Canadian Patrol Frigate (CPF)

By Dennis Abbott.

In early 1981, the Saint John Shipbuilding and Dry Dock Co. Ltd. of Saint John, New Brunswick team submitted a Contract Definition (CD) phase proposal defining their approach to meet the requirements for the Canadian Patrol Frigate (CPF) program. From the five proposals submitted, the Saint John Shipbuilding and SCAN Marine (a Pratt-Whitney Canadian subsidiary) teams were selected to prepare and submit detailed proposals for the design, development and delivery of the six new ships. In deciding to proceed with the CPF Project, the government was determined to maximize the economic benefits to Canadian industry and to enhance the Canadian high technology electronic capability. To accomplish this objective, the government required that all six ships would be built in Canada and the contract industrial benefits requirement would be 100%. In response to the government's emphasis on the CPF Project being a Canadian Program, the Sperry Corporation, as the Saint John's team principal subcontractor for the design, development and delivery of the combat system suite, proposed to establish Paramax as a new Canadian company and commit to have it become a Canadian controlled company by the end of the contract. Permanent facilities would be established in Montreal which would include a Combat System Test, Integration and Maintenance Facility. Defense Systems in Eagan, as primary software, Data Processing and SHINPADS© hardware provider, already had established the Defense Systems Canada manufacturing facility in Winnipeg, Manitoba to build CPF hardware, proposed to expand Defense Systems Canada by establishing a significant software development capability in Montreal.

During the 15 month Contract Definition Phase, a very talented Defense System's design team succeeded in developing an advanced distributed combat system architecture which provided maximum redundancy utilizing the AN/UYC-501 SHINPADS Serial Data Bus (SDB). Four data lines were run the length of the hull with Bus Access Modules (BAMs) tying into all four lines, of which only two are used at one time. Command and Control (C&C) functionally was distributed among five AN/UYK-505 and thirty AN/UYK-502 computers including one tied to each UYQ-501 Standard Display (developed by CDC Canada). Two UYK-502's were dedicated to the File Manger (FM) function which managed/monitored memory resources, provided for downloading the C&C and some subsystem software over the data bus, as well as providing the system control, status monitoring and testing function which was aided by a comprehensive data extraction and on line reduction capability. Duplicate peripherals and access to both UYH-3 Disks by each FM processor provided complete redundancy. The system design also provided improved system reliability through advancements in automated Error Detection and Recovery functionality. An automated memory test was run prior to system load and the software was automatically loaded around any bad memory detected. The system Health Monitoring and Maintenance Test functions provided for automatic logging of error data, reconfiguration of the system around errors/casualties, and on line diagnostics and test at the system, box or interface level with isolation down to the Lowest Replaceable Unit (LRU). Diagnostic testing could be performed in the background (confidence tests), or on line by reconfiguring around the asset under test. On line test provided the ability to do routine maintenance/repair of system equipment while still running the Operational Program

The Eagan Defense Systems CD Phase team assisted Sperry Systems Management (SSM) in the selection of subsystems and equipment required to meet the CPF Combat System requirements, and drove the corresponding data processing architecture and interconnect definition. This included providing the operational software and subsystem interface requirements, man machine concept definition and the Combat System Test and Support Facility (CSTSF) software requirements. The key element of the CSTSF was the definition of the Simulation system which was required to support software test, certification, software maintenance, combat system integration, and operator and crew training. This included a total integrated combat system wrap around simulation capability, which was necessary to create a realistic physical environment to accomplish total system integration, including testing of the entire combat system under extreme operational conditions prior to installation aboard ship.

In August 1983, the Canadian government announced that the Saint John team won the total ship procurement contract for the development and delivery of six new frigates. Defense Systems received approximately $150M for the hardware production and software development which represented the largest system/software development contract ever received by Defense Systems. The contract represented the development of over 1,000,000 source lines of code (SLOC) including Executive, Command and Control, Simulation, Training, Test, Data Extraction/Reduction and Program Generation software. The challenge represented by the shear size of this software development was compounded by splitting this effort equally between two locations in two different countries. Approximately fifty percent of the Command and Control Operational, Test, and Simulation/Training software allocated to Eagan were to be developed and integrated simultaneously with a similar number of SLOCs of each category of software developed in Montreal.

