Researchers bring radio-frequency identification technology to the supply chain

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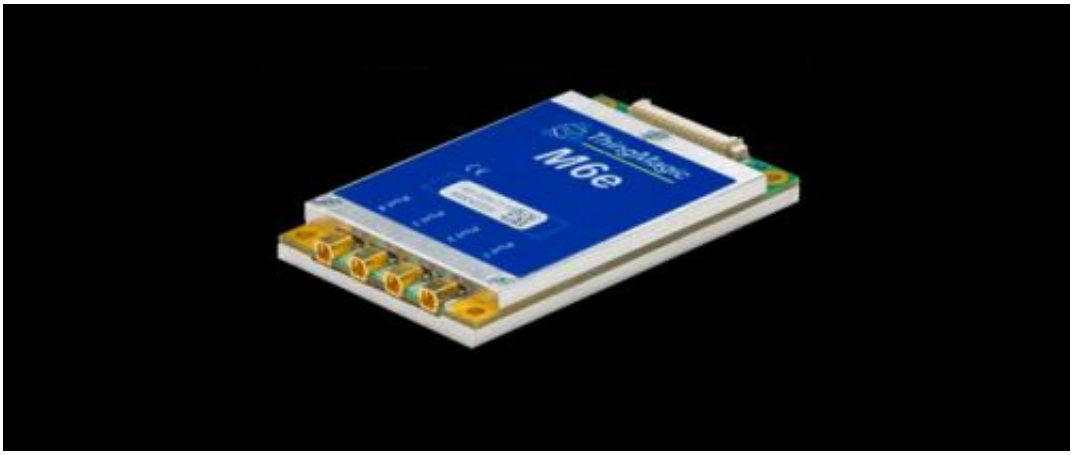

ThingMagic's Mercury6e, released in 2011, is a high-power, four-port, ultrahigh-frequency reader module that's able to read up to 750 tags per second, up to 30 feet away, and is small enough for use in mobile applications. Credit: Thingmagic, a division of Trimble.

In 2000, five MIT Media Lab alumni co-founded ThingMagic to help bring radio-frequency identification (RFID) technology—wireless readers and data-transmitting tags—to the supply chain. This meant companies would be able to track products, from the warehouse to delivery.

This mission served as the technological spark that catapulted ThingMagic into a leading role in a new generation of RFID systems that were, among other things, cheaper, faster, and more efficient than

similar technologies.

At the time of ThingMagic's founding, available RFID readers—which collect information by reading tags that transmit electronically stored information over radio waves—were insufficient for supply-chain use: They were too pricey, could only read one tag at a time, and suffered from other technological issues.

Based on work at MIT's Auto-ID Center, ThingMagic developed RFID readers for the supply chain that could read many tags, simultaneously, across multiple radio frequencies and from greater distances. They were also powered by software—an industry first—meaning users didn't need to rework the hardware to make modifications.

Growing from a Somerville, Mass., garage to an office in MIT's neighborhood of Kendall Square, the company, according to its co-founders, became one of the world's first profitable distributors of RFID technology in the mid-2000s.

"We found ourselves in the middle of a booming RFID market. Customers were hungry for the technology and they needed the skills we had assembled coming out of MIT," says Bernd Schoner PhD '00, a ThingMagic founder and the company's current vice president of business development.

Schoner wrote early code for ThingMagic's software, but ultimately became one of the company's key business strategists, focusing on sales, technology management, and administration.

In its early years, ThingMagic sold products to retail firms, but eventually expanded and diversified its product line to include embedded RFID modules and in-vehicle devices, becoming a leading developer of these technologies.

In 2010, ThingMagic sold to Trimble, a positioning and navigation-technology company; ThingMagic co-founders Schoner and former vice president of advanced development Ravi Pappu PhD '01, now a platform architect at Trimble, are working in Kendall Square to help incorporate RFID technology into Trimble products.

Other ThingMagic co-founders include Rehmi Post PhD '04, a principal at ThingMagic, and co-chief technology officers Matt Reynolds PhD '99 and Yael Maguire PhD '04. Maguire and Pappu were both named to Technology Review's "35 Under 35" list of top innovators for their work with RFID and other technologies. The World Economic Forum, Red Herring, and the Boston Globe have recognized ThingMagic as a top RFID innovator.

