Comparative Performance of TCP and MQTT

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Introduction

- **Data Transport Protocols**
  - Protocols to exchange data between source and destination
  - **Transmission Control Protocol (TCP)**
    - Transport layer protocol
    - Basic protocol with no advanced features
  - **Message Queueing Transport Telemetry (MQTT)**
    - Application layer protocol
    - Uses TCP for transport but adds some advanced features
- **Intelligent Cipher Transfer Object (ICTO)**
  - Data protection by secure object creation.
  - Access control and authorization policies embedded within secure object
  - Useful for IoT as the ICTO object remains secure even without security on transport channel

Research goal

- Problem
  - An efficient protocol for transporting ICTO objects must be determined for IoT environment
- Proposed solution
  - Compare performance of “bare” TCP and MQTT protocols based on goodput, and transmit time
- Goals
  - Assess MQTT and TCP in terms of network performance
  - Compare MQTT with baseline TCP for transport of ICTO

TCP Experiment Setup

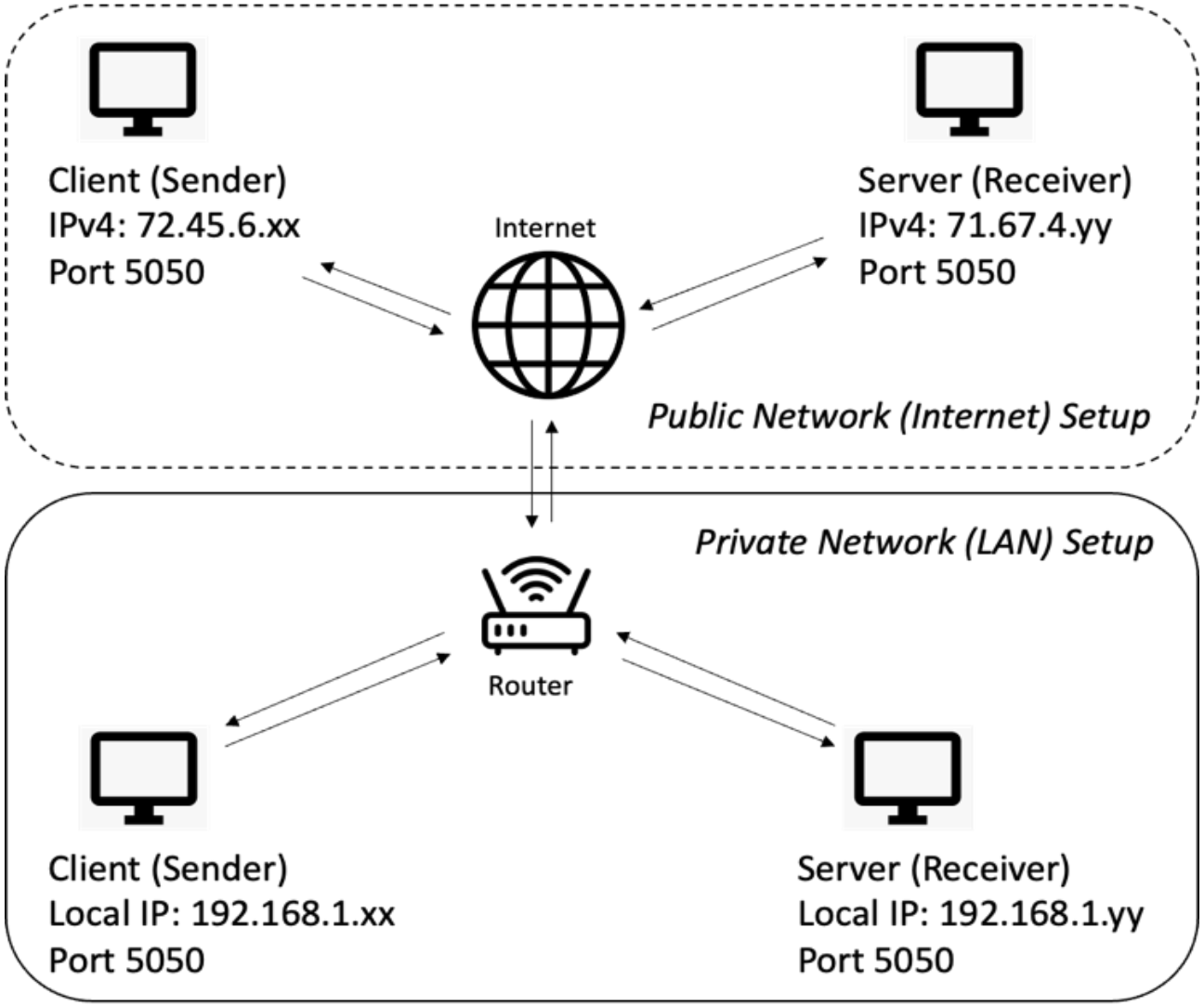

Figure 1. Experimental Setup for TCP socket communication

MQTT Experiment Setup

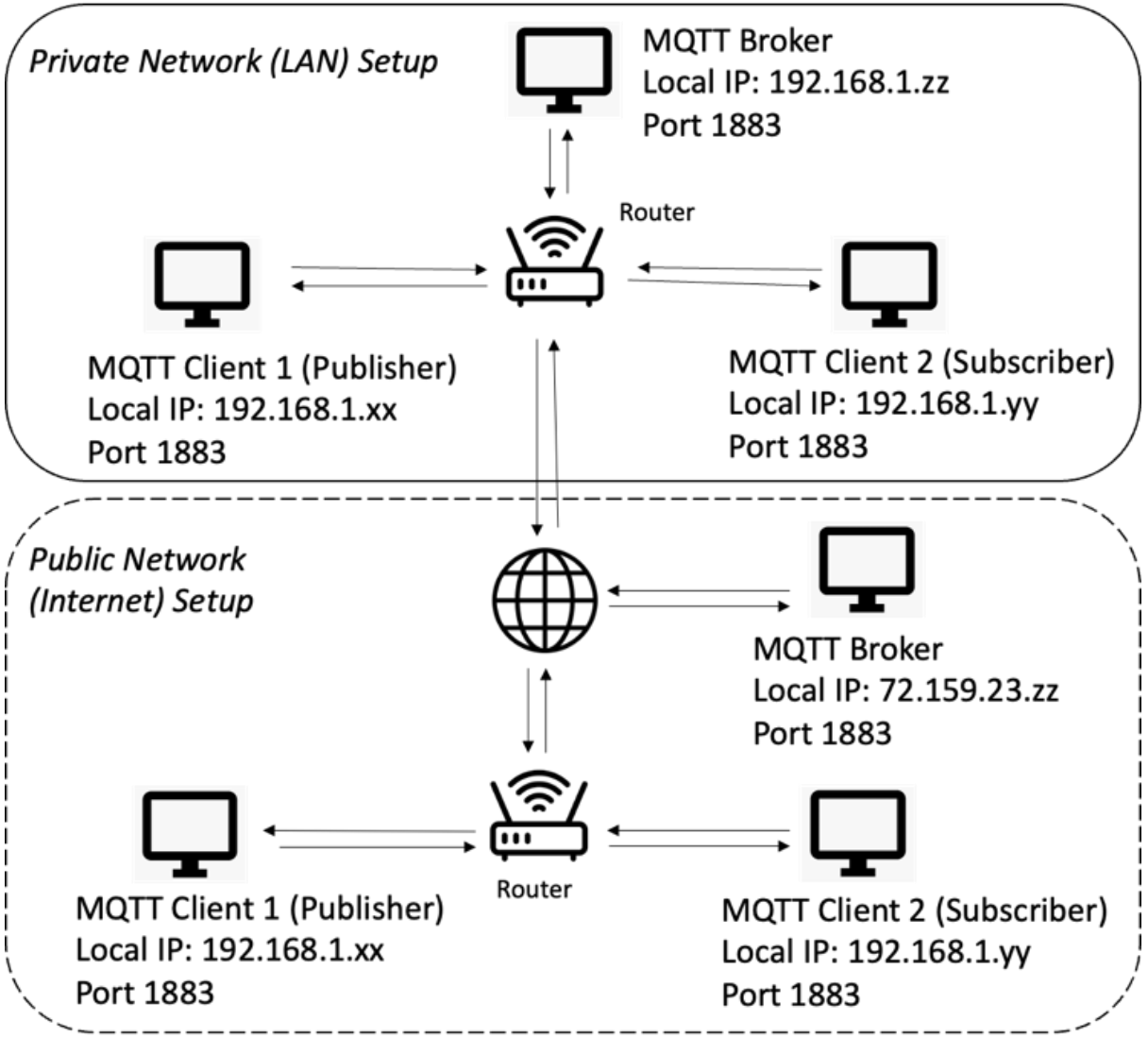

Figure 2. Experimental Setup for MQTT communication

Confidence Interval

- Confidence interval is the range of values that is likely for the population based on:
  - Sample mean
  - Desired level of confidence
- Confidence Interval portrays the probability that certain value falls between pair of values around mean.
- T-distribution was used to generate the confidence intervals with 95% confidence.
- T-distribution was used because the population's standard deviation is unknown.

