Water is a precious commodity. As the number of people living in the UK grows and weather patterns change, access to water becomes ever more important. Depending upon where you live, your water will come from different sources. Those in Birmingham, for example, have their water supplied from reservoirs in mid Wales. In the South East, water is more likely to be abstracted from boreholes. But what is important to all water companies is ensuring that as much water as possible reaches the consumer’s tap.

Minimising leakage has been at the top of the water industry’s agenda for the last decade. At the turn of the Millennium, leakage from the network maintained by the 24 water companies in England and Wales was in excess of 3300 million litre/day. A combination of consumer pressure in response to higher water bills and regulation by Ofwat – the Water Services Regulation Authority – saw water companies paying closer attention to the problem. Although the amount of water lost through leaks is 35% less since the mid 1990s, there is always more to be done – Ofwat’s 2009/2010 report stated leakage averaged 9.7 million per km of pipeline per day.

The problem is partly due to the UK’s ageing water distribution network. Much of this was installed many years ago using cast iron pipework. Inevitably, time has caught up with the pipes, which can develop pin hole leaks anywhere along their lengths or at the connections. More obvious are the water main bursts, which can see roads collapse.

An obvious solution is to find the leaks and fix them, but that is a task akin to ‘painting the Forth Bridge’; as soon as leaks are fixed, others will appear. While water companies are replacing cast iron with polypropylene, the new installations are still prone to very small leaks.

So what can be done? The answer is to control water pressure. By keeping water pressure to a minimum, leakage can be reduced significantly. And further benefits include lower energy and maintenance costs.

A leading developer of water pressure management systems is i2O Water. Andrew Burrows, the company’s chief technology officer and winner of the 2010 British Engineering Excellence Award Grand Prix, said: “Companies will never fix all the leaks because there are thousands of very small leaks; the only way to reduce leakage is to reduce pressure. But water companies still need the ability to identify big leaks and to fix them quickly.”

Burrows cofounded i2O Water in 2005 with Adam Kingdon to develop innovative solutions to the leakage problem. After initial trials with Severn Trent Water in 2007 reduced leakage by 26%, the company’s first commercial systems were installed the next year.

Cutting water main leaks is all about managing pressure in the pipes. By Graham Pitcher.
power and autonomous; they can operate without comms links because you can’t rely on comms being available.”

Data is communicated to a server based management platform, where it is integrated with third party data. “There’s an element of intelligence in all the devices,” Burrows pointed out. “If it thinks there’s a burst, it will escalate the information to the next level. This minimises the amount of processing on the device itself.”

But it’s possible that there will be more local processing in the future. “With the continuing development of ARM based microcontrollers and sophisticated power management capabilities, we are starting to build algorithms that will work locally on the devices, but I don’t believe they will compete with the server based processing model.

“I like to keep intelligence in the centre. I like devices to report by exception and the system has the ability to look ‘sideways’. There may be high demand for water because it’s a hot day and everyone is using their sprinklers. It can’t be a leak because the whole area has increased its consumption.”

The i20 system is all about identifying leakage, including bursts. “We’re looking for water flowing where it shouldn’t be,” Burrows explained. To achieve that goal, more and more sensors are needed in the network. “More data means more intelligence is available,” he said, “and we’d rather drive the cost down to get more data than increase the amount of intelligence at the device.”

Neither does Burrows set great store on communications other than by gsm. “The water industry is still reliant upon gsm,” he claimed. “Mesh networks aren’t feasible because the devices are underground. A lot of wireless comms protocols can’t cope when the next device maybe two miles away.”

Another i20 solution is pump optimisation. “These are big systems,” Burrows noted. “One pumping station in London supplies 500,000 customers. We can integrate a hardware/software solution on the pump, learn its characteristics and adjust the manifold pressure through variable speed drives. Not only does this save water, it also saves energy.”

One of i20’s latest customers is South East Water. With more than 2m customers, the company delivers 565m litre/day of drinking water through more than 14,000km of mains.

Keith Hilson is head of leakage. “Over the last 15 to 20 years, we have been installing pressure reducing valves (PRV) to deliver water at a more constant pressure to customers in about 1200 district metered areas (DMAs). However, we knew we could go further with optimisation.”

The company’s hand was forced, to a certain extent, with the drought at the beginning of 2012. “We looked at options to manage the situation,” Hilson noted, “and one was i20 because we had been trialling its technology for the previous two years.”

South East Water ordered 200 PRV systems, allowing it to optimise water pressure over a wider area. A DMA can be isolated from the water
network by valves, allowing the amount of water flowing into and out of the area to be metered. This tends to be done at night, when water consumption is at its lowest – providing the so-called night line figure. Because consumption is so low, most night line flow is from leaks.

PRVs work by cutting water pressure to the minimum service level.

“There is a powerful relationship between pressure and leakage and burst frequency,” Burrows asserted. “By monitoring what’s happening and controlling it, we can reduce water pressure.” On top of that is optimisation, where a learning algorithm allows the optimum pressure at any time of day to be determined. “Nobody else is doing this,” Burrows claimed. Hilson said a 10 to 14 day data collection and optimisation period is needed for the learning process.

PRVs are placed at so called critical points in the network where pressure is lowest (see fig 1). “Water companies know where these points are,” Burrows said, “either through modelling the network or from historical knowledge. We put loggers at multiple critical points, which allows us to learn the relationship between time of day and pressure loss. The output is the pressure needed to maintain the minimum service level.”

It’s not a closed feedback loop though. “Closed loop solutions have been tried with various degrees of success. Closed loop control depends on feedback,” Burrows said, “and you can’t rely on that in the water environment.”

“The i2O system allows us to control pressure based on demand,” Hilson continued. “But it was a £1.5m investment and we have to show a cost benefit. The first 30 systems showed a night line saving of around 500,000litre/day and a demand reduction of around 1m litre/day. In all, we are expecting a 5 to 6m litre/day reduction on the night line and 10m litre/day in demand.”

But South East Water isn’t alone in looking to reduce leakage. Thames Water has been deploying technology for more than 10 years, alongside upgrading its network.

Recently, it has installed a TaKaDu infrastructure monitoring system across London in a move to help locate where leakage is most prolific. The system creates what Thames Water calls a ‘smart grid’ to detect ‘hot spots’. Using this, water flow and pressure changes can be monitored and analysed to flag up potential problems.

TaKaDu says its approach to water network monitoring is ‘unique’: it makes use of all available data sources, including the utility’s sensors, meters and data systems, as well as publicly available data, including weather, holidays and special events.

Mathematical and statistical algorithms, developed specifically for handling water network data, are applied and this allows each network element’s ‘normal’ behaviour to be established, as well as the performance of network as a whole. From these baselines, network behaviour can be assessed in real time. Any deviations between observed and expected behaviours are analysed by further algorithms to rule out benign explanations.

Once an event is identified, hydraulic and mathematical processes are applied to determine what type of event, its magnitude and location.

Commercial director Piers Clark said: “Although we will never be able to prevent every burst, we have come a long way in the last couple of years to help get problem areas fixed before they become disruptive.

“Clearly, it is only the burst pipes which people know about and we know we still have a long way to go in upgrading our network. But this technology allows us to better manage what we do have. Not only is this system helping us to repair leaks to help prevent disruption, it’s also saving us a lot of water from being wasted – something that is vitally important.”

In 2012, the company said it had met its sixth successive annual leak cutting goal, with leakage 60m litre/day less than the figure required by Ofwat.

Meanwhile, Burrows said i2O’s pressure management approach is saving 150m litre/day of drinking water from being lost around the world.