To support their Integrated Water Supply Grid, which was designed and developed to improve resilience and security of supply in their region, Wessex Water recognised the need for a sophisticated control system. The Servelec Technologies pump optimisation system OptiMISER was identified as the best tool for this function and has been in use in the Control Room since September 2014. Since then it has been controlling pumps and valves across the Warminster area, ensuring pro-active optimal management of that part of the network, as a precursor to full implementation over the Grid.

The system has been expanded by Wessex Water since the original Phase 1 implementation. As of September 2016 it covered 18 sites. Wessex Water themselves are continuing to extend the area under control to incorporate their new Integrated Water Supply Grid.
• Improved security of supply and contingency planning
• Efficient management of assets in a complex transfer and distribution system
• Cost savings made by avoiding periods of high energy tariff
• Optimal outage planning
• Reduced call outs out-of-hours

Process
Model Configuration

Underlying the system is a model of the relevant area of the network. The model schematic for part of the Phase 1 area in Wessex Water is shown in Figure 1 below. Models are constructed using the OptiMISER Client interface, with configuration data typically including:

• Abstraction limits including from licences, monthly plans, river flows and spring yields
• Costs for chemicals and sludge treatment, and electricity tariffs
• Pump performance data and operating rules for pump switching and rotation
• Maximum/minimum flows/pressures, maximum rates of flow change
• Sweetening and conditioning flow requirements
• Service reservoir capacities, operating limits and target levels

Telemetry Data Connection

Digital and analogue signals are imported every 15 minutes to provide the current network state, including recent flows and pressures and prevailing reservoir levels, pump running/stopped status and availability, and digital alarms. The context of OptiMISER interacting with users and other systems is shown in Figure 2.
Analogue data are validated against a range of parameters before use and replaced if necessary. These data are processed to produce historical and predicted reservoir volumes, flows (e.g. to monitor daily licence usage) and demand values. Auto-regressive and exponential smoothing algorithms are used to forecast demand from the recent demand series at 15-minute intervals over the coming period. Telemetry alarms, such as in response to poor water quality, TRIAD warnings and pump outages, are imported via digital signals and used directly by OptiMISER to modify constraints within the model.

The same telemetry connection is also used to export control instructions from OptiMISER to the SCADA system for immediate implementation. Instructions can be issued in the form either of analogue signals, such as flow rates, or as digitals to control pump and valve status. Pump control can be applied either at the individual pump or pump set level.

**Optimisation**

Every 30 minutes, an optimisation of the network is carried out. Flow, reservoir volumes and where necessary network pressures are considered as variables in the optimisation problem. A mixed-integer solver is used to optimise the network over the whole horizon taking account of forecast demands and planned outages.

Multiple optimisation goals are considered in a prioritised sequence. Meeting demand is typically considered at highest priority. Although minimising cost is a key aim of OptiMISER, this is often configured at lower priority than respecting reservoir targets and operating limits but may be at higher priority than aiming to minimise pump switches, for instance. The sequence of priorities is fully configurable and goals can also be weighted against cost where appropriate.

**Control Room**

Output is in the form of flows, pump statuses, and reservoir levels planned at half-hourly steps over the coming 48-hour period. The optimisation results, as well as the current and recent state of the network, are monitored via a set of web pages.

These web pages are interactive, allowing Control Room staff to make operational overrides. For example, operators can review and approve schedules, or specify overrides to current and future operation.
Outcomes

Wessex Water has identified a range of benefits underpinning the success of the system. By allowing an holistic view of the supply network over the days ahead to be taken, OptiMISER has introduced profoundly different ways of controlling the water supply sources and network. As a result, security of supply and contingency planning have improved, transfer of flows and management of assets in the complex system are achieved efficiently, savings are made both directly in high energy tariff periods and through a reduction in call-outs out of hours, as confidence in the network’s flexibility has increased.

Conclusion

A range of benefits have been identified by Wessex Water and the practicality of on-line optimal control of pumps has been clearly demonstrated. Wessex Water has gained confidence in the system and are rolling it out to key parts of their network.

References

Matthew Main¹, Marcus Fowler¹, Drummond Modley²
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