

# Quanta Data Storage: A New Storage Paradigm

**Sai S. B. Narasimhamurthy**

**saib@asu.edu**



**NASA/IEEE MSST 2004**  
12th NASA Goddard/21st IEEE Conference on  
Mass Storage Systems & Technologies  
The Inn and Conference Center  
University of Maryland University College  
Adelphi MD USA  
April 13-16, 2004



---

# Problem and Solution

- Problems in IP Storage Network Solutions
    - Bottlenecks due to TCP implementation
    - Poor ISCSI implementation
    - Additional security mechanisms, viz. IPSEC
    - Redundant functions in protocol suite
    - Protocols designed for non storage specific requirements
-

---

# Problem and Solution

- Solution : Quanta Data Storage
    - Data stored, manipulated as fixed block sizes
    - Each block corresponds to Quantum of Data
    - Quanta are encrypted and preformatted
    - Stored as is on the server side (Target )
    - Quanta processed and transported across Internet using Effective Cross Layer
-

---

# Motivation

- IP networks-cheap and easy solution for transportation of bulk data
    - Inexpensive alternative to SCSI and Fiber Channel
    - iSCSI proposed for data transport over IP network
    - New protocols developed to ease the integration
    - Resulted in over layering and crowding
-

# Related Works

Stephen Aiken et. al	iSCSI based target on a specialized hardware Results indicate poor iSCSI performance
Y. Lu and D. Du	Performance analysis of iSCSI, NFS, SMB iSCSI storage performance close to Fiber Channel Attached Storage
Shaung-Yi Tang et al.	IPSEC below iSCSI and TCP/IP, low throughput Only provides security on the wire
Peter Druschel and Larry Peterson	Introduced facility called fast buffers OS facility implemented for I/O buffer mgt.
David D. Clark and David Tennenhouse	Data manipulation cost high compared to transfer control operation Application data units are the natural pipelining units