Results: Overhead in LAN

- MQTT requires greater header size for transmitting a user payload of given size as compared to the naked TCP socket.
- With increasing payload size, header overhead for the MQTT increases dramatically.
- In contrast, for the TCP baseline, header overhead remains constant and at least one order of magnitude smaller than MQTT.

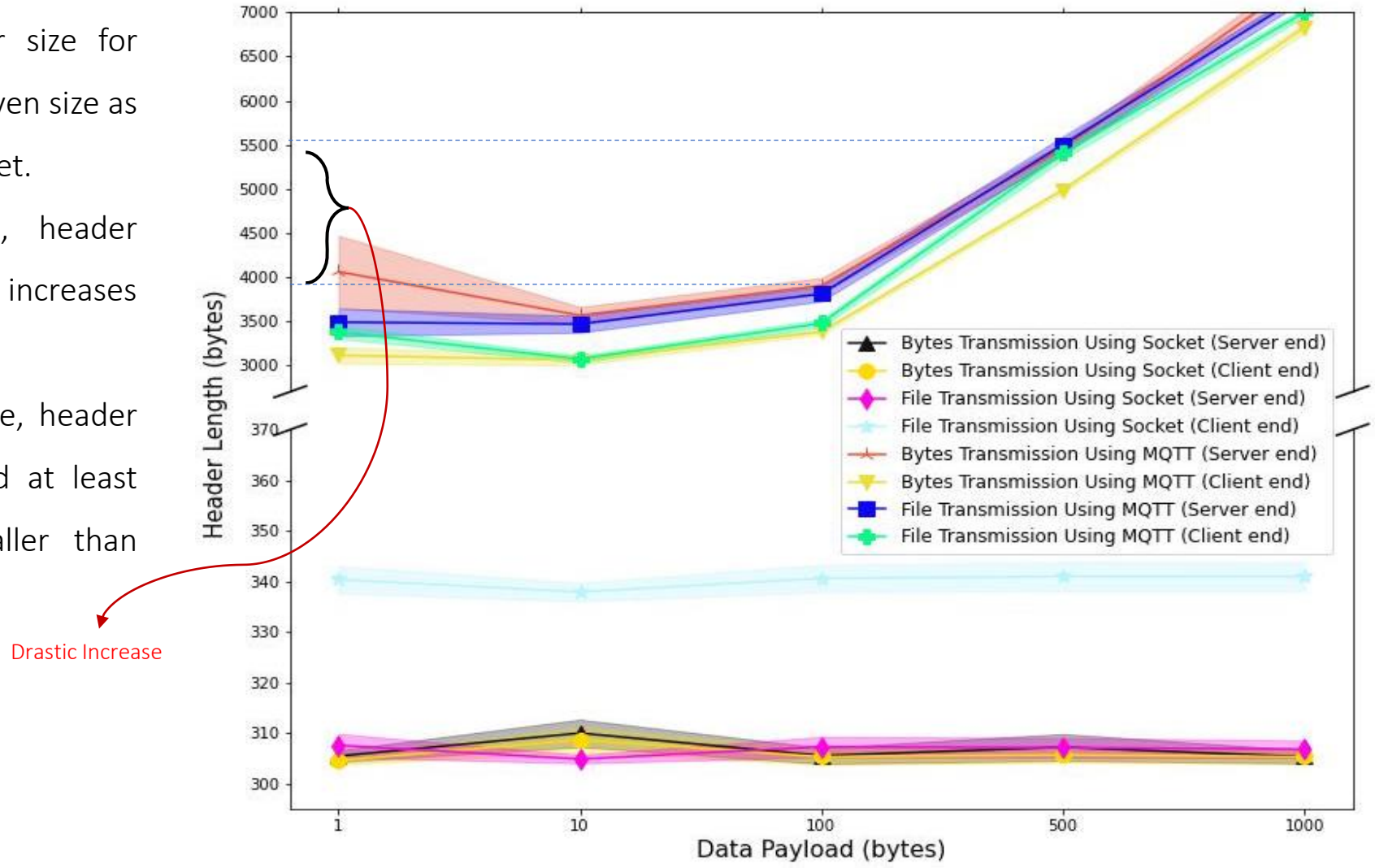

Figure 3: Cumulative Header Size vs Payload Size in LAN

Results: Total Time in LAN

- The time required for data exchange for most MQTT configurations is substantially higher (by a factor of 2 or more) than required for TCP.
- A significant difference in the cumulative header size for MQTT and TCP may be an intuitive reason for the observed time difference.

