SQUARED
TECHNOLOGIES INC.

What is Reflective Memory?

J-Squared Technologies Inc.
REFLECTIVE MEMORY DIVISION

Toll Free: 1.855.365.2188
Local: 1.613.592.9540
rfm@jsquared.com

SQUARED Reflective **Memory**

What is REFLECTIVE MEMORY?

A Reflective Memory network is a special type of shared memory system designed to enable multiple, separate computers to share a common set of data.

Reflective memory networks place an independent copy of the entire shared memory set in each attached system. Each attached system has dull, unrestricted rights to access and change this set of local data at the full speed of writing to local memory.

When data is written to the local copy of Reflective Memory, high speed logic simultaneously sends it to the next node on the ring network. Each subsequent node simultaneously writes this new data to its local copy and sends it on to the next node on the ring. When the message arrives back at the originating node, it is removed from the network and, depending on the specific hardware and number or nodes, every computer on the network has the same data at the same address within a few microseconds.

Local processors can read this data at any time without a network access. In this scheme, each computer always has an up to date copy of the shared memory set. In the four-node example shown, it takes 2.1 µs for all computer to receive the data that was written to Reflective Memory.*

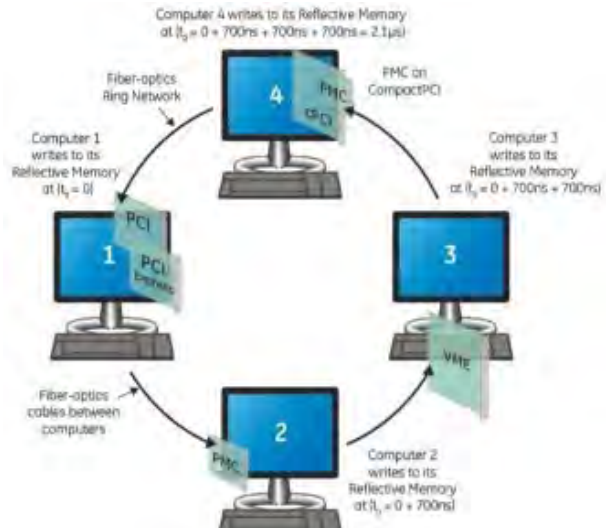

***Figure 1** Reflective Memory provides very low latency between nodes.*

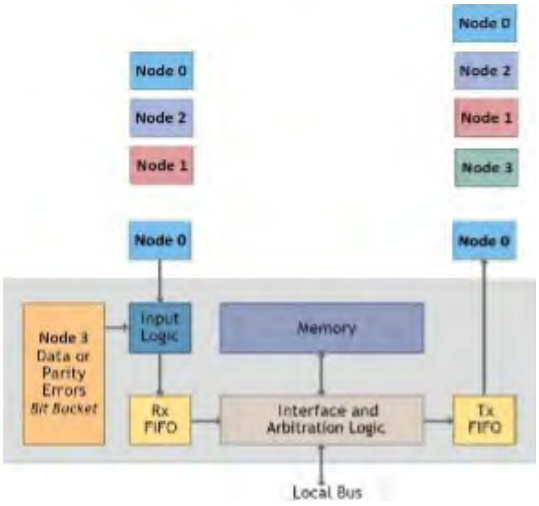

***Figure 2** Reflective Memory data insertion. Data from the network is automatically written to local memory and transmitted on to the next network node by embedded logic.*

A Reflective Memory board (node) consists of local memory, an embedded interface, and arbitration logic which provides access for both the host computer and the Reflective Memory.

The Reflective Memory boards may be physically installed or connected to a variety of computer buses, including VME, and PCI/PCI-X, Compact PCI, PCI Express or any standardized or proprietary system capable of hosting a PMC site. This allows most popular workstations and single board computers to be connected via Reflective Memory regardless of their interoperability.

** This latency is calculated assuming no network traffic, short cable lengths and the largest packet size is possible. Cable length and network traffic can cause the latency to increase, but as long as the bandwidth of the network is not exceeded, the latency should not increase significantly.*

What is REFLECTIVE MEMORY?

WHERE DO I USE REFLECTIVE MEMORY?

Reflective Memory may be used in any application that uses Ethernet, Fiber Channel, or other serial networks to connect computers or Programmable Logic Controllers (PLCs) together, but it is not ideal for all applications. Reflective Memory is most relevant in systems where interaction in real time is a primary concern. In systems where determinism, low latency, and high-speed communication are necessary, Reflective Memory boards, while typically more expensive than lower performance hardware, provide a huge return in performance with the added benefit of ease of use.

