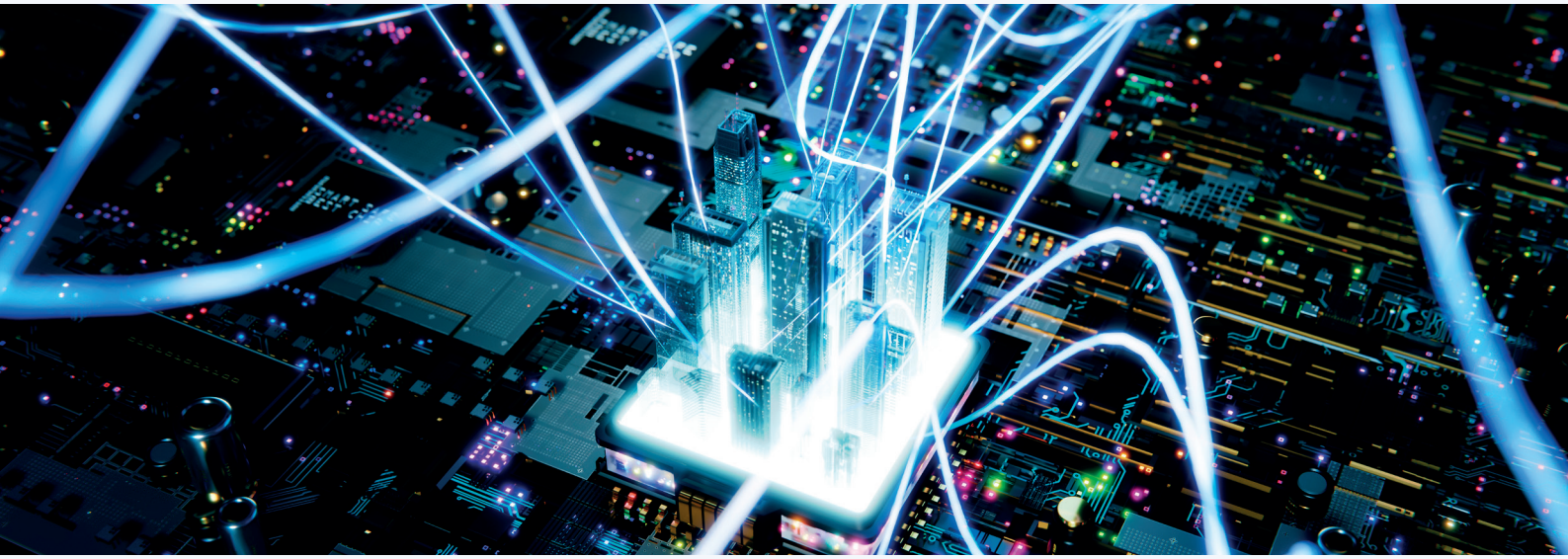
The 2010s and Beyond
The IoT Explosion



By C. J. Abate (Elektor)

Back in January 2010, every "thing" was not connected to the Internet. It was a simpler time, right? The first-generation iPad wasn't on the market yet, and Tesla's Model S was two years from hitting the road. Fast-forward 11 years and the high-tech landscape looks much different. The Internet of Things is still growing.

Is Coca-Cola the first thing that comes to your mind when someone mentions the "Internet of Things" (IoT)? Probably not. But there is an interesting connection between the IoT and the famous sugary beverage. In the early 1980s, a few caffeine-addicted, soda-loving students at Carnegie Mellon University (CMU) in Pittsburgh, Pennsylvania, developed an early IoT application — the CMU CS Department Coke Machine.

According to an interesting post on the CMU Department of Computer Science website, the creative students installed micro-switches in the ARPANET-connected machine to detect how many bottles were available. The switches were hooked up to the main departmental computer, and "a server program was written to keep tabs on the Coke machine's state, including how long each bottle had been in the machine."[1] By running the program, the students could determine, before deciding to walk to the machine, if cold Cokes were available. And by monitoring how long the bottles were in the machine, they could know if the bottles were cold. It was a truly innovative and fun project.

Internet-connected technology has come a long way during the past few years. Today, billions of connected devices share data over the Internet, and the IoT now enables everything from smart cities to global communications platforms. To get to this point, thousands of engineers and makers in Elektor's global community have contributed ideas, projects, and products (**Figure 1**). Let's take a brief look at where the IoT has been and where it's heading.

