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Internet of Things

Unit 1 - Fundamentals

NCI | Lárionad Néal-Inniúlachta Cloud Competency Centre

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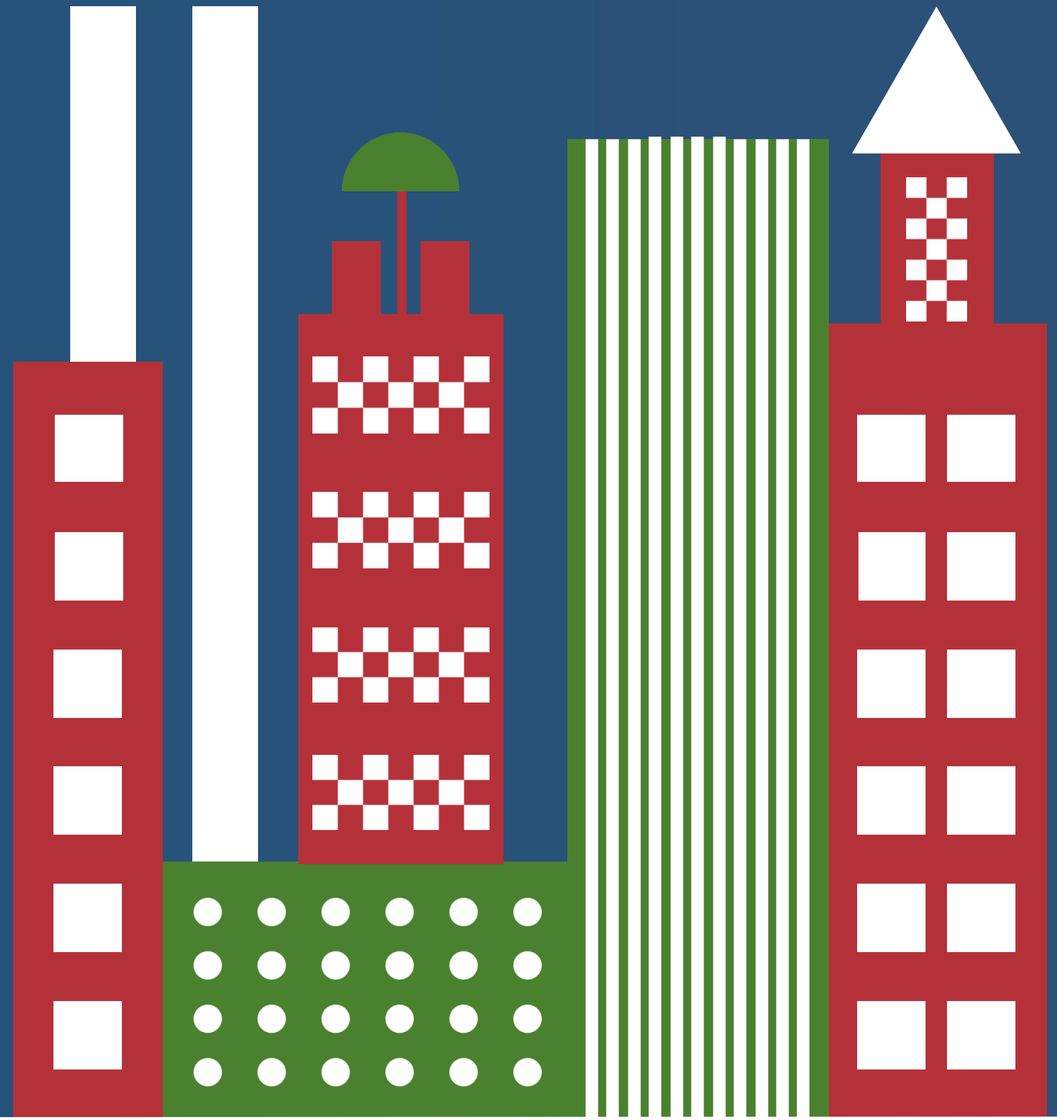

Unit 1: IoT Fundamentals

- Introduction to IoT
- Historical Development
- Key Concepts
- Applications Across Industries
- Challenges in IoT

