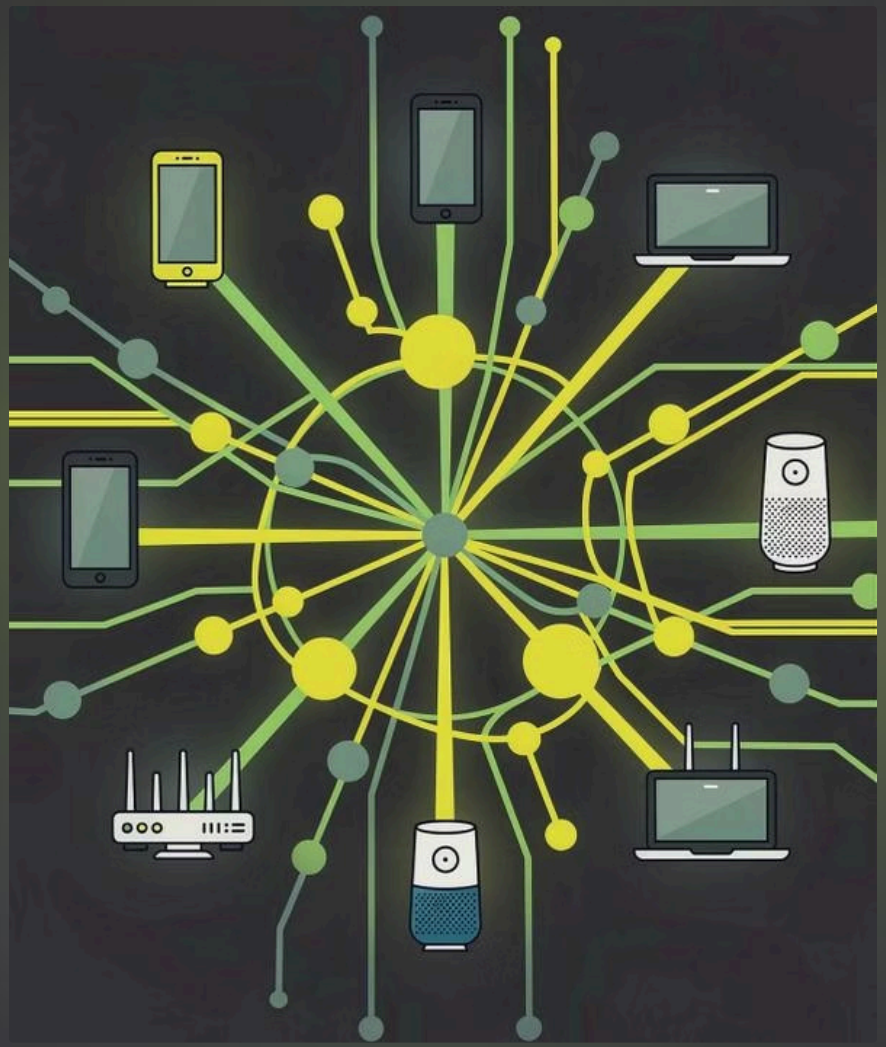
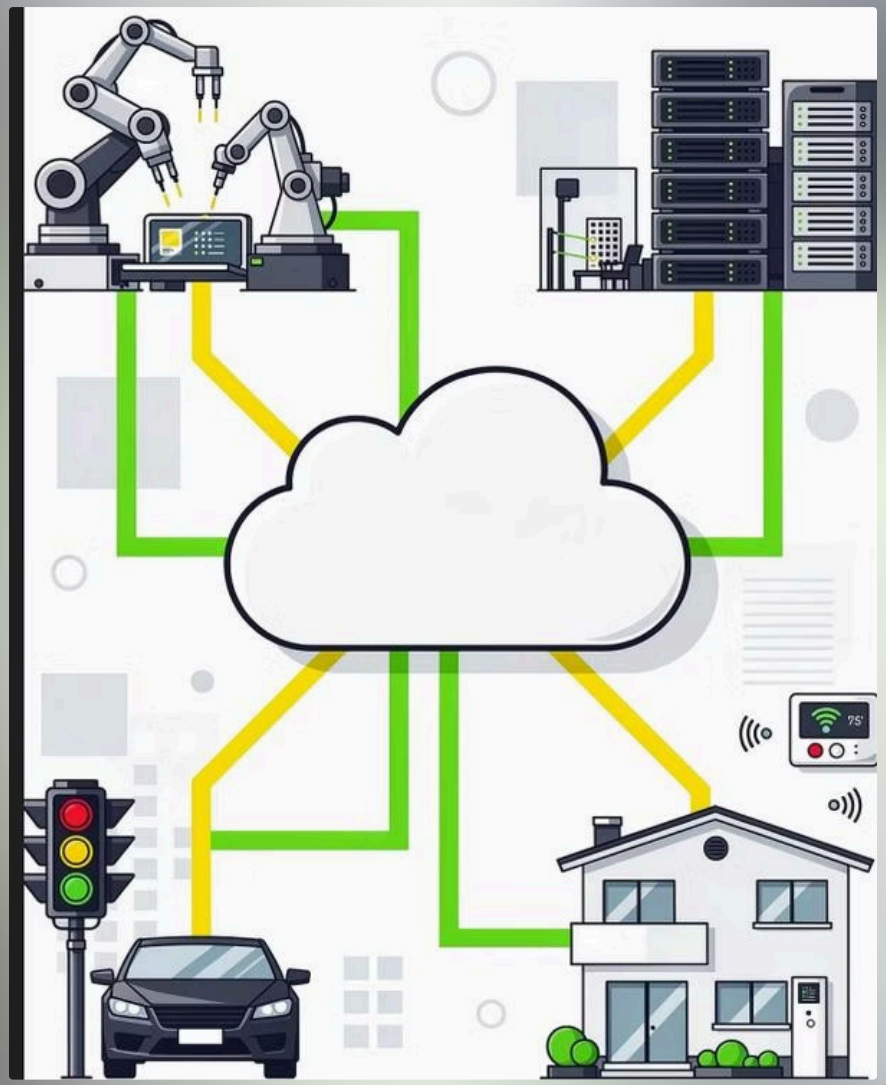


