Applications of The Internet of Things

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We need to empower computers with their own means of gathering information, so they can see, hear and smell the world for themselves, in all its random glory.

Kevin Ashton, RFID Journal, June 2009

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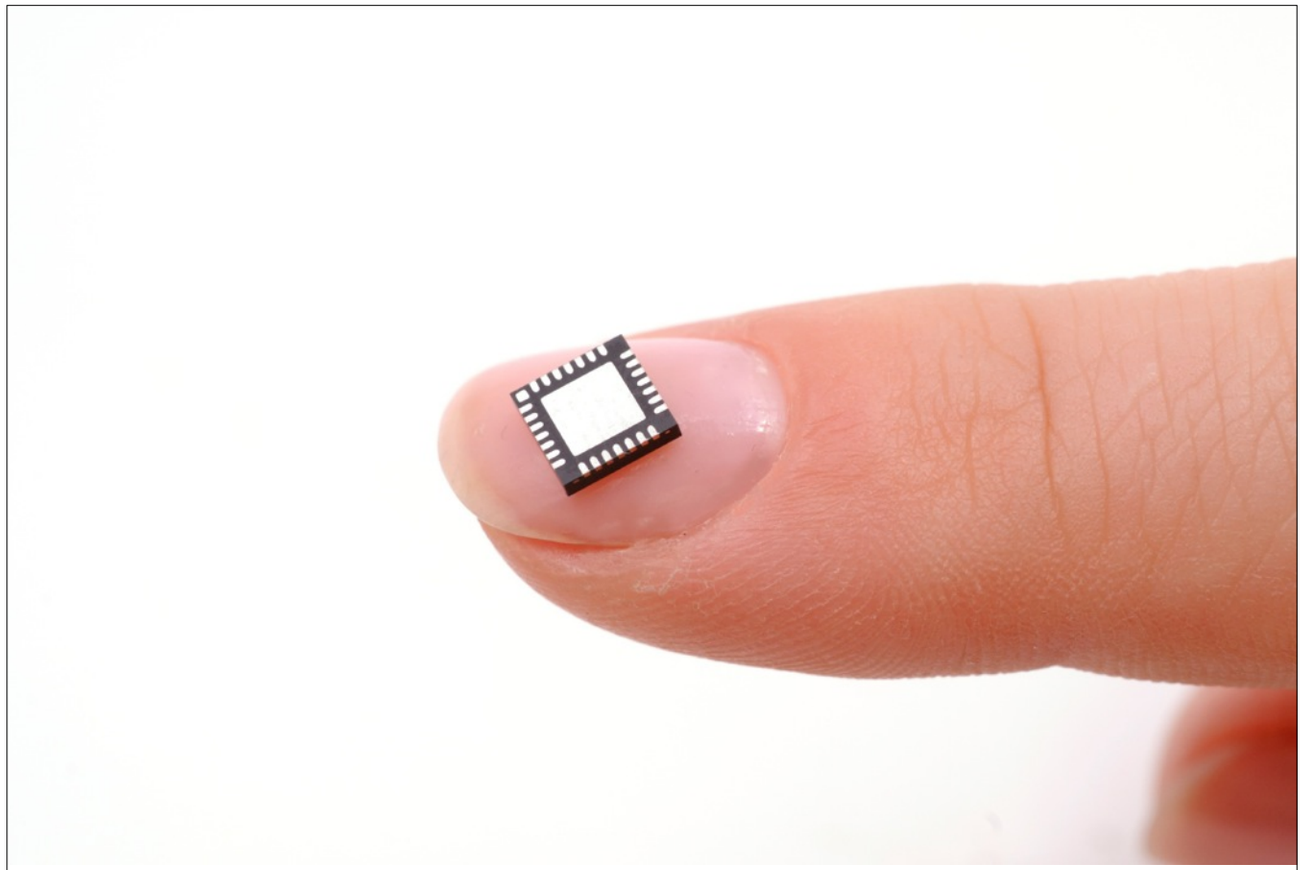
A network of physical objects, accessed through the Internet. The devices use embedded technology to sense or interact with the environment around them, and wireless technology to communicate with each other and the cloud.



