Performance Evaluation of RDMA Transfer Method for Security Added on Edge Computing

Yoobean Kwak and Jongpil Jeong

***Abstract*—Recently, the popularization of the cloud has been driven by the rise of smart factory, which has strengthened the role of processing medium-processed data in the Micro data center, such as Edge computing and Fog computing. Many researchers have previously presented many complementary performance and policy aspects to these environments, but this paper proposes an RDMA method that can complement the reduced performance of Edge devices and micro data computing centers because of the addition of general security solutions, and thus provide performance comparisons according to the specific methods.**

***Index Terms*—RDMA; RoCE; security; edge computing; security.**

I. Introduction

Many of the IoT environments in our daily lives have become visible and the resulting amount of data has been generated, so we need to prepare for faster speed improvements to accommodate the environment that is being developed. One of them, the link between the cloud and the smart factory, says many experts and professionals in the main direction of inevitable future value. The resulting arrangements are among many environments, the most important being the ability to transmit data.

The resulting transmission phase of the data can refer to the fourth phase of the data center or the cloud infrastructure, where the data is generated, the data is collected in the first phase, the data is collected in the second phase, and the data. I think we should have three approaches based on the above step-by-step approach. The first is openness, which is a general-purpose approach through platform sharing with other platform manufacturers. Second, it is selective in the collection of data. Collecting large volumes of data that are unconditionally appropriate without setting a selective ranking and goal for data results in failure of strategies that utilize IoT and Big Data. Third is collaboration between organizations.

The data of sensors in the actual manufacturing environment should be provided with information that can help the manufacturing environment again through analysis in the IT environment, and the resulting convergence and utilization of information will ensure success in smart factory and IoT. In addition, the data in the smart factory based on the importance of the data above should be able to suggest that there are no performance or transmission issues. In these circumstances, the performance downward movement in the grafting of security can be seen as a result of the underlying nature of the system, and the resulting performance problems should be improved hardware or software.

The composition of this paper is as follows. Section 2 explains the justification for the relevant research and the reasons for the technical proposals and details the advantages and disadvantages of the RoCE proposed in section 3. Section 4 describes the process and its consequences for the proposed security and delivery methods. Section 5 describes the conclusions and future requests for improvement.

II. Related Work

As the IT environment evolves, more and more security is being emphasized in many areas. As a result, a lot of security has evolved together. But there are realistically many problems with security. There is no capability for security currently in use in smart factory and edge computing. This is further explained in the paper "Measuring Performance Impact of Security Protocols in Wireless Local Area Networks" about the problem and the solution-specific impact that can occur when security is grafted with the solution, as well as the use of wireless smart factory and edge computing over problems with current wired use [1].

In particularly, the 'Overhead Associated with Security Policies' paragraph and the Authentication Time show that the author is taking the time to describe the performance overhead and thus the authentication time. In addition, the eyes of the actual "Cloud-Assisted IoT-based SCADA Systems Security: A Review of the State of the Art and Future Challenges" describe the relationship between CPS, IoT and wireless Internet, and the type of attack is well described by you. In particular, the role of "Authentication and Encryption" in various ways in "Efforts to secure SCADA systems" suggests that even more security capabilities are important [2].

The "Recommendation and best practices for IoT-Cloud based SCADA system" can further emphasize the security issues of the Smart Factory IoT that the author emphasizes, considering the Malicious activities of the network packet and the pattern in how to improve network traffic analysis [3].

Other papers also interpreted this from a different perspective. "A Critical Analysis on the Security Concerns of IoT" has been organized at various angles, but the most important of which is the effectiveness of security and the resulting challenges [4].

While there are many issues on the agenda, the author can cite the Challenge in the Network layer. The paper

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currently mentioned focuses on wireless security. If these security issues and proven facts apply to Edge computing of current Smart Factory and IoT, performance considerations will arise and improvements should be taken into account. So the author wants to circumvent this problem more quickly by accelerating the hardware-based data transfer [5].

III. RDMA Transfer Processor [RoCE]

In this section, the importance of data transfer continues to grow, and in response to this market response, Remote Direct Memory Access (RDMA) Protocol, which is based on DDP (Distributed Data Protocol), enables manufacturers to directly transfer data to the Upper Layer Protocol buffer (ULP) without the need for an intermediate copy of the data. It enables the implementation of the kernel bypass approach. The above-mentioned RDMA method is being used to pay high costs for consumption on systems that require high efficiency, including a specific set of products in the IT industry. The above mentioned RDMA method ensures more robust transmission performance. These methods include InfiniBand, iWARP & RoCE, but the author proposes RoCE among several.