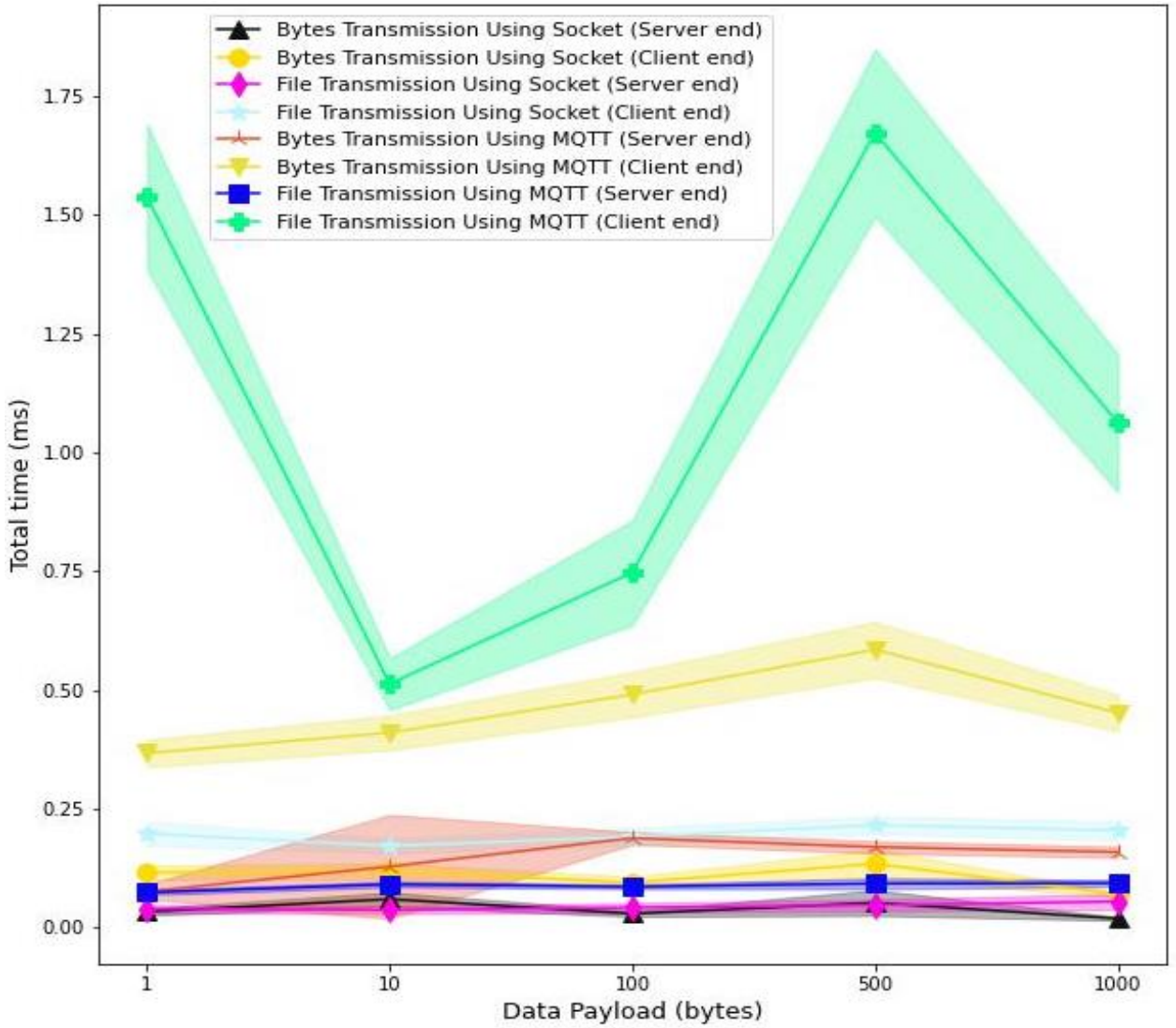

Figure 4: Total Time (ms) vs Payload Size in LAN

Results: Overhead in Internet

- The header overhead for MQTT is an order of magnitude greater than TCP.
- Header overhead for MQTT seems to be steady with increasing payload size in the Internet environment.

