Security Assessment of Gas-Electric Networks

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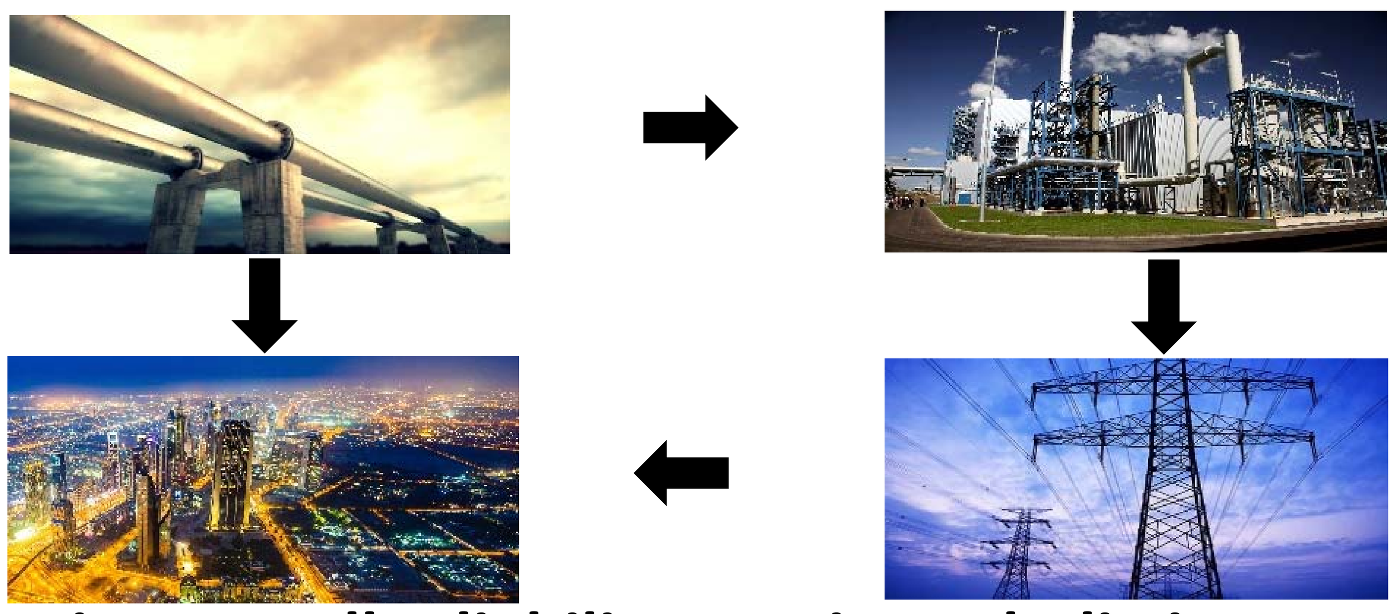
1. Motivation

Interdependence between gas and power networks



Ensuring overall reliability requires a holistic approach

2. Research Questions

1. How can security be achieved in a transient gas network?
2. How can security in the gas network affect the operation of the power system?

3. Gas Network Operation and Security

Transient Gas Flow is described by partial differential equations:

$$\frac{\partial p}{\partial t} = -\frac{c^2}{A}\frac{\partial m}{\partial x},$$

$$\frac{\partial m}{\partial t} + A\frac{\partial p}{\partial x} = \frac{-fc^2 m|m|}{2DAp}$$

