Small leak and burst detection and localisation based on a data-driven hydraulic modelling framework

Sophocles Sophocleous[1], Dragan Savic[1], Zoran Kapelan[1], Chris Gilbert2, Paul Sage[3]

[1]University of Exeter, [2]Severn Trent Water, [3]WITS Consult Ltd;

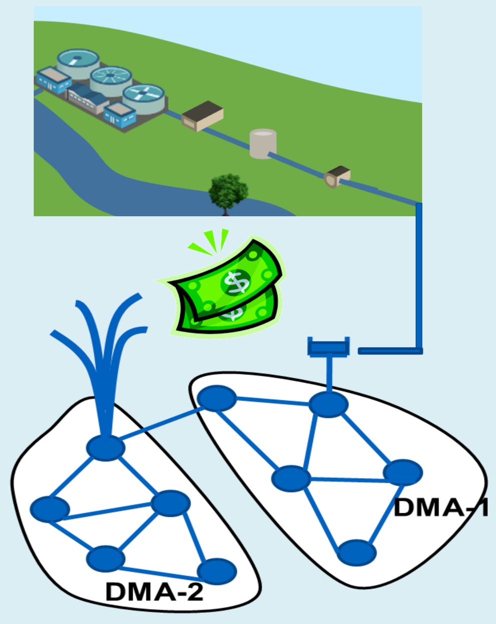
Stream
The Industrial Doctorate Centre for the Water Sector

Question: How can we respond faster to leaks and deliver efficient network operation?
Answer: Automated detection and location based on hydraulic models

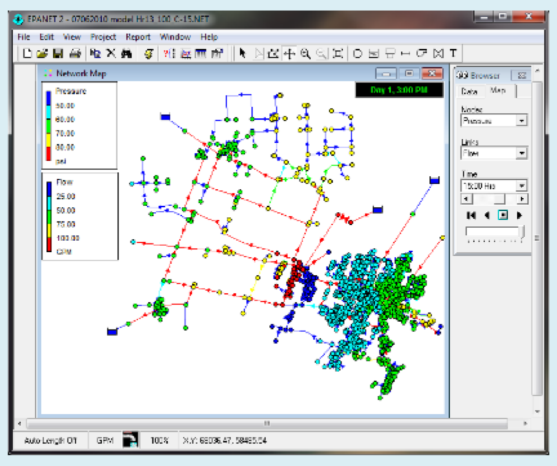
Introduction and Aims

Leak losses of up to 30% of input waste water, energy, and add to treatment costs.

Traditionally a leak is repaired only when it becomes visible. Thus, it is important to develop methods that report leaks at an earlier stage.



A leak generates a pressure and flow signature which can be used to automatically detect the leak and narrow down the search area.