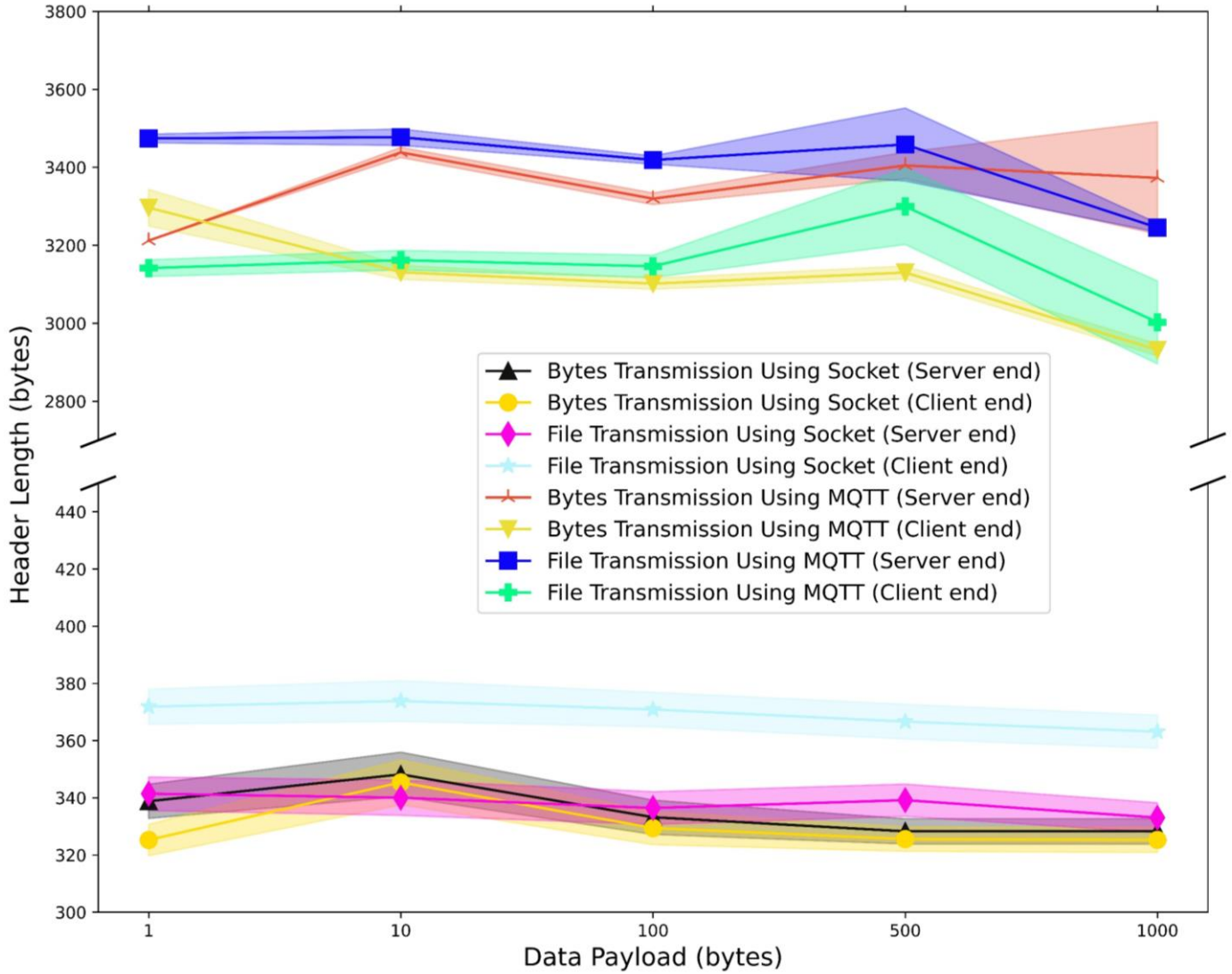

Figure 5: Cumulative Header Size vs Payload Size in Internet

Results: Total Time in Internet

- The total transmission time is typically faster by a factor of 2 or more for TCP sockets vs. the MQTT protocol.
- Wide confidence intervals may be due to the dynamic/unpredictable nature of routing, packet loss, and other factors present in Internet traffic.

