Smart World’s IoT System Analysis and Recommendations for SDN Integration

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Abstract

The IoT value chain structure, which includes hardware devices, connectivity network layers, data processing layers, and application layers, is crucial for delivering IoT products and services in smart homes and offices. However, the current structure faces limitations in starting 50,000 users initially, due to limited data transmission and low speed of 2G IoT sensors. To address these issues, we can implement edge computing, integrate 5G Wi-Fi with a multi-layered switch (MLS) gateway for network connectivity to the main cloud, and enhance performance and cost-effectiveness using the WebSocket protocol and the back-end data-sharing communication model. In order to improve the system's adaptability for future device growth, we should integrate a microservice architecture, containerization, and software-defined networking (SDN) with edge computing methods. These methods are essential for processing necessary data, reducing unnecessary data near the server instead of sending all of them to the main cloud server. This approach with microservice design facilitates efficient traffic management, enhances security, scalability, and interoperability, and cultivates a flexible network architecture. Challenges include the management of an increasing array of IoT devices, security risks, protocol discrepancies, real-time data transfer, and resource limitations.

Keywords-Internet of Things; Smart Home, SDN, communication model and protocol, Microservice design architecture

Introduction

The goal of this study is to enhance the efficiency, security, and user experience of smart home and office services through an innovative IoT solution. It targets an initial user base of 50,000 individuals, focusing on seamless integration, real-time data processing, and advanced security measures. The "Smart World" IoT solution uses advanced technologies like edge computing, advanced communication protocols, and software-defined networking to address current limitations in smart home and office technologies.

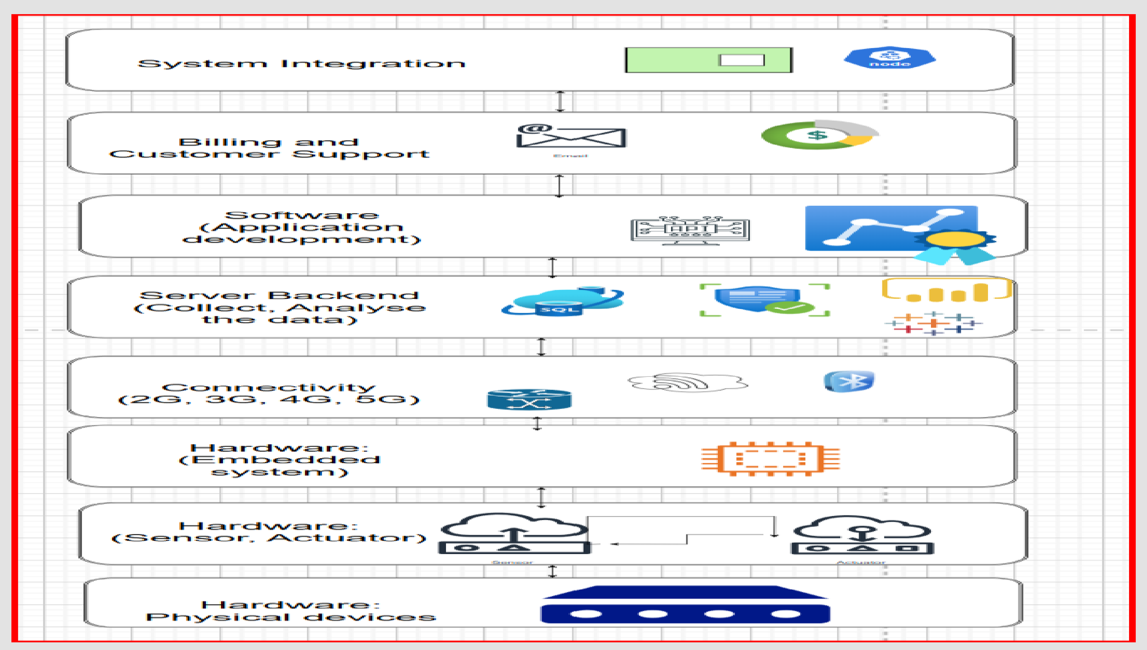


Figure 1: The proposed components of the IoT value chain structure

However, Microservice design architecture with edge computing can be integrated with 5G WIFI coverages, and managed by Microservice design architecture while SDN can control different traffic flows by automated system.