The Internet of Things is Small.

Small microprocessors, small sensors, small amounts of memory, small bits of data, small antennas, and small wireless transactions moving data around.

The Internet of Things is Big.

Small microprocessors are inexpensive, and they're in everything. Your microwave oven, washer, dryer, dishwasher, coffee maker, refrigerator, VCR, television, video-game console, stereo receiver, CD player, DVD player, remote control for the TV, remote for the VCR, remote for the stereo, garage-door opener, automatic sprinkler timer, phone, answering machine, etc.. These devices become the Internet of things when they start talking to the world through wireless networks.

Let’s start with the cliche of the Internet of Things, the connected refrigerator. In the future, we are told, your refrigerator will know more about what you eat than you do. It will know what you put in, it will know what you take out. It will be able to order more beer (and of the right brand) when you run low. It will send a note to your doctor if you run out of beer too often. But this is silly consumerism, and what our workshop this week focuses on is practical, real-life applications of the Internet of Things today.

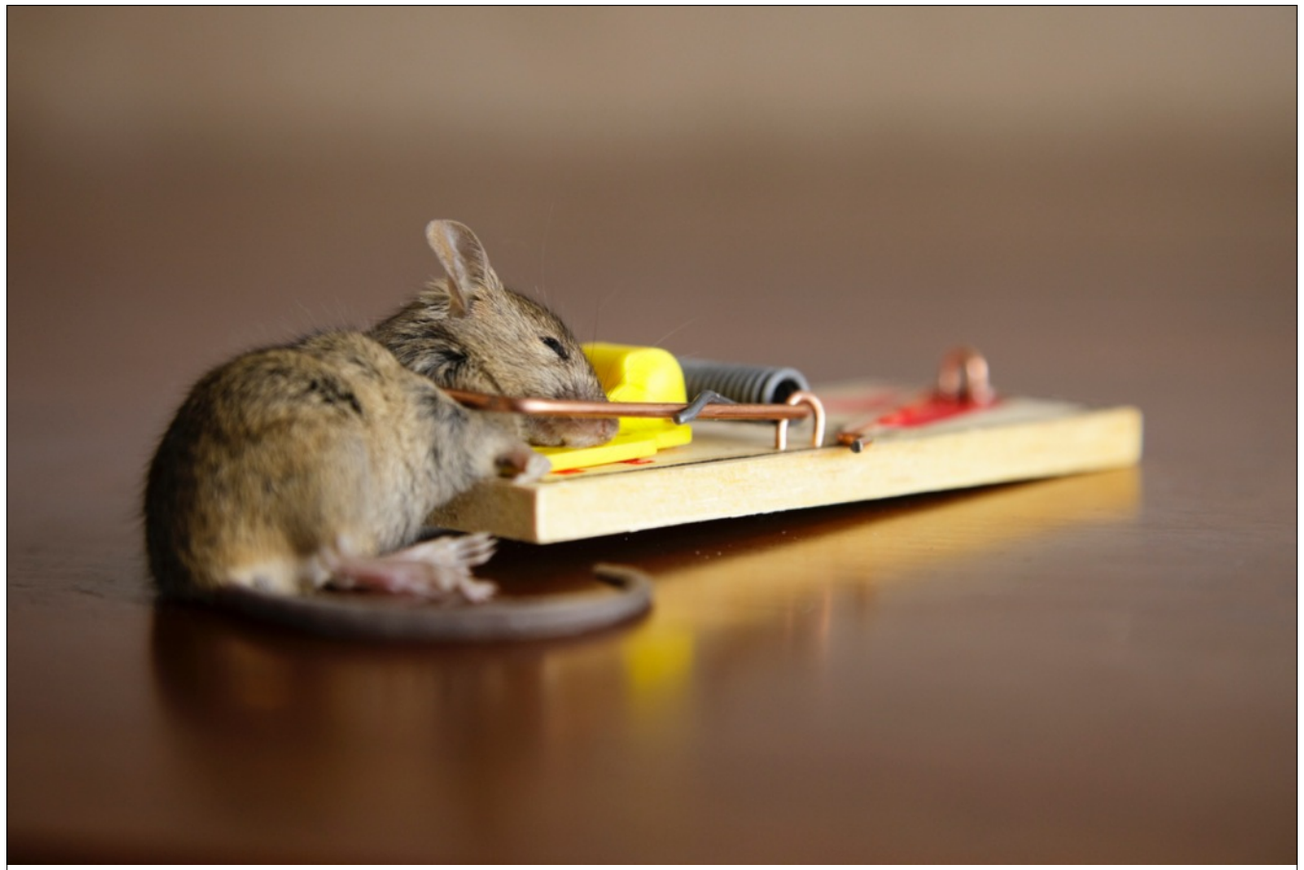
So let's look at a different kind of fridge. Commercial and industrial refrigerators are present in every shop, every supermarket, every food storage warehouse, and most food production facilities. Working refrigeration is critical to the safety of the food system in the industrialised world. It's so important that governments are starting to regulate the use of commercial refrigerators. In New Zealand, the government requires commercial refrigerator owners to keep a log book of refrigerator temperatures, measured a few times a day. With Internet of Things technology, that logbook can be digital, the measurements can be made continuously, and the cost of the devices is lower than the labour involved. A real, practical use of the Internet of Things.