Internet of Things Projects

A comprehensive study guide covering the technical, implementation, and strategic aspects of the IoT ecosystem — from hardware fundamentals to real-world deployments.



Internet of Things: From Vision to Reality

IoT is no longer a futuristic concept — it is an integral part of industrial production, urban management, and modern lifestyles. Physical objects equipped with electronic components and network connectivity become active participants in the digital ecosystem.

These devices generate enormous volumes of data, processed at the network edge or in the cloud to provide critical real-time insights. The sector is driven by falling sensor costs, expanding 5G networks, and the integration of artificial intelligence into analytics layers.

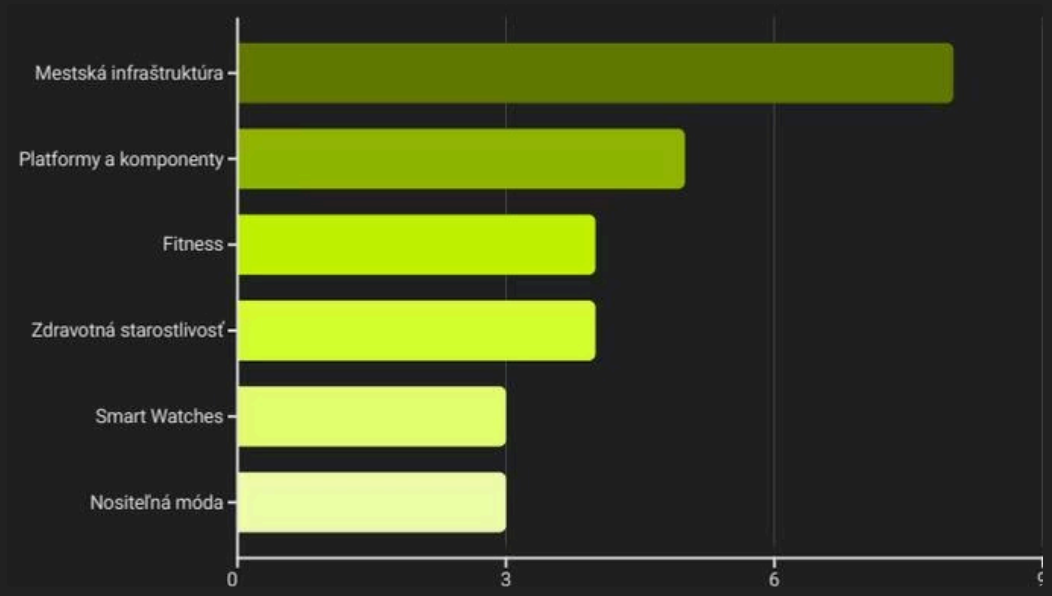
Global IoT Market Landscape

Key Market Categories

The IoT market is fragmented into **15 major categories** defining investment and innovation direction:

- **Home Automation** — highest number of firms, high consumer penetration
- **Health Care** — steady growth driven by aging populations
- **Energy** — pressure for efficiency and sustainability
- **UI Platforms** — highest average funding per company
- **Urban Infrastructure** — most mature segment, median age 8 years

IoT Segment Maturity



Urban Infrastructure leads maturity (~7.5 yrs), while wearable fashion and smartwatches are youngest (~3 yrs). The US dominates global IoT innovation, ahead of the UK and Canada.

