

Challenges and Opportunities in Using the Age of Information for the Tactile Internet

Project topic adaptable for Oberseminar, Student Thesis, Bachelor, or Master/Diploma-Thesis



Reference: abcnews.go.com

Objective of Work

The Tactile Internet enables real-time transmission of haptic feedback, audio, and video, allowing users to interact with remote environments with near-instantaneous response. This is especially critical in applications like remote surgery, where a surgeon requires a highly stable, low-latency, and deterministic connection to control remote devices. To meet such demands, Time-Sensitive Networking (TSN) can be utilized, which offers mechanisms such as Time-Aware Shaping (TAS), Credit-Based Shaping (CBS), and Precision Time Protocol (PTP), which enable bounded latency, low jitter, and guaranteed delivery.

The thesis aims to explore how Linux-based TSN features can be used to improve the temporal relevance of transmitted data, with a focus on delivering fresh information. Age of Information (AoI) is considered an alternative performance metric to latency, aiming to assess whether it better captures the quality of experience in real-time systems. Furthermore, the thesis will evaluate whether existing TSN tools and implementations in Linux are sufficient for the demands of Tactile Internet use cases or if additional mechanisms and optimizations are required.

Focus of Work

In the thesis, the following tasks should be addressed:

- Conduct a literature review on Time-Sensitive Networking (TSN), the Tactile Internet, and the Age of Information (AoI)
- Set up and commission a TSN-based testbed for Tactile Internet applications
- Measure the AoI of transmitted packets within the testbed
- Investigate and develop AoI-aware traffic configurations using available TSN tools
- Analyze the potential benefits and challenges of using AoI as a performance metric in Tactile Internet scenarios
- Compare the pros and cons of AoI versus traditional metrics for such use cases
- Documentation and presentation of the work and results in a scientific way

Material for Further Reading

- R. D. Yates et al., "Age of Information: An Introduction and Survey," *IEEE Journal on Selected Areas in Communications*, vol. 39, no. 5, pp. 1183–1210, May 2021.
- N. Promwongsa et al., "A Comprehensive Survey of the Tactile Internet: State-of-the-Art and Research Directions," in *IEEE Communications Surveys & Tutorials*, vol. 23, no. 1, pp. 472-523, 2021
- M. Ulbricht et al., "TSN-FlexTest: Flexible TSN Measurement Testbed," in *IEEE Transactions on Network and Service Management*, vol. 21, no. 2, pp. 1387-1402, April 2024

Keywords

Age of Information, Tactile Internet, Deterministic Communication, Time-Sensitive Communication

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