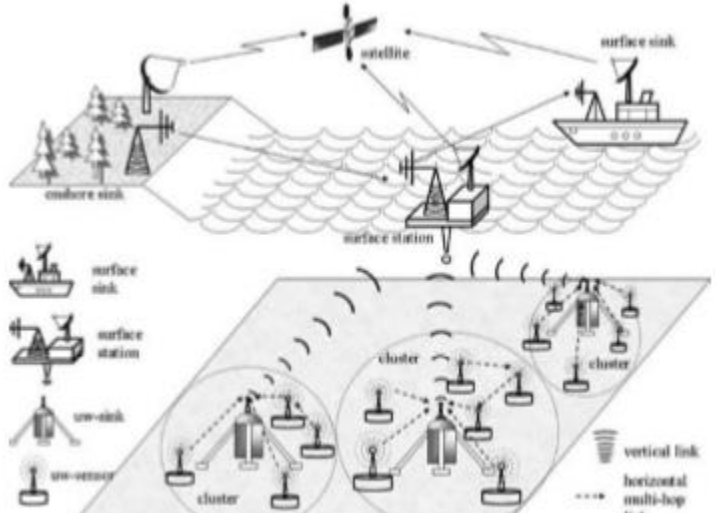
Wireless Underwater Sensor Networks (UWSN)

- Wireless underwater sensor networks (UWSNs) are envisioned to enable applications for a wide variety of purposes such as oceanographic data collection, pollution monitoring, offshore exploration, disaster prevention, assistednavigation,andtacticalsurveillance
- https://www.youtube.com/watch?v=QrkqXvlKZYk



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Wireless Underwater Sensor Networks (UWSN)

- No real-time monitoring: The recorded data cannot be accessed until the instruments are recovered, which may be several days, weeks, or months after beginning the monitoring mission. In surveillance or environmental monitoring applications such as seismic monitoring, however, real-time data retrieval is crucial.
- No online system reconfiguration: Interaction between onshore control systems and the monitoring instruments is not possible. This impedes any adaptive tuning of the instruments; nor is it possible to reconfigure the system after particular events occur.
- Nofailuredetection:If failures or misconfigurations occur, itmay not be possible todetect them before the instruments are recovered. This can easily lead to the complete failure of a monitoring mission.
- Limited storage capacity: The amount of data that can be recorded during the monitoring mission by every sensor is limited by the capacity of the onboard storage devices (memories, hard disks).

https://www.youtube.com/watch?v=IwE-FegRjls

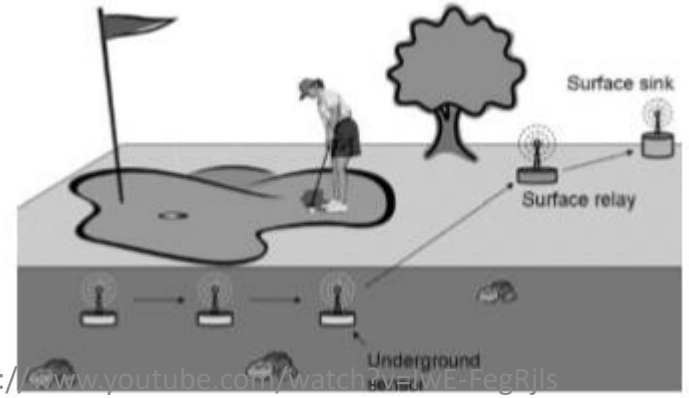
UWSN Challenges

- The available bandwidth is severely limited.
- Propagation delay under water is five orders of magnitude higher than that in RF terrestrial channels and extremely variable.
- The underwater channel is severely impaired, especially because of multi-path and fading problems.
- High bit error rates and temporary losses of connectivity (shadow zones) can be experienced due to the extreme characteristics of the underwater channel.
- Battery power is limited and usually batteries cannot be recharged; also, solar energy cannot be exploited.