Further away from the equator, in cold lands like New Zealand, Northern Italy, and Denmark, heating our houses and buildings is a major use of electricity and gas. And yet we are so unscientific about how we do it. We might have only one or two points in a house where we measure the temperature, to decide how much heat to use. Most of us have a thermostat that has one or perhaps two settings.

Here we go. This looks like the thermostat in my hotel room. During the day I set it to 21 degrees. At night I lower it to 18 degrees. It's never actually that temperature, as hard as the air conditioning tries. It's not surprising that the most exciting startup in the Internet of Things is a cloud connected thermostat, the Nest device. Last year Google paid a billion dollars for Nest, who have a thermostat that learns the behaviour of the inhabitants of a house, and helps keep people comfortable while saving money.

Saving of money is important to utility companies too. What do we see here? A large row of manual, mechanical gas meters. There's no electricity nearby, as that can be quite dangerous around gas. There's probably very little sunlight, as gas meters are placed out of sight, at the back of buildings and in alleys. So here we have a problem being solved by new battery technology and low power wireless communications. New gas meters have been developed with ten year batteries, in sealed packages. No wires, no power connection, and no maintenance, and no manual meter reads for ten years.

Utilities can save money on labour by installing automated meters, but they can also save money on infrastructure using the Internet of Things. Each of these transformers is worth thousands of dollars, and can last twenty years. How long they last is a matter of statistics and finance. Leave them in service too long and they might stop working or even explode. Take them out when they still have years of life left and you're throwing away money. With Internet of Things technology, these formerly unconnected transformers can be monitored for performance, allowing utility companies to use them longer before replacement, without worrying about failure. How can this happen? Utilities can attach simple thermometers and voltage meters to the transformers, and remote switches to turn them off if a catastrophic failure is imminent. Ten years ago such technology cost thousands of dollars. Now costs hundreds. Soon it will cost tens. The financial decision to use Internet of Things technologies will soon be very simple.



Getting back to the home, we have the mousetrap. Build a better mousetrap and the world will beat a path to your door. But this is ridiculous. What does a mousetrap have to do with the Internet of Things?

Supermarkets in the United Kingdom are required to ensure that mousetraps are always clear within 24 hours of use. So people have to walk around the stores every night, checking every mousetrap. The traps are under shelves, behind counters, and in dark, hidden places. Pest control company Rentokil and Internet of Things company Neul have developed a mousetrap that sends a wireless signal when it catches a mouse. Now supermarket chain Tesco has stores in Milton Keynes where they no longer have to check their traps every day.

Milton Keynes also has smart trash cans. Instead of sending city employees to look at every trash can in the city every day, the cans have sensors to alert the city when they're full. Does this take away jobs? Maybe, I don't know. Or maybe it gives city employees more time to keep their cities working well in other ways.