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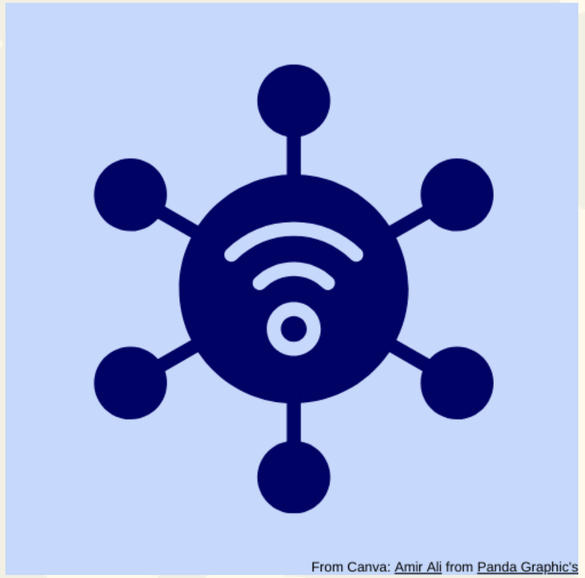
What is Internet of Things?

The term internet of things refers to a network of physical devices designed for specific tasks. They are either connected to the internet or other communication networks. These devices need varying levels of computational power, but typically use the lower end of the scale. They have embedded sensors and software and other technologies which collect and exchange data. This data enables them to communicate with applications and each other. Examples of IoT include Smart home devices (Smart Ovens, Smart Thermostats, Smart Security systems), Wearable Heath devices, etc.



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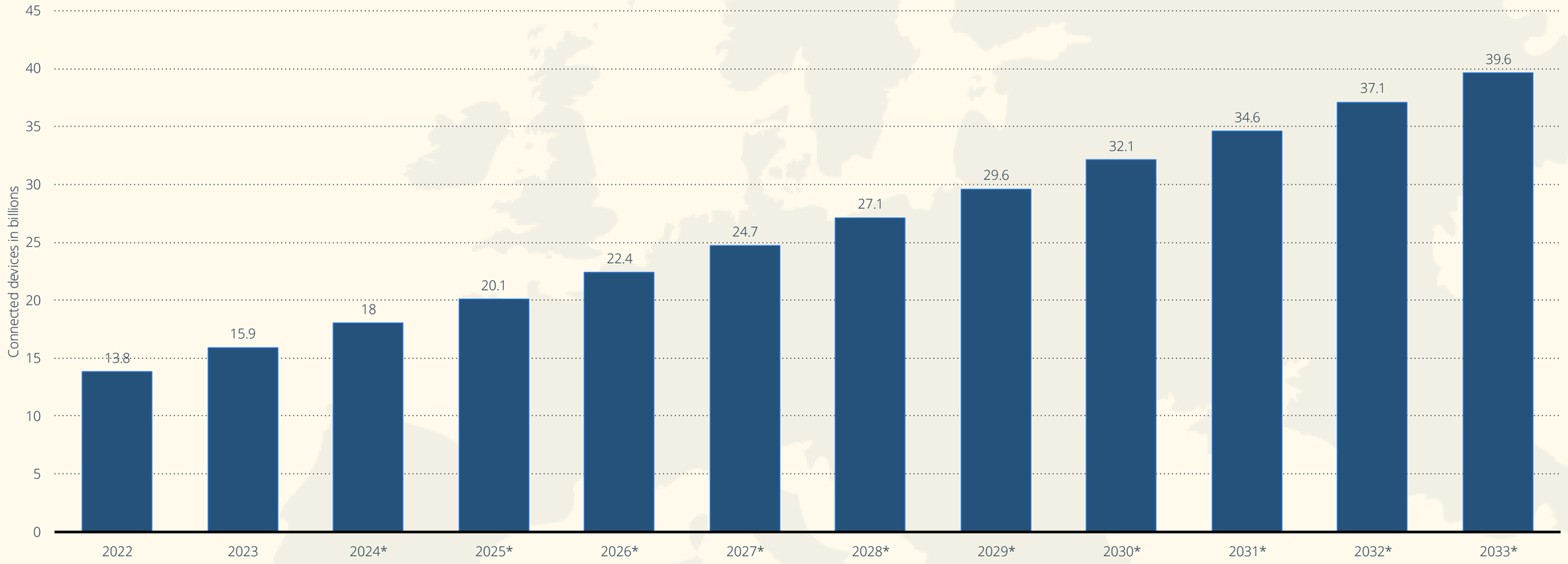
Number of Internet of Things (IoT) connections worldwide from 2022 to 2023, with forecasts from 2024 to 2033 (in billions)