The CPF Program presented both a technical and management challenge to the CPF Project team. Although the system loader, multiprocessing, on line testing, dynamic modular replacement, causality recovery and system control/reconfiguration technologies had been developed/proven on the DLGN-38/DD-993 Programs, the CPF was the first to implement a distributed combat system architecture. However, since the SDB ongoing testing had continued to produce positive results and the experienced SDB development personnel were available to the CFF Project, the technical risk of implementing a distributed architecture was overshadowed by the risk associated with such a large software development split between two sites.

The CPF Project benefited from a management team and a significant number of technical personnel with previous experience on one or more large system/software developments (DLGN-38, DD-993, F-122, SSN, etc.), which gave them an appreciation for the challenges of a development of this magnitude. From day one the CPF Project team believed the key to mitigating this risk was to implement a more advance automated development process. Automation began with the detailed project planning and continued through all phases of the development which greatly assisted in the coordination and timely exchange of data between development sites, configuration management and control, as well as overall project management. Automation of the software development started with requirements allocation/traceability and proceeded through documentation development, software generation, software testing including static procedure level testing, system generation and build control.

Integrated data collection and monitoring capabilities also provided faster and more accurate project development status.

In addition to automation solid project planning, which addressed the work split between Eagan and Montreal, was critical to program success. With the experienced personnel base in Eagan, the front end detailed planning and major requirements phase tasks were allocated to the Eagan team. This provided the time required to hire and train the staff in Montreal prior to the software design phase. Requirements tasks included updating the System Requirements Document (SRD) and the associated Requirements Traceability Matrix, and the allocation of those requirements to the appropriate subsystem(s). The requirements allocated to software were decomposed into more detailed requirements and described/documented in the Software Requirements Specification (SRS). The contract also called out the development and delivery of the System Operators Manual (SOM) during the requirements phase. This included the definition and layout of operator actions and readouts for all operator positions. Although the Montreal personnel did provide some assistance in the SRS and SOM development, in order to maintain the equal work split, Montreal was allocated the primary role for software certification and combat system integration at the LBTS as well as aboard ship. The software development work split began with the detail design and the generation of the Software Design Documents (SDD). Approximately half of each category of software (Command and Control, Test, and Simulation/Training) was allocated to Eagan and half to Montreal. The time critical basic operating system functionality (Executive, Bus Handlers, File Manager, System Control/Monitoring, Display, etc.) for both the Command and Control and Simulation/Training Programs was developed in Eagan where personnel with the applicable experience were available, including the SDB developers. This provided an operational platform to which functionality could be added and tested in the lab early in the program. Major functionality allocated to Montreal included Anti Submarine Warfare, Electronic Warfare, Operator Training, Crew Training and Data Extraction/Reduction.

During the initial months of the contract, efforts began to identify the Defense System's Management team required to relocate to Montreal to establish the Defense Systems Canada office and initiate the hiring and training of the Canadian staff. This included hiring a large number of software development and test personnel, as well as Configuration Management, Data Management, Contracts, Quality Assurance and other office support staff, which peaked at over 200 people during the development phase. During this same period of time, SSM established a presence in Montreal and began building the Paramax organization and planning for the construction of the Paramax facility. Although SSM was not hiring a significant number of software development personnel, we were competing for many of the same people in other disciplines, including Systems, Test, Configuration Management, Data Management, Contracts, and office personnel. The Montreal team did an excellent job of selecting and training quality personnel enabling the software design effort to start as scheduled.

To ensure a compatible design and product consistency in the development of the software and associated documentation, detailed processes, procedures and guidelines were provided prior to each development phase. This included a sample Software Requirements Specification (SRS), Software Design Document (SDD), Test Plan and Test Procedure that defined the paragraph numbering, structure and content for each document. Detailed code generation guidelines addressed such items as procedure and module size/structure, naming conventions, data store

structure, naming and label conventions and I/O handling. These practices/guidelines were closely monitored with results documented and tracked through the peer review and walk through process. The consistency obtained by strictly following this development process not only helped in integrating code exchanged between sites during development, but most importantly it provided a consistent foundation for ease of future software maintenance.