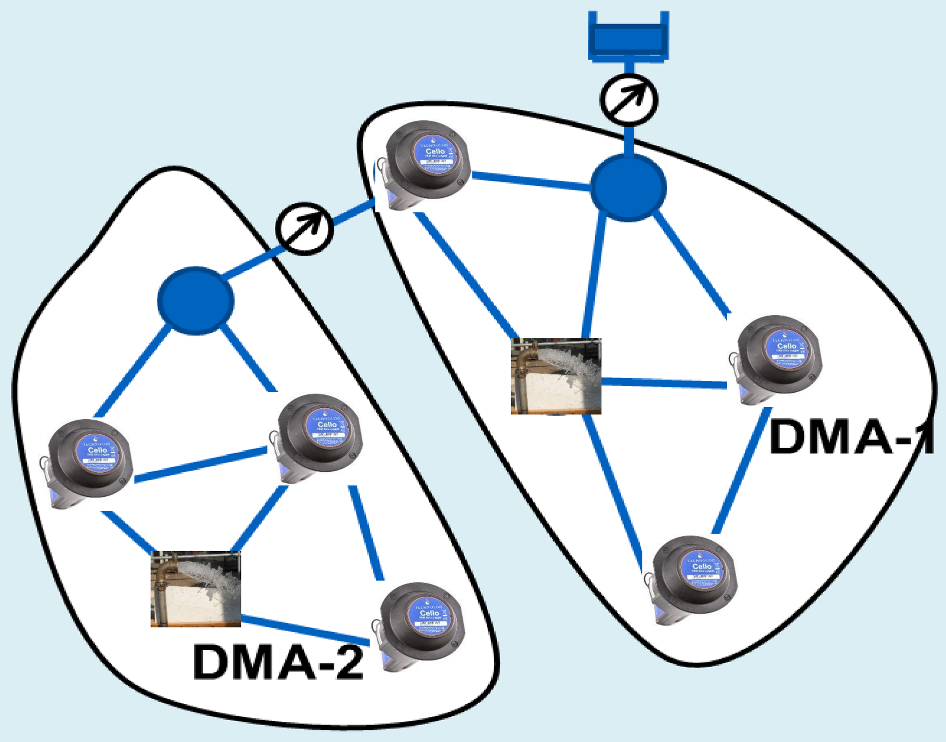


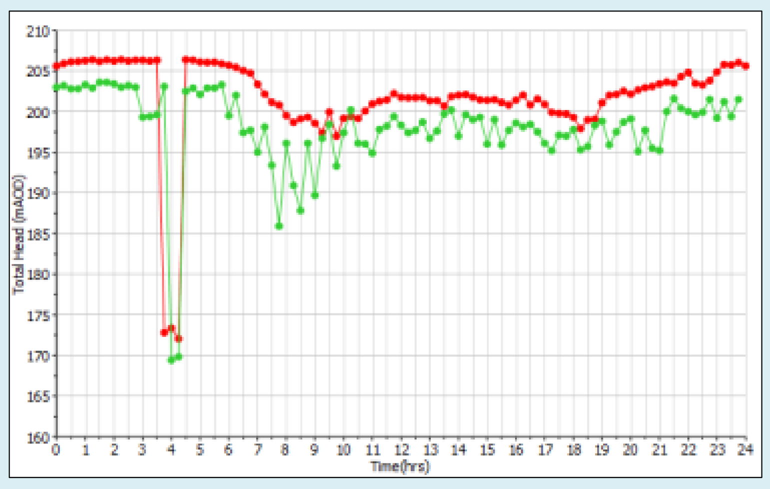
Inverse modelling methods reduce the time and leak search area [1]. The problem is difficult to solve [2], due to the coarse calibration accuracy and system/data anomalies [3].

Data Collection Strategy

Pressure sensors are installed at various parts of the DMA recording pressure variations.

Engineered events are introduced to simulate bursts and/or leaks, closed/open valves, or incorrectly calibrated models.