---

# Glossary

*iSCSI*- Internet Small Computer System Interface

*IPSEC*- Internet Protocol Security

*RDMA*- Remote Direct Memory Access

*DDP*- Direct Data Placement

*MPA*- Marker PDU Aligned Framing for TCP

*AES*- Advanced Encryption Standard

*ECL*- Effective Cross Layer

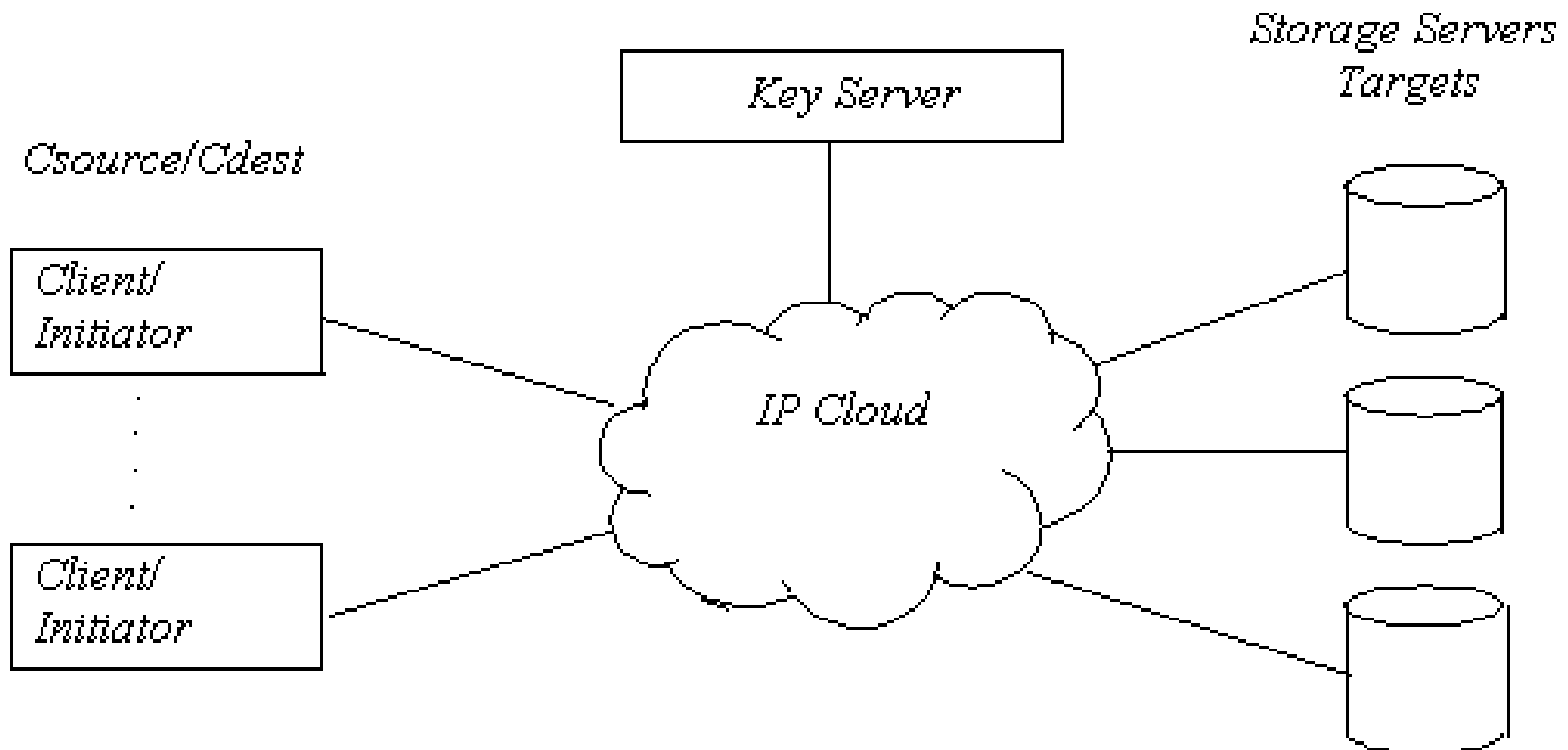
---

---

# Cross Layer Architectural Goals

- Minimize data handling and processing
  - Provide security on the wire and storage
  - Provide the features of iSCSI protocol
  - Provide application level buffering by incorporating DDP
  - Provide transport layer mechanism
-