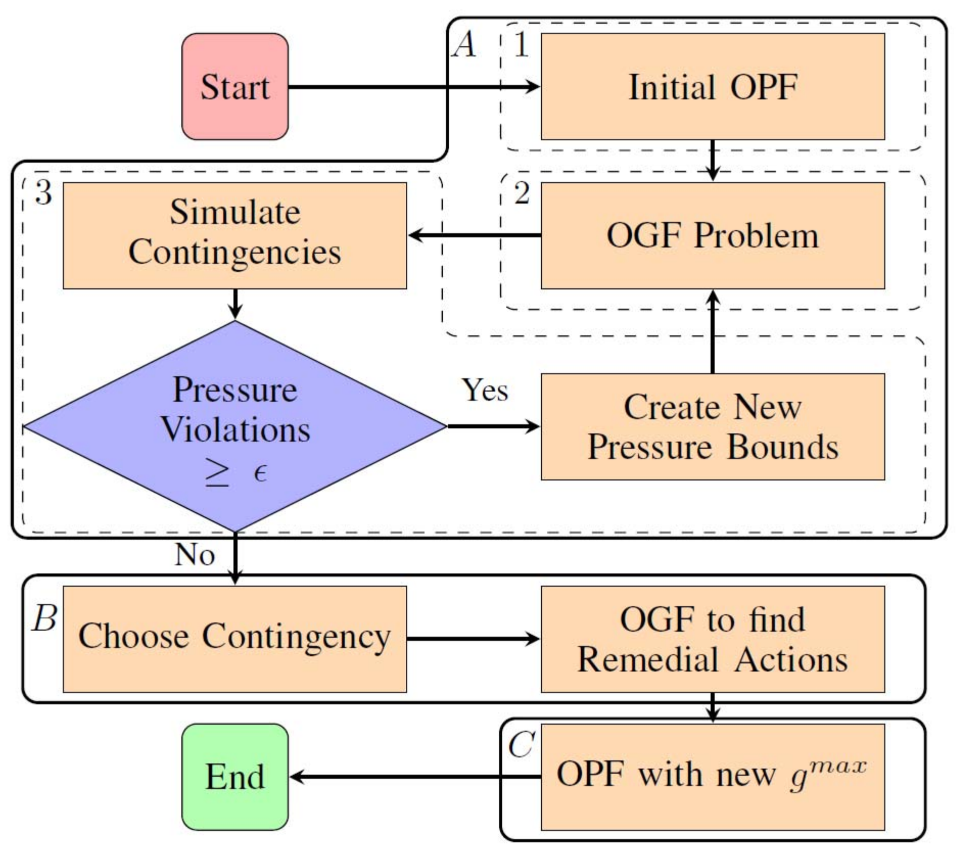
Gas can move at approximately 30km/hr.

Linepack is the total gas in the network. The transient behavior allows for a mismatch between supply and demand through the day as excess is *stored* in the network.

Pressure Cover ensures that no pressure violations occur for a specified amount of time after a contingency occurs. This wait time reflects the lead time required to take appropriate actions.