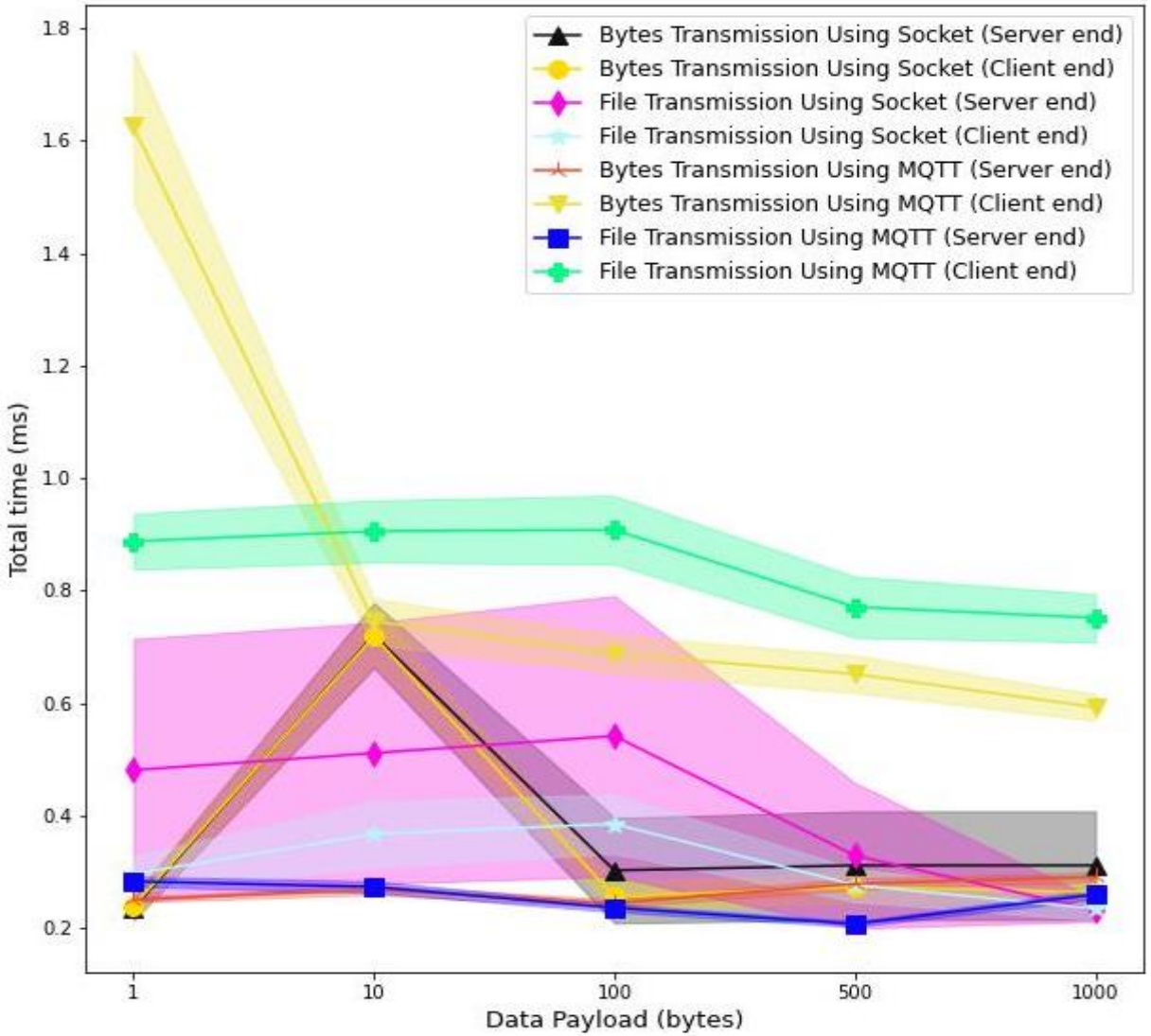

Figure 6: Total Time (ms) vs Payload Size in Internet

Conclusion

- TCP performs better in total transmit time and payload to header ratio (goodput) for both file and bytes transmission.
- The overall efficiency of MQTT is lower than TCP, providing transmission delay of at least a factor of 2, and an overhead inefficiency of an order of magnitude, for both public and private networks.
- The presence of a broker to moderate communication between publishers and subscribers in MQTT may provide application flexibility, but the resulting operational inefficiencies are concerning.
- Since security is intrinsic in ICTO objects, use of TCP seems preferable for their transport.