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Real time open system interconnection standard for data communication

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ABSTRACT

Open System Interconnection is the globally defined standards for the network and data communication devices and protocols. The standardization of communication standard is specified by International Organization for Standardization. Real time communication standard is another benchmark with the Open System Interconnection which is basic requirement for the data communication network that handles the real time events. The heterogeneous nature of the diverse standard of the machinery and equipment integrated with computing nodes and communication network to manage and handle the functional control through remote action requires the real time open system interconnection structure. In this paper, the distributive active simulation application with Distributed System Network is taken to determine the real time functional aspects. The upper layers of the Open System Interconnection standard with selected PDU having the encoding and decoding with optimization of complexity and delay prediction is stated for the real time feasibility of the communication through the networks.

Keywords: PDU – Protocol Data Unit, OSI – Open System Interconnection, DIS – Distributed Interactive Simulation, DSN – Distributed System Network, TCP – Transmission Control Protocol, UDP – User Datagram Protocol, ISO – International Organization for Standardization

1. INTRODUCTION

Open System Interconnection (OSI) is a reference model for the data communication standard around the globe. OSI model defined with seven different layers for the governance of communication of data and information through the networks. Each layer of the OSI model defines the functional aspects of the communication through the specified protocols in standardized forms to manage the communication among the various categories of networks. OSI reference model includes application, presentation, session, transport, network, data link and physical layers.

Application layer defines the protocols and their standards for the different categories of application that are used by the users. The basic services provided by application layer are file transfer, electronic message transfer, hyper text transfer and many other network applications. These all services are governed and managed with the help of protocols for each of the applications.

Presentation layer provides the transformation of data belonging to applications to network and also network to applications. The name presentation is enough to understand the functional properties of presentation layer in OSI reference model. Encryption and decryptions protocols are defined under the presentation layer to manage the formats of data for the its upper layer such as application layer.

Session layer gives the services to handle the connections of the applications. The primary functional aspects of this session layer in OSI reference model is to establish, handles and close the connections between the various applications of the application layers of end user entities.

Transport layer is considered as the heart of the OSI reference model. This layer manages the end to end delivery between two hosts of the network. There are two main protocols of the transport layer are Transmission Control Protocol (TCP) and User Datagram Protocol (UDP). The error detection and correction, Quality of Service (QoS), multiplexing of the connections, reliability etc are main functional aspects of the transport layer in OSI reference model.

Network Layer provides the services to route and switch the packets in network to reach the packets from source to destination. Routing the packets from source station to next nodes or node to destination machine or forwarding the packets from node to next node in internetwork, controlling the congestion in network are primary functions of the network layer in OSI reference model. Internet Protocol (IP) is one of the most common network layer protocol used in Internetworking.

Data link layer provides the services to convert the network packets into frames and physical layer data bits into frame. The primary functions of the data link is encoding and decoding of bits, synchronization of frames, error detection and correction into frame, flow control.

Physical layer provides interface between physical connection and data link layer to convert the digital data into electrical signal to be transmitted through mediums and also electrical signal to digital bits for data link layer to make frame for upper layers.

Above all mentioned layers of OSI reference model is standard for defining the communication framework of computer networks. This is only reference and implementation of above layers characterized by protocols inclusion for the communication standards for computer network. One of the internetwork protocol suite such as Transmission Control Protocol/Internet Protocol (TCP/IP). This protocol suite is implemented version of the protocol suite that follows the defined standards of the OSI model. The difference between the TCP/IP and OSI model is that OSI is only reference model where as TCP/IP protocol suite is implementation of the OSI reference model layers. Another difference is that the upper three layers such application, presentation and session layers of OSI reference model is combined together in single layer of application layer under the TCP/IP protocol suite.

Real time open system interconnection is a way where the protocol suite such as TCP/IP handles the governance of data communication in real time and all the facets involved with protocol supervision on the data is handled automatically. This type of the implementation is basically found in the area of distributed interactive simulation of the process control through the distributed system network. Distributed Interactive Simulation and Distributed System Network are primary and secondary requirements of the given system with the real time scope of the communication via aligned networking environment. The Distributed System Network consists of the various heterogeneous systems and hardware architectures are integrated with the communication network where self aware systems handle the communication of the data for the various interfaces by detecting the source and destination entities in parallel mode.

Open System Interconnection standards is implemented under the distributed network for the distributed interactive simulative application to handle the processes of the integrated system through the remote action via communication network and computing nodes or workstations. Open system interconnection standards with upper layers protocols are considered to provide the the real time services to make the open system interaction standard as a real time open system interconnection standards with physical system. The protocol data units are taken to be modified as per the current to modified version to make the conceptual model to real time functional model for real time communication of data.