# Encryption Mechanism



**System Setup for Data Storage Centric Networks**

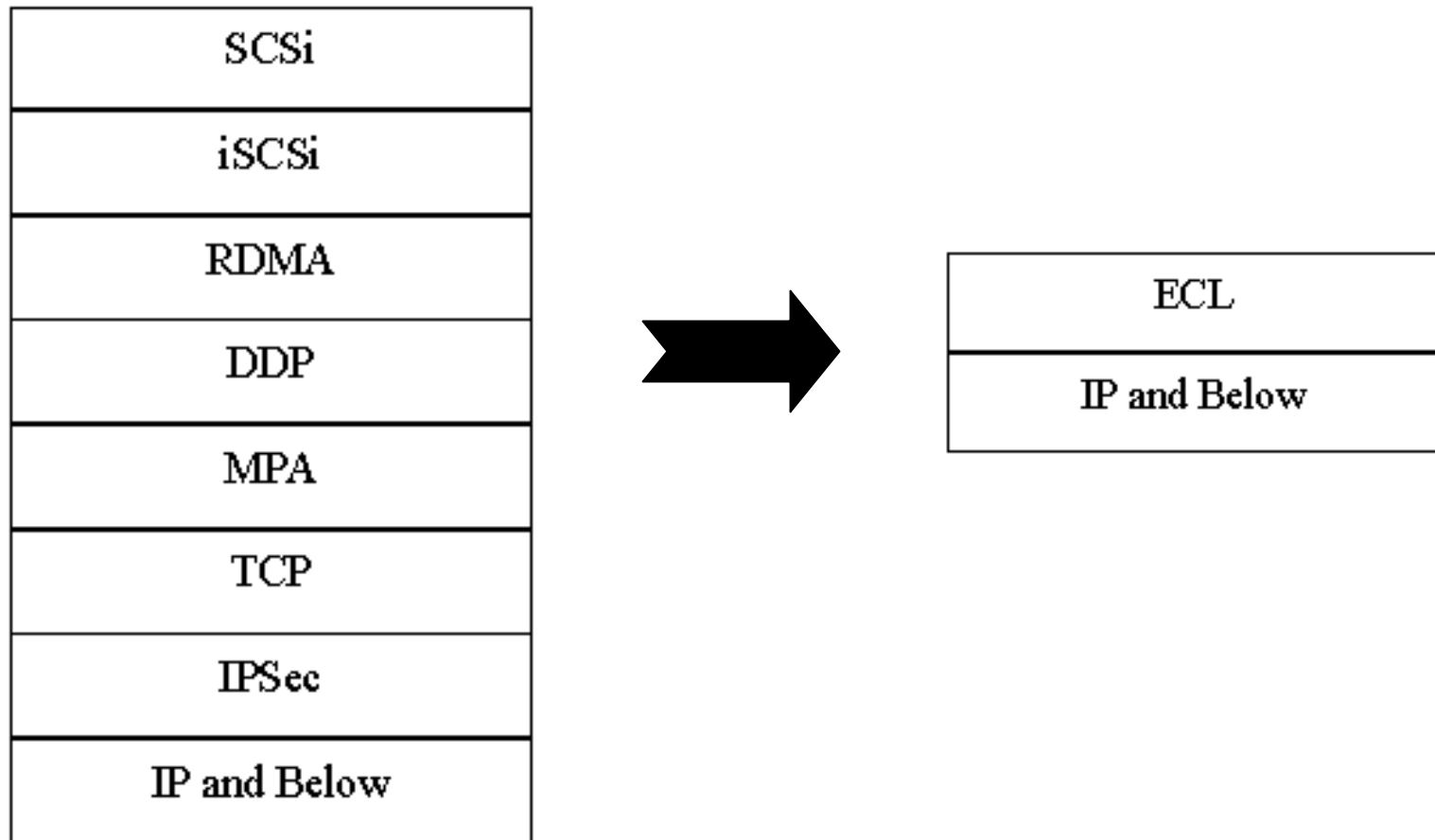


---

# Encryption Mechanism

- EDU-Encrypted Data Unit stored on server
  - EDU is transported to server using ECL
  - Encryption keys generated using AES
  - Keys are stored in a centralized key server
  - A valid client can access the file and keys
-

# Effective Cross Layer (ECL)



**Effective Cross Layer**

# Effective Cross Layer (ECL)

CHECKSUM (16)		T (1)	RESERVED (15)
DATA SINK STAG (32)			
I (2)	OPCODE (8)	F (1)	OPCODE SPECIFIC FIELDS (21)
TOTAL AHS LENGTH (8)		DATA SEGMENT LENGTH (24)	
LUN OR OPCODE SPECIFIC FIELDS (32)			
INITIATOR TASK TAG (32)			
OPCODE SPECIFIC FIELDS (224)			
AHS (OPTIONAL)			

