The first CANDU* reactor (Pickering A, Unit 1), began commercial operation in 1971 at Ontario Hydro’s Pickering A reactor site, just east of Toronto. In 1973, the Pickering A Nuclear Generating Station equipped with four CANDU reactors, produced more electricity than any nuclear power station in the world at that time.

Through cooperation with CANDU designer Atomic Energy of Canada Ltd. (AECL) and/or Candu Energy, or directly with power generation utilities, L-3 MAPPS 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, L-3 MAPPS has continued to upgrade the technology over the last three decades.

L-3 MAPPS has sold DCC systems for CANDU nuclear power plants in Argentina, Canada, China, Italy, Korea and Romania. Since 2006, L-3 MAPPS has 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 L-3 MAPPS’ main Montreal, Canada facility and is used to provide support to all participating COG members for up to 30 years.

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 purpose-built process I/O interface 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 input/output (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 control system technology is designed and manufactured to monitor and control 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.

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 (MOS) memory with error-correcting code (ECC) on a single plug-in module. Along with the SSCI-based CPU architecture, L-3 MAPPS has supplied and supported the PDP-11/70 DCC CPU architecture. This implementation, in service for fifteen years at Ontario Power Generation’s Darlington Nuclear Generating Station, is presently the subject of an innovative L-3 MAPPS 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, L-3 MAPPS has 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, L-3 MAPPS has 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

L-3 MAPPS’ goal is to ensure that COG has a solid, reliable supplier on whom it can rely for its maintenance and support services. L-3 MAPPS has been supporting the DCC for more than 30 years and L-3 MAPPS is firmly committed to not only continue, but to enhance its support for the product line for the next 30 years.

L-3 MAPPS has been supplying CANDU plant computer systems hardware (known as Digital Control Computer (DCC) systems) for nuclear power plants since 1970. DCC systems are used to monitor and control all major reactor and power plant functions. In response to demand, L-3 MAPPS has continued to upgrade the technology over the last four decades.

Plant units making use of L-3 MAPPS DCC systems follow.

ARGENTINA
Embalse

CANADA
Bruce A Unit 1
Bruce A Unit 2
Bruce A Unit 3
Bruce A Unit 4
Bruce B Unit 5
Bruce B Unit 6
Bruce B Unit 7
Bruce B Unit 8
CANDU Owners Group
Darlington Unit 1
Darlington Unit 2
Darlington Unit 3
Darlington Unit 4
Gentily-2
Pickering B Unit 5
Pickering B Unit 6
Pickering B Unit 7
Pickering B Unit 8
Point Lepreau

KOREA
Wolsong Unit 1
Wolsong Unit 2
Wolsong Unit 3
Wolsong Unit 4

ROMANIA
Cernavoda Unit 1
Cernavoda Unit 2

CHINA
Qinshan Phase III Unit 1
Qinshan Phase III Unit 2

* CANDU is a registered trademark of Atomic Energy of Canada Limited, exclusively licensed to Candu Energy Inc. CANDU is an acronym for CANada Deuterium Uranium, designed by AECL. The CANDU system is a design that uses deuterium oxide (heavy water) as the moderator and coolant, and natural uranium as fuel.