IoT Ecosystem in Slovakia

89%

5G Coverage

Operators like O2 reach up to 89% population coverage, creating a robust base for enterprise IoT verticals.

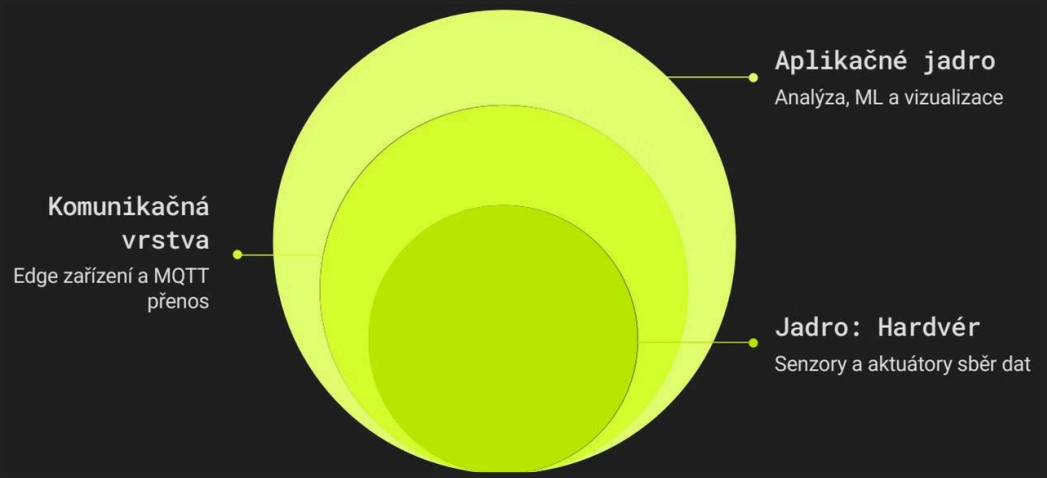
4.35%

CAGR to 2030

Projected annual growth of M2M services in Slovakia, driven by enterprise digital transformation.

Slovakia has the potential to become a regional hub for IoT solutions in smart transport and energy, thanks to its progressive 5G infrastructure and strong tech presence in Košice and Bratislava.

Multi-Layer IoT Architecture



Hardware Layer

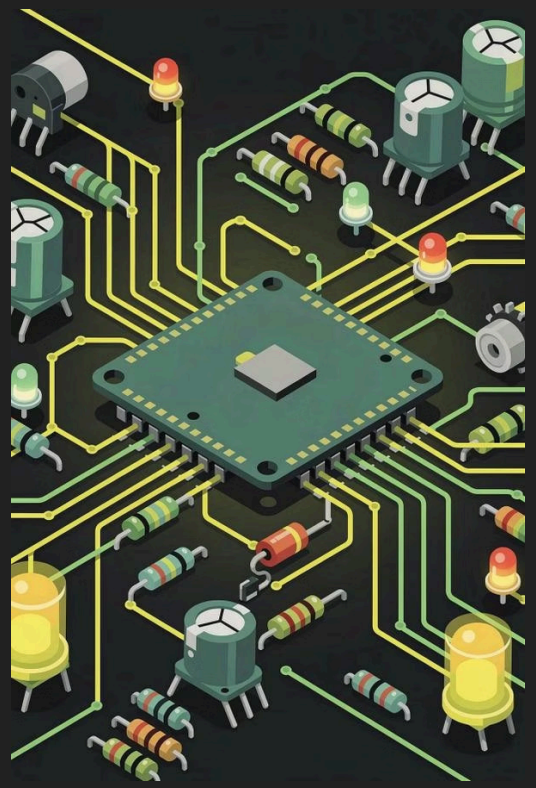
Sensors capture physical variables; actuators execute mechanical changes. Sensors convert non-electrical quantities into electrical signals.

Communication Layer

Ensures secure connectivity between devices and the cloud. Performs edge preprocessing — filtering and aggregation — to conserve energy.

Analytics & Application Layer

Transforms raw data into actionable insights via pattern detection and predictive models. Delivered through dashboards, mobile apps, and reports.



Electronics & Software Fundamentals

Core Electronics Laws

Ohm's Law: $I = U / R$ — essential for sizing resistors to protect components like LEDs.

Power: $P = U \cdot I$ — must be monitored to prevent overheating.

Kirchhoff's Laws: Current sum at a node = 0; voltage drops equal source voltage.

