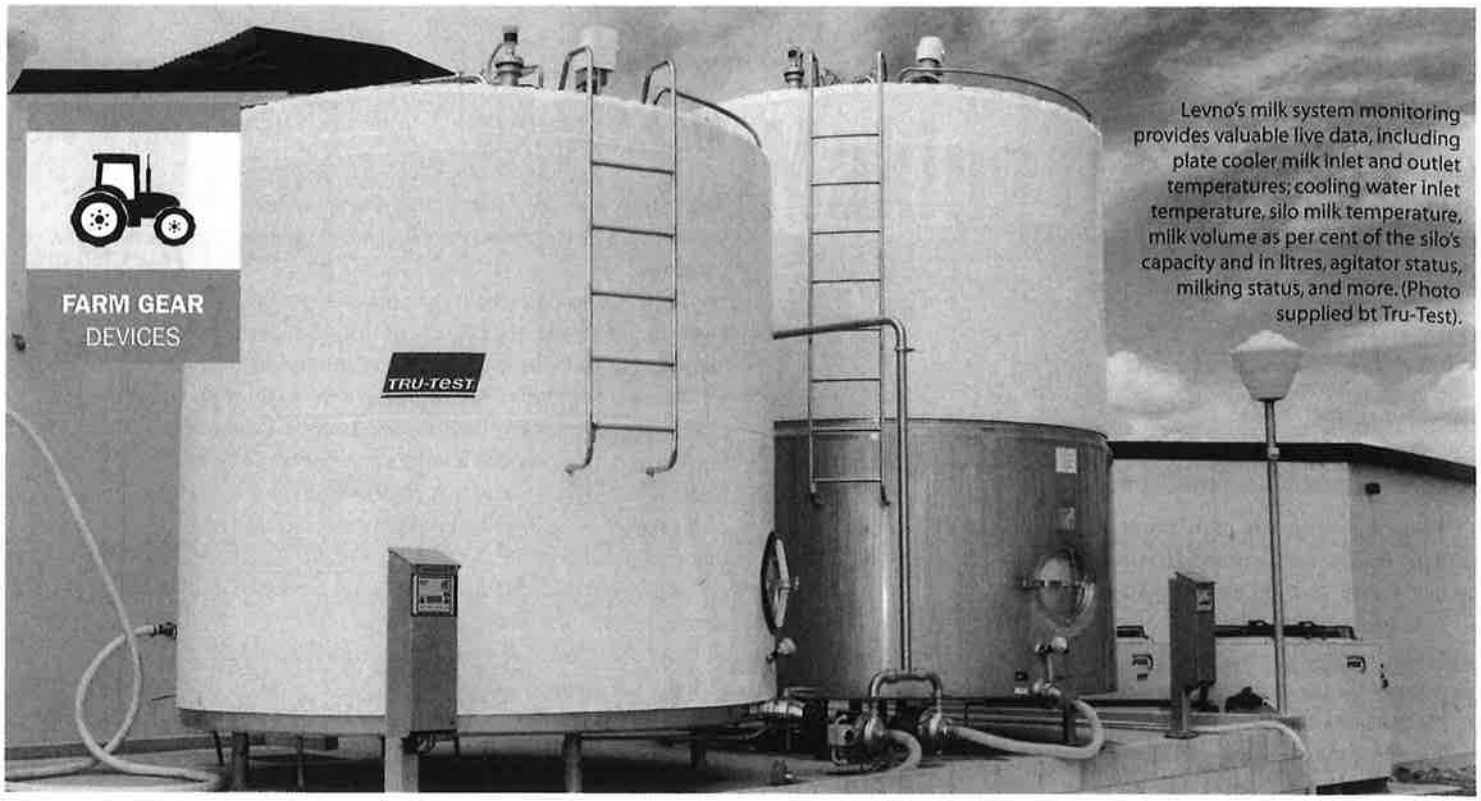

Levno's milk system monitoring provides valuable live data, including plate cooler milk inlet and outlet temperatures; cooling water inlet temperature, silo milk temperature, milk volume as per cent of the silo's capacity and in litres, agitator status, milking status, and more. (Photo supplied bt Tru-Test).