Number of IoT connections worldwide 2022-2033, with forecasts to 2030



Note(s): Worldwide; 2024
Source(s): Transforma Insights; Exploding Topics; ID 1183457

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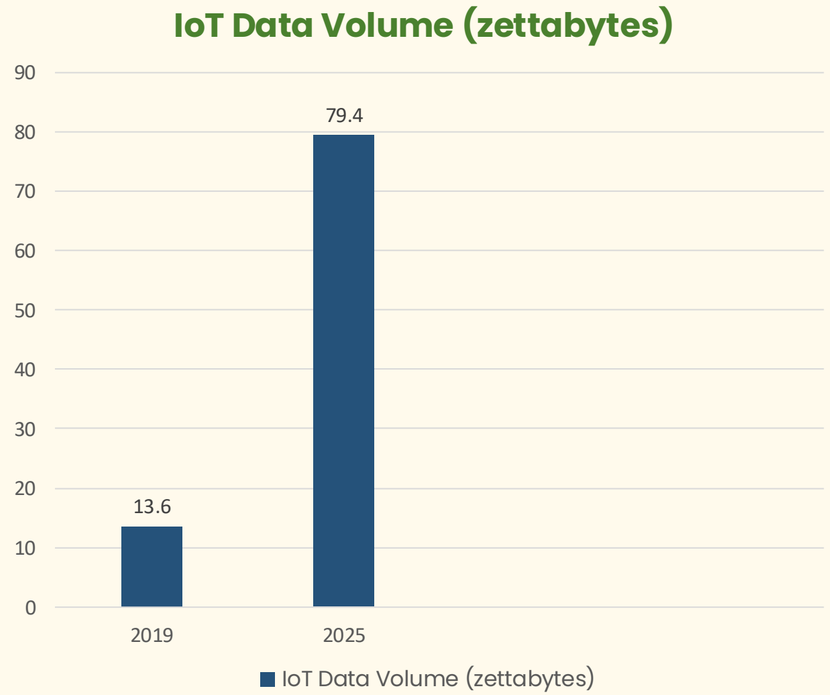
Data From IoT

According to IDC (2020) 13.6 zettabytes of data came from IoT devices in 2019 and they have projected that by 2025 the data volume will reach 79.4 zettabytes. To put this in perspective, 1 zettabyte is 1 Billion Terabytes.

Other interesting stats include:

- ✓ 130 million Households have at least one IoT device in their homes (Armstrong, 2022)
- ✓ By 2024 world Revenue from IoT is expected to reach €878.60bn (Statista, 2024)
- ✓ Top 5 Countries which gain most revenue from IoT:
  - United States
  - China
  - Germany
  - Japan
  - India