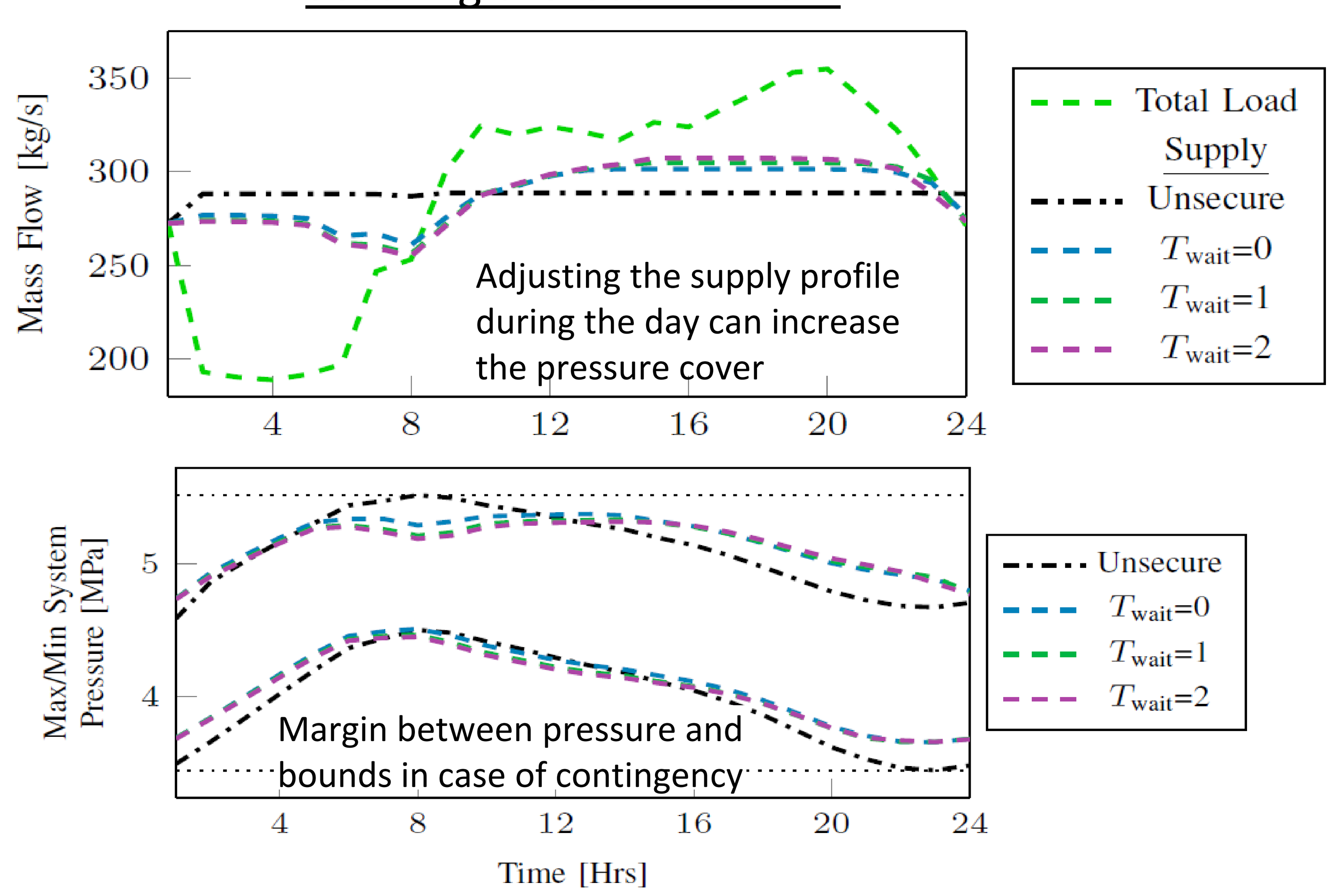
The Optimal Gas Flow (OGF) Problem is to control the compressors and supply to the network such that the network pressures do not exceed their limits under the transient flow conditions.