Key Components

- **Passive:** Resistors, potentiometers, photoresistors
- **Active:** Diodes, NPN/PNP transistors as electronic switches
- **ICs:** Millions of components on one chip (e.g., H-bridge L293B for motors)

Software Toolchain

Tool	Domain	Advantage
Arduino IDE	MCU (C++)	Simplicity
Node-RED	Orchestration	Visual debugging
Python/Flask	Backend API	Data science
ThingsBoard	Monitoring	Ready widgets
Blockly	Education	Graphical blocks

Project 1: Occupancy Monitoring System

A smart parking/public space occupancy system integrates sensors, wireless communication, and cloud visualization to provide real-time availability data — **reducing search time by 30%**.

1 2 3

01 Detection Node

ESP32 + HC-SR04 ultrasonic sensor + magnetometer. Wakes every 10 seconds; battery lasts several months.

02 Gateway

Raspberry Pi 4 with Mosquitto MQTT broker collects node messages and forwards them to the cloud.

03 Output

LCD displays and green/red LED indicators on-site; web dashboard for remote access and analytics.

Business Model: Customer segments: parking operators, clinics, malls. Revenue: one-time HW sales + monthly SaaS licenses. Key activities: sensor node development, cloud management, predictive analytics.

Project 2: Smart Home & Early Warning System

Smart Home Energy Management

Beyond remote light control — an autonomous system optimizing energy consumption and resident safety via closed-loop regulation.

- **Relay modules:** Control 230V AC appliances
- **ACS712 current sensor:** Hall-effect measurement
- **PWM regulation:** LED strip dimming
- **DHT22 / PIR sensors:** Temperature, humidity, presence

PID thermostat provides adaptive heating with trend prediction. Python scripts calculate kWh consumption, detect anomalies (e.g., iron left on), and auto-disconnect relays on alarm. ThingsBoard/Flask dashboards visualize energy flows between grid, solar panels, and appliances.

Early Warning Notification System

Low-cost, highly reliable solution for rural areas and industrial warehouses using LoRa protocol for multi-kilometer range.

Fire Detection

TMP36 temperature sensor + gas/smoke sensor combination

Flood Detection

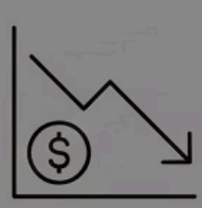
Capacitive soil moisture sensor + float switches for overflow indication

Structural Integrity

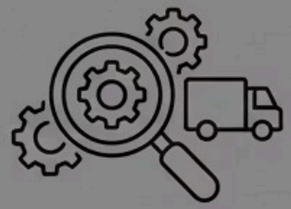
Accelerometers detect dangerous vibrations in industrial equipment and buildings

IoT SWOT Analysis

STRENGTHS

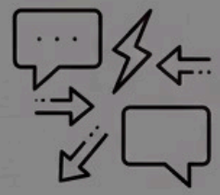


COST REDUCTION
Reduces Op Costs
20-40%



VISIBILITY
Real-time production & logistics visibility

WEAKNESSES



FRAGMENTATION
Fragmentation of communication protocols

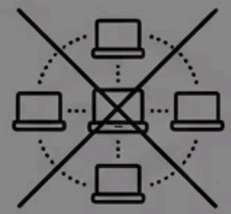
VULNERABILITY
High vulnerability of low-cost devices

OPPORTUNITIES

MARKET EXPANSION
expansion in telemedicine & Smart City

CONNECTIVITY GROWTH
satellite IoT connectivity growth

THREATS



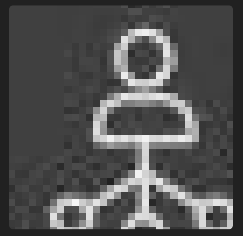
CYBERATTACKS
botnet cyberattacks (e.g. Mirai)

SPECIALIST SHORTAGE
shortage of qualified specialists

MoSCoW Prioritization: Must have: basic connectivity, security. **Should have:** OTA updates, historical graphs. **Could have:** meteorological data integration. **Won't have:** advanced ML on unpowered edge devices.

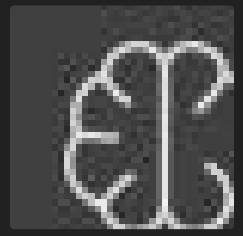
Technology Outlook: IoT 2025–2030

IoT will shift from data collection to **autonomous decision-making**. Edge computing will enable intelligent gateways to perform complex analyses on-site, radically reducing latency — critical for autonomous vehicles and industrial robotics.



5G Infrastructure

Massive coverage expansion, latency below 1ms enabling real-time industrial control.



Edge AI

Intelligence on devices — local processing without cloud dependency for critical applications.

Security

NIST/ENISA frameworks and hardware cryptography as standard for all IoT deployments.

Sustainability

Energy-efficient protocols and green transformation driving next-generation IoT design.

Success requires integrating diverse disciplines — from physics and electronics through software engineering to business strategy. Only a holistic view of the IoT ecosystem enables solutions that deliver real societal and economic value.