HOW DO I USE REFLECTIVE MEMORY?

Using a Reflective Memory network requires only a few simple steps:

- Plug Reflective Memory into any available backplane slot (VME, PCI Express, etc.), or connect it to any single board computer or carrier (VME, CompactPCI etc.) with a PMC or XMC site and connect cabling
- Write to memory (Reflective Memory's global memory appears to the computer as standard RAM)
- Read memory (any Reflective Memory board on the network)
- Configure x540-T1 Ethernet NIC's for Desired User IP Address and set MTU Size to 9000 Bytes

The benefit of a low software, high-speed, hardware-driven network like Reflective Memory is extremely low data latency, both overall and between individual network nodes. This low-latency performance is of paramount importance when building real-time systems such as simulators.

WHO USES REFLECTIVE MEMORY?

Reflective Memory is used in hundreds of applications, including the following:

- Aircraft or Avionics simulators
- Power plant simulators
- Industrial process control
- Over-the-horizon radar
- Marine vessel Simulators
- Automated testing systems
- Aluminum or Steel rolling mill
- Control/monitoring
- Engine test stands
- High speed data acquisition
- PLC users

WHY WOULD I CHOOSE REFLECTIVE MEMORY?

Reflective Memory LANs or Real-time Networks are usually constructed because the designer has needs or problems that are solved by one or more of the following Reflective Memory board characteristics:

- Deterministic data transfers
- High-speed performance
- Ease of use
- Operating system and processor independence
- Economics and available time-to-build systems
- Advantages over Standard LAN Technologies

What is REFLECTIVE MEMORY?

DETERMINISTIC DATA TRANSFERS

Reflective Memory is a hardware-based network. All data transferred to a node is stored in local memory and automatically sequenced out to all the other nodes' memory. There are no software delays and minimal hardware delays associated in the data transfer. Any latency is imposed at the hardware level and can be predetermined within a very small window of best-to- worst case latency. The determinism of Reflective Memory, the guaranteed time in which communication between two or more nodes is completed, allows system designers to build effective real-time LANs that can guarantee data delivery within a tight window of time. This enables guaranteed scheduling of sequential actions and ensures that data is not lost.

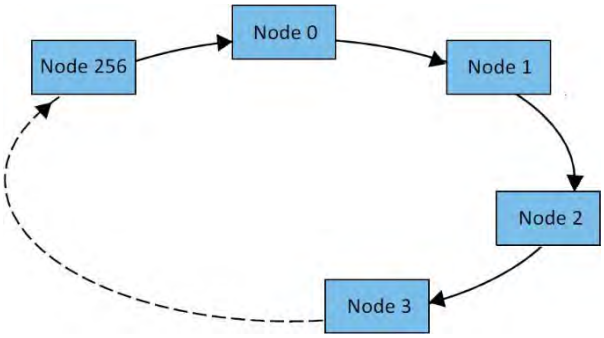

Figure 3 *Reflective Memory Ring Architecture connects up to 256 separate network nodes in real time*

HIGH-SPEED PERFORMANCE

The demands of real-time performance dictate that Reflective Memory networks must operate at very high speeds. In some cases, this speed and the throughput it generates are compelling reasons to use Reflective Memory. As an example, the Reflective Memory products supplied by J-Squared offer dynamic packet sizing (4 to 64 bytes), DMA capability for minimal CPU overhead, up to 256 Mbyte DRAM, 2.12 Gbaud fiber optic connections, and a sustained 170 MB/s transfer rate. This compares favorably for both speed and throughput against most data networks.

EASE OF USE

No other high-performance LAN is as easy to install and operate as Reflective Memory. An ideal network would allow every computer simultaneous access to every computer's memory. Reflective Memory approximates this ideal by giving every computer on the network an actual copy of all the other computers' memories in microseconds, in up to 256 distinct computers. Since this memory is global, accesses may be simultaneous by multiple computers. All CPU write accesses to this common memory space are replicated to all nodes in the net- work. Reflective Memory transparently monitors and replicates this data, so that the application(s) can share the data without software overhead penalties.