The internet of everything

Gizmos galore now connect a vast range of operations via the internet. ***Tim McVeagh*** *looks at just some of the technologies available with dairy farming applications.*

An estimated 8.4 billion Internet of Things (IoT) devices were available world wide by 2017, with a projected 50b by 2020. Like a lot of the new technology it's suddenly upon us, rapidly developing, and offers great potential. So what is IoT and how can it benefit the dairy farmer.

Massey University's Chair of Computer Science Professor Hans Guesgen explains the IoT:

"We are all familiar with the internet where we exchange emails and connect to a server to learn, socialise, or do business.

"With the IoT, instead of restricting access to people, devices also connect to the network. These devices are commonly small ones with limited capabilities, and have sensors detecting phenomena like light, temperature, humidity, and motion. They may allow the triggering of some action, like opening a valve."

Devices applicable to dairy farming will be found in or on farm vehicles, plant and machinery, paddocks, vats, fuel tanks, water tanks, irrigators, water lines, staff, feed silos, livestock, weather stations, electric fences – in fact pretty well everywhere. It's no wonder the IoT is sometimes referred to as the Internet of Everything.

The three main components of the IoT are:

- **Things:** Devices that can connect wirelessly or wired to a wider network; for example, a temperature probe in a milk line. They may have unique addresses based on standard communication protocols, and may be traced through the internet by RFID transponders.
- **Network:** Like a router in the home situation, the network connects multiple things to the cloud.
- **Cloud:** This refers to remote servers in a data centre, storing, analysing, and acting on the data.

"Little data", the small bytes of simple data generated by things, is condensed and tracked in the cloud over time to become "big data". This allows millions of data points to be analysed to monitor and control processes more effectively.

Connecting devices to the network has traditionally been by WiFi, radio networks, cell phone or Bluetooth. These have limited range and are more expensive than the newer low-power wide-area network (LPWAN) that cover most of the country. This allows data from the devices to be transmitted more cheaply and using less power than cellular networks, and over longer distances.

Examples of these are Spark's LoRaWAN and Kordia's Sigfox. A suitable network must be used based on data rate, power consumption, range, and frequencies available. Devices do not need to be on the same network to communicate, as cloud services can be used to connect the devices. There are a lot of technical hurdles to overcome around network protocol, although there has been a lot of progress in terms of standardisation.

One intriguing aspect of the IoT, is that systems may be contained within a farm, without being connected to the internet.

"The farmer can set up a dedicated network on the dairy farm that has nothing to do with providers, but acts as a hub to connect to a provider. Network coverage for dairy farms is not a limiting factor where most of the communication will be within the farm. Only when the data is sent to other providers for analysis, is internet service needed", Guesgen says.

"The government through its broadband investment so far has done a lot to bring much better broadband into rural NZ, but everyone including the government knows more needs to be done," Microsoft's national technical officer Russell Craig says.

"There's lots of activity looking at ways in which those areas in the country that don't have good broadband, particularly in farming communities, can get it. That's a problem that will be resolved through a mixture of different technologies including

cellular, satellites, more local wireless providers, and from a Microsoft perspective a technology called TV White Spaces. This refers to the unused radio spectrum below 700Mhz, once used for analogue TV transmission.

How will the IoT benefit dairy farming?

The European Union estimates that for agriculture, the IoT will allow an income increase of about 20% and a reduction in expenditure of 10-20%. A third benefit is to demonstrate a reduction in environmental impact and environmental improvement as new measurable data becomes available.

Some IoT examples from New Zealand and further afield, that are already here, or on the way:

- **Livestock location tracking:** An animal's location can be tracked with the help of an IoT collar or ear tag, which is GPS and RFID-enabled. As well as location, monitoring a cow's movements can be used in heat and lameness detection, and with the right equipment, stock can be excluded from specific areas. It is an essential part of Halter's fenceless farming system.
- **Heat detection:** There is a range of IoT heat detection devices as reported in last month's column, which fall into one of three categories:

1. Rump contact devices activated by bulling;
2. Monitoring of cows' activity and other behavioural or physiological changes associated with oestrous; and
3. Monitoring of teaser bulls' behaviour associated with oestrous. Most of these monitor behaviour and alert farmers of oestrous, with some activating drafting of cows ready for mating.