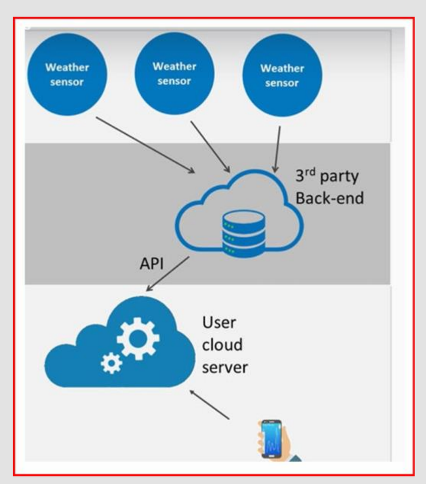
Body

The research questions encompass enhancing edge computing for the performance and security of IoT devices, identifying effective communication models for efficient data transmission, improving scalability and flexibility through Software Defined Networking (SDN), tackling critical challenges in the IoT value chain to enhance user experience, and employing microservices architecture for scalability and reliability in IoT applications.

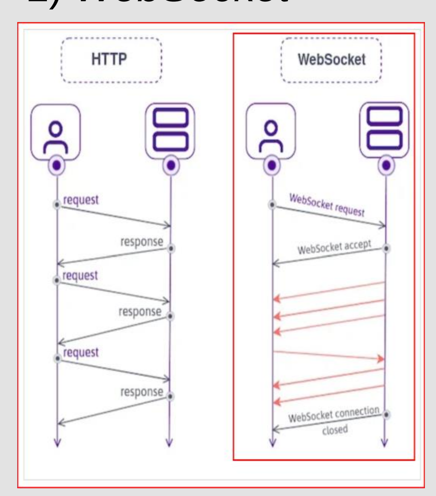
Brief analysis: Edge computing can address limited data transmission and low speed issues in 2G IoT sensors by increasing transmitted data and reducing security risks by processing data closer to the source.

Evaluation: Edge computing enhances performance by minimising latency and optimising real-time data processing. It improves security by processing data nearer to the edge server(*Towards Smart Home Automation*. Communication models include request-and-response, publisher-subscriber, and backend data sharing. MQTT, DDS, WebSocket, and HTTP and Software Defined Networking (SDN). MQTT is appropriate for low-bandwidth networks but is not optimal for high traffic volumes. DDS enables rapid communication but demands intricate configuration and upkeep.

1) *Back-End Data Sharing*



2) *WebSocket*



1) Figure 2: Back-End Data Sharing model. Source: (5. IoT Communication Models.Pdf: DNCT702 - Internet of Things, n.d.)
2) Figure 3: Comparison between HTTP and WebSocket. Source:(IoT Communication Protocols—IoT Data Protocols - Technical Articles, n.d.)

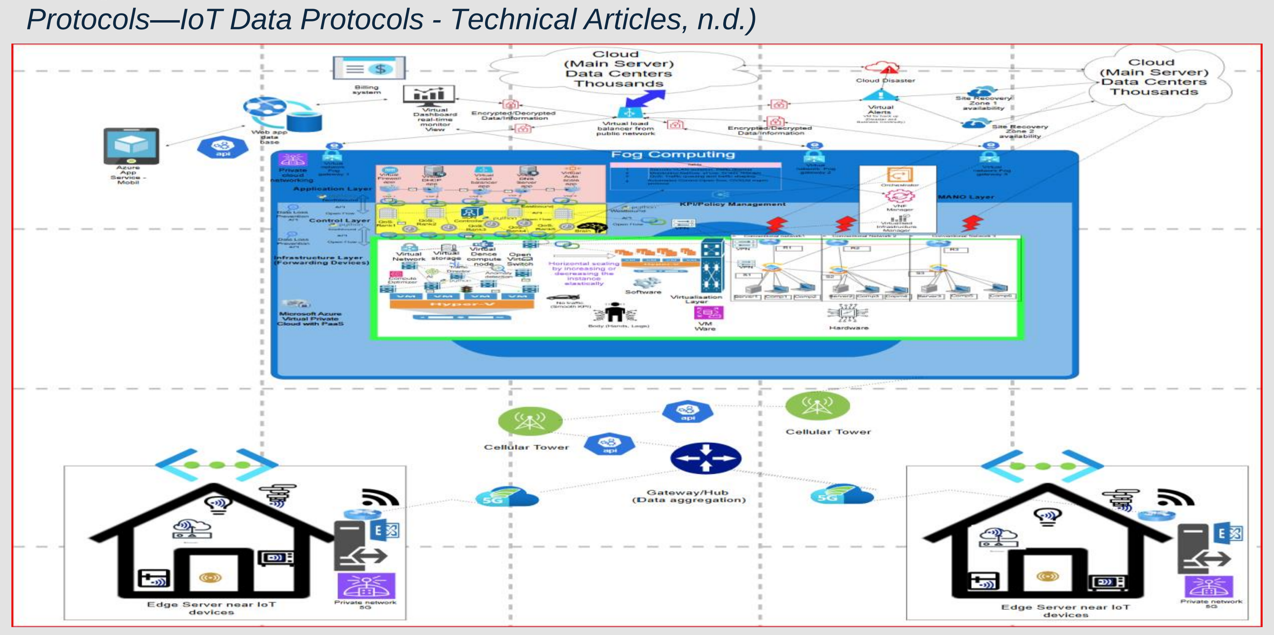


Figure 4: The proposed components of the IoT value chain structure incorporate the modified IoT architecture, including the integration of SDN