Billions of Devices, Three World Cups

What comes to mind when someone says "connected device"? While your nontechnical friends almost surely will think of a

2010 *Sigfox founded*

2010 *First iPad released*

2012 *Elektor Live! seminar and exhibition in Dortmund, Germany*

product like a smartphone, your technical peers will likely think about embedded IoT devices. No matter what comes to your mind, you will certainly agree that our reliance on such technologies is growing. And due to the seemingly endless flow of new wearables (e.g., watches), industrial devices (e.g., thermal imaging systems), and automotive technologies (e.g., vehicle condition monitoring systems) hitting the market each month, it is difficult to say how many IoT devices are deployed at any given moment.

Predicting the IoT's future is even trickier. For instance, we've recently studied reports estimating that anywhere from as few as a dozen billion to more than 500 billion devices will be connected to the Internet by 2030.[2] That's a wide disparity. What is clear, though, is that the IoT is rapidly evolving, and the evolution presents countless new opportunities for electronics manufacturers, wafer fabs, security companies, data management outfits, and Internet providers.

So, what was the state of IoT affairs in the early 2010s? Things looked much different back then. Take January 1, 2010, for instance. On that New Year's Day, the iPhone was not yet 3 years old, the first Tesla Model S was two years from the road, the world's first publicly accessible long-term evolution (LTE) service was just weeks old, and the first-generation iPad was still several weeks away from release. Clearly, the IoT was more sparsely populated than it is now. According to a 2011 Cisco whitepaper, approximately 12.5 billion devices were connected to the Internet at the time.[3] Not surprisingly, explosive growth followed. When we fast-forward 10 years to 2020 — you remember, the year that will forever be remembered for the COVID-19 pandemic — Cisco forecasted that 29.3 billion networked devices would be in play by the year 2023 [4]. Clearly, a lot of technological innovation and IoT expansion occurred as the world watched European footballers win three FIFA World Cup championships (Spain in 2010, Germany in 2014, and France in 2018). And more is to come.

IoT Projects Abound

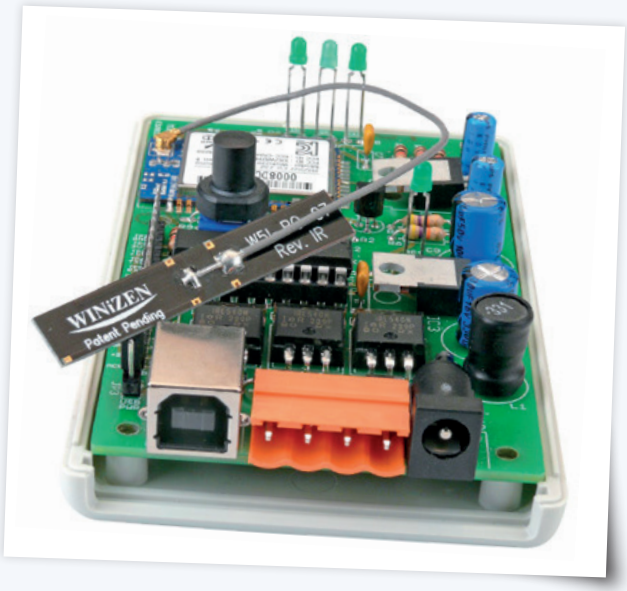
IoT projects and tutorials have appeared in the pages of *Elektor* for well over a decade (**Figure 2**). And today, each new edition of *Elektor* and *Elektor Industry* touches on the IoT in one way or another. Don't expect to see the influx of new IoT-related projects and articles slow down any time soon. Many of tomorrow's disruptive IoT solutions are currently under development on Elektor community members' workbenches.

