Unit 2
Modern World Approaches Towards Built Environment
(Internet of Things and the 'Smart Concept')

DOMESTIC AND HOME AUTOMATION (SMART HOMES)

Definition
Domestic and home automation refers to the control and integration of household systems such as lighting, heating, ventilation, air conditioning (HVAC), security, and appliances via the Internet of Things (IoT) and automation technologies.

Core Technologies
- *Internet of Things (IoT):* Smart sensors and devices connected over the internet
- *Wireless Communication:* Bluetooth, Zigbee, Wi-Fi, Z-Wave
- *Voice Recognition:* Amazon Alexa, Google Assistant, Apple Siri
- *Mobile Apps:* Apps to control appliances, monitor security, adjust temperature

Components
- *Sensors:* Detect temperature, humidity, gas leaks, motion, light intensity
- *Actuators:* Switches, motors, valves that act based on sensor input
- *Controllers:* Smartphones, remote controls, tablets
- *User Interfaces:* Voice control, touch panels, mobile dashboards

Applications
- *Lighting Automation:* Lights switch ON/OFF based on motion, time, or daylight
- *Climate Control:* Smart thermostats regulate HVAC based on user preferences and weather
- *Security Systems:* Door sensors, CCTV, alarm systems, biometric locks
- *Appliance Control:* Timed coffee makers, smart ovens, robotic vacuum cleaners
- *Utility Monitoring:* Smart meters for electricity, gas, water

Intrusion Detection System (IDS)
Used for detecting unauthorized access:
- *Signature-based IDS:* Compares with known threats
- *Anomaly-based IDS:* Detects deviations from typical behaviour

Advantages
- Convenience, comfort, and remote access
- Energy efficiency and cost reduction
- Safety and intrusion detection
- Elderly and disability assistance

SMART CITIES

Definition
A smart city uses information and communication technology (ICT) and Internet of Things (IoT) to manage resources efficiently and offer improved services to residents. It integrates digital technology with urban

planning to enhance infrastructure, mobility, public services, and environment.

Features

- Sustainable development
- Digital governance
- Automated public utilities
- Intelligent transport systems

Key Smart City Applications

1. Smart Parking:

- Sensors detect vacant parking spaces
- Real-time data shared via mobile apps
- Reduces time spent on parking search, fuel usage, and congestion

2. Structural Health Monitoring (SHM):

- Uses sensors to detect strain, cracks, vibration, and tilt in infrastructure (bridges, buildings)
- Alerts during earthquake, overload, or wear and tear
- Ensures preventive maintenance

3. Noise Urban Mapping:

- IoT microphones record real-time sound levels
- GIS maps noise levels across city zones
- Helps draft policies for zoning, construction regulations

4. Electromagnetic Field Detection:

- Monitors radiation from telecom towers, transformers
- Assesses human health impact
- Creates electromagnetic field safety zones

Typical Sources of Electromagnetic Fields		
Frequency Range	**Frequencies**	**Some Examples of Exposure Sources**
Static	0 Hz	Video display units; MRI (medical imaging) and other diagnostic or scientific instrumentation; industrial electrolysis; welding devices
ELF [Extremely Low Frequencies]	0-300 Hz	Power lines; domestic distribution lines; domestic appliances; electric engines in cars, trains and tramways; welding devices
IF [Intermediate Frequencies]	300 Hz - 100 kHz	Video display units; anti-theft devices in shops; hands-free access control systems, card readers and metal detectors; MRI; welding devices
RF [Radio Frequencies]	100 kHz - 300 GHz	Mobile telephones; broadcasting and TV; microwave ovens; radar and radio transceivers; portable radios; MRI

5. Smart Lighting:

- LED lights controlled via apps or sensors
- Operate on motion detection or daylight sensors
- Reduce energy consumption and light pollution

6. Smart Roads:

- Solar-powered surfaces
- Glow-in-the-dark paint

- Lane monitoring, real-time speed adjustment
- Wireless vehicle charging lanes
- AI-based traffic rerouting

Benefits
- Improved governance and transparency
- Efficient use of resources
- Enhanced quality of urban life
- Lower operational costs for municipalities

SMART ENVIRONMENT

Definition

A smart environment is equipped with sensors, embedded systems, and computing to monitor, analyse, and manage environmental variables in real-time. It aids in sustainability, disaster prevention, and pollution control.