2. BACKGROUND WORK

Gaurav B., Saurabh B., Shivendra S., Sheikh A., in their paper titled, 'OSI reference model: An overview', stated that OSI reference model is a conceptual and theoretic standard for the communication networks [1]. This conceptual model addresses all the required parameters through the help of various protocols taken with different stages. These different stages on which the protocols are taken to facilitates the services of the particular scope under the reference model is called layer. Due to this facts of the OSI reference model this is called a layered architectural model for the open system interconnection. Their paper also says that the physical implementation of the OSI reference model can be taken with real time functional scope. The real time functional scope can be inherited through the modification of the protocol functionalities with different layer protocol with the concerted physical model of the OSI reference model. The network standard is also created by them to address the application scenarios related with the real time functional requirements from the given open system interconnection standards. The scheme of the network works according to the defined standard but it provides the requirements of the real time communication with entities.

Case study titled, 'An open system interconnection – implementation' published in computer communication proceedings by Elsevier under volume 10, issue 4, states that the implementation of the open system interconnection with various computing and communication requirements [2]. The implanted network based on the standard of open system interconnection standard functions as like the real time scope of the internetworking among the interconnected DEC, GEC and ICL computer systems, The Public Switched Telephone Network (PSTN) is also be supported with the network to communicate the data beyond the boundary of mentioned computers.

Hung S. in his article entitled 'An open system interconnection model for mechatronics' states the basic model of the OSI with its reference with ISO/IEC7498 is a framework related with the topology [3]. This topological framework is information technology development artifacts for the large number of communities involved in the development of the networking components and systems. He also stated that the OSI have given the tremendous support to develop the new international standard for the communication of information through telecommunications and computer communication system. As with mechatronics it is very much required facts about the network interface to be the real time controllable. To handle the industrial functions the auto self governed real time control for the mechanical and electrical equipments are primary requirements.

Ginis R. and Wolfe V. in their article,'The design of an open system with distributed real time requirements', stated that an open system interface with distributed requirement with real time functional aspects for United States Navy attack submarine C3I system [4]. They have presented the prototype for open system interconnection interface to address the requirements of the C3I system. In their discussion in the paper it is defined that open systems gives more accurate and optimized result for the real time functional works.

Varun, Ritula T., in their paper titled, 'A review of PRFINET Fieldbus System', stated that the control of the system by network communication with computing platform is major aspect of the controlling of the distributed system [5]. The industrial automation system relies upon the different verities of the fieldbus standards that all are based on the open system interconnection architecture. The plan system is being integrated with the fieldbus system to control the functional role of the machinery in the real time control manner to avoid the criticality of the system. Their paper gives the outlook of the OSI reference model and review of the experiment in the area of PROFINET.

3. REAL TIME STANDARDS OF OPEN SYSTEM INTERCONNECTION NETWORK

The special purpose real time hardware of heterogeneous environment from the area of computer system are being integrated through the local and wide area networks. The modern applications are supported through the communication system with controlling from remote location with the help of reliable medium of network communication. The standards defined through the OSI model is not violated as the hardware is also following the specified standards. The communication of data is based on the same standard as specified with OSI reference model called Protocol Data Unit (PDU). OSI application layer, session and presentation layer are being implemented with a common syntax to transfer the data over the networks. Distributed Active Simulation(DIS)and Distributed Simulation Network (DSN) are defined with upper layers of OSI reference model to transfer the common syntax to achieve the real time environment of communication with properties required under the real time systems. As DIS system is very slow in functioning due to the heterogeneity but employed common transfer syntax deployed on the upper layers such as application, session and presentation layers of OSI the slowness of the DIS is decreased and it becomes fast for achieving the target of real time performance.

Interoperability of the DIS network depends upon the implemented common interoperable syntax with the upper layers of OSI model. The adoption of the OSI addresses the problem of the heterogeneous representation of data and encoding methodology for the syntax of the transfer [6]. The scheme behind the support for real time functional aspects the OSI with DIS optimized through three mechanisms.

1. The transformation of the PDU is taken first from current form to the transfer syntax through the help of the encoding methods on the sender machine.
2. The PDU of the transfer syntax is being transferred to the communication stack of the sender machine and also the same transfer syntax is received by receiving machine.
3. When the the receiving machine receives the transfer syntax PDU then it converts to the local representation through the help of decoding rules.

