

Simulation now forms a major role in the development of land, sea and air vehicles. Simulation early in the design stage can iron out problems before they are engineered into the final design, reducing costly delays and minimising budget overspend. For all but the most simple simulation model, multiple computers need to work in parallel to provide sufficient processing power to achieve real-time performance. This involves sharing data between multiple hardware platforms using high bandwidth communications to minimise latency. In this App Note we describe a new concept in Reflective Memory implementation which makes traditional systems based on complex proprietary hardware and interface standards obsolete.

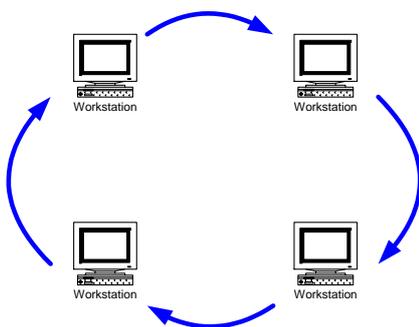


Typical Architecture

If someone mentions “flight simulator”, your first thought might be the Microsoft video game loved by millions worldwide. This game introduced many people to the fun of flying and surprised many with what could be achieved using a single computer programmed with the appropriate models of aircraft behaviour, terrain, etc.

But making the simulation experience sufficiently lifelike for training commercial and military pilots needs more complex models with additional elements (hydraulic movement of the pilots cockpit, extra instruments, additional viewing screens, etc). As a result, a network of computers is needed to run the individual model elements. These computers must each run their own parts of the model in real time, and share substantial datasets with the other machines to form the complete simulation environment. The importance of good simulation is underlined by the decision to build the UK’s new F35 Lightning II aircraft as only a single seat version. At around £70M per plane, a new pilot needs to be expert in operating the aircraft before he straps himself in for his maiden flight.

Traditional simulators have been built using Reflective Memory (RM) products from companies such as Curtiss Wright (CW) or GE. In these systems, each computer contains a proprietary RM card, fitted with a small block of dedicated shared memory. These RM cards communicate via a ring architecture to share data using copper or fibre interfaces. This approach means accepting high latency through each node and low bandwidth data transfers, plus a risk that failure of a single cable will bring the whole network to a halt.



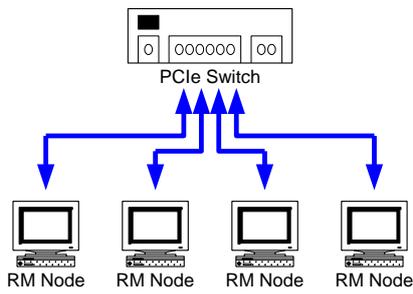
Traditional Ring Reflective Memory

- Limited shared memory on each node
- Slow communication between nodes
- Significant latency through each node
- Latency increases when adding nodes
- Single cable failure kills entire ring
- BAD!!

Figure 1 - Traditional Ring-based architectures

Now there is a new way for simulation networks to communicate which uses a better approach to data sharing. Dolphin ICS (a Norwegian company) has introduced a series of PCIe-based RM products which combine low cost hardware with sophisticated software drivers. The result is a new type of shared memory network with performance

that is orders of magnitude faster than traditional RM. Dolphin’s approach uses simple, low-cost PCIe interface cards communicating with each other using high speed PCIe cables and dedicated PCIe switches.



Dolphin ICS Reflective Memory (Single Switch)

- Up to **8Gbytes** memory on each node
- **>2Gbytes/s** PCIe communication between nodes
- Node-to-node latency under 1µs
- Simultaneous data transfer to each node
- Latency stays constant when nodes added
- Cable failure only affects one node
- MUCH BETTER!!

Figure 2 - Dolphin ICS Reflective Memory System

PCIe switches can be stacked to create large arrays of nodes (up to 56 endpoints) operating with very low latency and very high bandwidth. The network communicates using copper or fibre cabling, or a mixture of both, allowing switches and nodes to be positioned over a wide area. The nodes and switches incorporate management software so that a single operator can monitor the entire network status over ethernet.

Another limitation of traditional RM systems is the small capacity of shared memory on each node, and the overhead of having to copy data between the RM node and the host computer. In contrast, Dolphin RM maps a block of the host computer’s own memory into the PCI address space, which allows nodes to share up to 8GB of storage. Nodes can perform unicast or multicast transfers to further optimise the available data bandwidth. Dolphin RM also supports peer to peer transfers, allowing , for example, FPGA or GPU processors in each computer to transfer data directly to remote nodes without local CPU intervention. Dolphin RM products currently support PCIe Gen2, providing a huge performance increase over traditional dedicated RM systems. In addition, Dolphin ICS are working on PCIe Gen3 support which will further extend the bandwidth and reduce the latency.

Of course, fast hardware is useless without good software APIs. Dolphin ICS provide several ways of accessing the hardware including:-

- Supersockets – Berkeley compliant socket interface for easy integration with existing code
- SISI API – simple shared memory programming model (supports Programmed IO and DMA transfers)

Driver software is available for Windows, Linux and VxWorks platforms. Each software package includes extensive example code, making it easy to set up and operate a Dolphin RM network.

Conclusion

Dolphin’s radical approach to Reflective Memory combines a massive increase in performance with large shared memory spaces. The resulting high bandwidth, low latency network means that RM performance is no longer a limiting factor in the design of a new simulator. The low cost per node and extensive roadmap for future support makes a compelling case for using Dolphin ICS products when designing new simulation applications or refreshing existing programmes.



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