L3HARRIS™
FAST. FORWARD.

CANDU PLANT COMPUTER SYSTEMS

Evolving and Replacing CANDU Plant Computer Systems

L3Harris has been supplying CANDU plant computer systems—known as Digital Control Computer (DCC) systems — for nuclear power plants since 1970. In addition to keeping the DCC technology relevant for today's CANDU plants, L3Harris offers other CANDU plant I&C replacements and CANDU plant simulator overhauls.

Through cooperation with CANDU designer SNC-Lavalin, or directly with power generation utilities, L3Harris has been supplying CANDU plant computer systems - known as Digital Control Computer (DCC) systems – for nuclear power plants since 1970. DCC systems are used to monitor and control all the major reactor and power plant functions. In response to demand we have continued to upgrade the technology over the last five decades.

SYSTEM OVERVIEW

A typical system consists of two DCCs. DCC X and DCC Y are redundant on-line controllers, which control the nuclear reactor. Each controller uses a computer with a purpose-built process input/output (I/O) system and peripherals housed in cabinets, and utilize additional freestanding peripherals such as keyboards, printers and monitors. A contact scanner is used to scan relay contacts, limit switches, or other similar types of contacts. The scanner is connected to both DCC X and DCC Y, but communicates with only the annunciating DCC.

TECHNOLOGY BASIS

The DCC system architecture is centered on two technologies – the central processing unit (CPU) and the I/O system. The CPU technology has evolved from the initial Varian 70 family of microcomputers to the current Second Source Computers Inc. (SSCI) CPU, first the SSCI-125 generation and now the SSCI-890. The I/O system is based on the Datapath 50 data acquisition and the control system technology is designed and manufactured to monitor andcontrol CANDU reactor units. Every consideration has been taken into account throughout all stages of design and construction to ensure that the system operates with maximum efficiency and reliability.

L3Harris has provided DCC systems for CANDU nuclear power plants in Argentina, Canada, China, Italy, Korea and Romania. Since 2006, we have been working with the CANDU Owners Group (COG) to enhance the DCC technology and documentation to serve as a reference for future DCC projects. A current generation DCC system resides at L3Harris' main Montréal, Canada facility and is used to provide support to all participating COG members until 2035.

OUR CANDU CUSTOMERS

ARGENTINA

> Embalse

CANADA

> Bruce A
> Bruce B
> Candu Energy, a member of SNC-Lavalin Group
> CANDU Owners Group
> Darlington
> Gentilly-2
> Pickering A
> Pickering B
> Point Lepreau

CHINA

> Qinshan Phase III

KOREA

> Wolsong

ROMANIA

> Cernavodă

L3Harris.com

CPU PROGRESSION

The SSCI-890 computer features a single board CPU, a cache board and 2MB memory modules. The CPU and memory communicate over a special system connector plane that eliminates inter-connect cables. The SSCI-890 CPU includes mapped main memory. A map on the CPU board can perform efficient memory management for up to sixteen million bytes of main memory with full memory protection. The memory modules combine 2MB of metal-oxide semiconductor memory with error-correcting code on a single plug-in module.

Along with the SSCI-based CPU architecture, we have supplied and supported the PDP-11/70 DCC CPU architecture. This implementation, in service for more than 15 years at Ontario Power Generation's (OPG) Darlington Nuclear Generating Station, was the subject of an innovative L3Harris replacement through a fit, form, and function hardware emulation.

