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End-to-end delay analysis for networked systems

Key words: Networked system, End-to-end, Delay distribution

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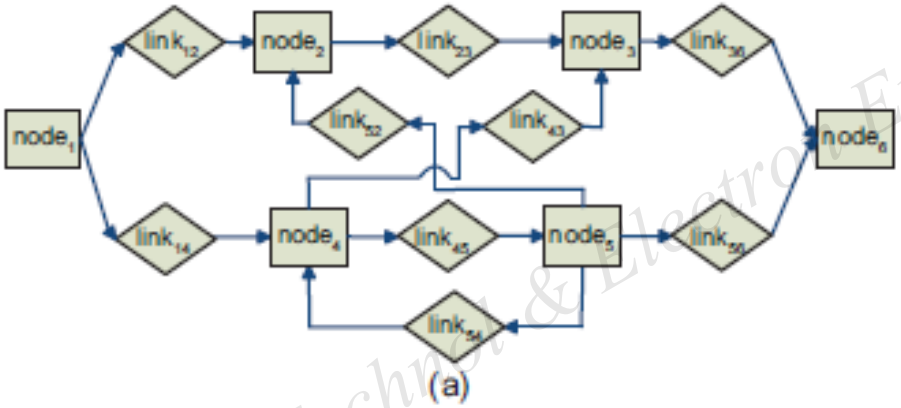
Introduction

- There is an urgent demand for methodologies to efficiently analyze the end-to-end delay distribution for large-scale networked systems.

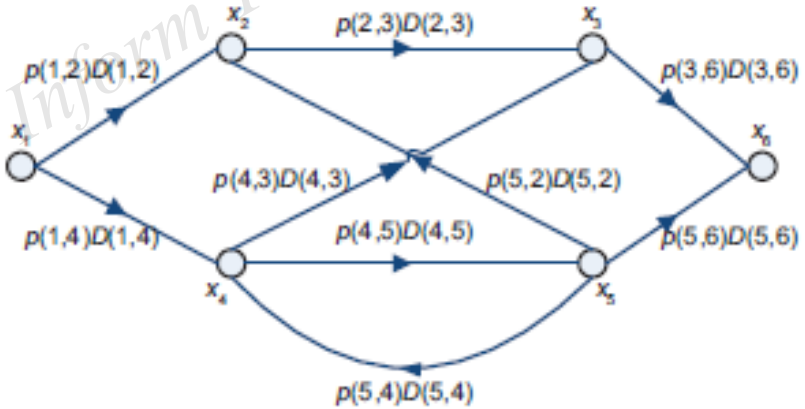
- Traditional methods based on time domain analysis are not convenient for large-scale networked systems.

- A new theoretical framework for end-to-end delay distribution analysis of networked systems through frequency control theory has been presented in this work.

Signal flow graph model



(a)



(b)

Fig. 1 A networked system architecture: (a) nodes and links; (b) signal flow graph