These three mentioned optimization processes are additional integrated common syntax with the upper layer of OSI to make the DIS functional aspects real time.

4. EXPERIMENTAL SETUP

Distributed active simulation and Distributed network over the inherited functions of the OSI reference model is taken to setup the entities for the experiment to verify the real time functional aspects of OSI Model. DIS and OSI testbed is taken to verify the functions. OSI protocol stack with upper layer protocols are taken for the testing of the real time working conditions. Experiment is design with many PDUs with different categories and all the PDUs are transmitted through the

DIS network. The PDU type selected for the experiment with specified time for delay to take to verification with the transfer syntax and without transfer syntax is defined under the table 1.

Table 1: Experimental setup PDU end to end delay

PDU No.	PDU Having Transfer Syntax	PDU Not Having Transfer Syntax
1	24.39 ms	7.6 ms
2	18.81 ms	8.17 ms
3	25.07 ms	7.53 ms
4	15.02 ms	7.45 ms
5	13.63 ms	7.38 ms
6	13. 83 ms	7.47 ms
7	18.27 ms	7.34 ms
8	10.15 ms	7.35 ms
9	10.64 ms	7.37 ms
10	10.64 ms	7.6 ms

The delay is per-determined for the experiment as the real time performance the optimized delay is considered in the given scenario for the PDU end to end communication with distributed active network.

Each PDU has specified number of bits to be transmitted from the one end of the system to given other end of the system. The experimental setup holds the ten PDU with fixed amount bits to verify the performances as required for the real time function with upper layers of OSI reference model.

The architecture of heterogeneous systems for the node of DIS and DSN networks are taken as Sparc 1, Sun 3, HCX 9, Motorola 68030 and Harris 3000. These all systems are taken as node for the selected network to run the experiment to define the outcome for real time functional aspects of the network.
The encoding and decoding time for the values of the PDU is also pre determined on the average basis. The encoding and decoding time in average for the PDU is represented in table 2.

Table 2: Encoding and Decoding Time of PDU

Node System Architecture	Average Encoding Time	Average Decoding Time
Sparc 1	8.6 ms	7.8 ms
Sun 3	24.9 ms	23.2 ms
HCX 9	28.33 ms	24.43 ms
Motorola 68030	30.0 ms	28.89 ms
Harris 3000	18.67 ms	11.34 ms

The specified encoding and decoding time for the PDU data is average and observed through the expectation to optimize the given delay scenario. The delay is not inclusive with the given table 2 encoding and decoding time for the PDU data. The delay is taken for the communication through the network.

5. EXPERIMENT EVALUATION AND RESULTS

The experimental evaluation of the setup of the system is performed under the simulative environment. The real amount of the delay of the PDU in the phase of communication depends on the hardware types. The PDU complexity is also a factor that contributes the delay for the communication of the PDU as defined in the experimental setup [7]. A simple metric is taken here to evaluate the complexities of different PDUs taken for the experiment.
Suppose that,

D_i is equal to the average no. of fixed data units under the PDU having number i, P_i is the equal no. of the fractional data units under the PDU i, and O_i is the average number of octets or character data under the PDU i, thus, the complexity C_i for the processing of the PDU at individual node with different architecture of the machine or node is defined as,
$C_i = m \text{ x } D_i + n \text{ x } P_i \text{ x } o \text{ x } O_i$, here m, n, o are the taken constants for the minute adjustment factors.

Hence the relationship between the speed up and complexity factors of the PDU with various hardware system taken are defined under figure 1.