PERIPHERAL SYSTEMS AND INTERFACE CONTROLLERS UPDATES

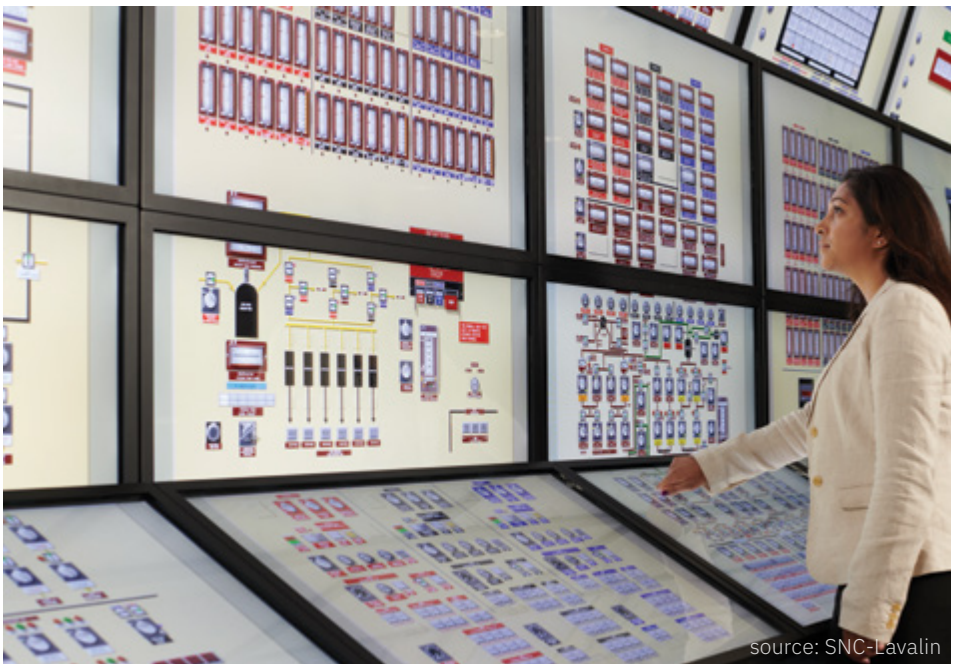
In addition to the continuous enhancement of CPU performance of the DCCs, we have updated and re-designed several peripheral equipment and interface controllers related to the data storage, printing, and the data acquisition interface with PCs. The new bulk storage memory unit increases the total memory size to 128MB and provides for an extended area of housing software applications and historical data storage buffers. The new technology of network printing – using fast laser printers – required an adaptation of printer controllers for alarm messaging and hardcopy functions.

Committed to continuous improvement of the DCC design, we have successfully emulated the functionality of the Main Control Room Display System with the use of its VME-based technology. This emulation solution has resulted in a complete replacement of Ramtek equipment while maintaining the same DCC software developed by utilities and used on the original display system hardware.

The same VME-based technology was the baseline of replacing the Contact Scanner equipment and presently this implementation is in operation in both units at the Qinshan Phase III Nuclear Power Project (Zhejiang, China) and on Unit 2 at the Cernavoda Nuclear Power Plant (Cernavoda, Romania).

LONG-TERM SUPPORT

Our goal is to ensure that COG and CANDU plant operators have a solid, reliable supplier on whom they can rely for their maintenance and support services. L3Harris has been supporting the DCC for nearly 50 years and is firmly committed to enhancing its support for the product line for the next 50 years.



source: SNC-Lavalin

L3HARRIS REFURBISHMENT ACTIVITIES FOR THE CANDU FLEET

DCC AND PERIPHERALS UPGRADES AND REPLACEMENT

- Full DCC system replacements
- SSCI-890 CPU and controllers upgrades and replacements
- DCC display system upgrades and replacements
- PDP-11/D CPU and display controller upgrades and replacements
- I/O system upgrades and replacements
- Contact scanner replacements
- DCC software development test bench
- Spare parts and services

OTHER CANDU PLANT I&C REPLACEMENTS

- Shutdown system trip computer replacements
- Display/test computer replacements
- Reactor regulating system logic module replacements
- Other I&C system reverse engineering replacements
- Spare parts and services

SIMULATOR OVERHAULS

- Platform upgrades
- Plant model modernizations
- DCC emulations
- Severe accident simulation
- Control room panels and instrumentation
- "Second" simulators
- I/O system replacements
- Spare parts and services