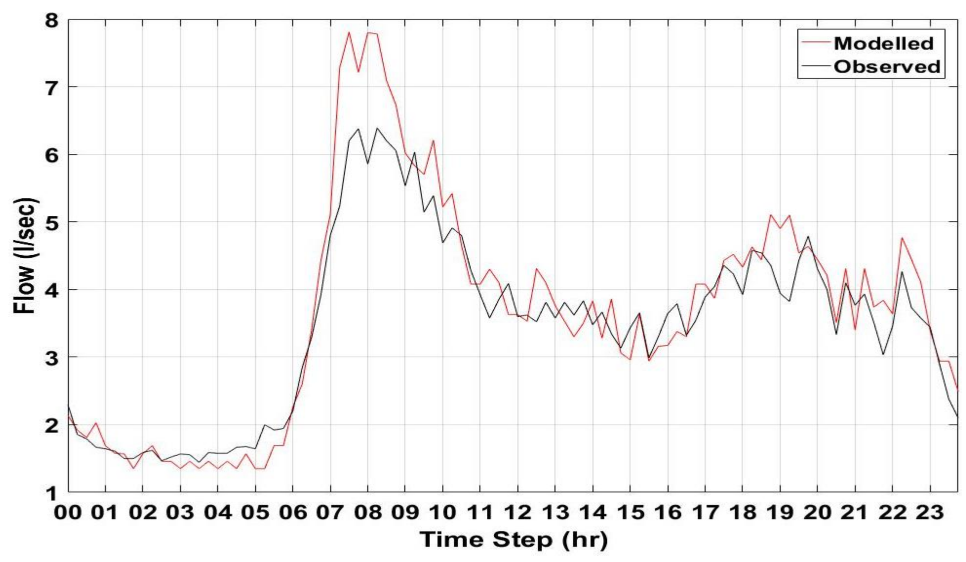




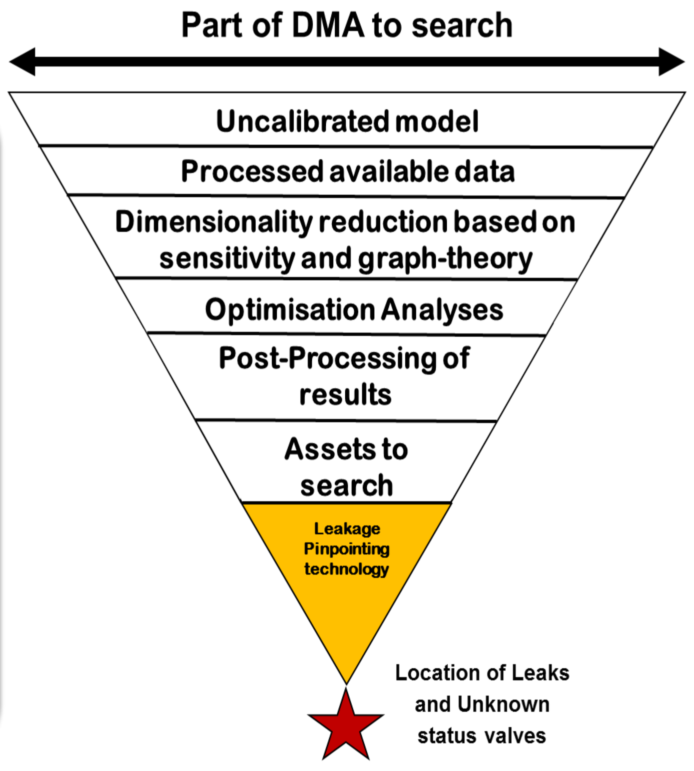
Data from field measurements, major customers and previous events are taken into account along with pipe information.

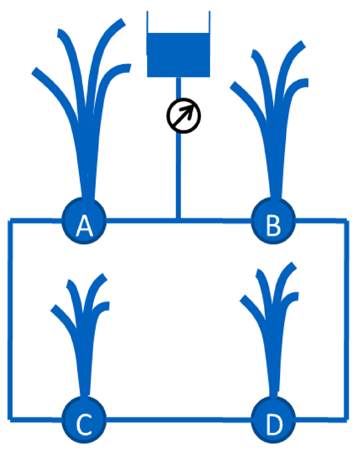
Inverse modelling for combined leak detection and model calibration

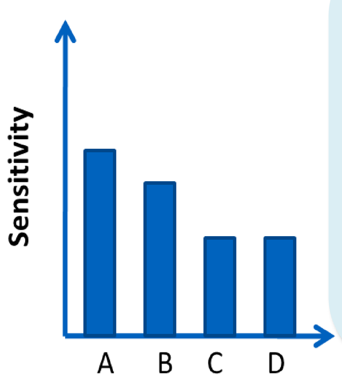
This study uses the available information, novel pre-processing algorithms and new ways of analysing the hydraulic model parameters, to reduce the dimensionality of the problem.



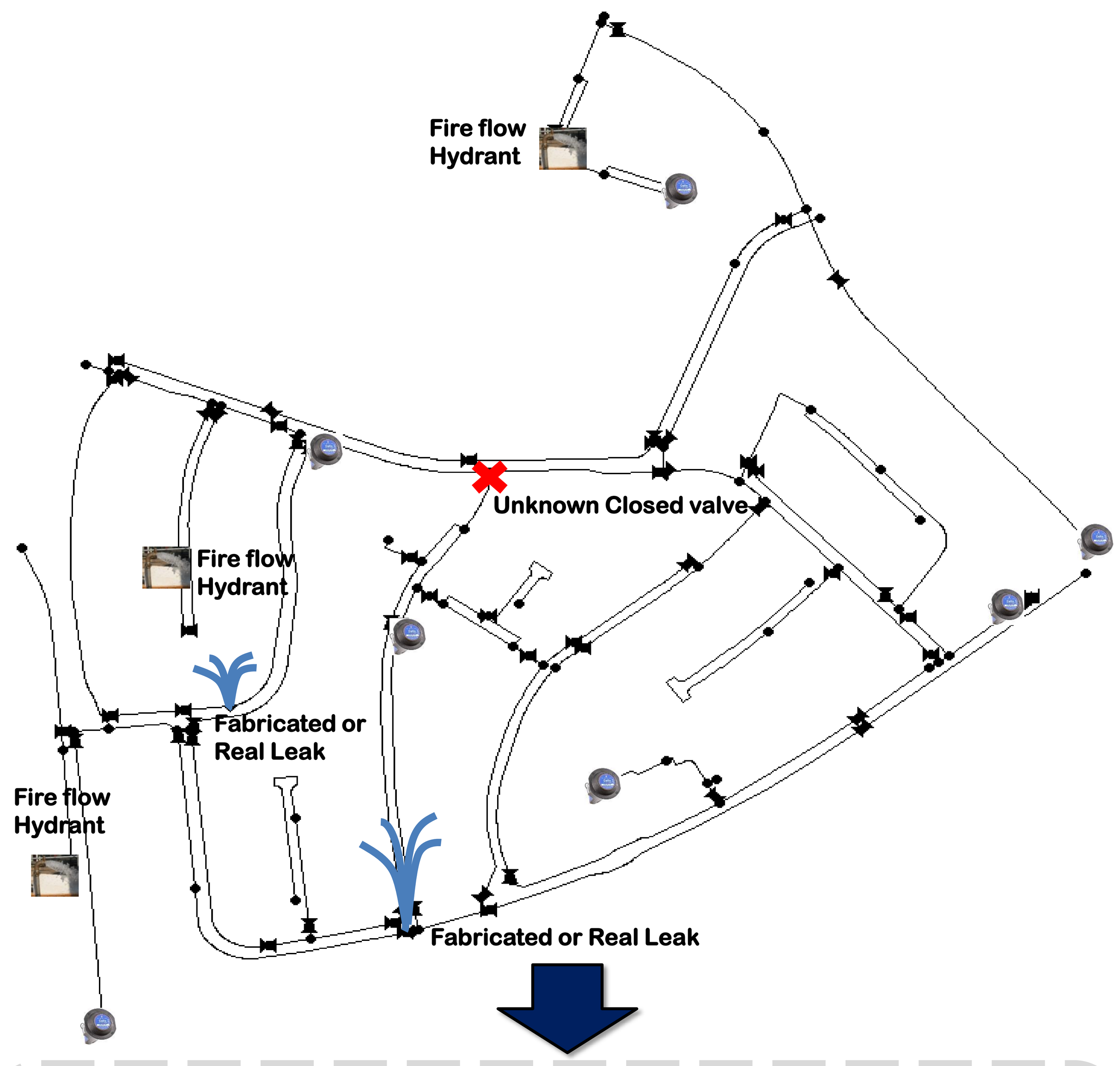
A systematic pre-processing framework is developed so that only leaks that produce a significant impact can be identified and only part of the model needs calibrating.