Software-defined radio

ThingMagic's commercial origins were in MIT's Auto-ID Center (now Auto-ID Labs), where David Brock, now a principal research scientist at MIT's Laboratory for Manufacturing Productivity, and mechanical engineering professor Sanjay Sarma, now director of digital learning at MIT, had already done groundbreaking work to enable cheap and simple RFID tags for the supply chain. Basic data, embedded on microchips, could be rapidly collected and stored in a readily accessible online database.

Prompted by the Auto-ID Center to develop, and eventually commercialize, more advanced RFID readers for the supply chain, the five co-founders moved the ThingMagic office back to Kendall, published several papers on RFID technology, and began designing the next-generation RFID systems.

By 2002, the team was among the first to design and patent an agile reader, a "dual-frequency reader" that could read tags on high and

ultrahigh frequencies (UHF). (Generally, RFID readers operate on only one of three different frequencies—low, high, or ultrahigh.)

Additionally, this reader represented the first-ever software-defined radio in the RFID industry. A single reader could scan and decode hundreds of tags at once, regardless of the RFID protocols used—the rules that govern how data can be exchanged between readers and tags. This helped users track retail inventory more quickly and accurately.

"RFID protocols were still evolving rapidly at the time, both in terms of performance and standards. This meant we had to design our readers in such a way that they could be adapted rapidly to new requirements. That's impossible, if you have to change the hardware each time you want to implement a small improvement," Schoner says. With a software-defined radio, "the idea is that you handle all of the encoding and decoding of signals in software, rather than redesigning the hardware."

Initially, ThingMagic provided its Agile RFID reader, dubbed the Mercury2, to the Auto-ID Center for research purposes. But the company soon developed this technology into its first commercial product, called the Mercury3—using Linux for the software core.

Over the years, this has become a core of ThingMagic's technology: In 2011, the company released its latest model, the Mercury6 reader, under Trimble, which again represented several firsts. For example, it is powered by the Mercury6e, which, according to the company, represents the world's smallest high-power, four-port, ultrahigh-frequency reader module on the market. Among other things, it can read up to 750 tags per second, up to 30 feet away, and is small enough for use in mobile applications.

After the 'retail debacle'

In the mid-2000s, RFID technology was hyped in the market, and ThingMagic attracted more than $20 million in venture capital. However, market hype was followed by stagnation: Investors stopped spending money on RFID. Due to privacy issues with tracking inventory, retailers dismissed RFID technology. ThingMagic's first major deals—with Walmart and other retailers to bring RFID technology to retail supply chains—fizzled.

It was a tough time for RFID companies. But persevering through "the retail debacle," as Schoner calls it, ThingMagic found a new avenue for profit by designing card-level tag UHF-reader modules, about the size of a credit card, for companies to embed in their products to enable RFID capabilities.

"It became all about embedding RFID at that point, as opposed to building fixed systems … that would act like infrastructure," Schoner says. "Instead of building the system, we design the engines that can power RFID features on already existing devices." Companies such as bar code- and receipt-printing firm Zebra Technologies embedded these modules into their printers to encode RFID tags on labels and other documents.

Over the years, ThingMagic developed a significant product line of fixed systems (or "boxes"), embedded readers for equipment manufacturers, developer kits, application programming interfaces, consulting services, and other RFID accessories. At the time of its acquisition, ThingMagic's customers included Ford, Wegmans, and New Balance, which all used the technology to track inventory. Additionally, hospitals have used the systems to keep track of patients and surgery tools.

This is 'the Internet of things'

One of ThingMagic's initial, ambitious goals was to support "the Internet

of things," a concept coined by the founder and then-director of the Auto-ID Center, Kevin Ashton.

This concept meant embedding RFID tags in objects—from products to medical devices to personal items—so they could be managed and inventoried by computers. The aim was to reduce loss and waste, and ultimately drive down the cost of products.

After more than a decade of increasingly ubiquitous RFID technology, what has become of "the Internet of things"? "Depending on how you look at it, it either never came to fruition or it is revolutionizing the world around us," Schoner says "but at this point personal devices and consumers have become the driving force behind the concept."

Smartphones, for instance, come equipped with near-field communication technology, powered by RFID, where two phones can establish radio communication simply by touching or by being in close proximity.

"If you let another 10 years go by," Schoner says, "we may look back and say, 'We tried to implement the Internet of things on the business-to-business track and we failed.' But consumer technology, I think, will ultimately make it happen."

More information: www.thingmagic.com/
www.autoidlabs.org/

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