The same goes for streetlights. It’s hard to tell if a streetlight is working or not during the day. They’re mostly set to switch on at night, maybe with a light detecting resistor and a small microprocessor. Or perhaps they have an internal clock, or a combination of the two. Checking the operation of streetlights is a real burden to a large city. With Internet of Things technology streetlights in Milton Keynes and many other cities in the world now alert their owners when they stop working.

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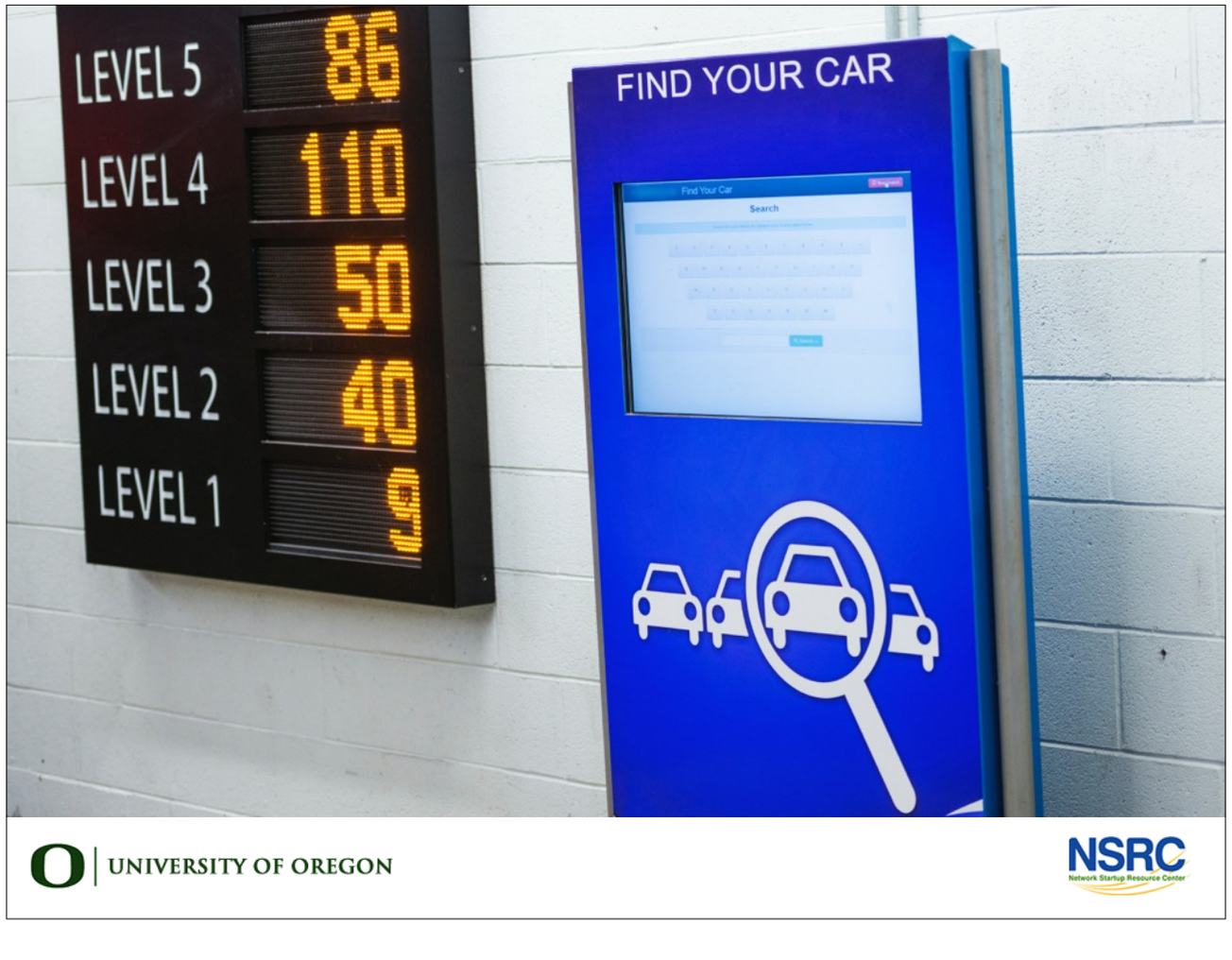
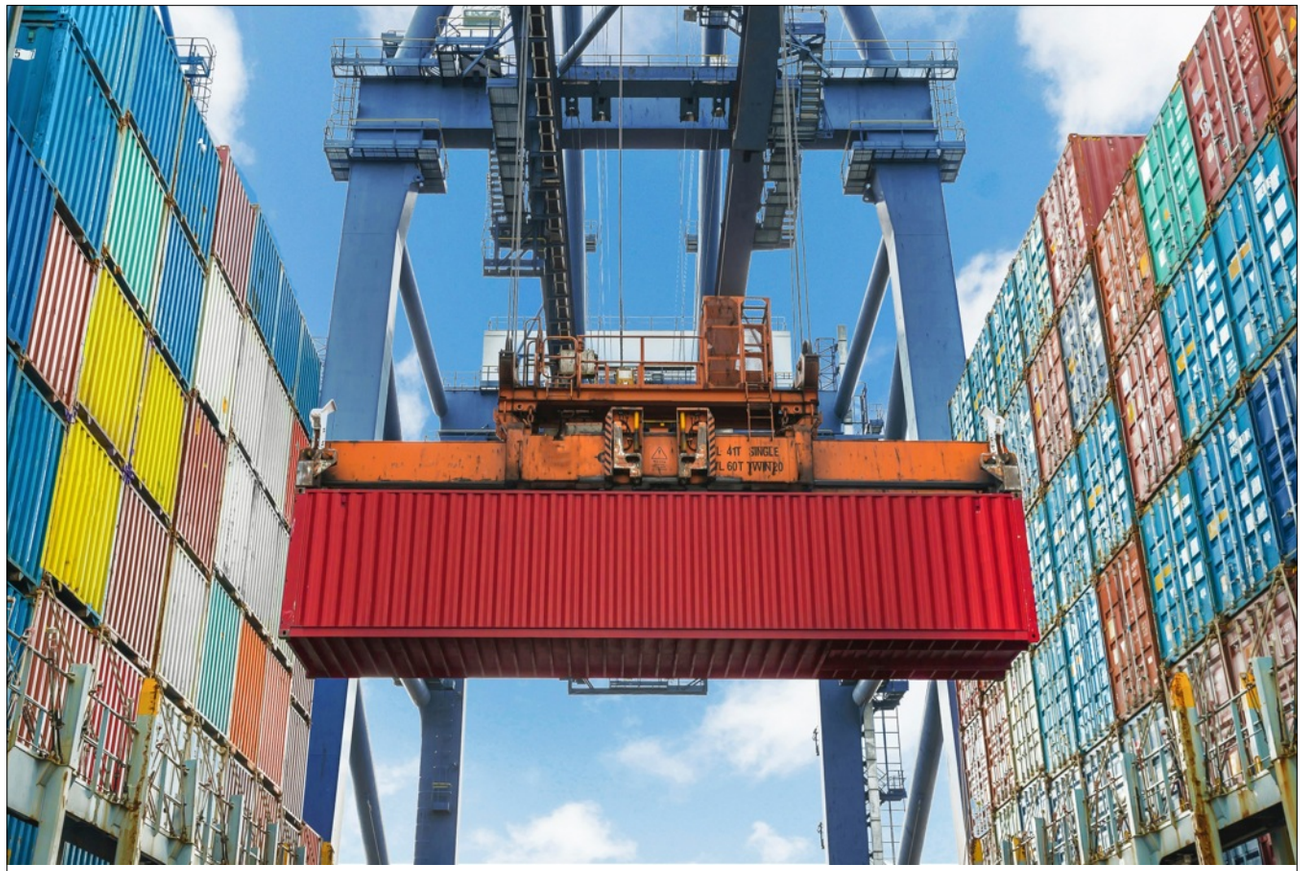
Parking may seem like a convenience, or an inconvenience, but getting cars off the street quickly is important for the traffic management of a city. How can a parking garage know how many spots it has free? In some new garages, small light sensors with wireless radios and light sensors are stuck to the concrete on each spot. They signal a central receiver to make a map of how many parking spaces are free, and where!