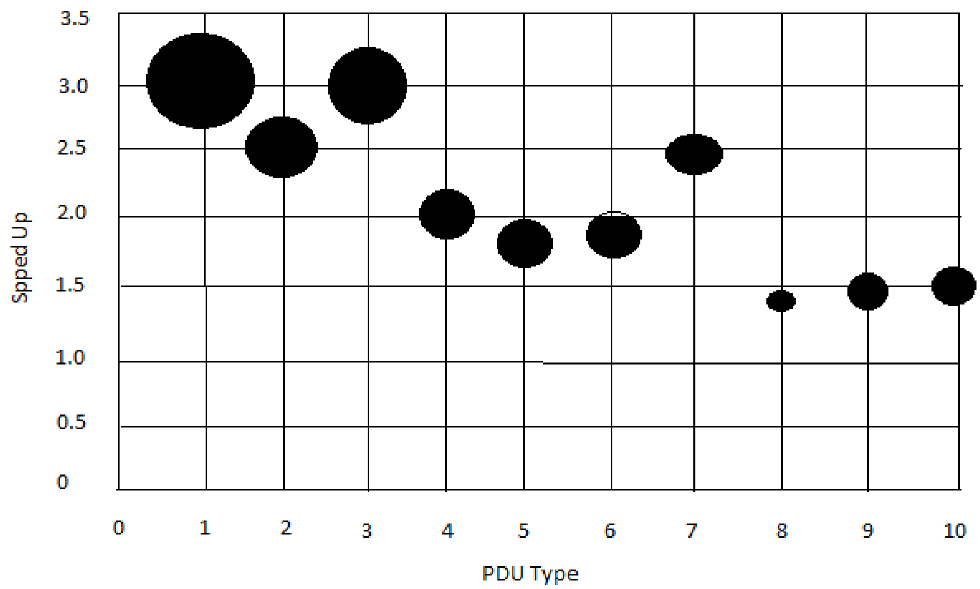

Figure 1: Speed Factors with PDU Types

With figure 1 the speed up factors for the different PDUs selected for the experiment under the real time functional aspects for the given architectures of the hardware system having heterogeneous categories are represented. In the representation it is clear that first three PDUs have higher speed up ratio than other next PDUs. This indicates that the starting of the communication is handled efficiently under the real time integration of the OSI upper layers integration but when the PDUs increases the complexity for the encoding, decoding and communication also increases [8][9][10].

Therefore, it is obvious that the OSI reference model having its upper most layers are capable for the real time functioning whenever the PDUs are lower in numbers at the time and it is also true that when lower layers are not involved under the encoding and decoding processes [11][12].

Speed up values for the four selected hardware such as Sparc, Motorola, Sun and Harris are represented with a graphical notation under figure 2.

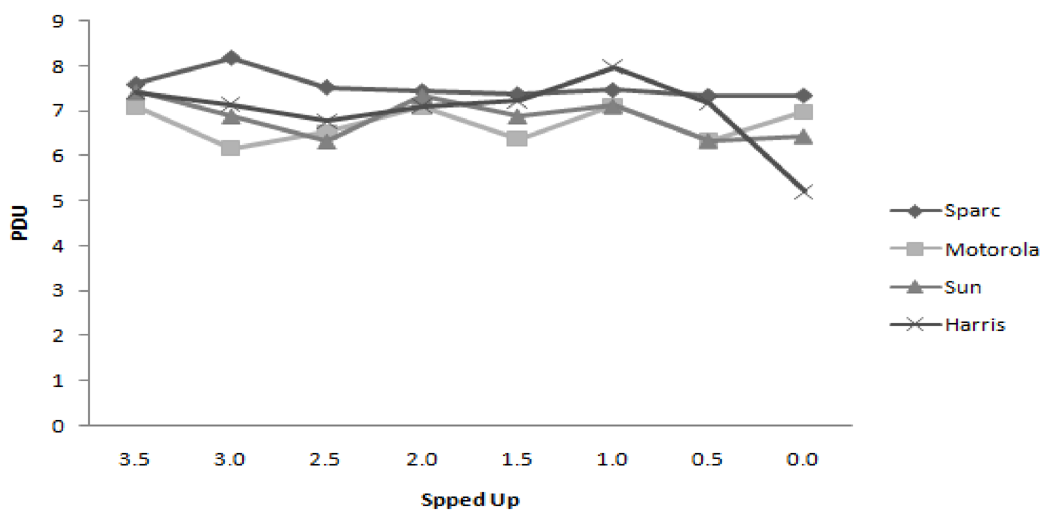

Figure 2. PDU and Speed Up Graph For Given 4 Hardware Systems

When the decoding process is flexible in nature the transfer syntax for the given PDU does not impacted the complexity.

CONCLUSION

The usability of the computational power with heterogeneous system are increasing day by day and the advancement of networking technology also enables the usability through efficient capability to send and receive the data and signals to manage the functions of active critical system. Distributed interactive simulation to control the running processes of heterogeneous machines integrated through the computational units via the communication network. Open system interconnection is standard that is not directly fitted for the real time functions. The real time open system interconnection needs the OSI upper layer protocols to support the intelligent functions. The protocols of the OSI upper layers are considered to transfer the PDU with targeted delay to cope the required aspects of the real time interactive simulation of the integrated applications with active critical systems. Finally, it is also dependent upon the different architectures of the systems that is used for the control management of the data. The network is distributed so effectiveness of the real time version of the open system interconnection standard is optimized with different node architectural platforms.

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