An Intelligent Transportation System (ITS) Approach to Teletraffic Engineering

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1. Problem Statement

Software-Defined Networking (SDN) is a networking paradigm aiming to separate a network's control plane from its data plane and centralize control logic into a single place [1]. The paradigm is motivated by the fact that new routing protocols are incredibly difficult to deploy, as well as that replacing IP entirely is considered infeasible in practice [1]. Wireless Ad-Hoc Networks (WANETs) are composed of autonomous nodes, and in contrast to software-defined networking, communicate with decentralized (rather than centralized) control logic [2].

Despite fundamental differences, *teletraffic engineering* practices, which explore similarities between routing packets and navigating cars, can be applied to both technologies. For instance, research has previously applied game theory to both SDN [3] and WANETs [4]. Therefore, the guiding question for this project's research asks *how can teletraffic engineering approaches improve strategies for SDN or WANETs)?*

2. Previous Work

Cooperation [5] and game theory [4] have both been previously explored in WANETs. However, existing work in game theory applications to ad-hoc networks struggles to reconcile game theory's core assumption of players acting rationally with cooperative behaviour in areas such as peer-to-peer networks [4]. In contrast, Liu et al.'s work on trustless SDN notes that this lack of trust is a threat to overall performance, particularly when dealing with selfish actors [3].

3. Methodology

Building upon recent research, I will select a communication networks protocol from the area of WANETs or SDN which can benefit from improvements from the domain of intelligent transportation systems (ITS) and/or teletraffic engineering.

Using the selected system, I will attempt a small-scale replication of the performance analysis performed by the paper which introduces the system and propose further improvements inspired by teletraffic engineering, game theory, and ITS.

Lastly, I will evaluate the improved system against the existing work, comparing the two systems using a formal approach (e.g. queueing system analysis) as well as with a simulation.

4. Deliverables

i. A selected protocol

ii. Small-scale replication of existing work
iii. Proposed improvements to existing work
iv. Evaluation of impact of improvements to existing work

5. Biweekly Schedule

Week	Deliverables
W5	Proposal (Feb 7); narrow project ideas and scope
W6	Explore background literature in depth: [1], [4], [5]
W7	Biweekly update (Feb 21); present results of informal lit survey
W8	Dive deep into strategies of related work, select protocol to augment with my own ideas
W9	Midterm update (Mar 7); present progress on my improvements to the selected protocol
W10	Select simulation tools for analysis; attempt selected replication of paper results
W11	Biweekly update (Mar 21); present progress on simulation results of my improvements
W12	Complete queueing system analysis (or use another formal method)
W13	Final presentation (Apr 4); prepare rough materials for peers
W14	Final report (Apr 11); finishing touches

6. Website

https://anormananderson.github.io/teletraffic-engineering/

References

[1] D. Kreutz, F. M. V. Ramos, P. E. Veríssimo, C. E. Rothenberg, S. Azodolmolky, and S. Uhlig, “Software-Defined Networking: A Comprehensive Survey,” *Proc. IEEE*, vol. 103, no. 1, pp. 14–76, Jan. 2015, doi: 10.1109/JPROC.2014.2371999.

[2] F. Tong, “Protocol design and performance evaluation for wireless ad hoc networks,” University of Victoria, 2016.

[3] Y. Liu, J. Hua, Y. Zhang, and S. Zhong, “GameTE: A Game-Theoretic Distributed Traffic Engineering in Trustless Multi-Domain SDN,” in *2024 IEEE 44th International Conference on Distributed Computing Systems (ICDCS)*, Jul. 2024, pp. 1248–1259. doi: 10.1109/ICDCS60910.2024.00118.

[4] V. Srivastava *et al.*, “Using game theory to analyze wireless ad hoc networks,” *IEEE Commun. Surv. Tutor.*, vol. 7, no. 4, pp. 46–56, 2005.

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