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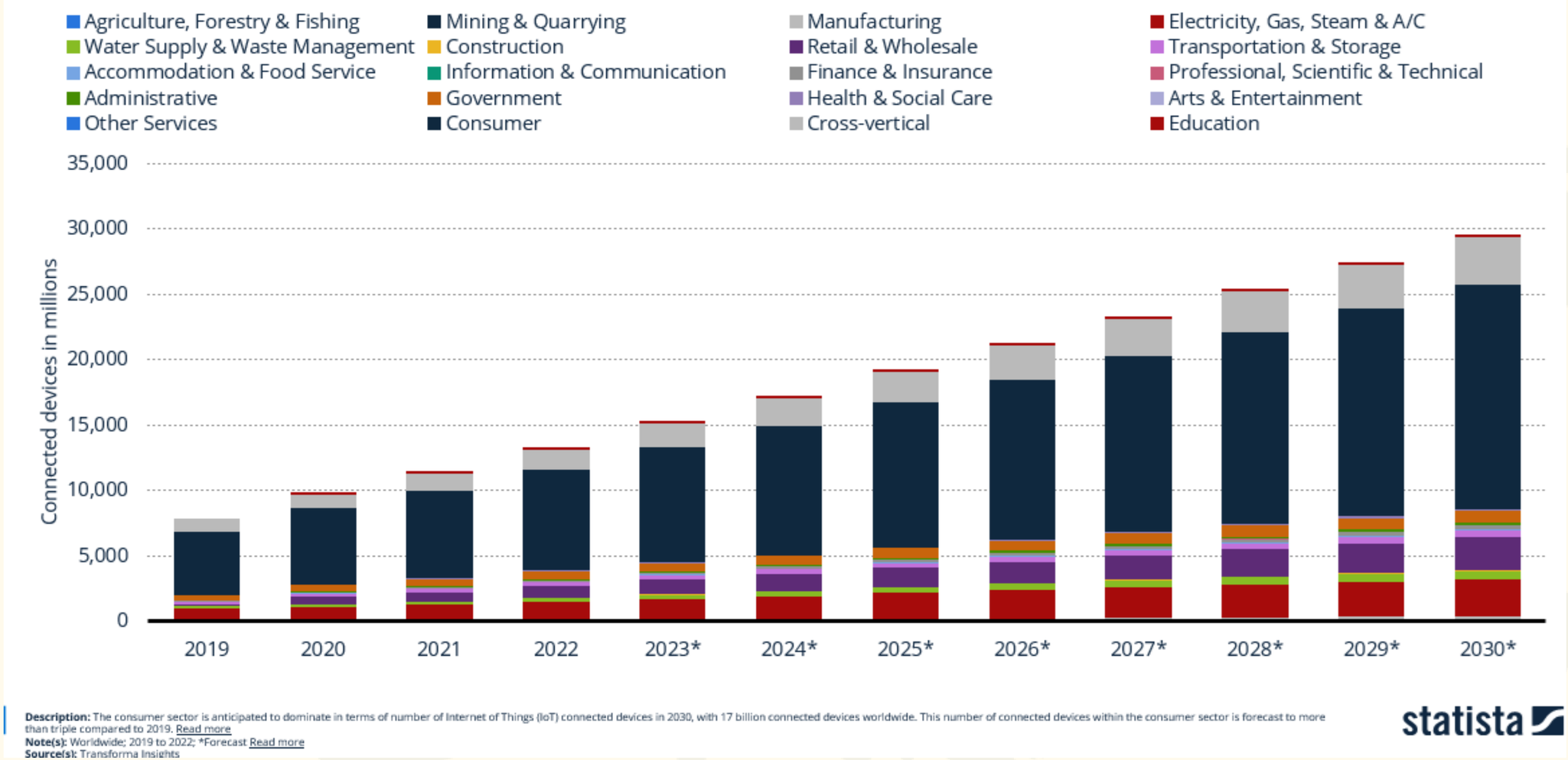
Number of Internet of Things (IoT) connected devices worldwide from 2019 to 2030, by vertical (in millions)



Description: The consumer sector is anticipated to dominate in terms of number of Internet of Things (IoT) connected devices in 2030, with 17 billion connected devices worldwide. This number of connected devices within the consumer sector is forecast to more than triple compared to 2019. Read more
Note(s): Worldwide; 2019 to 2022; *Forecast Read more
Source(s): Transforma Insights

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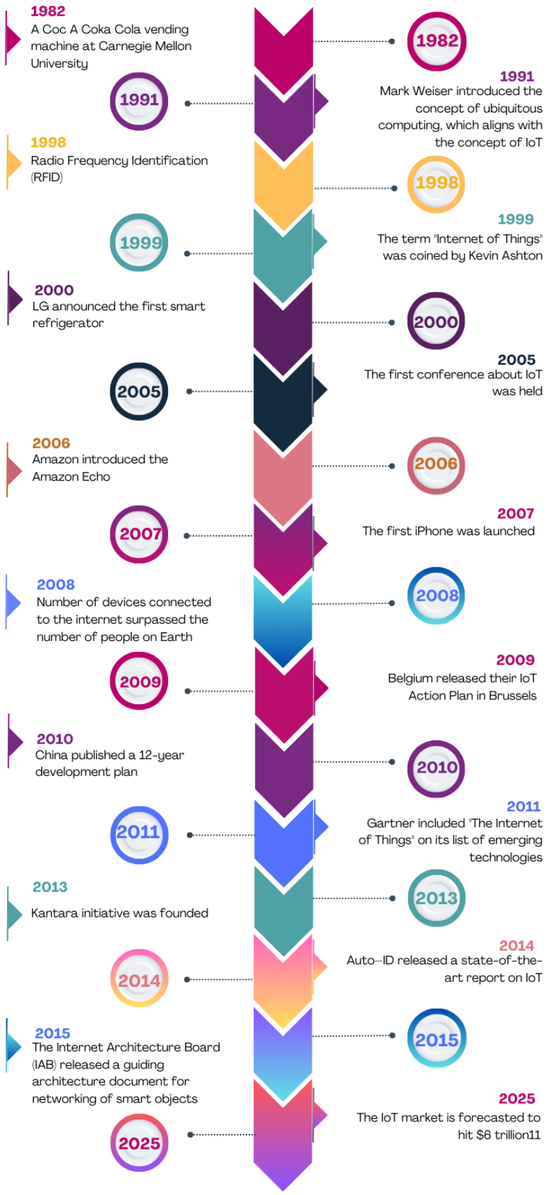
IoT's Historical Development Timeline