Obtain e2e delay from the responses

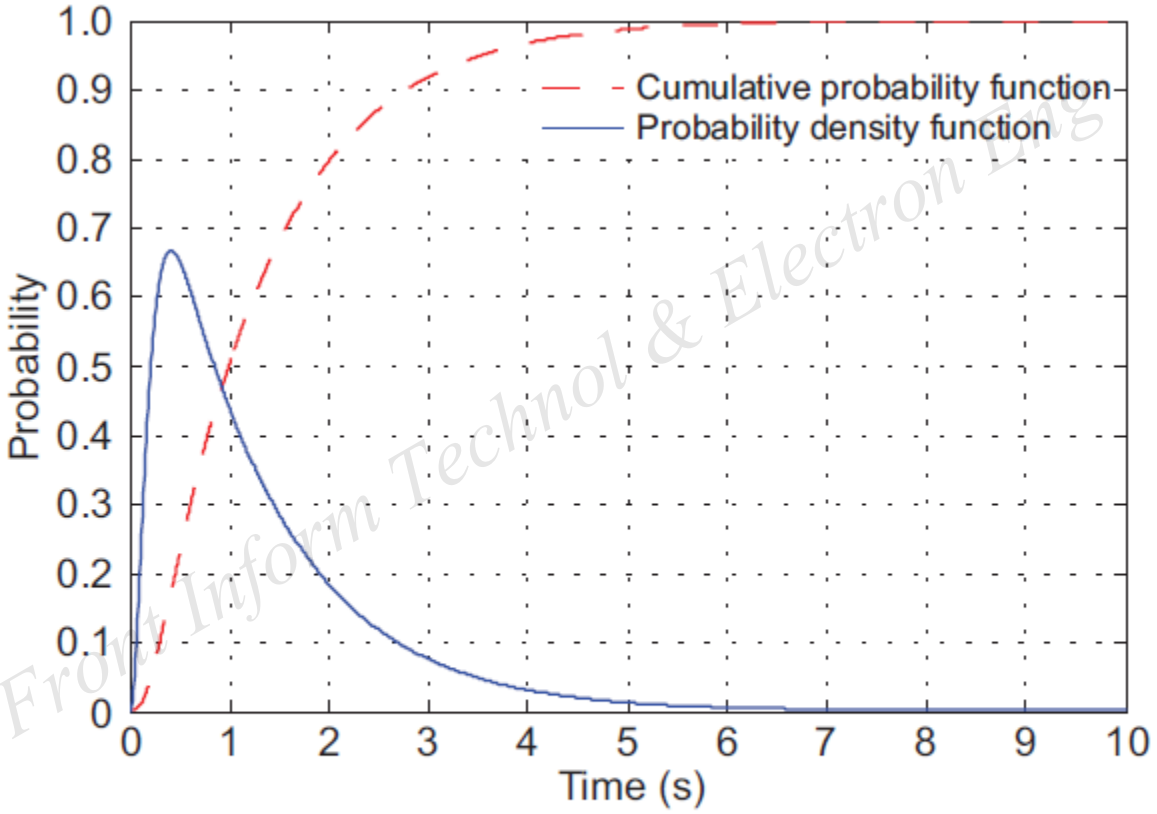


Fig. 2 Probability density function and cumulative distribution function of end-to-end delay

Case study (1)