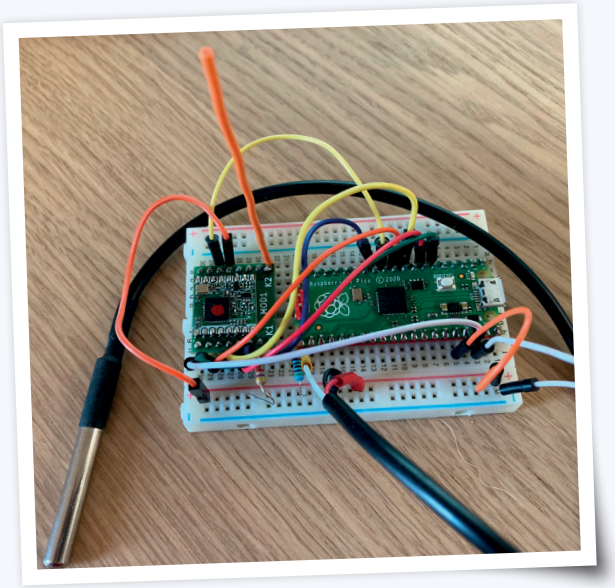
Figure 1: In early 2020, Elektor engineer Luc Lemmens presented a ESP32 doorbell project that many will find useful. When the doorbell rings, the circuit can send a message to your smartphone or computer. (Elektor March & April 2020)

Figure 2: In this 2014 article, Elektor engineer Clemens Valens highlights a few interesting IoT projects. (Elektor January & February 2014)

IoT Projects in Elektor

From 2010 to the present, Elektor has featured countless IoT-related project articles, reviews, and tutorials. In fact, articles about Internet-connected solutions were featured even decades earlier. In this section, we focus on some standout IoT-focused articles from the 2010s and beyond.





LoRa with the Raspberry Pi Pico

By Mathias Claussen (Elektor July/August 2021)

Using a Raspberry Pi Pico with MicroPython is a beginner-friendly way to program. Adding a SeeedStudio RFM95 LoRa module and a DS18B20 temperature sensor can create a quick LoRaWAN node with MicroPython. The project transmits data to a LoRaWAN gateway which forwards the data to The Things Network Cloud.

https://www.elektormagazine.com/magazine/elektor-179/59721

Wi-Fi Controller Board

Control RGB LED Strips, Motors, Relays & Stuff, but No Wires

By Clemens Valens (Elektor June 2013)

Wi-Fi modules were pervasive even back in 2013. At that time, Clemens was thinking about adding household appliances to a home Wi-Fi network. To that end, he showed that controlling your home from your mobile phone was easy with the universal Wi-Fi controller board presented in this article.

https://www.elektormagazine.com/magazine/elektor-201306/20740

IoT Gateway and Wireless Nodes

By Hennie Spaninks (Elektor March/April 2017)

Would you like to have specific functions in a home automation system that are not available in a commercial product? You can develop your own system that features wireless communication between the various nodes and a central gateway. The gateway in the project uses MQTT to send measurement data to an OpenHAB server, which processes and displays the data.

https://www.elektormagazine.com/magazine/elektor-201703/40212

IoT Shield for Arduino

By Clemens Valens (Elektor January/February 2017)

This handy Arduino Uno R3-compatible shield is intended for simple control applications in and around the house. The circuit on the board proper does not use all of the Arduino signals, and other shields can be stacked on it as long as they do not interfere with our board, making the system very flexible and extensible. When the system is connected to the Internet, the label "Internet of Things" (IoT) becomes applicable.

https://www.elektormagazine.com/magazine/elektor-201701/40145

Solar Panel Voltage Converter for IoT Devices

Yes We CAN Exploit Indoor Lighting

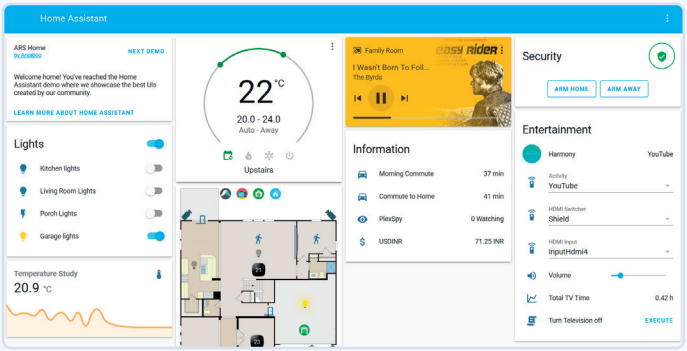
By Sunil Malekar (Elektor July/August 2015)

With this microcontroller-free project, you can build a compact supply to power small indoor IoT devices from a solar panel — indoors! The project can operate from an input source as weak as 7.5 µW, so you can use an inexpensive mini solar panel. At the heart of the converter is either an LTC3129 or an LTC3129-1 IC. Hardly a microwatt of solar power is wasted in this circuit.