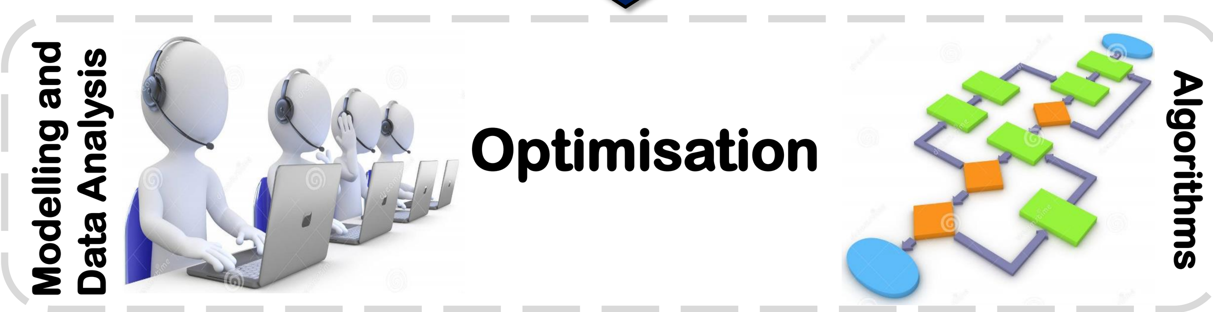




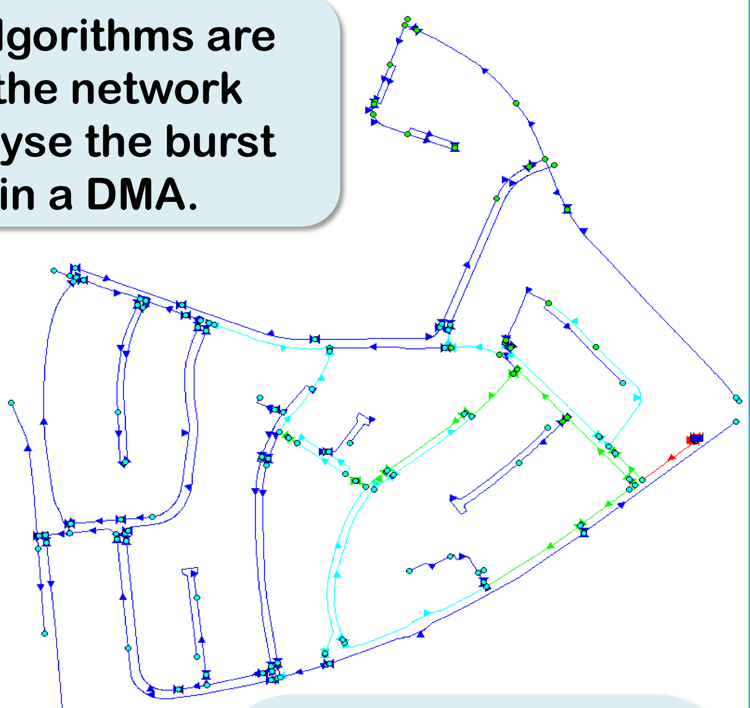


A leak is simulated at every location and the resulting pressure change is used to analyse the sensitivity to a specific scenario.