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Key Features of IoT

1

Interconnectivity: Connecting devices to the internet for seamless communication.

2

"Things": Physical or virtual objects with unique identifiers that collect and share data.

3

Unique Identification: Essential for remote monitoring and control via IP addresses or similar identifiers.

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Core Functions of IoT

Sensing and Actuation: Sensors collect environmental data. Actuators enable devices to respond or take action autonomously.

Communication: Data exchange via technologies like Wi-Fi, Bluetooth, or Ethernet.

Data Collection and Analysis: Data processed locally or in the cloud for optimisation, efficiency, and user experience enhancement.

Intelligence and Autonomy: Devices can act on data using AI/ML without human intervention.

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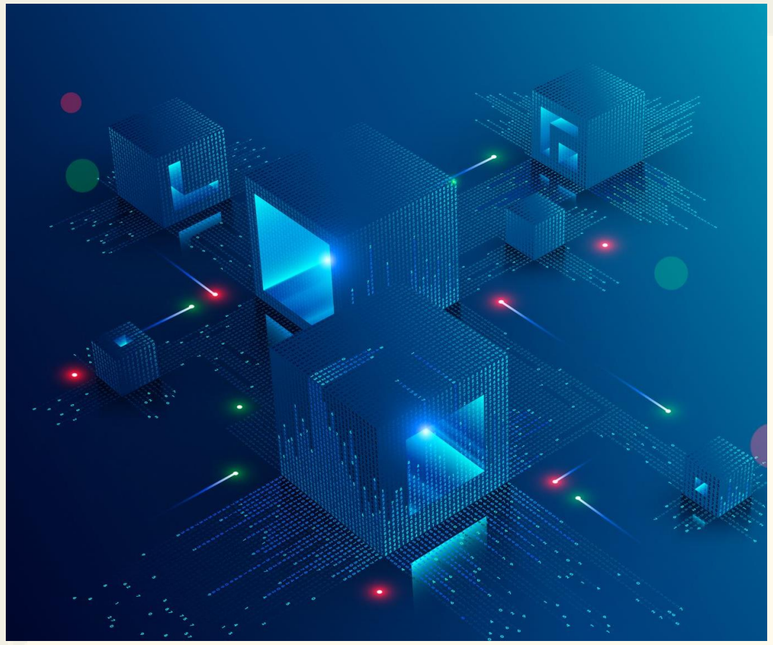
Principles of IoT Ecosystem

The Building Blocks of IoT Ecosystem include:

- **Interoperability:**
  Devices and services share data across various technologies and standards.
- **Scalability:**
  Designed to handle increasing devices and data loads.
- **Ubiquity:**
  Devices are connected anytime, anywhere.
- **Heterogeneity:**
  Diverse devices and networks form the ecosystem.
- **Security:**
  Critical to prevent data breaches and unauthorised access.



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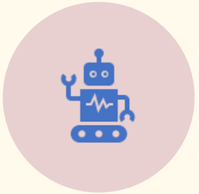
Supporting Technologies in IoT



Machine-to-Machine (M2M) Communication: Automation of data exchange between devices.

Cloud Computing: Provides storage and processing for IoT data.

Fog and Edge Computing: Processes data closer to devices for low latency.