Therefore, while backend data sharing communication models and WebSocket protocols facilitate real-time data transfer, they may be resource-intensive. SDN improves scalability and security by monitoring traffic patterns and enforcing real-time security protocols In Figure-4.

Body

Discussion relevant to the report
Recommended Communication Model and Protocol
1)Back-End Data Sharing Model:
Justification: Improves scalability and data validation.

2)WebSocket Protocol:
Justification: Enables two-way communications with high security and low latency.
Improving Scalability of the System
Challenges:
Performance Testing: Evaluating data transmission speed and efficiency.
Traffic Congestion: Adding new IP addresses can lead to network performance issues.
Recommendations:
Microservice Design: Enables easy integration of new devices and improves scalability.
Containerisation: Allows the use of one service independently without affecting others.
The report looks at problems and possible solutions in the hardware device layer. It talks about edge computing to improve data transfer and security, 5G Wi-Fi and multi-layered switch gateways for better connectivity, parallel distributed processing architecture and AI for better data management, and microservices architecture for flexibility and scalability. Edge computing diminishes latency and promotes real-time data processing, while SDN integration streamlines network administration, bolsters security, and enhances scalability via centralized control and automated network activities.
Solutions:
Multiple diagrams and charts depict the structure of the IoT value chain, encompassing the hardware device layer, connectivity network layer, data processing layer, and application layer. The client-server architecture demonstrates the interaction between clients and the central server. The Publisher-Subscriber model illustrates the functions of publishers, brokers, and consumers in data dissemination. The back-end data sharing model consolidates and transmits data from smart devices to the central cloud. The MQTT Publish/Subscribe architecture illustrates the interaction among publishers, brokers, and subscribers. The DDS Global Data Space illustrates the connectivity between publishers and subscribers. Comparisons between HTTP and WebSocket emphasize the request/response model and the microservices-oriented recommendation system. The revised IoT architecture, which features integrated SDN, exhibits centralized management and automation of network operations.

Table1: Comparative Analysis of 2G and 5G: Transmission Speed, Connectivity Delay, Connectivity Capacity, and Data Storage

1)2G WIFI

500KB	
KB	500
kbps	10
Send Time (sec)	417
Send Time (min)	7
1GB	
File size (GB)	1
Transfer speed (kbps)	10
Send Time (sec)	873,813
Send Time (hrs)	243
Sending Time (Days)	10

2) 5G WIFI

500KB imagery	
KB	500
Transfer Speed (Gbps)	1
Send Time (sec)	0.004000
Send Time (min)	0.000067
1GB high resolution live stream	
File size (GB)	1
Transfer Speed (Gbps)	1
Send Time (sec)	8
Send Time (hrs)	0.002330
Sending Time (Days)	0.000097

Body

As an evidence in Table 1, we also present a comparison of 2G and 5G technologies for analysis of differences between sending time per second, hours and days.

Conclusion

The report focuses on the proposed IoT solution for a "Smart World," with the objective of enhancing the efficiency, security, and user experience of smart home and office services. It delineates essential elements of the IoT value chain, examines existing challenges, and offers recommendations for enhancement. The implementation of edge computing can mitigate primary challenges, such as restricted data transmission and the low velocity of 2G IoT sensors, enhance data transmission, and reduce security vulnerabilities. We can enhance the connectivity network layer, which is characterised by restricted data transfer capabilities, by implementing 5G Wi-Fi and multi-layered switch gateways. Implementing parallel distributed processing architecture and artificial intelligence for effective data management can enhance the data processing layer, potentially causing traffic congestion. Adopting a microservices architecture can mitigate constraints in user interfaces and authentication methods of the application layer, thereby enhancing flexibility and scalability. We can optimise communication models and protocols, such as the backend data sharing model and web socket, for real-time data transmission and enhanced security. The future of IoT depends on the seamless integration of advanced technologies to meet and surpass user expectations.

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