Imagine if every parking garage had such signs posted outside and in. The technology is simple, inexpensive, and in a decade will be everywhere.

While the movement and parking of cars - even when it helps with traffic - may seem a trivial use of the Internet of Things, the movement of goods is a different story. This container could be filled with timber, or electronics, solar panels, milk powder, coffee beans…

It could be sitting on a dock in China, or Africa, or Australia.



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Or it could be loaded onto a cargo ship, about to move halfway around the world. Where's the container? Ten years ago it might have thousands of dollars just to track a container's location. Today the electronics required - thanks to Internet of Things technologies, cost hundreds. And they might not just track location. For a few dollars extra they could track temperature, humidity, vibrations, exposure to light, exposure to gas, and more.

As the containers sail the world on the container ships that tie the world together, they pass thousands of lights. Just like streetlights these have bulbs that burn out. Unlike streetlights, they're very hard to get to, and very hard to check. And if they go out, the consequences can be disastrous. The important navigation lights I work on in New Zealand have small microprocessors in them, and a carousel of bulbs. When a bulb goes out, a new bulb is rotated in without intervention. But do we know this has happened? No, right now we go to visit the light twice a year to make sure there are enough spare bulbs. In the future we'll attach a sensor to this light so we're alerted every time a bulb is used, so we can ensure a fault doesn't ever take the light out of service.

But enough about cities and transportation and shipping. Let's talk about food and water. The pivot irrigator has enabled intensive agriculture on a scale unimaginable one hundred years ago. As a result, aquifers across the midwest and west of the United States have been drained to nearly empty. In order to save water, some new irrigators are using Internet of Things technologies to sense dry areas and adjust water volumes as they roll over an area.

If you don’t have enough water for pivot irrigators, it’s time to move to drip irrigation. Here this system puts a constant amount of water in the soil per plant. But what if the soil type changes across a pasture? Is it reasonable to measure soil moisture and adjust water delivery on a granular level? Not ten years ago. Perhaps not today, but with Internet of Things technology it will happen.

It’s already happening in controlled environments like greenhouses. Here not only the water delivery is controlled, but the heat levels. It’s expensive to use propane gas to heat big areas, so temperature sensors throughout the greenhouse ensure only enough heat is used.

All this water control isn't enough though, and many places that once grew crops are now used for grazing cattle. Today it's part of the regular routine of farmers to drive around their farms checking on water tanks, once a day or once a week. Earlier this year I worked on an Internet of Things device that for less than $100 in parts can report the levels of water in a tank via a 3g network. For another $100 in parts it could use a satellite network.

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When the water runs out - and it does, water is trucked in from wetter parts. In Australia there are nearly a thousand companies delivering water to houses and farms that run out. Internet of Things technology is already helping delivery companies plan their schedules based on when their users are going to run out. The same goes for diesel fuel, fertiliser, and animal feed.

If you look closely you'll see that every single one of these rooftops has a water tank on it. Throughout Asia, water supplies are often stressed, and water distribution networks can sometimes run only a few hours a week. When the water is on, people race to pump it to tanks on their roofs, or into bathtubs or barrels in their kitchens. While the Internet of Things hasn't yet solved this problem, it will. Already in India there is a text message service called NextDrop. Subscribers can get a text message alert when the water in their neighbourhood is about to come on, so they're ready to store it away.

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But Thailand isn’t a dry country. Fortunately and unfortunately! There’s plenty of water here to go around. Ok, maybe more than enough. So what can we do with all this water?

This week one of our goals will be to learn to use Internet of Things technology for growing fresh water fish. We'll build inexpensive monitors that will measure the temperature, pH, and dissolved oxygen levels in fish ponds. The technology that we will use is the same as used in all of the examples I've given you. Heating and refrigeration control, utilities monitoring, transportation, water management, food safety - you name it - it's all based on the same small microprocessors and communications technology. Thank you for being with us this week and I hope we can all experience the magic of Internet of Things together.