TSNet: Transient Simulation for Water Networks

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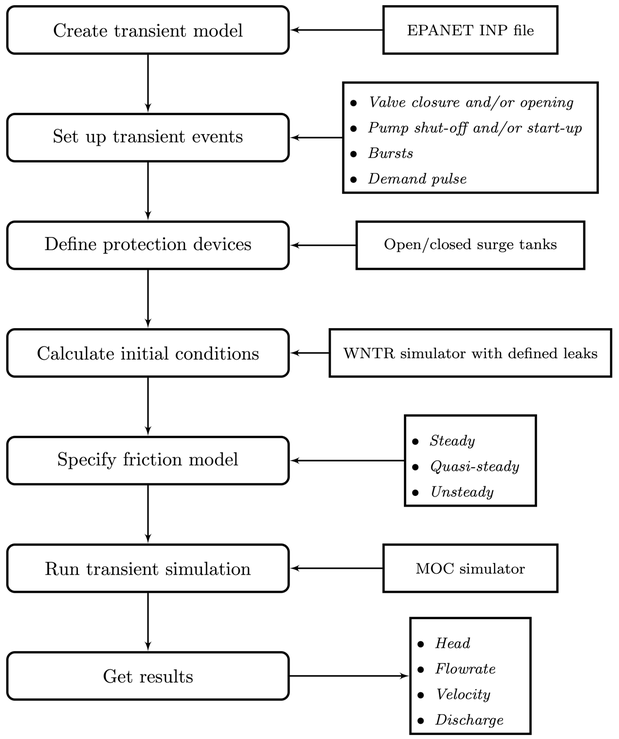
Abstract To facilitate the integration of transient simulation in these simulation-based applications, this paper contributes the first, general, and open-source implementation of transient simulation software: Transient Simulation in water Networks (TSNet). TSNet , a Python package that can be freely downloaded from PyPI, provides capabilities of simulating various transient events in water distribution systems. TSNet not only provides transparency needed by the research community, but also presents a platform where users and developers can further develop, improve and extend the existing transient model.

Keywords: transient simulation; open-source software; Python; water distribution networks

Methods

- Hydraulic modeling of pressure transients in water distribution networks (WDNs) has shown increasing promises in various applications, such as WDN design, fault detection, and risk assessment.
- Lack of open-source software implement the development of transient-based methods.
- This paper contributes a Python software for transient simulation using method of characteristics (MOC).



Results

- The example application demonstrates the multiple capabilities of TSNet on an example network.
- The wave speed for all pipes are set as 1200m/s.
- S1 simulates pipe burst at Junction 73, which starts at 1s and takes 1s to fully develop to the final burst coefficient of $0.01m^3/s/(mH_2O)^{0.5}$;
- S2 models the linear closure of Valve-1 within 1s;
- S3 predicts the impacts of PUMP-1 linear shut-off within 1s;
- S4 simulates the background leak at Junction-20 with leak coefficient of $0.01m^3/s/(mH_2O)^{0.5}$.

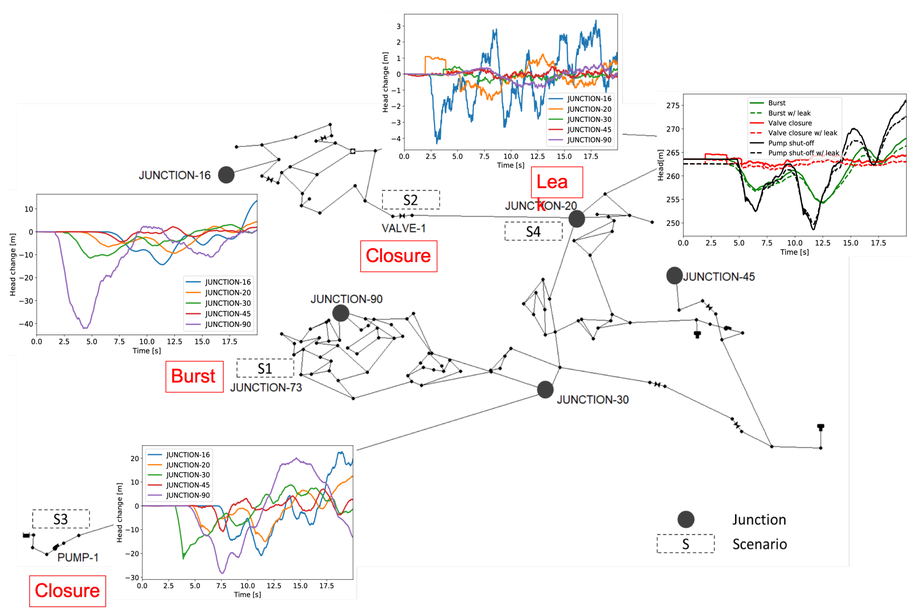


Figure 2: Simulation results on an example network

Conclusions

- TSNet provides a an open-source and freely-available Python codes for simulating transients in WDSs.
- TSNet is a Python package with the following capacities:
  1) read INP files and establish initial conditions,
  2) perform transient simulations under various conditions, i.e., valve and pump operations, leaks, and bursts, with and without surge protection devices
  3) obtain, visualize, and post-process results.
- TSNet not only provides transparency needed by the research community, but also presents a platform where users and developers can further develop, improve and extend the existing transient model.

Bibliography

Chaudhry M. H. (2014). Applied Hydraulic Transients, ISBN 978-1-4614-8537-7. New York, NY: Springer New York.

Wood, D. J., Lingireddy, S., Boulos, P. F., Karney, B. W., & McPherson, D. L. (2005). Numerical methods for modeling transient flow in distribution systems. *Journal of American Water Works Association*, *97*(7), 104-115.

Xing, L., & Sela, L. (2020). Transient simulations in water distribution networks: TSNet python package. *Advances in Engineering Software*, *149*, 102884.