Applications

1. Forest Fire Detection:
- IoT temperature and smoke sensors
- Drones for aerial surveillance
- Early alerts reduce loss of life and property

2. Air Pollution Control:
- Continuous air quality monitoring (PM2.5, PM10, CO2)
- Automated ventilation control in smart buildings
- Pollution-responsive traffic and industry regulation

3. Snow Level Monitoring:
- Infrared/ultrasonic sensors to measure rooftop and street snow
- Prevents structural overload and collapses

4. Landslide & Avalanche Prevention:
- Tiltmeters, piezometers monitor soil and slope movement
- AI-based prediction of slope failure
- Smart barriers, ground anchors

5. Earthquake Early Detection:
- Seismometers detect P-waves (faster, harmless)
- Sends warning before damaging S-waves
- Integrated with metro, hospitals, and emergency services

Technologies Used
- Wireless Sensor Networks (WSN)
- Geographic Information Systems (GIS)
- Machine Learning and AI
- Cloud-based analytics

SMART WATER MANAGEMENT

Definition

Smart water technologies optimize the collection, treatment, distribution, and monitoring of water through real-time data and automation.

Key Systems

1. Potable Water Monitoring:
- IoT sensors detect turbidity, pH, chlorine, contaminants
- Alerts in case of contamination

2. Chemical Leakage Detection:
- Detects leakage in chemical pipelines (chlorine, ammonia)
- Prevents contamination of drinking water

3. Swimming Pool Measurement:
- Smart controllers balance pH, chlorine, and temperature
- Automatic filtration based on usage

4. Water Leakages:
- Smart meters detect pressure drops
- Identify hidden leakages in underground lines
- Use of acoustic monitoring, flow imbalance

5. River Flood Monitoring:
- River level gauges send alerts to authorities
- Flood mapping via GIS tools
- Real-time public alert systems

Benefits
- Conservation of water
- Safe drinking supply
- Disaster prevention
- Cost reduction in maintenance

SMART METERING

Definition

Smart metering uses digital meters and sensors to track real-time usage of utilities (electricity, gas, water) with remote access and analytics.

Applications

1. Smart Grid:
- Dynamic demand-response system
- Prevents overload and outages
- Integrates with solar, wind energy
- Detects faults instantly

2. Tank Level Monitoring:
- Used for water, fuel, oil, chemicals
- Alerts for overflows or shortages
- Prevents industrial accidents

3. Water Flow Monitoring:
- Measures flow velocity and pressure
- Detects blockages or unauthorized usage
- Optimizes supply distribution

Advantages
- Transparent billing
- Reduced losses and theft
- Efficient utility distribution
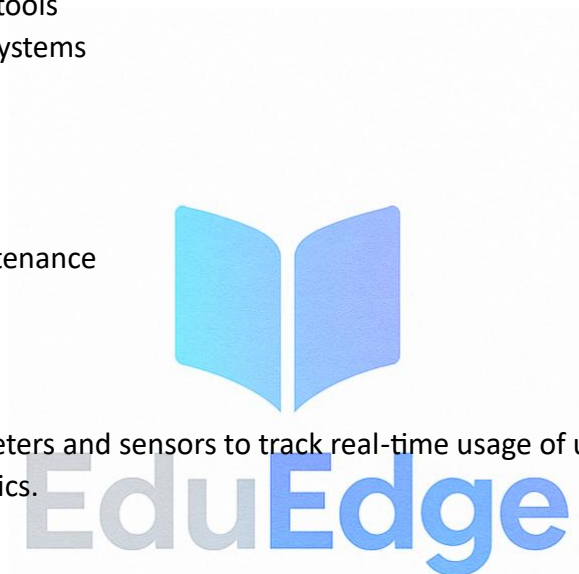
- Real-time analytics for consumers and suppliers