- **Calving monitoring**: A Moocall Calving Sensor, fitted to the cow's tail to assess motion synonymous with calving, sends a text alert to the farmer's phone, about one hour before calving. From a laptop or smart phone, farmers can review calving history for each cow.
- **Animal health:** American company VitalHerd has under development a wireless inter-rumen bolus which measures core temperature, heart rate, respiration rate, and stomach-contraction, rate every 15 minutes. Data is transmitted wirelessly to VitalHerd's cloud-based herd-management software, to assess illness, heat stress, oestrous, calving status, rumen health. The boluses remain in place for the animal's life.
- **Soil and atmospheric monitoring:** Farmote's "motes" are solar powered poles which contain sensors for atmosphere, pasture, and soil monitoring, and are permanently positioned in paddocks. Sunlight, temperature, relative humidity, atmospheric pressure, soil temperature, and soil moisture is recorded. Motes automatically upload data to a mobile-friendly web site via a LoRaWAN network.

Automatic stand alone weather stations like this Harvest Standard model present live data from the Harvest web page on computer or smart phone. (Photo supplied by Harvest).

- **Milk monitoring:** Palmerston North company Levno's dashboard for farmers displays plate cooler milk inlet and outlet temperatures; cooling water inlet temperature, silo milk temperature, milk volume as per cent of the silo's capacity and in litres, agitator status, milking status, and more. Levno signed up as Spark's first IoT customer and is working with Spark to extend coverage.
- **Fuel storage monitoring:** "Levno for Fuel" monitors fuel volume in farm tanks and stores this data in the cloud. Volume, in litres and percentage of tank volume; as well as positive and negative changes, (deliveries and discharges) are updated on the dashboard. Levno uses the LoRaWAN network.
- **Electric fence monitoring:** Gallagher's "Dashboard Fence" monitors the voltage and current from the energiser and up to six fence zones. Alerts can be set for each. Daily, weekly, and monthly graphs can be accessed; and the energiser turned on and off from a smart phone.
- **Water storage monitoring:** Gallagher provide one of the wireless water storage monitoring systems available in New Zealand. Tank water volume data, as measured by pressure, is sent from up to nine tanks to a display unit mounted in a convenient place. A water pump can be activated automatically to replenish any tank.
- **Water meter telemetry:** Harvest is one of the companies which provide water meter monitors to present real time water usage data, with this being sent to the council for consent purposes if required. The stand-alone unit meets council regulations and has inputs for two flow meters, is solar powered, and uses the cellular network to send data to the Harvest web page.
- **Irrigation:** Precision Irrigation's Fieldnet app allows remote monitoring and control of irrigators. They can be started, stopped, application rates can be changed, and variable rate application plans modified, based on soil moisture data. Harvest provide a system which will turn off an effluent irrigator's pump when there is a misfunction.
- **Self driving tractors**: In 2016, John Deere alone had about 200,000 self-driving tractors around the world. JD claimed a productivity increase of at least 10% with self-driving tractors, which are equipped with GPS and low-Earth satellite telematics navigation systems. This allows them to drive more accurately, avoiding overlaps and so not double sowing, or harvesting already covered rows.
- **Weather stations:** Data from Harvest automated weather stations is transmitted on a 3G cellular network, and displayed on a web page. From the farm's stand-alone base station a network of other IoT units can be built around the property using UHF radio. They are connected to the internet via the base station. Live data is displayed on the Harvest web page via computer or smart phone.
- **Security:** There are security risks for our farmers, not so much in terms of the damage that can be done, but more privacy concerns.
- **The future:** "The challenge is for farmers to dive down into all of this data and emerge with better decision-making", Dairy NZ Scientist Brian Dela Rue says.

"Middleware, a broad term for software with built-in artificial intelligence to gather big data and analyse and learn from it, promises to be the answer and work is emerging in this space. It's potentially capable of pulling together data required for smart, timely decisions, weigh up the trade-offs and suggest tactical options.

"The major challenge is to ensure that using this software is simple and it leads to improved decision making."