OPERATING SYSTEM AND PROCESSOR INDEPENDENCE

Reflective Memory hardware is currently available for VME, PCI/PCI-X, PMC, PCI Express, XMC and various other form factors. This allows dissimilar buses to be connected in a single Reflective Memory network. An embedded single board computer (VME or CompactPCI) with a PMC or XMC site may use a Reflective Memory PMC or XMC board to offload traffic on the host backplane in Programmed IO or DMA Data transfers.

Users are able to configure a high-speed network where any desktop workstation, single board computer, or server can share information directly with ANY computer having an available CompactPCI, PCI/PCI-X, PCI Express, VMEbus slot, or PMC/XMC site in Linux, VxWorks or Windows Operating Systems.

What is REFLECTIVE MEMORY?

Even when connecting different computer types which use different byte formatting (big- and little-endian types), byte swapping is a non-issue in Reflective Memory systems. PCI- based Reflective Memory boards can include hardware designed specifically to translate the language of byte swapping. This hardware provides quick, efficient and repeatable bidirectional conversion. Again, no protocol overhead or time penalties are incurred for conversion between big- and little- endian types. Reflective Memory has the same ease of use regardless of the operating system or machine it is used in.

ECONOMICS AND AVAILABLE TIME-TO-BUILD SYSTEMS

System designers are increasingly asked to build more capable, complex systems in a shorter amount of time. In such cases, the cost of hardware may be minimal when compared to software and the time spent integrating hardware/software. This is especially true of one-of-a-kind or small-run systems. In cases where time to market is a critical dimension, the lower investment in software person-hours required to get a system up and running when using Reflective Memory may be an extreme benefit. In these demanding systems, Reflective Memory's simple read/write method of communication substantially improves time to market, as well as improving data throughput on the network.

ADVANTAGES OVER STANDARD LAN TECHNOLOGIES

Reflective Memory offers a variety of features over standard networks, such as global memory, high speed data transfers, and software transparency, which make Reflective Memory an attractive solution to multicomputer communication. Compared to the costs of additional development time, testing, maintenance, documentation and extra CPU requirements for traditional communication approaches, Reflective Memory provides a cost-effective alternative.

SUMMARY

Reflective Memory is an optimal way to share data in time- critical applications ranging from data acquisition and process control to advanced simulation. Reflective Memory networks provide a real-time networking capability that surpasses most communications technologies for low latency and deterministic performance. Reflective Memory networks connect systems with minimal update delays and no access restrictions, to enable multiple, remotely located nodes to share a single data set in real time.

Comparison

OFF-THE-SHELF NETWORKING TECHNOLOGIES

Reflective Memory Network Characteristics	5565PIORC	10/100 Ethernet	Gigabit Ethernet
Transmission Speed	2.1 GBaud/s	10/100 Mbit/s	1000 Mbit/s
Data Transfer Speed	170 MB/s	1/10 MB/s	100 MB/s
Endian Data Conversion	Yes	No	No
Software Transparent	Yes	No	No
Media	Fiber Optic	Coax, UTP	Fiber Optic
Topology	Ring	Ring, Hub	Ring
Network Data Transmission/ Reception Is Deterministic?	Yes	No	No
Network Transfer Scheme	Data Insertion	Carrier Sense Multiple Access/ Collision Detect	Token Passing
Memory Mapped Access to Shared Data?	Yes	No - Messaging Application Application Must Be Built	No - Messaging Application Must Be Built
Application Must Be Constructed to Share Data?	No	Yes - Messaging Application	Yes - Messaging Application
Application Must Encode/Decode Messages?	No	Yes	Yes
Application Must Perform Error Check/Handling Retransmits, etc.?	No	Yes	Yes
CPU Overhead to Support Shared Data Functionality?	No	Yes	Yes
CPU Overhead Required at Transmission Hardware Interface?	No	Yes	Yes

ESL Technology INC
TESTING YOUR LIMITS

TEST STANDARDS:

MIL-STD-167
MIL-STD-810
MIL-STD-108E
MIL-E-5400T
MIL-STD-2164
MIL-S-901D
MIL-STD-461G
60068-2
60529
60945
60598-2-3

OCTAGON SYSTEMS

- Small Form Factor Rugged Computers/Mission Computers
- Ruggedized Servers
- Ruggedized Switches
- Ruggedized Displays

J SQUARED Reflective Memory

Toll Free: 1.855.365.2188
Local: 1.613.592.9540

Email: rfm@jsquared.com
reflectivememory.com