While the RDMA overarching Ethernet (RoCE) proposed in this paper provides all the benefits of RDMA, RoCE can save a company a huge amount of capital expenditure by eliminating the need to transform its data center from Ethernet to InfiniBand in traditional Ethernet networks.

There is not much difference between using RDMA on InfiniBand and using RDMA on Ethernet, and in an Ethernet environment, RoCE is managed in an Ethernet environment.

As mentioned earlier, RoCE introduced RDMA technology into an Ethernet-based data center, enabling the data center to take advantage of the low latency RDMA method without having to adopt an InfiniBand-based network infrastructure.

The effects currently mentioned are described by referring to the "RoCE-Accelate-DC-performance_Final" and comparing Fig. 1 and Fig. 2 below.

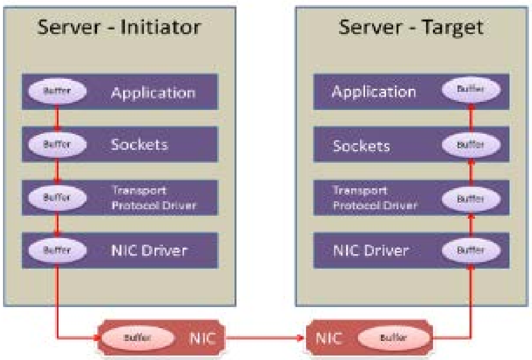

Fig. 1. TCP/IP communication [6].

In the existing TCP/IP transmission process, Fig. 1 buffer the layer of the layer for each Source and Destination and takes time. However, with the RDMA method in Fig. 2 it would only take a buffer in the application layer, which would reduce the time required to ensure faster transfer times. Also, RoCE's header format is as follows. Fig. 3 as described below. The third part is "The RoCE v1 protocol is an Ethernet link layer protocol with Ethertype 0x8915. This means that the frame is length limits of the Ethernet protocol: 1500 bytes for a regular Ethernet frame and 9000 bytes for a jumbo frame [7].

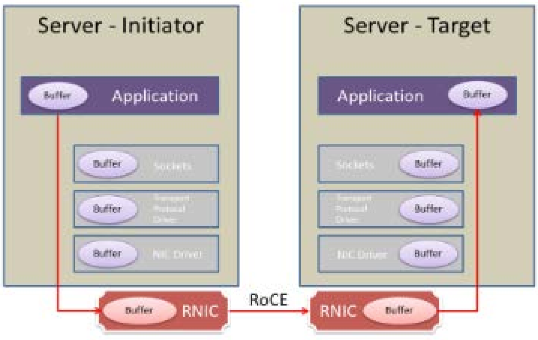

Fig. 2. RDMA communication [6].

And this is what Fig.3 explains to RoCEv2. "The RoCEv2 protocol exists on top of either the UDP/IPv4 or the UDP/IPv6 protocol. The UDP destination port number 4791 has been reserved for RoCE v2. Since RoCEv2 packets are routable the RoCE v2 protocol is sometimes called Routable RoCE or RRoCE. Although in general the delivery order of UDP packets is not guaranteed, the RoCEv2 specification requires that packets with the same UDP source port and the same destination address must not be reordered. In addition, RoCEv2 defines a congestion control mechanism that uses the IP ECN bits for marking and CNP frames for the acknowledgment notification. Software support for RoCE v2 is still emerging. Mellanox OFED 2.3 or later has RoCE v2 support and also Linux Kernel v4.5. [7].

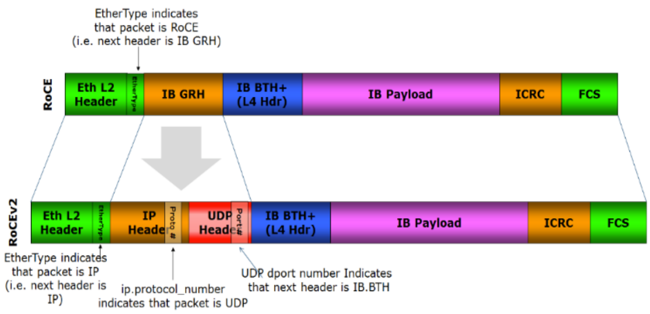

Fig. 3. RoCE Header format [7].

As the RoCE continues to evolve, the author believes that future use will be easier. Based on the above technical facts, the effects of the current system are as follows.

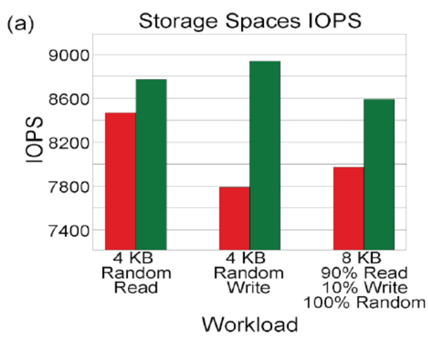

Fig. 4. Storage Spaes IOPS [8].