https://www.youtube.com/watch?v=IwE-FegRjls

Wireless Underground Sensor Networks

- Wireless underground sensor networks (WUSNs) consist of wireless devices that operate below the ground surface. These devices are either buried completely under dense soil, or placed within a bounded open underground space, such as mines and road/subway tunnels. WUSNs promise to enable a wide variety of novel applications that were not possible with current underground monitoring techniques



https://www.youtube.com/watch?v=WE-FegRjls

Applications

- Environmental Monitoring
- Infrastructure Monitoring
- Location Determination of Objects
- Border Patrol and Security Monitoring

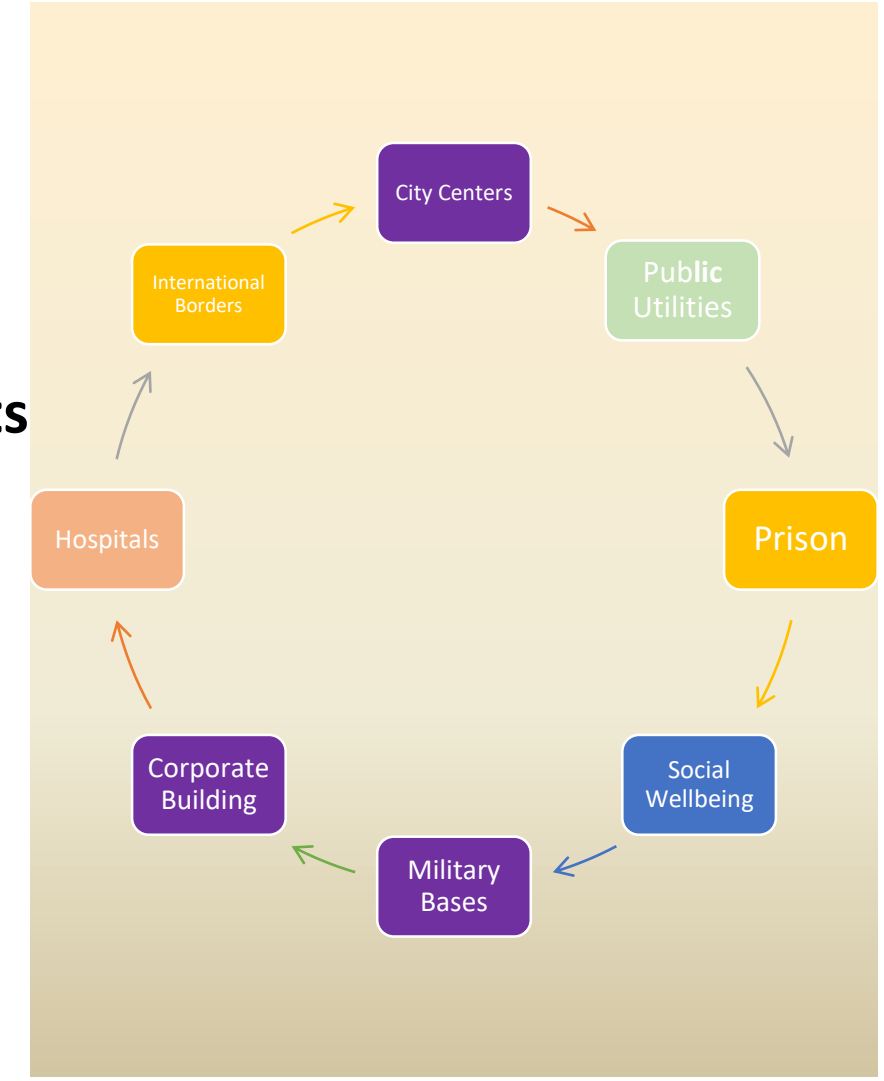
https://www.youtube.com/watch?v=IwE-FegRjls

Design Challenges

- Energy Efficiency
- Topology Design
- Antenna Design
- Environmental Extremes

https://www.youtube.com/watch?v=IwE-FegRjls

Markets



- Vehicle Motion Surveillance System

- Intruder Movement within Premise

- Server/Secured Room Monitoring

Patient Motion Detect

Smart (Home)Surveillance –

using motion sensor – turn on light, trigger alarm

Potential Applications

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