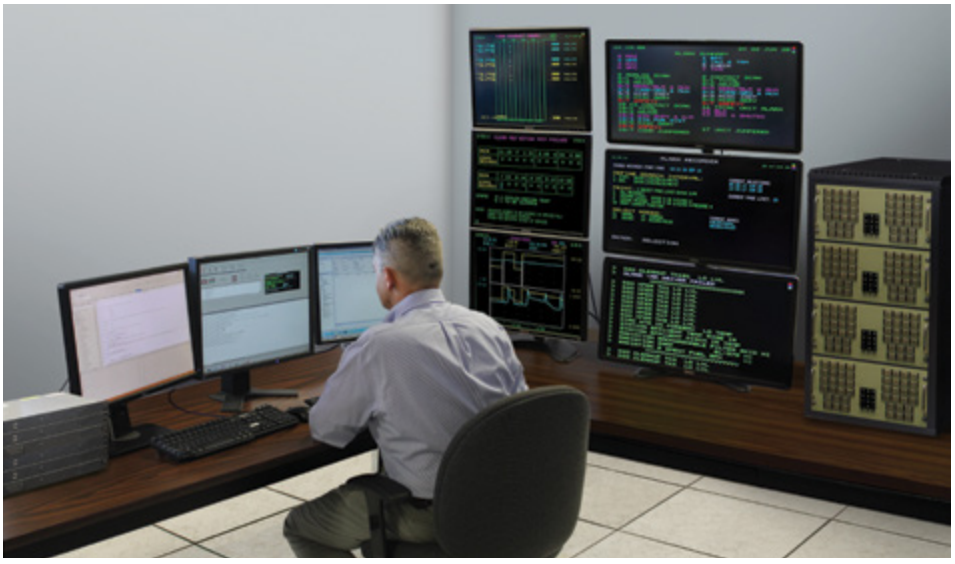
CASE STUDIES

DARLINGTON SDS2

In support of the Darlington refurbishment program and OPG's overall effort to design and develop a replacement for SDS2, L3Harris carried out the hardware design, integration and testing of prototype systems, including qualification testing, followed by the delivery of production units for the SDS2 trip computers and the SDS1 and SDS2 display/test computers.

BRUCE DCC TEST BENCH

L3Harris successfully designed and delivered an SSCI-890 test bench comprising a CPU that is identical to those in the plant computers. The test bench is connected to the plant's operator training simulator (or equivalent) to support development, testing and validation of new software programs for the plant DCC and DCC software changes.



BRUCE A & B DCC ALARM RECORDER

To enhance the plant process operator Supervisory Control & Data Acquisition system and to modernize the storage and searching capabilities of the extensive information provided by the DCCs at Bruce A & B, L3Harris designed and developed a new alarm recorder system, which collects, streams and transfers the process data and alarms generated during plant operation. The alarm recorder system benefits from a highly performant interface controller (PCI-based parallel data link controller designed by L3Harris) connected to the DCCs.

source: Ontario Power Generation

source: SNC-Lavalin

EC6 ENGINEERING SIMULATOR

L3Harris provided SNC-Lavalin with a full real-time simulation of a CANDU 6 plant operating on a PC/Windows platform powered by the industry-leading Orchid® simulation environment. The simulator is equipped with interactive soft panels representing the MCR and a dual DCC emulation. The interactive soft panels are enabled on multiple video display units to represent the Enhanced CANDU 6 (EC6) MCR. The emulated DCC is used as a baseline to iteratively change out control programs and logic with new PES control software modeled and verified in our Orchid® Modeling Environment. In addition, training and support were provided to ensure that all of SNC-Lavalin's objectives were met.

LEARN MORE

For more information on L3Harris' CANDU fleet refurbishment capabilities, visit L3Harris.com

CANDU Plant Computer Systems

L3HARRIS™
FAST. FORWARD.

8565 Côte-de-Liesse
Montréal, Québec, Canada H4T 1G5
t +1 514 787 4999 | f +1 514 788 1442
power.mapps@L3Harris.com