Official data also showed a clear performance gap as shown in Fig. 4. Fig. 4 compares IOPS performance of TCP/IP and RoCE running different read, write, and online transaction processing (OLTP) workloads. Fig. 5 show that 10Gbe TCP/IP use more than twice the CPU of 10GbE RoCE for both read and write operations [8].

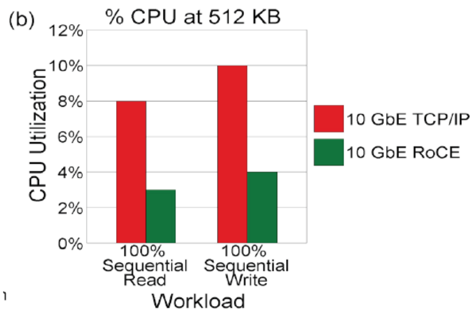

Fig. 5. CPU Utilization at 512KB [8].

IV. Experiment and Performance Evaluation

We had taken to test the transmission performance of RoCE on RDMA. As shown in Fig 6, we have prepared five Cisco Servers. The system specification used is 2Port 40G 2ea universal translate port in Storage Server 1ea with 32G memory of 2.1Ghz CPU, 800GB of storage, and 5ea of 32GB memory of 2.1GHz CPU, 480G SSD 5ea and 2Port 40G 2ea translate port. The switch also prepared and connected network switch Nexus3232C model from Cisco. In addition, the network driver settings on both sides are set to RoCE Network Driver.

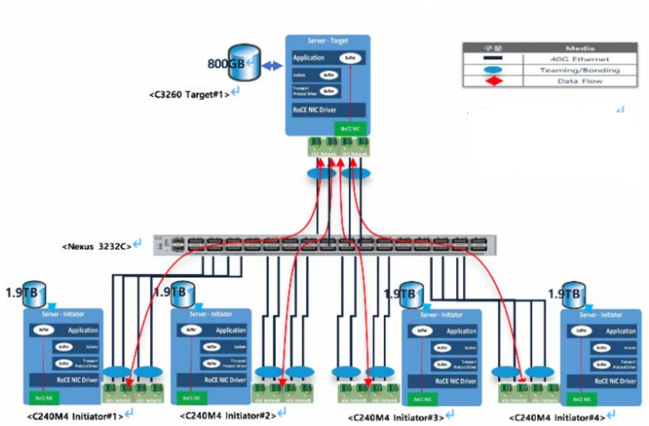

Fig. 6. Experiment setting.

As a tool for the tests mentioned above, we were able to bring in the following data transmission.

1) C240M4 (4) + C3260(1) + Nexus 3232C (1). Window 2012 R2 + SMB2.0 (RoCE) = **18Gbps (2.2GB)**
2) C240M4 (4) + C3260(1) + Nexus 3232C (1). Window 2012 R2 = **14Gbps (1.7GB)**

We were able to achieve the above results here, and we found that the above transmission methods were better than the typical Ethernet transmission speeds.
In addition, the paper below supports the current results.
"Component Performance Analysis of RDMA-Enhanced Ethernet" also shows the performance of a good situation. It also includes points that we did not test. In addition, the general Ethernet situation is being attached, and the consequent throughput and latency have been identified, indicating a clear difference [9].

However, InfiniBand, which has the most preferred performance here, which was excluded due to the following shortcomings: The reason why traffic is not managed because it is not an Ethernet base, restrictions on distance, expensive equipment cost.

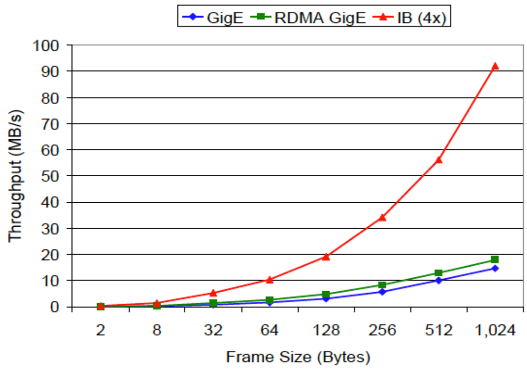

Fig. 7. Ping throughput [9].

As shown in the figure above, the PMB network ping test shows the transmission rate measured in megabytes per second with the sizes of each TCP/IP Giga Ethernet, RDMA Giga Ethernet, and Byte unit on InfiniBand. Although there is a huge difference in performance from InfiniBand, we measured the delay latency of three different transmission methods for network I/O in the same situation as mentioned earlier.