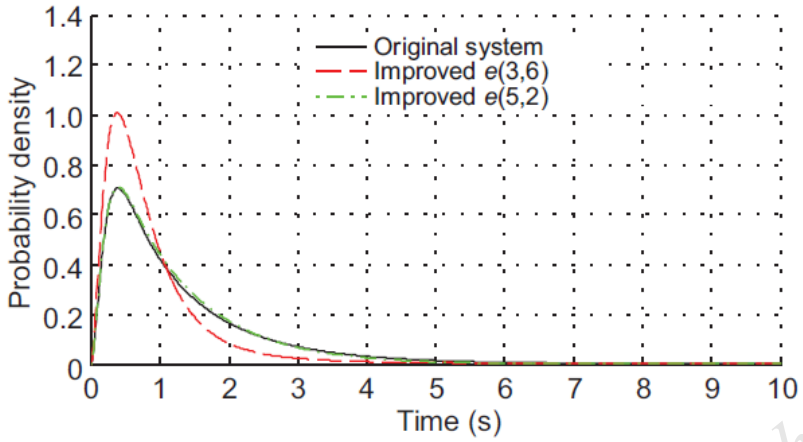


Fig. 3 The impulse response of the example system after improving a few links

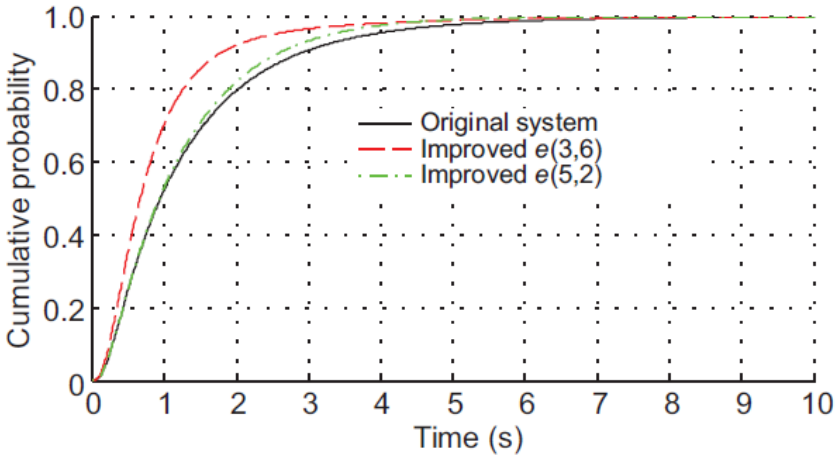


Fig. 4 Step response of the example system after improving a few links

Case study (2)

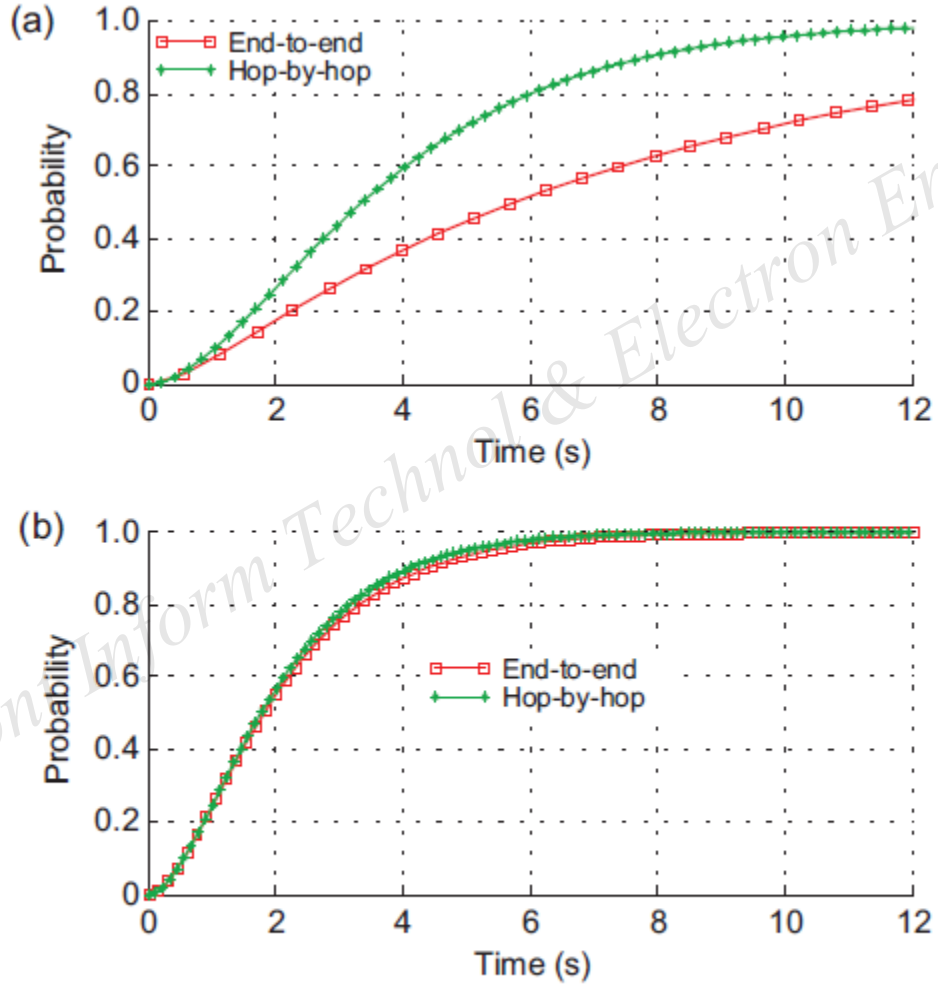


Fig. 6 Delay distribution under link loss probability p=0.5 (a) and p=0.05 (b)

Conclusions

- The proposed framework which analyzes the end-to-end delay distribution for networked systems in the frequency domain is efficient.
- Based on our framework, we efficiently work out the bottleneck links.
- We use our framework to analyze network protocol performance and achieve good results