Wireless Sensor Networks (WSNs): Networks of distributed sensors collecting environmental data.

Smart Objects: Objects enhanced with intelligence and remote monitoring capabilities.

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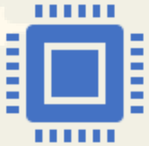
General Applications for IoT

Optimisation & Efficiency: Streamlining processes, reducing costs, and improving operations.

Data Collection & Analysis: Gathering and analysing real-time data to make informed decisions.

Automation & Control: Devices automatically respond to real-time data for enhanced efficiency.



Monitoring & Control: Real-time monitoring of systems and environments.

Enhanced User Experience: Personalised, timely services for better customer satisfaction.

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Key Consumer Applications

Smart Homes: Control lighting, appliances, security, and climate via a single device.

Wearables: Fitness trackers, smartwatches, and health monitors enable real-time tracking and insights.

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Business & Government Applications

IoT in Business & Public Sector can include:

- **Business Applications**
  - **Industrial Automation:** Monitor equipment, predict maintenance, and optimise production.
  - **Supply Chain Management:** Track goods and optimise logistics with IoT sensors.
  - **Retail:** Automated scanning, express shopping, and optimised checkouts.
- **Governmental Applications**
  - **Smart Cities:** Traffic, waste, energy, and public safety management.
  - **Environmental Monitoring:** Pollution tracking, wildlife monitoring, and disaster alerts.

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Other Key Industry Applications

Healthcare

- **Patient Monitoring:** Track health metrics remotely and in real-time.
- **Remote Care:** Provide access to healthcare services while reducing costs.

Agriculture

- **Smart Farming:** Monitor environmental conditions and manage resources for higher yields.
- **Livestock Monitoring:** Track animal health via wearable sensors.

Transportation

- **Intelligent Transport Systems:** Optimise movement of people and goods.
- **Connected Vehicles:** Communication between vehicles and infrastructure for safety and efficiency.

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Emerging Applications and Innovations

Smart Villages: IoT in rural development for e-governance and smart farming.

Smart Grids: Managing energy flow and enabling sustainable energy solutions.

Waste Management: Monitoring container fill levels for timely disposal.

Smart Parking: Real-time information on parking availability to reduce congestion.

Semantic IoT: Advanced applications in annotation, metadata, and knowledge sharing.

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Challenges in IoT

- **Broad Challenges:**
  - Technical, security, ethical, and economic considerations.
  - Addressing these requires collaboration across research, business, and policy domains.
- **Key Focus Areas:**
  - Technical Challenges
  - Security & Privacy Challenges
  - Ethical & Social Challenges
  - Economic & Business Challenges

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Technical Challenges in IoT

Interoperability:	Lack of unified standards for hardware, networks, and communication protocols.
Scalability:	Managing vast numbers of devices and data.
Data Management:	Efficiently storing, processing, and integrating heterogeneous data.
Energy Efficiency:	IoT devices often have limited power and storage.
Connectivity:	Ensuring reliable networks for diverse devices and environments.

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Security & Privacy Challenges

- **Security Vulnerabilities:** Lack of built-in security features in devices.
- **Increased Attack Surface:** More connected devices create more opportunities for breaches.
- **Data Breaches:** Vulnerability of sensitive data to theft.
- **Privacy Concerns:** Personal data exposure without user consent.
- **Authentication & Authorisation:** Securing connections and preventing unauthorized access.

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Ethical, Social, and Economic Challenges

Ethical & Social Challenges:

- Surveillance concerns and transparency in IoT operations.
- Consumer trust erosion due to ethical lapses.

Economic Challenges:

- Cost-sharing among stakeholders.
- Viable business models for IoT services.
- Market fragmentation due to lack of standardisation.

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Addressing IoT Challenges

Collaboration:

- Researchers, businesses, and policymakers must work together.

Focus Areas:

- Develop secure, reliable, and ethical IoT systems.
- Invest in training and technical expertise.
- Encourage the adoption of unified standards.

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Unit Completed - What's Next?

To consolidate your learning and reflect on the key concepts covered, please take a moment to complete this quiz.

Your feedback and results will help you track your progress and support continuous improvement of the training experience.

By completing this quiz, you will also become eligible to receive a certificate of successful training completion.

Click the link to begin the quiz!

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