To support the code generation, test and integration phase, a dedicated 1100 based program generation center was staged at both the Eagan and Montreal facilities. A Software Integration and Test lab was also built in Eagan, utilizing diverted ship set equipment, to support software development through verification testing. Montreal software integration and test was accomplished at the Paramax LBTS. This impressive facility, when built, was the largest shield in North America with room to stage all Combat System equipment, the Program Generation/Maintenance Center and a Simulation System that provided for training and total combat system integration. Bridge and Combat Information Center mockups were built one and one half actual size to support crew training. Each ship set of equipment was staged and tested at the LBTS prior to installation aboard ship. At the completion of the program the shield was disassembled and moved to the Canadian Military Maintenance Facility in Halifax Nova Scotia.

The software debug and integration phase was the largest Configuration Management (CM) challenge of the project. With such a large amount of software being developed, debugged and integrated simultaneously at both sites, it was critical to maintain positive control, without burdening the software developers, to ensure an orderly progression in expanding the Operational and Simulation Software capability. The solid System Generation and Configuration Management processes and controls implemented were effective in accomplishing this objective. Software testing began at the procedure level, or groups of procedures, in a static environment with the results documented and tracked. As software completed procedure level testing, the new functionality was added to a developmental build where the software developer tested/debugged the new functionality on the target equipment. In this environment, the software developers would identify problems, make source corrections and generate an updated disk. With the dedicated automated system generation capability, this process was accomplished in minutes rather hours which eliminated all software patching. Once the new functionality passed developmental build tests, the functionality was added to the configuration managed build at the local site. Automated scenario testing was then conducted on the new CM System Build to validate that previous functionality was not impacted. This was followed by the validation of the new/modified capabilities which, when successfully completed, were provided to the other site. Unclassified data exchanges were accomplished via electronic transfers. To facilitate the transfer of classified data/source code in a timely manner, regular carrier service was established though the Canadian Forces. During the critical test phase many of these transfers were accomplished within a 24 hour period. In addition, parallel efforts in support of the software debug and integration phase included CPU loading, modeling, and the development of the System Build Interdependency Network, which was incorporated into the CPF Integrated Master Plan.

As the functionality of the Operational and Simulation CM Builds expanded, the test personnel initiated the validation of the test procedures on the target configuration in both Eagan and Montreal. The software testers worked independently, as well as with the software developers during the initial software integration phase, and documented all suspected software problems

encountered on Program Trouble Reports (PTR). All updates to the CM Build required a documented problem report which included the retest procedure. The verification test phase consisted of two complete passes through the test procedures, with test step pass/fail and High, Medium and Low PTR entrance and exit criteria. Four years after contract award the formal Defense Systems verification/certification was successfully completed in the fall of 1987, meeting the contract PTR acceptance criteria of 0 Highs, 25 Mediums and 50 Lows.

With the successful completion of the formal verification/certification testing and documentation updates, the planned transition of primary responsibility to the Defense Systems Montreal organization was near completion, and Eagan's involvement was reduced to a support role including on-site support as required. However, during this period Unisys management, as part of the company realignment process following the merger, made a decision to close the Defense Systems Montreal facility and merge the personnel into the Paramax organization. In this process Paramax assumed the remaining Defense Systems Montreal responsibilities and associated dollars which were primarily for supporting combat system integration at the LBTS and aboard ship. Defense Systems Eagan's support role remained unchanged except for placing the CPF Project Engineering Manager on site to help smooth the transition process, coordinate Eagan resource requirements, and to assist Paramax in planning/preparing for a software recertification per an agreement with Saint John Shipbuilding and the customer.

CPF was an extremely successful program for Defense Systems. This success is directly attributed to a dedicated and talented team that met the challenge of a multiple site development of the largest software development contract ever received by Defense Systems. The CPF Project team recognized the importance of solid planning, automated tools, detail processes/procedures and associated controls for a development of this magnitude. In spite of the normal pressures to expedite the debug/test process, the software development team believed in and embraced the system generation and configuration processes and controls that were instrumental in the success of the CPF Program.

Dennis Abbott worked at Sperry Univac/Unisys from February 1965 to September 2000. From early 1980 to August 1983, as Manger of the International Systems Development Group, he participated in the CPF Program acquisition process through contract award. From August 1983 to November 1987 he was the Project Manager responsible for Eagan CPF Engineering activities. From December 1987 to April 1989 he was the Defense Systems site manger at Paramax in Montreal, Canada and functioned as the Software Engineering Director within the Paramax organization. A more complete career history on the Peoples section is pending

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