Analysis Framework to achieve security

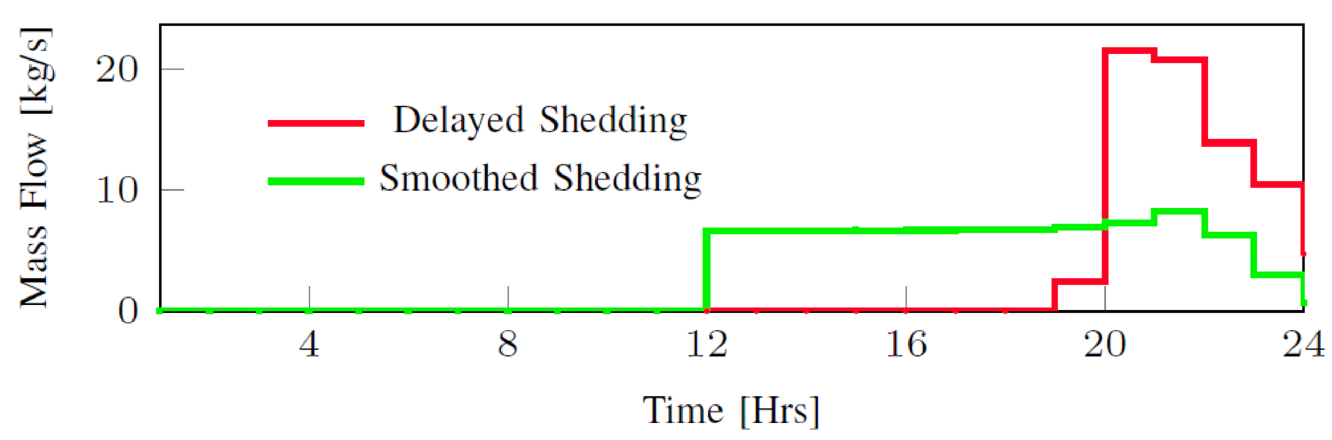


4. Results

Securing the Gas Network

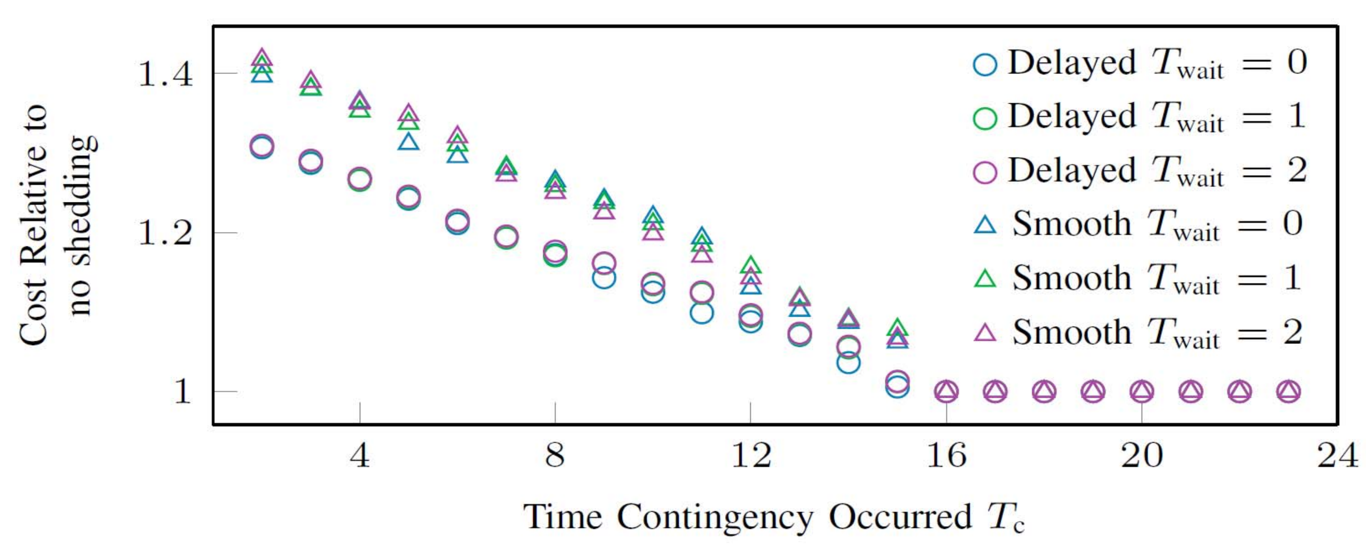


Gas Generation Supply Shed Following Contingency



Total Load shed is the same but with different magnitudes during the day

New Economic Dispatch Costs due to reduction in Gas Generation



Smoother load shedding results in a higher cost of operation for the electrical network

5. Conclusion & Future Work

- Include the temporal constraints on the power system such as the unit commitment problem and generator ramping limits. Furthermore, uncertainty during the real-time operation also needs to be studied.
- The initial economic dispatch of the power system may result in a scenario where it is not possible to achieve security in the gas network. The information required to rectify this scenario needs to be chosen and communicated effectively between the network operators.
- The spatio-temporal characteristics of the gas network could allow for gas load to be increased in parts of the network while load is being shed in other parts of the network. A more sophisticated load shedding scheme could reduce the impact on the cost of power system operation