



Storage Solutions

White Paper



Introduction

Auriga, Inc. has significant experience in product development in the area of high performance storage solutions, based on SAN, Fibre Channel, SCSI, iSCSI, and I2O technologies. Auriga's development teams worked with major customers and provided high quality storage products and networking products oriented to SAN systems.

Development of various system level software, including device drivers, network protocol stacks, networking applications and services, is within the core competence of Auriga. Auriga developed system level products under most major operating systems and real-time operating systems, including:

- Linux x86 and Linux PowerPC
- Solaris
- SCO OpenServer
- SCO UnixWare
- Digital UNIX
- Windows NT, Windows NT Embedded, Windows 2000, Windows XP
- VxWorks
- LynxOS
- OSE

Another key strength of Auriga is vast experience in CompactPCI High Availability solutions, which can be important for the storage market. Auriga's engineers developed complete CompactPCI hot swap infrastructures, drivers for specialized hardware allowing for HA system control, and true HA products that operated in hot failover mode and allowed for non-stop operation during hardware and/or software failures, maintenance, and upgrades.

Fibre Channel Device Drivers

One of the projects done by Auriga engineers was development of a suite of Fibre Channel device drivers.

The suite was developed as a part of a bigger project targeted to providing a highcapacity SAN-based storage solution for one of the top 4 leading suppliers of storage products. The Fibre Channel drivers developed by the Auriga team allowed for simultaneous data and control transfers over the Fibre Channel fabric and combined SCSI over Fibre Channel and IP over Fibre Channel with a highly efficient native Fibre Channel protocol. The protocol allowed running the checkpointing subsystem of the high availability package that controlled operation of the system over the Fibre Channel media bypassing the slow TCP/IP stack. The project was done under LynxOS.

The suite of Fibre Channel drivers included:

- The low-level hardware driver that serviced Interphase's x526 family of Fibre Channel host bus adapters, which were used in the project.
- The Fibre Channel Master protocol driver that implemented high level operations associated with the Fibre Channel protocol using the interfaces exported by the low-level HBA driver. The Master driver provided general purpose Fibre Channel support services and interfaces that allowed for registration and operation of the Upper Level Protocol drivers and hardware drivers.
- The SCSI driver that converted SCSI transactions to Fibre Channel transactions.
- The network interface driver that forwarded Ethernet frames over Fibre Channel.
- The raw Fibre Channel driver that allowed sending raw Fibre Channel frames to any Fibre Channel node. The driver allowed simulating a UDP oriented network interface optimized for maximum performance since the conventional kernel TCP/IP stack was bypassed.
- Management and configuration utilities. Allowed system administrators to control the Fibre Channel drivers.

At the later stages of development, an accent was made on testing the Fibre Channel drivers. Various test suites were used to verify that the Fibre Channel interfaces operate correctly. Also, the correct behavior of the HBAs controlled by our Fibre Channel drivers was verified at the hardware level using a Fibre Channel protocol analyzer.

SCSI Drivers

Auriga's development teams were involved in several projects related to SCSI driver development. These projects included:

- Development of a driver for an NCR SCSI adapter. The driver was a part of a firmware developed by Auriga's engineers.
- Development of The Host Bus Adapter Certification Test Suite for SCO OpenServer 5.0.5. The test suite verified operation of all OpenServer 5.0.5 drivers that controlled various types of storage on top of a particular SCSI HBA and HBA driver. The test suite was developed for Santa Cruz Operation, Inc. and allowed the company to carry out formal certification of HBA drivers.
- Development of user-mode programs that programmed SCSI devices using a pass-through interface, which allowed sending SCSI commands directly to SCSI devices.



I2O Protocol

Auriga's engineers have in-depth knowledge of the I2O specification. Although primarily intended for server systems, the I2O protocol can be used as a vehicle for various communication needs in PCI and CompactPCI based systems. Auriga's engineers participated in two large projects where I2O was used to allow CompactPCI, PCI, and PMC boards communicating over the PCI bus. Each board was running its own OS/RTOS and drivers equivalent to OSM/DDM modules.

Thanks to these projects, Auriga's developers have exceptional knowledge of the I2O protocol and are ready for various projects related to using I2O in storage solutions.

iSCSI and Networking Technologies

The importance of broad expertise in networking for companies that work in the area of storage solutions cannot be underestimated. The growing popularity of iSCSI solutions is one of the evidences of how networking technologies can open new horizons for storage products. Auriga has a long record of successful networking products, some of them related to storage technologies.

The team engaged in Linux and embedded Linux development performed a detailed comparison of various existing iSCSI implementations, which included both testing different implementations on chosen hardware and in depth code analysis.

Another team that worked in cooperation with Santa Cruz Operation developers worked on adding means for unattended backups and upgrades to SCO's Network Client Operating System.

Other networking projects undertaken by Auriga include:

- Development of complex system network services, state-of-the-art network testing tools, remote access tools for embedded systems that were using our own optimized protocols.
- Development of the DHCP client for the embedded version of SCO OpenServer.
- Development of network interface device drivers. Our engineers created various network device drivers for SCO UnixWare, LynxOS, Linux, VxWorks, OSE, Windows NT 4.0, and Windows 2000.
- Development of CompactPCI, PCI, and VME backplane networking products. Apart from the need to create network interface device drivers that allowed using backplane buses transparently as an Ethernet network, our engineers had to create a number of complex protocols allowing to configure and manage backplane networks. Auriga's engineers actively participated in the work of the PICMG 2.14 subcommittee that recently defined a standard for communications in CompactPCI backplane networks.



Auriga's engineers are knowledgeable in internals of several networking stacks. This includes the BSD 4.4 TCP/IP stack, BSD-derived VxWorks network stack, and a commercial embedded STREAMS-based network stack. Also, Auriga's engineers participated in convergence of SCO UnixWare 2.1 and SCO OpenServer 5.0.5 network stacks into the SCO UnixWare 7 network stack. Deep understanding of operation of networking stacks allowed our engineers to perform complex tasks of tuning operation of device drivers and network protocols under several operating systems.

High Availability

Auriga took part in development of several products that allow achieving 99.999% or better uptime on CompactPCI platforms. For several years Auriga's development teams have been working on HA solutions based on Motorola Computer Group's CPX8216 and CPX8221 platforms. An interesting fact is that Auriga got a CPX8216 chassis in Moscow at an early point when the first 5 CPX8216 chassis ever produced by Motorola were shipped to its partners.

CompactPCI hot swap, HA chassis/slot control, and hot CompactPCI domain failover are the technologies that enable true high availability in CompactPCI based products. Auriga's engineers are experts in all these technologies.

- **Auriga's development team** created Pigeon Point Systems' Hot Swap Kit and the Hot Swap Controller Kit that support hot swap and chassis/slot control under Windows 2000, Windows XP, Linux x86, and Linux PowerPC.
- **Auriga's development team** created Pigeon Point System's Open MultiComputing Kit allowing for CompactPCI, PCI, and backplane communications between processor boards running different operating systems. The Open MultiComputing Kit supports the hot CompactPCI domain failover where the system control can be passed from the active host to the standby host without disrupting the operation of non-system slot processors and various system devices.
- **Auriga's development team** took part in development of a giant storage solution based on the CPX8216 chassis running LynxOS on PowerPC processor boards and using Fibre Channel for accessing disk arrays and for intra-system communications. The system operated in HA mode.