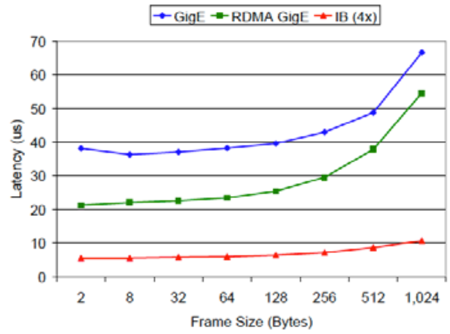

Fig. 8. Ping latency [9].

In the same situation, Fig. 8 measured the network translate I/O latency of the three transmission methods.

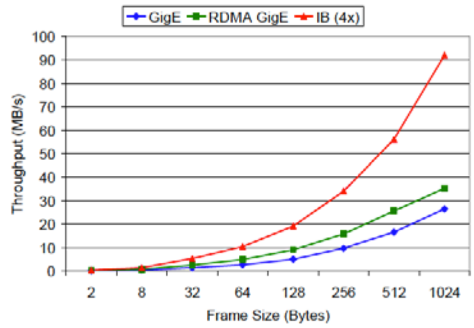

Fig. 9. SendRecv throughput [9].

Fig. 9 is also a result of measuring the network translate I/O throughput of the three transmission methods under the same situation.

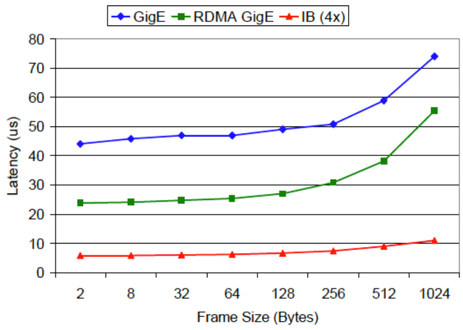

Fig. 10. SendRecv latency [9].

Finally, Fig. 10 is the result of measuring the ratio of the three transmission methods in the same situation. As shown in Fig. 7-10, InfiniBand is best for all performance evaluations, but as we can see here that RDMA gigabyte is better than normal gigabyte.

By proposing the RDMA-based RoCE described in section 4, the author seeks to address the lack of performance issues in the system's I/O performance with respect to the policy, performance, and certification of security solutions.

In addition to the mitigating aspects of network performance, we can see improvements in CPU, memory used rate and lossless data. The relevant data can be found in the attached data below. In addition, according to the referenced paper, "Comparison of 40G RDMA and Tradition Ethernet Technologies," the RoCE method sent 24hr 420TB, while the typical Ethernet method delivered 225TB [10]. In addition, the second result of the two tests, as shown by the results of the Appendix referenced in the paper, was well delivered without losing data, even though the Job Scheduling using two CPUs was operated as a single CPU with an interval of 1 second apart [10]. In addition, the author was able to test the current system of 5ea and check the following results.

TABLE I: RoCE System Resource Test with SSL

	User	SYS	NET	IDLE	WAIT	SSL	RoCE
CPU	o	13.7	1844	85.2	o	On	Off
	o	11.1	2132	87.4	o	On	On
	o	9	1924	95.5	o	Off	Off
	o	9	2254	98.1	o	Off	On

In Table I above, the test of the ROCE transmission method showed the performance benefits of the system in both the switched on and off situations. The best performance was when security modules were turned off and second good performance is when security modules being turned on and operating ROCE. It was also apparent that the amount of traffic on the system, including: "SYS", the effective system: "IDLE" and network differed significantly from.

V. Conclusion and Future Work

In the future development direction of Smart Factory, data transmission technology is currently looking for many improvements. In addition, the importance of security is becoming more and more important at a time when the shift from wired to wireless is taking place. In response, security-related factors are receiving much attention. The situation is not entirely about performance. However, the author believes that security is the most urgent issue that needs to be solved first, Therefore, I believe that these security issues are important and need to be supplemented externally.

No matter how strong and high-performance security procedures are, it is truly unfortunate if they are not properly used on the scene. In response, the author proposed to improve the data transfer method called RoCE in the RDMA method as shown in this paper to supplement the performance factor. In the future, many manufacturers will have to work harder to apply related technologies for generalization of this method and better performance.

In addition, Edge computing and wireless are becoming mainstream in IoT field, especially in Smart factories.

However, if you have unsecured information, you won't know what will happen to you. So security is much more important and there is much more to do in the future. First of all, encryption and performance issues will be more technology on the wire, and further they will be applied to wireless. Finally, the author of this paper hopes that all such skills will be well settled.

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