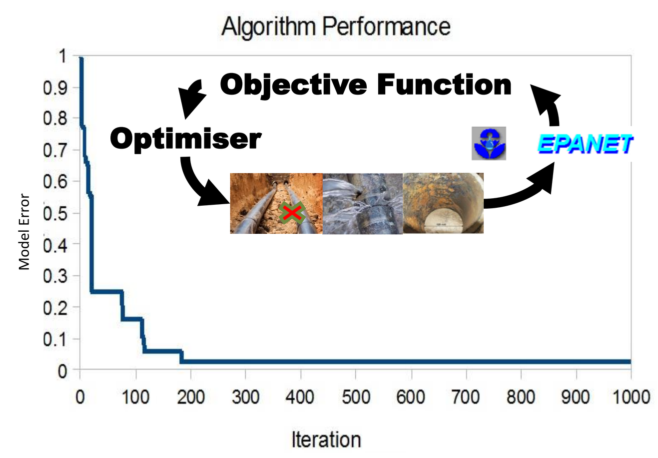




Graph theoretic algorithms are used to explore the network topology and analyse the burst signature within a DMA.

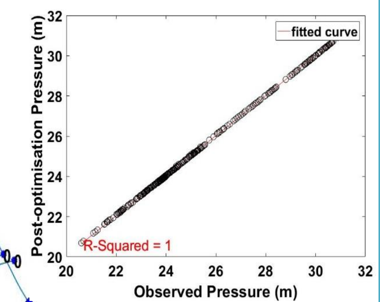


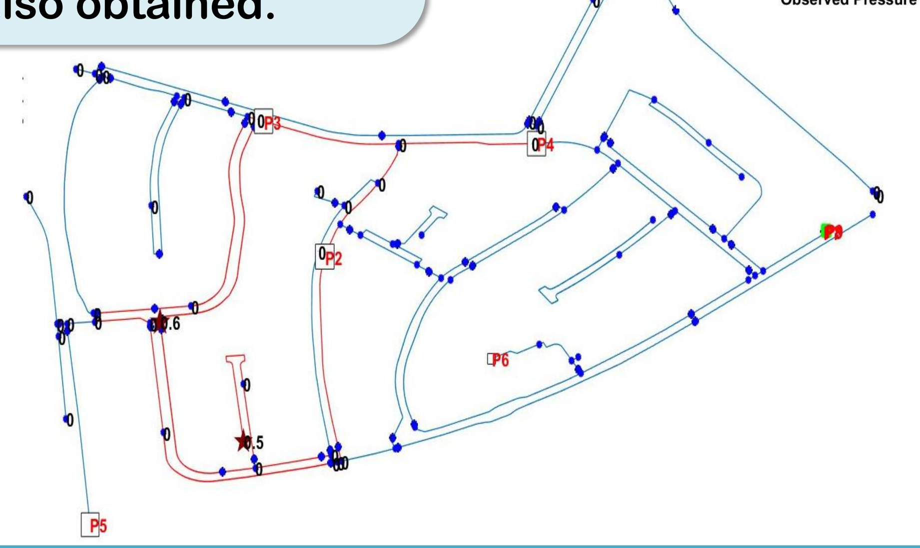
The narrowing down process falsifies infeasible leak scenarios and constrains the search for the leak location and the range of flows.



A hydraulic simulator is linked with an optimisation technique. The optimiser generates various solutions to match the model hydraulics with the observed data.

A post-processing analysis creates a hotspot map with the proposed leak locations. An accuracy assessment is also obtained.





Conclusion and Further Work

- The pre-processing method reduce the search for leaks by 80-90%.
- The optimisation analysis detects the state of assets quickly, conveniently and accurately, while calibrating the hydraulic model.
- The developed methodology can improve leak detection and identification, acting as a support tool for network operations and the prioritisation of repairs.
- Next steps will validate the methodology using real field data.

References

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University of Exeter Centre for Water Systems — Severn Trent Water — WITSConsult Ltd — EPSRC Engineering and Physical Sciences Research Council

For further information: ss694@exeter.ac.uk