Web Performance of IoT applications.

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***Abstract*— The rapid integration of the Internet of Things (IoT) across diverse domains, encompassing transportation, healthcare, and smart homes, underscores the critical need for robust data communication frameworks. In response to the challenges of transmitting and storing sensing data from resource-constrained IoT devices to cloud platforms, the paper introduces two innovative solutions—Dynamic Tree Chaining (DTC) and Geometric Star Chaining (GSC). These frameworks address authenticity, integrity, sampling uniformity, system efficiency, and application flexibility. Extensive simulations and prototype emulation experiments, driven by real IoT data, demonstrate the superior efficiency of the proposed system. Simultaneously, the study delves into the performance evaluation of IoT Web applications, comparing different web platforms and messaging protocols. Leveraging HTML5, WebSocket, and Canvas graphics, the research assesses the capabilities of Adobe Flash, HTML5, and Microsoft Silverlight in running real-time IoT applications. Notably, MQTT emerges as a preferred messaging protocol, albeit with considerations for potential implementation shortcomings. This combined research paper offers a comprehensive review of IoT data communication challenges, introduces efficient solutions, and provides insights into the performance nuances of web platforms and messaging protocols, contributing to the evolving IoT landscape.**

Keywords*— *Real-time systems, web and internet services, performance evaluation, sensor systems, IoT, Cloud, Authentication, Partial Data Retrieval, Sampling

I. Introduction

The rapid proliferation of the Internet of Things (IoT) has ushered in an era characterized by the seamless integration of sensors, devices, and applications, generating vast volumes of real-world data. This influx of data, crucial for diverse applications ranging from smart environments to healthcare and industrial automation, necessitates robust methodologies for its collection, management, and communication. Two distinct research efforts contribute valuable insights to this discourse.

The first research effort focuses on the fundamental classification of IoT sensing data into two primary types: time series data and event data. Time series data, generated at fixed intervals, serves continuous monitoring tasks, while event data captures discrete occurrences such as the appearance of a vehicle in a smart camera. Emphasis is placed on the unique challenges posed by event-based data management, given its inherent complexity compared to time series data.

The second research effort addresses critical challenges in IoT data communication, particularly concerning data sampling, authenticity, integrity, and application-specific requirements. With limited resources for transmitting and storing data, the paper underscores the significance of data sampling to meet fixed resource budgets. It further emphasizes the imperative of ensuring the authenticity and integrity of sensing data stored in third-party clouds, considering potential threats from outside attackers and transmission failures.

Both research efforts converge on the overarching need for efficient and secure data communication frameworks in the IoT ecosystem. As the IoT landscape continues to evolve, it becomes paramount to devise methodologies that cater to the diverse nature of sensing data, uphold data authenticity and integrity, and accommodate varied application requirements. This common thread forms the foundation for the subsequent discussions on data sampling, authenticity, integrity, and application-specific considerations in the IoT framework.

II. Methodology

The research introduces two signature schemes - Dynamic Tree Chaining (DTC) and Geometric Star Chaining (GSC) - aimed at improving efficiency and reducing computational costs for authenticating IoT data communicated over the internet. Of the two, GSC demonstrates superior performance in terms of throughput, memory usage and uniformity verification due to its compatibility with the proposed sampling protocol and minimal space complexity.

For testing web platform performance for IoT applications, the research implements client test applications using HTML5, Adobe Flash and Microsoft Silverlight. The testing methodology utilizes Domain Time II for clock synchronization to ensure consistency across platforms. Detailed development and testing processes are outlined for each technology, covering aspects such as messaging formats and server-side implementation.

In conclusion, the combined methodologies provide both back-end and front-end solutions for addressing performance challenges with IoT applications. The signature schemes and sampling protocol optimize authentication of IoT data transmission over the internet. The web application testing across platforms offers insights into optimal technologies for building responsive cross-platform IoT interfaces. Together, these solutions can enable higher efficiency and improved quality of service for internet connected IoT systems.

III. Results

The sampling protocol for Internet of Things (IoT) data transmission demonstrates efficient budget utilization, adapting to fluctuations in monitored events while maintaining uniformity critical for accurate analytics. Experiments reveal 75% budget use on average. The protocol outperforms naive truncation that compromises uniformity, as shown in an exemplary temperature data use case.

For web platforms, Protocol Buffers encoding yields shorter messages, but higher transfer times compared to JSON. Despite lower latency from optimized decoding, extremely compact formats like Protocol Buffers indicate trade-offs versus performance. Web Sockets lower latency versus long polling. HTML5 Canvas proves adequate for basic IoT visualizations. Challenges emerge in large message handling for Protocol Buffers and Web Sockets.

In conclusion, the studies showcase protocols enhancing efficiency in IoT data transmission, and comparative analysis highlighting performance trade-offs in web technologies and messaging formats. The key results emphasize the need for adaptive protocols maintaining data integrity, along with selecting web platforms and encodings optimized for intended IoT applications. These insights advance knowledge regarding real-time communication for internet-connected devices and systems.

IV. Conclusion

In summary, our evaluation of IoT data communication frameworks underscores HTML5 as a mature platform for real-time messaging, offering comparable performance to Adobe Flash and Microsoft Silverlight. Despite Adobe Flash exhibiting slightly shorter latency, HTML5's widespread compatibility, particularly on mobile devices, positions it as the superior choice for the future of IoT applications. Our study highlights the need for enhancements, such as improved support for binary messages in HTML5, to further optimize performance.

Additionally, our exploration of IoT messaging protocols identifies specific shortcomings, with MQTT recommended as a robust choice for most IoT web application requirements. However, considerations arise when using the Mosquitto message broker and the JavaScript client publishing messages over WebSocket. Furthermore, our focus on challenges in IoT data communication leads to the design of a system adept at uniformly sampling data from sensing devices and securely storing it in the cloud within defined resource budget constraints. Extensive simulations and prototype emulation experiments validate the proposed system's efficiency in both space and time, providing valuable insights for the optimal development and deployment of IoT applications in the evolving web performance landscape

V. References

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