SECURITY AND EMERGENCY MANAGEMENT

Purpose
Technology-enhanced monitoring and response to secure facilities and handle emergencies promptly.
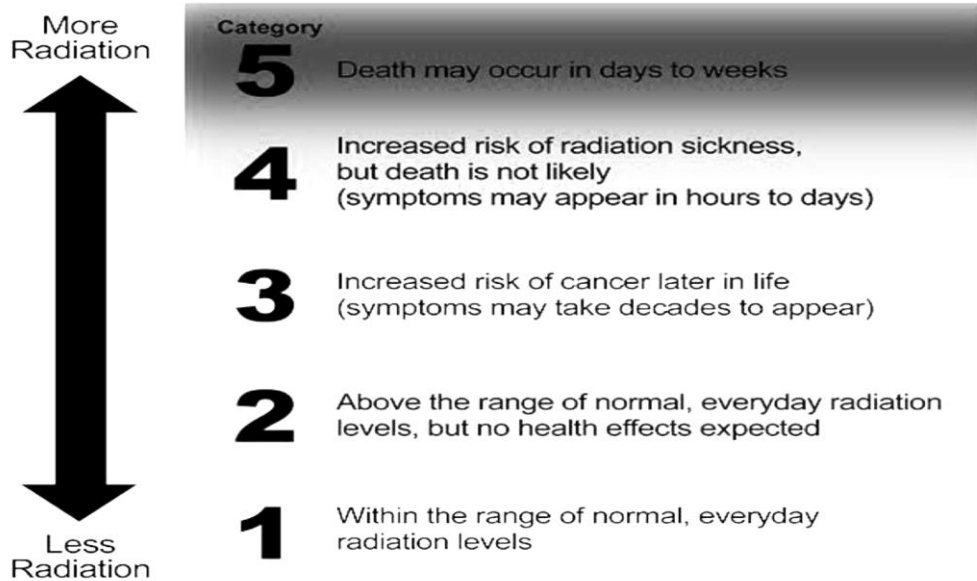
Major Systems

1. Perimeter Access Control:
- Keypads, RFID cards, biometric readers
- Turnstiles, boom barriers, geofencing

2. Liquid Presence Detection:
- Detects presence of unwanted fluids in data centres, labs
- Sensors detect conductive liquids and raise alarms

3. Radiation Detection:
- EMF and radioactive leak monitoring
- Sensors calibrated to categories (0–5)
- Safety thresholds predefined

4. Gas Leak Detection:
- Sensors for CO, CH4, NH3, H2S
- Integrated exhaust fans, alarms, and shutoff valves
- Applications: Hospitals, chemical plants, mining

Features
- SMS/email alerts
- Cloud-based dashboards
- Integration with emergency services
- Evacuation support and simulation

SMART RETAIL SYSTEMS

Definition
Smart retail integrates IoT, AI, and cloud computing to streamline operations, enhance customer experience, and monitor inventory in real-time.

Key Innovations

1. Supply Chain Monitoring:

- RFID and barcode scanners track product movement
- Prevent theft, loss, and spoilage
- Real-time tracking for logistics

2. NFC-Based Payments:

- Quick, secure contactless payments
- Digital wallets (Google Pay, Apple Pay)
- Reduces queues and touchpoints

3. Product Management:

- Smart shelves detect low inventory
- Sensors monitor temperature and humidity
- AI recommends restocking and layout optimization

Benefits

- Enhanced customer satisfaction
- Reduced operational costs
- Real-time inventory transparency
- Improved marketing and personalization