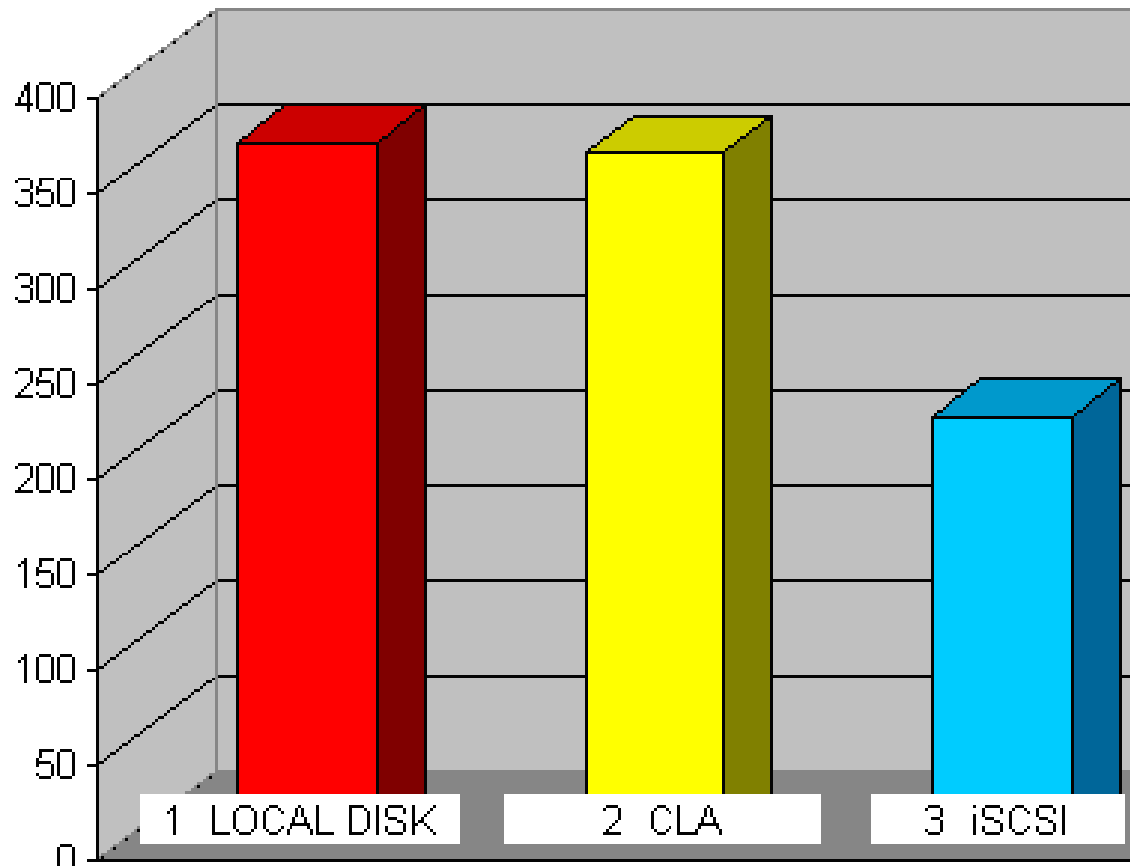
**ECL Header for WRITE Operation**

---

# Emulation of ECL by HyperSCSI

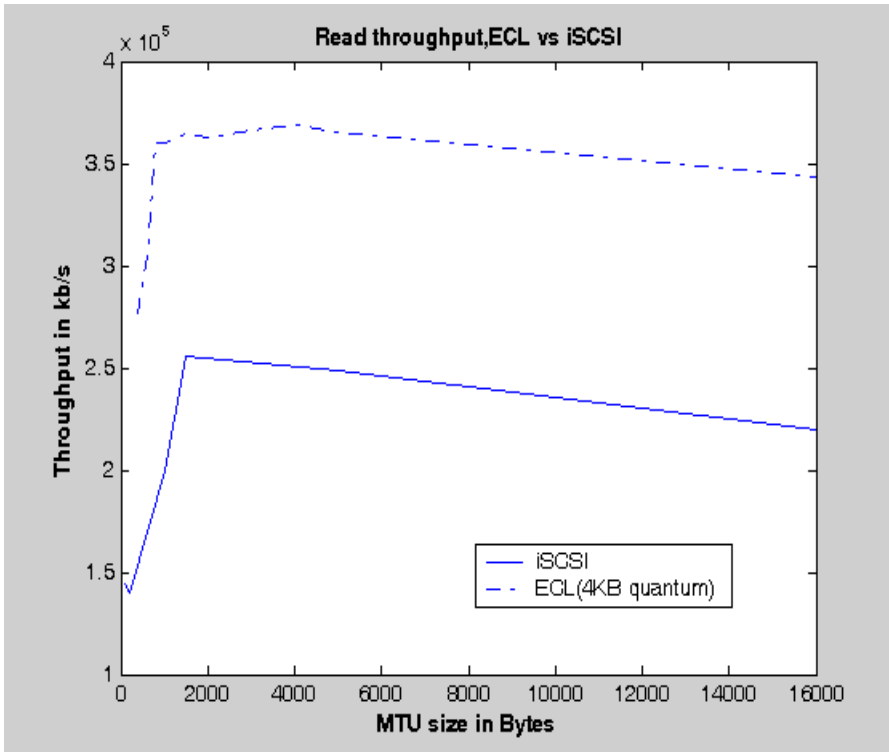
- HyperSCSI emulates a simple version of ECL
  - Two Dell Power Edge Servers
  - Linux Kernel Version 2.4.20-18.7
  - Throughput measured using Bonnie++1.03
  - TCPDUMP and Ethereal for packet dumps
  - iSCSI reference 0.18 v10
  - 40 GB *Quantum* hard disks with ULTRA-160 SCSI bus
-