https://www.elektormagazine.com/magazine/elektor-201507/27965

5G rollout begins
2018

Raspberry Pi 4 Model B released
2019



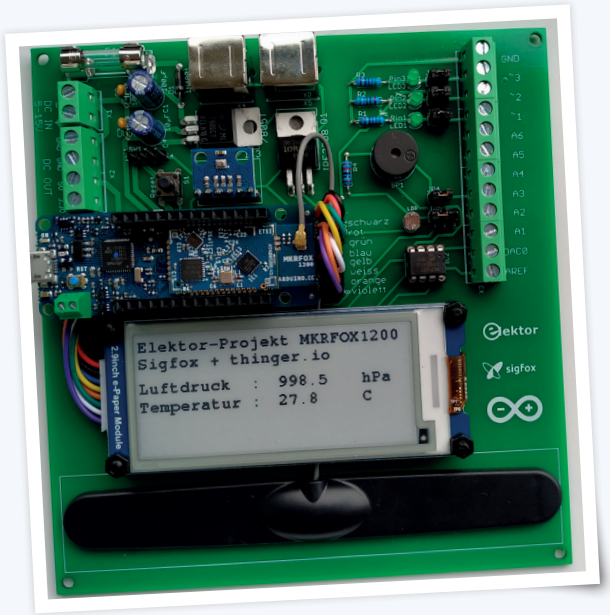
Home Automation Made Easy

With ESPHome, Home Assistant & MySensors

By Clemens Valens (Elektor September/October 2020)

Want to equip your home with remote-controlled lights, curtains, or window shutters? Looking for a DIY solution for controlling your sprinkler system or home security setup? Home automation is easier than ever with low-power IoT devices and tools like ESPHome, Home Assistant, MySensors.

https://www.elektormagazine.com/magazine/elektor-155/58951



E-Lock, The First Elektor Chip

By Eduardo Corral (Elektor April 2014)

IoT security has been an important topic ever since the dawn of the IoT. Back in 2014, Elektor teamed up with Intelligent SoC to develop a highly dedicated chip to protect a wide variety of "things." E-Lock, the first Elektor chip, was a solution developed for engineers and makers who wanted to design secure IoT devices. This article covers the E-Lock project and details all the specs.

https://www.elektormagazine.com/magazine/elektor-201404/26214

SigFox and the IoT (Parts 1-4)

By Frank Schleking and Bernd vom Berg (Elektor 2019 and 2020)

Wireless standards such as Sigfox and LoRa are available whenever battery-powered sensors need to transmit data to an Internet gateway. Sigfox scores high with a uniform and well-developed network. All the user must do is program and log on the sensor nodes in order to visualize their output data on the Internet. This series details how to use inexpensive hardware and free software to realize your first Sigfox projects.

https://www.elektormagazine.com/magazine/elektor-114/56832

WLAN for Microcontrollers

Take control with an ESP8266

By Walter Trojan (Elektor January & February 2016)

Taking your first steps into the Internet of Things, may seem a bit daunting for many, but don't despair, the hurdle is not as high as it seems. A low-cost WLAN board, a standard microcontroller, and some software are all you need to build a project that enables you to control LEDs from a PC, tablet or smartphone.

https://www.elektormagazine.com/magazine/elektor-201601/28726

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About the Author

C. J. Abate is Elektor's Director of Content. You can read his recent Elektor articles at https://www.elektormagazine.com/abate and follow him on Twitter at https://twitter.com/Elektor_US.

WEB LINKS

[1] Dept. of Computer Science, "The 'Only' Coke Machine on the Internet," Carnegie Mellon University.: https://www.cs.cmu.edu/~coke/history_long.txt

[2] Cisco, "Internet of Things at a Glance," 2016.: https://www.cisco.com/c/en/us/products/collateral/se/internet-of-things/at-a-glance-c45-731471.pdf

[3] D. Evans, "The Internet of Things How the Next Evolution of the Internet Is Changing Everything," Cisco IBSG, April 2011.: https://www.cisco.com/c/dam/en_us/about/ac79/docs/innov/IoT_IBSG_0411FINAL.pdf

[4] Cisco, "Cisco Annual Internet Report (2018–2023) White Paper," March 9, 2020. : https://bit.ly/cisco-annual-2020

2020 — *COVID-19 lockdowns begin*

2021 — *Elektor turns 60*