# Results

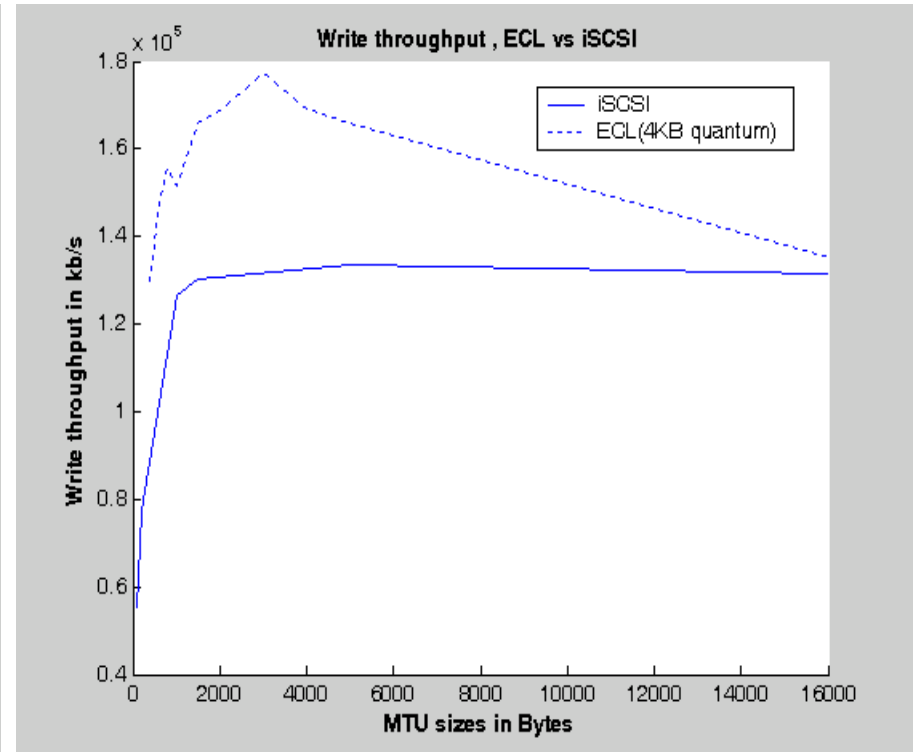


**Read performance through the ECL**

# Results

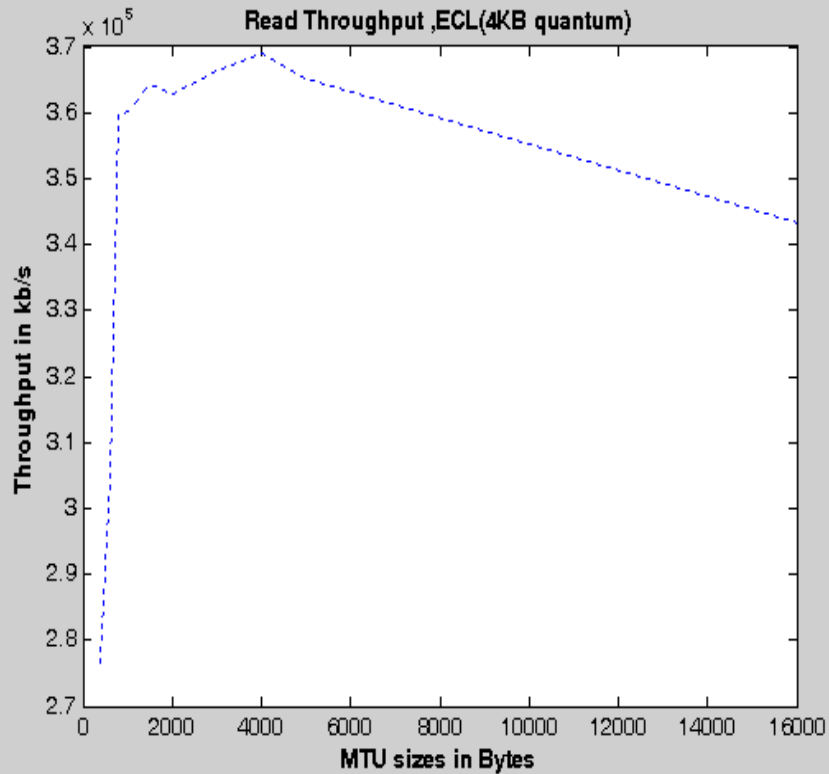


**Bulk read throughput results**

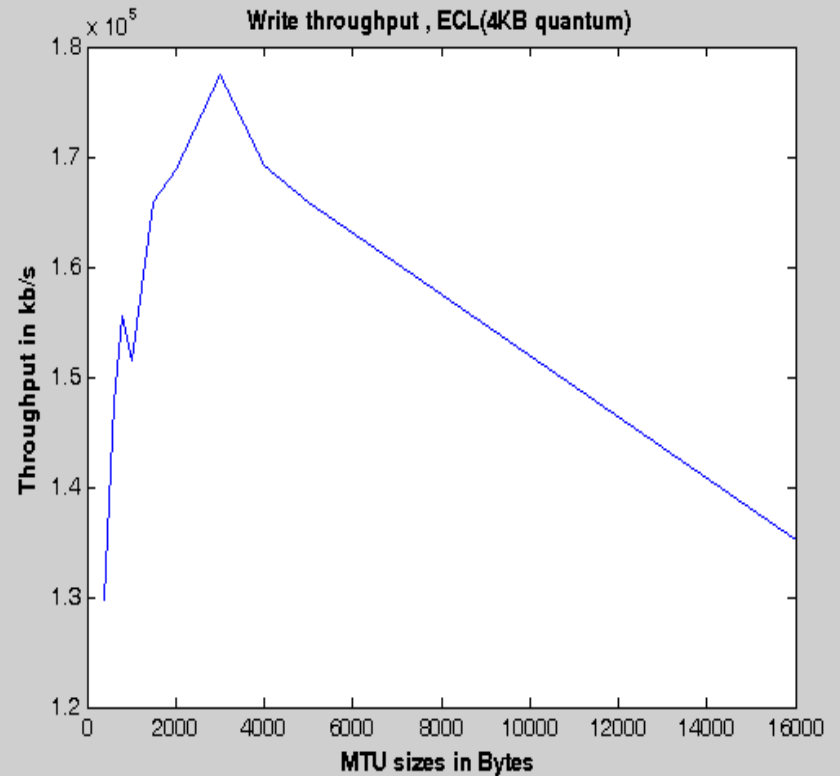


**Bulk write throughput results**

# Results

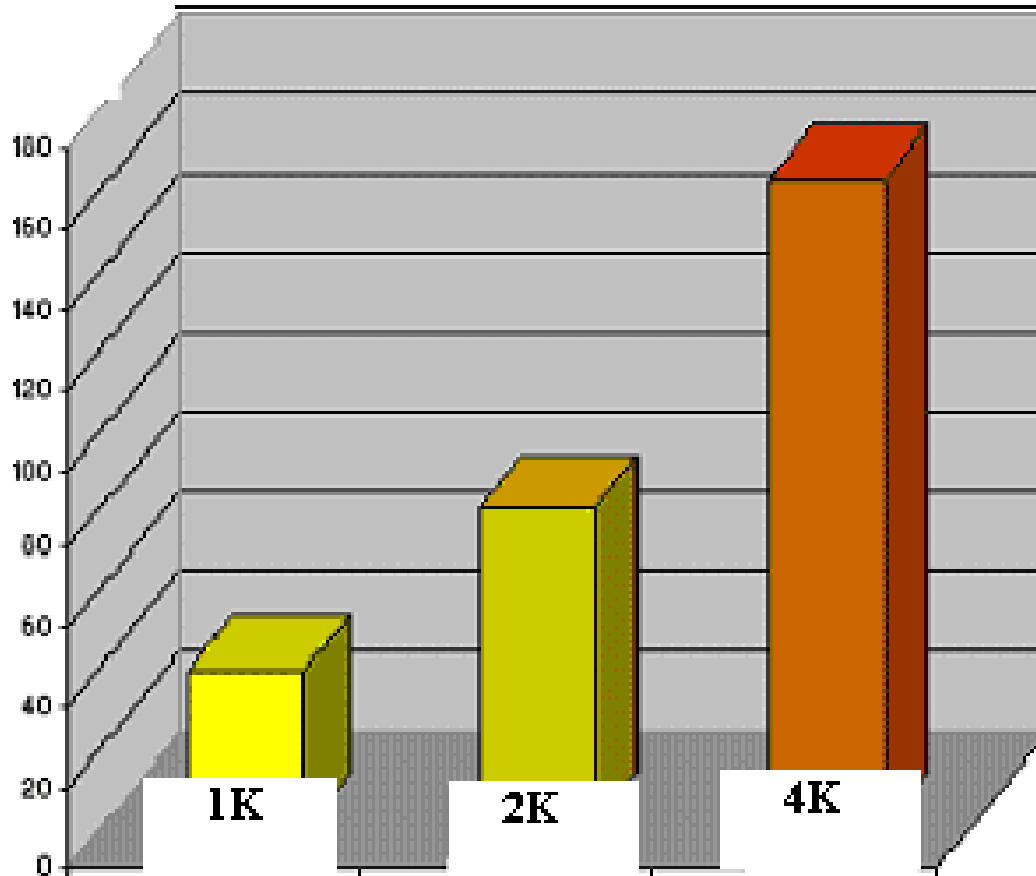


**ECL bulk read throughput results**



**ECL bulk write throughput results**

# Results



**Write throughput for 1K, 2K, and 4K quantum sizes – in Mbps for 5K path MTU**

---



---

# Conclusions and Future Works

## ■ Conclusions

- ❑ Problems in existing storage networks
- ❑ Quanta Data Storage along with ECL and security provides solution
- ❑ Quantum data lengths less than or equal to path MTU

## ■ Future Works

- ❑ Characterize memory bandwidth improvements
  - ❑ Group key management protocol
-